TheCityUK

ICE

Global carbon pricing mechanisms and their interaction with carbon markets

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TheCityUK is the industry-led body representing UK-based financial and related professional services. We champion and support the success of the ecosystem, and thereby our members, promoting policies in the UK and internationally that drive competitiveness, support job creation and ensure long-term economic growth. The industry contributes 12% of the UK's total economic output and employs nearly 2.5 million people, with two thirds of these jobs outside London. It is the UK's largest net exporting industry and generates a trade surplus exceeding that of all other net exporting industries combined. It is also the largest taxpayer, and makes a real difference to people in their daily lives, helping them save for the future, buy a home, invest in a business and protect and manage risk.

About ICE

Intercontinental Exchange, Inc. (NYSE: ICE) is a Fortune 500 company that designs, builds and operates digital networks to connect people to opportunity. We provide financial technology and data services across major asset classes that offer our customers access to mission-critical workflow tools that increase transparency and operational efficiencies.

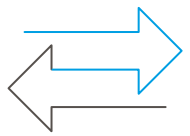
In 2000, ICE was founded on the principle of bringing price transparency to energy markets and soon after became a first mover in environmental markets, by acquiring the Climate Exchange. Today, ICE is a leader in global environmental markets and hosts the most liquid carbon markets in the world with a notional value of US$1trillion per annum. By combining price transparency in energy and environmental markets, our data, technology and digital networks are at the heart of net zero, the world's most important energy transition and the mitigation pathway for climate risk.

ICE operates exchanges, including the New York Stock Exchange, and clearing houses that help people invest, raise capital and manage risk across multiple asset classes. Our comprehensive fixed income data services and execution capabilities provide information, analytics and platforms that help our customers capitalize on opportunities and operate more efficiently. At ICE Mortgage Technology, we are transforming and digitizing the U.S. residential mortgage process, from consumer engagement through loan registration. Together, we transform, streamline and automate industries to connect our customers to opportunity.

Contents

Carbon markets worldwide

As of April 2022, there were
36
implemented carbon tax programmes around the world

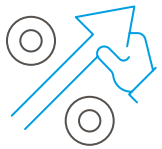


There were
34
Emissions Trading Systems (ETSs) implemented globally as of April 2022

The **EU ETS** is the world's oldest ETS and its largest by traded value; **China's national ETS** is the world's largest in terms of emissions covered

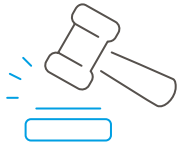
Between 1991 and 2021, estimated **global carbon tax revenues** grew by an annual average of
10.8%

Estimated global ETS revenue increased from **US$1.9bn** in 2012 to **US$56.4bn** in 2021



The EU ETS has grown at CAGR* of
56%
with a total revenue of **US$115.6bn** over 2012-21

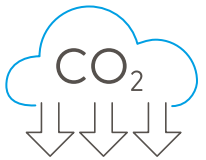
*Compound annual growth rate



In 2022, the volume of UK allowances auctioned reached **81 $MtCO_2e$*** and generated a value of **£6.5bn**

*Million tonnes of carbon dioxide equivalent

In 2021 the voluntary market grew to almost
US$2bn



In 2021, there was a global total of **352.5 $MtCO_2e$** in credits issued, involved in **223** activities

The estimated value of the global compliance market was around **US$850bn** in 2021*

*Excluding options trading

Around
90%
of the total carbon volume traded is in Europe

As of 2022 there were over **2,000 registered projects** in the Verified Carbon Standard* programme and **1,037 $MtCO_2e$** in credits issued

*It is the world's leading greenhouse gas crediting programme

Foreword from TheCityUK

In many ways, carbon markets are today where the wider universe of green finance was years ago when TheCityUK published `Growing green finance', its first economic research report on the subject. At that time, financial-market participants and policymakers understood that green finance was of serious and growing importance – but it was not well-understood outside a circle of dedicated professionals with extensive, specialist expertise.

Similarly, carbon markets are now in the headlines, evolving rapidly, and considered an increasingly important tool in the pursuit of net-zero carbon emissions targets. In `Growing green finance', we excluded what we then called emissions trading programmes from our broad definition of green finance on the grounds that such programmes did not represent a form of capital raising in its purest sense.

The ground has shifted considerably since 2017, when we published that research. Today, carbon markets include a panoply of tax, trading and crediting mechanisms that generate revenue which can be used for decarbonisation projects. Innovative new FinTechs are harnessing natural capital to generate strong financial returns which can then be used to finance environmentally-friendly projects. However, as with green finance almost a decade ago, understanding of the range and functionality of carbon markets is generally limited to a relatively small pool of subject-matter experts. The information gap is exacerbated by the fact that robust, comparable data are scarce; greater transparency about these markets' performance will help them to scale in future.

TheCityUK is therefore proud to have partnered with ICE to present this groundbreaking new research which seeks to present an overview of carbon markets, including the underlying principle of carbon pricing; and to quantify various mechanisms to give a sense of the scale of the market and how it has grown in recent years. A more widespread understanding of the role and importance of carbon markets will help government and broader society to marshal the resources needed to meet the net-zero targets that will be central to combating climate change.

Anjalika Bardalai

Chief Economist & Head of Research, TheCityUK

Foreword from ICE

The road to a net-zero carbon economy will be a long and complex transition. It will involve a move to cleaner energy sources and the ability to place a value on the conservation of nature. Here, markets will play a critical role. Financial markets allocate capital and manage risk. They facilitate economic growth, which contributes to global prosperity and wellbeing. The political recognition that addressing climate change is integral to these has seen markets adapt by providing a way to value factors like pollution, carbon sequestration and renewable electricity.

In doing this, environmental markets offer the opportunity to manage a finite carbon budget - the maximum amount of carbon which can be emitted to limit global warming to a certain level. Environmental markets allow companies and policymakers to quantify, manage and value the environmental impact of their activities. In this way, they incentivise positive behavioural change and help erode any additional cost of clean energy generation over fossil fuels.

Carbon allowances are the best example of an instrument which puts a value on emissions. These allowances are issued by a government under an emissions cap-and-trade program and are a revenue generator through the auction process. Companies pay for their emission liabilities through the purchase of an allowance and a carbon price is determined by allowing the trading of allowances between counterparties.

In the absence of government mandates, carbon credits provide an important alternative climate finance tool allowing companies to pay for their emission liabilities. Carbon credits represent either a reduction or removal of carbon. By purchasing a credit, representing a positive impact to the carbon budget, a company compensates for its pollution.

Compensating for emissions through carbon allowances or carbon credits incentivises companies to seek lower cost abatement opportunities.

An abatement opportunity could come in the form of a company deciding to use solar or wind-generated electricity illustrates how markets can value positive environmental choices. In a world where carbon emissions will increasingly be seen as liabilities to be managed, companies can use instruments like Environmental Attribute Certificates (EAC) as tools to prove renewable energy consumption and reduce their liabilities.

Environmental markets are therefore the bridge between science and economics. They help solve for the twin market failures of emitting carbon without penalty, nor attributing a value to technologies which absorb carbon. As governments and companies increase their commitments to a net-zero world, environmental markets can be the mechanism to help achieve those goals.

Gordon Bennett

Managing Director, Utility Markets, ICE

Introduction

The urgency of climate change and the need to mitigate it has been rising up the public and political agenda in recent years. Limiting global warming to a 1.5 degrees Celsius pathway should significantly reduce climate risk.

Financial markets play a fundamental role in helping to allocate capital efficiently; following on from this, carbon markets can provide price signals to efficiently allocate capital across the carbon cycle, and to manage the uncertainties in meeting the goal of net zero. Simply put, this goal is to conserve the world's finite carbon budget under a 1.5 degrees Celsius scenario. However, markets need reliable environmental and energy benchmarks to support an efficient transition from high- to low-carbon energy generation, and to create asset classes for natural and technological carbon sinks.

This report begins by describing the main carbon-pricing instruments. These instruments are foundational, because they enable atmospheric pollution to be quantified, rather than treating it as an (uncosted) negative externality as was historically the case.[1] It then explains the various ways the financial services industry contributes to progress towards net zero targets, beyond straightforward project financing; its contribution includes ensuring market liquidity, delivering tools which aid in the creation and discovery of high-quality carbon credits, and reducing financing costs for new, clean-energy technologies. Finally, to the extent possible given limited data availability, the report quantifies the growth and scale of various carbon-pricing instruments and carbon markets: carbon-tax schemes, emissions trading systems (ETSs) and carbon-crediting programmes.

It is clear from the research that these markets have the potential to contribute in a significant way to net-zero targets, which have ever-greater reach: Oxford Net Zero estimates that more than 90% of global GDP (in PPP terms) is now covered by net-zero targets.[2] But carbon markets still need greater scale to fulfil their potential in this regard.

1 A core principle in economics, an externality is, in essence, something unpriced in a market transaction. Externalities can be positive or negative; a negative externality is an indirect cost borne by a third party—neither the producer nor the consumer. Atmospheric pollution is the quintessential example of a negative externality.

2 Oxford Net Zero, Net Zero Tracker; available at: https:\\zerotracker.net

Executive summary

- Net-zero—short for net-zero carbon emissions—is the mitigation pathway for climate risk. The widespread adoption of environmental markets can help allocate resources efficiently to balance the carbon budget by pricing negative and positive externalities to solve for the twin market failures of using the atmosphere for free and not valuing the role of technologies which remove carbon.
- Carbon pricing brings together finance and economics by acknowledging that the atmosphere is a scarce resource. It tries to capture the external cost of carbon emissions, while permitting the reduction of carbon emissions, and allowing emitters to bear the cost of this pollution. This approach constitutes an economic incentive to polluters and allows them to decide to either transform their activities and lower their emissions, or continue emitting and paying for that.
- Carbon emissions taxes are taxes or fees imposed by a government on some polluting industries according to the level of greenhouse gas (GHG) emissions resulting from their production of goods and services (although they do not directly control the quantity of GHG emissions). As of April 2022, there were 36 implemented carbon tax programmes around the world.
- Trading mechanisms which allow emitters to compensate for their emissions have historically been included under the compliance (allowances) and voluntary (credits) carbon markets taxonomy. However, the boundary between the two is increasingly blurred, as allowances can be bought and retired "voluntarily" and some credits issued by independent standards are fungible with government programmes.
- Allowances and credits perform the same role; they allow the emitter to compensate for their emissions. The key point of any trading mechanism is the incentive to comply with a government mandate or another stakeholder commitment, and the existence (or lack thereof) of any penalty for non-compliance. Mechanisms with penalties create demand for the climate instrument which measures the externality. Any mechanism without a penalty becomes quasi-voluntary, and the climate instrument remains a discretionary good which limits the demand.
- Emissions Trading Systems (ETSs) are cost-effective pricing policies where an authority sets a maximum level of carbon emissions produced by some industries, and then issues an annual amount of carbon emissions permits (for each tonne of GHG emitted), keeping the emitters within their pre-allocated carbon budget. As of April 2022, there were 34 ETSs implemented globally. Estimated global ETS revenue increased sharply over the last decade up to 2021, from US$1.9bn in 2012 to US$56.4bn in 2021. Cap and trades are the only mechanism which control the quantity of emissions.

- In 2013 the UK government implemented the Carbon Price Floor (CPF) scheme to support the EU ETS in order to underpin the price of carbon at a level that drives low carbon investment. The price floor consists of two components which were paid for by energy generators in two different ways: the EU ETS allowance price; and the Carbon Price Support, which tops up the EU ETS allowance prices, as projected by the government, to the carbon floor price target. This scheme represented unilateral policy support to correct a market failure, and demonstrates the UK's leading role in using carbon markets to decarbonise the electricity-generating sector.
- The UK ETS was implemented in January 2021 as result of Brexit, and covers energy-intensive industries, the power sector, and the aviation sector within the UK and European Economic Area. The scheme issues units of allowances called UKAs, each one representing 1 tonne of carbon dioxide equivalent; trading of these allowances started in May 2021 under a price floor of £22/tonne.
- Crediting mechanisms issue carbon credits which are instruments certified by a government or by an independent body that represent the avoidance, reduction or removal of GHG emissions, measured in metric tonnes of carbon dioxide equivalent. According to the latest available data, in 2021 there was a total of 352.5 $MtCO_2e$ (million tonnes of carbon dioxide equivalent) in credits issued, involved in 223 activities, most of them related to agriculture, forestry, waste, energy efficiency, and industrial gases reduction.
- The Verified Carbon Standard programme, developed and run by the non-profit organisation Verra, is the world's leading greenhouse gas crediting programme. As of 2022 there were over 2,000 registered projects in the VCS programme and 1,037 $MtCO_2e$ in credits issued.
- Compared to the allowance market, the credit market is small in terms of emissions trading notional value. In 2021 the voluntary market grew to almost US$2bn, while the estimated value of the global compliance market was US$850bn. An alternative estimate including options, which the US$850bn estimate excludes, would be considerably higher.
- Carbon credits can be part of the compliance market or the voluntary market. However, carbon credits constitute all of the voluntary market and a small part of the compliance market.
- As the use of environmental markets becomes more widespread, the UK has an opportunity to play a leading role in these markets' ongoing development given its robust financial-market infrastructure combined with its strengths in energy and environmental markets. In its 2023 Green Finance strategy, the government confirmed its intention to position the UK as a global hub for trading in voluntary carbon markets.

Carbon pricing

In order to understand the development and importance of carbon markets, it is critical to first understand the mechanism of carbon pricing. Carbon pricing is an approach that tries to capture the external cost of carbon emissions, while permitting the reduction of carbon emissions, and allowing emitters to bear the cost of this pollution. This approach constitutes an economic incentive to polluters allowing them to decide to either transform their activities and lower their emissions, or continue emitting and paying for that.[3]

There are several instruments for carbon pricing, which all fall under two main categories: direct and indirect instruments.

Direct pricing instruments set a price directly proportional to the level of carbon emissions; in general, the price is expressed as the value per tonne[4] of carbon dioxide equivalent ($MtCO_2e$). These schemes make the incentives consistent and cost-effective.

Indirect pricing instruments can change the price of products or services related to carbon emissions in a way that is not proportional to the associated level of pollution. Examples include fuel and commodity taxes, as well as fuel subsidies affecting energy consumers. Even the subsidies can incentivise higher consumption of fuel and in consequence, a higher level of CO_2 emissions; those negative incentives which are related to other socioeconomic objectives beyond the reduction of carbon emissions can be considered as indirect instruments.[5]

This report will concentrate its analysis on direct pricing instruments, the most common of which are: 1) carbon tax schemes, 2) emissions trading systems, and 3) carbon crediting mechanisms.

Carbon emissions taxes: are levies or fees imposed by a government on some polluting industries according to the level of greenhouse gas (GHG) emissions resulting from their production of goods and services. The tax aims to incentivise these companies to reduce their carbon emissions so they can avoid the tax liability.[6] In this scheme, the price per tonne of CO_2 is pre-defined by the authority, but the level of emissions is determined by the market as a result of the price. The revenue from a carbon tax can be used for projects to repair environmental damage, as well as to subside new clean energy systems; more generally, the revenue is committed to supporting tax policy changes, suggesting that carbon taxes frequently feature as elements of a broader tax reform package.[7]

Nevertheless, this carbon pricing instrument has raised some concerns around the world. Although it can help incentivise companies to invest in some clean energy programmes, or new technologies to reduce their carbon

3 World Bank, 'What is carbon pricing?', available at: https://carbonpricingdashboard.worldbank.org/what-carbon-pricing

4 1 tonne = metric ton = $MtCO_2e$ = 1.10231 tons. Either of these terms can be used across the report referring to the same metric.

5 World Bank, 'State and Trends of Carbon Pricing', (2022), p.13, available at: https://openknowledge.worldbank.org/handle/10986/37455

6 World Bank, 'What is carbon pricing?, available at: https://www.worldbank.org/en/programs/pricing-carbon#:~:text=A%20carbon%20tax%20directly%20sets,but%20the%20carbon%20price%20is.

7 OECD, 'The use of revenues from carbon pricing', (June 2019), available at: https://www.oecd-ilibrary.org/taxation/the-use-of-revenues-from-carbon-pricing_3cb265e4-en

emissions, it also can be seen as signalling that the industries can pollute as much as they want and need, if they pay for it.[8] Other potential problems follow this argument. For example, it is difficult to measure the external cost of carbon emissions, and in consequence, the accurate tax rate that could offset the damage; moreover, the production might migrate to economies where a carbon price does not exist. Additionally, there are some socioeconomic reasons why governments would be reluctant to impose a higher level of carbon tax—for example, the commercial and political cost, and the indirect effects on prices which are ultimately borne by the consumers.[9]

Emissions Trading Systems (ETSs): Generally known as cap-and-trade systems, these are cost-effective pricing policies where a government (or other authority) sets a maximum level of carbon emissions (a 'cap') produced by some industries, and then issues an annual amount of carbon emissions permits - for each tonne of GHG emitted[10]- keeping the emitters within their pre-allocated carbon budget. The idea is that the cap gets stricter over time to ensure a reduction of total emissions. The main targets of such caps are carbon dioxide and related pollutants that drive global warming.[11]

A government distributes the allowances to companies either for free or by auction. In the first case, the permits can be allocated according to a certain parameter such as the historical emissions of the participant entities, or according to some performance indicators. In the second case (**primary market**), the allocation is normally conducted via 'blind' auctions, where all bidders offer once and pay the same price; or by dynamic 'ascending clock' auctions where each bidder pays closer to what they are willing to pay as revealed through multiple rounds of bidding. The revenue generated from auctions can be used by the government to address climate change.[12]

According to the OECD, ETS auctions revenues are the most constrained of the three carbon pricing instruments (in the sense of being committed to a specific programme or purpose), and are generally related to energy-savings projects among households and businesses, and projects promoting electric mobility and public transport. Additionally, these returns can be spent on renewable energy subsides and in the development of public accessibility to electrified mobility.[13]

Furthermore, some cap-and-trade systems allow those industries with low emissions to sell their extra allowances to larger emitters, creating a market where the price is established by the demand and supply of the permits.[14] It is not the price that causes the reductions in emissions. The cap determines the level of emissions, and the required reductions in emissions determine the price. Trading on the CO_2 market can be carried out either directly between buyer and seller, or via exchanges or other intermediaries who are participants of the **secondary market**. This market comprises all the subsequent transactions after the first allocation of allowances and can be bigger than the primary market in terms of the volume of carbon emissions transacted. Participants can exchange allowances directly, or they can exchange futures contracts (a type of derivative). Eligible participation in the secondary market is determined by each ETS.[15]

Some ETS programmes use another, less-well-known system: the baseline-and-credit scheme. In this system, the government does not set a cap on the total emissions per sector; instead, entities covered under the scheme can get emission credits if they produce fewer emissions than a pre-determined baseline set by the government. These credits also can be sold to other entities in the scheme which exceeded their baseline emission levels.[16]

ETS delivers some advantages, such as: certainty about the environmental impact by setting a cap on the total amount of carbon emissions; the low cost per tonne of abated emissions; the promotion of development and innovation of low-carbon technology; and the possibility of dealing with price fluctuations through futures contracts (secondary market), which enhance liquidity and information dissemination, enabling higher trading volumes and lower volatility. The EU ETS, the oldest system in force, has been an effective mechanism for reducing emissions cost-effectively. Installations[17] covered by the EU ETS reduced emissions by about 41% between 2005 and 2020.[18] However, there are also some challenges to overcome, related to over-allocation of permits, weak emissions caps, windfall profits for energy-generation companies, price volatility, and in general for failing to meet its goals.[19]

Crediting mechanisms: A carbon credit is an instrument certified by a government or by an independent body that represents the avoidance, reduction or removal of GHG emissions, measured in $mtCO_2e$. Credits and allowances both follow the 'polluter pays' framework; the differences are that allowances under cap and trade systems restrict the number of emissions (credits do not); and the use of funds received by the government (with credits, the funds go to project developers, who then reallocate the proceeds). Following on from this, there are three main types of carbon credits: credits of avoidance, reduction and removal. The first are generated from projects which could include activities such as avoiding deforestation or fuel-switching; the second and third refer to those credits related to projects that reduce or remove carbon dioxide from the atmosphere, such as afforestation.[20] Moreover, carbon credits can be traded with

8 World Bank, 'What is carbon pricing?', available at: https://carbonpricingdashboard.worldbank.org/what-carbon-pricing
9 World Bank, 'What a carbon tax can do and why it cannot do it all', (19 January 2022), available at: https://blogs.worldbank.org/energy/what-carbon-tax-can-do-and-why-it-cannot-do-it-all
10 United Nations Climate Change, 'About carbon pricing', available at: https://unfccc.int/about-us/regional-collaboration-centres/the-ciaca/about-carbon-pricing#Which-types-of-carbon-pricing-exist?-
11 Environmental Defense Fund, 'How cap and trade works', available at: https://www.edf.org/climate/how-cap-and-trade-works
12 International Carbon Action Partnership (ICAP), 'Emissions trading systems – allocation', available at: https://icapcarbonaction.com/en/allocation
13 OECD, 'The use of revenues from carbon pricing', (June 2019), available at: https://www.oecd-ilibrary.org/taxation/the-use-of-revenues-from-carbon-pricing_3cb265e4-en
14 World Bank, ' What is carbon pricing?, available at: https://www.worldbank.org/en/programs/pricing-carbon#:~:text=A%20carbon%20tax%20directly%20sets,but%20the%20carbon%20price%20is.
15 Center for Climate and Energy Solutions, 'Secondary carbon markets', (2016), available at: https://www.c2es.org/wp-content/uploads/2016/04/secondary-carbon-markets.pdf
16 World Bank, 'State and Trends of Carbon Pricing', (2022), p.13, available at: https://openknowledge.worldbank.org/handle/10986/37455
17 An installation is a stationary technical unit where one or more activities under the scope of the EU ETS and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution.
18 European Commission, 'EU Emissions Trading System', available at: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en
19 Climate Scorecard, 'The EU Emissions Trading System Seeking to Improve', (2020), available at: https://www.climatescorecard.org/2020/03/the-evolving-eu-emissions-trading-system/
20 Climate Change Committee, 'Voluntary Carbon Markets and Offsetting', (October 2022), p.20-22, available at: https://www.theccc.org.uk/publication/voluntary-carbon-markets-and-offsetting/

two main purposes: to sell these credits to companies regulated by cap-and-trade schemes who will use them to meet their compliance obligations; or to sell them to entities that have the purpose of complying with voluntary mitigation commitments. The price of carbon credits is determined in the market via demand and supply. Carbon credits are issued by several authorities—independent, international, or domestic (further detail is in the following sections).

Carbon credits create a monetary incentive for companies to reduce their carbon emissions because it is cheaper for them to reduce their emissions than to pay for their pollution by buying a credit. In this way, buyers can seek to invest in new and more efficient technologies which could lead to lower production costs in the future.[21]

The possibility that companies or countries can continue polluting just by purchasing more carbon credits is one of the main perceived concerns about this pricing instrument. Additionally, some studies have questioned whether carbon credits represent valid GHG reductions. According to analysis by EY, doubts can arise for a variety of reasons, such as inaccurate benchmarking (e.g. deforestation rates claimed as benchmark), inaccurate carbon sequestration claims (e.g. less tree planting than claimed), lack of additionality (i.e. the project would have happened anyway), leakage (i.e. emissions are moved elsewhere), and others. However, since the only way to reduce liability is through abatement, these doubts are misplaced given the reality of the market.

