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State and Trends of Carbon Pricing 2023

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List of Abbreviations

ACCU	Australian Carbon Credit Units
BC	British Columbia
BCA	Border carbon adjustment
CAD	Canadian dollar
CAD Trust	Climate Action Data Trust
CARB	California Air Resources Board
CBAM	Carbon border adjustment mechanism
CCDR	Country Change and Development Report
CCM	Cost containment mechanism
CCR	Cost containment reserve
CCPs	Core Carbon Principles
CDM	Clean Development Mechanism
CER	Certified emission reduction
CHF	Swiss franc
CNY	Chinese yuan
CO_2	Carbon dioxide
COP	Conference of the Parties
COP21	2015 United Nations Climate Change Conference (21st Conference of the Parties)
COP26	2021 United Nations Climate Change Conference (26th Conference of the Parties)
COP27	2022 United Nations Climate Change Conference (27th Conference of the Parties)
COP28	2023 United Nations Climate Change Conference (28th Conference of the Parties)
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DKK	Danish krone
EDGAR	Emissions Database for Global Atmospheric Research
EEB	Ecology and Environment Bureau (China)
ETF	Exchange-traded fund
ETS	Emissions trading system
EU	European Union
EUR	Euro
G7	Group of Seven
GDP	Gross domestic product
GHG	Greenhouse gas
ICAO	International Civil Aviation Organization
ICAP	International Carbon Action Partnership
ICP	Internal carbon price
ICVCM	Integrity Council for the Voluntary Carbon Market
IEA	International Energy Agency
IETA	International Emissions Trading Association
IMF	International Monetary Fund
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
ITMO	Internationally transferred mitigation outcome
JCM	Joint Crediting Mechanism
LNG	Liquefied natural gas
MEMR	Ministry of Energy and Mineral Resources (Indonesia)
MoU	Memorandum of understanding
$MtCO_2$	Million metric tons of carbon dioxide
MRV	Monitoring, reporting, and verification
MXN	Mexican peso
NDC	Nationally determined contribution
NECR	Net Effective Carbon Rates
NGFS	Network of Central Banks and Supervisors Greening the Financial System
NOK	Norwegian krone
OBPS	Output-based pricing system (Canada)
OECD	Organisation for Economic Co-operation and Development
OTC	Over-the-counter
PAT	Perform, Achieve, and Trade Scheme (India)
PMI	Partnership for Market Implementation
PSS	Performance standards system (Canada)
PVC	Plan Vivo certificate
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RGGI	Regional Greenhouse Gas Initiative
SDG	Sustainable Development Goal
SEMARNAT	Ministry of Environment and Natural Resources (Mexico)
SGD	Singapore dollar
tCO_2	Metric tons of carbon dioxide
tCO_2e	Metric tons of carbon dioxide equivalent
TIER	Technology Innovations and Emissions Reduction (Canada)
UMA	Unit of Measurement and Update (Mexico)
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States dollar
UYU	Uruguayan peso
VAT	Value-added tax
VCMI	Voluntary Carbon Markets Integrity Initiative
VCS	Verified Carbon Standard

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Foreword

Carbon markets and mechanisms have steadily evolved since the first State and Trends report was published 10 years ago. The share of global emissions covered by carbon taxes and emissions trading systems (ETSs) has grown from 7% to around 23%. Jurisdictions continue to introduce new carbon pricing instruments, such as Indonesia's ETS this year, and cover new emission sources, such as aviation. Government revenues from carbon taxes and ETSs have grown nearly fivefold as policies have evolved and diversified to reflect increased ambition. And voluntary action around carbon markets has proliferated as corporations have become the biggest source of demand for carbon credits.

Over the decade, the State and Trends report and the Carbon Pricing Dashboard have provided objective and up-to-date information on direct carbon pricing. They have guided policymakers, supported academic and analytical work, and informed the private sector and nongovernmental organizations alike. This year's report shows that governments are prioritizing direct carbon pricing policies to reduce emissions, even in difficult economic times. The economic turmoil and geopolitical instability of this past year threatened to divert attention from the pressing need to act on climate. Despite these pressures, ETSs and carbon taxes have proven resilient; several jurisdictions either delivered on existing plans for new ETSs or taxes, increased their ambition, or announced further proposals for developing new initiatives in the coming years. Recent developments on Article 6 suggest a pathway for international carbon markets, though more work is needed to build the administrative capacity for countries to engage further.

Governments, the private sector, and others are thinking about carbon markets and pricing in increasingly sophisticated ways. Direct carbon pricing is being viewed through a broader lens, not only as a key mitigation policy but also as a tool to raise revenue, drive innovation, and help deliver on broader sustainability and development goals. The World Bank's pioneering new diagnostic, the Country Climate and Development Report (CCDR), has emphasized the potential for direct carbon pricing policies to support countries on their development journeys.

There is still a long path ahead even as the need for more progress intensifies. Climate-related natural disasters in 2022 cost lives, caused billions of dollars of damage, and displaced millions, particularly in the developing world. The Intergovernmental Panel on Climate Change's Sixth Assessment Report laid bare the increasingly dangerous and irreversible risks of failing to act. But the report also offered hope that we can still prevent the worst effects if we act now to transition to a low-carbon future.

Introducing a price signal for climate mitigation is critical to driving investment and behavior change to lower emissions. Carbon pricing must continue to grow, both in terms of coverage and price, to drive the transformational change needed to meet the Paris temperature goals. However, governments need to consider trade-offs when deciding which carbon pricing approach to use: ETSs, carbon taxes and carbon crediting, and international carbon markets each have their place. The World Bank is supporting many countries to engage with the full range of carbon pricing policies—including through the Partnership for Market Implementation (PMI) program, which provides technical assistance for domestic carbon pricing and operationalizing Article 6 of the Paris Agreement.

State and Trends takes stock of progress and reiterates the World Bank's commitment to work with governments and stakeholders to put a price on carbon to accelerate climate action.

Jennifer Sara,
Climate Change Global Director, World Bank Group

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Executive Summary

THE PAST YEAR HAS SEEN GOVERNMENTS FACE CHALLENGES ON SEVERAL FRONTS

- Facing a global energy crisis and high inflation, many countries responded with relief measures: lowering energy prices for businesses and households through changes to energy taxes, fossil fuel subsidies, or price controls, or by making direct payments.
- These measures saw already high levels of government debt continue to climb.
- Despite these challenges, there was continued momentum for climate action. Several high-emitting countries strengthened domestic climate policies and targets, though global efforts still fall short of what is required.
- In this context, the political economy of carbon pricing has become even more complex.

ETSs AND CARBON TAXES HAVE WEATHERED THE 2022 GLOBAL ENERGY CRISIS RELATIVELY WELL

- Prices increased in half of ETSs or carbon taxes, although in real terms surging inflation will have offset some of the increase.
- There were only a few instances where governments wound back ETSs or carbon taxes in response to the energy crisis by delaying the start of a new instrument, postponing a planned expansion or price increase, or in one case repealing a carbon tax.
- With several new instruments launched and some scope expansions, the number of implemented instruments increased to 73 with the share of global GHG emissions covered around 23%.

RECORD HIGH REVENUES FROM ETSs AND CARBON TAXES APPROACHED USD 100 BILLION

- Governments continue to face trade-offs between different objectives, such as increasing revenue, promoting community acceptance, and managing international competitiveness.
- Revenues from ETSs and carbon taxes are often used for specific purposes—almost 40% of the revenue is earmarked for green spending, and 10% is used to compensate households or businesses. Both are seen as ways to increase support for these policies.
- The revenue potential of ETSs and carbon taxes has become more relevant in light of increasing pressures on public budgets.

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Executive Summary

UPTAKE OF ETSs AND CARBON TAXES ARE RISING IN EMERGING ECONOMIES; HIGH-INCOME COUNTRIES STILL DOMINATE

- Most existing instruments are in high-income countries in North America and Europe, at either the national, subnational, or regional level. High-income jurisdictions account for the highest carbon prices.
- There is only one instrument in the Middle East and Africa region. However, several African countries are exploring options and taking preparatory steps.
- Interest from emerging economies is driven by the need for climate change mitigation policy but also managing transition risks, exploring revenue opportunities, and preparing for European Union accession.

CARBON CREDIT MARKETS EXPERIENCED A SLOWDOWN AFTER YEARS OF RAPID GROWTH

- Both issuances and retirements of carbon credits fell slightly compared to 2021, although they remain significantly above levels in preceding years.
- Voluntary demand from companies remains the primary driver of market activity, but compliance demand could become more important.
- Prices and price trends varied: prices for exchange-traded credits declined across all categories, especially those from nature-based projects, while some participants have seen prices increase in over-the-counter transactions.
- Macroeconomic conditions, prominent critiques of carbon credits and offsetting, and bottlenecks in issuance are among the apparent causes of dynamics over the past year.

CARBON CREDIT MARKETS CONTINUE TO DIVERSIFY AND BECOME MORE SOPHISTICATED

- New investors, financial products, technological platforms, and service providers are laying the foundations for what some expect will be a decade of significant growth.
- Different initiatives seek to promote standardization and improve transparency in carbon credit markets—seeking to encourage market growth and integrity of corporate action.
- Implementation of Article 6 is moving forward as more countries sign bilateral cooperation agreements and the first activities to generate authorized emissions reductions are developed.

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Chapter 1

Introduction

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BOX 1
DEFINITIONS: CARBON PRICING POLICIES

This report focuses on direct carbon pricing instruments—those that provide a clear price signal with the aim of reducing GHG emissions. These include ETSs, carbon taxes, and carbon crediting. An ETS limits emissions from covered entities by issuing tradable emission units that entities can use to meet their compliance obligations. ETSs can be designed in different ways: the most common are cap-and-trade ETSs that set an overall limit for emissions from covered entities and rate-based systems where total emissions are not capped but individual entities are allocated a performance benchmark that serves as a limit on their net emissions. A carbon tax imposes a fee on the emissions produced (or the emissions embodied in an amount of fuel). A carbon crediting mechanism generates tradable certificates representing emission reductions.

Indirect carbon pricing refers to other policies that change the price of products associated with GHG emissions in ways that are not directly proportional to the relative emissions associated with those products. These instruments (such as fuel excise taxes) provide a carbon price signal, even though they are not usually implemented to achieve climate outcomes. While **Box 3** provides some further information on recent trends in indirect carbon pricing, these policies are not included in the core analysis and text of this report.

Further information on definitions can be found in Annex A.

The global energy crisis posed significant challenges for energy markets and the world economy in 2022. Governments have responded with measures to shield consumers from price hikes, adding to fiscal pressures accumulated during the pandemic. In this context, the political economy of implementing direct carbon pricing policies has become more complex. On the one hand, the increasing urgency of addressing the climate crisis, the benefits of diversifying energy supplies, and the need to shore up government revenues have provided an even stronger rationale for introducing new and strengthening existing carbon pricing policies. On the other hand, pressure on governments to consider any measures to reduce prices in the short term has been working against emissions trading systems (ETSs) and carbon taxes. This report provides an update on developments in existing and planned direct carbon pricing policies (e.g., ETSs, carbon taxes, and crediting mechanisms) over the past year, revealing how these contextual factors have affected prices, uptake, reform, and plans for these policies.

Direct carbon pricing policies are touted as an efficient and effective climate mitigation policy, but their uptake and impact depend on many factors (see Box 1 for definitions). A carbon price provides an economic signal, allowing markets (instead of governments) to determine where emissions can be reduced for the lowest cost. In considering these policies, governments weigh the political economy implications of the different options, in particular how they will affect consumers (particularly through energy prices), how they will affect government revenue, and the urgency of reducing emissions.[i] Governments also consider the broader policy landscape—how direct and indirect carbon pricing interact—as well as the appetite for alternative climate change mitigation policy approaches. Broader developments including economic growth and trends in energy markets, voter preferences, and the state of public finances all shape how and whether direct carbon pricing instruments are considered, adopted, reformed, or perhaps in some cases repealed. Further, for ETSs, where the carbon price emerges as a function of the supply and demand for allowances, these broader factors can directly and indirectly affect prices day by day. Against this backdrop, this report provides a brief overview of the key trends shaping direct carbon pricing policies over the past year, before detailing the observed changes in these policies over the same period.[1]

The year 2022 was marked by a global energy crisis that contributed to high inflation and a cost-of-living crisis in many parts of the world. The quick economic rebound from the COVID-19 pandemic had already started to drive up energy

(i) For further reading on the political economy of carbon pricing see, e.g., G. Dolphin, M.G. Pollitt, and D.M. Newbery, "The Political Economy of Carbon Pricing: A Panel Analysis," *Oxford Economic Papers* 72, no. 2 (April 2020): 472–500; World Bank Group, "The FASTER Principles for Successful Carbon Pricing: An Approach Based on Initial Experience," 2017; D. Victor, E. Toder, R. Repetto, J. Bordoff, J. Stock, and M. Mildenberger, "The Political Economy of Carbon Pricing: Presentations and Discussion," presented at Global Harmonized Carbon Pricing: Looking Beyond Paris, Yale Center for the Study of Globalization International Conference, May 27–28, 2015.

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"The developing world now faces a record amount of debt, amounting to nearly USD 100 trillion in early 2023."

demand and prices in 2021. Russia's invasion of Ukraine greatly amplified this effect, pushing up fossil fuel prices even farther and to unprecedented heights. Combined with supply chain disruptions in the aftermath of the pandemic, the energy crisis drove up global inflation to its highest level in 30 years, triggering tighter monetary policy in most countries. As a consequence, global economic growth slowed in 2022 and is expected to decline even more sharply by 1.7% to 2.9% in 2023, significantly below the historical average over the past two decades.[2] High levels of inflation, caused by higher prices not just for energy but also food and housing, have led to a cost-of-living crisis affecting particularly developing countries and those with low incomes.[3]

As countries suffered from record-high fossil fuel prices, governments responded by prioritizing relief measures for households and businesses. The concerns over poverty, especially energy poverty, were felt worldwide. In the developing world, the energy price spikes threatened to roll back progress on universal access to electricity, and the International Energy Agency (IEA) warned that "almost 100 million people may be pushed back into reliance on firewood for cooking instead of cleaner, healthier solutions."[4] In response, many countries provided temporary energy price relief for consumers. Most European countries have temporarily lowered value-added tax (VAT) on fuels and other energy taxes, regulated the retail price of fuels, or provided direct assistance to fuel consumers.[5] Other nations, including Australia, Mexico, and South Africa, temporarily suspended or reduced federal fuel excise taxes or delayed planned increases.[6] Some policies were targeted toward those most vulnerable to high prices; the Republic of Korea, for example, provided vouchers for energy expenses to around 1.2 million low-income households.[7]

The combination of the economic turmoil in 2022 and the pandemic hangover has left many governments facing fiscal pressures. Having spent heavily in response to the COVID-19 pandemic (with amounts exceeding 5% or even 10% of gross domestic product (GDP) in most industrialized and many emerging economies), relief measures to address the energy crisis have put an additional dent in national budgets over the past year.[8] According to the IEA, fossil fuel subsidies hit an all-time high in 2022, rising beyond USD 1 trillion, and doubling compared to their 2021 levels.[9] As a result, the developing world now faces a record amount of debt, amounting to nearly USD 100 trillion in early 2023.[10] At the same time tax revenue is declining in many places due to slow economic growth, and higher interest rates make servicing the debt more difficult. All this significantly constrains governments' room to maneuver.

Meanwhile, the urgency of tackling the climate crisis is as strong as ever. Extreme weather events hit most regions of the world in 2022. Large-scale flooding covered one-third of Pakistan's territory; extreme heat and drought affected parts of Europe, China, and India, breaking local temperature records by large margins; and the most severe drought on record hit the horn of Africa, putting 22 million people at risk of starvation.[11]

In terms of international climate policy, the 27th Conference of the Parties of the United Nations Framework Convention on Climate Change (COP27) made progress in some areas, but not others. The loss and damage fund, aimed at assisting vulnerable countries in managing the effects of climate disasters, saw advancement. Workstreams to operationalize Article 6 of the Paris Agreement also moved ahead, and delegates at COP28 in the United Arab Emirates will further address this process. The need for transparency and accountability in goal setting and reporting by nonstate actors received significant attention through the report of the High-Level Expert Group on Net Zero Emissions Commitments of Non-State Entities.[12] However, the summit fell short of expectations by failing to commit to the phasing out of fossil fuels and making only limited progress in discussions and pledges made on climate finance.

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Domestically, many nations forged ahead with climate action in 2022. Responding to the ever-increasing urgency of the climate crisis, but also driven by the rising price of fossil fuels, many countries around the world set new climate targets or progressed concrete policies to reduce emissions. Australia updating its nationally determined contribution (NDC) target and passing legislation on climate targets, Chile adopting a climate framework law and a net-zero commitment and policies to achieve it, and India updating its NDC target and committing to a net-zero target are just some examples. On the whole, 89 countries,[13] representing 86% of global emissions, had adopted net-zero commitments at the end of 2022, with target dates ranging from 2035 to 2060.[14] Many countries also adopted substantial market and regulatory incentives for the accelerated deployment of renewable electricity generation capacity; electrification of end uses, for example with heat pumps and electric vehicles; investments in energy efficiency, electricity storage, and grid expansion; and support for the development of advanced low-carbon technologies such as green hydrogen. In many European countries ETSs and carbon tax policies remain central to climate policy, while other countries are focusing on more directly supporting green industries and jobs. For example, the Inflation Reduction Act in the United States constituted a hallmark achievement in 2022, including measures such as the introduction of a methane emissions charge; subsidies for electric vehicles; and increased tax credits for carbon capture, utilization, and storage.

Yet, overall, countries are still not on track to meet the goals of the Paris Agreement. Despite encouraging signs, the overall ambition of climate policies still falls severely short of what is required.[15] The latest United Nations Environment Programme emissions gap report makes clear that without imminent large-scale transformation of the global economy, the collective goal of limiting global temperature increase to 1.5°C will be out of reach.[16] Countries' new and updated NDCs are, if implemented, projected to result in global warming of 2.4°C–2.6°C.[17,ii] To get on track toward 1.5°C (without significant overshoot), the world must cut current emissions by 45% until 2030.[18] The solutions to achieve the necessary transformation are well known and the Intergovernmental Panel on Climate Change's Sixth Assessment Report concludes that there is sufficient finance in the global system to close the respective investment gaps, but more action is needed.[19]

In this context, the political economy of direct carbon pricing is becoming more complex. The steep rise in consumer prices, and in particular energy bills, turned up the pressure on policymakers to consider all options to reduce cost burdens in the short term—including in some cases calls for changes to carbon taxes and ETSs.[20] At the same time, the International Monetary Fund and others argued that the energy crisis underlined the importance of promoting energy independence and achieving energy security and that adequate carbon pricing can support these goals by incentivizing the deployment of domestic renewables and energy-saving measures.[21] Targeted revenue recycling and incentives for low-carbon investment have been used to improve access to low-carbon alternatives, promote development projects, and reduce the cost of living for the poor. Various studies have suggested that direct carbon pricing can support economic development objectives and does not necessarily reduce economic growth or employment.[22] The need to develop cost-efficient strategies for NDC implementation and the demonstrated effectiveness of carbon pricing at reducing emissions increase momentum for direct carbon pricing and make it a central element for many countries' plans to deliver on the Paris goals.

"The latest United Nations Environment Programme emissions gap report makes clear that without imminent large-scale transformation of the global economy, the collective goal of limiting global temperature increase to 1.5°C will be out of reach."

(ii) The International Energy Agency expects a temperature rise of 1.7°C by 2100, under the scenario that current climate pledges and additional national and sectoral commitments to climate are achieved in full. For further reading see, International Energy Agency, "World Economic Outlook 2022," November 2022.

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"The prevalence and magnitude of indirect carbon pricing policies still dwarf the impact of direct carbon pricing."

State and Trends of Carbon Pricing 2023 provides a comprehensive overview of the developments in direct carbon pricing during 2022 and into 2023. The report covers ETSs, carbon taxes, and carbon crediting mechanisms, each of which provides a clear monetary incentive directly linked to the associated volume of emissions (see **Box 1** for short definitions of these instruments). This annual update is intended to serve as a factual and timely reference for anyone interested in these policies. It provides information on observable metrics, such as prices, coverage, and revenues, and how these have changed, particularly over the past year. The report is not intended to critically assess particular approaches or design features, but rather to provide insights on the observed changes and their drivers and to summarize how governments and others have responded to the changing political and economic landscapes.

While it is not the main focus, the report also recognizes that these policies exist in the context of a broader carbon price signal that includes indirect carbon prices like fuel excise taxes and fossil fuel subsidies (see Box 3). This is particularly relevant in a year where the energy crisis prompted governments to consider all avenues to support consumers. The prevalence and magnitude of indirect carbon pricing policies still dwarf the impact of direct carbon pricing: fossil fuel excise taxes and subsidies are worth over USD 1 trillion each year.[23] Despite the growth in direct carbon pricing over the past years, this is still significantly larger than ETSs and carbon taxes, which raised almost USD 100 billion in revenues in 2022, and the voluntary carbon market, with a total annual value in the order of USD 2 billion.[24]

Chapters 2 and 3 analyze key trends and developments in carbon markets and pricing globally over the last year, focusing on carbon taxes and ETSs in chapter 2 and carbon crediting mechanisms in chapter 3. Chapter 4 concludes. Annexes A–D provide key definitions and further information on the latest developments for individual initiatives. For more detailed information on all carbon taxes, ETSs, and carbon crediting mechanisms, please refer to the Carbon Pricing Dashboard (https://carbonpricingdashboard.worldbank.org/).

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Chapter 2

Carbon Taxes and Emissions Trading Systems

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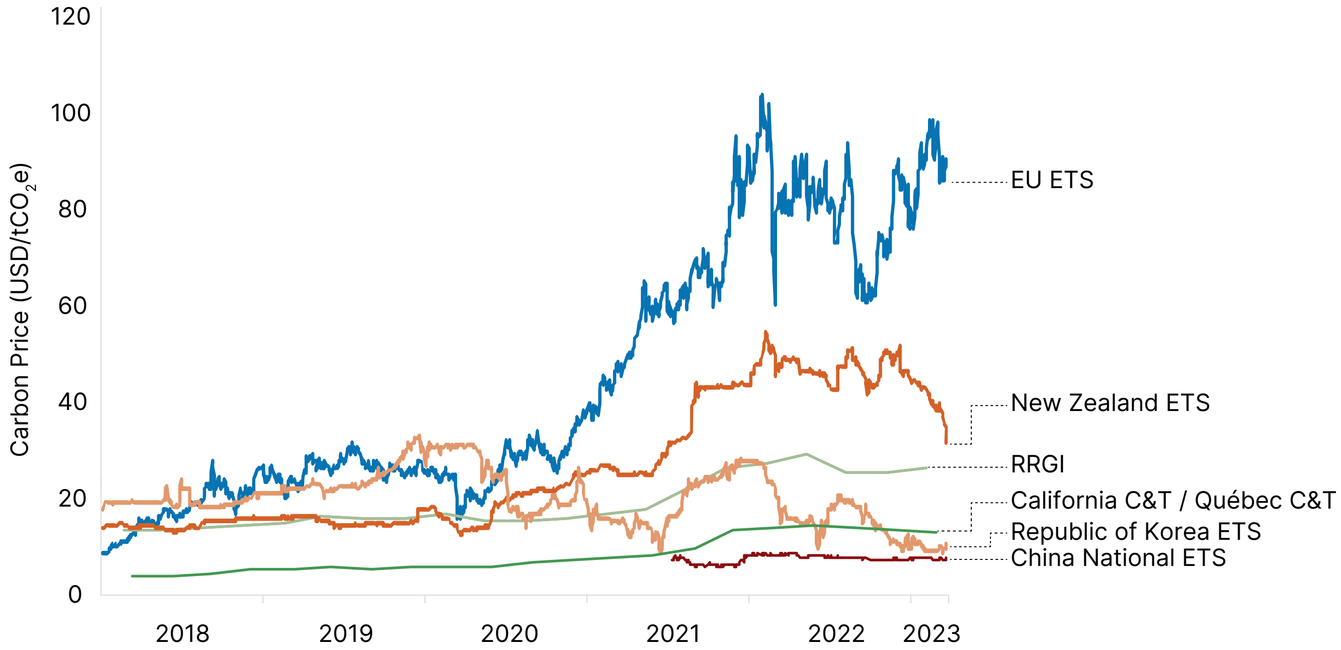
Energy prices and the cost-of-living crisis were major factors driving price trends and influencing the design and implementation of carbon taxes and emissions trading systems (ETSs) over 2022. Despite this, these policies appear to be weathering the challenging political and economic circumstances relatively well. While some countries directly intervened to keep carbon tax or ETS prices low, most prices remained relatively stable, and in some jurisdictions, notably in Europe, they increased. Some ETSs experienced more volatility in 2022 as a result of fluctuating energy prices and to a lesser extent government responses to the energy crisis. High-income countries still see the highest direct carbon pricing coverage, prices, and revenues. Yet there is growing interest especially among low- and middle-income countries, especially in light of the potential for careful design and targeted use of carbon pricing revenue to support development goals.

2.1 Growth in prices in ETSs and carbon taxes slowed following years of steep growth, but showed resilience in the face of challenging circumstances

Overall, ETSs and carbon taxes have weathered the 2022 global energy crisis relatively well. Half of these instruments saw prices increase, while around a third (those with fixed prices) saw prices unchanged.[iii] Fewer than 15% of instruments saw prices decrease. The biggest increases were seen in the European Union Emissions Trading System (EU ETS) linked with the Switzerland ETS, with the EU ETS price exceeding EUR 100 (USD 109) for the very first time in March 2023 (Figure 1).[iv] Price movements in these markets were more volatile in 2022 compared to previous years. However, many ETSs saw prices drop—by as much as 35% in the Republic of Korea.

Only a few countries responded to the political pressures from high energy prices by deliberately lowering carbon tax rates or postponing scheduled increases. Citing surging energy prices, Germany postponed by a year the planned increase of the price in its national ETS,[v] which

FIGURE 1
PRICE EVOLUTION IN SELECTED ETSs FROM 2018 TO 2022



Note: Based on data from ICAP Allowance Price Explorer. Prices for the RGGI initiative and for California and Québec CaT, come from the primary market, whereas for the other systems the prices reflect the secondary market

(iii) The level of the carbon price represents the strength of the signal to avoid or remove emissions. If prices rise, there is a stronger signal to drive further emission reductions. If prices decrease, there is less incentive to act. See, e.g., World Bank Group, "FASTER Principles."
(iv) The Austria ETS and Germany ETS are not included here, as the prices in these mechanisms will be set by the respective governments until 2025.

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was due to move from EUR 30 to EUR 35 (from USD 33 to USD 38) at the start of 2023, also delaying by a year subsequent scheduled increases in 2024 and 2025.[25] South Africa extended an existing arrangement in its national carbon tax, under which companies are allocated a tax-free emissions allowance, similar in effect to a free allocation in an ETS, though this did not affect the headline price.[26] Sweden has also postponed planned price increases.

