ASEAN

Neutral *(no change)*

Commodities - Overall

Carbon markets 101

- This report aims to provide an understanding of how carbon markets can play an important role in reducing carbon emissions.
- With the EU ETS and China ETS already in place, ASEAN member states are looking to introduce/strengthen their carbon taxes and domestic ETSs.
- The rise in corporate net zero goals may also increase demand for voluntary carbon credits in the years to come and supply will likely follow.

Carbon tax and ETS developments in ASEAN should accelerate

The IEA believes that current global efforts to reduce CO2e emissions are insufficient to prevent climate disaster, with the world's average temperatures likely to rise to 1.5°C above pre-industrial levels by 2040; above this level, extreme weather events and melting ice caps may threaten food security and raise sea water levels. The planned actions of ASEAN member states only amount to 43-54% of the emissions cuts necessary by 2030 to put ASEAN on a path compatible with the goals of the Paris Agreement (PA), according to consultant Bain & Co. As a result, nations need to up the ante on their climate ambitions. The EU ETS has shown the way since 2018 through reduced supply and rising prices of allowances, with prices closing in on €100/tCO2e last week. The EC's proposed 'Fit for 55' package aims to aggressively accelerate the EU's climate ambition. Meanwhile, the China ETS took off in 2021, even though its emission targets are still lenient compared to the EU ETS and an oversupply of allowances has put pressure on prices. Within ASEAN, Singapore has led the way with a carbon tax regime since 2019 and it has already announced a pathway of large rate increases. Indonesia may introduce its carbon tax this year after piloting an ETS last year. Malaysia, Thailand and Vietnam are also in various stages of considering or piloting carbon taxes, ETS and voluntary carbon markets; faster action will be needed if ASEAN is to contribute substantively towards the PA's climate goals, in our view.

Corporates should explore the use of voluntary carbon credits

The traded values of carbon credits in VCMs are very small compared to ETSs (compliance carbon markets) but the rise in corporate net zero or carbon neutrality targets suggests that VCMs may have the potential to grow significantly. The key enabler of growth is adequate supply of carbon credits, verified by respected standards to ensure additionality, permanence and other measures of quality, such as vintage. Airlines will also begin to participate in VCMs under ICAO's CORSIA scheme as soon as their capacities recover above their 2019 baselines. Countries can also buy credits from each other under the PA's Article 6 Mechanism in order to achieve their nationally determined contributions (NDC). We highlight that carbon markets – compliance or voluntary – are merely tools to an end, which is to reduce CO2e emissions. We encourage investors to continue conversations with their investee companies over the importance of setting carbon neutral or net zero goals and of active carbon mitigation investments and actions and to encourage companies to explore the use of voluntary carbon credits to offset their emissions in the meantime.

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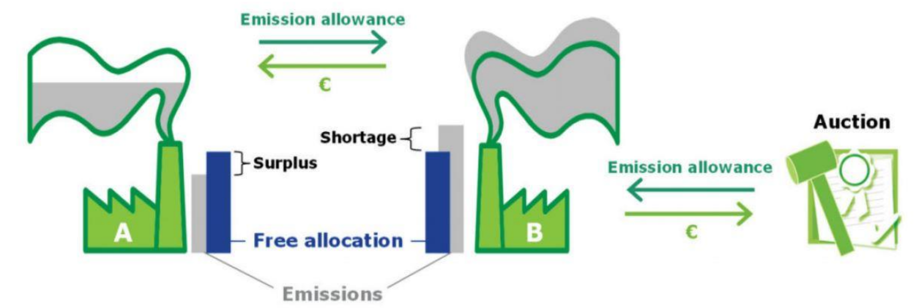
Figure 1: The EU ETS is an example of a cap-and-trade (CAT) ETS scheme