Nevertheless, perceptions of `greenwashing' (or potential greenwashing) have been one of the main reasons for the relatively soft demand for carbon credits. This highlights the necessity of having valid schemes which measure effectively those investments that could mitigate environmental damage while carbon credit owners are emitting carbon as a consequence of their permits. Market participants are already taking steps in this regard. EY note, for example, that:

- carbon credit ratings companies are using new technology, such as satellite data and AI, to test credit quality;
- informed corporate buyers are looking at quality and legal compliance as principal priorities;
- industry groups such as the Integrity Council for the Voluntary Carbon Market are setting standards; and
- governments are recognising that quality is a key requirement for the market to operate and grow.

21 Environmental Defense Fund, 'How cap and trade works', available at: https://www.edf.org/climate/how-cap-and-trade-works

From carbon pricing to carbon markets

Carbon markets emerged as a response to the high level of environmental degradation and the urgency of reducing GHG emissions over time. These markets are trading systems where agents–individuals, companies or government–can buy and sell units of GHG emissions which are similar to a commodity, aiming to limit global carbon emissions and to help to constrain the long-term rise of global temperatures.[22] These markets mobilise resources and reduce production costs by giving companies and nations the possibility of a smooth transition towards lower carbon emissions. In that sense, the Kyoto Protocol, adopted in 1997, was the first agreement that committed developed economies to reduce their emissions (by 5% on average during 2008-2012 compared to the levels in 1990).[23] However, the 2015 Paris Agreement established some commitments to reach net-zero carbon emissions by 2050, and in consequence, this specialised market gained more relevance, highlighting the need to concentrate efforts not only on lowering emissions but also in making the impact of these reductions more transparent (see Appendix I for further detail).[24]

Voluntary vs compliance carbon markets

The mechanism which sets the carbon price and the way the economic agents who participate in the transactions act together have led to the creation of two different carbon market types: compliance and voluntary markets. The difference between them lies in the kind of regulation under which they operate, the trading instruments used in the market, and the actors involved in carbon transactions.

The compliance market is the largest market involved in carbon trading. This is supported and regulated by a national, international, or regional authority, usually operating under the cap-and-trade system explained in the previous chapter (see pages 12-13 for detail). In compliance markets, the government is the entity which establishes which industries or companies need to participate in the process of carbon emission reductions, and their participation is compulsory. Robust, publicly available data on carbon markets are still extremely limited, so a precise quantification is impossible. According to data from Refinitiv (also widely cited, including in research by Shell and BCG), the compliance market soared to an estimated value of about US$850bn (or €762bn) in 2021, nearly 2.5 times the value in 2020.[25] However, using a wider definition than Refinitiv (including options, which the Refinitiv data exclude), ICE estimate the notional value of carbon allowances traded on its exchange to be US$1 trillion in 2021–implying that total global trading was considerably higher.[26]

22 United Nations-REDD Programme, 'Carbon Market', available at: https://www.un-redd.org/glossary/carbon-market#:~:text=A%20popular%20(but%20misleading)%20term,states%20of%20the%20European%20Union.

23 United Nations, 'What is the Kyoto Protocol?', available at: https://unfccc.int/kyoto_protocol

24 United Nations, 'The Paris Agreement', available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

25 Shell and BCG, 'The voluntary carbon market: 2022 insights and trends', (2022), available at: https://www.shell.com/shellenergy/othersolutions/carbonmarketreports.html

26 ICE, 'Record Volume of Environmental Contracts Traded on ICE in 2021 Equivalent to an Estimated $1 Trillion in Notional Value', available at: https://ir.theice.com/press/news-details/2022/Record-Volume-of-Environmental-Contracts-Traded-on-ICE-in-2021-Equivalent-to-an-Estimated-1-Trillion-in-Notional-Value/default.aspx

The Kyoto Protocol laid the first basis for the compliance market with the intention of reducing GHG emissions in industrialised countries. However, it was not until 2005 that the first ETS was established, the EU ETS scheme. After that, various jurisdictions have adopted different cap-and-trade programmes, and some others are contemplating the possibility of including this form of carbon pricing mechanism; for that reason, a robust financial market that integrates transparency, integrity, and stability is crucial, as the International Organization of Securities Commissions (IOSCO) consultation of 2022 suggests.[27]

In contrast, the voluntary market is not legally mandated, it is a decentralised regime where companies/industries choose by themselves (as the name suggests) to compensate for their emissions by purchasing carbon credits. Usually, the entities can buy carbon credits for voluntary use rather than to fulfil a mandatory level of emissions.[28] Offset credits are generated by companies with operations that avoid, reduce or remove carbon emissions already in the atmosphere—for instance, by investing in fuel switching or reforestation.

This could be motivated by an industry looking to offset its longer-term climate risks/sustainability goals, and by intangible factors not related to emissions being liabilities, such as ethics and reputation.

According to Ecosystem Marketplace (a not-for-profit organisation providing information on environmental markets), the total traded value of the voluntary market in 2021 was almost US$2bn.[29] Most of the transactions are over-the-counter trades. There are some spot OTC marketplaces, such as US-based Xpansiv and Singapore-based AirCarbon Exchange, where carbon credits can be traded and futures exchanges such as CME, EEX and ICE now also offer carbon credit futures for trading.[30]

However, the 2022 IOSCO consultation recognises the growing interoperability between some compliance markets and the use of carbon credits; in consequence, the distinction between mandatory and voluntary markets is becoming increasingly unclear.[31] The boundary between the two is increasingly blurred, as allowances can be bought and retired "voluntarily" and some credits issued by independent standards are fungible with government programmes. For instance, certain compliance markets are accepting high-quality carbon credits issued by voluntary GHG crediting programs, such as the Verified Carbon Standard (VCS), to fulfil their respective emission reduction and/or removal requirements.

27 IOSCO, 'Compliance Carbon Markets', (November 2022), available at: https://www.iosco.org/library/pubdocs/pdf/IOSCOPD719.pdf

28 Environmental Defense Fund, 'Mandatory & voluntary offset markets', available at: https://www.offsetguide.org/understanding-carbon-offsets/carbon-offset-programs/mandatory-voluntary-offset-markets/#:~:text=Compliance%20markets%20are%20created%20and,intended%20use%20for%20compliance%20purposes.

29 Ecosystem Marketplace, 'State of VCM 2022 – Q3', (August 2022), available at: https://www.ecosystemmarketplace.com/publications/state-of-the-voluntary-carbon-markets-2022/

30 Norton Rose Fulbright, 'Carbon offsets as a potential source of revenue', (February 2022), available at: https://www.projectfinance.law/publications/2022/february/carbon-offsets-as-a-potential-source-of-revenue/

31 TheCityUK, ' Public Comment on Voluntary Carbon Markets – Discussion Report and Compliance Carbon markets', (2023).

In addition to the perception challenge around carbon credits outlined on pg 14, a number of other challenges surround the continued growth of VCMs. According to analysis by EY, these include:

- **Delays of credits going to market from projects.** Delays of 2-5 years for credits going to market are common.[32] There are multiple reasons for this, but this is frequently due the lack of technology used to provide data required to assess standards, and the lack of market infrastructure integration – with inefficient and sometimes repetitive data flows between key market participants.
- **Lack of integration of market participants and lack of use of technology.** Key market players often take paper-based approaches to the verification of credits, causing the time delays of credits going to market, as well as associated risks to data flow. Standard spot and future contracts are only now becoming commonplace. The digital transactions of credits need to be protected against cyber security threats.
- **Information gaps.** Data gaps increase risk and uncertainty across the carbon credit value chain. Project information, quality and standards can be difficult to ascertain, especially in such a nascent market. This also inhibits accurate pricing and price projection of credits, which can increase project uncertainty and risk.
- **Legal risk.** There lacks legal certainty on credits and underlying projects, including how they are legally constituted. This creates commercial risk including with respect to lack of standardised contracts (although there has been some recent improvement in this regard), uncertainty around division of rights and responsibilities and between asset owner and credit owner, and risk allocation. Other markets and initiatives without a firm legal basis for asset and business have shown that the financial provider carriers the risk without an ability to get insurance.[33]
- **Lack capital market infrastructure and oversight.** VCM infrastructure across the transaction lifecycle requires maturity and oversight to enable scale and access to capital markets. Conduct and prudential regulators are required to provide oversight of markets.

32 Defined as a credit getting through verification and registration and to point of sale

33 Even if the asset is securitised, the principal financier will still carry most of the risk.

The role of financial and related professional services in carbon markets' development

One of the main concerns across many industries around the world, regardless of their main activity, is climate change and in consequence the need to cut carbon emissions. When considering sustainable finance, it is important to consider the basic proposition of financial markets; to allocate capital and manage risk. Capital allocated to the most productive causes fuels economic growth, contributing to wider prosperity and wellbeing. This is the basis of the 'social contract' that connects citizens with a sense of hope that challenges can be overcome.

The financial and related professional services industry has been contributing and searching for ways to enhance its contribution to emissions reduction for many years. For example, it is crucial that financial institutions offer debt financing to the project developers creating carbon offsets to a greater extent or scale than they do currently. However, to reach this goal, the creation of a legal environment with established rules governing how financial institutions could participate is imperative. There are still some programmes in the compliance market that do not allow the participation of financial institutions in the schemes. Research by independent regulators and academics has shown that financial participation is crucial for carbon markets to function effectively and improve liquidity. For instance, a report prepared by the European Securities and Markets Authority (ESMA) established that financial entities can provide liquidity to EU Allowances (EUAs) because most of them are buying physical EUAs with the plan to sell them again in the future.[34]

However, higher prices for allowances or credits and market volatility can generate political debate on the functioning of carbon markets and the impact of speculation and financial participation. Reaching a global consensus on the benefits of financial participation may help to prevent abrupt policy changes; such abrupt changes can damage the functioning of carbon markets and affect governments' abilities to meet climate goals. Therefore, the participation of non-compliance entities (i.e., firms for whom participation in ETS is not mandatory) in primary and secondary carbon markets is necessary.[35] In addition, a report prepared by Oxera suggests that financial institutions and other market participants willing to take financial positions in the market are integral to the provision of liquidity and price formation. They bring liquidity and have financial incentives to take positions and assume market risk.[36]

Banks play a significant role in the compliance markets by offering a liquid market with price certainty and transparency to companies governed by cap-and-trade programmes. Chartered Banker sets out some additional ways in which banks can add value to carbon markets:

- Financing project development – banks might need to offer debt financing or blended financing to the project developers creating carbon offsets.
- Financing capacity development – beyond financing projects, more capital should be channelled into training people to develop projects related to carbon emission reductions.
- Bridging the information gap – banks play an intermediary role between project developers accessing financial support and the market; in that way banks could help manage the information asymmetry between project developers who look to sell their offsets and the market which constantly seeks more understanding and information about carbon offsets.[37]

Some concerns have emerged in the voluntary market about the lack of transparency around the precise commissions and profits that agents obtain when they buy and sell carbon credits, the lack of standardised verification and insufficient monitoring of these voluntary carbon markets, and the irregularity of public data. In an attempt to address these concerns, an increasing number of initiatives and startups are coming into this space.

Some recent initiatives, such as Carbon Reference Entity Data Service (CRED) launched by ICE in 2022, aim to facilitate the management of carbon credits through the trade lifecycle. Verified carbon credits are issued in respect of registered projects, and are typically recorded and held in registries which identify the number of carbon credits that are issued, retired, cancelled or converted. ICE CRED normalises, standardises, aggregates and supplements carbon credit reference data from global registries and assigns a unique identifier to carbon credits for each project and vintage, providing a universal reference code to facilitate their use.[38] Additionally, nine of the largest global financial institutions[39] developed a carbon credit transaction FinTech named Carbonplace, headquartered in London. Conceived of as serving the purpose in carbon markets that SWIFT serves in financial transactions and payments markets, it is intended to enable the simple, secure, and transparent transfer of certified carbon credits. This project will start operations in the second half of 2023 and aims to enable the trust, transparency, and accessibility required to scale the voluntary carbon market (VCM) and accelerate global climate action.[40]

Moreover, the industry could help to improve the transparency and integrity of the VCM by investing in or furthering initiatives that are developing projects which have been demonstrating real reductions or removals of carbon emissions.

One example of such an initiative is Cultivo, a FinTech which builds portfolios of high-quality natural capital that generate healthy financial returns that are good for nature and society. Cultivo's goal is to deploy US$1bn in nature and restore at least 3.5m hectares of land by 2025 by financing a diverse range of projects including forests, grasslands, wetlands, and regenerative agriculture. Cultivo's mission is to bridge the funding gap by providing an innovative financing mechanism that connects financial institutions to NGOs and landowners. The investment is used to fund sustainable activities such as regenerative grazing or planting trees which in turn generate carbon credits and other offsets that can be sold.[41]

34 ESMA, 'Final report: Emission allowances and associated derivatives', (March 2022), p.15, available at: https://www.esma.europa.eu/sites/default/files/library/esma70-445-38_final_report_on_emission_allowances_and_associated_derivatives.pdf

35 TheCityUK, 'Public Comment on Voluntary Carbon Markets – Discussion Report and Compliance Carbon markets', (2023).

36 Oxera, 'Carbon Trading in the European Union', (2022), available at: https://www.oxera.com/wp-content/uploads/2022/02/Oxera-EU-carbon-trading-report-3.pdf

37 Chartered Banker, 'What do bankers need to know about carbon markets?', (November 2022), available at: https://www.charteredbanker.com/resource_listing/knowledge-hub-listing/what-do-bankers-need-to-know-about-carbon-markets.html

38 ICE, 'ICE Benchmark Administration Launches the ICE Carbon Reference Entity Data Service', (2022), available at: https://ir.theice.com/press/news-details/2022/ICE-Benchmark-Administration-Launches-the-ICE-Carbon-Reference-Entity-Data-Service/default.aspx

39 BNP Paribas, CIBC, Itaú Unibanco, National Australia Bank, NatWest Group, BBVA, SMBC, Standard Chartered and UBS

40 Carbonplace, 'About Carbonplace', available at: https://carbonplace.com/

41 Cultivo, 'Restoring nature at scale is crucial for Paris Agreement success', (2020), available at: https://cultivo.land/company/news/press-release-15-december-2020

In addition, there are some UK FinTechs such as Sylvera, which delivers carbon credit ratings and analytics which can assist with discovery of high-quality carbon credits, thus facilitating investment in real climate impact. Another example is BeZero Carbon, which delivers tools, analytics and project ratings on the voluntary carbon market with the aim of helping market participants make better decisions. In 2022 Molten Ventures, a venture capital firm, participated in BeZero's US$15m Series A and US$50 Series B fundraising round with strategic investment from Norrsken VC, EDF Group, Hitachi Ventures and ICE, demonstrating as well the appetite for UK venture capital investment in this space.

The financial and related professional services industry is also playing a role in addressing the current gaps in pricing externalities by looking at voluntary carbon pricing markets. In response to questions about the quality of carbon credits and the appropriate use of offsets by corporates, several initiatives have emerged to add greater regulation and standardisation to the carbon credit market. These include the Integrity Council for the Voluntary Carbon Market (IC-VCM) and the Voluntary Carbon Markets Integrity Initiative (VCMI). The IC-VCM has emerged to provide supply-side integrity by establishing a standard for high-quality carbon credits, through the Core Carbon Principles (CCPs) and an associated Assessment Framework. The VCMI is addressing integrity on the buy side through the development of its Claims Code of Practice which sets guidance on how carbon credits can be voluntarily used and claimed by buyers as part of credible net-zero strategies.

The industry is also engaged through initiatives such as the private sector led UK Voluntary Carbon Markets Forum, supported by the City of London Corporation. The Forum was established in 2021 to operationalise recommendations of the global Taskforce for Scaling Voluntary Carbon Markets, and has published research setting out the range of initiatives that have developed recently to support the scaling of high integrity VCMs.[42]

Furthermore, the financial and related professional services industry is innovating in the carbon market, creating schemes that facilitate the accurate and effective allocation of resources to carbon projects committed to a real reduction or removal of emissions. In this context, the Carbon Cap, a London-based environmental investment company, manages a fund focused on investing globally into liquid and regulated carbon markets or ETSs: the World Carbon Fund, which rose by 7.4% year on year in 2022. Its objectives are to generate absolute returns with a low correlation plus a direct impact on climate change.[43,44]

In recent years, numerous exchange-traded funds (ETFs) or products have been launched to support investment in compliance markets. For example, the ICE Carbon Futures Index Family is made up of pricing from the four most actively traded carbon markets in the world: EU ETS, California Cap and Trade Programme, RGGI and UK ETS. Together, these markets represent some of the largest regional economies in the world, and the secondary futures market for those programmes which trade on ICE's futures markets make up the majority of the volume in all carbon-based futures contracts.[45] In addition, the IHS Markit Global Carbon Index tracks the most liquid segment of the tradable carbon credit futures markets. The index covers the major European and North American cap-and-trade programs: EU ETS, California Carbon Allowances and RGGI, with pricing data from IHS Markit OPIS Pricing (North American Pricing) and ICE Futures Pricing (European Pricing). Another initiative is a physically-backed by carbon exchange-traded commodity (ETC) security, launched by HANetf. ETCs are different from conventional ETFs because they are backed by carbon allowances, becoming debt instruments which use the commodity tracked.[46]

With regard to exchanges, in 2022 LSEG became the first exchange in the world to apply a public equity market framework to facilitate financing in climate change mitigation projects that generate carbon credits (VCM). It also provides access for investors and corporates seeking exposure to carbon credits which may be issued in the form of a dividend in specie. In addition, ICE launched ten new nature-based solutions carbon credit futures contracts, providing a carbon credit futures contract portfolio which allows market participants to buy, sell and hedge carbon credits from 2016 out to 2030.

The development of financial products such as these helps link carbon markets to the world of green and sustainable finance by allowing wider groups of participants to access carbon markets. The participation of the financial and related professional services industry helps ensure the allocation of the best resources to the most innovative carbon projects.

The role of financial markets in a low-carbon future

Climate change is one of the biggest global challenges of our time, and will require significant changes to every aspect of the energy system, from exploration and production to transport, storage and consumption of energy. Fortunately, history shows us that the transition to new energy sources is not unprecedented but has been a continual process, driven by the forces of supply and demand, as well as technological innovation and public policymaking. The complexity of the energy transition lies in the fact that policymakers and market participants do not know from the outset which business models and technologies to invest in and support in order to reap the highest carbon returns.

The main purpose of financial markets is to provide a transparent price signal that allows participants to allocate capital and manage risk efficiently. This function will be critical in helping achieve the net-zero objective. More specifically, the price signals from financial markets have previously proven to be a beacon for policymakers and market participants alike.

42 City of London Corporation and UK VCMF, 'The Future of Voluntary Carbon Markets', (2022), available at: https://www.cityoflondon.gov.uk/supporting-businesses/economic-research/research-publications/the-future-of-voluntary-carbon-markets

43 Carbon Cap, 'World Carbon Fund', available at: https://www.carbon-cap.com/world-carbon-fund

44 Quantum Commodity Intelligence, 'World Carbon Fund', available at: https://www.qcintel.com/carbon/article/world-carbon-fund-had-lowest-annual-return-in-2022-10937.html

45 ICE, 'ICE Carbon Futures Index Family', available at: https://www.theice.com/market-data/indices/commodity-indices/carbon-futures

46 Environmental Finance, 'First EU carbon allowance-backed security launched', available at: https://www.environmental-finance.com/content/news/first-eu-carbon-allowance-backed-security-launched.html

The development of liberalised energy markets

The foundation of liquid markets is liberalisation—the process of removing government or other 'control' and opening markets up to supply and demand forces.

The UK was the first country in Europe to liberalise its gas and electricity markets, through a series of policy reforms dating back to the 1980s, which privatised and unbundled the state-owned monopolies.

Other European countries followed suit, and the EU introduced three consecutive legislative packages to harmonise and liberalise the internal gas and electricity market during the late 1990s and early 2000s. In addition, the EU introduced an Emissions Trading System (EU ETS) in 2005.

Following decades of policy developments and privatisations, the UK and Europe now provide the best examples of wholesale energy and carbon markets where the whole electricity generation value chains are subject to market forces.

Importantly, electricity (output) is a secondary form of energy generated from primary energy sources (input) such as oil, coal, natural gas, nuclear and renewables (e.g. solar and wind). In a liberalised energy market, the price of electricity predominantly results from ranking the available sources of primary energy based on ascending order of price—the 'merit order'. The cheapest primary energy source sets the price of the marginal megawatt hour (MWh). In the UK and Europe, the price of the marginal MWh of electricity results from the competition between natural gas and coal, while taking into account the cost of greenhouse gas emissions. The theoretical profit margin of generating 'decarbonised' electricity from natural gas or coal is referred to respectively as the 'clean spark spread' and 'clean dark spread'.[47]

The role of market infrastructure providers

Market operators and intermediaries play an integral role in facilitating liquid markets by allowing the interests of buyers and sellers to be matched. Brokers are critical in the early stages of market development: where products are generally not standardised, participants demand flexibility in contract design to meet specific hedging needs and where there are high search costs associated with locating a buyer or seller to trade with.

As markets mature, exchanges compete to introduce their own standardised, exchange-traded contracts. This brings several benefits to developing energy markets.

First, switching to exchange trading from predominantly 'over-the-counter' (OTC) physical markets can reduce barriers to entry for new participants and make trading more accessible. This is because new trading participants do not have to establish bilateral trading, credit and settlement relationships with incumbent participants. Instead, traders can access liquidity through a single point of entry—i.e. the exchange. This also means that a trader can execute against all prices on an exchange, in comparison to broker venues, in which the trader can trade only with counterparties with which it has established a trading and credit agreement. Similarly, new trading participants do not have to invest so heavily in the logistics associated with physically delivering the underlying commodity.

Second, exchange trading rules facilitate non-discretionary, anonymous and multilateral trading. The non-discretionary nature of an exchange order book means that orders are matched automatically on a price-time basis. Therefore, in order to trade, participants must provide competitive quotes (i.e. lower ask prices or higher bid prices). Anonymity of trading can also bring benefits to participants by reducing the risk of information revelation and adverse selection.[48]

Third, exchange-traded futures are cleared by definition. The promotion of more central counterparty clearing was a key policy objective supported by G20 and central bankers following the 2008 global financial crisis. Central clearing provides critical credit risk mitigation, as well as the efficient allocation of capital by providing offsets for correlated contracts. This is even more pertinent in the energy world due to the plethora of spread relationships that exist through either the conversion of one energy to another or the increasing globalisation of trade.

The breadth and diversity of trading participants that are attracted to the exchange model explains why most liquidity 'benchmark' contracts are exchange-traded. These key benchmark contracts provide price discovery and risk-management for several markets, not just the market for the underlying asset—in other words, benchmarks are proxies, as there is a pay-off between liquidity and basis risk.

Role of liquid markets

Price discovery and competition between energy sources

The transition to net zero will involve altering the aforementioned merit order to prioritise primary sources of energy that can be generated with lower or no greenhouse gas emissions.[49] This will require changes across multiple sectors, including power generation, industry, mobility and buildings (heating and cooling) across the globe.

Well-functioning, transparent and liquid markets are critical to the energy transition as they provide a price discovery mechanism that fosters competition between energy sources.[50] A clear price signal allows market participants to accurately value the energy we generate and consume. Moreover, it allows investors to value their capital at risk with more certainty, and investors and investees to manage risk.