By contrast, most jurisdictions did not tone down the ambition of their carbon taxes or ETSs. Scheduled price increases or other tightening measures were implemented for a number of fixed-price instruments. In many instances, this happened automatically since the tax rate is indexed to inflation (see **Box 2**). In some other jurisdictions, prices increased far more than inflation: national carbon taxes in Ireland, Luxemburg, the Netherlands, and Norway, as well as the Canadian federal carbon tax, all increased by 20% or more, well above the respective inflation rates. New Zealand continued phasing down free allocations in its ETS, further tightened the eligibility and accounting rules for free allocation, and tightened the cap to align with the country's national emissions budgets. The EU ETS cap continued its planned downward trajectory, with 2.2%, or 43 million allowances, cut in 2022, and free allocations were also reduced. In Switzerland's ETS, surplus allowances in circulation triggered the new market stability mechanism, which cut auction volumes by 50%. However, although momentum behind carbon taxes and ETSs remained resilient, other interventions in many of these jurisdictions to lower energy prices have impacted overall carbon price policy signals (see **Box 3**).

What is more, several jurisdictions made decisions to further strengthen existing carbon taxes or ETSs in the coming years. In November 2022, Singapore amended its carbon pricing bill to lock in price increases announced in 2021. This will increase the country's carbon tax from its current rate of SGD 5 to SGD 45 (USD 4–34) starting in 2026, reaching as high as SGD 50 to SGD 80 (USD 38–60) by 2030. Canada is also proceeding with its approach to increase the stringency of its federal benchmark,[vi] with prices set to exceed CAD 170 (USD 127) by 2030. Based on this approach, the updated 2023 Federal Fuel Charge starts at CAD 65 (USD 48). South Africa has proposed a rising trajectory for its national carbon tax, set to reach at least USD 30 in 2030, despite resistance from business stakeholders.[27] The EU agreed to a further tightening of the EU ETS cap as part of its "Fit for 55" package, with the rate of decline doubling to 4.4% annually beginning in 2028. Finally, in the US state of California, the Air Resources Board published its 2022 Scoping Plan for Achieving Climate Neutrality by 2045.[28] While the plan still needs to be translated into concrete regulatory changes for the Californian cap-and-trade system, the document sets out a sectoral roadmap for the transition away from fossil fuels.

(v) The price in Germany's national ETS will be set by the government until 2025, with the price planned to rise each year. The updated trajectory will see allowances sold at EUR 30 (USD 33) in 2023, EUR 35 (USD 38) in 2024, and EUR 45 (USD 49) in 2025 (see Annex A for more details). Prices for the RGGI initiative and for California and Québec CaT, come from the primary market, whereas for the other systems the prices reflect the secondary market (vi) The Canadian federal government sets minimum national stringency standards (the federal "benchmark") that all subnational systems must meet to avoid the federal system applying.

BOX 2
ETS AND CARBON TAX PRICES AND INFLATION

Globally, inflation reached close to 8.8% in 2022.[29] While such inflation levels are not unusual in many developing countries and emerging economies, most advanced economies had not experienced them for decades. In this context, there are larger than usual differences between the nominal changes in prices expressed in local currency and the real changes in prices.

Inflation affects carbon tax and ETS prices in different ways, depending on how prices are set. Prices in most ETSs are influenced by inflation; these prices are determined based on developments in other markets (including energy commodities, electricity, etc.), so price developments in these markets would affect the ETS price. In the EU ETS and the linked Switzerland ETS, a large increase in nominal prices is more modest in real terms—the EU ETS price increased by 3.9% in real terms. On the other hand, real declines in other markets are larger than nominal changes: the 35% nominal decrease in the Korean ETS is even larger in real terms at around 40%. Several carbon taxes, such as those in Colombia and Poland, are inflation adjusted, as are the auction floor prices in the California and Québec ETSs, which increase annually by 5% plus the rate of inflation. There is usually some delay in applying the inflation adjustment, so these instruments might still see decreasing real prices this year but real increases next year. By contrast, the price in the German national ETS and carbon taxes in the Canadian provinces, Chile, Singapore, and some European countries were fixed in nominal terms. In these cases, inflation erodes the carbon price signal. Where prices are scheduled to increase by a predefined value, real increases are smaller than the defined nominal increase.

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BOX 3
TRACKING BROADER CARBON PRICES: BEYOND ETSs AND CARBON TAXES

While this report focuses on direct carbon pricing policies—ETSs, carbon taxes, and carbon crediting—indirect carbon pricing policies such as fuel excise taxes, fossil fuel subsidies, and differentiated VAT rates can also provide a strong price signal that changes the economics of high-emissions fuels or products (Annex A includes more detailed definitions of these concepts).

Looking at both direct and indirect policies in combination gives a more complete picture of the overall carbon price incentives. Analysis combining direct and indirect carbon pricing policies gives a better sense of which emissions are covered by a carbon price signal, the strength of the signal, and how this landscape evolves over time. This can show, for example, where a positive carbon price is canceled out by negative carbon pricing (i.e., fossil fuel subsidies) or when indirect carbon prices are converted to (or renamed as) direct policies without materially changing the strength of the overall incentive. Recognizing the importance of this broader view of carbon pricing, several organizations have been working on analyses that quantify the combined impact of direct and indirect carbon pricing. In 2022, the Organisation for Economic Co-operation and Development (OECD) published Net Effective Carbon Rates (NECR) for 71 countries (predominantly in the OECD and Group of 20). The NECR is an indicator that includes direct carbon pricing in the form of carbon taxes and ETSs, plus indirect carbon pricing through fossil fuel taxes and fossil fuel subsidies.[vii] This builds on the OECD's previous work on Effective Carbon Rates, but importantly includes the impact of fossil fuel subsidies for the first time. In a similar vein, the World Bank is developing a Total Carbon Price metric that covers a broader range of countries.[30]

Indirect carbon prices are much more widespread than carbon taxes or ETSs, but carbon taxes and ETSs are growing more quickly, albeit from a smaller base. In 2021, out of the 71 countries the OECD assessed, 67 had positive indirect carbon prices in the form of fuel taxes while only 39 had carbon taxes or ETSs. This shows not only that most energy emissions are priced in some way, but also that most countries have experience in implementing policies that provide a carbon price signal. However, the change between 2018 and 2021 shows direct carbon prices are expanding at a faster rate. While the share of emissions covered by an ETS or carbon tax increased by more than 50%, the share of emissions covered by other fuel taxes barely changed. This contrast is particularly noticeable in developing countries, due primarily to substantially increased emissions coverage as a result of the launch of China's national ETS. Indirect carbon prices set by fuel taxes are generally much higher than direct ones set by carbon taxes or ETSs: the weighted average fossil fuel tax in 2021 was three times the level of the average carbon price as a result of carbon taxes and ETSs.[31] This gap, however, is narrowing, with prices in most ETSs and carbon taxes in the NECR dataset increasing by over 50% between 2018 and 2021.[32]

Fossil fuel subsidies are still widespread and erode the incentive provided by positive carbon prices. Effectively, these constitute a negative indirect carbon price, which counteracts the positive price signal from direct and indirect carbon pricing instruments. Fossil fuel subsidies are still common: nearly all the countries in the OECD's analysis employed them. Their impact is significant: on average across the sample, fossil fuel subsidies reduced the NECR by around USD 0.90 in 2021, offsetting around a fifth of the direct carbon price (the average price provided by ETSs and carbon taxes in 2021 in select countries was USD 4.50).

While many governments made changes to energy policies in 2022, with the aim of supporting vulnerable consumers and safeguarding their economies, some of these measures have also reduced policy signals to reduce emissions. Whether countries stepped back on ETSs or carbon taxes, reduced or paused fossil fuel taxes, or increased energy subsidies, these measures had a dampening effect on the overall carbon price incentive in many countries. While only a few countries changed ETSs or carbon taxes in response to the crisis, many reduced or paused fossil fuel taxes or increased energy subsidies.[33] This vastly expanded public expenditure in support of fossil fuel use: the International Energy Agency estimates that, globally, public spending to lower energy bills added up to USD 500 billion in 2022, of which Europe accounted for 70%.[34]

Despite lower policy signals, final energy prices have still gone up. Government interventions have not fully offset the increase in fossil fuel costs—households in many countries still face much higher energy bills than they did in the past. This overall increase in energy prices, and especially fossil fuels, means the economic imperative for energy efficiency, energy conservation, and carbon-free electricity generation has likely become stronger over the year. However, these price increases do not provide the same investment signals as direct carbon prices because they may be short-lived and, like indirect carbon prices, do not reflect the relative carbon content of different fuels.

As with direct carbon prices, overall carbon price incentives are insufficient to deliver the transformational change needed to deliver on the Paris goals. Only about 19% of emissions in the countries included in the NECR dataset are priced at a level needed by 2030 to be consistent with net-zero emissions targets.[viii] The International Monetary Fund, OECD, and others continue to highlight that fossil fuel prices generally fail to appropriately price environmental impacts.

(vii) The OECD categorizes policies as "explicit" and "implicit," which are similar, respectively, to the "direct" and "indirect" terms used in this report.
(viii) EUR 60 per metric ton of CO_2 is used as a midpoint estimate for carbon costs in 2020 and a low-end estimate for 2030; OECD, "Pricing Greenhouse Gas Emissions: Turning Climate Targets into Climate Action," 2022.

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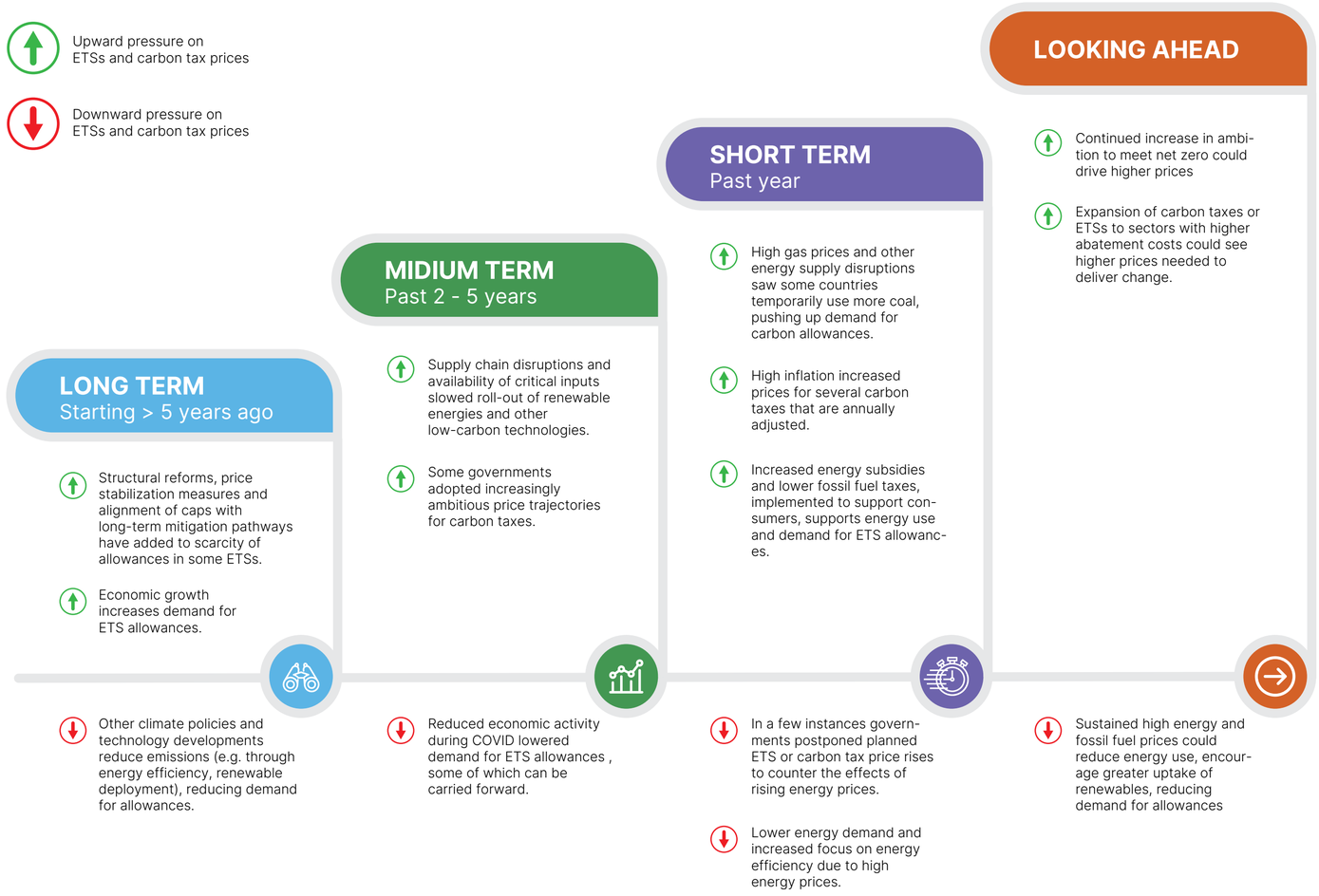
FIGURE 2
KEY DRIVERS OR RECENT ETS AND CARBON TAX PRICE DEVELOPMENTS



Beyond policy changes, energy markets were the biggest of several factors influencing prices in most ETSs (Figure 2). Limited gas supply and extremely high gas prices made coal relatively more competitive. Compounding the issue was drought in Europe, China, and the United States in 2022, causing temporary shortfalls in hydropower output and creating problems for some thermal power plants—on top of existing technical and heat-related issues among, in particular, French nuclear power plants. In many European countries, the combined effect was sufficient to temporarily pause the multiyear trend of decreasing coal usage, and resulting higher power sector emissions drove up EU ETS prices.[35] Other economies and their ETSs were more shielded from energy price effects by their long-term liquefied natural gas (LNG) supply contracts. However, if high energy prices are sustained, they will eventually affect all markets. Projections of global energy consumption growth have been revised down considerably in light of higher fossil fuel price projections. Lower energy use would reduce demand for ETS allowances and have a dampening effect on prices where prices are determined by allowance supply and demand.

Overall, carbon prices would need to rise in the longer term to drive investments into climate neutrality at the scale and pace required. The High-Level Commission on Carbon Prices concluded in 2017 that carbon prices needed to be at the level of USD 40/metric tons of carbon dioxide (tCO_2) to USD 80/tCO_2 in 2020 and reach USD 50/tCO_2 to 100/tCO_2 by 2030 to be on track to keep temperatures below 2°C—the upper end of the limit agreed upon in the Paris Agreement (2017 USD) (see **Box 4**).[ix] Adjusting for inflation allows a more direct comparison with current carbon prices—prices would need to reach USD 61 to USD 122 by 2030 in 2023 USD.[36] As of April 1, 2023, less than 5% of global greenhouse gas (GHG) emissions are covered by a direct carbon price at

(ix) Low and high shadow prices of carbon values are suggested to account for the uncertainty associated with the estimates.

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"As of April 1, 2023, less than 5% of of global greenhouse gas emissions are covered by a direct carbon price at or above the range recommended by 2030"

BOX 4
THE LEVEL OF DIRECT CARBON PRICING NEEDED TO BE CONSISTENT WITH THE PARIS TEMPERATURE TARGET

In 2017, Joseph Stiglitz and Nicholas Stern led a report of the High-Level Commission on Carbon Prices. This report recommended that direct carbon price levels must reach at least USD 40 to USD 80/metric ton of carbon dioxide equivalent (tCO_2e) in 2020 and USD 50 to USD 100/tCO_2e in real terms (in 2017 USD) by 2030 (or USD 61–122 by 2030 in 2023 terms) to limit global warming to below 2°C, provided a supportive policy environment is in place. More recent assessments align with the recommendations from the High-Level Commission on Carbon Prices. For example, the Intergovernmental Panel on Climate Change's (IPCC) Working Group III contribution to the Sixth Assessment Report indicates that with a mitigation pathway limiting warming to 2°C the marginal abatement costs of carbon are around USD 90/tCO_2 by 2030 in 2015 terms or USD 115 in 2023 terms.[37]

More recently, the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) released its updated scenarios for central banks and supervisors in September 2022. NGFS's modeling suggests that carbon prices need to be around USD 50 by 2030 in 2010 terms (or USD 69 in 2023 terms) and subsequently around USD 200 (or USD 276 in 2023 terms) by 2050 to achieve a below-2°C outcome.[38] IPCC modeling (which includes models used by NGFS) concludes that significantly higher carbon prices would be needed for meeting the 1.5°C-equivalent scenarios.

or above the range recommended by 2030 (in 2023 USD), with most of these high-price instruments located in Europe (**Figure 3**). Policy features such as free allocations or rebates can also limit the extent to which a carbon price can drive the necessary volume of emission reductions, depending on their design. Furthermore, in many jurisdictions, the growth in (nominal) carbon prices failed to match inflation, meaning that carbon prices actually declined in real terms (see **Box 2**). Another important consideration is the share of emissions within a jurisdiction that face a carbon price incentive, which varies widely across countries (see Section 2.2). **Figure 3** indicatively illustrates this—the shading indicates the proportion of the jurisdiction's emissions covered by each carbon tax or ETS. Some jurisdictions have more than one of these policies (such as Poland, which has a carbon tax and participates in the EU ETS); in these cases (indicated with asterisks) the total share of the jurisdiction's emissions that are covered is higher than the coverage of an individual policy. Further, the overall strength of the price signal includes policies beyond direct carbon prices (see **Box 3**) and can also be reflected through internal carbon pricing (see **Box 5**).

2.2 Uptake of ETSs and carbon taxes grew slightly, mostly in countries that are already pricing carbon

As of April 2023, there are 73 carbon taxes or ETSs in operation (Figure 5). Since April 2022 new ETSs commenced in Austria and the state of Washington in the United States, and Indonesia announced the launch of a mandatory national ETS. At the subnational level, three new carbon taxes were implemented in states within Mexico—Querétaro, the State of Mexico, and Yucatán—while a fourth carbon tax in Guanajuato will enter into force in June 2023. With the exception of Indonesia, all of these new instruments are in countries where carbon taxes or ETSs had already been in place but cover new sectors or strengthen existing price signals. In addition to these new instruments, Germany's national ETS expanded in January 2023 to cover coal-derived fuels used in facilities currently outside of the EU ETS. The Netherlands introduced carbon price floors for electricity and industry, which ensure a minimum carbon price for emissions covered by the EU ETS and form part of the country's carbon tax.

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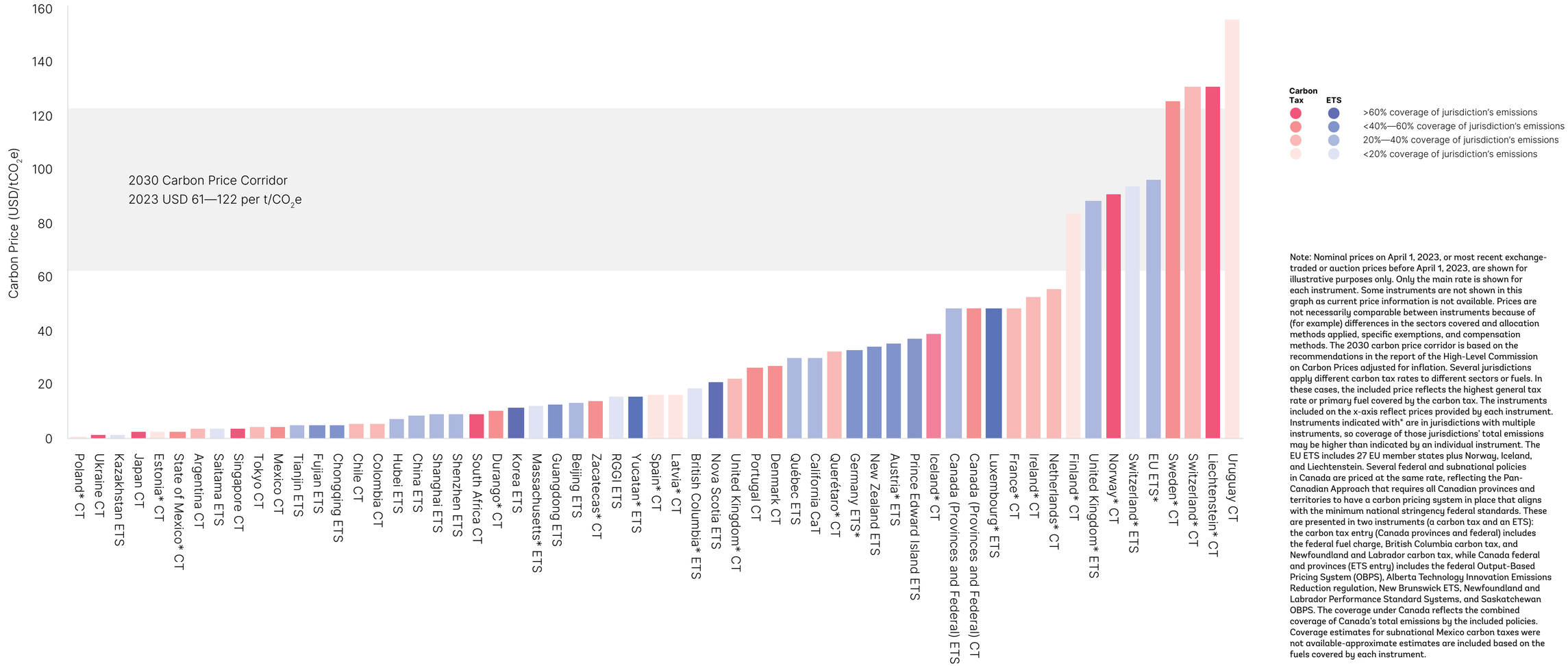
FIGURE 3
PRICES AND COVERAGE ACROSS ETSs AND CARBON TAXES



Note: Nominal prices on April 1, 2023, or most recent exchange-traded or auction prices before April 1, 2023, are shown for illustrative purposes only. Only the main rate is shown for each instrument. Some instruments are not shown in this graph as current price information is not available. Prices are not necessarily comparable between instruments because of (for example) differences in the sectors covered and allocation methods applied, specific exemptions, and compensation methods. The 2030 carbon price corridor is based on the recommendations in the report of the High-Level Commission on Carbon Prices adjusted for inflation. Several jurisdictions apply different carbon tax rates to different sectors or fuels. In these cases, the included price reflects the highest general tax rate or primary fuel covered by the carbon tax. The instruments included on the x-axis reflect prices provided by each instrument. Instruments indicated with* are in jurisdictions with multiple instruments, so coverage of those jurisdictions' total emissions may be higher than indicated by an individual instrument. The EU ETS includes 27 EU member states plus Norway, Iceland, and Liechtenstein. Several federal and subnational policies in Canada are priced at the same rate, reflecting the Pan-Canadian Approach that requires all Canadian provinces and territories to have a carbon pricing system in place that aligns with the minimum national stringency federal standards. These are presented in two instruments (a carbon tax and an ETS): the carbon tax entry (Canada provinces and federal) includes the federal fuel charge, British Columbia carbon tax, and Newfoundland and Labrador carbon tax, while Canada federal and provinces (ETS entry) includes the federal Output-Based Pricing System (OBPS), Alberta Technology Innovation Emissions Reduction regulation, New Brunswick ETS, Newfoundland and Labrador Performance Standard Systems, and Saskatchewan OBPS. The coverage under Canada reflects the combined coverage of Canada's total emissions by the included policies. Coverage estimates for subnational Mexico carbon taxes were not available-approximate estimates are included based on the fuels covered by each instrument.

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BOX 5
INTERNAL CARBON PRICING

Some organizations voluntarily use different kinds of internal carbon prices (ICPs) to manage climate-related business risks and prepare for the transition to climate neutrality. Shadow pricing assigns a theoretical price per unit of emissions, which is then factored into the organization's decision-making processes. Through internal carbon fees, organizations allocate 'fee' revenues to fund emissions reduction activities. Other types of ICPs include implicit carbon pricing,[x] offset purchasing and internal carbon trading. Organizations can use ICPs to manage scope 1 (direct), scope 2 (electricity use), or scope 3 (other supply chain) emissions.

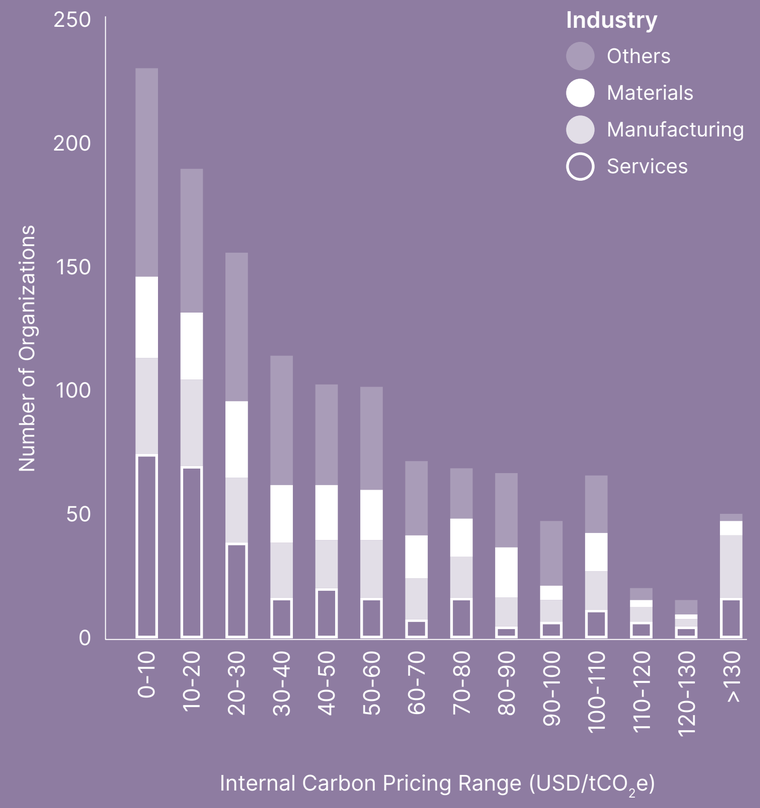
Of all 8,402 companies reporting under CDP (formally the Carbon Disclosure Project) in 2022, 15% (1,203 companies) reported having implemented an ICP and a further 18% plan to do so in the next two years. Shadow carbon is the most common, accounting for 68% of reported ICPs. The main motivations for implementing ICPs remained consistent with previous years: to drive low-carbon investment and energy efficiency measures. Other motivations were to change internal behavior, to identify and seize low-carbon opportunities, and to navigate GHG regulations.

Of all the companies that report the use of an ICP, around half (52%) are already subject to a carbon tax or ETS, and a further 15% expect that will be the case in the next three years. Europe and the Asia-Pacific region continue to account for the highest share of companies reporting the use of an ICP. The service industry, in particular the financial industry, remains the one with the highest number of companies reporting an ICP, accounting for over a quarter of the total. In 2022 the manufacturing industry overtook materials[xi] as the industry with the second highest number of companies reporting an ICP.