SOURCE: EUROPEAN UNION

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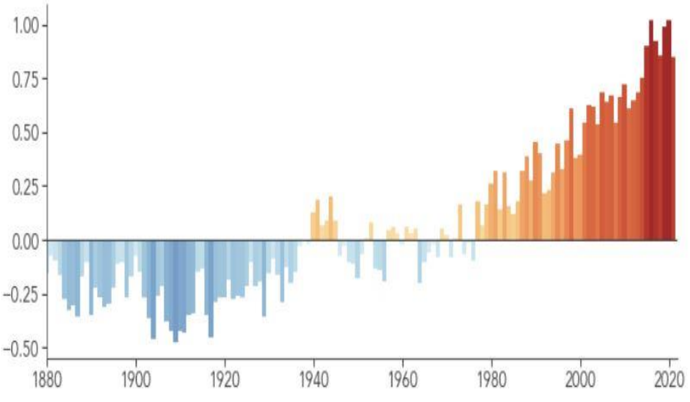
KEY CHARTS

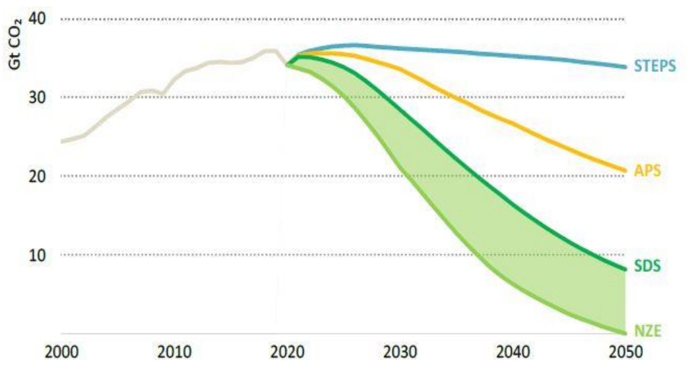
Average temperatures have risen a lot

NASA of the US has produced research showing that, since 2015 and to the most recent observation in 2021, the world's average temperature has risen by between 0.75°C and 1°C higher than the average during 1951-1980, with the latter average being the baseline for the measurement of global temperature anomaly in this chart. The IEA wrote in its World Energy Outlook that global average temperatures have already risen at least 1.1°C higher than the pre-industrial age, which is defined as the period 1850-1900.



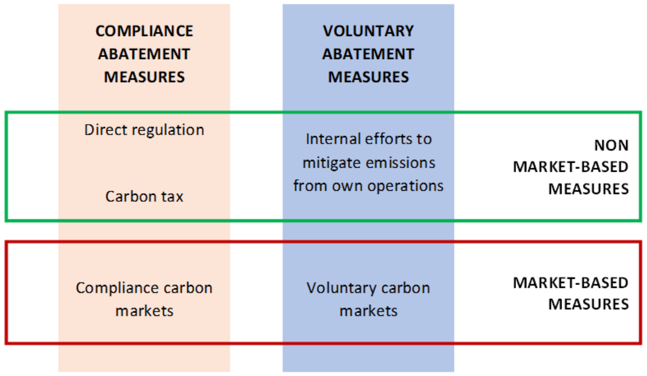
The world is not yet doing enough

If the world maintains its current trajectory under the Stated Policies Scenario (STEPS), temperatures will rise by 2°C by 2050 and by 2.6°C by 2100 compared to the pre-industrial period, according to the IEA. The Announced Pledges Scenario (APS) will likely lead to temperature increases of 1.8°C by 2050 and by 2.1°C by 2100, which may still put the world at risk of destructive climate change. Only by achieving the Sustainable Development Scenario (SDS) and the Net Zero Emissions by 2050 Scenario (NZE) will the increase in temperatures be limited to around 1.5°C by 2100.