The development of key benchmarks across the fuel inputs of electricity generation in Europe—API2 (coal), NBP and

47 Clean dark spreads are defined as the average difference between the price of coal and carbon emission, and the equivalent price of electricity. If the level of dark spreads is above 0, coal power plant operators are competitive in the observed period. Clean spark spreads are defined as the average difference between the cost of gas and emissions, and the equivalent price of electricity. If the level of spark spreads is above 0, gas power plant operators are competitive in the observed period.

48 Knowing the identity of the participant may provide information with respect to the direction (buying or selling) of the trade, and the pricing available may therefore be framed differently.

49 The merit order defines the sequence in which various energy sources are preferred for a given use (e.g. for heating, transportation or electricity generation, or as a feedstock in manufacturing).

50 'Price discovery' refers to the process by which information is incorporated into prices.

TTF (natural gas), and EUAs or European Emissions Allowances (underpinned by the EU ETS)—meant that the cost of pollution could now be reflected in the price of electricity. The era of carbonomics was born, and the profit margin of electricity from natural gas and coal was now determined through the clean spark spread and clean dark spread.

Reducing financing costs for new technologies

Energy derivatives markets also provide participants in the energy value chain with the ability to hedge risk associated with fluctuating energy prices.

Because primary energy is part of global supply chains, the interplay between primary and secondary energy sources brings about a high degree of complexity and uncertainty, and therefore volatility. Factors such as weather, geopolitics, storage and transport capacity constraints, as well as the availability of market information, all contribute to volatility in energy markets. Renewable fuel sources add an extra layer of complexity to this value chain due to their intermittent nature, which means that cash flows for companies in the energy value chain can be highly uncertain. The ability to hedge lowers funding costs for these companies by reducing the uncertainty of these cash flows.[51]

Several academic papers show that, by reducing the volatility of these cash flows, hedging can have a tangible impact on cost of capital. This research indicates that the ability to hedge can reduce the cost of debt by around 19–54bps and the cost of equity by around 24–78bps.[52]

This is important when thinking about financing investments in new, cleaner energy technology. Here, carbon pricing plays a key role in dealing with what Bill Gates calls the 'green premiums' issue. Green premiums describe the cost difference between a product that involves emitting carbon and an alternative that does not. Understanding this premium is vital to addressing climate change, as it indicates how far down the road to net zero one is with regard to a specific fuel or technology.

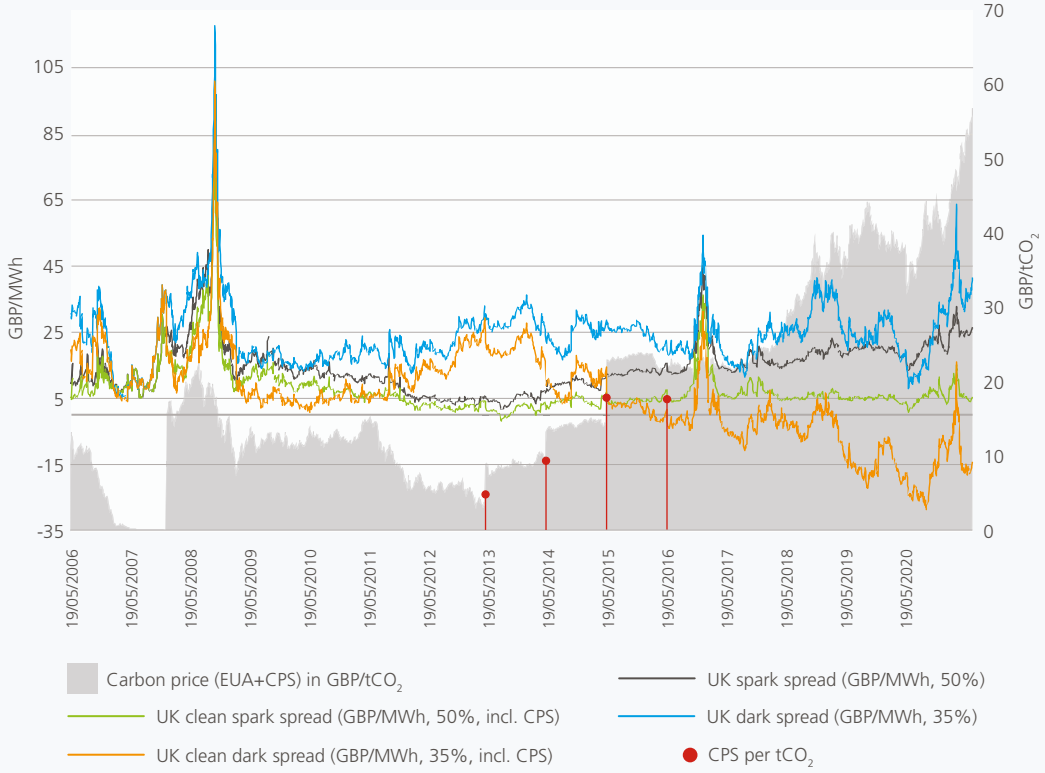
The UK and Europe have been applying this concept, through the application of carbon pricing. In particular, the UK has all but removed oil and coal, the most carbon-intensive fuels, from the electricity generation merit order. This has been undertaken through the application of market-based carbon pricing from the EU ETS and unilateral policy interventions—for instance, the introduction of the Carbon Price Support (CPS) via a carbon tax in 2013, which makes it more expensive to generate electricity from oil and coal than from natural gas.

51 In a frictionless market, individual investors can hedge themselves. If the assumptions of a perfect capital market are violated (e.g. if investors do not have perfect information or access to the same hedging instruments), firm-level hedging can increase shareholder value.

52 For example: Bartram, S.M., Brown, G.W. and Conrad, J. (2011), 'The effects of derivatives on firm risk and value', The Journal of Financial and Quantitative Analysis, and Campello, M., Lin, C., Ma, Y. and Zou, H. (2010), 'The real and financial implications of corporate hedging', NBER Working Paper No. 16622

The chart below shows the theoretical gross margin of gas- and coal-fired power plants in Great Britain from selling a unit (MWh) of electricity (i) excluding the cost of GHG emissions—spark and dark spreads respectively—and (ii) including the cost of GHG emissions—clean spark and clean dark spreads respectively. Applying the cost of GHG emissions (measured as the price of EUA futures including the Carbon Price Support) inverts the merit order; coal goes from the most profitable to the least profitable source of fuel in the electricity generation mix, thereby meeting the policy objective of using 'cap and trade' programmes to limit emissions.

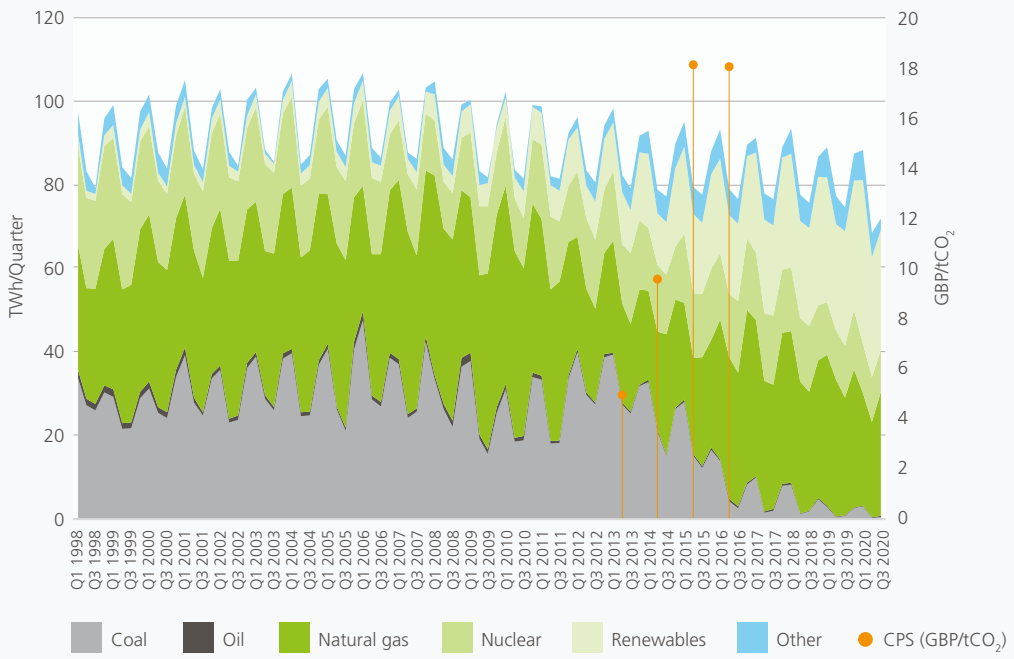
Great Britain clean dark and spark spreads



Source: ICE.

Meanwhile, coal has all but been removed as a source of fuel from the electricity generation mix in Great Britain. This reduction correlates with the introduction of the CPS in 2013 and increases in 2014 and 2015 respectively, which has contributed to the corresponding deterioration in the clean dark spread vs. the clean spark spread in GB. This is evident in the chart below:

Great Britain electricity generation mix by fuel source



Source: Ofgem (2021), 'Electricity generation mix by quarter and fuel source (GB)', April.

The EU achieved the same objective via the Market Stability Reserve in 2019. The decline in electricity generation from coal in Europe is expected to play out as it did in the UK.

Despite the success of carbon cap and trade in abating emissions in Europe, awareness of carbon pricing's impact does not seem to be widespread. This is because carbon cap and trade programmes only cover approximately 40% of emissions in Europe and have their greatest impact in the electricity generation sector. Unlike other sectors, the electricity generation sector does not receive free allocation and must buy an allowance for every tonne emitted. Due to this exposure to carbon pricing, Europe's electricity generation sector has arguably witnessed the birth of carbonomics via the establishment of the clean dark spread and clean spark spread.

Yet this era is ending. Companies across the globe will likely need to adopt carbon pricing in their business models in order to accurately reflect the value of assets and liabilities in this new, sustainable finance world. At a higher level, this will allow governments to meet the goals of the Paris Agreement, and contribute to global prosperity.

This text is adapted from an article by Gordon Bennett originally published as Bennett, G. (2021), 'Green derivatives? Trading for a low-carbon future', Agenda, April.

The quantitative analysis in the subsequent chapter is concentrated on carbon markets through their pricing instruments and according to data availability.

Impact of carbon pricing instruments and carbon markets

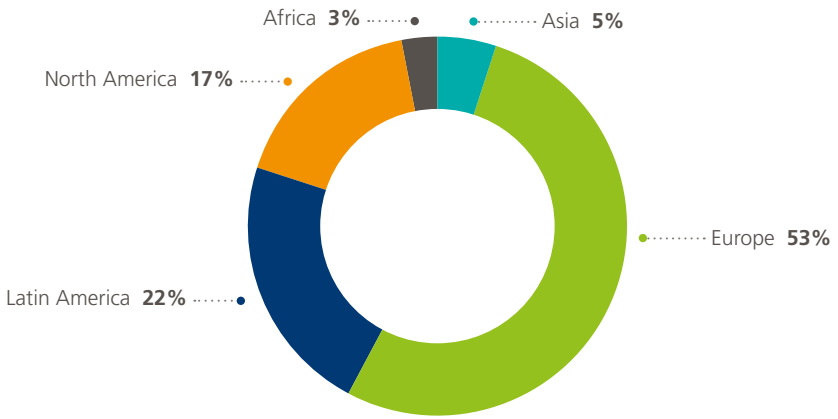
Carbon emission tax

The carbon tax has been an important instrument widely used by governments to control carbon emissions derived from transport fuels, fluorinated gases (F-gases), and other fossil fuels[53]. As discussed in the previous chapter, under a carbon tax regime the price established per tonne of carbon emissions is driven by a government policy. Although this is not a system within the compliance carbon market, both share some similarities, and analysis of carbon taxes is key to understanding the most important strategies implemented by some jurisdictions as part of their environmental policy.

According to World Bank data,[54] as of April 2022, there were 36 implemented carbon tax programmes around the world. More than 50% of these are in Europe (see Figure 1). Finland and Poland were the pioneer countries using this carbon policy in 1990; subsequently, other countries continued introducing carbon taxes, subject to some variations and revisions, and over the last decade up to 2021, an increasing trend is evident, with the number of countries introducing such schemes rising by an average of 10% a year. Uruguay implemented a new carbon tax program in January 2022.

Figure 1: Implemented carbon tax schemes by region as of April 2022

Source: World Bank



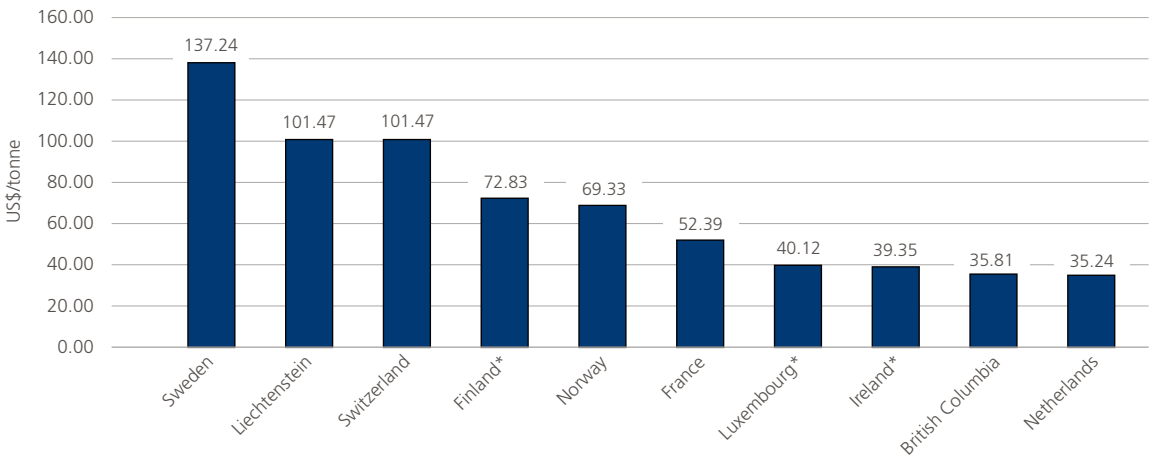
53 Fossil fuels could include oil, coal, natural gas, and gasoline. When these fuels are burned, they produce greenhouse gas emissions.

54 World Bank, 'Carbon Pricing Dashboard', (April 2022), available at: https://carbonpricingdashboard.worldbank.org/map_data

The tax level varies according to the jurisdiction where it is applied and the policy of carbon reduction that each government wants to reach. However, in US dollar terms, some countries have implemented a relatively high tax burden as of April 2022, such as Sweden (US$137.24/tonne), Liechtenstein and Switzerland (both US$101.47/tonne), Finland (US$72.83/tonne), Norway (US$69.33/tonne), and France (US$52.39/tonne); almost 49% of the carbon tax initiatives established a price over US$30, according to World Bank data (though the Bank notes that cross-jurisdiction comparisons of prices may not be entirely accurate).[55,56] For more information see Figure 2. British Columbia (in Canada), France, and Ireland increased their carbon tax fee by 55% on average in the last five years due to changes in their policies.

Figure 2: Top ten jurisdictions with the highest carbon tax as of April 2022

Source: World Bank



*Tax on a specific type of fuel

Since 1991, one year after the first-ever implementation of carbon tax policies (in Finland and Poland), estimated global carbon tax revenues demonstrated exponential growth up to 2021, with an annual average growth rate of 10.8%. This increase could easily be explained by the increasing number of jurisdictions that have committed to this policy over the

55 The World Bank emphasises that prices are not necessarily comparable between carbon pricing initiatives because of differences in the number of sectors covered and allocation methods applied, specific exemptions, and different compensation methods. Due to the dynamic approach to continuously improve data quality and fluctuating exchange rates, data of different years may not always be comparable and could be amended following new information from official government sources.

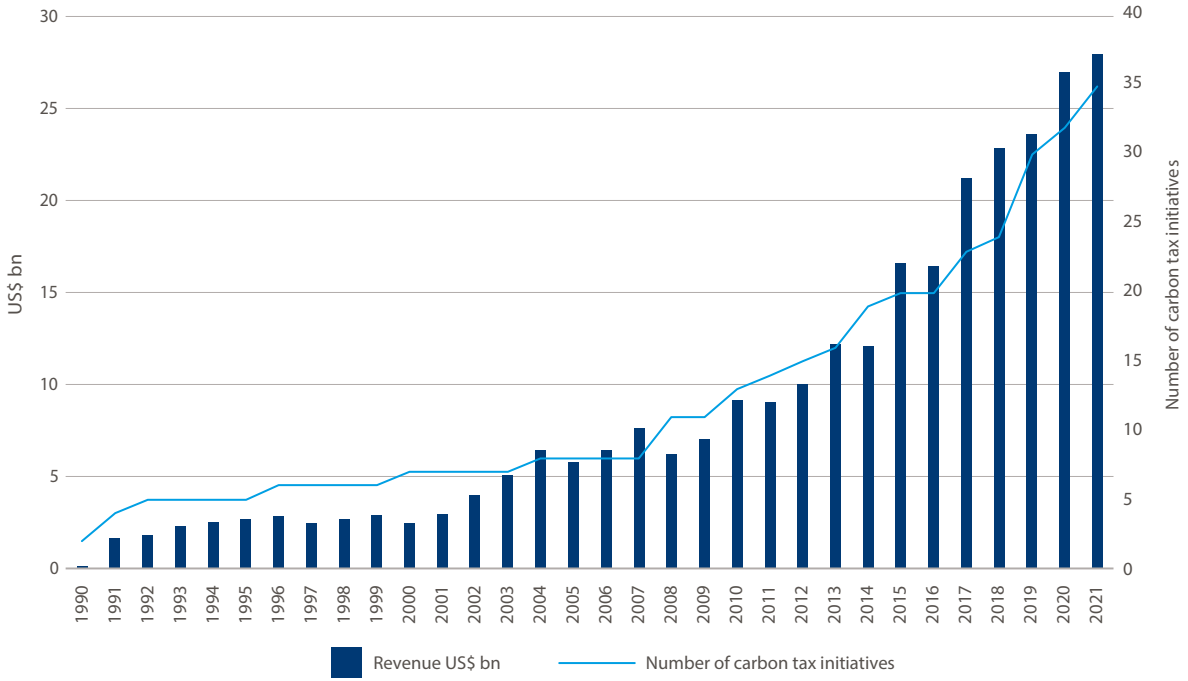
56 World Bank, 'Carbon Pricing Dashboard', (April 2022), available at: https://carbonpricingdashboard.worldbank.org/map_data

years. In 1991 there were four countries that had implemented a carbon tax scheme, and by 2021 the total number was 35. The most significant revenue increase occurred in 2015, when the number of countries with some kind of carbon tax was 20, and the amount collected rose by 37% year on year. For more information see Figure 3.

Figure 3: Estimated total revenue collected by carbon tax initiatives, US$bn, 1990-2021

Source: World Bank

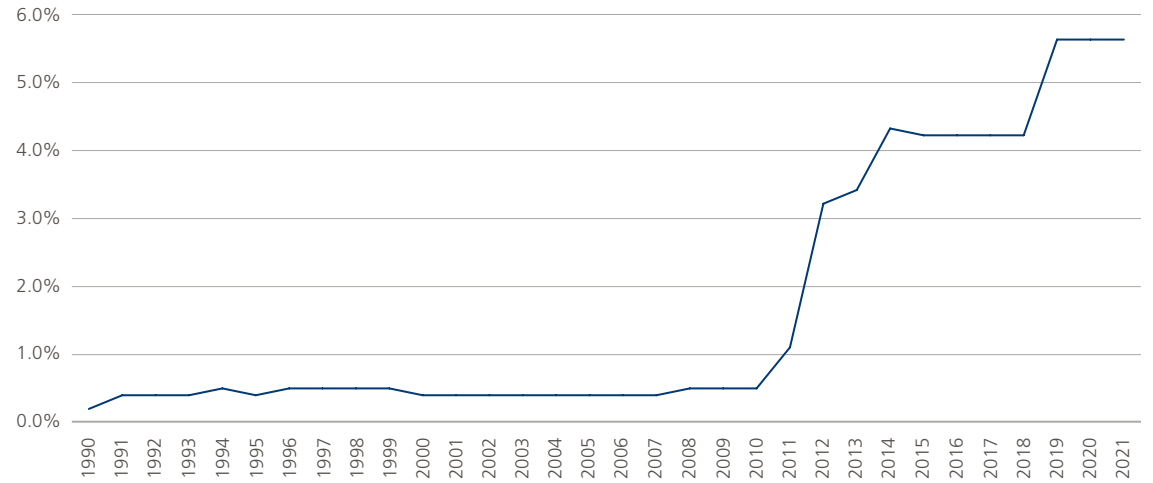
Note: Data for a limited number of initiatives may be incomplete as they are in the process of being validated and will be updated by the World Bank following confirmation from official government sources.



Although the number of initiatives increased from two in 1990 to 13 in 2010, the global GHG emissions covered by this policy nevertheless increased steadily, from 0.2% of total GHG emissions in 1990 to 0.5% in 2010, which represented an annual average increase of 0.02 percentage points. The coverage grew sharply over the last decade, at an annual average growth rate of 24.8%, reaching 5.6% of total GHG emissions in 2021. This percentage remains low relative to expectations of emissions reduction. For more information see Figure 4.

Figure 4: Percentage of global GHG covered by carbon tax initiatives, 1990-21

Source: World Bank

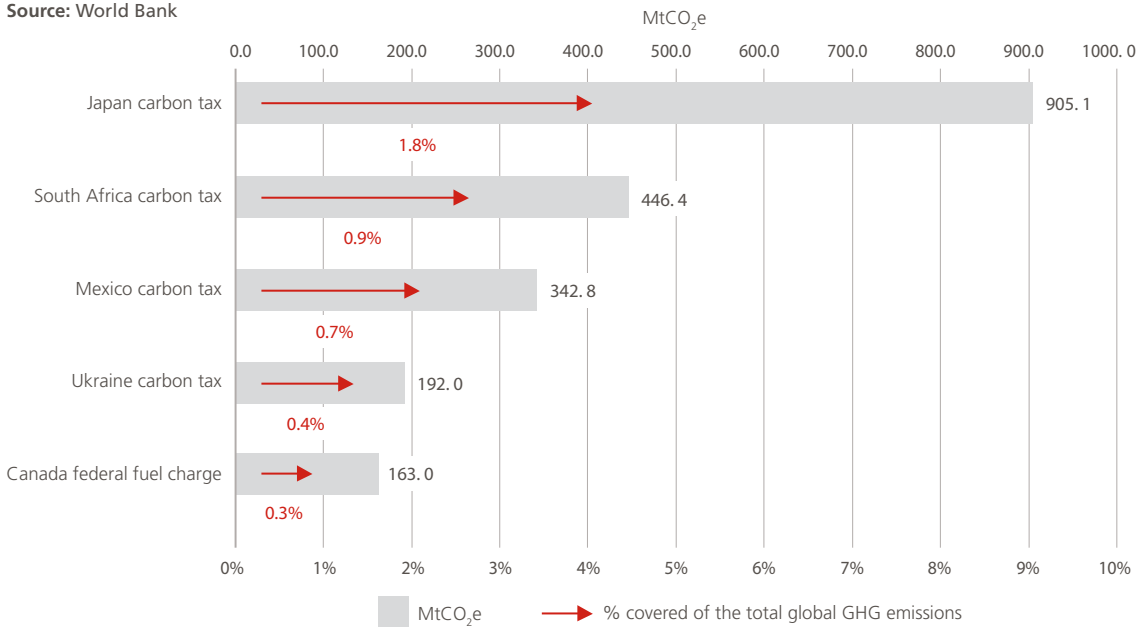


In 2021, only five carbon tax policies covered 4.1% of the total global GHG emissions, which corresponded to 2,049 $MtCO_2e$[57], and more than 70% of the total emissions covered by any carbon tax programme. The initiative which registered the most coverage was Japan's carbon tax with 952 $MtCO_2e$ in 2021 (see Figure 5).