There is massive variation in the level of ICPs companies apply. While it is difficult to compare ICPs reported by companies and how ICPs are used, due to limitations around data availability and transparency, the range of reported prices provide insights on the breadth of ICPs across companies and industries. Reported ICPs range from USD 0.01/tCO_2 to USD 3,556/tCO_2, but nearly all are below USD 130/tCO_2 (see Figure 4). While only 146 companies (13%) reported an internal carbon price above USD 100/tCO_2, this has increased significantly since 2021. Most ICPs are below the levels recommended by the High-Level Commission on Carbon Prices to be aligned with the Paris Agreement (see **Box 4**).

Multilateral development banks also use shadow carbon pricing. For example, as part of its Climate Change Action Plan 2021–2025, the World Bank Group began an institution-wide effort to further mainstream climate considerations into all development projects. This includes applying a shadow price of carbon in the economic analysis of Investment Project Financing projects[xii] where Bank methodologies exist to better understand the costs and benefits of investments and alternatives. While the shadow prices applied across and within institutions is not uniform, they generally align with recommendations from the High-Level Commission on Carbon Prices (see **Box 4**). For example, World Bank guidance recommends a shadow carbon price in line with the High-Level Commission on Carbon Prices' carbon pricing corridor[39] and the Asia Development Bank uses a global social cost of carbon, which translates to similar levels.[40]

FIGURE 4
INTERNAL CARBON PRICES APPLIED ACROSS INDUSTRIES



(x) Note some organizations use the term "implicit carbon pricing" differently, for example to refer to fuel excise taxes and fossil fuel subsidies. (xi) The materials sector covers activities related to both manufacturing and raw materials (Sector definitions can be found on the CDP website.) (xii) This includes medium- to long-term projects in sectors across infrastructure and sustainable development work programs.

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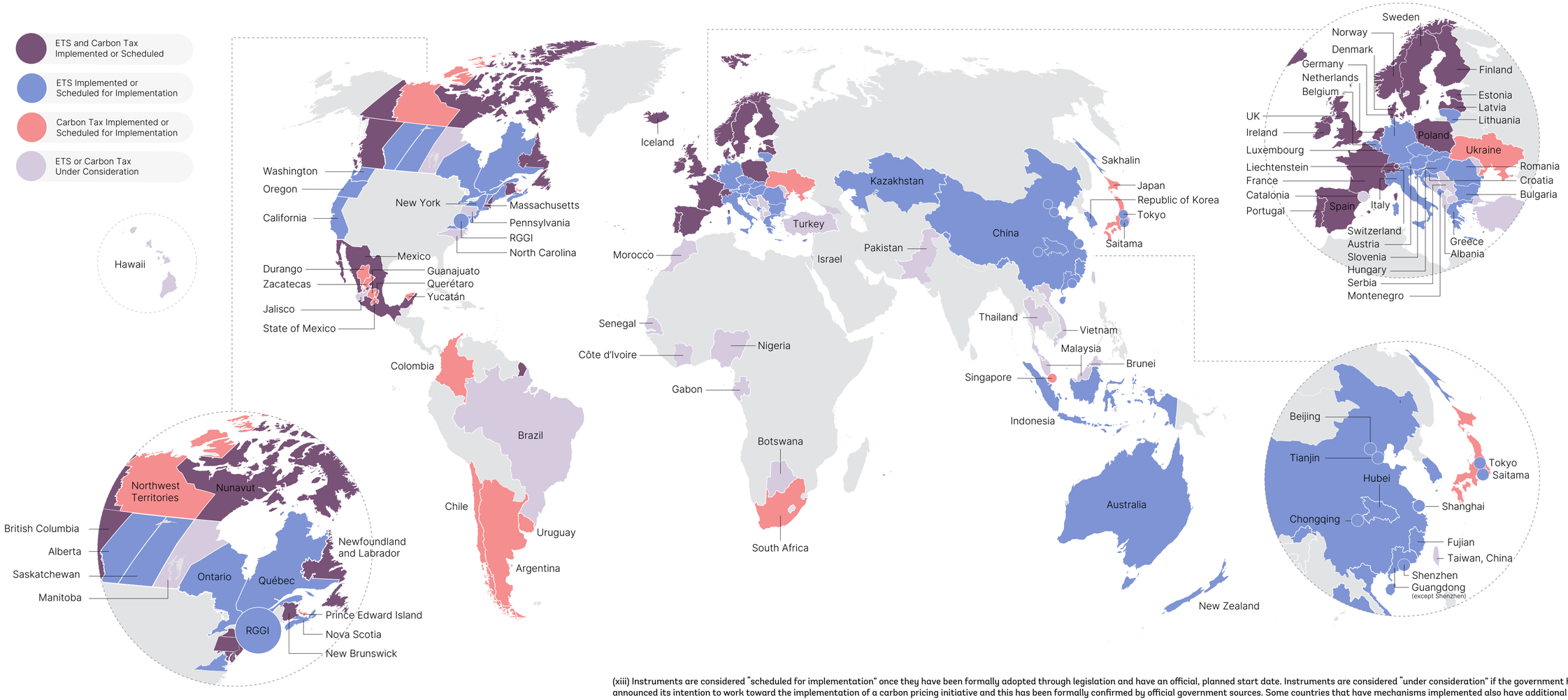
FIGURE 5
MAP OF CARBON TAXES AND ETSs[xiii]



(xiii) Instruments are considered "scheduled for implementation" once they have been formally adopted through legislation and have an official, planned start date. Instruments are considered "under consideration" if the government has announced its intention to work toward the implementation of a carbon pricing initiative and this has been formally confirmed by official government sources. Some countries that have mechanisms implemented also have additional instruments under consideration. For subnational jurisdictions only the subnational instrument is reflected.

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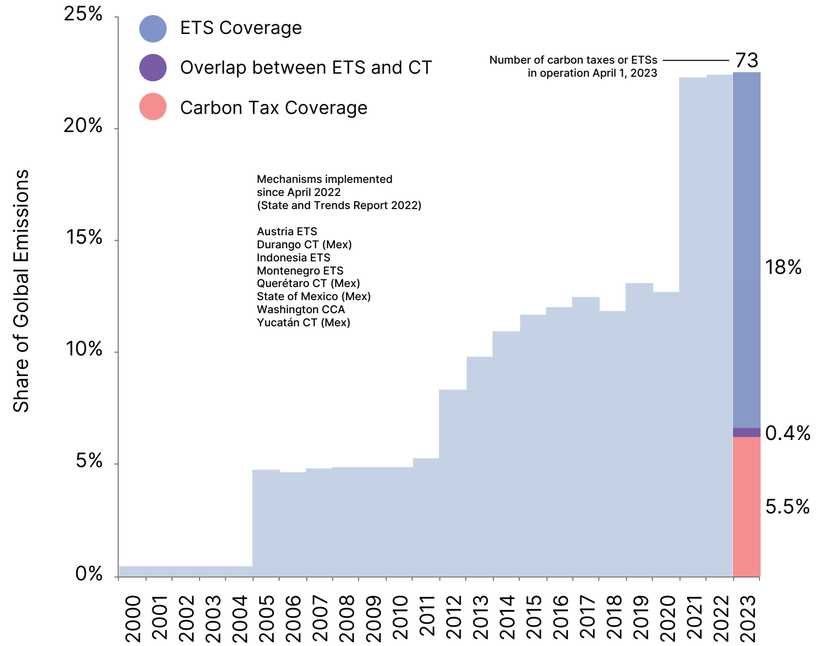
"ETSs and carbon taxes in operation cover around 23% of global GHG emissions"

There were also delays and repeals, largely driven by the energy crisis. Slovenia repealed its carbon tax, which had been in place since 1996, citing energy prices. Indonesia delayed the introduction of its planned carbon tax, which was due to start in 2022, referencing global risks stemming from Russia's invasion of Ukraine, although it has since launched its ETS.[41] Austria delayed its national ETS by three months, but it commenced in October 2022. Germany pushed back the planned expansion of its national ETS to cover waste incineration until 2024. While the US state of Pennsylvania passed legislation to join the Regional Greenhouse Gas Initiative (RGGI), its implementation is on hold due to a court challenge.

The net result of developments over the past year is a minor increase in the share of global GHG emissions that are covered by carbon taxes or ETSs. ETSs and carbon taxes in operation cover around 23% of global GHG emissions (**Figure 6**), an increase of less than 1% compared with 12 months ago.[xiv] This figure accounts for overlap between instruments and the fact that coverage differs substantially from country to country—for example Uruguay, with a carbon tax that only covers gasoline, compared with more comprehensive approaches, such as Singapore with a carbon tax applied to around 80% of national GHG emissions. The relatively small increase in global coverage—despite the expanding scope of some policies and new instruments being implemented – is also a result of the fact that GHG emissions are decreasing in most jurisdictions that have implemented a carbon tax or ETS.

Newly implemented instruments share design elements from existing systems. Similar to China's national ETS, Indonesia's ETS will function like a tradable performance standard for around 100 grid-connected, coal-fired power stations, with emissions intensity baselines based on the category of power plant, the average emissions intensity, and the average GHG emissions of the power station. Like the national ETS in neighboring Germany, the Austrian national ETS covers fuel combustion in road transport, buildings, and agriculture (i.e., emission sources not covered by the EU ETS) and has started with a price that will be set by the government each year until 2025.

FIGURE 6
SHARE OF GLOBAL GHG EMISSIONS COVERED BY ETSS AND CARBON TAXES



(xiv) Changes to the proportion of global GHG emissions covered since last year's report reflect factors beyond increased coverage of direct carbon pricing instruments. This includes changes as a result of applying updated GHG emission estimates. The current report uses updated GHG estimates taken from version 7.0 of the Emissions Database for Global Atmospheric Research (EDGAR) (https://edgar.jrc.ec.europa.eu/), which were released at the end of 2022. EDGAR 7.0 includes a range of updates and provides GHG emission values up to 2021 (previous versions only included up to 2018).

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In the United States, Washington State launched its "cap-and-invest" system in January 2023, modeled after the cap-and-trade systems already in operation in California and Québec.

Several jurisdictions announced plans to expand the coverage of existing instruments or to adopt new ones. The Mexican ETS completed its pilot phase in 2022 and is intending to enter its operational phase in 2023; the Mexican Ministry of Environment and Natural Resources (SEMARNAT) is preparing to publish the final rules for the operational phase.[xv] Australia's parliament has passed legislation to introduce crediting into its existing safeguard mechanism starting from July 1, 2023, effectively transitioning into a rate-based ETS. The reform would also tighten baselines, to align with Australia's 2030 targets. The EU agreed to establish a new, separate ETS by 2027 to cover emissions from buildings and road transport, as well as small energy and industry installations outside the scope of the existing EU ETS. The changes would also expand the existing EU ETS to include maritime shipping from 2024. Shipping companies will gradually face surrender obligations under the EU ETS, starting from 40% of verified emissions in 2024 and increasing to 70% in 2025 and 100% in 2026. At that point the plan will cover 100% of emissions for voyages between member state ports and 50% for those between EU ports and third-country ports. The EU also reached agreement on the details of its Carbon Border Adjustment Mechanism (CBAM). It will apply to emissions embedded in iron and steel, cement, aluminum, electricity, fertilizers, and hydrogen imported into the EU. The mechanism will function as a carbon price levied on imports to the EU that have embodied emissions priced below the EU carbon price, with obligations for importers to submit "CBAM certificates" priced in line with EU ETS allowances from 2026. Further details on carbon tax and ETS updates are outlined in **Annex C**.

New Zealand is set to become the first country in the world to price agricultural emissions from 2025, which would extend carbon pricing beyond traditionally covered sectors.[42] Until now, carbon taxes and ETSs have largely focused on energy and industrial emissions: most carbon taxes apply to specific fossil fuels used for energy in different sectors, while ETSs mostly focus on stationary energy and large industrial facilities (see **Annex C**). The New Zealand government announced in December 2022 that the carbon price, a separate mechanism from the New Zealand ETS, will be charged at the farm level. The design of the mechanism underwent a final round of consultations in late 2022, with a government decision expected in the first half of 2023. A similar approach has also been floated in Denmark, where the Danish Climate Council recommended introducing a tax on farming emissions to help meet the country's emissions targets.[43] Expanding carbon pricing to agricultural emissions comes with its own set of challenges, with stakeholders raising concerns about impacts on food security, limited opportunities to reduce emissions from agricultural activities (and associated risks of carbon leakage), interactions with preexisting market distortions, and difficulties ensuring robust monitoring, reporting, and verification.[44] Others argue customers are seeking more sustainable alternatives, new approaches to reducing agricultural emissions are emerging, and carbon pricing could ensure greater investment in further developing new ways to reduce agricultural emissions.[45] If the New Zealand approach is successful, it will provide a useful example of an approach to apply carbon taxes or ETSs to agricultural emissions and potentially to other sectors less commonly covered by these policies.

Beyond those countries implementing and refining carbon taxes and ETSs, several jurisdictions continue to take preparatory steps for implementing these policies. In East Asia and the Pacific, several countries continue to

"New Zealand is set to become the first country in the world to price agricultural emissions from 2025"

(xv) The "pilot phase" ran from January 1, 2020, to December 31, 2021. The pilot phase was designed to have no economic effects, meaning that there were no monetary penalties and allowances were allocated for free, in a proportion equivalent to the reported emissions of covered entities. During the "transition phase," which began in 2022, the rules for the pilot phase remain applicable until SEMARNAT publishes the rules for the "operational phase," which is expected later in 2023.

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"Revenues from carbon taxes and ETSs grew by over 10% in 2022, reaching almost USD95 billion globally"

explore carbon pricing policies. Malaysia, Vietnam, and Thailand, for instance, are all considering options for future ETSs. Japan's Ministry of Economy, Trade and Industry presented plans that could see a national ETS starting in 2026.[46] In August 2022, Chile announced its intention to develop a pilot ETS for the energy sector as part of its 2022–2026 Energy Agenda. In Türkiye, the Medium Term Programme (2023–2025) mentions the conversion of energy taxes to a carbon tax and the introduction of a national ETS. In January 2023, Taiwan, China, passed a law to introduce a carbon tax on large emitters, as well as a CBAM for carbon-intensive imports. The designs of both systems have yet to be determined.

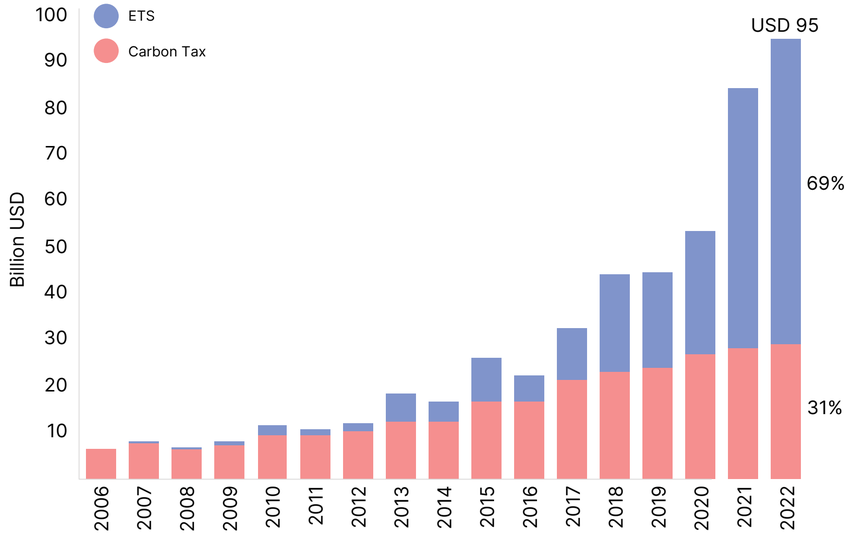
2.3 Government revenues from ETSs and carbon taxes continue to grow and reached a new record high in 2022

Continuing with previous trends, revenues[xvi] from carbon taxes and ETSs grew by over 10% in 2022, reaching almost USD 95 billion globally. Carbon revenues are a function of the carbon price, the emissions covered, and other design features such as the method of allowance allocation or the availability of rebates. Compared to the previous year, global revenue from carbon taxes and ETSs increased by around USD 10 billion. In absolute terms, the EU ETS generated the most revenue in 2022, namely USD 42 billion, and the increase in revenues of about USD 7.8 billion was responsible for more than 76% of the total increase in global carbon pricing revenues. On a per capita basis, Sweden's carbon tax for road transport was the instrument that delivered the highest revenues, amounting to slightly more than USD 200 per citizen. In 2022, ETSs accounted for 69% of global government revenues from direct carbon pricing, with the remaining 31% from carbon taxes (**Figure 7**).

(xvi) Includes revenues from carbon taxes and ETSs (e.g., from auctioning) collected by governments. It does not account for foregone revenue, for example from freely allocated units or tax exemptions.

There are trade-offs made between different objectives, with the amount of revenue raised dependent on design features. There are many different design decisions that impact the amount of revenue raised by a carbon tax or ETS, including which emissions sources are covered and how the price is set, as well as the level of baselines or free allocations, the use of auctions, the use of rebate schemes, and the use of offsets. Most of the policies that delivered the highest government revenues were ETSs, but this largely reflected higher prices and the size of the economies they covered.

FIGURE 7
EVOLUTION OF GLOBAL REVENUES FROM CARBON TAXES AND ETSs OVER TIME (NOMINAL)



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The dominance of the EU ETS in terms of revenues collected reflects in part its size and price, but also its evolving approach to allowance allocation. Revenue in the EU ETS has increased sevenfold since 2017. This is due partly to higher prices, but also to the gradual shift from free allocation toward auctioning. Still, around 35% of EU ETS allowances are allocated for free.[47] This constitutes a sizable opportunity cost—auctioning these allowances could yield revenues in the order of an additional USD 20 billion per year.[xvii] China's national ETS covers more than double the emissions of the EU ETS, but in effect it adopts 100% free allocation through technology-specific, emissions-intensity baselines. This approach means low direct costs for most covered entities, but also that the policy has not raised any revenue. Comparing ETSs with carbon taxes, which often have fewer exemptions or free allocations, gives a different perspective. For example, the Republic of Korea's ETS covers more emissions than Mexico's carbon tax and at a higher price, but free allocations and the availability of offsets in the Korean ETS means government revenue was similar for both mechanisms at around USD 240 million.

Collected revenue from carbon taxes and ETSs is frequently used for specific predetermined purposes, helping to ease political resistance. Based on data collected by the Institute for Climate Economics, 40% of revenues from carbon taxes and ETSs were earmarked[xviii] for dedicated purposes, in particular green spending, and a further 10% for direct transfers to vulnerable households and firms. The remainder was used for the general budget (20%), tax cuts (9%), and other purposes (6%) (**Figure 8**). This is an increase in the proportion of carbon revenue being used for specific purposes compared to previous years. This increase was driven by the increase in revenue collected under the EU ETS, where the majority of auction revenue allocated to Member States is used for climate- and energy-related purposes (and is well above the 50% required by EU legislation).[48] By contrast, the majority of revenues from indirect carbon prices (such as fuel excise taxes) are not earmarked for specific purposes.[49] New research from the OECD indicates there is greater public support for climate policy, including ETSs and carbon taxes, if revenues are used to fund green infrastructure and low-carbon technologies or redistributed to low-income households or those most affected by the policy.[50,xix] Earmarking revenues has been used to support the long-term transformation of energy-intensive industries. For instance, in British Columbia (BC) carbon tax revenues are used to manage impacts on households, maintain industry competitiveness, and encourage new green investments. The "Clean BC Program" directs an amount equal to the incremental carbon tax paid by industry above CAD 30/tCO_2e (USD 22) into incentives for cleaner operations and emission reduction projects. The EU will use close to EUR 40 billion (USD 43 billion) from ETS revenues for the Innovation Fund to finance the development of new technologies and big flagship projects. Alberta uses most of the revenues from its ETS to help support regulated firms transition away from fossil fuels. From the first installment of CAD 750 million (USD 558 million), CAD 131 million (USD 97 million) was used to fund seven projects under the Industrial Energy Efficiency and Carbon Capture Utilization and Storage Grant Program.[51] In some jurisdictions, though, earmarking of public revenues is not allowed, reflecting concerns that earmarking reduces policymakers' flexibility and might create a lock-in of economically inefficient spending.[52]

Recycling revenues through direct transfers have been implemented through lump-sum payments and targeted vulnerable households or those most impacted. Policymakers are often concerned that carbon pricing adds to financial pressure on low-income households.[53] Although carbon pricing can have a progressive effect on income distribution,[54] higher energy costs are an additional burden for low-income households.[55] Returning carbon pricing revenue to affected households can reduce or eliminate this pressure. The

"Revenue in the EU ETS has increased sevenfold since 2017. This is due partly to higher prices, but also to the gradual shift from free allocation toward auctioning."

(xvii) This figure represents an indicative value of revenue based on the proportion of allowances allocated for free in 2022 and the price in 2022. It does not account for broader market impacts that would result from increasing the proportion of allowances auctioned. (xviii) Note, earmarking includes where requirements are set out in legal text or where there is clear documentation explaining how revenue has been allocated. (xix) For more information on how revenue use can affect political acceptability, see D. Klenert, L. Mattauch, E. Combet, O. Edenhofer, C. Hepburn, R. Rafaty, and N. Stern, "Making Carbon Pricing Work for Citizens," *Nature Climate Change* 8 (2018): 669–677, https://doi.org/10.1038/s41558-018-0201-2.

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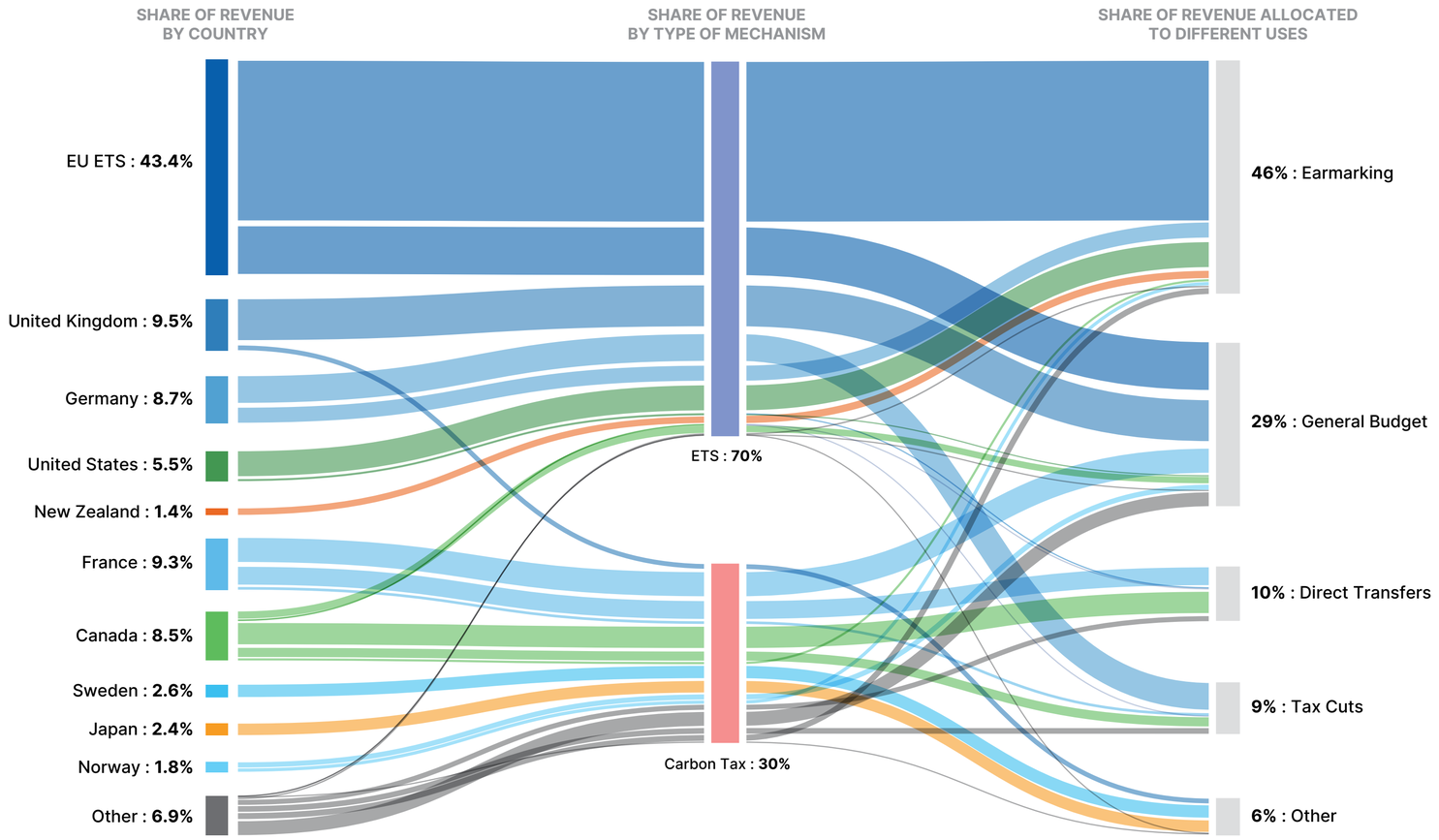
FIGURE 8
SCALE AND USES OF CARBON REVENUE IN 2021



Source: Based on 2021 data from Institute for Climate Economics.
Note: All auction revenue allocated to EU Member States is reflected under the EU ETS revenue (not individual member states). Revenues collected under separate instruments (e.g., France Carbon Tax or Germany ETS) are displayed separately. Share of revenue allocated to different uses in 2021, meaning that revenue use displayed could include revenue collected prior to 2021.

Canadian federal pollution pricing system addresses this by returning revenue to citizens through "Climate Action Incentive payments" aimed at primarily benefiting low- and middle-income households and families. The EU's Fit for 55 climate policy package includes a "Social Climate Fund" that will return EUR 65 billion (USD 71 billion) generated from carbon pricing revenue to vulnerable households, micro enterprises, and transport users, specifically through temporary direct income support as well as supporting investments in energy efficiency of buildings, decarbonization of heating and cooling of buildings, and improving access to low-carbon mobility.[56] The largest share of the CO_2 levy is recycled back in the form of lump-sum equal per capita transfers to households by means of reducing mandatory health insurance contributions. Austria has set up a rebate system for its national ETS: the so-called "climate bonus" that recycles carbon pricing revenue to households. The first payments were made in August 2022 in combination with financial support to address higher costs of living. In total, every adult received EUR 500 (USD 544) and every child EUR 250 (USD 272).[57] For the next payments in October 2023, the bonus will be between EUR 100 and EUR 200 (USD 109–217), depending on the place of residence, with higher payments for people living in areas with lower access to public transportation.