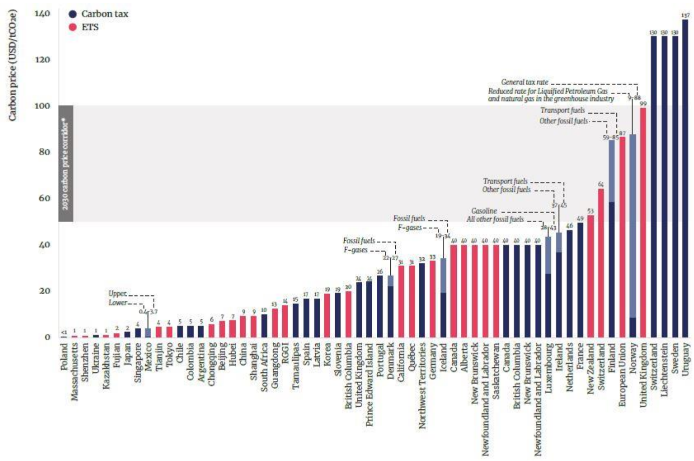
Multiple levers to influence emissions

CO2e emissions can be reduced in multiple ways. Compliance measures are government-directed measures, such as direct regulations, the imposition of carbon taxes, or the setting up of compliance carbon markets (CCM). However, polluting entities can also undertake voluntary efforts to mitigate their own operations' emissions or offset their emissions by buying a carbon credit in a voluntary carbon market (VCM). Non-market-based measures include direct regulation, carbon tax and internal mitigation efforts; market-based measures include the establishment of CCMs and VCMs.



Carbon prices mostly remain too low

The cost of emitting one tonne of CO2e is encapsulated in the carbon tax rates as well as the prices of allowances in compliance carbon markets, known as Emissions Trading Systems (ETS). Only a handful of ETS and carbon tax regimes, most notably the EU ETS, have prices (as at 1 April 2022) that exceed the US$50-100/tCO2e levels that the Carbon Pricing Leadership Coalition claim will be needed by 2030 if the goals of the Paris Agreement are to be met, i.e. to keep the global average temperature increase to below 2°C (preferably up to 1.5°C) above the pre-industrial level.



SOURCES: CGS-CIMB RESEARCH, NASA, IEA, WORLD BANK

Carbon markets 101

EXECUTIVE SUMMARY

Why we wrote this report

This report aims to provide a high-level understanding of how carbon markets can play an important role in global efforts to mitigate, reduce or abate carbon emissions that are currently threatening to bring climate disaster to the world in the coming decades. We hope that this report can add to investors' understanding of this complex topic in advance of carbon markets being introduced in ASEAN. We encourage investors to continue conversations with their investee companies over the importance of carbon mitigation and of carbon neutral or net zero goals and to propose to companies the potential use of carbon credits to offset their emissions in the meantime. As carbon markets develop and grow, it may become viable for investors in ASEAN to invest in or trade carbon credits as a commodity and new asset class in the future. This is our first report in what we expect to be a series aimed at shedding light on carbon markets for our ASEAN audience.

Sectional summaries

Section 1: Are we headed towards a global climate crisis?

The world has already seen a significant temperature increase of at least 1.1°C when compared against the pre-industrial age and it is on track to reach global warming of 1.5°C by around 2040 if the current rate of warming continues unabated. If global warming exceeds 1.5°C or 2°C, sea levels may increase and extreme climate events may become more common. Unfortunately, countries' stated policies for mitigation of carbon emissions as well as their announced pledges will not be sufficient to prevent destructive climate change in the decades to come. Nations need to step up to introduce more effective and meaningful mitigation measures but it remains to be seen if this can actually be achieved in the years to come.

Section 2: The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is the main global coordinating body for climate action. The most significant developments from the annual UNFCCC meetings, or Conference of the Parties (COP), are the 1997 Kyoto Protocol (KP) and the 2015 Paris Agreement (PA); these two key benchmark treaties outlined the strategies with which the UNFCCC signatories were to achieve the principal goal of reining in global warming.