57 $MtCO_2e$ = million tonnes equivalent

Figure 5: Top 5 carbon tax schemes, 2021

Source: World Bank



Leading carbon tax initiatives

Canada federal fuel charge

Canada is the leading country as measured by revenue collected from a carbon tax initiative, which reached US$4.8bn in 2021. The Pan-Canadian Framework on Clean Growth and Climate Change requires all Canadian provinces to have a carbon pricing system, which could be created by themselves as long as they comply with the minimum requirements set by the federal government. The provinces which applied this Canadian federal fuel charge are Alberta, Ontario, and Saskatchewan.[58] The charge covers 21 types of fuel, and it varies depending on the carbon content of the fuel in question. However, the rates reflected a carbon pollution price of US$15 per tonne of carbon dioxide in 2019–the year of implementation–rising by US$7.3 per tonne annually up to US$40 per tonne in 2022. The rates are based on global warming potential and emission factors used by Environment and Climate Change Canada.[59] Moreover, this initiative registered a coverage of 168 $MtCO_2e$ – 0.3% of the total global emissions in 2021.

Japan carbon tax

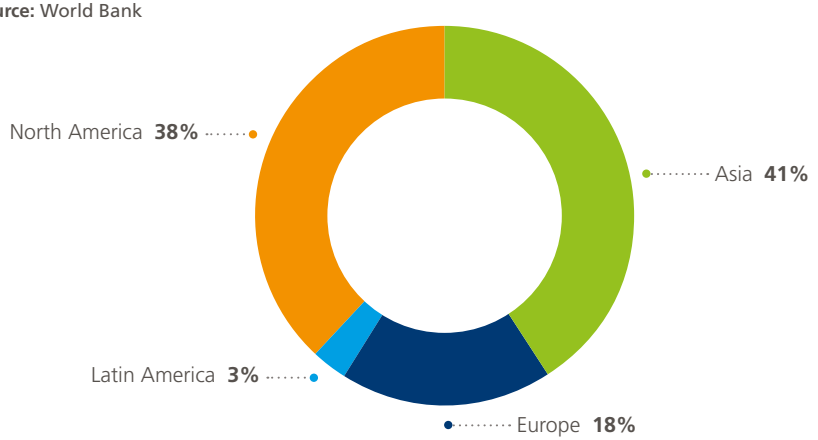
Considering the level of coverage, Japan is without a doubt the global leader. Japan's Tax for Climate Change Mitigation was implemented in 2012 with the aim of putting an economy-wide and fair burden on the use of all fossil fuels based on their CO_2 content. It is applied to CO_2 emissions from the combustion of fossil fuels across all sectors, with some exemptions for the industry, power, agriculture, and transport sectors.[60] According to World Bank data, in 2021 the programme achieved 1.9% of global carbon emissions coverage representing 952 $MtCO_2e$, but almost 75% of the total national emissions. The revenue generated under this programme has increased at an annual average growth rate of 23.3%, reaching US$1.8bn in 2021.

Emissions Trading System (ETS)

The ETS scheme is the most important system within the carbon market and the largest carbon pricing instrument by value in the world. As of April 2022, there were 34 ETSs implemented around the world: 22 at a subnational level, 11 at a national level, and 1 at a regional level. Moreover, 41% of the programs were in Asia, and 38% in North America – most of the latter in the United States (see Figure 6). There are also 19 initiatives around the world catalogued as 'under consideration'.

Figure 6: ETSs implemented by region as of April 2022

Source: World Bank



58 Government of Canada, 'Carbon pollution pricing systems across Canada', available at: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work.html

59 Government of Canada, 'Fuel Charge Rates', available at: https://www.canada.ca/en/revenue-agency/services/forms-publications/publications/fcrates/fuel-charge-rates.html

60 World Bank, 'Carbon Pricing Dashboard', (April 2022), available at: https://carbonpricingdashboard.worldbank.org/map_data

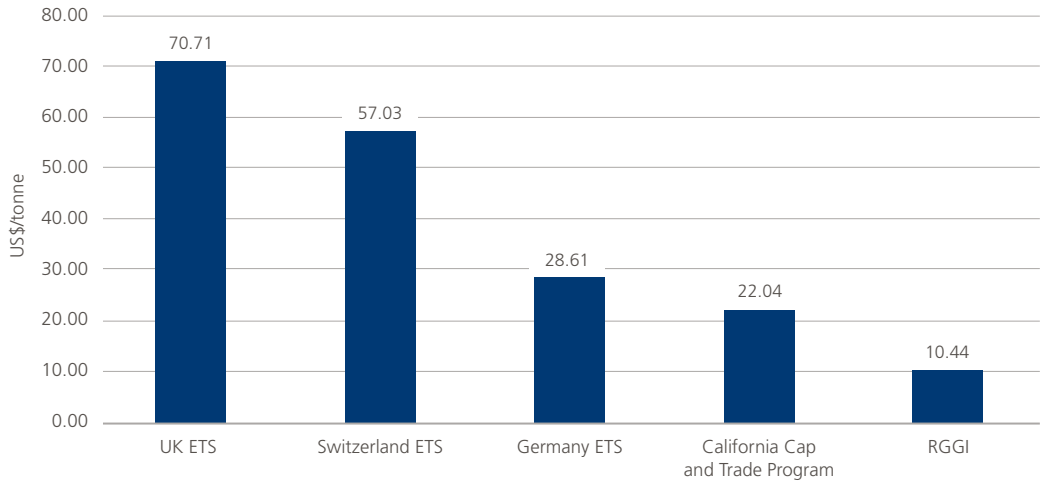
Primary market

According to data from the International Carbon Action Partnership (ICAP),[61] the UK ETS presented the highest annual average auction price in 2021, at US$70.71/tonne[62], followed by Switzerland's ETS at US$57.03/tonne, and Germany's ETS at US$28.61/tonne; for more information see Figure 7. These initiatives were implemented in different years, with the UK ETS being the newest and the Swiss initiative being the oldest. The Swiss programme's price evolved from an average of US$6.49/tonne in 2017 to US$57.03/tonne in 2021,[63] while the Regional Greenhouse Gas Initiative (RGGI) increased its allowance price from an average of US$3.76/tonne in 2017 to US$10.44/tonne in 2021.

Figure 7: Annual average auction price of selected ETSs, 2021-2022, US$

Source: ICAP data

Notes: (1) The ETSs for the comparison were selected according to the data availability.
(2) UK ETS was implemented in 2021; Switzerland ETS was implemented in 2008; Germany ETS was implemented in 2021; California Cap and Trade Program was implemented in 2012; and RGGI was implemented in 2009.



61 The ICAP Allowance Price Explorer app contains only some datasets of the most important ETSs around the world.

62 Carbon Price Support (CPS) is a carbon tax levied on electricity generation in the UK, designed to top up EU ETS prices and then UK ETS prices and to improve incentives for decarbonisation of power. In 2021 the Carbon Price Support was set at £18 (around US$25).

63 There is available information from 2014.

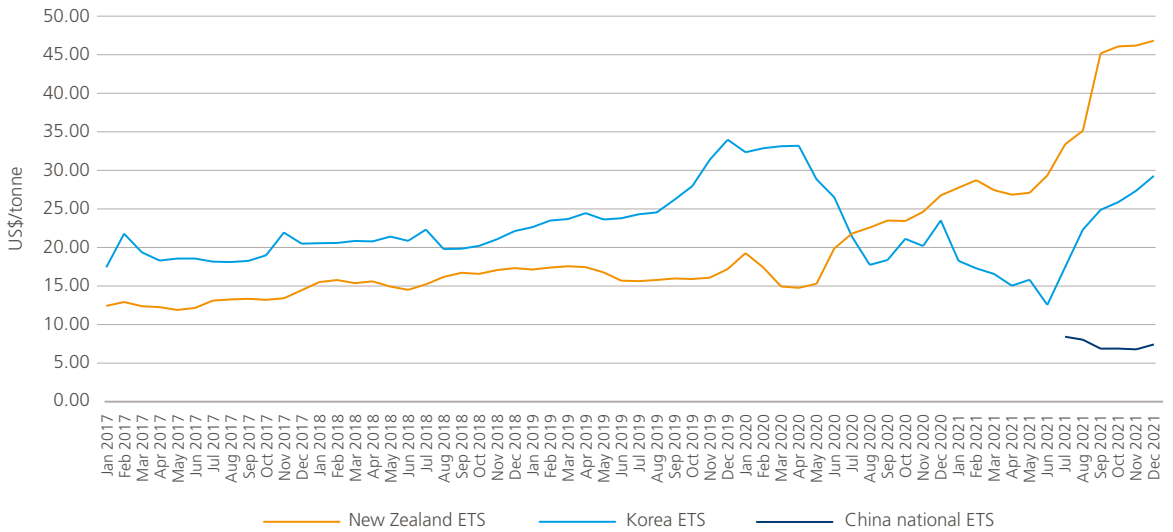
Secondary market

ICAP provides data of the spot price in the secondary market for three of the main ETSs. In the case of the New Zealand ETS, the spot price remained relatively stable between 2017 and 2019, followed by an average monthly growth of 4.7% until December 2021. The Korean ETS allowance increased by 68% between January 2017 and December 2021, but with a lower average monthly growth rate of 1.4%. The China National ETS initiative is one of the world's newest programmes and registered an average monthly growth rate of 2.2% in 2021. For more information see Figure 8.

Figure 8: Average monthly prices in the secondary market of selected ETS initiatives, 2017-21, US$

Source: ICAP data

Note: (1) The ETSs for the comparison were selected according to data availability.
(2) New Zealand ETS was implemented in 2008; Korean ETS was implemented in 2015; and China national ETS was implemented in 2021.



According to futures data from ICE, the average monthly price of two of the oldest ETSs (the California scheme (CC) and RGGI) remained relatively stable for almost a decade, from early 2013 to mid-2021; after that, both programmes registered an average rise of 2% per month up to April 2023. In the case of EUA, the price fluctuated between US$4.73/tonne and US$103.63/tonne from 2013 to April 2023. In general, the EU initiative showed a significant increasing trend since the last months of 2020. During this period, EUA price grew at an average rate of 3% per month. However, there were some months in 2022 when the price fell due to the Ukraine invasion, to then experience a recovery later the same year. The EU ETS Market Stability Reserve (MSR) was introduced in 2015 and became

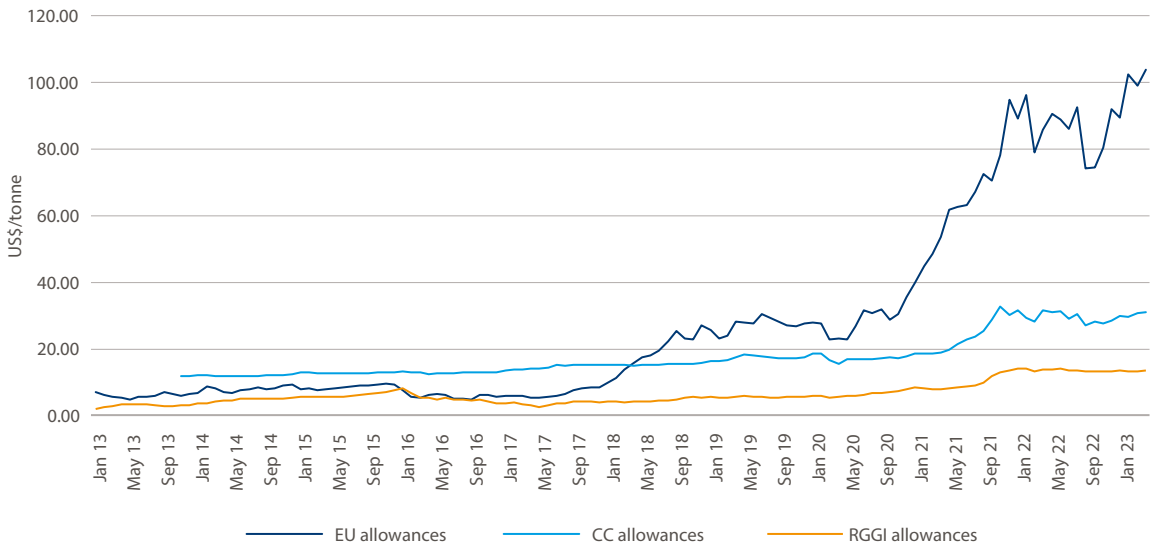
operational in 2019, to balance out the surplus in its allowances, improve the market stability, and thus restore its incentives for low-carbon investments. The hope is that strong allowance prices can be sustained to drive abatement activity. For more information see Figure 9.

Figure 9: Average monthly futures price in the secondary market of selected oldest ETS initiatives, 2013-23, US$

Source: TheCityUK calculations based on ICE data

Note: (1) The ETSs for the comparison were selected according to the data availability.
(2) EU ETS was implemented in 2005; RGGI in 2009 California carbon scheme (CC) was implemented in 2012
(3) For consistency purposes the original data was converted from euros to US dollars using annual average exchange rates retrieved from the European Central Bank.

*The price is based on the prompt December expiry, which is the benchmark contract.



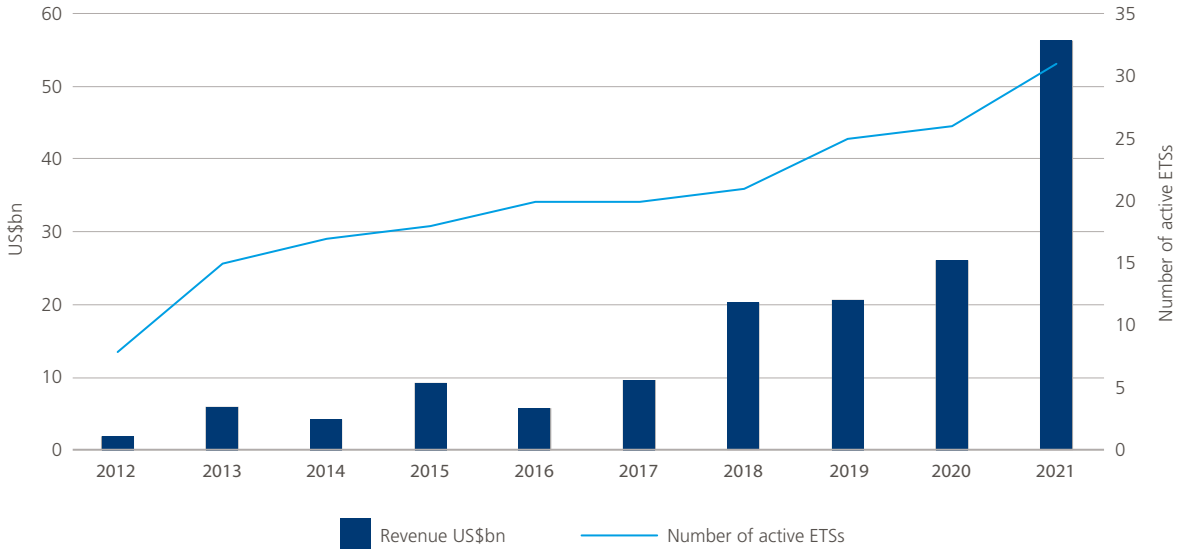
As discussed in the previous chapter, in ETSs the government/authority can distribute emissions permits for free or by auction processes. Through the latter approach, the government can generate revenues, which can be used to fund climate programmes. The amount of revenue generated usually depends on the size of the jurisdiction covered by the system, share auctioned allowances, and allowance prices.

In general, estimated global ETS revenue increased sharply over the last decade up to 2021, from US$1.9bn in 2012 to US$56.4bn in 2021 at a compound annual growth rate (CAGR) of 45%. This increase could be explained by significant growth in the number of ETSs implemented over time; there were 29 initiatives in 2021, up from eight in 2012. Furthermore, the increase in revenue has also been driven by the increase in the ETS prices and the increasing share of auctioned allowances rather than free allocation. For more information see Figure 10.

Figure 10: Estimated total revenue collected by ETS initiatives, 2012-21

Source: World Bank

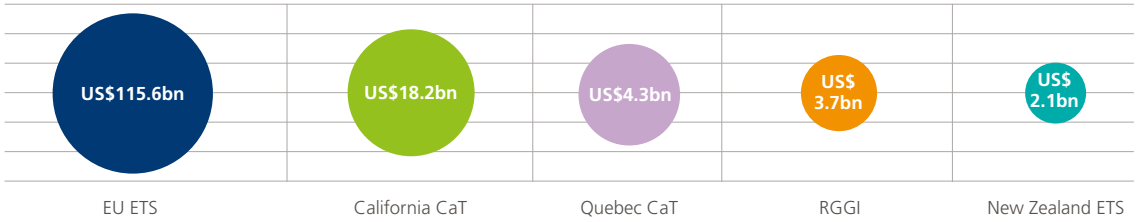
Note: Data for a limited number of initiatives may be incomplete as they are in the process of being validated and will be updated by the World Bank following confirmation from official government sources.



However, it is notable that the biggest increase in revenue collected occurred in 2021, when the income rose 115% year on year, which can be explained by the money raised by important programmes such as the German and UK ETSs. Additionally, some of the oldest ETS initiatives generated more than US$2bn over the last decade up to 2021; the EU ETS is the oldest programme within the compliance market and the one that has grown at CAGR of 56%, registering total revenue of US$115.6bn between 2012 and 2021. For more information see Figure 11.

Figure 11: Total auction revenue of the oldest ETSs, 2012-21, US$bn

Source: World Bank



Official statistics on the traded values and volumes of ETSs do not exist. However, according to a Credit Suisse report, around 90% of the total volume traded is in Europe, which has the largest compliance market in terms of volume (EU ETS). In 2021, the European market represented 12,214m tonnes, or US$807bn.[64] For more information see Figure 12.

Figure 12: Carbon market trading volume and value in 2021

Source: Credit Suisse

Note: For consistency purposes the original data was converted from euros to US dollars using annual average exchange rates retrieved from the European Central Bank.

*Markets include California, Quebec and RGGI.

**China includes national ETS and pilots program.

***Represent carbon offset credits traded in primary and secondary market.

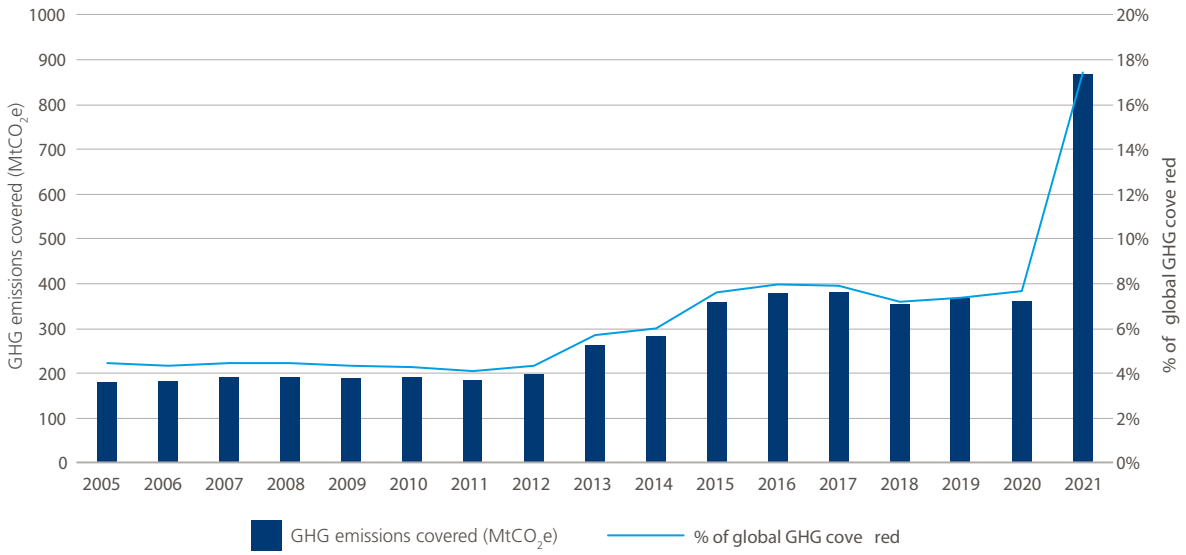
Global Carbon Markets	Total volume traded (million tonnes)	Total trading value (US$ bn)
Europe	12,214	807.4
UK	335	27.0
North America*	2,680	58.3
China**	412	1.5
South Korea	51	0.9
New Zealand	81	3.0
CERs***	38	0.2

64 Credit Suisse, 'Carbon Markets: the beginning of the big carbon age', (April 2022), p.19, available at: https://www.credit-suisse.com/about-us-news/en/articles/securities-research-reports/report-1-202205.html

The first-ever ETS programme was implemented in 2005; it registered global GHG emissions coverage of 4.4%. Between 2005 and 2020 the rate of coverage increased only very gradually, rising to just 7.7% in 2020, despite the increase in the number of ETSs. However, in 2021 emissions covered jumped to 17.4% of the total global emissions – around 8,700 $MtCO_2e$. In this year the Chinese government implemented its national programme, becoming the most important programme worldwide in terms of carbon dioxide emissions covered. It recorded coverage of 8.8%, corresponding to 4,500 $MtCO_2e$, and more than 50% of the total discharges covered by an ETS initiative; for more information see Figure 13.

Figure 13: Global GHG emissions covered by ETSs initiatives, 2005-21

Source: TheCityUK calculations based on Climate Watch and European Commission data; and Carbon Pricing Dashboard data



Leading ETS initiatives: EU ETS and China national ETS

EU ETS

The EU ETS was introduced in 2005, and it is the oldest ETS programme and the world's largest domestic carbon market by traded value. This system covered around 36% of EU emissions between 2020 and 2021, encompassing activities from the power sector, manufacturing industry, and aviation within the European Economic Area, and greenhouse gases such

as CO_2, N_2O, and PFCs.[65] In 2020, the EU ETS accounted for around 90% of the global carbon market value.[66] It could be considered a genuine compliance scheme in part due to its penalty approach, which means that regulated entities must pay an excess emissions penalty of EUR100 (US$105.30), adjusted for inflation, for each tonne of CO_2 emitted for which no allowance has been surrendered, in addition to buying and surrendering the equivalent number of allowances.[67] The system has undergone various reforms aiming to improve the control over carbon emissions through the time; a summary of the key features during the four phases of the programme can be found in Figure 14.