2.4 High-income nations have higher uptake, prices, and revenues, but other countries are increasingly showing interest

The vast majority of carbon taxes and ETSs are located in high-income countries in Europe and North America. Every country in the European Economic Area[xx] and North America has at least some of its emissions covered by one of these mechanisms (noting that in the United States these policies are implemented almost entirely at the subnational level). China's national ETS accounts for almost all of the emissions covered in East Asia and the Pacific. While some countries

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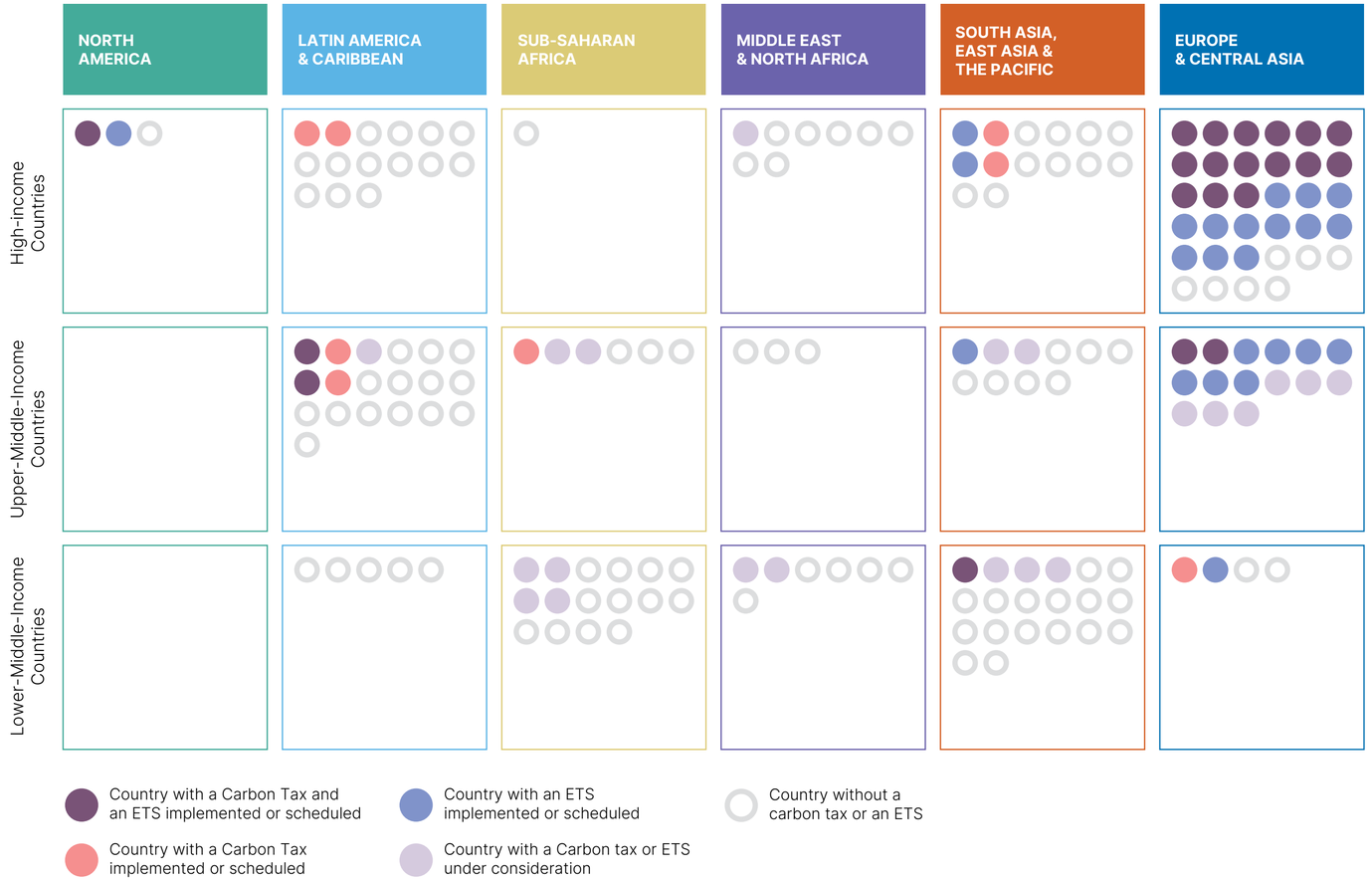
in Latin America and the Caribbean and South Asia have carbon taxes, Mexico is the only one to have implemented an ETS. In Africa and the Middle East, there are hardly any examples of either instrument. ETSs or carbon taxes are mostly limited to middle-income and high-income countries (**Figure 9**).

Carbon tax rates and ETS prices in high-income countries tend to be higher than those in middle-income countries (Figure 10). Most instruments in high-income countries have prices above USD 50, and nearly all above USD 15. In middle-income countries most instruments have prices below USD 10. There are, though, several examples of instruments in middle-income countries with prices above USD 10, such as in the Beijing and Guangdong ETS Pilots (in China), the carbon tax of Latvia, and the subnational carbon taxes in Mexico (Querétaro, Yucatán, and Zacatecas).

High-income countries are responsible for collecting almost all of the revenues from carbon taxes and ETSs, reflecting higher prices, higher jurisdictional emissions, and greater uptake but also different designs. Of the 16 national policies that delivered less than USD 30 million in 2022, only a few were in high-income countries—and these were carbon taxes that supplement an ETS. There are eight rate-based ETSs in middle-income countries that delivered little or no revenue. These designs are not unique to middle-income countries; Canada's Output-Based Pricing System, along with several subnational Canadian systems, and Australia's scheduled ETS operate on a similar basis. Cap-and-trade ETSs are much more likely to be in high-income countries and deliver higher revenues, but this depends on the level of free allocation and eligibility of offsets (as noted in Section 2.3). The only cap-and trade ETS not in a high-income country are the Kazakhstan and Mexican ETSs, which have not auctioned allowances to date. Middle-income countries were more likely to generate revenues through carbon taxes; for example, Argentina's carbon tax brought in USD 167 million in 2022 and Colombia's USD 92 million. The impact of exemptions, differential rates, and

FIGURE 9
COUNTRIES WITH CARBON TAXES AND ETSs BY WORLD REGIONS AND INCOME LEVELS – IMPLEMENTED, SCHEDULED, OR UNDER CONSIDERATION



(xx) The European Economic Area includes Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

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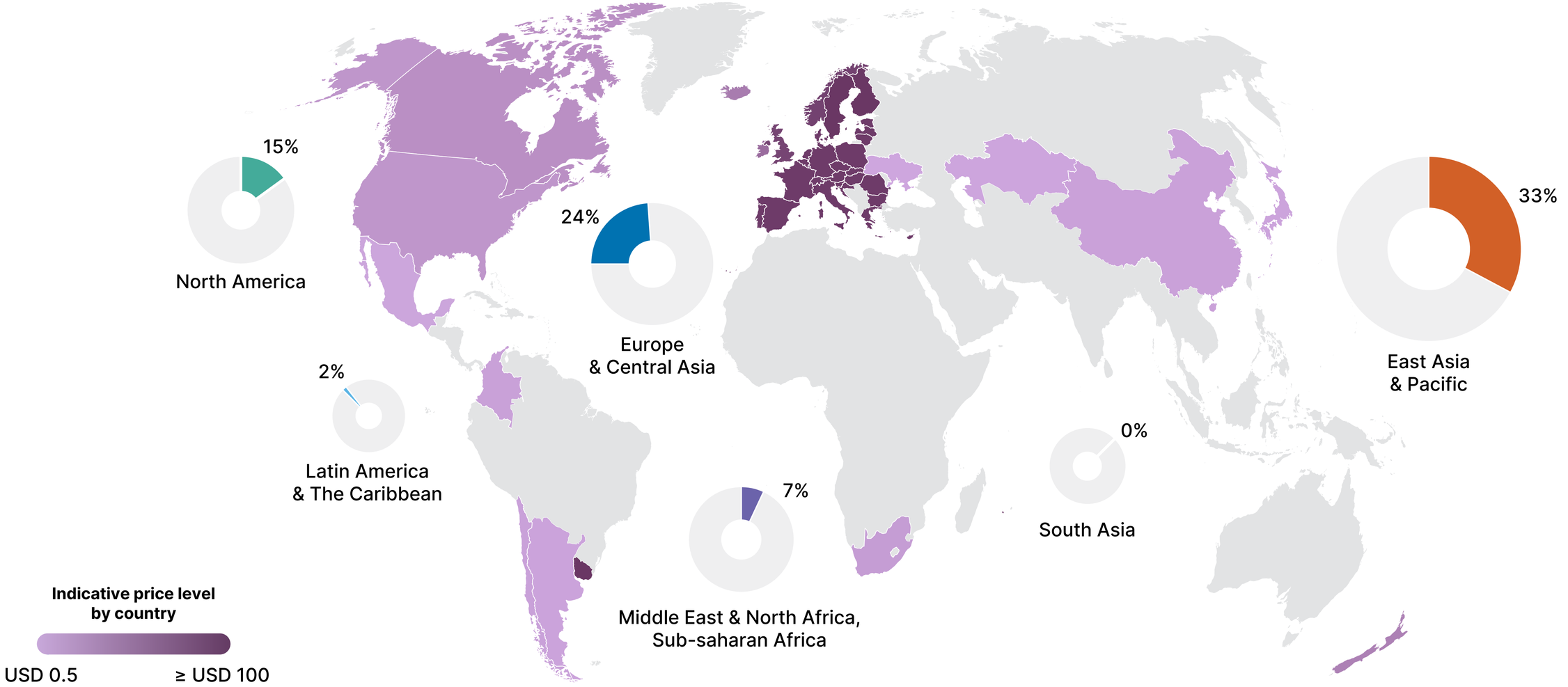
FIGURE 10
MAP OF CARBON PRICE LEVELS AND COVERAGE OF IMPLEMENTED CARBON TAXES AND ETSs



The size of each regional chart represents the total emissions in the corresponding region, whereas the colored section is the share of emissions in the region covered by ETSs and carbon taxes. The price for each country reflects the main rate that applies to the greatest portion of GHG emissions.

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rebates within carbon taxes on revenue levels is also evident, though. South Africa's carbon tax covers nearly 10 times more emissions than Colombia's at a higher rate but delivered a similar volume of revenues.

These trends reflect the early stage of climate policy in many developing countries, but also their need to focus on other development goals and barriers to implementation. Several instruments in developing countries have remained "under consideration" for some time. For jurisdictions without binding emissions targets before the Paris Agreement (including non-Annex I countries[xxi]), there has historically been less of an imperative to implement policies to reduce GHG emissions. Further, developing countries face particular social, economic, legal, and political barriers to implementing carbon taxes or ETS.[58] In particular, many countries are focused on increasing energy access and keeping energy costs low.[xxii] Some countries are seeking to design and implement multiple direct carbon pricing policies simultaneously, which may help to accommodate specific sectoral circumstances and political or regulatory constraints but makes design and implementation more complex. For example, Indonesia, Malaysia, Mexico, and Vietnam, among others, are all considering or progressing multiple instruments—applying them either at the same time but in different sectors, at different levels of governance, or even in combination to cover the same emissions.

Despite these barriers, there is increasing interest in carbon taxes and ETSs in regions with low coverage, such as Africa. There are low- and middle-income countries considering carbon taxes or ETSs in almost every world region (**Figure 9**). South Africa's carbon tax is so far the only one of these policies implemented in Africa, but Botswana,[59] Côte d'Ivoire,[60] Gabon, Morocco,[61] Nigeria, and Senegal[62] have all made indications that there is appetite to adopt either a carbon tax or an ETS. Côte d'Ivoire and Senegal have undertaken feasibility and impact assessment studies with international donor support, and Botswana continues to explore the feasibility of implementing a carbon tax. Both Gabon and Nigeria have published legal frameworks for establishing their respective domestic ETSs. Gabon's decree sets up a framework for both an ETS and a carbon offsetting system,[63] while Nigeria's Climate Act creates a council vested with powers to establish an ETS.[64] Should these carbon pricing efforts progress, the global map of uptake could start to look very different.

Drivers of this growing interest among a broader set of countries include fiscal pragmatism, border carbon adjustments, EU accession, and new policy designs, in addition to climate action. Governments are increasingly recognizing the opportunity for carbon taxes or ETSs to support fiscal reform by raising revenue through a mechanism that provides positive incentives for change. This is especially relevant now, as many countries face high levels of sovereign debt[65] and for countries where a high level of informality can make other types of revenue-raising (like VAT or income tax) less effective.[66] The examples in Mexico described in **Box 6** provide an apt illustration, and revenue from carbon taxes and ETSs is discussed further in Section 2.3. The EU's planned CBAM includes provisions for imports to the EU to be granted reduced charges if the embedded emissions have already been subject to a direct carbon price in their country of origin. For countries that export to the EU, this changes the politics of carbon pricing: it is now a question of whether carbon price revenues go to the EU or to the country's own government. This argument is stronger for countries that have close trade ties with Europe. For instance, Türkiye's Medium Term Programme (2023–2025) explicitly connects its plans for introducing a national ETS in Türkiye to the EU CBAM. The goal of EU accession provides an incentive for countries in the Western Balkans and Eastern Europe to prepare for emissions trading. To be able to join the EU, they must put in place much of the infrastructure for the EU ETS (e.g., monitoring, reporting, and verification and compliance systems). Finally, many countries have cited the need to deliver on Paris targets and net-zero commitments as a driver for pursuing these policies.[67]

"There are low- and middle-income countries considering carbon taxes or ETSs in almost every world region."

(xxi) Non-Annex I Parties under the United Nations Framework Convention on Climate Change are mostly developing countries. (xxii) For further discussion on barriers and case studies see A. Burns, C. Jooste, and G. Schwerhoff, "Climate Modeling for Macroeconomic Policy: A Case Study for Pakistan," World Bank Group, Policy Research Working Paper 9780, September 2021; United Nations Environment Programme, "The Closing Window: Climate Crisis Calls for Rapid Transformation of Societies, The Emissions Gap Report 2022" (Nairobi: United Nations Environment Programme, 2022); and B. Doda, M. Hall, C. Haug, E. Kuneman, and T. Laroche-Theune, "Carbon Pricing Potential in East and South Asia: Synthesis and Case Studies for Indonesia, Vietnam, and Pakistan" (Dessau-Roßlau: German Environment Agency, 2023).

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BOX 6
USING CARBON PRICING AS A FISCAL TOOL: MEXICO SUBNATIONALS CASE STUDY

Mexico is the first country in Latin America and the Caribbean with operational subnational carbon taxes—eight states have introduced a green fiscal reform with carbon pricing elements. Zacatecas led the way in 2017, followed by Baja California (which has since been suspended) and Tamaulipas (repealed in 2022), and subsequently the State of Mexico, Querétaro, and Yucatán in 2022. Durango and Guanajuato are the most recent states to enact carbon taxes. Durango's carbon tax entered into force in January 2023 and Guanajuato's is scheduled for June 2023. More could be implemented in the following years, with a carbon tax under consideration in the state of Jalisco.[68] Measures adopted include new taxes that provide incentives to invest in green, low-carbon technologies and infrastructure, as well as to finance government-sponsored climate change adaptation measures, while reducing inefficient subsidies and distortionary taxation. In Yucatan and Guanajuato, taxes on activities that contribute to ground, underground, and water pollution accompanied carbon taxes. Zacatecas, Baja California, Tamaulipas, and the state of Mexico all introduced carbon taxes as a part of a broader reform package with significant environmental protection elements.[69] In Zacatecas and Querétaro packages included taxes on minerals extraction and waste.[70]

The carbon tax rates are equivalent to or higher than those in several high-income countries. The five states that apply a carbon tax as of April 2023—Durango, Querétaro, State of Mexico, Yucatán and Zacatecas—have placed an average carbon price of around MXN 266.6 (USD 14.78)/tCO_2e. The highest rate among the Mexican states, Querétaro's, is above USD 30/tCO_2e, a significant rate for a developing economy.

Legislators' rationales may provide useful examples and lessons for other jurisdictions. For example, a desire to enhance fiscal space at the subnational level due to spending pressures from the COVID-19 pandemic drove the adoption of the tax in Tamaulipas (which has since been repealed). In the state of Mexico, reform was aimed at increasing local tax revenues and an increased emphasis on the need for greater efficiency in tax collection. However, the constitutional challenge to Baja California's effort to institute a tax on emissions, and the ensuing Supreme Court ruling in favor of the plaintiffs, presents a cautionary tale regarding the complexitiesof subnational green fiscal reform efforts. The Mexican federal government and a group of regulated entities successfully argued that, according to the Mexican Constitution, only the federal government can implement a tax on fuels (the tax applied to emissions generated by the consumption of gasoline and diesel). This ruling could in the future limit the power of local legislators to establish taxeson the carbon content of gasoline and other oil products.[71]

2.5 Progress on international cooperation to impose a cost on emissions has been limited

While discussions have continued in international organizations around minimum carbon prices or aligning policies, there were no concrete steps forward. The International Monetary Fund and others have continued long-running calls for greater cooperation on carbon pricing.[72] In December 2022, the Group of Seven (G7) formally launched its "Climate Club" as one flagship of the German G7 presidency.[73] A key question for many of these initiatives, especially regarding minimum carbon prices, is agreeing on definitions. For example, some initiatives focus on indirect carbon pricing (e.g., eliminating fossil fuel subsidies), while others are focused only on direct carbon pricing (see **Box 1**, **Box 3**, and **Annex A** for definitions used in this report). International Maritime Organization (IMO) member states have agreed in principle to price carbon dioxide emissions from global shipping, but details are yet to be settled. The IMO adopted its initial strategy to reduce GHG emissions from international shipping in 2018. This includes a target to at least halve the sector's GHG emissions by 2050 relative to 2008. Over the past year, IMO negotiations have focused on revising the initial strategy—with many IMO member states calling for full decarbonization by 2050—which will need to be agreed on in July 2023. To achieve these goals, the IMO is developing a basket of climate policy measures that are likely to include a mechanism to price GHG emissions from international shipping. In recent meetings, many governments and industry representatives voiced support for implementing a market-based measure to price GHG emissions from international shipping as part of a basket of measures alongside technical standards. Such market-based measures could include carbon levies and feebate systems.[xxiii,74]

The International Civil Aviation Organization (ICAO) agreed on the main parameters for its Carbon Offsetting and Reduction Scheme for International Aviation. At its 41st Assembly meeting in October 2022, the ICAO Assembly agreed to set the baseline for offsetting requirements at 85% of 2019 emissions for both the voluntary (2024–2026) and mandatory (2027–2035) phases. Airlines must offset any emissions above this baseline. The original plans had foreseen that the baseline should be based on the average emissions of 2019 and 2020. Owing to the strong decline of passenger numbers in 2020 due to the pandemic, this would have entailed a much stricter baseline. At the same meeting, ICAO also adopted its long-term aspirational goal, a non-binding target to reach net-zero carbon emissions by 2050.

(xxiii) Central aspects of IMO negotiations relate to addressing potential disproportionately negative impacts on states from any climate change mitigation policies (including carbon pricing), fairness and equity considerations, and the future availability of zero-carbon bunker fuels. In this context, there is strong interest in the use of the potential revenues from such an instrument to address these issues. Revenues generated by the instrument could be significant—on the order of USD 40 to USD 60 billion annually until 2050—and could therefore play a key role in ensuring an effective and equitable energy transition in the sector.

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Chapter 3

Carbon Crediting—Markets and Mechanisms

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After two years of rapid growth, carbon credit markets slowed in 2022. Supply of new credits and demand from end users both fell slightly, which represents a reversal of the sharp increases experienced in 2021. While independent crediting mechanisms still dominate supply, issuances from the Clean Development Mechanism (CDM) have surged, and more countries are considering establishing domestic crediting mechanisms. Voluntary corporate use remains the main source of demand, but compliance demand is becoming more important.

Challenging macroeconomic conditions also impacted carbon credit markets, although the impact on prices was not uniform. These headwinds were compounded by prominent public criticism of the integrity of some carbon credits and continued uncertainty around best-practice use of carbon credits by companies for voluntary purposes. Despite these difficulties, carbon credit markets continue to evolve and become more sophisticated, with new investors, financial products, technological platforms, and service providers laying the foundations for what some expect will be a decade of significant growth. Guidance from different voluntary initiatives aimed at driving high-integrity action is taking shape, with these efforts accompanied by growing regulatory interest. Implementation of international cooperation under Article 6 of the Paris Agreement is progressing, and the past year saw several new bilateral agreements and the first projects that will generate authorized emissions reductions.

3.1 Supply of carbon credits dropped slightly, but the trend is not uniform across mechanism or project types

Independent crediting mechanisms and standards again issued the most carbon credits but saw volumes drop in 2022. Independent crediting mechanisms issued 275 million credits, which accounted for 58% of the 475 million credits issued in 2022 (see **Figure 11**).[xxiv] This represented a drop of 22% in credits issued compared with 2021.

(xxiv) The figure for total credits issued represents a net value that removes overlap where credits are converted or reported under multiple crediting mechanisms.

BOX 7
DEFINITIONS: CARBON CREDITING MARKETS AND MECHANISMS

Carbon credit markets trade "carbon credits," which are units that are generated through voluntarily implemented emission reduction activities. Carbon credits can represent emission reductions achieved through either avoidance, for instance by capturing methane from landfills, or removal from the atmosphere, such as sequestering carbon through afforestation or directly capturing carbon from the air and storing it. Each carbon credit represents 1 metric ton of carbon dioxide equivalent (tCO_2e) reduced or removed.

Supply of carbon credits is represented by issuances from carbon crediting mechanisms (see Annex A), including international crediting mechanisms established under international treaties, such as the Kyoto Protocol and Paris Agreement;[xxv] domestic crediting mechanisms established by regional, national, or subnational governments, such as the California Compliance Offset Program; and independent crediting mechanisms (or independent standards), which include standards and crediting mechanisms managed by independent nongovernmental entities, for example Verra's Verified Carbon Standard (VCS) and Gold Standard.

Demand for carbon credits comes from a range of sources. Voluntary demand consists of (mostly private) entities purchasing carbon credits to meet voluntary goals or green claims. International compliance demand includes countries seeking credits representing emission reductions in other countries to help meet their own emission reduction commitments, such as those established under the Paris Agreement, and airlines purchasing credits eligible for meeting their obligations established under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Domestic compliance demand comes from companies seeking credits to meet their obligations under a domestic law, usually an emissions trading system (ETS) or a carbon tax. In these cases, there are interactions between the price signals and emission reduction incentives provided through the carbon tax or ETS policy and carbon crediting.

Demand can also come from results-based climate finance where governments or international organizations incentivize climate action by purchasing carbon credits. This approach differs from the vast majority of public climate finance, which is provided up front. The emissions reductions achieved help recipient countries meet their nationally determined contribution (NDC) targets and are not claimed or counted by the governments or organizations providing the finance.

(xxv) Article 6 of the Paris Agreement provides the framework for international compliance carbon markets: Article 6.4 establishes a centralized mechanism supervised and governed by the United Nations Framework Convention on Climate Change, which is expected to be administratively similar to the CDM of the Kyoto Protocol; Article 6.2, on the other hand, provides a basis for bilateral or plurilateral voluntary cooperation among countries, which potentially offers flexibility to reduce greenhouse gas emissions through a variety of processes, mechanisms, and standards.

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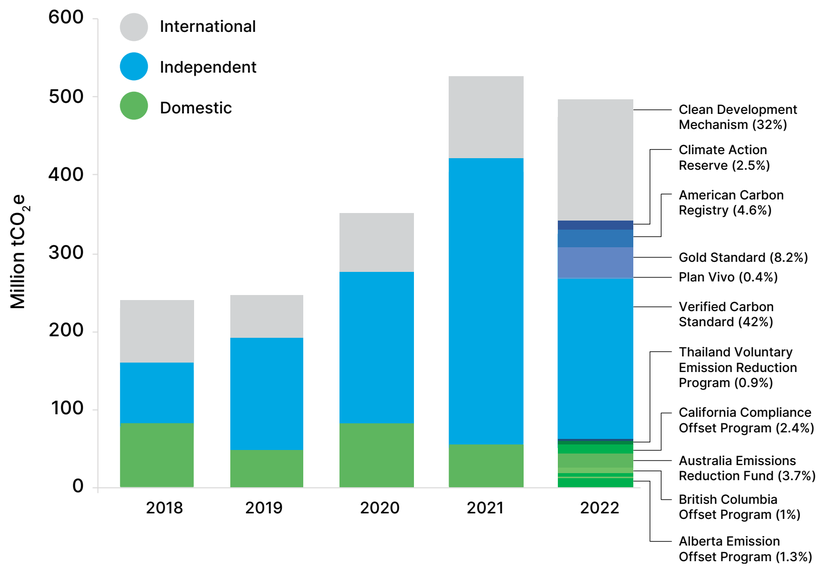
FIGURE 11
GLOBAL VOLUME OF ISSUANCES BY CREDITING MECHANISM TYPE (2018—2022)



However, the supply of credits from international crediting mechanisms grew in 2022, accounting for more than 30% of all credits issued. The sharp increase seen in 2022 may have been driven by developments at the international level, with the decision taken at the 26th Conference of the Parties of the United Nations Framework Convention on Climate Change (COP26) that some CDM credits could be used to meet countries' first nationally determined contribution (NDC) targets,[xxvi] as well as to satisfy increased demand for voluntary offsetting purposes.[75] Issuances from domestic mechanisms represent a small portion of total issuances and remained fairly steady over the past year. However, this masks the increasing issuance from domestic mechanisms that utilize international or independent crediting mechanisms to generate credits.[xxvii] For example, South Africa has listed around 13 million credits issued by the CDM, Gold Standard, and VCS in its domestic Carbon Offset Administration System.[76]

More countries are looking to set up domestic crediting mechanisms, often in conjunction with an emissions trading system (ETS) or carbon tax that would become a source of demand for credits (see Figure 12). In 2022 both Indonesia and Vietnam took steps to establish their own domestic crediting mechanisms, while South Africa consulted on a framework to assess the eligibility of domestic standards to supply credits.[77] India's parliament passed legislation to establish a domestic crediting mechanism, alongside a potential ETS that would act as a source of demand.[78] In June, Canada published the first methodology for its new domestic crediting mechanism, credits from which can be used for voluntary purposes or by firms to meet compliance obligations under the federal Output-Based Pricing System.[79] Multiple factors are driving the trend toward more domestic supply, including demand from national ETSs and carbon taxes, as well as local voluntary demand for carbon credits, or to generate credits under Article 6 of the Paris Agreement.

Current supply is still concentrated on crediting from renewable energy activities, but nature-based sources may become increasingly important. Based on carbon crediting mechanism registry data compiled by Ecosystem Marketplace, the percentage of issuances of credit from renewable energy activities has generally been increasing since 2018, reaching

"More countries are looking to set up domestic crediting mechanisms, often in conjunction with an emission trading system or carbon tax"

(xxvi) Credits generated from CDM project activities or programs of activities registered after January 1, 2013, are eligible to be used to meet countries' first NDC target. At COP27 countries adopted further guidance on how this will be implemented in the registry and how to account for CDM credits. See Box 10 for more details. (xxvii) These credits are included only once in the figures to avoid double counting of the emission reductions achieved by these mechanisms and the volume of credits available to end users. Where sufficient data are available (e.g., California) they are included in "domestic" mechanisms; otherwise, they are listed under the original issuing mechanism.