Figure 14: Phases of EU ETS

Source: ICAP and European Commission

Phase	Period	CAP	Key features
Phase one	2005-2007	The cap was established bottom-up, based on the aggregation of the national allocation plans of each Member State; it started with a cap of 2,096 $MtCO_2e$ in 2005.	• Covered only CO_2 emissions from power generators and energy-intensive industries. • Almost all allowances were given to businesses for free.
Phase two	2008-2012	The cap was established bottom-up, based on the aggregation of the national allocation plans of each Member State; it started with a cap of 2,049 $MtCO_2e$ in 2008.	• Lower cap on allowances (some 6.5% lower compared to 2005). • Nitrous oxide emissions from the production of nitric acid included by a number of countries. • Businesses were allowed to buy international credits totalling around 1.4bn tonnes of CO_2e.
Phase three	2013-2020	A single EU-wide cap for stationary sources: 2,084 $MtCO_2e$ in 2013, which was annually reduced by a linear reduction factor of 1.74 %.	• There was a single EU-wide cap on emissions in place of the previous system of national caps. • Auctioning as the default method for allocating allowances. • Harmonised allocation rules applying to the allowances still given away for free. • More sectors and gases included.
Phase four	2021-2030	A single EU-wide cap for stationary installations: 1,572 $MtCO_2e$ in 2021. A linear cap reduction factor of 2.2% applies to both stationary sources and the aviation sector each year; the linear reduction factor does not have a sunset clause and the cap will continue to decline beyond 2030. The cap for aviation operators starts at 24.5 $MtCO_2e$.	• Aligned to climate neutrality goal in the EU by 2050. • The Market Stability Reserve (MSR) mechanism is established by the EU to reduce the surplus of emission allowances in the carbon market. • From 2023 onwards the number of allowances held in the reserve will be limited to the auction volume of the previous year. Holdings above that amount will lose their validity.

65 ICAP, 'Emissions Trading Worldwide', (2022), p.48, available at: https://icapcarbonaction.com/system/files/document/220408_icap_report_rz_web.pdf

66 ESMA, 'Final Report: Emission allowances and associated derivatives', (March 2022), p.16, available at: https://www.esma.europa.eu/sites/default/files/library/esma70-445-38_final_report_on_emission_allowances_and_associated_derivatives.pdf

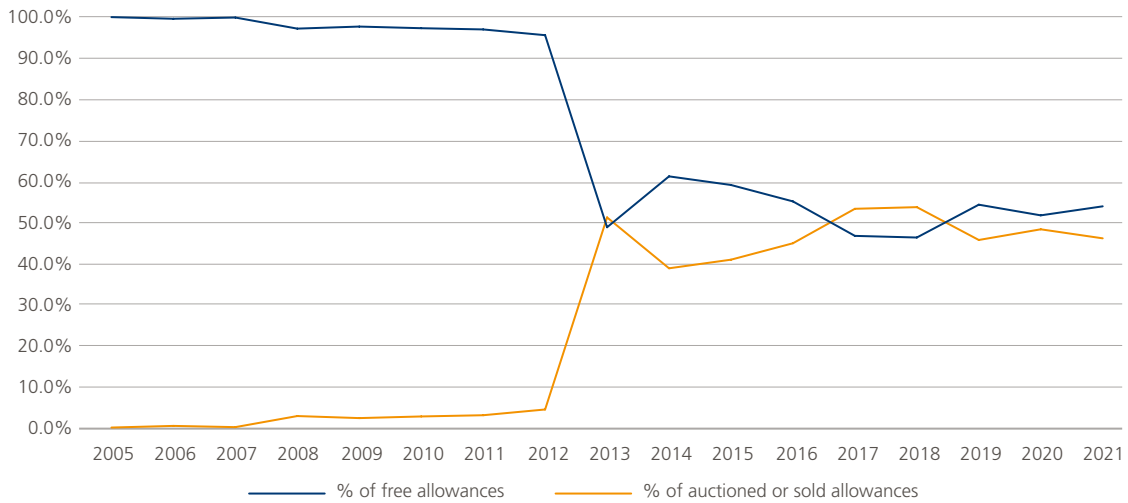
67 ICAP, 'EU ETS', available at: https://icapcarbonaction.com/en/compare/43

According to European Environment Agency data, the total number of allowances emitted under the EU ETS has decreased by 45% between 2005 and 2021 with big reductions during the first years of every phase. Similarly, the verified emissions have decreased at an annual average rate of 2% over the same period, which would justify the decline in the total supply of allowances. Additionally, the percentage of auctioned or sold allowances out of the total allowances changed dramatically in 2013, the year when auction processes was selected as the default method for allocating allowances for the following years. From 2005 to 2012 almost 100% of the total allowances were distributed for free, but from 2013 this percentage was on average 52% while the percentage of allowances auctioned or sold was on average 48%. (For more information see Figure 15 and Figure 16.) In this context, auctioning constitutes a transparent method for allocating emission allowances and puts into practice the principle that the polluter should pay. It creates a robust policy framework, facilitating efficient corporate and private decisions that contribute to the most economical response to climate policy, and removes uncertainties about further changes in the allocation scheme. In contrast, free allowances allocation distributes public assets to the operators of installations, which are often financially strong companies. These companies are not required to use the income either for investment and innovation in low-carbon options or for any other activity that benefits the country that issues the allowances.[68]

Figure 15: Evolution of percentage of free allowances and auctioned/sold allowances, 2005-21

Source: European Environment Agency

Note: Data corresponds to EU 27 countries.

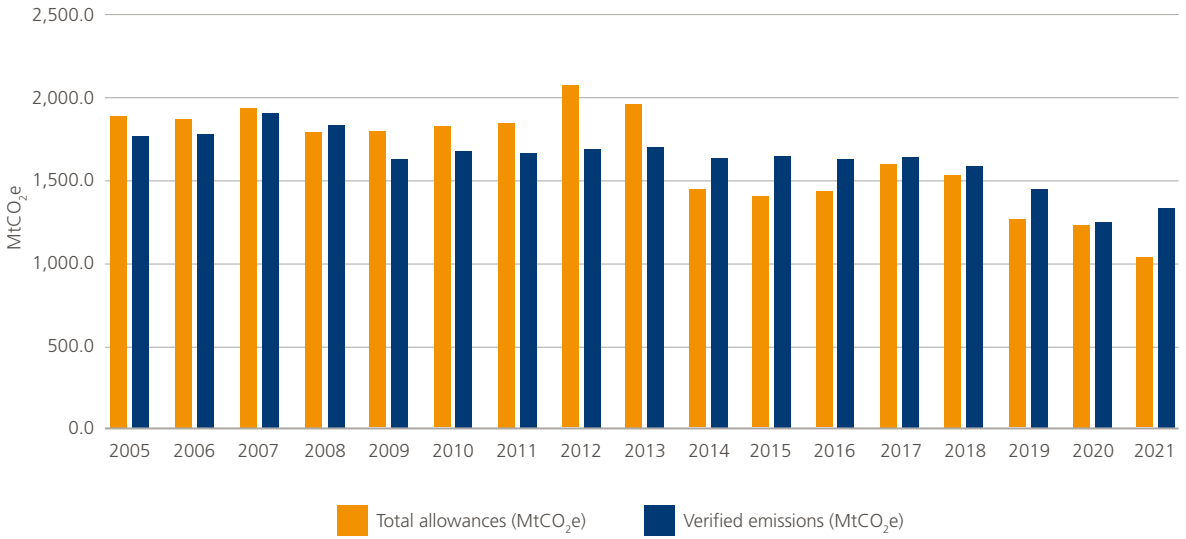


68 Climate Strategies, 'The role of auctions for emissions trading', available at: https://climatestrategies.org/wp-content/uploads/2014/11/role-of-auctions-oct-exectutive-summary.pdf

Figure 16: Evolution of total allowances and verified emissions under EU ETS, 2005-21

Source: European Environment Agency

Note: Data corresponds to EU 27 countries.



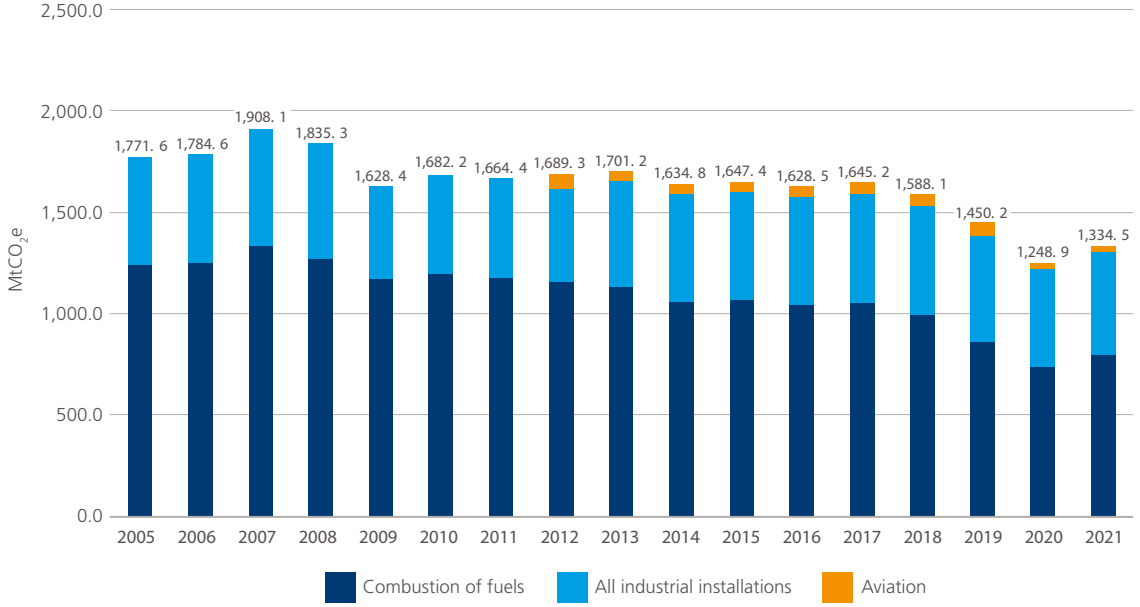
The aviation sector is one of the fastest-growing sources of greenhouse gas emissions; for that reason, in 2012 it was included within the ETS, and from that year the average percentage of total annual allowances delivered to the aviation industry was 2.9% (44.8 $MtCO_2e$). Analysing the verified emissions by sector, there is a clear decrease—albeit a slow one—in the discharge of GHG over time in all sectors involved in the EU programme. Unsurprisingly, the two years which exhibited the most significant declines were 2009 and 2020—both years in which economic activity contracted sharply on account of the financial crisis and Covid-induced mobility restrictions, respectively. In 2009, however, there was also strong growth in renewable energy.[69] Over 2018-19 there was also a notable decrease, driven by the substitution of coal with lower carbon fuels, linked to low gas prices and the increased penetration of renewable sources of energy. For more information see Figure 17.

69 European Environment Agency, 'Recession and renewables cut greenhouse emissions in 2009', (2011), available at: https://www.eea.europa.eu/media/newsreleases/recession-and-renewables-cut-greenhouse#:~:text=Key%20findings%20for%202009&text=In%20line%20with%20EEA%20estimates,below%20the%20base%20year%20level.

Figure 17: EU ETS verified emissions by activity, 2005-21

Source: European Environment Agency

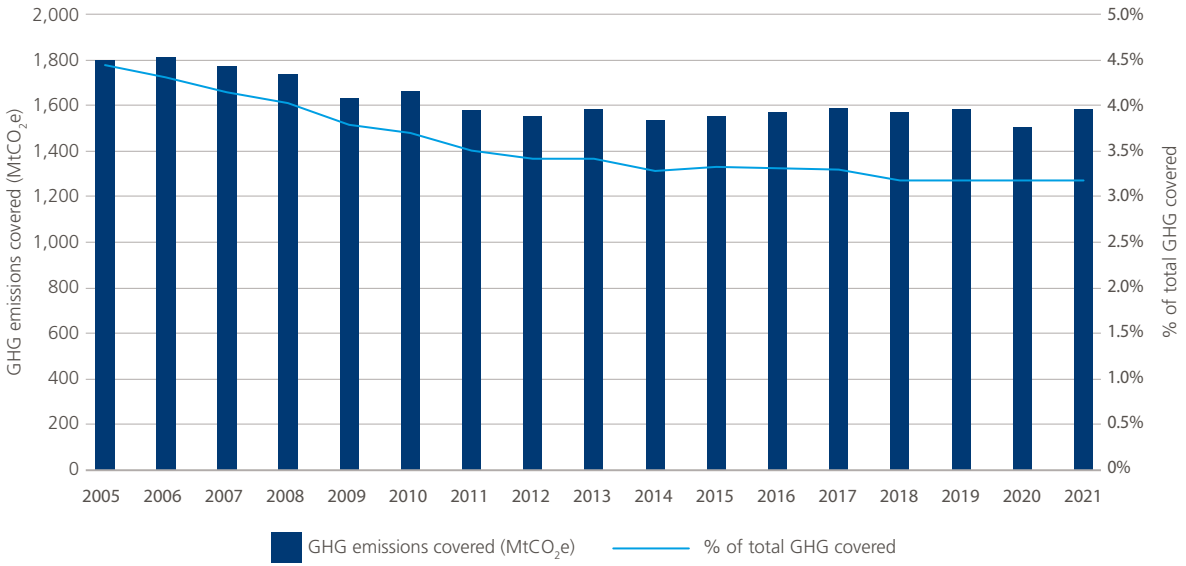
Note: Data corresponds to EU 27 countries.



In terms of global emissions coverage, the EU ETS remains one of the most important programmes globally, despite its decline in the percentage of global GHG emissions handled. In 2005 this initiative registered a global GHG emissions coverage of 4.4%, but this had fallen to 3.2% in 2021. However, in that year the system recorded a coverage of almost 1,584 $MtCO_2e$, which represented around 18% of the total discharges covered by an ETS initiative; for more information see Figure 18.

Figure 18: GHG emissions covered by EU ETS, 2005-21

Source: TheCityUK calculations based on Climate Watch and European Commission data; and Carbon Pricing Dashboard data.

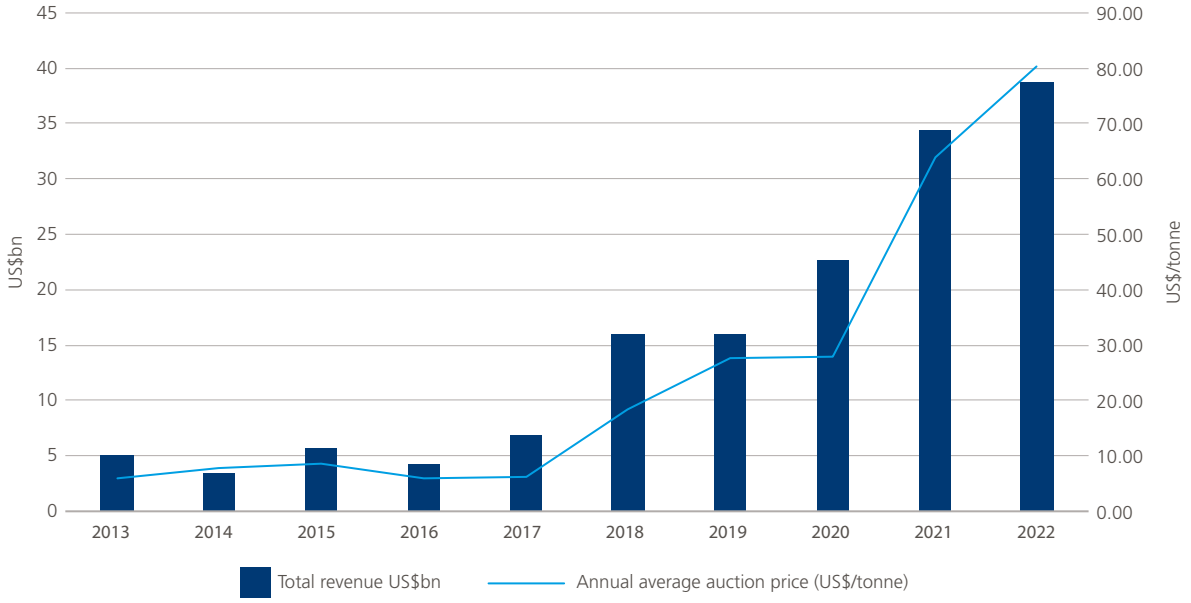


Over the last decade, the EU ETS has used the auction process as the first method to deliver an allowance. According to European Energy Exchange (EEX) data, the annual average auction price rose sharply, especially from 2018 when the average price experienced an increase of almost 200% year on year, to later reach an annual average auction price of US$84.50/tonne in 2022. As was expected, the revenue generated from these auction processes followed a similar pattern of the price, growing at a CAGR of 26% between 2013 and 2022, which means that revenue rose from US$5bn to US$38.8bn. On average, the number of auction processes remained similar over the period analysed, at around 200 per year. Regarding the auctioned volume, the EEX Emission market registered a drop of 33% from 731 $MtCO_2e$ in 2013 to 491 $MtCO_2e$ in 2022. For more information see Figure 19.

Figure 19: EU ETS - Annual average auction price and total revenue received, 2013-22

Source: European Energy Exchange and World Bank

Note: For consistency purposes the original data was converted from euros to dollars using annual average exchange rates retrieved from the European Central Bank.



Three European trading venues offer trading in different contracts on EU Allowances (EUAs): EEX, ICE Endex, and Nasdaq. The main contracts offered for trading are contracts with a daily expiry called 'spot', and futures with various maturities. All derivatives have a standardised contract size of 1,000 allowances. Additionally, EUAs can also be exchanged between two entities outside a regulated trading platform, as in OTC operations. This trade could involve participants — banks or hedge funds — without compliance obligations. The total volume of EUAs exchanged in 2022 was 8,450 $MtCO_2e$ (excluding EUA options), down 24% from 2021; whereas the volume of OTC transactions reached a volume of 335 $MtCO_2e$ in 2022, 28% less than in 2021. The traded valued generated by EUAs traded was US$722bn in 2022, down by 3% year on year; the EUAs OTC showed a similar decrease year on year from US$30bn in 2021 to US$29 in 2022.

Moreover, the EU ETS saw record trading activity and prices in both spot and futures markets in recent years. After the key pandemic year 2020, the price of EUAs showed a significant increase in 2021, almost tripling the price of the previous year. In 2022, after Russia's invasion of Ukraine, the price fell from US$100 to US$58, and then recovered to around US$80.[70] See page 36 for analysis of EUA prices in the secondary market.

China national ETS

China's national ETS started its operation in July 2021 and focused on CO_2 emissions in the power sector, regulating over 2,000 companies involved in this industry. Unlike other ETSs, the Chinese scheme does not currently put a fixed cap on emissions; it has a flexible emissions cap that can go up or down from year to year, depending on the output of the regulated sites. The cap is set bottom-up, which means that the sum of the total allowance allocation to all covered entities forms the cap. It is an intensity-based cap, which changes according to the actual production levels.[71] This ETS initiative is the world's largest in terms of emissions covered—around 4,500 $MtCO_2e$ in 2021—accounting for over 40% of the country's carbon emissions. This programme was the result of numerous efforts to establish a national carbon pricing system based on experience from the regional pilot carbon schemes in China. Indeed, power companies covered by the Chinese regional ETS pilots have transitioned into the national market. In that way, at the end of 2021, this initiative reached a compliance rate of 99.5% measured in terms of surrendered allowances. All the required allowances were distributed to power companies by the government for free, based on historical output and benchmarks. Entities received allowances at 70% of their 2021 verified emissions.[72]

Currently, the emissions permits are distributed by free allocation (Auction processes are planned in the coming years, but there is no formal proposal yet.) Trades are conducted electronically, and only spot transactions are allowed (no futures or other derivatives are permitted). Transactions are referred to as either listed trades or OTC bulk trades (bilateral OTC trades that are cleared on exchange at the end of each session). These transactions involve minimum batches of 100,000 allowances by mutual agreement and a daily price fluctuation limit of 30% where only covered entities may trade. Financial institutions are not yet allowed to participate in the market.[73]

A total of 179m tonnes of allowances were transacted by the end of 2021, which represented a value of US$1.3bn. The allowances' price closed the year at US$8.52/tonne, up by 8% on 16 July 2021 (US$7.91/tonne), the official start date of trading under the national ETS. In 2022 prices rose year on year, with a daily average price of US$8.63/tonne.

70 TheCityUK calculations based on Refinitiv data, 'Review of carbon markets in 2022', (2023), available at: https://www.refinitiv.com/en/trading-solutions/commodities-trading/carbon-trading#:~:text=The%202022%20edition%20highlights%20the,for%20the%20voluntary%20carbon%20market.

71 ICAP, 'China National ETS', available at: https://icapcarbonaction.com/en/ets/china-national-ets

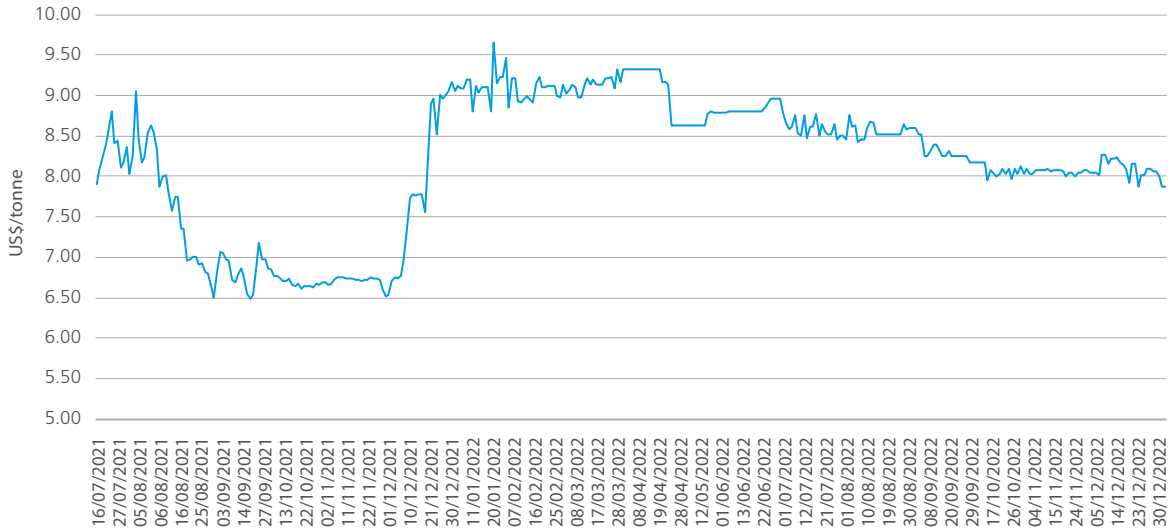
72 ICAP, 'Emissions Trading Worldwide', (2022), p.14, available at: https://icapcarbonaction.com/system/files/document/220408_icap_report_rz_web.pdf

73 China Dialogue, 'The first year of China's national carbon market, review', (February 2022), available at: https://chinadialogue.net/en/climate/the-first-year-of-chinas-national-carbon-market-reviewed/

However, during the second half of the year the price experienced a slight decrease, closing the year at US$7.88/tonne. According to a Refinitiv report, a total of 51 million tonnes of Chinese Emissions Allowances were transacted in 2021, which meant a total value of US$415m.[74] For more information see Figure 20.

Figure 20: China national ETS - carbon market daily price of allowances, 2021-22

Source: ICAP data



In 2021, around 83% of the total volume transacted was traded OTC. On average, prices for OTC block trades were 7% lower than those for listed trades. The OTC average price over the first compliance period was US$6.55/tonne while the listed average price was US$7.06/tonne. It is thought that large corporates used OTC block trades to match intra-group companies to conduct transactions at lower costs. By this mechanism, the entities took advantage of the block trade price limit which allows more flexibility than the online transaction limit and thereby reduces overall compliance costs.[75] Additionally, there was a steep drop in the OTC price during the first month, reaching a price of US$6.35/tonne, as well as in November 2021, with a price of US$4.68/tonne. In general, listed prices remained stable during the first four months, and then by mid-December showed an increasing trend. For more information see Figure 21.

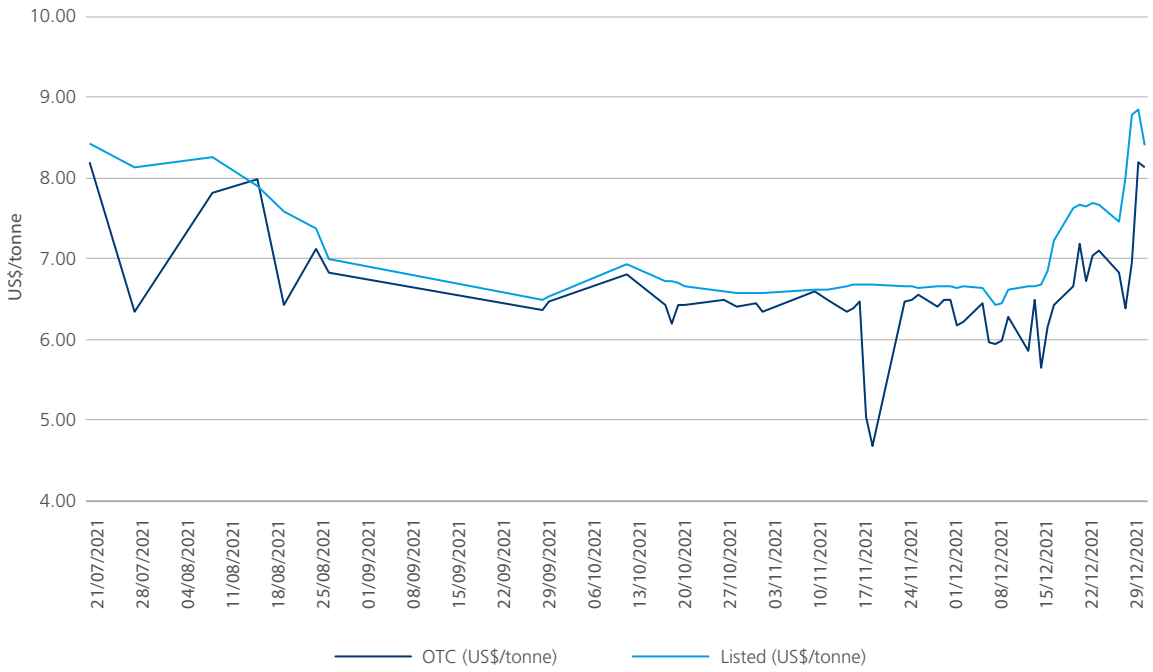
74 Refinitiv, 'Review of Carbon Markets in 2022', (2023), available at: https://www.refinitiv.com/en/trading-solutions/commodities-trading/carbon-trading#:~:text=The%202022%20edition%20highlights%20the,for%20the%20voluntary%20carbon%20market.

75 ICAP, 'Emissions Trading Worldwide', (2022), p.15, available at: https://icapcarbonaction.com/system/files/document/220408_icap_report_rz_web.pdf

Figure 21: China national ETS - carbon market daily closing price for listed trades and OTC trades, 2021

Source: China Dialogue with data from Refinitiv

Note: Renminbi to US dollar conversions were made using the annual average exchange rate in 2021.



Crediting mechanisms

The issuance of carbon credits is another instrument of carbon pricing which allows entities to comply with their required reductions or help them with their voluntary carbon objectives. In that way, carbon credits can be part of the compliance market or the voluntary market. It can be considered that carbon credits constitute all of the voluntary market and a small part of the compliance market. However, at COP26 in Glasgow, nations reached new agreements on Article 6 of the Paris Agreement for market mechanisms, supporting the transfer of emissions between countries to meet their emissions targets, which would increase the trade of carbon credits in the compliance market in coming years.[76] Nevertheless, for now, the activity of carbon credits is concentrated more in the voluntary market.[77]

The World Bank provides information about 31 carbon crediting mechanisms implemented around the world, most of them categorised as domestic. Only five mechanisms are categorised as independent; however, four of them are important in terms of the volume of issuances. In 2021 there was a total of 352.5 $MtCO_2e$ in credits issued, involved in 223 activities, most of them related to agriculture, forestry, waste, energy efficiency, and industrial gases reduction (Figure 22). However, historically the independent Verified Carbon Standard (VCS) programme and the international Clean Development Mechanism (CDM) have been the main credit issuers; in 2021 the VCS issued 62% of the global volume, and CDM issued 11%.

Figure 22: Top 10 crediting mechanisms by volume of credits issued and number of projects in 2021

Source: World Bank

Crediting mechanism	Credits issued ($MtCO_2e$)	Number of projects (*)	Type of credit mechanism
Verified Carbon Standard	295.1	110	Independent
Clean Development Mechanism	59.5	0	International
Gold Standard	43.8	51	Independent
California Compliance Offset Program	17.4	38	Domestic
Australia Emission Reduction Fund	17.1	142	Domestic
Taiwan GHG Offset Management Program	12.4	20	Domestic
American Carbon Registry	8.8	18	Independent
Saitama Target Setting Emissions Trading System	6.4	592	Domestic
Republic of Korea Offset Credit Mechanism	5.2	28	Domestic
Climate Action Reserve	4.8	44	Independent

*Number of projects represent the new activities developed in 2021.

Sector wise, forestry, energy efficiency and renewable energy were the leading sectors covered by carbon credit mechanisms in 2021. For more information see Figure 23.

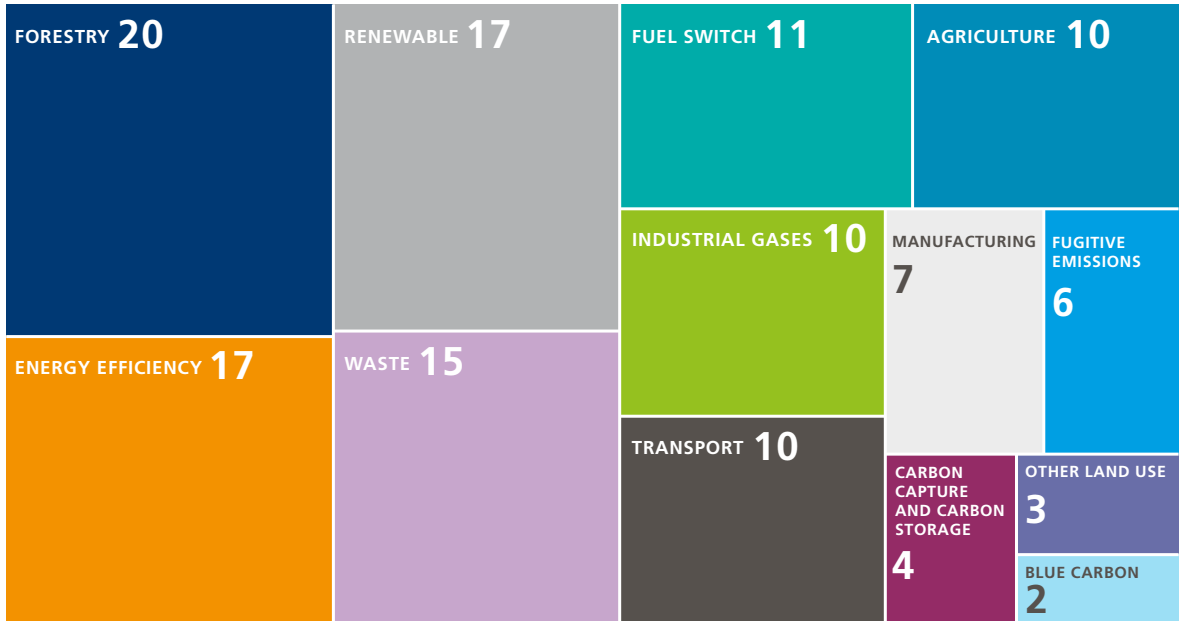
76 United Nations, 'COP26 Outcome: Market mechanisms and non-market approaches', available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-glasgow-climate-pact/cop26-outcomes-market-mechanisms-and-non-market-approaches-article-6

77 World Bank, 'State and Trends of Carbon Pricing', (2022), p.33, available at: https://openknowledge.worldbank.org/handle/10986/37455

Figure 23: Number of crediting mechanisms by sector, 2021

Source: World Bank

Note: The chart was built using information available for 29 crediting mechanisms. A single mechanism can participate in more than one sector.



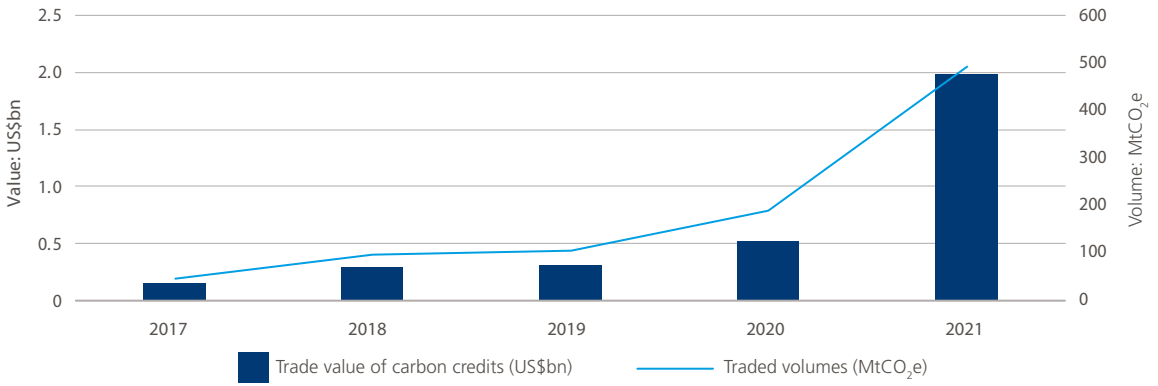
Voluntary market

As stated above, the VCM is composed entirely of carbon credits. Compared to the compliance market, the voluntary market is small in terms of emissions volume and financial value. The market grew to almost US$2bn in 2021, around four times the market size in 2020, according to TheCityUK calculations based on Ecosystem Marketplace data.[78] The expansion of the market in terms of value is explained by rising prices and higher demand from corporate buyers; private companies are increasing their voluntary commitments to climate targets which have greatly increased the demand for carbon credits. However, plans to achieve these goals vary in terms of scope, coverage, timing, and intended use of carbon credits. In this market, the sectors that are progressively generating more interest are forestry and renewable energy.[79]

According to Ecosystem Marketplace reports, the total estimated[80] traded value of carbon credits totalled almost US$2bn in 2021, up from US$146m in 2017, showing a CAGR of 92% over a five-year period. The total volume of credits transacted rose from 46 $MtCO_2e$ in 2017 to around 493 $MtCO_2e$ in 2021, a CAGR of 81% over the period analysed. Furthermore, in 2021, carbon credit markets grew 46% year on year (Figure 24). According to World Bank, the cumulative number of credits issued since 2007 totalled around 4.7 $bntCO_2e$.

Figure 24: Global carbon credits by traded value and volume of voluntary carbon offsets, 2017-21

Source: Ecosystem Marketplace reports 2022; World Bank



There has been a significant increase in the value of credits traded over the period 2017-21. Every category has shown a CAGR of over 35%; indeed, some categories, such as forestry and land use, and transportation, had a CAGR of over 100%. Moreover, the value of carbon credits in the chemical processes and industrial manufacturing sector rose from US$3.9m to US$53.9m between 2020 and 2021. For more information see Figure 25.

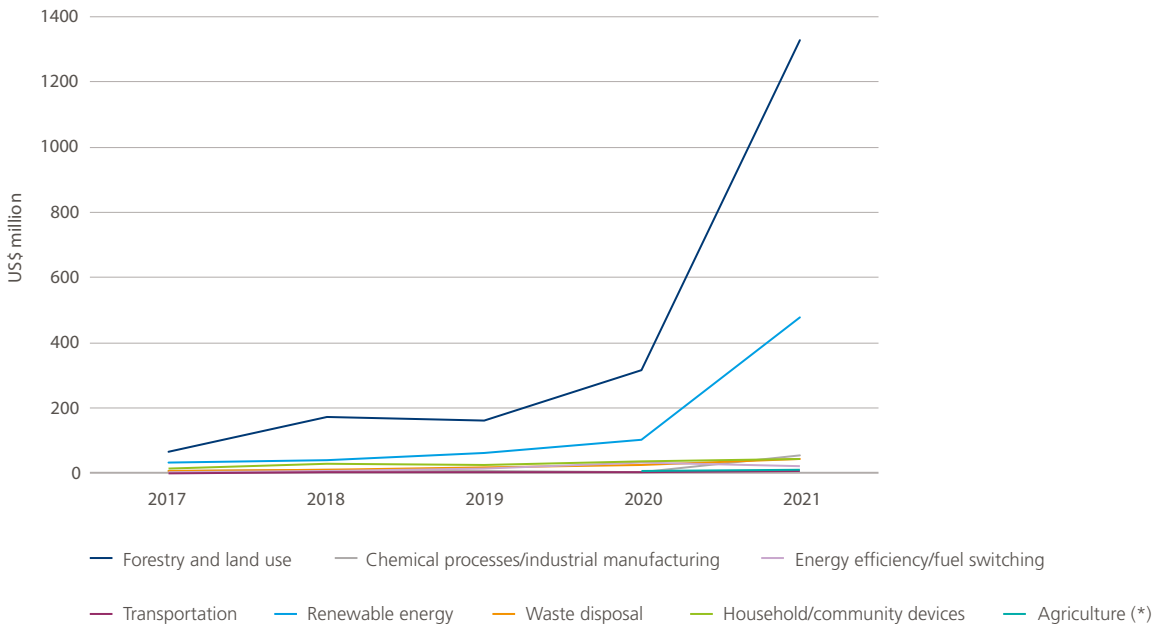
78 Ecosystem Marketplace, 'State of VCM 2022 – Q3', (August 2022), available at: https://www.ecosystemmarketplace.com/publications/state-of-the-voluntary-carbon-markets-2022/

79 World Bank, 'State and Trends of Carbon Pricing', (2022), p. 40, available at: https://openknowledge.worldbank.org/handle/10986/37455

80 The figures presented are an estimation for transacted credits in the voluntary market only based on a survey from Ecosystem Market. There is not a clear separation between the compliance and voluntary market when both participate in crediting mechanisms.

Figure 25: Value of transactions in VCM by category of projects, US$ m

Source: Ecosystem Marketplace reports 2019-22



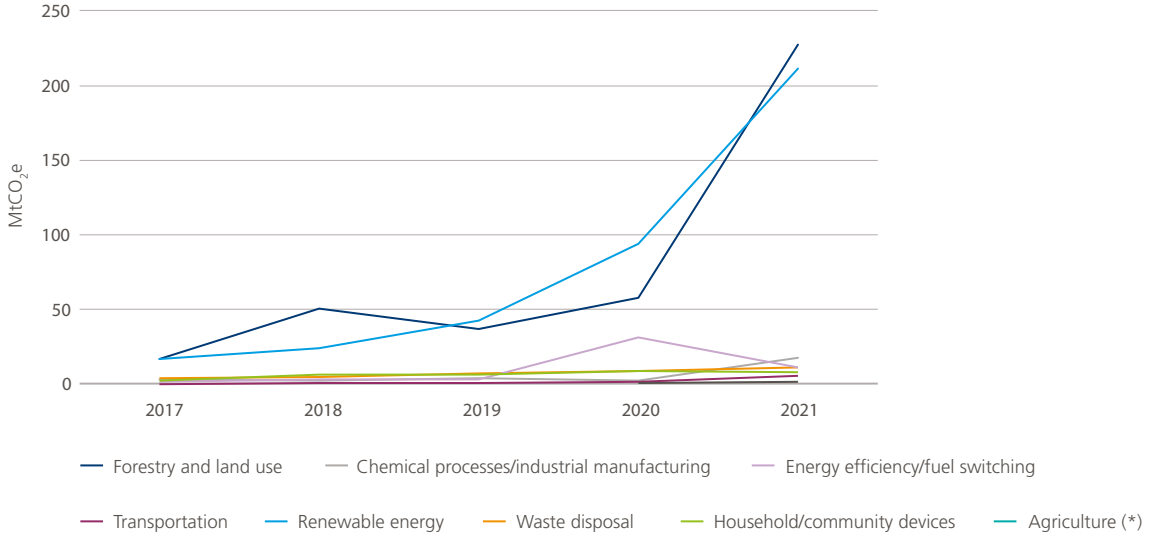
*Data for Agriculture between 2017-2019 are not available.

**The value of transactions could vary if another category would be included.

Traded volumes reached almost 500 $MtCO_2e$, corresponding to 1% of the estimated global carbon emissions, in 2021. Indeed, there has been a huge annual increase in the volume of carbon credits traded in the voluntary market, with an average CAGR of 80% in all the sectors analysed over the five-year period 2017-21. Forestry and land use, and transportation were the sectors exhibiting the highest CAGRs in terms of traded volumes. For more information see Figure 26.

Figure 26: Volume of transactions in VCM transactions by category of projects, $MtCO_2e$, 2017-21

Source: Ecosystem Marketplace reports 2019-22

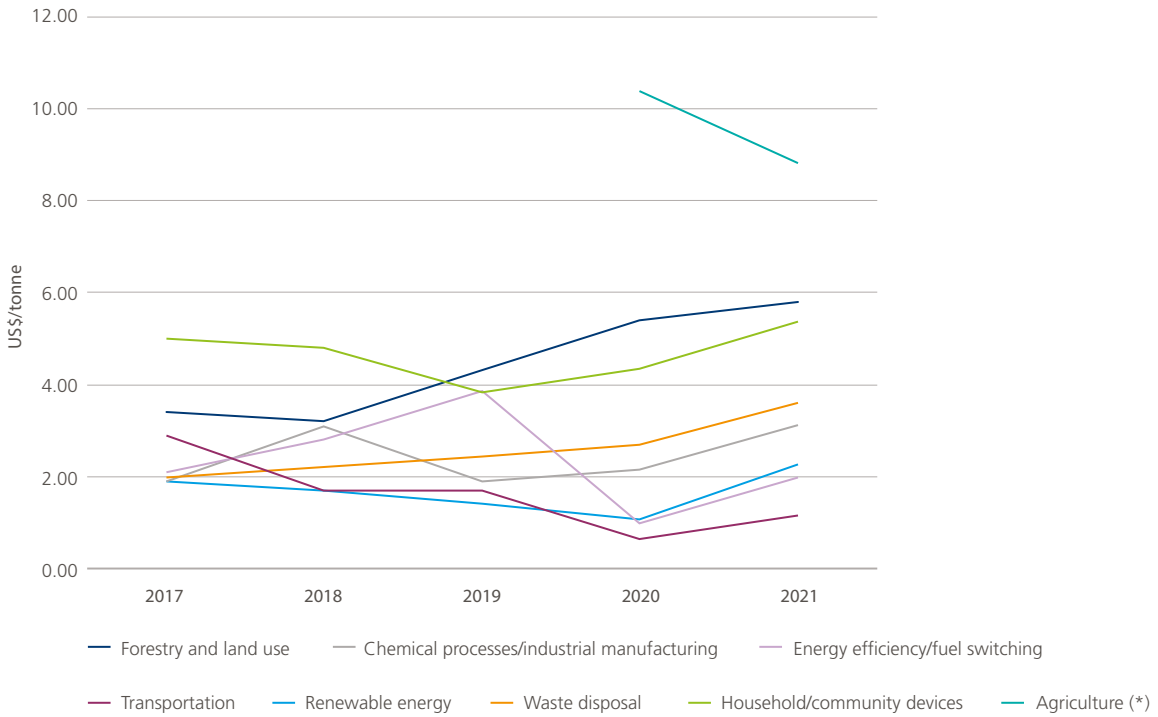


*Data for Agriculture between 2017-2019 are not available.

According to the UK's Climate Change Committee, global carbon credit prices in the voluntary market were estimated at around US$3/tonne on average in 2021, with a wide variation from US$1/tonne to US$15/tonne depending on the type of credit and the issuer mechanism. The average price in some sectors has grown steadily over the five-year period since 2017. For instance, forestry and land activities had an average price of US$5.80/tonne in 2021, up by 71% from 2017. This sector also presented the second-highest average price per tonne in 2021, after agriculture, which reached US$8.81/tonne. However, the sector which showed a general decrease over the analysed period is transportation, with an annual average decrease of 6%; the average price of agriculture credits dropped by 15% in 2021 in comparison to 2020 (see Figure 27).

Figure 27: Average price in VCM by category of projects, US$/tonne

Source: Ecosystem Marketplace reports 2019-22



*Data for Agriculture between 2017-2019 are not available.

Although the voluntary market is still small, increased interest in it is driving some innovations which could help to develop new mechanisms to buy and sell credits. For example, carbon credits futures allow buyers to cut emissions through carbon offset projects, but without directly investing in any projects at the exact time of investment. Revenue can then be derived from the sale of these carbon credits.

Leading crediting programmes

Verified Carbon Standard (VCS) programme

VCS is an independent crediting mechanism developed and run by the non-profit organisation Verra and recognised as the world's most widely-recognised GHG crediting programme. It drives finance toward activities that reduce and remove carbon emissions. Projects and programmes registered in the VCS programme are issued unique carbon credits known as Verified Carbon Units (VCUs); each VCU represents a reduction or removal of 1 tonne of carbon dioxide equivalent achieved by a certain project.[81]

Considering the high quality[82] of the issued credits, some compliance markets are also accepting them, aiming to comply with emission reduction or removal requirements. As of April 2023, the VCS credits are accepted in compliance markets in Colombia and South Africa.[83]

The latest available data shows that there are over 2,000 registered projects in the VCS programme; 94% of these are in countries not considered in the least-developed countries classification. Renewable energy represented around 60% of the total projects as of 2022, followed by nature-based solutions (14%), and waste (11%). Since 2020 the VCS programme has only accepted registrations of new large-scale renewable energy projects located in the least-developed countries given that in more economically developed countries, these projects do not necessarily require carbon finance to be viable.[84]

As of 2022, VCS issued 1,037 $MtCO_2e$ in credits. Just in 2022 more than 40% of the credits issued belonged to nature-based solutions projects, showing a slight increase in the preferences for this kind of projects in comparison to 10 years prior, when almost 50% of the credits issued came from renewable energy projects. For more information see Figure 28.