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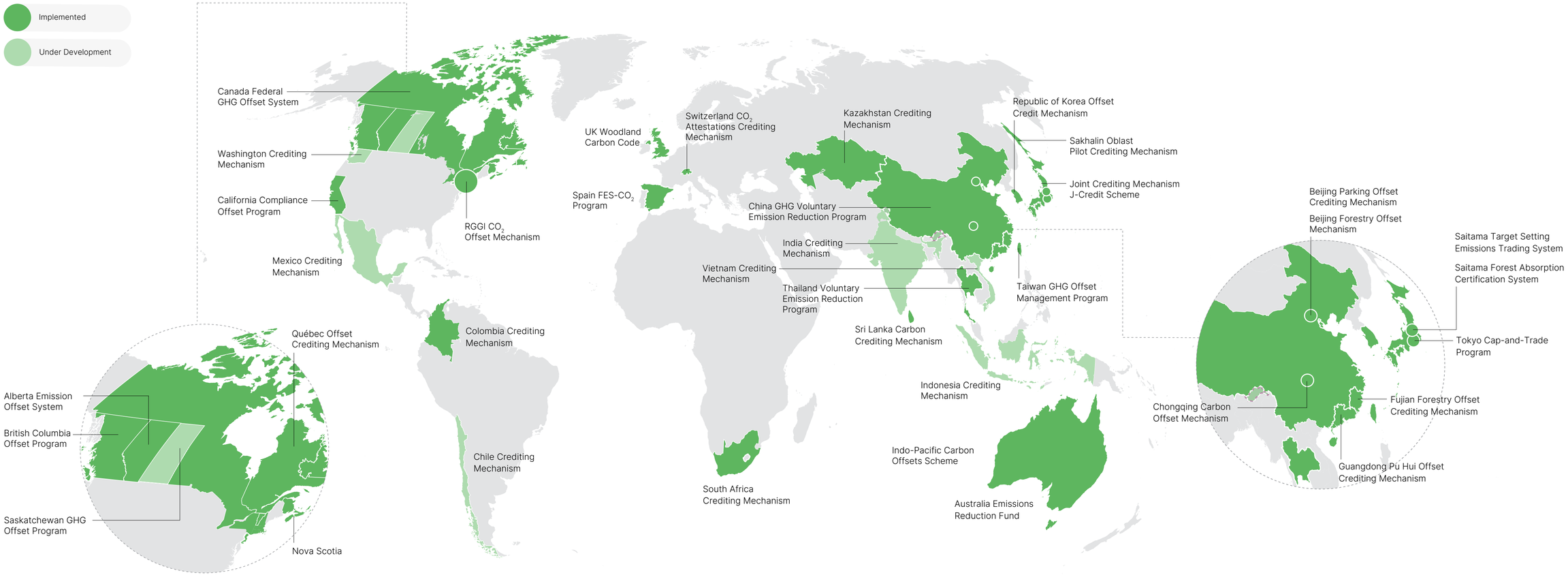
FIGURE 12
MAP OF NATIONAL AND SUBNATIONAL CREDITING MECHANISMS



Circles represent crediting mechanisms in subnational jurisdictions and cities. "Implemented" crediting mechanisms have the required framework (e.g., legislative mandate) as well as the supporting procedures, emission reduction protocols and registry systems in place to allow for crediting to take place. For subnational jurisdictions, the color reflects the status of subnational instruments.

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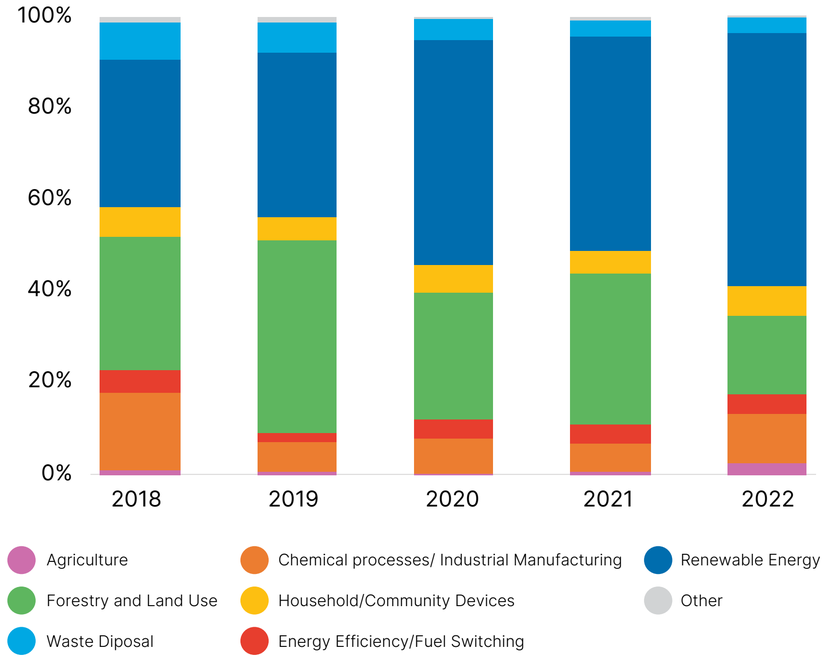
55% of credits issued in 2022 (see **Figure 13**).[xxviii] Renewable energy activities represent around 45% of registered projects and have dominated supply in carbon credit markets since their inception. However, dramatic falls in the costs of renewables over the past decade mean that, in an increasing number of cases, these activities are economically attractive without the extra revenue offered through carbon crediting. In such cases, the resulting emission reductions would not meet financial additionality requirements. As a result, supply of credits from new large-scale renewable energy projects will likely reduce over time, with some independent crediting mechanisms having already restricted eligibility, largely to activities located in least developed countries.[80] Instead, there has been a growing focus on nature-based activities, covering emissions reductions from agriculture as well as forestry and land use activities. These credits sometimes offer cobenefits valued by buyers, but also come with their own unique challenges (see discussion on REDD+ in **Box 8**). While issuances of forestry and land use credits have varied in recent years, with a substantial drop in both absolute and relative terms in 2022, this could soon change. According to Ecosystem Marketplace, in 2022 54% of new project registrations were for forestry and land use activities, suggesting a potentially significant expansion of supply in the future.

FIGURE 13
PERCENTAGE OF TOTAL ISSUANCE BY PROJECT CATEGORY AND YEAR



Bottlenecks in the carbon credit supply chain are proving a barrier to expansion. Requests for project registration and verification at Verra, which operates VCS (the largest independent crediting mechanism), grew by 243% and 90%, respectively, in 2022 compared with 2021.[81] This sudden growth of requests contributed to delays in issuing credits. The influx of new entrants to the market, who were completing applications for the first time, also led to longer-than-usual review periods during which documents had to be revised. A scarcity of accredited validators and verifiers also slowed down the registration of new projects and issuance of credits.[82] Restrictions on credit issuance by some countries, such as in Indonesia, also contributed toward reduced supply in 2022.[83] While these bottlenecks pose immediate challenges, they also suggest that a potentially significant amount of unrealized supply could be brought to market in the coming years as crediting mechanisms and other stakeholders adjust to the increased demand.

"Restrictions on credit issuance by some countries, such as in Indonesia, also contributed toward reduced supply in 2022."

(xxviii) Data on issuances, retirements, and project registrations by project category have been provided by Ecosystem Marketplace and cover the following crediting mechanisms: American Carbon Registry, California Air Resources Board, City Forest Credits, Clean Development Mechanism, Climate Action Reserve, Global Carbon Council, Gold Standard, Plan Vivo, UK Peatland Code, UK Woodland Carbon Code, and Verified Carbon Standard.

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BOX 8
CARBON CREDIT MARKETS AS A VEHICLE TO FINANCE FOREST PRESERVATION

Tropical deforestation is a major source of carbon emissions, and carbon finance has long been considered a way to incentivize forest preservation. Land use change, primarily from deforestation, was responsible for approximately 11% of net global greenhouse gas (GHG) emissions (around 6.5 gigatons of carbon dioxide equivalent) in 2019.[84] Reducing and ultimately reversing emissions from deforestation is therefore a key part of reaching global net-zero emissions. Carbon crediting markets can support this by providing payments for emissions reductions through reducing deforestation and forest degradation as well as improving forestry management—collectively referred to as well as REDD+.

"REDD+ is implemented through project- and jurisdictional-level approaches, each with its own benefits and challenges."

REDD+ is implemented through project- and jurisdictional-level approaches, each with its own benefits and challenges. The carbon crediting mechanisms discussed in this report are generally implemented at the project level. These activities cover a defined area of forested land and are typically implemented by private-sector developers. In parallel, various initiatives have sought to develop programs at the jurisdictional level. These approaches account for emissions across all forested area within a country or subnational jurisdiction (e.g., a province) and are managed by governments or public authorities. By taking a broader perspective and expanding the coverage, jurisdictional-level REDD+ provides an opportunity to scale up crediting from REDD+ and address some of the challenges faced by project-level activities. Foremost among these is the risk of emissions leakage within the jurisdiction (i.e., that the avoided deforestation will simply lead to deforestation elsewhere) and the accuracy of baseline calculations.[85] While many consider that jurisdictional REDD+ has the potential to improve the robustness of the credits generated, it also faces challenges, including the need to build the human and institutional capacities to manage upscaled programs, calculating baseline scenarios at the jurisdictional or national level, and managing the risk of international carbon leakage.

In 2022 carbon credits were issued under jurisdictional REDD+ programs for the first time. Independent crediting mechanisms have been issuing carbon credits from project-level activities for over a decade—these are included in the analysis of issuances and retirements in the core of this report.[86] So far jurisdictional approaches have mostly been focused on results-based payments. In 2021, Mozambique became the first country to receive a payment from the World Bank's Forest Carbon Partnership Facility. Costa Rica, Indonesia, and Ghana have since followed. A further milestone for jurisdictional REDD+ was reached in December 2022, when Guyana became the first country to have tradable carbon credits issued to it under the Architecture for REDD+ Transaction's jurisdictional REDD+ program. This achievement also reflects the potential of jurisdictional REDD+ activities to supply credits on a large scale, with the 33.47 million credits issued to Guyana representing around 8% of all project-level credits issued in 2022.[87]

Several countries announced their intention to issue "sovereign" carbon credits. These are carbon credits created by governments using the framework established under the United Nations Framework Convention on Climate Change to provide results-based payments for reduced deforestation at the national level. The processes to generate these "sovereign" credits differ from those of independent crediting mechanisms in some important respects, including the approach to calculating baselines, the way risks of impermanence are managed, and the role of independent validators and verifiers. As a result, some have raised concerns about the integrity of the credits.[88] Nevertheless, the scale of the supply here is significant, with Gabon planning to issue 90 million credits covering the period 2010–2018.[89]

The past year also saw new analyses of project-level REDD+ activities feed into prominent criticism of the integrity of these carbon credits. In particular, concerns were raised around overcrediting—that is, when the calculation of the avoided emissions overestimates the level of deforestation that is assumed would occur in the absence of the project—which cast doubt on whether the credits therefore reflect real emissions reductions.[90] Although criticisms around baseline setting and permanence in REDD+ are not new, the recent growth of interest in carbon crediting markets has again highlighted the importance of continuous efforts to improve environmental integrity. Verra, which was already in the process of reviewing the REDD+ methodological approach for its independent crediting mechanism VCS, announced that a revised methodology would be published in the third quarter of 2023. Verra expects that this new methodology will improve the accuracy of baseline calculations and assessment of deforestation risks.[91] At the international level, a decision on whether emissions avoidance activities, which may include REDD+, should be included in the Article 6.4 crediting mechanism will be negotiated at COP-28 in 2023.[92] **Box 9** provides an update on broader initiatives to improve information on the integrity of carbon credits.

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Carbon credit markets have the potential to support the deployment and scaling up of technological removals, but only if credit prices increase significantly. As the Intergovernmental Panel on Climate Change's Sixth Assessment Report's chapter on the mitigation of climate change indicates, limiting global temperature increase to 2°C or less will require large-scale technological removal of carbon dioxide (CO_2) from the atmosphere.[93] Many of these technologies are currently in the early stages of deployment and cost significantly more than prevailing market prices. For example, the costs of removal by direct air CO_2 capture and storage are estimated at USD 250 to USD 600 per metric ton.[94] Given the divergence with today's prices, carbon credit markets currently cannot provide an effective price signal to support deployment of technological removals. In lieu of an effective price signal, several voluntary corporate-led initiatives launched in 2022, seeking to support development of these technologies by making long-term purchase commitments for technological removals.[95] Until there is greater convergence between prices in carbon credit markets and the costs of technological removals, they will continue to play a marginal role in supply.

3.2 Voluntary demand is still the primary driver, although compliance demand will likely grow in the years ahead

Despite its recent decline, voluntary demand from corporates is still the primary driver behind market activity, with compliance demand playing a small role. Overall retirements in the registries of crediting mechanisms tracked by Ecosystem Marketplace were down around 1.3% to 196 million in 2022. The vast majority of these retirements represent voluntary demand.[xxix] Based on information provided by governments, around 43 million credits were used in 2022 to meet obligations under domestic compliance programs including ETSs and carbon taxes.[xxx] Around 5 million credits were purchased between the Australian and Spanish governments under their domestic results-based climate finance programs. Among the reasons cited by market analysts for the overall slowdown in voluntary retirements are the macroeconomic climate, bans on tokenization of carbon credits, and increased scrutiny of the integrity of offsetting (see Section 3.4). The latter may be causing buyers to delay purchasing and retiring credits until the release of final guidance from key standard-setting initiatives (see **Box 9**).[96] In spite of the slight year-on-year fall, retirements in 2022 were still much higher than 2019 and 2020 levels, up by around 140% and 70%, respectively. The continued dominance of voluntary demand reflects broad corporate engagement: a survey of more than 500 medium and large businesses across the United States and Europe found that nearly 90% consider carbon credits important to compensate for unabated emissions that they are not currently able to reduce.[97] Looking ahead, independent analyses continue to forecast significant market growth driven by voluntary demand over the next decade.[98]

Most credits retired came from renewable energy projects, with buyers tending toward newer vintages. Of carbon credits retired in 2022, 52% came from renewable energy projects, up from 44% in 2021.[xxxi] Credits from this project category are among the most available and lowest cost on the market (see **Figure 14**). Despite the increased focus on nature-based activities in prior years, retirements of credits from forestry and land use projects declined significantly between 2021 and 2022, from 36% to 23% of the total, with the impacts of public criticism of these activities one possible cause for the

"In spite of the slight year-on-year fall, retirements in 2022 were still much higher than 2019 and 2020 levels,"

(xxix) It is difficult to determine the precise number of credits that are retired for voluntary use as some domestic crediting systems and compliance programs rely on issuance and either cancellation or retirement in the registries of independent or international crediting mechanisms. However, given the relatively small number of credits retired under domestic compliance mechanisms, the lack of CORSIA demand, and the fact that countries using certified emissions reductions (CERs) for compliance do so within their own registries (not the CDM registry), it is clear that most of these credits are retired for voluntary purposes. (xxx) This includes data provided by governments covering the Alberta Emission Offset Program, Australia Emissions Reduction Fund, British Columbia Offset Program, California Compliance Offset Program, Colombia Crediting Mechanism, J-Credit Scheme, Republic of Korea Offset Crediting Mechanism, South Africa Crediting Mechanism, Switzerland CO_2 Attestations Crediting Mechanism, and Tokyo Cap-and-Trade Program. This number could be higher, as, for example, the volume of credits retired under China's GHG voluntary emission reduction program in 2022 is not available. Note that some, but not all, of these retirements will be reflected within the 196 million figure for registries tracked by Ecosystem Marketplace. (xxxi) Based on carbon crediting mechanism registry data compiled by Ecosystem Marketplace.

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"Although still only a small portion of total retirements, the increase of over 30% in retirements of household device credits, including from clean cookstove projects, suggests more buyers are valuing projects with sustainable development cobenefits, even if the price of these credits is higher."

fall (see **Box 8**). Although still only a small portion of total retirements, the increase of over 30% in 2022 in retirements of household device credits, including from clean cookstove projects, suggests more buyers are valuing projects with sustainable development cobenefits, even if the price of these credits is higher. According to Allied Offsets, buyers are also generally seeking newer credits, with retirements of post-2016 vintages growing sharply to reach a new high in 2022.[99]

Domestic compliance demand could grow in the coming years but will be restricted by the ambition of ETSs and carbon taxes as well as limits on offset use. Around half of existing ETSs and some carbon taxes (e.g., those of Colombia, Mexico, and South Africa) allow companies to use carbon credits to meet their obligations. Nearly all have quantitative limits and restrict eligibility to credits from local projects.[100] Low prices in some ETSs and carbon taxes, together with high rates of free allocation and rebates, mean that current demand from these mechanisms is limited.[xxxii] New ETSs and carbon taxes and those under consideration—including from large emitters such as Indonesia, Türkiye, and Vietnam—could boost demand if carbon credits are allowed to be used for compliance. Some of this future demand is already known. For example, Singapore has announced that from 2024 companies subject to the carbon tax will be able to meet up to 5% of their liability using international carbon credits.[101] On the other hand, demand in some domestic compliance mechanisms may fall. For instance, in December Colombia passed a revised law halving the maximum allowable usage of carbon credits in the country's carbon tax to 50%.[102]

International agreements could soon start to drive international compliance demand. Countries with emissions reduction targets will have to complete their accounting for obligations under the second commitment of the Kyoto Protocol in the second half of 2023. This may lead to some additional demand for CERs from countries that haven't achieved their targets and need to buy credits, although in aggregate this is expected to be small.[103] More than three years after the onset of the COVID-19 pandemic, the International Civil Aviation Organization (ICAO) expects passenger demand to surpass 2019 levels in 2023.[104] Nevertheless, projections presented in June 2022 at ICAO forecast that, even under a quick recovery scenario, emissions levels would not surpass the 2019 baseline level until 2024, meaning potentially no carbon credits would be needed for compliance during the pilot phase (2021–2023).[105] New demand could also emerge from countries buying carbon credits to meet their NDC targets. In 2022 the first projects to generate authorized credits under Article 6 were launched as part of Switzerland's intention to meet its NDC target partly through international carbon credits (see Section 3.5). In practice, buyer countries may use domestic compliance markets as a vehicle to source these credits, as Singapore is planning. Companies would surrender international carbon credits to meet their obligations under an ETS or carbon tax, while the government would also claim the emissions reductions, underpinning the credits toward its NDC target.

3.3 Carbon credit prices and trends varied across market segment and project category

While prices for exchange-traded credits fell across all categories, some market participants saw prices rise. The initial drop prompted by Russia's invasion of Ukraine was followed by sustained price declines for the rest of the year. The extent of the decline varied among credit types, with nature-based credits experiencing the greatest drop, from a high of around USD 16 to close the year at under USD 5 (see **Figure 14**). According to Ecosystem Marketplace, some market actors have pointed to the

(xxxii) Free allocation of allowances and rebates both reduce the portion of a regulated entity's emissions facing a carbon price obligation—needing to buy additional allowances or pay a carbon tax—and that could instead be met by surrendering offsets if they are eligible.

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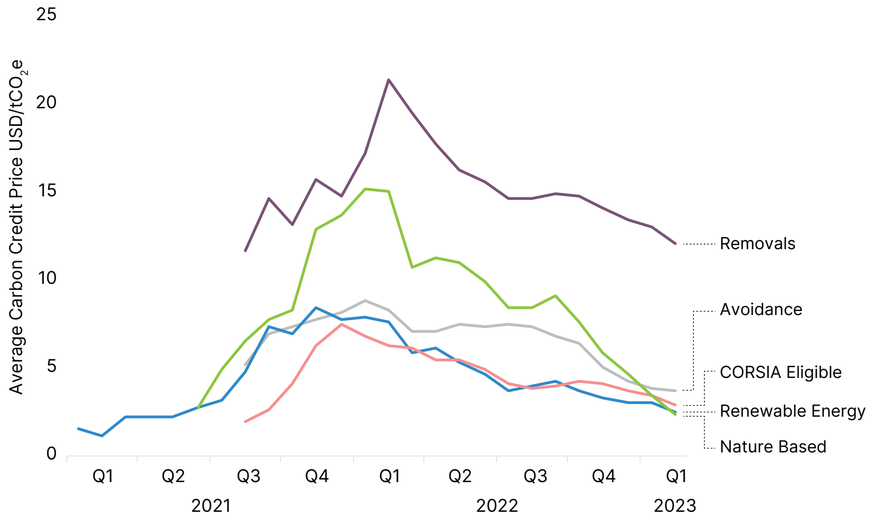
growing use of standardized contracts as a source of downward price pressure. By grouping credits that meet certain minimum criteria, exchanges increase market liquidity and facilitate investments, but the specific attributes of the highest quality projects, and consequently their value, can be lost to a "least common denominator" effect. To avoid this, sellers of credits with features that can attract a higher price may opt to sell through bilateral deals rather than on exchanges. The result is a bifurcation in pricing and available credits between over-the-counter (OTC) and exchange-traded markets. This was seen in 2022 when, despite falls in exchange-traded credit prices, preliminary analysis from Ecosystem Marketplace covering selected participants in the OTC market suggested that the average price for those actors in fact increased by more than 70% to USD 6.83.[xxxv] This increase in average prices is in line with estimates by other market analysts, although the magnitude of the increase varies.[106]

FIGURE 14
PRICES OF STANDARDIZED CARBON CREDIT CONTRACTS 2021–2023[xxxiii, xxxiv]



(xxxiii) Removals is a basket assessment of carbon credits from nature-based or technological projects that remove GHG emissions from the atmosphere. Avoidance is a basket assessment of carbon credits from projects that avoid GHG emissions. Nature Based reflects nature-based carbon credits from projects that either avoid or remove GHG emissions. Renewable Energy reflects carbon credits from renewable energy projects that avoid GHG emissions. CORSIA Eligible reflects carbon credits eligible for use in the CORSIA program. (xxxiv) Source: Based on data from S&P Global Platts, 2022, by S&P Global Inc. Prices shown are monthly averages. More details on Platts' assessments can be found in the Platts' Specification Guide: https://www.spglobal.com/commodityinsights/PlattsContent/_assets/_files/en/our-methodology/methodology-specifications/method_carbon_credits.pdf

Price differentiation across most credit categories has narrowed, with exchange-traded credits from removal projects now trading at a clear premium. Unlike allowances in an ETS, carbon credits are fundamentally heterogeneous. Credits differ along various lines, including the underlying project type, the standard issuing the credits, the vintage, and the cobenefits of the activity. As a result, prices between different types of credits often vary considerably, reflecting both the varying costs of project implementation and buyer preferences (see **Figure 14**). This differentiation was seen for much of 2022, although the falling price of nature-based and avoidance credits led to much greater convergence by the year's end, with only removal credits still trading at a clear price premium. Price differentials can also be seen between credits from the same project type. For example, assessments by S&P Global Platts show that household device projects, which are primarily clean cookstoves, located in the least developed countries command a higher price than similar activities in other countries. In addition to project category, data from 2022 trading of nature-based credits on Xpansiv CBL's global exchange platform shows that credit vintage is also a significant price determinant, with newer credits selling for higher prices.[107]

(xxxiii) Comparison based on 2021 and 2022 survey returns from 29 respondents, representing a total trading volume of 126 million tons in 2022. (xxxv) Some project types are covered by more than one category.

"Sellers of credits with features that can attract a higher price may opt to sell through bilateral deals rather than on exchanges"

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"The price of futures contracts suggests market participants expect prices to rise and the price premium for exchange-traded, nature-based credits, which had largely disappeared in 2022, could reemerge."

Futures contracts suggest modest price increases in the coming years. Despite falling in 2022, prices are anticipated to rise over the next two years. Futures contracts traded on the Chicago Mercantile Exchange for December 2024 delivery of CORSIA-eligible and nature-based credits settled at around USD 2.8 and USD 4.5, respectively. This represents an increase from their current prices of around USD 2, although much lower than the prices seen in 2021. As with spot-traded carbon credits, futures contracts experienced fluctuation in the past year and therefore expectations for future prices could change. However, the price of futures contracts suggests market participants expect prices to rise and the price premium for exchange-traded, nature-based credits, which had largely disappeared in 2022, could reemerge.[xxxvi,108]

3.4 As the market continues to grow in diversity and sophistication, voluntary and regulatory initiatives seek to ensure high-quality action

The prospect of significant growth is attracting wider participation in carbon credit markets. New technologies and service offerings are reducing barriers to access for different participants. The growth of exchange trading supported the launch of KraneShares' first exchange-traded fund (ETF) focused solely on carbon credits in the United States in April 2022.[109] ETFs offer a low-cost and easy-access way for investors to gain diversified exposure to particular asset classes and have been increasingly active in compliance carbon markets.[110] Similarly, new private funds focused on carbon credits, either to support the initial costs of project development or to purchase credits from primary and secondary markets, are attracting investors.[111] These funds can offer payments in cash or carbon credits, with the latter giving investors the opportunity to benefit from rising credit prices without direct involvement in project development. These funding vehicles may serve as models to attract larger-scale financing, including from institutional investors.[112] Efforts are also underway to support broader geographical participation, with the Africa Carbon Markets Initiative launched with the aim of having 300 million carbon credits from African projects retired annually by 2030.[113]

Growing investment and new financial models, in turn, are supporting additional sources of supply. Carbon service provider Abatable estimates that more than USD 10 billion of upstream investment in carbon credit generation occurred in 2022, an approximately 40% increase from 2021. The number of new project developers involved in registering carbon crediting activities has also increased.[114] Growing investor interest in carbon credits and new financial models may now be easing access to finance for project developers.[115] Emission-reduction projects often face challenges in financing upfront development costs, as revenues from selling carbon credits are often uncertain and only start flowing years after the project is implemented. As the demand for credits grows, investors and project financiers appear more willing to take direct stakes in project development ventures at an earlier stage.[116] New financial instruments are providing another route for early-stage financing. For example, January 2023 saw the world's first public sale of a "forward carbon token."[xxxvii] The proceeds from the sale can be used to support up-front project development costs, while the forward carbon tokens can later be swapped for regular carbon tokens—which can be traded or retired for offsetting purposes—once the underlying emissions reductions have been verified.[117] Another example is the USD 50 million

(xxxvi) Settlement prices on March 31, 2023, for December 2024 delivery of CBL Global Emissions Offset Futures and CBL Nature-Based Global Emission Offset Futures. Accessed from CME Group. (xxxvii) A carbon token is a blockchain-based carbon asset.

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Emission Reduction-Linked Bond in Vietnam, which tries to align up-front financing requirements with future financial returns from the generation of carbon credits.[118] Investors in the bond earn a return linked to the carbon credits generated by a water purifier project in Vietnam.