81 Verra, 'VCS Programs Details', (2023), available at: https://verra.org/programs/verified-carbon-standard/vcs-program-details/

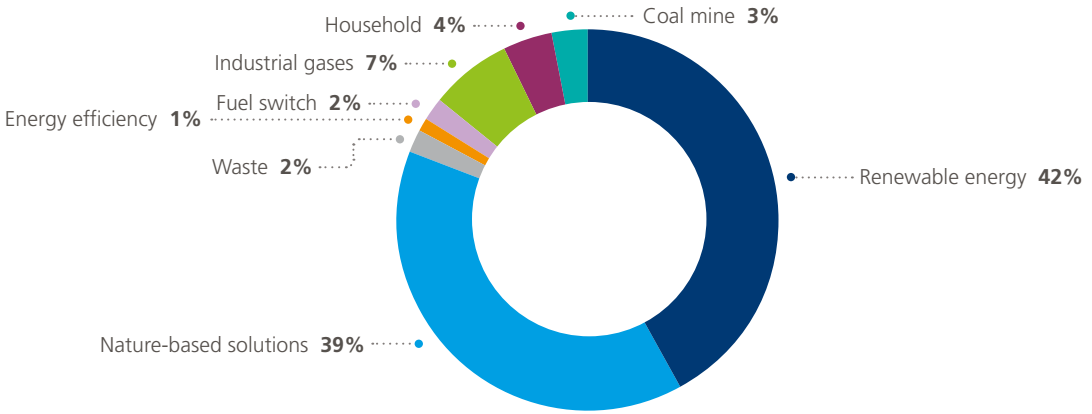
82 High-quality involves being real, measurable, additional, permanent, independently verified, conservatively estimated, uniquely numbered and transparently listed.

83 Verra, 'The VCS in compliance market', (2023), available at: https://verra.org/programs/verified-carbon-standard/vcs-in-compliance-markets/

84 World Bank, 'State and Trends of Carbon Pricing', (2022), p. 44, available at: https://openknowledge.worldbank.org/handle/10986/37455

Figure 28: VCS - Credits issued by activity type in 2022

Source: Climate Focus

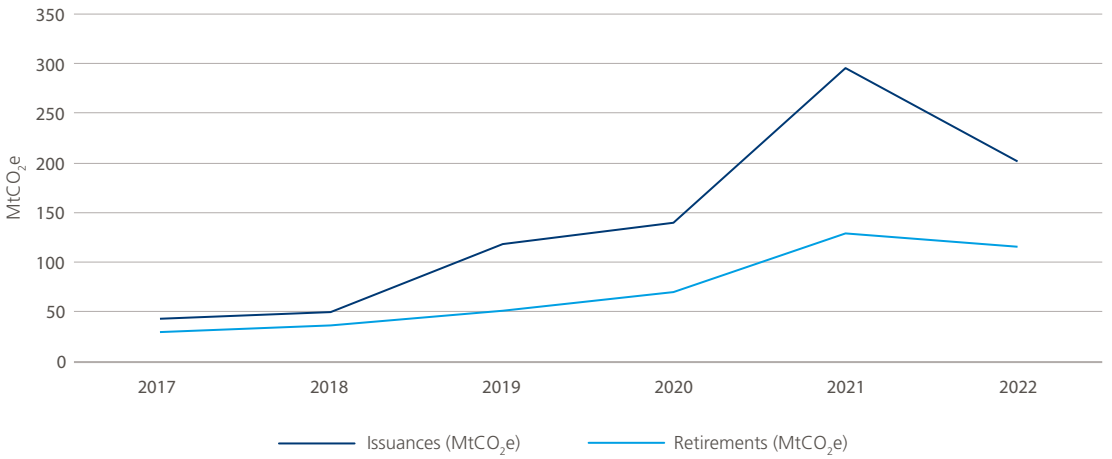


Moreover, the gap between the level of issuances and retirements[85] increased considerably over the period 2017-22, showing CAGRs of 36% and 31%, respectively. In 2017 total issuances represented 1.5 times the total level of retirements; in 2021 retirements were just 40% of the total credits issued. In 2022 the trend of both series seems to decrease, although the volume of retirements was around 116 $MtCO_2e$ whereas the volume of credits issued was 201 $MtCO_2e$, almost double of the retired credits. This increasing gap resulted in a surplus of voluntary credits, a situation that was exacerbated by the growth of new projects registrations and issuances each year (see Figure 29). Although prices are also showing a positive trend, the increase is not at the level expected due to the existing surplus. In 2021 the average price was around US$4.2/tonne compared to US$1.62/tonne in 2020.

85 Carbon retirement means that the emission the emissions reduction/removal cannot be used again.

Figure 29: Issuances vs retirements in VCS programme

Source: Climate Focus



Gold Standard

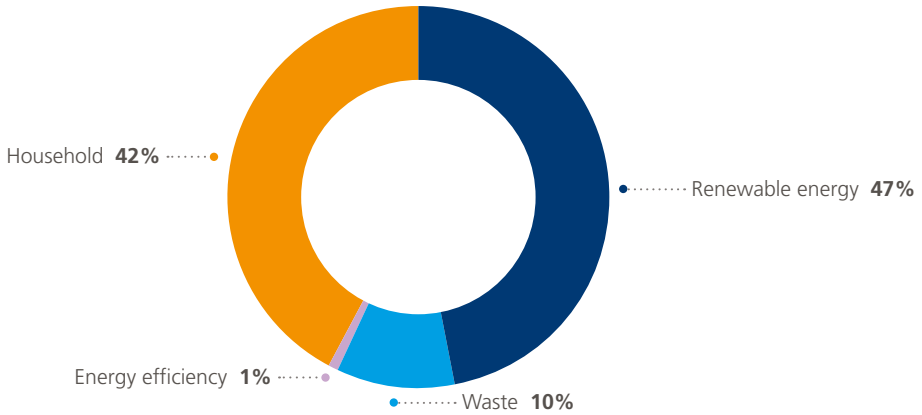
Gold Standard (GS) is a voluntary carbon offset program which seeks to ensure projects that reduce carbon emissions feature the highest levels of environmental integrity and contribute to sustainable development. The objective of GS is to add a quality label to carbon credits generated by projects which can then be bought and traded by countries that have a binding legal commitment according to the Kyoto Protocol; businesses; or other organisations for carbon offsetting purposes.[86]

By the end of 2022, GS had issued 238 $MtCO_2e$ of carbon credits from around 2,000 projects based in more than 100 different countries. In 2022 the projects that dominated the credits issued were those related to renewable energy, accounting for 47% of the credits issued, representing 20.6 $MtCO_2e$. This was followed by household projects, with 42% of the total, or 18.4 $MtCO_2e$. In the past decade, both categories have been dominant. For more information see Figure 30.

86 Gold Standard, 'Vision and Impacts', available at: https://www.goldstandard.org/about-us/vision-and-mission

Figure 30: GS - Credits issued by activity type in 2022

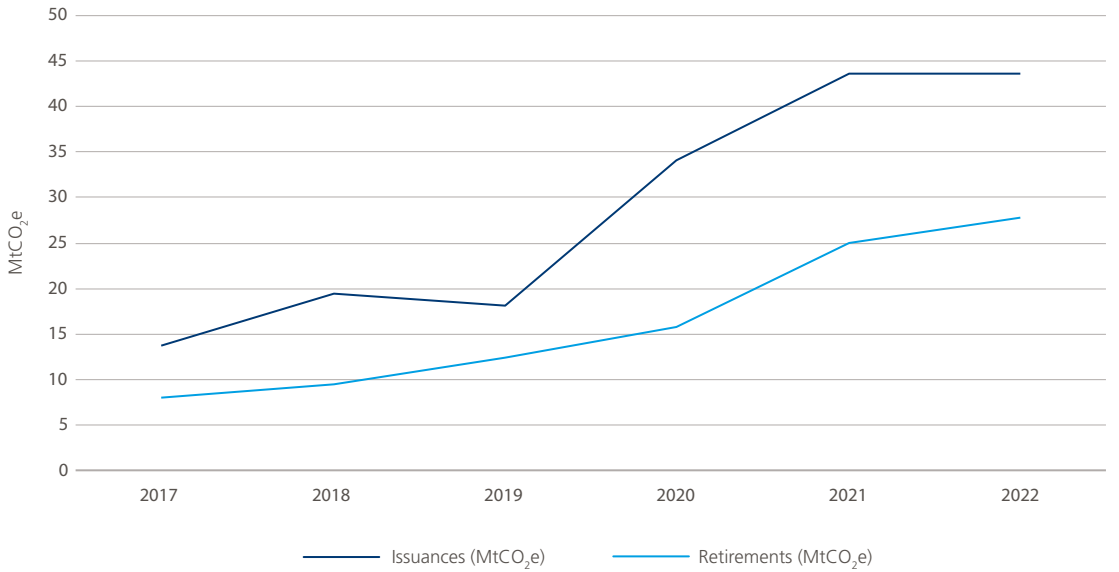
Source: Climate Focus



As with the VCS programme, there is a gap between the level of GS issuances and retirements. Although the gap is smaller than in the VCS credits, it is clear that a significant surplus exists and has shown a CAGR of 22% between 2017 and 2022. According to the latest available data, the level of issuances reached a volume of 43.6 $MtCO_2e$ in 2022 while the level of retirements was 27.7 $MtCO_2e$ (see Figure 31). Reflecting this surplus, the average price declined from of US$5.7/tonne in 2020 to US$3.9/tonne in 2021.

Figure 31: Issuances vs retirements in GS programme

Source: Climate Focus



The Clean Development Mechanism (CDM)

CDM is one of the oldest international crediting mechanisms. It was defined in Article 12 of the Kyoto Protocol, adopted in 1997; it allows industrialised countries to implement emissions-reduction projects in developing countries with the objective of earning a certified emission reduction (CER) credit, equivalent to 1 tonne of CO_2 equivalent. These CERs can be traded and sold and used by countries to meet a part of their emissions-reduction targets under the Kyoto Protocol. In this way, developed countries are financing carbon emissions-reduction projects in low- and middle-income countries.

A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient boilers. Projects and credits issued, are in theory, subject to approval to ensure that these emissions-reductions are real. Most of the signatory countries were European, so the market was concentrated in that region. This scheme gave some flexibility in how some countries meet their emissions-reduction or limitation targets.[87]

87 United Nations, 'What is CDM', available at: https://cdm.unfccc.int/about/index.html

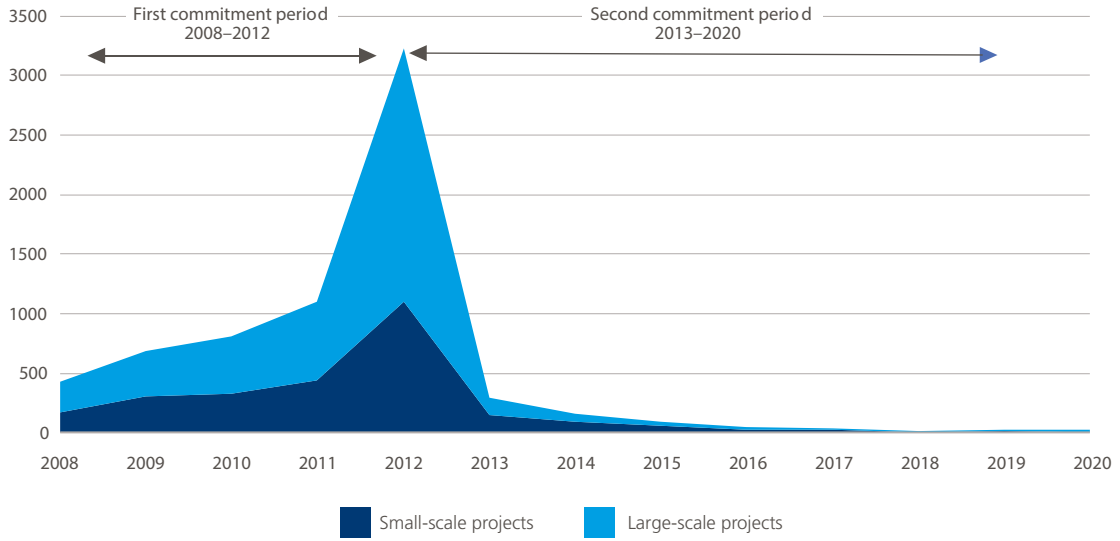
During the first commitment period of the Kyoto Protocol (2008–12), there were over 6,000 projects registered, and the credit issued represented around 1,052 $MtCO_2e$, according to United Nations data. However, while there was an increasing trend in the verified credits, the price decreased. Indeed, the price had reached a record in 2008, at US$20 per tonne, before falling to almost US$5 per tonne in 2012.[88]

The second commitment period (2013-20) saw the number of registered projects fall by 88% in comparison with the first commitment period. Additionally, the issuances totalled 911 $MtCO_2e$, 13% less than in the first period.

The number of CERs issued reached its peak in 2012 with a total of 342.9 $MtCO_2e$, followed by a remarkable negative trend until 2019 when the total volume issued hit 44.2 $MtCO_2e$.The trend reversed and the total CERs reached 155.7 $MtCO_2e$ in 2022, almost 3.5 times the volume in 2019. For more information see Figures 32 and 33.

Figure 32: Number of projects registered under CDM, 2008-20

Source: UNFCCC

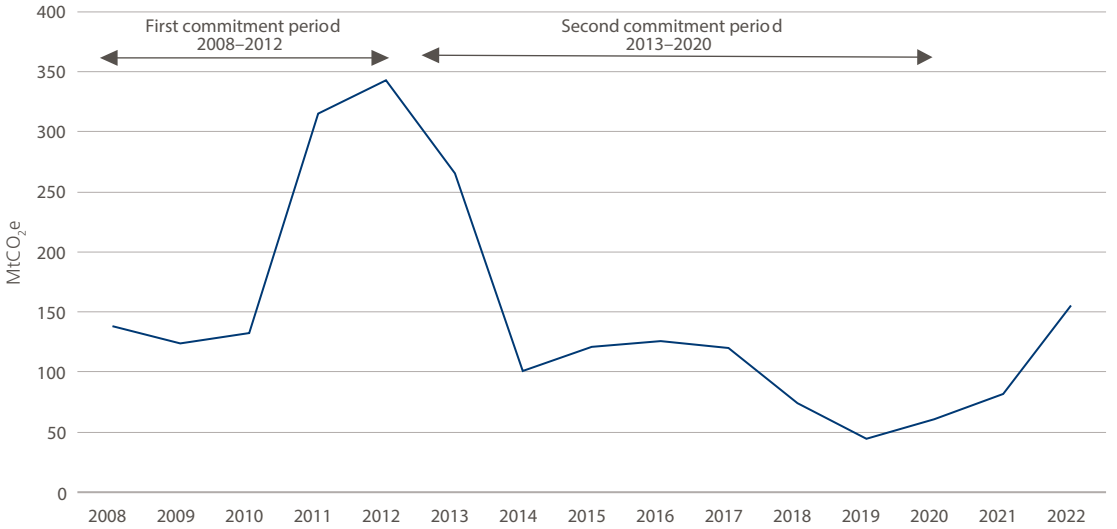


*The figures presented are the latest available data by UNFCCC

88 The Economist, 'Carbon Markets: Complete Disaster in the Making',(2012), available at: https://www.economist.com/finance-and-economics/2012/09/15/complete-disaster-in-the-making

Figure 33: CERs issued between 2008-22

Source: UNFCCC



At the conclusion of the Kyoto Protocol's second period, the Protocol began a transition to mechanisms created under the Paris Agreement (Article 6.4). The request to transition the CDM activity must be made by the end of 2023, and the host country's approval for such transitions must be made by the end of 2025. Although the Article 6.4 mechanism is built on the previous experience of the CDM, it will have its own set of rules, modalities, and procedures.[89] For detail about the link between the Kyoto Protocol and the CDM, see Appendix II.

Indeed, EU ETS participants could use international credits from CDM towards fulfilling part of their obligations under the EU ETS, especially in phase 2 and phase 3. Participants used 1,058bn tonnes of international credits in phase 2 (2008-12) to account for their emissions. Unused entitlements were transferred to phase 3 (2013-20). However, since phase 3, CERs could be used but subject to quantitative and qualitative restrictions; from 1 April 2015, only international credits from projects registered in an LDC post 2012 were eligible for use in the EU ETS, except for credits from nuclear energy projects, afforestation or reforestation projects and projects involving the destruction of industrial gases. Furthermore, international credits must be exchanged for EU allowances before they can be used for compliance

89 World Bank, 'State and Trends of Carbon Pricing', (2022), p.69, available at: https://openknowledge.worldbank.org/handle/10986/37455

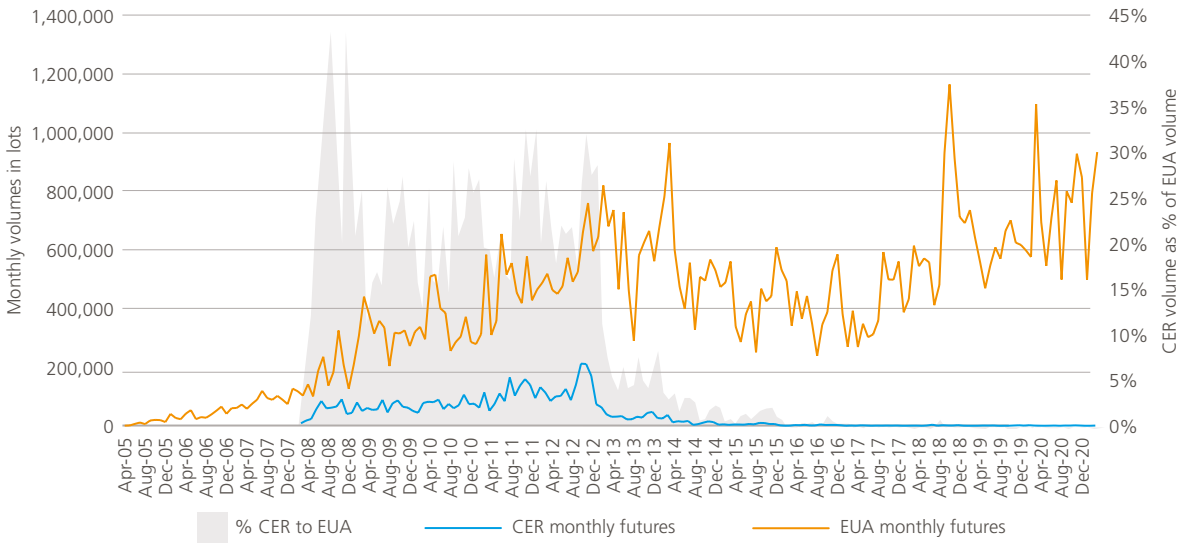
in the EU ETS. In phase 4, CERs can no longer be exchanged for EU allowances; an exchange was only possible until 30 April 2021.[90, 91]

As the world's largest carbon market, the EU ETS was the biggest source of demand for international credits, making it the main driver of the international carbon market and the main provider of clean energy investment in developing countries and economies in transition. According to ICE data, CERs futures demonstrated increasing demand from 2008-12 (EU ETS phase 2), showing an average monthly volume of 85,928 lots, an average increase of 13.1%. During this phase, CERs' volume was on average 23.3% of EUA volume. During the third phase, CERs futures experienced a dramatic decrease, showing an average of 8,137 lots per month, and an average of 1.4% of EUA volume. For more information see Figure 34.

Figure 34: EUA and CER Futures 2005-21

Source: ICE

Note: one lot = 1,000 tonnes



90 European Commission, 'Use of international credits', available at: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/use-international-credits_en#use-of-international-credits-in-eu-ets-after-2020

91 Austrian Emissions Trading Registry, 'information regarding the validity of EU Allowances (EUA)', available at: https://www.emissionshandelsregister.at/en/emissionstrading/tradableunits

The UK's carbon market schemes

The UK has a long history as a leading financial centre, and it is home to some of the world's leading financial market infrastructure. Since the G20 agreed to make central clearing mandatory for OTC derivatives at the 2009 Pittsburgh summit, Central Clearing Couterparties (CCPs) in the UK has led the way. Although the benefits are far reaching, the primary value that CCPs offer is significant reduction in counterparty credit risk. This reduces costs of accessing markets, whilst reducing the system wide risk.

More importantly, these services allow markets to scale, enhancing general market liquidity. The fact that the UK is home to the leading interest rate, energy and metals clearing houses creates a network effect that pulls in world-class intermediaries that serve an international customer base. This network of expertise helps to explain how the UK has emerged as a market leader in environmental markets. ICE Clear Europe, regulated by the Bank of England, is the leading CCP in compliance markets. European, UK and North American compliance futures clear at ICE Clear Europe, alongside the energy derivatives where ICE the global leader.

This means that the UK is at the centre of energy markets, and therefore the net-zero transition. This creates a foundation on which to build, and on which to ensure that the best in class risk management services are there to support the future of carbon credit markets.

UK as part of the EU ETS

Since 2001 the UK has been engaged in searching for carbon pricing mechanisms that will facilitate the reduction of GHGs. One such mechanism was the Climate Change Levy (CCL), an environmental tax introduced in April 2001 and applied to businesses in the industrial, public services, commercial, and agricultural sectors to encourage them to be more energy efficient in how they operate, as well as helping to reduce their overall emissions.[92] However, the EU ETS was the main carbon pricing mechanism in the UK before Brexit (2020): a scheme introduced in 2005 and which limited the maximum level of emissions for several highly polluting sectors: power, industrial, and aviation segments.

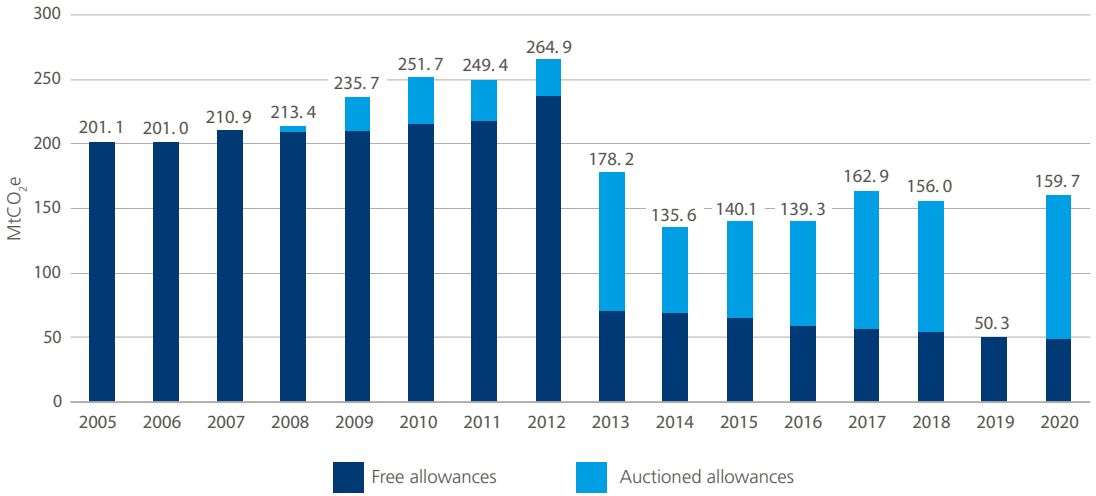
According to European Environment Agency data, the level of allowances delivered in the UK under the EU ETS increased steadily between 2005 and 2012, at an annual average rate of 4%. During that period more than 80% of allowances were allocated for free. However, since 2013 total UK allowances dropped steadily from 178.2 $MtCO_2e$ to 159.7 $MtCO_2e$ in 2020. The level of free allowances decreased at an annual average rate of 5% from 70.8 $MtCO_2e$ in 2013 to 48.6 $MtCO_2e$ in 2020; the volume of auctioned allowances represented around 60% of the total allowances between 2013 and 2020. For more information see Figure 35.

92 SEFE Energy, 'What is the Climate Change Levy?', available at: https://www.sefe-energy.co.uk/help-and-support/bills-payments/what-is-the-climate-change-levy-ccl/#:~:text=Of%20these%20many%20measures%20is,first%20introduced%20in%20April%202001.

Figure 35: Evolution of UK allowances under EU ETS: free and auctioned, 2005-20

Source: European Environment Agency

Note: Figures exclude NI data.

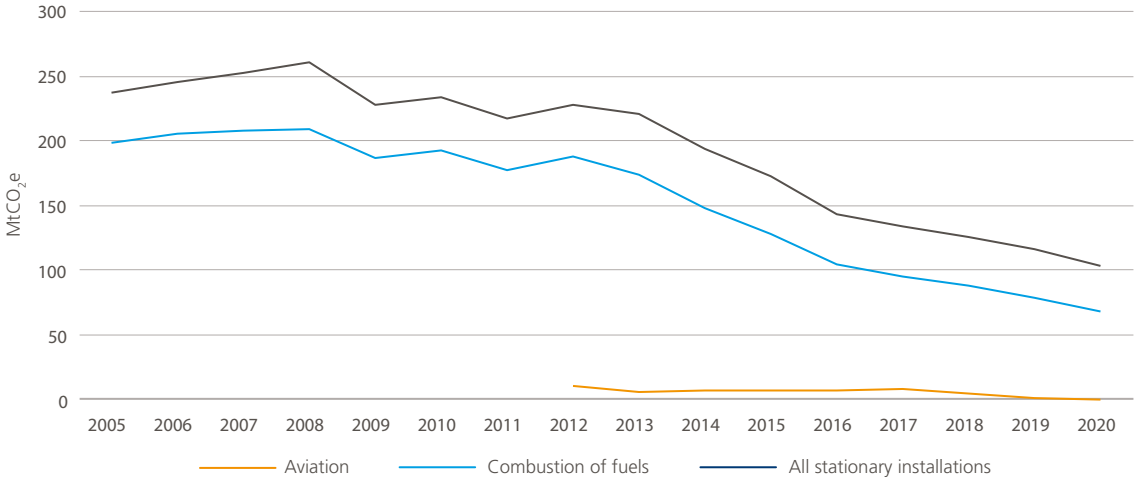


Verified emissions declined across every sector covered by the EU ETS over 2005-20. The fuel combustion sector reduced its verified emissions at an annual average rate of 7%, while stationary installations' verified emissions decreased by an annual average of 5%. The aviation sector was, however, the one which demonstrated the sharpest decline, from 9.7 $MtCO_2e$ in 2012 to 0.2 $MtCO_2e$ in 2020, representing a reduction of almost 100% during the analysed period. For more information see Figure 36.

Figure 36: UK verified emissions under EU ETS by activity, 2005-20

Source: European Environment Agency

Note: Figures exclude NI data.



In 2013 the UK government implemented the Carbon Price Floor (CPF) scheme to support the EU ETS in order to underpin the price of carbon at a level that drives low carbon investment, which the EU ETS had not achieved. The CPF taxes fossil fuels used to generate electricity via rates set under the Climate Change Levy. The price floor consists of two components which were paid for by energy generators in two different ways: the EU ETS allowance price; and the Carbon Price Support, which tops up the EU ETS allowance prices, as projected by the government, to the carbon floor price target.[93] This scheme represented unilateral policy support to correct a market failure, and demonstrates the UK's leading role in using carbon markets to decarbonise the electricity-generating sector.

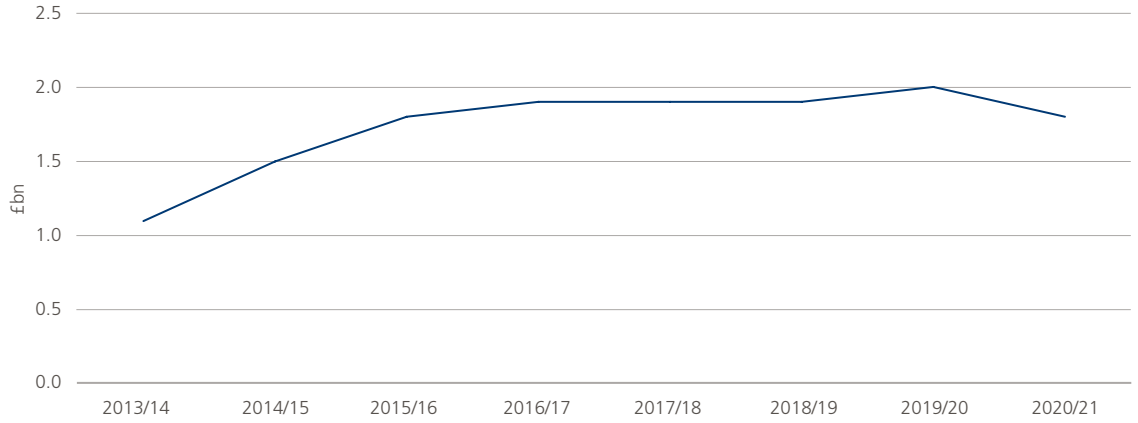
According to the latest available data, the revenue received from CCL and CPF increased from £1bn in 2013/14 to £1.8bn in 2020/21, showing relative stability during the last five years (see Figure 37). Despite some criticism about the effectiveness of the CPF in emissions reductions, declarations for solid and other fuels followed a consistent downward trend since 2013/14, likely reflecting declining quantities of coal used for electricity production in the UK.[94] This environmental tax has continued to be applied after Brexit and once the UK ETS was introduced in 2021.

93 House of Commons Library, 'Carbon Price Floor and the price support mechanism', (2018), available at: https://commonslibrary.parliament.uk/research-briefings/sn05927/#:~:text=The%20Carbon%20Price%20Floor%20(CPF,EU%20ETS%20has%20not%20achieved.

94 HM Revenue and Customs, 'Environmental Taxes Bulletin commentary', (June 2022), available at: https://www.gov.uk/government/statistics/environmental-taxes-bulletin/environmental-taxes-bulletin-commentary-june-2022#:~:text=Total%20provisional%20Climate%20Change%20Levy,than%20the%20previous%20financial%20year.

Figure 37: Total CCL and CPF receipts by financial year, £bn

Source: HM Revenue and Customs



UK ETS

The UK ETS was implemented in January 2021 as result of Brexit, and covers energy-intensive industries, the power sector, and the aviation sector within the UK and European Economic Area. Those three sectors represented almost one-third of the UK's GHG emissions. The UK ETS set the cap 5% below the UK's notional share of the EU ETS cap and which must decline by 4.2 $MtCO_2e$ per year. The annual cap for 2023 is 147.2 $MtCO_2e$. Moreover, Phase 1 of the scheme will run until 2030 and in between will have two revisions, in 2023 and 2028.

The scheme issues units of allowances called UKAs, each one representing 1 tonne of carbon dioxide equivalent. Currently, the emissions permits are primarily distributed by auction processes but there is a proportion allocated for free to safeguard the competitiveness of emissions-intensive trade-exposed (EITE) sectors. Additionally, the system has an auction reserve price, to support market stability. The trading of these allowances started in May 2021 under a price floor of £22/tonne. To avoid instability in allowance prices, the UK ETS has a cost containment mechanism (CCM) that allows auctioning of additional allowances. Although there is an active primary and secondary market of UKAs, the use of offsets for compliance is not permitted at this stage.[95,96]

95 Refinitiv, 'Carbon Market Year in Review 2022', (February 2023), available at: https://www.refinitiv.com/en/trading-solutions/commodities-trading/carbon-trading

96 ICAP, 'Emissions Trading Worldwide', (2022), p.81, available at: https://icapcarbonaction.com/system/files/document/220408_icap_report_rz_web.pdf

According to UK Emissions Trading Registry data, there were 41.4m allocations in 2022 (allowances held in Operator Holding Accounts and Aircraft Operator Holding Accounts), down by 2% year on year. However, the number of account holders remains the same, a total of 1,157. Additionally, auctions of UKAs are held via ICE, and occur every two weeks. The latest Refinitiv report about Carbon Markets shows that the volume of UKAs in 2022 reached 81 $MtCO_2e$, generating a value of £6.5bn, whereas in 2021 the volume auctioned was 84 $MtCO_2e$ with revenue of £4.3bn. Regarding UKAs' traded volume, in 2022 there were 431 $MtCO_2e$, up by 72% year on year, while the value traded increased by 132%.[97] Volumes were up from 2021, as trading in that year did not begin until May. For more information see Figure 38.

Figure 38: UKA trading in 2021-22 - Auctions and exchange*

Source: Refinitiv report - Carbon Market 2022

Note: For consistency purposes the original data was converted from euros to GBP using annual average exchange rates retrieved from the European Central Bank.

	2020		2021	
	$MtCO_2e$	£ million	$MtCO_2e$	£ million
UKAs auctioned	84	4,346	81	6,493
UKAs exchange traded	251	15,300	431	35,471
Total UK	**335**	**19,646**	**512**	**41,963**

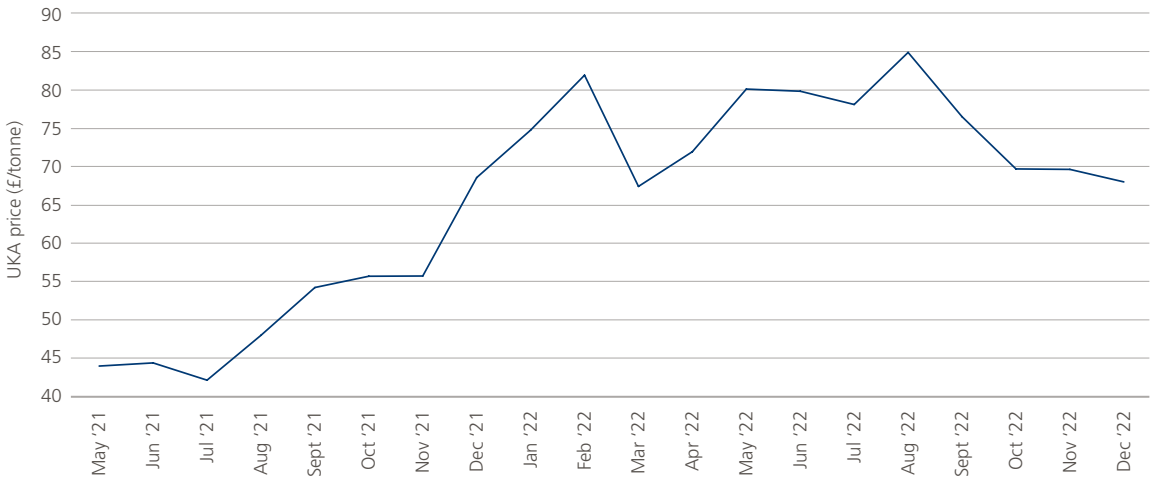
*These volumes exclude OTC transactions

By the end of 2022, the average monthly price rose by 55%, from £43.99/tonne in May 2021 to £68/tonne in December 2022. The highest auction price occurred in August 2022, when it reached a value of £84.88/tonne (see Figure 39).

97 Refinitiv, 'Review of carbon markets in 2022', (2023), available at: https://www.refinitiv.com/en/trading-solutions/commodities-trading/carbon-trading#:~:text=The%202022%20edition%20highlights%20the,for%20the%20voluntary%20carbon%20market.

Figure 39: UK ETS - Average monthly auction price 2021-22, £/tonne

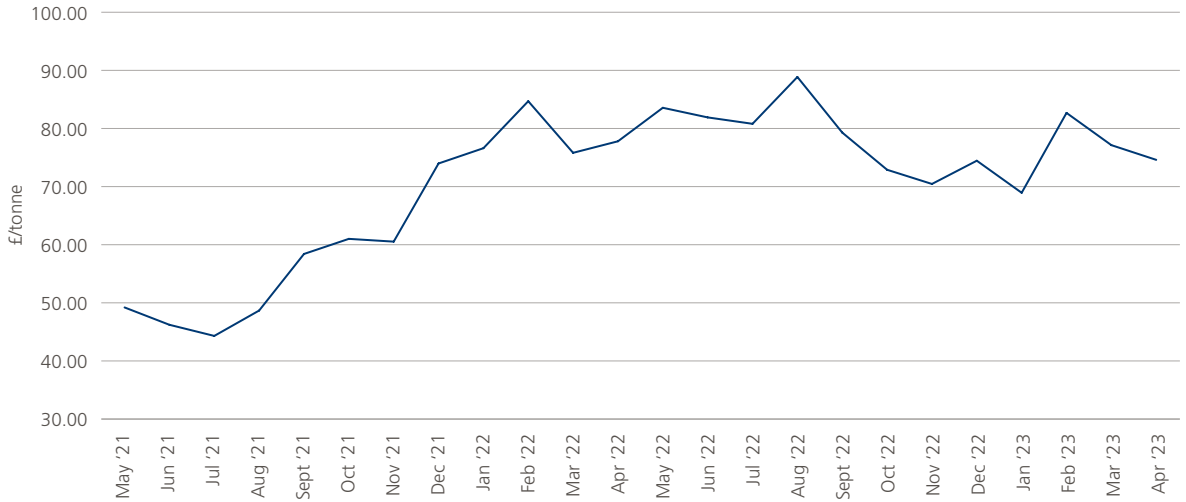
Source: ICAP



ICE negotiates UKA futures contracts, where each clearing member with a position open at the cessation of trading for a contract month is obliged to make or take delivery of UKAs to or from the UK Emissions Trading Registry according to the ICE regulations. Over the first 16 months of the programme, the UKA futures price showed an increasing trend in the average monthly price per tonne, beginning with an approximate price of £49.09 in May 2021, and reaching a peak of £89.05/tonne in August 2022. Thereafter, the price showed a broadly declining trend, fluctuating between £68/tonne and £83/tonne. For more information see Figure 40.

Figure 40: Average monthly price - UKA Futures, 2021-23

Source: TheCityUK calculations based on ICE data



*The price is based on the prompt December expiry, which is the benchmark contract.

Voluntary Carbon Market in the UK

London Stock Exchange's Voluntary Carbon Market

Following one of the UK's government's priorities related to net-zero carbon emissions, the London Stock Exchange Group launched its voluntary carbon market in December 2022, aiming to develop a new market offering to support publicly traded carbon funds focused on investing in climate mitigation projects by increasing the supply of quality carbon credits worldwide and increasing the flow of financing into projects that will directly reduce the amount of GHGs in the atmosphere.

Funds or operative companies which are admitted to the Main Market and AIM can be part of the voluntary market, where they can intend to invest in climate change mitigation projects that are expected to yield carbon credits. Eligible issuers will be seeking to finance projects directly or indirectly and may issue carbon credits as a dividend in specie, retire or sell the carbon credits.[98]

98 LSE, 'London Stock Exchange's Voluntary Carbon Market', available at: https://www.londonstockexchange.com/raise-finance/equity/voluntary-carbon-market

Further regulatory development is needed in order to ensure the integrity of voluntary carbon markets. The Voluntary Carbon Markets Forum has established six areas for action in order to ensure high integrity in VCMs:

- Core Carbon Principles (CCP) to ensure credits of high integrity;
- Core carbon reference contracts to drive a transparent price signal;
- Infrastructure supporting trade, post-trade, financing, and data;
- Strong and transparent demand signalling;
- Consensus on legitimacy of offsetting; and,
- Market integrity assurance e.g., legal and accounting enablers in place.

The City of London Corporation notes that growing demand for quality carbon offsets is serving as a catalyst for the innovation and behavioural shifts needed from a broad range of private, corporate and government actors. It will be important for innovation in this area to be transparent, credible and widely understood in order to ensure the integrity of the voluntary market.[99]

However, some voluntary carbon programmes use Measurement, Reporting, and Verification (MRV) frameworks which could help to demonstrate the high quality of the credits. These systems refer to the multi-step process to measure the amount of GHG emissions reduced by a specific mitigation activity, such as reducing emissions from deforestation and forest degradation, and report these findings to an accredited third party. The third party then verifies the report so that the results can be certified, and carbon credits can be issued.[100] Nevertheless, there are no globally accepted MRV protocols. Moreover, the complexity and duration of a MRV vary by approach and the establishment of an independent third party may well be key to carbon accounting efforts.[101]

In August 2022, ICE announced that it had launched ten new nature-based solutions carbon credit futures contracts, providing a carbon credit futures contract portfolio which allows market participants to buy, sell and hedge carbon credits from 2016 out to 2030. They allow single vintages to be traded with the added liquidity benefits from having each futures contract deliver a fixed five-year vintage bucket. They provide a forward curve out to 2030, and customers can extend carry trades for multiple years while trading vintage spreads without the basis risk from the cost of carry.[102]

99 City of London Corporation and UK VCMF, 'The Future of Voluntary Carbon Markets', (2022), p.2, available at: https://www.cityoflondon.gov.uk/supporting-businesses/economic-research/research-publications/the-future-of-voluntary-carbon-markets

100 The World Bank, 'What You Need to Know About the Measurement, Reporting, and Verification (MRV) of Carbon Credits', (July 2022), available at: https://www.worldbank.org/en/news/feature/2022/07/27/what-you-need-to-know-about-the-measurement-reporting-and-verification-mrv-of-carbon-credits

101 BEIS UK, 'Monitoring, Reporting and Verification of Greenhouse Gas Removals', (2021), available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1026994/mrv-ggrs-task-report.pdf

102 ICE, 'ICE Launches 10 Carbon Credit Futures Vintages Extending Out to 2030', (August 2022), available at: https://ir.theice.com/press/news-details/2022/ICE-Launches-10-Carbon-Credit-Futures-Vintages-Extending-Out-to-2030/default.aspx

At the same time, ICE is bringing price discovery and transparency to the primary carbon credit market by connecting a global network of high-quality developers with a wide range of potential buyers, all hosted on state-of-the-art trading infrastructure through its carbon credit auction service offering. ICE has conducted carbon auctions for over a decade and hosts the four largest and most liquid carbon allowance futures markets in the world.[103]

Current and future UK developments

In March 2023 the UK government issued an updated version of its 2019 Green Finance Strategy setting out how UK leadership on green finance will cement the UK's place at the forefront of this growing global market, and how the UK will mobilise the investment needed to meet its climate and nature objectives. The new strategy included the following points relevant to the further development of carbon markets:[104]

- Currently, the goal is to make the UK ETS the world's first net-zero consistent cap and trade market.
- Due to the increasing demand from the private sector for high-integrity carbon markets, the UK government is committed to fostering growth in these markets in a way that is high integrity and unlocks truly additional finance for net zero.
- Due to the concerns raised by financial institutions about the need for clarity on what constitutes a good quality credit in the voluntary market, how credits should be used when claiming the achievement of private sector net-zero targets, and relevant disclosure and assurance processes, UK government action to ensure the market grows in a manner that provides reassurance on market integrity is imperative. This includes considering targeted regulatory interventions where these will help the market play a greater role in the transition to net zero and ensure companies are not incentivised to use credits as an alternative to acting on their internal emissions.
- The IC-VCM and the VCMI will publish guidance in 2023 about how to create a greater clarity on the definition of high-integrity VCMs, which will be considered by the UK government a basis for international best practices on market integrity.
- The UK government has confirmed its intention to position the UK as a global hub for trading in voluntary carbon markets.
- The UK government will work with the UK ETS Authority to consider options for integrating greenhouse gas removals in the UK ETS, subject to the outcomes of last year's UK ETS consultation.

103 ICE, 'Carbon Credit Auctions', available at: https://www.theice.com/emissions/auctions/carbon-auctions

104 HM Government, 'Mobilising Green Investment', (March 2023), available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147377/mobilising-green-investment-2023-green-finance-strategy.pdf

Conclusion

In essence, financial markets support the efficient allocation of capital. When it comes to the environment, it is now widely accepted that the market mechanism can catalyse the scaling of sustainable finance, with the ultimate benefit of creating the appropriate incentives to meet net-zero targets. The political impetus around addressing climate change has encouraged financial markets to adapt by providing a way to value externalities, like those associated with pollution, carbon sequestration and renewable electricity.

The quantitative analysis in this research was constrained by the information and data publicly available, which is still relatively limited. The size of this market segment is notoriously difficult to measure as it relates to the extent to which emissions are treated as liabilities. Indeed, one of the main challenges for the further development of carbon markets is the accurate and comprehensive monitoring of these markets through official entities which can provide transparent information about their performance.

Nevertheless, it is clear that carbon markets have grown at record pace in recent years, despite the economic shocks experienced around the world. The estimated value of the global compliance market was US$850bn in 2021; using a wider definition (including allowances), the estimate would be considerably higher. Meanwhile, the value of the global voluntary market reached almost US$2bn. There is currently a growing demand for credits issued within the voluntary market that could also be used within the mandatory one, as well as an increasing private interest in investing in environmental projects that allow the avoidance, reduction or removal of carbon emissions. With an increasing number of corporates making net-zero commitments, carbon credits are critical to those firms being able to meet their commitments. The UK has the potential to be a leader in carbon markets, combining purpose and potential to build the markets of the future.

Appendix I: the Paris Agreement, COP26 and carbon pricing

The Paris Agreement of 2015 set the objective of keeping the increase in the global average temperature below 2 degrees Celsius relative to pre-industrial levels, and to limit the temperature rise to 1.5 degrees Celsius, which would significantly reduce the risks and impacts of climate change. This Agreement helped to organise and define objectives related to the establishment, development, and regulation of carbon pricing systems. Subsequently, during the COP26 climate summit in Glasgow participants approved Article 6 of the Paris Agreement related to the establishment of international compliance carbon markets where countries can trade carbon credits. Under this article, the relevant points are:[105,106]

Article 6.2: Allows countries to trade emission reductions and removals with one another through bilateral or multilateral agreements. These traded credits are called Internationally Transferred Mitigation Outcomes (ITMOs). They can be measured in carbon dioxide equivalent (CO2e) or using other metrics, such as kilowatt-hours (KWh) of renewable energy. Moreover, this can encourage the linking of carbon pricing approaches across countries and jurisdictions, resulting in the reduction of emissions by a magnitude greater than what is possible solely domestically or nationally.

Article 6.4: Creates a new multilateral mechanism to replace the old CDM; a global carbon market overseen by a United Nations entity, currently referred to only as the "Supervisory Body". Project developers must request to register their projects with the Supervisory Body. A project must be approved by both the country where it is implemented, and the Supervisory Body, before it can start issuing UN-recognised credits. These credits, known as A6.4ERs, can be bought by countries, companies, or even individuals. The mitigation engendered under this mechanism can also be used by parties other than the host party to fulfil their nationally determined contributions (NDCs). In other words, this provision allows for offsetting through the trading of emission reduction credits.

Article 6.5: Puts in place robust accounting measures to avoid double counting of emission reductions and increase transparency, thereby ensuring the integrity of the proposed market-based approaches.

105 UNFCCC, 'Paris Agreement', (2015), available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf
106 UNFCCC, 'About Carbon Pricing', available at: https://unfccc.int/about-us/regional-collaboration-centres/the-ciaca/about-carbon-pricing#Can-countries-use-carbon-pricing-for-achieving-the

Appendix II: the Kyoto Protocol and CDM

Article 12.1: A clean development mechanism is hereby defined.

Article 12.3: Under the clean development mechanism:

(a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and

(b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

Article 12.5: Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

(a) Voluntary participation approved by each Party involved;

(b) Real, measurable, and long-term benefits related to the mitigation of climate change; and

(c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

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