More trade is being facilitated through exchanges, and the number of platforms is expanding. While OTC trading of carbon credits remains an important means of transaction, recent years have seen a sharp increase in the volumes traded on public exchanges. This stalled somewhat in 2022, with the volumes traded on Xpansiv CBL's global exchange platform, the world's largest for carbon credits, dropping by 6%. However, the total value of carbon credits traded on the exchange increased significantly, up 44% to USD 795 million.[119] The ability to trade carbon credits on different exchanges is also expanding. The Intercontinental Exchange and the European Energy Exchange, two large commodities trading platforms, both listed new futures contracts for carbon credits.In addition, several new exchanges and platforms focused on carbontrading were launched in different parts of the world, including Abu Dhabi, Hong Kong, Kenya, Malaysia, Saudi Arabia, Singapore, and Thailand.[120]

More standardization will support increased exchange-based trading, providing clearer price signals for the whole market. Greater standardization of trade in carbon credits was one of the recommendations made by the Taskforce on Scaling Voluntary Carbon Markets. In December 2022, the International Swaps and Derivatives Association launched its standard definitions for the voluntary carbon market. It provides a set of terms and conditions for physically settled spot, forward, or options transactions, addressing issues such as how trades can be settled and what to do if settlements are disrupted.[121] Providing standard definitions will allow for greater harmonization, which in turn can support the growth of both OTC and exchange-based secondary trading. In particular, higher volumes of trade on exchanges can provide reliable, transparent, and up-to-date benchmark prices. Clear price signals allow project developers to better assess investment opportunities and enable buyers to manage their price risks. More liquid secondary markets also enable the development of market indices, which can be used to assess overall market performance and structure index-linked investment vehicles. The first such index focused on the voluntary carbon market was launched in June 2022.[122] However, concerns around carbon credit quality pose a challenge to greater standardization, as buyers seek to manage their risk by sourcing credits from particular projects or project types bilaterallyor through specialized intermediaries (see **Box 8**).

The increasing size of the market is bringing more attention to concerns about carbon offsetting. The recent growth in the size and activity in carbon credit markets has intensified the long-standing debate on the quality and role of carbon credits (see **Box 8**). The expanding number of companies looking to use carbon credits as part of meeting voluntary corporate sustainability commitments is also raising familiar concerns around "greenwashing," where organizations give a false portrayal of the environmental benefits of their products or services. Companies must also be increasingly careful in how they describe their offsetting activities. In October 2022, Shell lost an appeal against the Dutch Advertising Code Committee, which found that its advertisement promoting compensation for fuel emissions through carbon credits was misleading.[123] Similar cases against corporate marketing of "carbon neutral" and "net-zero" claims involving carbon credits are ongoing in France and Germany.[124]

"While OTC trading of carbon credits remains an important means of transaction, recent years have seen a sharp increase in the volumes traded on public exchanges."

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Regulators are becoming more proactive through developing guidance on company claims and carbon credits markets. Until recently, guidance for how to use carbon credits in a robust way had primarily been pursued by voluntary initiatives, which made further progress in 2022 (see Box 9). Government efforts have largely focused on improving transparency. In March 2022, the International Financial Reporting Standards Foundation released a draft of its climate-related disclosures guidance for publicly listed companies. It calls for disclosure of the extent to which a company's climate targets rely on credits and information needed to assess the integrity of any credits used.[125] Similar reporting requirements were consulted separately in other countries,[126] while in March 2023 the European Commission launched a proposal for legislation that would improve transparency around environmental claims, including as they relate to carbon credits.[127] Regulation beyond corporate disclosures is already being explored. At COP27, the International Organization of Securities Commissions, the leading international forum for securities regulators, launched a consultation on howto enhance the resilience and integrity of voluntary carbon markets.[128] As the size, financial value, and complexity of the market increases, greater interest from regulators is likely in the years ahead.[129]

Carbon credit rating agencies are offering buyers an additional source of information on carbon credit integrity. Historically, buyers have relied on the processes of carbon crediting mechanisms and standards (including independent verifications) and advice from market intermediaries to assess the quality of credits. In addition, specialized carbon credit rating agencies now offer ratings for individual projects using assessments across several criteria, including the likelihood of additionality and risk of carbon leakage, utilizing advances in machine learning, and geospatial data acquisition and analysis. As of March 2023, the three biggest third-party rating agencies—BeZero Carbon, Calyx Global, and Sylvera—had assessed more than 300 projects representing more than half of all outstanding credits.[130] Their ratings are being integrated into exchanges and online retail marketplaces,[131] providing buyers with more information at the point of purchase. Voluntary stakeholder initiatives are seeking to provide further guidance on identifying high-quality credits (see **Box 9**).

New products are emerging to help participants manage both familiar and novel risks, tackling currently existing barriers to expanding the market. Carbon credit markets have always involved risks for both sellers and buyers. For sellers, the number of credits generated from a project is often lower than expected, impacting its financial performance. The credits a company buys may be subject to

BOX 9
RAISING THE INTEGRITY OF SUPPLY AND DEMAND IN VOLUNTARY CARBON CREDIT MARKETS

Several initiatives are aiming to help buyers to identify high-quality credits.[132] The Integrity Council for the Voluntary Carbon Market (ICVCM), among the most prominent of these initiatives, launched a public consultation in July 2022 on its effort to create a minimum global benchmark for high-quality carbon credits. The proposed benchmark consists of 10 crediting attributes, termed the Core Carbon Principles (CCPs), and an assessment framework. The ICVCM will use the assessment framework to evaluate both crediting mechanisms and credit categories, with those that meet the standard allowed to use a CCP-approved label. In March 2023, the CCPs were released, along with the first part of the assessment framework covering crediting mechanisms. The first CCP-labeled credits are expected to be available in the third quarter of 2023.[133] Other initiatives are also working to improve transparency on credit supply, such as the Carbon Credit Quality Initiative, which provides a free online tool to assess carbon credit types against seven different criteria.[134]

Further guidance is also emerging on how companies should use carbon credits. In June, the Voluntary Carbon Markets Integrity Initiative (VCMI) launched its provisional Claims Code of Practice for public comment. It provides guidance for companies on when and how they should use carbon credits as part of their net-zero targets. The code establishes three claim types—gold, silver, and bronze—depending on a company's progress in reducing emissions within its value chain and the number of its remaining emissions it offsets through high-quality credits. By standardizing the claims that companies make, the VCMI hopes to increase transparency over how carbon credits are used, ensuring they complement, and do not delay, companies' own decarbonization actions.[135] The final Claims Code of Practice will be published in 2023. The VCMI complements work by the Science Based Targets Initiative, which provides guidance for companies setting Paris Agreement–aligned decarbonization plans, and the role of offsets in meeting those targets. The question of offset use was also addressed over the past year by the United Nations High-Level Expert Group on the Net-Zero Emissions Commitments of Non-State Entities—the expert group recommended that high-quality credits should not be counted toward interim emissions targets on a net zero–aligned pathway, but rather used only to compensate for additional emissions.[136]

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external criticism, causing reputational damage. New products are now being developed to insure against different risks faced by buyers, such as losses due to third-party negligence or fraud.[137] For example, in January 2023 the start-up company Kita launched a product covering buyers against the nondelivery risk of forward purchased carbon removal credits.[138] Such measures aim to encourage more investment into emission-reduction projects. Today's market actors also face new types of risks. These include direct government interventions—for instance, the temporary pause on new issuances announced by Indonesia[139] and a moratorium on new projects imposed by Papua New Guinea[140]—or failing to apply corresponding adjustments under Article 6 (see Section 3.5). Insurance against these more political risks is being explored by the Multilateral Investment Guarantee Agency, including to cover the event of a revocation of Article 6 authorizations.[141]

The rapid growth of demand for carbon credits has encouraged stakeholders to explore and leverage digital technologies including blockchain, seeking to reduce transaction costs and improve transparency. Some carbon market actors—such as registries, exchanges, or Web3 providers—are using blockchain technology for processes like tracking carbon credit transactions or monitoring, reporting, and verification (MRV).[142] Proponents argue that the immutable record of data within a blockchain can improve the auditability of emission-reduction project data, streamlining verification processes and thus reducing transaction costs and enhancing trust among market participants. Others point out limitations, in particular that blockchain by itself does not assure data quality or integrity and the data entering the system needs independent quality assurance to ensure that it is reputable before it enters the system. Examples of blockchain technology use cases include a number of initiatives. For example, in December 2022, the World Bank, together with the government of Singapore and the International Emissions Trading Association (IETA), launched the Climate Action Data Trust (CAD Trust)—a free, open-source global platform that connects, aggregates, and harmonizes carbon credit data.[143] The platform's primary goal is to support reporting in carbon markets and enable transparent accounting of emission reduction units in line with the Paris Agreement.[144] The CAD Trust is designed to be decentralized, with data stored locally by registries and governments, and auditable by leveraging blockchain technology to record an immutable history of transactions. By connecting various registries worldwide, the system should help to detect "double claiming"—when multiple entities claim the same emissions reductions.

New restrictions halted the dramatic surge of tokenization of existing carbon credits, but emerging guidance raises opportunities and challenges. The growth of carbon credit tokens was a major development across late 2021 into 2022. Tokens are created via a "bridging" process, where carbon credits are canceled or retired in a crediting mechanism registry and reissued as blockchain-based crypto assets. Tokenization of credits offers the possibility of increasing transparency and expanding market participation, thereby creating new sources of demand and improving market liquidity. The bridging process drove a surge of retirements. For example, between October 2021 and May 2022, the Toucan Protocol had bridged 22 million carbon credits—equivalent to more than 10% of carbon credits retired in the 2022 calendar year.[145] Following public criticism of the quality of the bridged credits and concerns over the use of carbon tokens,[146] in May and June the major independent crediting mechanisms announced bans on tokenization of their credits without explicit approval.[147] Verra, the American Carbon Registry, and the Gold Standard subsequently launched public consultations addressing the conditions and process for tokenizing their credits. Although responses varied, the general consensus was that independent crediting

"New restrictions halted the dramatic surge of tokenization of existing carbon credits, but emerging guidance raises opportunities and challenges."

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mechanisms should allow tokenization but adopt safeguards to manage potential risks. Accordingly, Gold Standard and others will be rolling out pilots in 2023 to test out various digitalasset creation models that can best integrate with their registry and developing best practice guidelines for tokenization, building on initial recommendations laid out by IETA's Taskforce on Digital Climate Markets.[xxxviii]

3.5 Implementation of Article 6 is progressing on various fronts

Progress was made on Article 6 on several fronts at COP27, particularly around infrastructure and reporting requirements. Article 6 of the Paris Agreement covers cooperation between countries, including through carbon trading. The deal reached at COP26, in 2021, provided a framework for reporting and accounting for "internationally transferred mitigation outcomes" (ITMOs, Article 6.2), as well as an initial ruleset for the new Article 6.4 crediting mechanism. The decisions adopted in November 2022 at COP27 saw further progress on reporting templates, infrastructure design, and guidelines for the Article 6 review process, as well as several operational provisions of the Article 6.4 mechanism. This included introducing the concept of "mitigation contribution A6.4ERs," which are emission reductions generated through the Article 6.4 mechanism but not authorized for international compliance use. Instead, these credits may be used for purposes including results-based climate finance, domestic carbon pricing schemes, or voluntary action.

Substantial work remains to finalize the rules for Article 6. An extensive program of further work on Article 6 agreed upon in 2021 will take several years to implement. Following progress in 2022, many of the outstanding decisions are technical in nature, such as adopting new tools for reporting quantitative information in a standardized electronic format. The negotiations at COP27 in November 2022 also brought to light new issues. Among these was authorization, the process by which a country agrees to apply corresponding adjustments[xxxix] for credits it buys or sells. Debate centered around when emissions reductions would be authorized and whether this authorization could be revoked or amended at a later stage. Retroactive changes to authorization status would have impacts for both sellers and buyers, as corresponding adjustments are needed for credits to be eligible for certain uses (e.g., to meet offsetting obligations under CORSIA). An agreement on requirements for methodologies for Article 6.4 activities was also not reached (see **Box 10**). These issues will now be considered at COP28 negotiations in 2023.

(xxxviii) Gold Standard has selected five Web3 companies to collaborate with based on their participation in its Working Group on Digital Assets for Climate Impact: Bitgreen, Earthchain, Flowcarbon, Thallo, and Toucan. See https://www.goldstandard.org/blog-item/tokenisation-consultation-feedback-and-next-steps-gold-standard. (xxxix) "Corresponding adjustment" is an accounting mechanism established under Article 6.2 of the Paris Agreement to avoid double counting. Emission reductions that have been authorized for transfer by the selling country's government (known as internationally transferred mitigation outcomes, or ITMOs) may be sold to another country, but only one country may count the emission reduction toward its NDC. When selling ITMOs, the transferring country increases its emissions (emissions balance/NDC) by an amount equal to the ITMOs for purposes of reporting NDC progress, and the acquiring country makes an equivalent subtraction to reflect its use of the ITMOs to meet the country's NDC target.

BOX 10
TRANSITIONING FROM THE CLEAN DEVELOPMENT MECHANISM TO ARTICLE 6.4

Established in 1997 through the Kyoto Protocol, CDM has played a pivotal role in the development of carbon credit markets. It is the world's largest carbon crediting mechanism, with around 8,000 registered projects and more than 2.3 billion certified emission reductions (CERs) issued.

At COP21, countries agreed to establish a new mechanism under Article 6.4 of the Paris Agreement. Among the most pressing issues was to determine the relationship between activities under the CDM and the new mechanism. At COP26, countries agreed that emissions reductions achieved after 2020 from CDM projects could not be issued as CERs, but CDM projects would be eligible to apply to transition to the new Article 6.4 mechanism, once the relevant processes were in place. The projects that successfully transitioned would then be able to issue credits through Article 6.4. No restrictions were placed on issuances of CERs from emissions reductions achieved up until the end of 2020.

The outcome from COP26 created a supply gap for post-2020 emissions reductions from international crediting mechanisms. The quicker the Article 6.4 mechanism is made operational, the shorter the duration of the gap will be. Initial progress was slow, as the Article 6.4 Supervisory Body, which oversees the mechanism and is responsible for many operational decisions, could not meet until July 2022 due to country disagreements over the body's membership. It subsequently adopted several recommendations to move forward with implementation, although no agreement emerged on the key topic of methodologies. This is a core design feature of Article 6.4 on which resolution will now be sought in 2023.

At COP27 further guidance was agreed on concerning the rules and processes for transitioning CDM projects.[148] Nevertheless, more work is needed, including building a new registry, before credits can be issued from the Article 6.4 mechanism and the gap can be closed.

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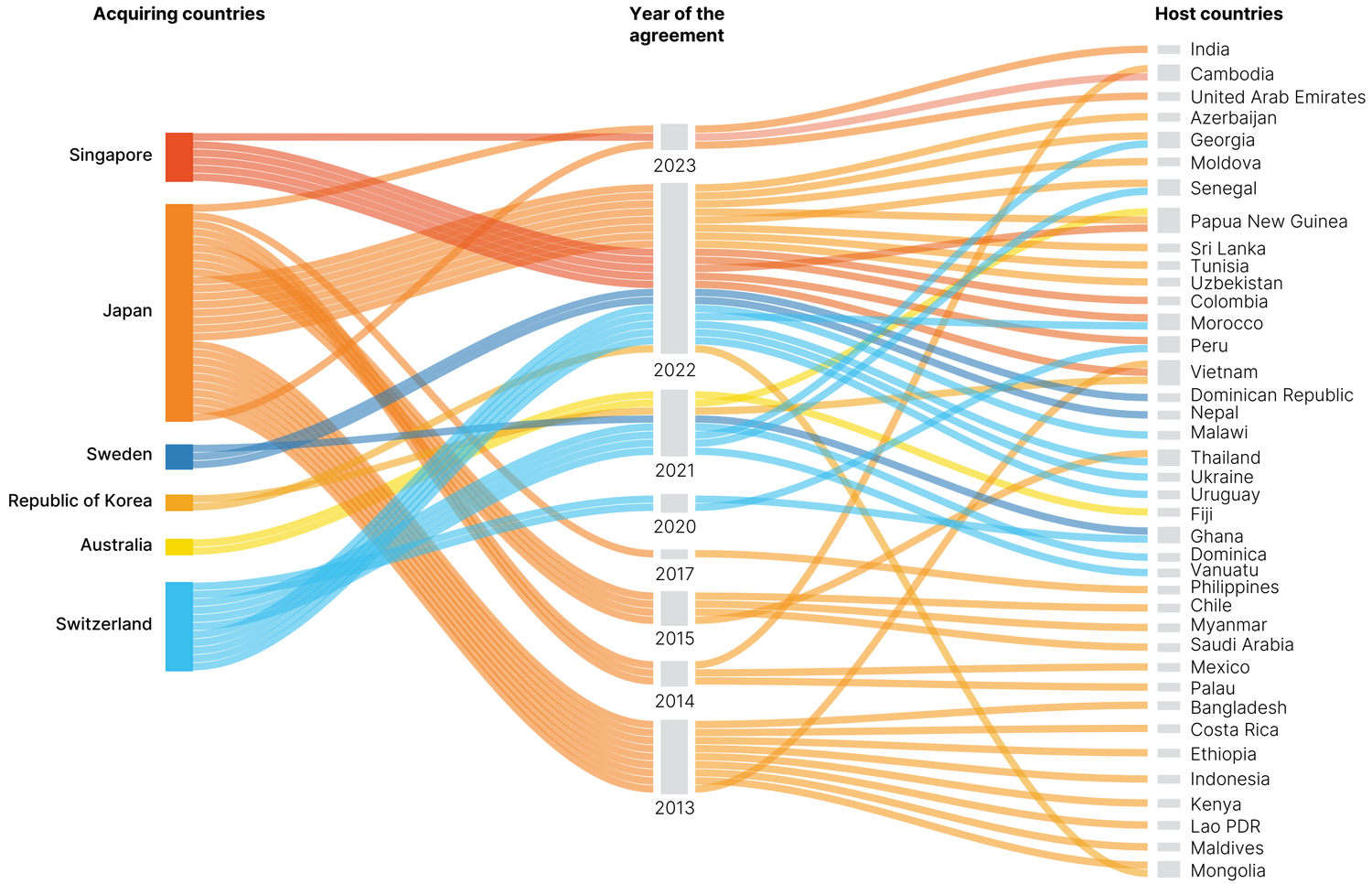
The number of countries planning to cooperate under Article 6.2 continues to grow. Even though further guidance for Article 6.2 is still being developed at the international level, countries are nevertheless pushing forward with implementation. In 2022, many countries looking to cooperate under Article 6.2 reached bilateral agreements (see Figure 15). The past year also saw memoranda of understanding (MoUs) signed between United Arab Emirates–based company Blue Carbon with the governments of Liberia, Tanzania, and Zambia,[149] while the Republic of Korea is currently in negotiations with several countries to establish cooperation agreements.[150,xl] At COP27, Ghana and Vanuatu, in partnership with Switzerland and the United Nations Development Programme, presented the first projects to generate authorized emissions reductions under Article 6.2,[151] and in February 2023, Thailand and Switzerland authorized the first Article 6 program in Asia.[152] Singapore has also signed a number of MoUs with crediting mechanisms in the context of supplying credits for its carbon tax.[153] The increasing number of agreements reflects the fact that ever more governments consider Article 6 an important tool to reach their NDC targets. As these agreements develop into full cooperative approaches under Article 6.2, it will become clearer how countries are using Article 6 to enable greater NDC ambition, while at the same time addressing the possible perverse incentive to lower future ambition in order to maximize the potential to generate credits.[154]

(xl) The Republic of Korea is pursuing deals with the following countries: Bangladesh, Brazil, Chile, Colombia, India, Indonesia, Laos, Mongolia, Morocco, Myanmar, Peru, Philippines, Saudi Arabia, Sri Lanka, Thailand, the United Arab Emirates, and Uzbekistan. In addition to these agreements and those reflected in Figure 16, agreements between Singapore and Ghana and Thailand are expected in 2023, and Switzerland has signed a joint declaration with Chile in 2022. Chile and New Zealand have also signaled possible cooperation through the "Climate Action Team" framework.

FIGURE 15
ARTICLE 6.2 BILATERAL AGREEMENTS AS OF APRIL 1, 2023[xli]



(xli) Reflects bilateral agreements that have been signed between national governments related to cooperation under Article 6 (as of April 1, 2023). The agreements have differing objectives and legal statuses. For Japan, bilateral agreements are intended to establish the Joint Crediting Mechanism, which includes activities that pre-date the Paris Agreement. For Australia, it includes Australia's partnerships with Fiji and Papua New Guinea announced under the Indo-Pacific Carbon Offsets Scheme.

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"For many countries, participating in Article 6 will involve much more preparation than the Kyoto Protocol required, where host country responsibilities were limited."

Governments are starting to implement national frameworks and establish institutional structures to support their participation in Article 6. For many countries, participating in Article 6 will involve much more preparation than the Kyoto Protocol required, where host country responsibilities were limited. Under Article 6, participation may involve adopting national legislation, establishing institutional arrangements, developing infrastructure to record and manage information on ITMOs, and meeting new reporting obligations.[155] Some governments have begun designing their intended policy and institutional frameworks. These can address issues such as identifying priority activity types, designing national MRV approaches, and setting up processes for authorizing and transferring ITMOs. For instance, Rwanda is preparing an "emissions trading and readiness framework" for Article 6, and in February 2023, India published a list of 13 activity types eligible to be credited under Article 6.2.[156] Over the last year, Ghana in particular has been at the forefront of these developments, publishing a comprehensive administrative framework for Article 6.2 participation, underpinned by a new draft law.[157] Countries still need to make progress on the necessary infrastructure, such as data management systems for MRV and the registry systems to track approved projects, issued credits, and authorizations.[xlii] Development partners are expanding their support to host countries to help build these structures and processes.[158] Host countries are cautious when authorizing emissions reductions, noting the potential impacts of corresponding adjustments. In a few instances project developers have already been able to secure commitments for corresponding adjustments from host countries.[159] It is not always clear, however, if countries have the necessary institutional structures and infrastructure in place to facilitate and track their participation in these transactions, or to assess the potential opportunity costs of applying corresponding adjustments. In some cases, applying corresponding adjustments could make it more difficult for a country to meet its NDC target.[xliii] Many countries are therefore exercising caution when considering authorizing emission reductions. Ghana has set clear conditions under which it will authorize ITMOs, which can only be generated from the conditional component of its NDC. Furthermore, only 99% of the emissions reductions achieved will be authorized, providing a safeguard against the risk that it will transfer too many ITMOs and undermine efforts to meet its own NDC. New capacity-building initiatives are aiming to provide countries with the means to assess how best to use Article 6 in a way that supports their NDC achievement, including support delivered through the World Bank's Partnership for Market Implementation.[160]

The implications of evolving guidance under Article 6 for voluntary carbon credit demand are still unclear, but the requirements of different buyers could converge. Such convergence might also be informed by the guidance and requirements specified by independent initiatives like ICVCM and VCMI. Ultimately, it will be up to individual companies and other buyers to decide on desirable credit attributes (e.g., project type, vintage, quality, etc.) and whether they source credits with or without a corresponding adjustment to meet voluntary commitments. As such, the size of voluntary demand for correspondingly adjusted credits, as distinct from mitigation contribution A6.4ERs or other carbon credits entirely outside of the Article 6 framework, remains to be seen.

(xlii) For example, the World Bank and the European Bank for Reconstruction and Development offer support on establishing digitalized MRV systems, and the United Nations Development Programme is offering a digital platform for Article 6.2 that facilitates the cooperative approaches between countries; the World Bank has developed an open-source registry that can be adopted as is or adapted to countries' needs and circumstances. (xliii) One example of this is if corresponding adjustments were applied to an activity that is among the policies and measures needed to meet a country's unconditional NDC target.

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Recognizing the potential need and demand for such correspondingly adjusted credits, some organizations that operate independent crediting mechanisms, such as Gold Standard and Verra, are investigating and/or making changes to their processes and registries so that a credit's authorization status can be transparently recorded, although neither are explicitly requiring emission reductions to have a corresponding adjustment status in order to issue credits.

Broad participation in Article 6 will require extensive capacity building. Although there is widespread interest in Article 6, particularly as a vehicle for crowding in carbon finance to meet NDC targets, many countries lack the information and institutional capacities needed to participate in these markets. Those with limited experience of carbon crediting under the Kyoto Protocol are at a particular disadvantage.

Several initiatives are now looking to support countries to prepare for participation. Institutions including the Global Green Growth Institute,[xliv] the United Nations Development Programme,[xlv] and the Institute for Global Environment Strategies[xlvi] are providing assistance in a variety of areas, such as designing regulatory frameworks; strengthening institutional capacities for authorization, transfer, and reporting; conducting capacity needs assessments for ITMO transfer readiness; and offering peer-to-peer training workshops. In an effort to encourage coordination between the various support programs, at COP27 the government of Japan launched the Article 6 Implementation Partnership to build on best practices for Article 6 participation.[161]

"In a few instances project developers have already been able to secure commitments for corresponding adjustment from host countries."

(xliv) Including the Designing Article 6 Policy Approaches program, the Mobilizing Article 6 Trading Structures program, and the Supporting Preparedness for Article 6 Preparation program. (xlv) The ITMOs for Development program is a collaboration with the Swiss Federal Office for the Environment. The Article 6 Transfer Readiness Project is in collaboration with the Swiss State Secretariat for Economic Affairs. (xlvi) The Mutual Learning Program for Enhanced Transparency is currently being implemented in Chile, Indonesia, Malaysia, Mongolia, and Thailand.

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Chapter 4

Conclusion

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Carbon pricing is an important policy tool that can be used as part of a comprehensive policy package to decarbonize economies. Through a variety of policy instruments, carbon pricing creates an economic incentive to support changes in investment, production, and consumption decisions. As highlighted in this report, there is no one-size-fits-all—the choice of instrument, the level of coverage, and the underpinning price can, and should be, tailored to meet domestic circumstances, priorities, and needs.

The State and Trends Report focuses on developments and trends in direct carbon pricing. It does this by engaging with almost 100 jurisdictions globally. The three direct carbon pricing instruments covered in the report are carbon taxes, emissions trading systems (ETSs), and carbon crediting mechanisms. While all three can promote incentives to reduce greenhouse gas emissions, each can be tailored to deliver broader benefits, such as raising revenue, addressing local pollution, or attracting international finance. As a result, there is significant heterogeneity in carbon pricing polices across jurisdictions.

The trends identified in this year's report show that momentum behind growing coverage and prices, especially in the form of ETSs and carbon taxes, is strong. Despite economic turmoil and energy price shocks, governments have generally maintained and, in some cases, advanced direct carbon pricing policies. This includes, for example, Indonesia launching its ETS for coal-fired power stations; Australia signaling a return to carbon pricing with legislation to transform its existing policy into a rate-based ETS; and India passing legislation to establish a domestic crediting mechanism, which could support a domestic ETS in the future. It also includes significant activity from subnational jurisdictions in Mexico that are increasingly looking to carbon pricing as a fiscal policy. This progress on direct carbon pricing comes at a time when governments are managing competing economic, social, and environmental objectives. These political challenges are further demonstrated by the increasing use of targeted energy price relief, including in countries that have implemented direct carbon pricing. This includes a delayed increase in fuel excise taxes in Mexico and targeted relief to low-income households in the Republic of Korea. While such measures can provide important relief to low-income households, they can also reduce thenet carbon price incentive on energy.

Carbon credit markets continued to expand their reach during 2022, with more governments considering domestic crediting mechanisms, but issuances and retirements globally fell compared to the highs of 2021. Carbon credit price trends also showed significant variances—while over-the-counter transactions saw some price increases, exchange-traded credits declined, particularly in relation to credits from nature-based credits, which saw a turbulent year. Importantly, there were early signs of progress on Article 6 operationalization, with not only increased evidence of bilateral agreements—such as through the first authorized Article 6 program in Asia (Thailand-Switzerland)—but also examples of establishing implementation frameworks and infrastructure to facilitate international cooperation, notably Ghana's newly published administrative framework for Article 6.2 participation. The growing interest in carbon crediting comes with increased momentum to address issues that undermine the integrity of carbon credit markets: enhancing approaches to ensure credit quality, promoting responsible use of offsetting, integrating new

"Despite economic turmoil and energy price shocks, governments have generally maintained and, in some cases, advanced direct carbon pricing policies."

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"Governments continued to pursue direct carbon pricing instruments with a range of different policy design specifications, reflecting increasingly diverse political, institutional, legal, and administrative environments"

infrastructure and technologies to support verification of voluntary claims, and progressing rules on Article 6. This includes workstreams under the UNFCCC to operationalize Article 6 of the Paris Agreement. It also includes efforts by the Integrity Council for the Voluntary Carbon Markets to establish guardrails to increase transparency and integrity and by the Voluntary Carbon Market Integrity initiative to provide guidance to corporates and help reduce greenwashing.

Governments continued to pursue a direct carbon pricing instruments with a range of different policy design specifications, reflecting increasingly diverse political, institutional, legal, and administrative environments. Governments also continued to operate indirect carbon pricing in the form of fossil fuel excise taxes and subsidies worth over USD 1 trillion each year, which influence the underpinning incentive even though they are not primarily adopted as a climate mitigation policy.

This highlights the growing complexity in tracking trends in carbon pricing and highlights an increased importance of understanding how developments in direct carbon pricing interact with indirect carbon pricing and with other policies to achieve climate and broader policy objectives. It also emphasizes the importance of bridging the data gaps to ensure that policymakers and others have up-to-date information on how carbon pricing is being implemented. This includes having access to current information on the level and coverage of indirect prices like fuel excise taxes and subsidies. By better integrating analyses of how jurisdictions apply direct and indirect carbon pricing, combined with more in-depth insights and critiques of different carbon pricing design options, the World Bank will continue to work with partner countries and organizations to ensure that policymakers, private-sector actors and investors, and civil society actors have access to robust and reliable evidence to inform their decision-making.

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Annexes

A. Annex
Definitions

B. Annex
Methodologies and Sources

C. Annex
Carbon Tax and ETS Update

D. Annex
Crediting Mechanism Updates

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A. Annex. Definitions

This Annex summarizes the key terms used in this report. Different organizations may use different terms and definitions to represent similar concepts. The rapid evolution of carbon pricing policies, in particular the diversification of designs, means that definitions will necessarily evolve over time.

Direct Carbon Pricing

Direct carbon pricing instruments are policies that provide a clear price signal with the aim of reducing greenhouse gas (GHG) emissions. These policies are usually denominated in unit of emissions—for example dollars per metric ton of carbon dioxide equivalent (tCO_2e). In some cases, prices may be expressed using another metric (e.g., dollars per liter of fuel), but the headline price is calculated by applying a certain price per unit of emissions to the relevant fuel. Either of these approaches can deliver a uniform price across emissions sources. The carbon pricing liability therefore increases proportionally with the volume of emissions from a given source (i.e., an emitter would face double the tax or compliance liability if their emissions doubled). A policy does not need to be uniformly applied across all sources in proportion to their emissions to be considered a "direct carbon pricing" instrument; in reality, of all the policies currently in operation that impose a price signal intended to reduce emissions, none cover and treat all sectors, fuels, activities, and/or gases equally.[xlvii]

A carbon tax is a policy instrument through which a government levies a fee on covered entities for their GHG emissions, providing a financial incentive to reduce emissions. Under a carbon tax, the government sets the price of emissions (the tax rate). The resulting amount of emissions reductions is determined by the response of the emitting entities.

In an emissions trading system (ETS), the government places a limit on the amount of GHG emissions from covered entities. Entities must surrender emission units (or "allowances") to cover their emissions within a compliance period. Each emission unit represents the right to emit a certain volume of emissions (typically 1 tCO_2e) and can be traded between covered entities or sometimes with other traders. There are several different types of ETSs, including "cap-and-trade" and "rate-based" approaches, and different terms are used for the emission units within different systems. The carbon price in these systems is a function of supply and demand for emission units.

Under a "cap-and-trade" ETS, the government sets a cap on the total net volume of GHG emissions in one or more sectors of the economy. A government then sells (sometimes through auctions) emission allowances and/or distributes allowances for free to entities covered by the cap, with the total volume of allowances issued equal to the emissions cap. Examples include the European Union (EU) ETS and the California Cap-and-Trade Program.

(xlvii) In considering whether to include policies as "direct carbon pricing" in this report, consideration was given to whether the policy is intended to reduce emissions and the extent to which it applies a uniform tCO_2e price to covered emissions and imposes a liability that is proportional to emissions.

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Under a "rate-based" trading system, total emissions are not fixed, but individual entities or facilities are instead allocated a performance benchmark, typically expressed as units of emissions per units of output (i.e., emissions intensity), which serves as a limit on their net emissions. Covered entities can "earn" emission units if they produce fewer emissions than they are allocated by the benchmark. These credits can then be traded. If a covered entity's emissions are higher than their benchmark allocation, they must purchase and surrender emission credits or other eligible emission units to cover their surplus emissions relative to the baseline. Allocations under rate-based systems are not fixed, but rather depend on an entity's level of or capacity for production. Examples of rate-based trading systems include China's National ETS and Canada's Output Based Pricing System.

Stabilization mechanisms refer to ETS design elements intended to stabilize the carbon price or the supply of allowances. In an ETS, the carbon price is not usually fixed by a government but instead is determined by the supply of and demand for eligible emission units. However, some ETSs incorporate price or supply stabilization mechanisms to ensure ambition or reduce price volatility. These can include auction reserve prices, to prevent allowances from being sold when prices fall below a floor threshold, or safety valves that release additional allowances when prices reach a ceiling threshold. For example, the EU ETS has a market stability reserve that brings allowances in and out of the market depending on the quantity of allowances in circulation. In some ETSs (e.g., Germany and Austria) the price of emission units is fixed (usually for an introductory phase) by making an unlimited number of units available at a predetermined price. Others (e.g., some Canadian provinces) offer an alternative compliance mechanism for paying a carbon tax, which then serves as a ceiling price.

Carbon crediting mechanism refers to a system where tradable credits (representing 1 tCO_2e) are generated through voluntary emissions reductions activities. Carbon credits can represent emissions reductions achieved through either avoidance, for instance by capturing methane from landfills, or removal from the atmosphere, such as sequestering carbon through afforestation or directly capturing carbon from the air and storing it. Carbon crediting mechanisms operate differently from carbon taxes and ETSs—rather than requiring businesses to pay for emitting (i.e., the polluter pays principle), businesses and other organizations can generate carbon credits (and hence revenue) by demonstrating that emissions have been reduced or sequestered relative to a counterfactual baseline. Unlike carbon taxes and ETSs, carbon crediting mechanisms provide a source of supply, but do not create a source of demand. For carbon credits to have value, crediting mechanisms require an external source of demand. This can include, for example, regulated emitters looking to reduce their liabilities under an ETS or carbon tax or corporations looking to meet their voluntary emissions reductions goals.

Border carbon adjustment mechanisms (BCAs) refers to a policy instrument whereby a government imposes a carbon price at the border on the emissions embodied in certain carbon-intensive goods that are imported from other jurisdictions. The main objective of a BCA is to equalize the carbon price levied on those imported goods with the carbon price charged on domestically produced goods (through a carbon tax or an ETS) in order to level the playing field and prevent carbon leakage. In this sense, a BCA can be considered an extension of a direct carbon pricing instrument like a carbon tax or an ETS for goods imported from other jurisdictions.

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Indirect Carbon Pricing

Indirect carbon pricing refers to instruments that change the price of products associated with carbon emissions in ways that are not directly proportional to the relative emissions associated with those products. These instruments provide a carbon price signal, even though they are often (primarily) adopted for other socioeconomic objectives, such as raising revenues or addressing air pollution.

Examples of indirect carbon pricing include fuel and commodity taxes, as well as fossil fuel subsidies affecting energy consumers. For example, fuel excise taxes apply a tax to the volume of fuels, such as gasoline and diesel (e.g., dollars per liter), which places a price on the carbon emissions from the combustion of those fuels. However, the price is not determined in proportion to the relative emissions resulting from the combustion of those fuels. Conversely, fuel subsidies that reduce the price of fossil fuels create a "negative" indirect carbon price signal, which incentivizes higher consumption and therefore increases carbon emissions.

While carbon pricing policies can be categorized as direct or indirect, in practice the distinction is not always obvious. The most direct carbon pricing policy would apply an equivalent and proportional incentive to reduce GHG emissions across all sectors and fuels. Indirect carbon pricing policies still create a price signal that applies to fossil fuels or products, but they are not designed to apply a consistent price across emissions from different sources (e.g., the price is not linked to actual GHG emissions or the carbon content of fuels). ETSs, carbon taxes, and carbon crediting are direct carbon pricing policies, but in reality, all examples of these policies currently in operation differ across sectors, fuels, activities, and/or gases. As a result, the distinction between direct and indirect carbon prices is less stark in practice, and carbon pricing policies sit on a spectrum from direct to indirect.

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B. Annex. Methodologies and Sources

1. Sources and timelines: The State and Trends of Carbon Pricing 2023 report draws on a range of sources, including official reporting (i.e., government budget documents), related legislation that underpins the carbon pricing initiative, statements from governments and public authorities, and information provided by jurisdictions. Data and updates in the report represent the situation as of April 1, 2023, unless stated otherwise.

2. Emissions: 2021 greenhouse gas (GHG) emissions data is sourced from the EDGAR (Emissions Database for Global Atmospheric Research) Community GHG Database, version 7 (2022), where available, or the most recent emissions data from official sources to be consistent across jurisdictions.

- GHG emissions values for Canadian provinces and territories are taken from Canada's latest national inventory.[163]
- GHG emissions values for U.S. states are based on official subnational GHG inventory reports from each of the respective states, available from the U.S. Environmental Protection Agency Greenhouse Gas Inventory Data Explorer.[164]
- GHG emissions values for Mexican states are based on the World Bank's emissions data and on the official reports of each of the respective states, available on the Emission National Registry. GHG emission estimates for China's subnational jurisdictions are based on estimates included in the International Carbon Action Partnership's (ICAP) Status Report 2023.[165]

The EDGAR dataset provides aggregate data for certain countries, including France and Monaco, Serbia and Montenegro, Spain and Andorra, and Switzerland and Liechtenstein. In these cases, the GHG emissions estimate for each country were determined based on the relative emissions of each country in the most recent GHG emissions inventory reported to the United Nations Framework Convention on Climate Change.

3. Coverage: The proportion of global GHG emissions covered by a direct carbon price is calculated based on direct carbon pricing instruments that are "implemented." The estimate of emissions coverage for each carbon pricing instrument is based wherever possible on official government sources and considers the scope (sectors, fuels, and/or gases) of policies but does not necessarily factor in all exemptions and/or emissions thresholds or free allocations.

4. Status of carbon pricing instruments: Carbon pricing instruments are considered "scheduled for implementation" once they have been formally adopted through legislation and have an official, planned start date. Carbon pricing instruments are considered "under consideration" if the government has announced its intention to work toward the implementation of a carbon pricing initiative and this has been formally confirmed by official government sources.

5. Price: Carbon prices are nominal prices and are generally based on the exchange-traded or auction prices on April 1, 2023, or the most recent prices available. Additional price information is further clarified here:

- As Mexico is transitioning its ETS from the pilot phase, with 100% free allocation, there is no price information currently available.
- Massachusetts ETS price data is equal to the auction clearing price for 2023 units from the auction held on March 15, 2023.
- California and Québec cap-and-trade price data are from the California Carbon Allowance Vintage 2023 Futures for April on March 31, 2023.

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- Regional Greenhouse Gas Initiative (RGGI) price data are the weighted average of the allowance transfer transaction prices on March 31, 2023, for the January 1, 2021, to December 31, 2023, allowance control period. Prices are converted from USD/short ton carbon dioxide equivalent (CO_2e) to USD/metric ton CO_2e.
- United Kingdom (UK) ETS price data are from the UK Allowance Daily Futures Price on March 31, 2023.
- New Zealand ETS price is the spot price on March 31, 2023.

6. Revenue: Revenue is for the period January 1 to December 31, 2022. For jurisdictions with their fiscal year starting on April 1, the revenue between January 1 and December 31, 2022, is estimated by the addition of one quarter of the April 1, 2021, to April 1, 2022, revenue and three quarters of the April 1, 2022, to April 1, 2023, revenue estimate. Where 2022 revenue was not available before the report was finalized, official revenue forecasts for 2022 are used, or revenue is estimated based on revenue collected in 2021.

7. Exchange rate conversions: Price and revenue data are converted from national currency to US dollars using the International Monetary Fund exchange rates on April 1, 2023.

8. 2022 ETS price developments: Price development data are taken from the ICAP's Allowance Price Explorer, which has up-to-date information on allowance prices in ETSs. The following sources were also drawn upon: the California Air Resources Board website, spot price data provided by the European Energy Exchange group for the EU ETS, the website of the Ministry for the Fight Against Climate Change of Québec, the RGGI website, and the Intercontinental Exchange and the Swiss Emissions Registry.

9. Crediting data: Carbon credit issuance and retirement data are for the period January 1 to December 31, 2022. Data are either sourced from publicly available carbon crediting mechanism registries or obtained by Ecosystem Marketplace directly from the organizations that operate independent crediting mechanisms. Data on issuances, retirements, and project registrations by project category for independent and international crediting mechanisms have been provided by Forest Trends' nonprofit initiative Ecosystem Marketplace and cover the following crediting mechanisms: American Carbon Registry, California Air Resources Board, City Forest Credits, Clean Development Mechanism, Climate Action Reserve, Global Carbon Council, Gold Standard, Plan Vivo, UK Peatland Code, UK Woodland Carbon Code, and Verified Carbon Standard. Data for domestic crediting mechanisms (including issuance and price data) were provided by jurisdiction governments for the following crediting mechanisms: Alberta Emission Offset Program, Australia Emissions Reduction Fund, British Columbia Offset Program, California Compliance Offset Program, Colombia Crediting Mechanism, J-Credit Scheme, Republic of Korea Offset Crediting Mechanism, South Africa Crediting Mechanism, Switzerland CO_2 Attestations Crediting Mechanism, and Tokyo Cap-and-Trade Program. Price data for exchange-traded transactions are provided by S&P Global Platts and reflect the most competitively priced underlying contract that meets the five carbon credit price assessments' specifications. Price data on over-the-counter transactions are provided by Ecosystem Marketplace and reflect price and transaction volume data confidentially disclosed to Ecosystem Marketplace by a control group of 29 organizations that had disclosed trades for both 2021 and 2022 at the time this report was written.

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C. Annex. Carbon Tax and ETS Updates

This section includes only jurisdictions that saw significant developments in carbon taxes and emissions trading systems (ETSs) in 2022 or early 2023 (before April 1). Updates are grouped by country, with the exception of the European Union (EU), which has its own entry for regional-level policies. For more detailed information on all carbon taxes and ETSs, please refer to the Carbon Pricing Dashboard, an interactive online platform that provides up-to-date information on existing and emerging carbon pricing instruments around the world.

Albania
Albania adopted its National Energy and Climate Plan in 2022, making clear the government's intention to progress policies and measures identified in that plan, including an ETS.

Argentina
The Argentinian carbon tax rate is subject to quarterly updates. However, the quarterly tax update for the third and fourth trimesters of 2021 and all of 2022 were postponed until April 1, 2023, for gasoline and gas oil.

Australia
Legislation to reform the Safeguard Mechanism was passed in March 2023, with changes to commence from July 1, 2023. The Safeguard Mechanism assigns emissions baselines for over 200 large facilities. Facilities emitting above their baseline must offset excess emissions. The reforms will reduce emissions baselines for covered facilities and allow the issuance of credits to facilities that overachieve on their baseline. This in effect will turn the Safeguard Mechanism into a rate-based ETS.

Austria
Austria's national ETS started operating on October 1, 2022. The system was originally scheduled to launch in July 2022 but was suspended for three months as part of the energy price relief plan of the Austrian government. The national ETS covers mainly heating and transportation emissions not covered under the EU ETS. Between 2022 and 2025, the system will operate with an annually increasing fixed price (starting at EUR 30 USD 32.6/metric ton of carbon dioxide equivalent (tCO_2e) in 2022 and up to EUR 55 USD 59.7/tCO_2e in 2025). A market phase will follow from 2026, subject to a review in 2024 and considering developments on the EU level. The system is to be supersededin 2027 by the implementation of the EU's ETS II for buildings and road transport.

Bosnia and Herzegovina
In 2022, the government prepared a roadmap for implementation of a national ETS with support from the energy community.

Brazil
Several parallel and ongoing processes are moving toward the implementation of an ETS in Brazil. In May 2022, the government published Decree 11,075, which established the National Greenhouse Gas Emissions Reduction System (Sinare). The decree requires the Ministries of Environment and Economy to develop sectoral climate change mitigation plans, including concrete emission targets, and establishes a roadmap for this process. It further calls for establishing "integration mechanisms with the internationally regulated market."

The year 2022 also saw the Brazilian Congress discuss a number of legislative proposals to establish an ETS in the country. This includes bills that were

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presented in both the Chamber of Deputies and the Senate. While there are differences in the details included in each of the proposed Bills, common elements suggest emerging themes, such as the establishment of a greenhouse gas (GHG) emissions monitoring, reporting, and verification (MRV) system and a centralized registry for Brazilian GHG mitigation projects and their resulting carbon credits, which could potentially be used for compliance purposes as offsets under an ETS.

Canada

All Canadian provinces and territories had to hand in proposals for carbon pricing systems for the 2023—2030 period. These must meet the strengthened federal benchmark criteria of CAD 65 (USD 48)/tCO_2e in 2023, increasing by CAD 15 (USD 11) each year to CAD 170 (USD 126)/tCO_2e in 2030. In November 2022, the Canadian government announced which provincial systems met the federal benchmark requirements. As a result, the federal fuel charge will expand to apply in Newfoundland and Labrador, Nova Scotia, and Prince Edward Island beginning July 1, 2023.

Chile

Chile has had a carbon tax in place since 2017. A regulation for the offsets system is pending approval by the Comptroller General's office. The government is currently considering a potential increase to the tax rate, as well as a new way of applying the carbon tax to the electricity sector.

TABLE C.1
CARBON PRICING DEVELOPMENTS IN SELECTED CANADIAN PROVINCES AND TERRITORIES

JURISDICTION	RECENT DEVELOPMENTS
Alberta	Alberta's Technology Innovation and Emissions Reduction (TIER) Regulation was amended in December 2022, with changes taking effect on January 1, 2023. Updates included setting the carbon price in line with the federal benchmark; tightening output-based benchmarks by 2% annually from 2023 to 2030 and also increasing the tightening rates of the oil sands sectors by 4% in 2029 and 2030; reducing the opt-in threshold to 2,000 tonne per year; increasing the limits on emission performance and offsets usage from 60% in 2023 by 10% annually until it reaches 90% in 2026; reducing the credit expiry to five years; establishing sequestration credits and capture recognition tonnes to support carbon capture, utilization, and storage investments; and changing the biomass emissions treatment to support bioenergy with carbon capture and storage. In November 2022, the federal government confirmed the Alberta TIER regulatory system continues to meet the federal benchmark requirements.
British Columbia	In November 2022, the federal government announced that British Columbia will continue to implement its own carbon pricing system.
Manitoba	In November 2022, the federal government announced that the federal output-based pricing system (OBPS) for industry and the federal fuel charge will continue to apply in Manitoba.
New Brunswick	In November 2022, the federal government announced that the New Brunswick system continues to meet the federal government's minimum requirements.
Newfoundland and Labrador	In November 2022, the federal government announced that the performance standards system (PSS) that applies to large facilities in Newfoundland and Labrador continues to meet the federal benchmark stringency requirements. Accordingly, the provinces system will continue to apply to large industry.
Northwest Territories	On October 31, 2022, the government announced changes to its carbon tax system to align with new federal government requirements. The change includes updates to the carbon tax rates and changes to address cost of living impacts, including removing the at-source rebate for heating fuel. From April 1, 2023, the carbon price will increase in line with the federal benchmark. In November 2022, the federal government announced that the Northwest Territories have proposed a full system that meets the updated federal benchmark.
Nova Scotia	In November 2022 the federal government approved the replacement of the province's cap-and-trade system with an OBPS from January 1, 2023. The cap-and-trade system will expire after the compliance deadline in December 2023, with two more auctions scheduled during the year to allow entities to purchase allowances for their verified 2022 emissions.
Ontario	In November 2022, the federal government announced that Ontario's carbon pricing system for industry meets the federal benchmark requirements. In December 2022, the Ontario government amended the Emissions Performance Standards program to meet the federal benchmark. This includes aligning with the federal minimum carbon price, strengthening the performance standard for electricity generation, and adjusting the stringency factors and emission standards.
Prince Edward Island	In November 2022, the federal government announced that the federal fuel charge will apply in Prince Edward Island from July 1, 2023, as the proposed system did not meet the benchmark criteria.
Québec	In September 2022, Québec adopted a new approach for free allocation, which will apply starting in 2024. Without reform, freely allocated allowances were forecast to represent an increasing share of the total cap as industrial output grew. It is expected that the new approach will lead to a reduction in free allocation of 2.9 million allowances between 2024 and 2030.
Saskatchewan	In November 2022, the federal government announced that the Saskatchewan OBPS program meets the federal benchmark requirements. This includes the addition of the electricity generation and natural gas transmission pipeline sectors. All covered industrial emitters in Saskatchewan will transfer to the provincial program from January 1, 2023. In the OBPS 2023 (the regulations in force since January 1, 2023), offsets have been removed as a compliance mechanism.

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TABLE C.2
DEVELOPMENTS IN CHINA'S SUBNATIONAL PILOTS

JURISDICTION	RECENT DEVELOPMENTS
Beijing	In November 2022, the first auction was held since 2013, generating a total revenue of CNY 113 million (USD 16.4 million).
Chongqing	In March 2022, the Chongqing Ecology and Environment Bureau (EEB) issued the Management Rules, which regulate the issuance of offset credits and the management of the respective platform.
Fujian	The Fujian ETS achieved 100% compliance for 2021. The Fujian provincial EEB released the 2021 allocation plan for public consultation in November 2022.
Guangdong	The Guangdong ETS achieved 99.4% compliance for 2021. In December, the Guangdong EEB released the 2022 allocation plan. The threshold for entities regulated under the ETS was lowered from 20,000 tCO_2/year or energy consumption of 10,000 metric tons of coal equivalent (tce)/year to 10,000 tCO_2/year or energy consumption of 5,000 tce/year. Twenty-two more entities were covered in 2022.
Hubei	Two auctions were held in 2022, which raised revenues of CNY 68.22 million (USD 9.9 million) and CNY 18.47 million (USD 2.68 million).
Shanghai	The Shanghai EEB released the 2021 allocation plan in February 2022. No significant changes were implemented to the allocation plan from the previous year, but the emissions factors of power and heat consumption were reduced, reflecting emissions reductions already achieved. Auctions were held in September and December 2022, generating a total revenue of CNY 140.69 million (USD 20.47 million).
Shenzhen	In August 2022, the China Emission Exchange (Shenzhen) held its second auction after the first one in 2014, generating a total revenue of CNY 25.26 million (USD 3.67 million).
Tianjin	The Tianjin ETS achieved 100% compliance for 2021. In July 2022, Tianjin published a draft roadmap to establish a Tan Pu Hui system, which is a local voluntary reduction scheme to encourage small-scale emissions reduction projects and personal low-carbon behavior. Credits from the system could be used for compliance under the Tianjin ETS. The plan is expected to start in 2025.

The 2022—2026 Energy Agenda published by the government in August 2022 stipulates that a pilot ETS project for the energy sector will be developed to evaluate the role of this instrument in achieving emissions reductions and a just transition in a cost-effective manner.

China

With the experience from the first compliance period of the national ETS, the Ministry of Ecology and Environment updated MRV guidelines in March 2022 with the aim of improving data quality. In November 2022, the ministry released draft allocation plans for 2021 and 2022 for public consultation, significantly tightening benchmark values for coal-fired power plants.

Colombia

In August 2022, the Colombian Ministry of Finance and Public Credit (Minhacienda) submitted to Congress a draft tax package to reform the existing carbon tax. The proposal was approved in December (Law 2277-2022). The reforms increased the carbon tax rate to COP 20,500 (USD 4.43)/tCO_2e for all petroleum derivatives and all types of fossil gas used for combustion, starting January 1, 2023. The tax rate applied for coal will be 25% of the total value in 2025 and 100% of the full tax in 2028.

The reform also expands the taxable base to include the domestic sale, import, and consumption of thermal coal, excluding coal exports and coal used in coking plants, with a gradual implementation period until 2028. The percentage of allowable offsets included in the carbon tax reform is 50%.

Denmark

The government has reached an agreement with several other parties to introduce a new CO_2 tax on companies from 2025. The tax would apply to companies within and outside of the EU ETS but at different rates: DKK 350 (USD 51)/tCO_2 in 2025 rising to DKK 750 (USD 109.48)/tCO_2 in 2030 for companies outside the EU ETS, DKK 75 (USD 10.94)/tCO_2 in 2025 rising to DKK 375 (USD 54.74)/tCO_2 for EU ETS companies, or DKK 100 (USD 14.6)/tCO_2 in 2025 rising to DKK 125 (USD 18.24)/tCO_2 for companies within mineralogical processes. The agreement also introduces a floor price for the EU ETS.

European Union

In December 2022, the EU Parliament and Council reached an agreement for a major reform of the EU ETS, strengthening its ambition in order to achieve the EU's 55% emissions reduction target for 2030. The reform includes a tighter cap for the existing EU ETS for electricity, industry, and aviation and a phase-in of the maritime sector from 2024 onward. A phase-out of free allocation of allowances for the industrial sector will be accompanied by a phase-in of the EU Carbon Border Adjustment Mechanism beginning in 2026. Moreover, the EU decided to introduce an "EU ETS 2" for buildings, road transport, and process heat in industry in 2027 or, if energy prices remain high, in 2028.

Germany

In response to the energy crisis, the German government pushed back by one year the planned EUR 5.00 (USD 5.43)

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increase of the fixed CO_2 price of its national ETS. The follow-up increases, previously planned for 2024 and 2025, will also be postponed by one year. The updated trajectory will see allowances sold at EUR 30 (USD 32.6) in 2023, EUR 35 (USD 38) in 2024, and EUR 45 (USD 48.9) in 2025. The delay will not affect the start of the auctioning phase in 2026. The extension of the system to cover waste incineration, previously also scheduled for 2023, was also postponed to January 1, 2024. GHG emissions from coal combustion by entities not already covered under the EU ETS have been included into the system, as planned since the start of 2023.

Iceland
The Icelandic carbon tax was increased on January 1, 2023, to match the expected inflation rate (7.7%).

Indonesia
On February 22, 2023, the Ministry of Energy and Mineral Resources (MEMR) announced the launch of a mandatory, intensity-based ETS for the power sector. The system will initially cover 99 coal-fired power plants that account for 81.4% of the country's national power generation capacity. MEMR expects to see a reduction of 500,000 tCO_2 in the sector through the ETS over the course of 2023.

Japan
In February 2022, the government announced the upcoming Green Transformation (GX) League, a baseline-and-credit system for companies expected to become fully operational in April 2023. This will build upon existing carbon trading systems such as the Joint Crediting Mechanism and J-Credit scheme. Although participation in the GX League is voluntary, compliance once formally a participant is mandatory.

In October 2022, the government tasked the Ministry of Economy, Trade and Industry with developing more specific plans to scale up "growth-oriented" carbon pricing from 2026 by combining carbon taxation with an ETS.

In February 2023, Japan's cabinet approved the basic GX plan, a 10-year roadmap that includes initial arrangements for a mandatory national ETS from 2026.

Kazakhstan
A new National Allocation Plan for 2022—2025 was approved in July 2022, establishing a cap of 163.7 $MtCO_2$ for 2023.

Liechtenstein
The Liechtenstein carbon tax was due to be revised, in line with a review of the equivalent tax in Switzerland. However, the proposed new framework for the Swiss carbon tax was unsuccessful. Therefore, Liechtenstein made adjustments, including to allow for emission reduction commitments out to 2024 (previously they only applied up until 2020) and enable the government to determine quality criteria for international offsets (with reference to Article 6 of the Paris Agreement).

Malaysia
The Government of Malaysia has commenced preliminary work in 2023 to investigate the potential for a carbon tax and plans to develop a policy and design framework for a domestic ETS.

In addition, the Malaysian stock exchange launched the Bursa Carbon Exchange, the world's first shariah-compliant Voluntary Carbon Market platform, in December 2022. The Bursa Carbon Exchange completed the country's first carbon credit auction on March 16, 2023.

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TABLE C.3
CARBON PRICING DEVELOPMENTS IN SELECTED MEXICAN STATES

JURISDICTION	RECENT DEVELOPMENTS
Durango	Carbon tax legislation was approved in 2022. The carbon tax applies to direct and indirect emissions of CO_2, methane, and nitrous oxide to all stationary sources within the state. The carbon tax was introduced with a fixed rate of MXN 179 (USD 9.9)/tCO_2e.
Guanajuato	Carbon tax legislation was approved in 2022. The carbon tax applies to direct and indirect emissions of CO_2, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride from GHG-emitting facilities or stationary sources. Commencement of the carbon tax has been postponed, and it will now commence in June 2023. The initial carbon tax rate will be MXN 250 (USD 13.8)/tCO_2e and will be updated annually.
State of Mexico	The carbon tax entered into force in April 2022, with a rate of MXN 43 (USD 2.37)/tCO_2e.
Querétaro	The carbon tax entered into force in January 2022. The increase of the daily "Unit of Measurement and Update" (UMA), increased the carbon tax rate by MXN 42.11 (USD 2.32) to MXN 580.94 (USD 32.07) in 2023.
Tamaulipas	Carbon tax legislation was approved in 2020, and while the tax officially commenced in 2022, it was repealed in January 2023 and is not currently operational.
Yucatán	The carbon tax entered into force in 2022. The increase of the daily UMA increased the carbon tax rate by approximately MXN 20.31 (USD 1.12) to MXN 280.7 (USD 15.46) in 2023.

Mexico
In January 2023, the operational phase of the Mexican ETS began. The Ministry of Environment and Natural Resources is expected to publish the regulations of the operational phase of the ETS in the first half of 2023.

Moldova
In November 2022, the Moldovan government released its concept Energy Strategy to 2050. The concept includes plans to transpose and implement the EU ETS domestically.

Montenegro
The operation of the Montenegro ETS was negatively affected by several changes of government throughout 2022, which caused major delays in the adoption of the annual allocation plan. The government set up a working group in mid-2022 to review the country's climate legislation, including the ETS. This work is still ongoing as of January 2023, with the adoption of the revised ETS Decree and Climate Law expected by April 2023.

Netherlands
The minimum carbon price for electricity entered into force on April 5, 2022. The minimum carbon price for industry began on January 1, 2023, and is intended to encourage industrial enterprises to make extra cuts in carbon emissions, covering all their emissions. Given that the EU ETS price remained well above the level of the floor prices, the price floors were not activated.

At the request of the Senate, there will be an interim evaluation of the planned trajectory for the minimum price for electricity in light of the recent increase in the EU ETS price. This was confirmed by a letter to the Senate on March 14, 2022.

New Zealand
After the major reforms of the previous years, in 2022 the New Zealand government continued to make incremental improvements to the operation of the NZ ETS. Changes coming into effect for the forestry sector in 2023 include a shift to average accounting and a new "permanent forest" category. Decisions were also taken to tighten the eligibility and accounting rules for industrial allocation. Consultations continue on an improved market governance framework, as well as a carbon pricing mechanism for biological emissions from agriculture.

The government also announced plans for an agricultural emissions pricing system. The government received advice from both the He Waka Eke Noa—Primary Sector Climate Action Partnership and the Climate Change Commission on agricultural emissions pricing. Public consultation on the government's proposed agricultural emissions pricing system ran for six weeks between October 11 and November 18, 2022. Subsequently, the government published a report in December 2022 setting out policy direction on agricultural emissions pricing. To ensure a system is in place by 2025, the cabinet will make final policy decisions on the agricultural emissions pricing system in early 2023. The government will then prepare legislation to implement this system.

Nigeria
In August 2022, the Nigerian Minister of the Environment announced that the country has started activities toward establishing a national ETS. The National Council for Climate Change, established in November 2021, is responsible for developing the system. Key design elements such as the nature, timeline, and sectoral scope remain to be decided. The proposal will go through stakeholder engagement before decisions are made on features such as the allocation framework.

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North Macedonia
In 2022, Macedonia adopted its National Energy and Climate Plan and has been actively developing its "Law on Climate Change," which would establish the basis for carbon pricing (subject to further subordinate legislation).

Norway
Norway increased the rates of its carbon tax by 28% for most fossil fuels in 2022 and 21% in 2023. Norway also introduced a tax on waste incineration at the rate of NOK 192 (USD 18.32)/tCO_2, as well as on natural gas and liquified petroleum gas used in greenhouses, which were previously exempt from the carbon tax, at the rate of NOK 77 (USD 7.34)/tCO_2 in 2022. The tax rate on waste incineration was increased and differentiated in 2023.

Portugal
The carbon tax rate was frozen at 2021 levels in response to extremely high energy prices. The price changes planned for the start of 2022 were delayed through the end of March 2023.

Republic of Korea
In November 2022, the government announced several near-term changes to the Korean ETS. These include increasing incentives to reduce emissions and facilitate low-carbon investment by issuing more free allowances to the most efficient covered entities; encouraging trading and mitigating price volatility by opening up the ETS to more financial firms and increasing the allowance holding limit; facilitating the conversion of international offset credits to Korean Credit Units; strengthening MRV; and increasing support for small businesses and new entrants.

Sakhalin (Russia)
In March 2022, the State Duma approved a "Federal Law on Conducting an Experiment to Limit GHG Emissions in Selected Federal States of the Russian Federation," introducing mandatory emissions reporting and verification requirements for regulated entities and obliging them to comply with the allocated emissions allowances. The law also sets a legal basis for "allowances circulation" between entities.

The Sakhalin pilot was mandated to launch on September 1, 2022, as a mandatory GHG regulation plan, but the start has been delayed pending cap setting and allowance allocation processes. The scope of the experiment can be extended to other federal states of the Russian Federation by introducing changes to the respective federal law.

Slovenia
The Slovenian carbon tax was abolished as of July 2022 due to high energy prices. So far, the government has made no decision to reintroduce the tax.

Spain
A recent law has modified the scope of the tax, so previously it was applied on the selling or delivery of fluorinated gases to the final customer, whereas now this law taxes fluorinate manufacturing, importing, and intra-EU acquisition.

Catalonia
The Vice-presidency of Economy and Finance of Catalonia started a public consultation process on March 1, 2022. The public consultation aims to guarantee the applicability of the tax on greenhouse emissions generated by economic activities and to achieve the energy transition objectives established by Law 16/2017 on climate change.

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Sweden

A waiver on the carbon tax for fuel for combined heat and power as well as heat produced by companies participating in the EU ETS came into force on January 1, 2023. These operators have previously been exempted from the carbon tax for electricity production, but fuel used for heat was covered by both the EU ETS and carbon tax. A temporary waiver on the carbon tax for professional use of diesel fuel in agriculture, forestry, and some activities taking place in lakes and the sea (such as fish farms) has been in place since January 1, 2022, and will remain at least until June 30, 2023. The tax rate was frozen at 2021 levels for 2022 in response to high energy prices.

Switzerland

In 2022 Switzerland introduced a market stability mechanism to its ETS where, due to a large number of allowances in circulation, the auction volume was reduced by 50%. After a revision of the CO_2 Act failed to pass a referendum in June 2021, the Swiss Parliament extended the current CO_2 Act to 2024. In November 2022, the Swiss Federal Council published a new proposal for a revision of the CO_2 Act that covers the period from 2025 to 2030 and hence Switzerland's 50% emission reduction target for 2030. The law is currently being debated in Parliament.

Taiwan, China

Taiwan's Legislative Yuan passed an amendment of the climate bill, renamed the "Climate Change Response Act," on January 10, 2023, and it entered into force on February 15, 2023. The act establishes a carbon fee system for large emitters and sets a goal of reaching net-zero emissions by 2050. The carbon fee will be levied on major emitters, and the fee rate and related subsidiary measures will be formulated in further regulation. The current plan is to implement the carbon fee before the ETS is considered in the future.

Thailand

The Thailand Voluntary ETS pilot project was extended to the Eastern Economic Corridor area, a key industrial region of Thailand. Early in 2022, the government also published rules and guidelines for carbon credit trading, which were followed in September 2022 by the launch of the carbon credit trading platform "Federation of Thai Industries Exchange."

Türkiye

In February 2022, Türkiye organized its first Climate Council meeting with participation by public and private institutions as well as nongovernmental organizations. The council recommended the launch of a pilot ETS in 2024 to align the development of a national ETS in Türkiye with the country's 2053 net-zero target. The council also recommended that future allowance auction revenues be devoted to green transformation. These recommendations were reflected in Türkiye's "Medium Term Programme (2023—2025)," which was approved by the president and published in the official gazette in September 2022.

Ukraine

The design process of the Ukrainian ETS has been severely impacted by Russia's invasion of Ukraine, making it impossible to finalize the draft instruments for cap-setting and allowance allocation developed during the year. A stakeholder engagement process was nevertheless carried out and finalized in early 2023.

United Kingdom

The United Kingdom launched a major consultation on plan reforms. The consultation addressed several issues, including how to align the cap trajectory with the country's net-zero target and expanding the plan's sectoral coverage. An initial response with changes to be implemented from 2023 was published in August 2022, while the full response is expected in 2023.

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United States

All of the significant carbon pricing developments that took place in the United States in 2022 and early 2023 occurred on the subnational level, as summarized in Table C.4.

Uruguay

Decree 435/022 set the new value of the Uruguayan carbon tax at UYU 6,024 (USD 155.86)/tCO_2e for 2023.

Vietnam

In July 2022, Vietnam issued a decision by which the country commits to achieving net-zero GHG emissions by 2050, with a midterm target of 43.5% below the baseline by 2030. This decision follows "Decree 06/2022/ND-CP," which outlines a roadmap for the implementation of an ETS with a declining cap corresponding to Vietnam's nationally determined contribution. The pilot National Crediting Program and pilot ETS are expected to start in 2024 and 2026, respectively. They will become fully operational by 2026 and 2028.

TABLE C.4
CARBON PRICING DEVELOPMENTS IN SELECTED US STATES

JURISDICTION	RECENT DEVELOPMENTS
California	In December 2022, the Board of the California Air Resources Board (CARB) adopted the state's Final 2022 Scoping Plan, which establishes the strategy to meet California's emissions reduction targets. In light of the additional emissions reductions now expected by 2030, the board announced it would review all major programs, including the state's cap-and-trade system. CARB will report to the state legislature on any potential program changes by the end of 2023.
Hawaii	Several carbon tax bills have been introduced in the current (2023) legislative session, including HB1146, SB1004, and SB1008.
Massachusetts	As a result of the review of the ETS regulation in 2021, the Massachusetts Department of Environmental Protection started auctioning future vintage allowances in June and September 2022. In each of the auctions, the department offered almost 400,000 2023-vintage allowances, equivalent to 5% of the 2023 cap.
New York State	In January 2023, New York's Climate Action Council issued a Final Scoping Plan that proposes a range of policies and actions to meet the state's carbon neutrality goal in 2050, including an economy-wide cap-and-invest program. When adopted, the program will cover all emitting sectors under an enforceable and declining cap, with the caps for 2030 and 2050 corresponding to state-wide emission limits. The governor has directed the Department of Environmental Conservation and the New York State Energy Research and Development Authority to develop ETS regulations before January 2024.
North Carolina	In an Environmental Management Commission Air Quality Committee meeting in July 2022, North Carolina's Department of Environmental Quality provided information on how a proposed regulation to become a participating state in RGGI deviates from the existing RGGI Model Rule. Among others, the North Carolina regulation would cover industrial units, regardless of grid connectivity, and emissions from biomass/biofuel. Consideration of the RGGI rule by North Carolina's Environmental Management Commission has been delayed until 2023.
Oregon	In March 2022, Oregon's Department of Environmental Quality distributed allowances to the 18 covered fuel suppliers currently subject to the emissions cap under the Climate Protection Program. The distribution of allowances was based on the program rules for the first compliance period, which began in 2022 and includes calendar years 2023 and 2024. In September 2022, the department launched a voluntary trading platform as well as the forms needed for trading between transferring and acquiring covered fuel suppliers.
Pennsylvania	In April 2022, the final regulation to establish an ETS in Pennsylvania and to participate in RGGI was published. The regulation is currently being challenged by several lawsuits and, until legal proceedings are concluded, the Pennsylvania Department of Environmental Protection will not take steps to implement or enforce the RGGI regulation.
Regional Greenhouse Gas Initiative (RGGI)	The RGGI member states are currently conducting the Third Program Review. As per the current timeline for the program review, released in November 2022, an updated draft Model Rule would be released in fall 2023, with the program review concluding in December 2023.
Washington State	Following a year of intensive preparations, Washington's new cap-and-invest program started operating in January 2023. The system's design closely resembles that of California's program. The state launched a public process to explore the possibility of linking to other cap-and-trade systems in February 2023.

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D. Annex. Crediting Mechanism Updates

This Annex presents an overview of crediting mechanisms that are in force, as well as significant developments in carbon crediting mechanisms in the year up to April 1, 2023. Where no significant changes occurred over the past year, these mechanisms are not included.

D.1 Domestic crediting mechanisms

This section outlines significant developments in regional, national, and subnational crediting mechanisms. For more detailed information on all carbon taxes and ETSs, see Annex C and the Carbon Pricing Dashboard, an interactive online platform that provides up-to-date information on existing and emerging carbon pricing instruments around the world.

Alberta emission offset system
The Technology Innovation and Emissions Reduction Regulation was amended effective January 1, 2023, and updated a number of requirements for regulated facilities and Alberta emission offset projects. These include a phased-in increase in credit use limits, updating the credit expiry period to five years, and additional reviews for project credit extensions. The guidance and requirements of the system are also updated, including the Project Standard for Emission Offset Project Developers and the Carbon Offset Emission Factor Handbook. Alberta Environment and Protected Areas approved and released a revised "Enhanced Oil Recovery" quantification protocol in 2022 and is developing an "Improved Forest Management on Private Lands" quantification protocol.

Australia emissions reduction fund
In 2022, the Australian government appointed an independent panel to review the integrity of Australian Carbon Credit Units (ACCUs) under the Emissions Reduction Fund. The panel examined governance arrangements and legislative requirements of the carbon crediting plan, as well as the integrity of the key methods used and other plan settings affecting the integrity of ACCUs.

The panel completed its review in December 2022, concluding that the ACCU plan arrangements are essentially sound, and includes a number of recommendations to help clarify governance, improve transparency, promote cobenefits, and enhance confidence in the integrity and effectiveness of the plan.

British Columbia offset program
A protocol on methane from organic waste was published in August 2022.

California compliance offset program
In November 2022, CARB held a public workshop to begin discussing possible updates to the Forest Offset Protocol.

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China greenhouse gas voluntary emissions reductions program
The government announced in late 2021 that Beijing Green Exchange will develop and host a new national trading platform of China Certified Emission Reductions (CCERs). In early 2022, CCERs were trading at about 45 CNY (USD 6.55) a tonne, and in July 2022, the price of CCERs exceeded the price of carbon emission allowances for the first time, a trend that continued in the second half of 2022.

Colombia crediting mechanism
According to the amendment made by Law 2277 in 2022 (Paragraph 1, Article 47), the use of carbon credits under the carbon tax exemption is limited to 50% of the greenhouse gas (GHG) emissions that would incur the tax.

Guangdong Pu Hui Offset Crediting Mechanism
In April 2022, the Department of Ecological Environment of Guangdong Province revised the Measures for the Administration of Carbon Pu Hui Trading in Guangdong Province. The Guangzhou Emissions Exchange organized the technical review of the revised version of emission reductions methodology.

India
In July 2022, the Indian Lower House of Parliament adopted an amendment bill to the 2001 "Energy Conservation Act" to provide the legal basis to establish a domestic carbon market and grant the power to issue carbon credit certificates for the reduction of carbon emissions. In December 2022, the Upper House of Parliament passed the amendment bill.

The credits may be used by Indian companies not covered under the Perform, Achieve, and Trade Scheme (PATS) for their voluntary commitments. Provisions for international use of the carbon credits created by exceeding PATS performance benchmarks is under consideration.

As of April 1, 2023, the Ministry of Power is consulting on a proposed framework for the Carbon Credit Trading Scheme.

Indonesia crediting mechanism
Under the umbrella of the 2021 presidential framework regulation on carbon pricing, Indonesia's Ministry of Environment and Forests adopted a ministerial regulation on domestic carbon trading on October 20, 2022. The regulation covers approaches and criteria for allowance-based emissions trading, carbon credit trading, and performance-based mitigation payments. In relation to domestic carbon crediting, the regulation outlines general rules and modalities for the validation and registration of eligible mitigation project activities and for verification, certification, and trading of achieved mitigation outcomes ("carbon credit"). The ministerial regulation states that carbon credit generation and trading would be eligible in the energy, waste, industrial processes, agriculture, and forestry sectors, as well as other sectors where there is sufficient knowledge and technology to carry out projects.

Indonesian government ministries must develop plans for each subsector they are responsible for on how the subsector will meet its share of Indonesia's nationally determined contribution (NDC) targets. The proposal requires a subsector plan to be in place before credits can be traded. The regulations set out that a proportion of issued credits will be withheld by the government to help ensure Indonesia meets its NDC. Importantly, the regulation also includes provisions for (1) mutual recognition of reputable international carbon standards and (2) corresponding adjustments, including implementation arrangements.

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Joint crediting mechanism
Twenty-five countries have joined the JCM. Between August and October 2022, Azerbaijan, Georgia, Moldova, Senegal, Tunisia, Sri Lanka, Uzbekistan, and Papua New Guinea were added as the newest JCM partners. Seventeen partners that had signed up before the pandemic include Bangladesh, Cambodia, Chile, Costa Rica, Ethiopia, Indonesia, Kenya, Laos, the Maldives, Mexico, Mongolia, Myanmar, Palau, the Philippines, Saudi Arabia, Thailand, and Vietnam.

Québec offset crediting mechanism
A regulation concerning afforestation or reforestation on private lands was adopted on December 13, 2022.

Sakhalin Oblast pilot crediting mechanism
In March 2022, Russia passed a federal law implementing a pilot system of emissions trading in Sakhalin Oblast that allows for carbon crediting. The first two projects were registered during the year. A solar power generation project was the first (and so far, only) project to be issued credits. The Moscow Exchange launched trading in carbon units in September 2022. The first trade was an auction of 20 units credited to a pilot project of DalEnergoInvest LLC on Sakhalin.

South Africa carbon tax offset system
The government is seeking to develop a domestic offset standard, intended to be operational in future phases.

Spanish carbon fund for a sustainable economy
A call for projects that was started in 2021 was concluded in 2022.

Switzerland CO_2 attestations crediting mechanism
Compensation projects abroad are possible under Article 6.2 of the Paris Agreement. Bilateral agreements with 11 partner countries are in place and a first project in Ghana has been authorized.

Thailand voluntary emissions reduction program
In August 2022, Verra and the Thailand Greenhouse Gas Management Organisation signed a memorandum of understanding to jointly support the implementation of the Thailand Voluntary Emission Reduction Program.

D.2 Independent crediting mechanisms and standards

Gold standard
Notable developments in 2022 included the introduction of mandatory use of a sustainable development goal (SDG) tool to support standardized reporting of SDG impacts, introduction of new registry functionality and requirements to support use of Article 6, and the launch of working groups and consultations on digitization of the carbon market, including digital monitoring, reporting, and verification (MRV) and digital infrastructure and tokenization.

In addition, Gold Standard introduced multiple new methodologies to enable crediting activities, including for electric two- and three-wheeled transportation, carbon sequestration through concrete aggregate, the paper and pulp sector, and its first clean cooking methodology integrating digital monitoring, reporting, and verification (MRV) to enable real-time measurement of energy use.

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Plan Vivo Standard

The newest version of the Plan Vivo Standard (V5.0) was launched in 2022. It consists of three key documents: Project Requirements, Methodology Requirements, and Validation & Verification Requirements. These documents are supplemented by various guidance documents, procedural documents, and templates.

Among other updates, the Standard V5.0 introduced three new unit types of Plan Vivo certificates (PVCs) to increase transparency on environmental benefits and claims:

- Verified PVCs (vPVCs) – PVCs whose monitoring data have been verified. These are to be at the core of the expost offering and may be issued onto a registry and retired.
- Reported PVCs (rPVCs) – PVCs that are based on monitoring data, indicating that the removal/mitigation event has taken place, but these data have not yet been verified. These units may be allocated to buyers on the registry, but not retired until conversion to vPVCs.
- Future PVCs (fPVCs) – PVCs that are expected to be achieved in the future based on current project activities and robust climate-benefit models.
- Plan Vivo has also developed procedures around managing environmental and social risk to ensure safeguarding of community rights.

Verified carbon standard

Verra celebrated the issuance of its 1 billionth Verified Carbon Standard (VCS) credit in 2022. Verra published two new methodologies under the VCS program, for “Improved Forest Management Projects” and “the production of biochar and its use in soils and other emerging applications”. Verra ran a public consultation in October 2022 on a new consolidated Reducing Emissions from Deforestation and Forest Degradation methodology for the VCS, expected to be finalized in the third quarter of 2023.

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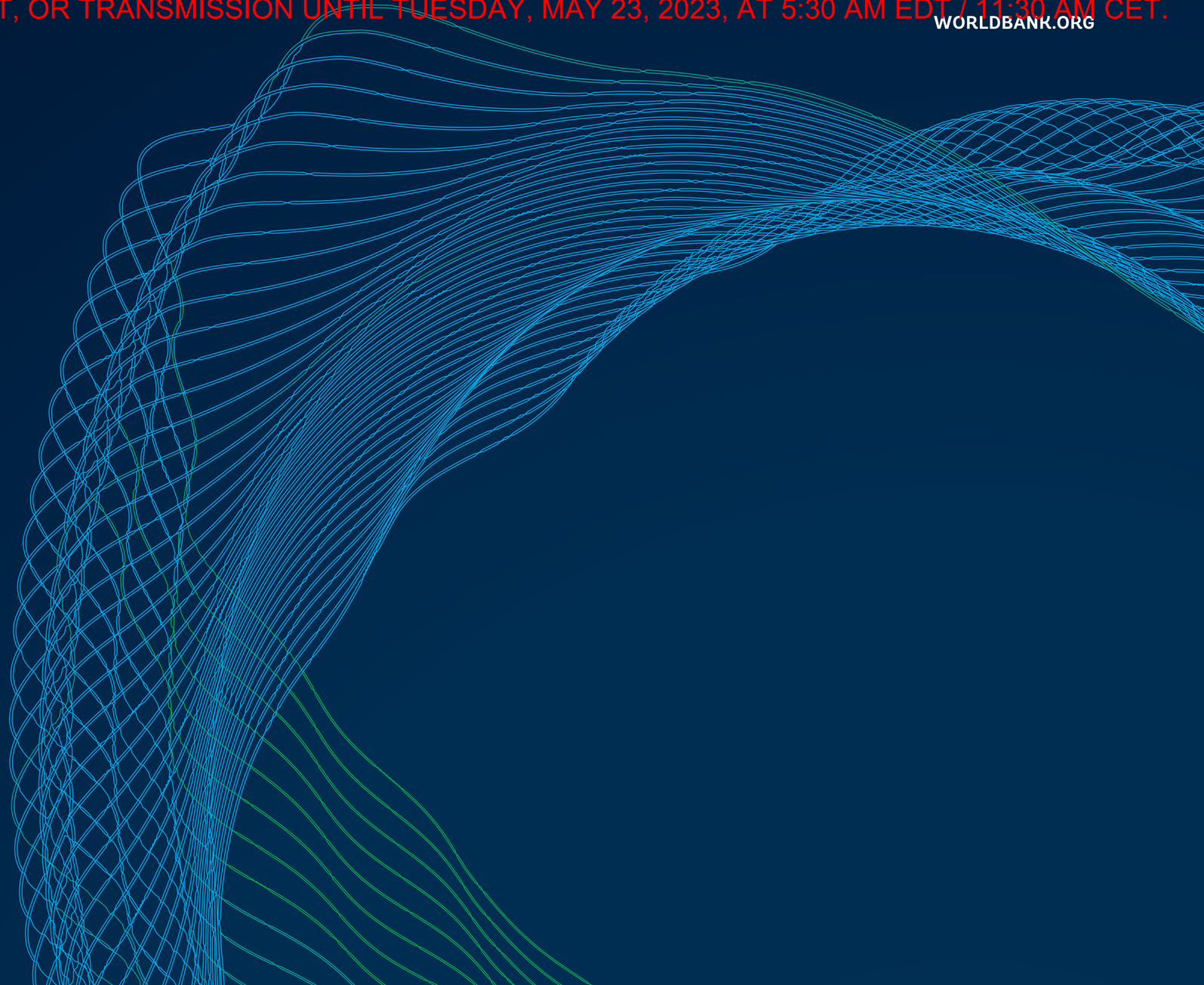
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