The KP established the world's first carbon markets, of which the Clean Development Mechanism (CDM) is the most important. Unfortunately, due to multiple issues, CDM carbon credit prices collapsed after 2012 and could no longer contribute effectively to the core goal of emissions reductions. Nevertheless, the CDM likely inspired the setting up of the European Union's Emissions Trading System (EU ETS) in 2005.

The KP ultimately failed to achieve its climate goals due to a plethora of issues, most notably because emissions mitigation efforts fell on the shoulders of a small group of developed nations in the EU and Japan as the US had refused to participate.

The PA emerged as Kyoto's successor and, this time round, the climate goals became global in nature, with both developed and developing countries expected to enumerate their contributions to emissions mitigation via their Nationally Determined Contributions (NDC). The PA also set up a broad framework for international cooperation in the exchange of carbon credits – called the Article 6 Mechanism (A6M) – the successor to the CDM.

Section 3: Mitigating carbon emissions

Carbon emissions can be reduced by employing multiple tools, such as:

1. Direct government regulation
2. Voluntary efforts by individual polluters
3. Carbon taxes
4. Compliance carbon markets (CCM), and
5. Voluntary carbon markets (VCM).

Direct government regulation involves the government setting certain emissions standards that must be followed by polluting entities or else be subject to sanction. Direct government regulation may not achieve the lowest-cost pathway to mitigation since this is not a market-based policy.

Companies with net zero targets are likely to work towards mitigation and abatement measures on a voluntary basis, especially when put under pressure by their investors, shareholders and financiers.

Governments may also tax carbon emissions and the market determines how much emissions to reduce, taking into account the relative cost of mitigation actions vs. the price of the carbon emissions. Once carbon taxes are high enough, the polluting facilities may be economically motivated to curb GHG emissions.

Governments can also use the mechanism of CCMs to achieve the goal of reducing domestic emissions. There are two types of CCMs: 1) Cap-and-trade (CAT) schemes, and 2) Baseline-and-credit (BAC) schemes. The essence of both schemes is for governments to reduce total emissions for the targeted industries over a period of time either by tightening the emissions cap or by reducing the baseline. Market-based measures like CCMs are superior to direct government regulation because the market is given a free hand to determine the lowest-cost pathway to abatement.

Finally, VCMs can help companies to offset, though not reduce, their carbon emissions. The demand for voluntary carbon credits typically comes from private companies that are interested in demonstrating commitment towards their publicly-declared climate goals (such as carbon neutral or net zero targets), especially for hard-to-mitigate emissions. These companies buy credits from project developers that invest in a certain emissions reduction project, e.g. a reforestation project or a renewable energy project.

All of the above methods are only a means to an end; the desired end result is the mitigation of emissions so that the PA goals can be met.

Section 4: Carbon taxes

Carbon taxes are generally imposed on emissions from domestic fixed installations, such as power plants or industrial facilities, and most commonly on emissions from the combustion of fossil fuels within the borders of the countries.

In Southeast Asia, only Singapore has had a carbon tax regime in place since 2019, with a series of rate increases scheduled until 2030. Indonesia had originally planned to introduce a carbon tax in April 2022 but postponed it due to the rising cost of fuel after the Russia-Ukraine war started; while there is no definitive date for the carbon tax to begin, Indonesia had previously said that it wanted the tax to be in place before the G20 summit in mid-November 2022. In September 2021, Malaysia mooted the introduction of a carbon tax; however, no details have emerged yet.

Carbon taxes on international emissions are in the works; the EU's proposed Carbon Border Adjustment Mechanism (CBAM) aims to impose carbon taxes across borders while the UN's International Maritime Organization (IMO) is considering proposals by various parties to impose carbon taxes on marine fuels.

Section 5: Compliance carbon markets (CCM)

CCMs are also called Emissions Trading Systems (ETS) and are made up of CAT and BAC schemes. CAT schemes involve governments setting the maximum permitted emissions levels (or an emissions cap) and distributing the emissions permits (or allowances) to various polluting entities, either for free or via auctions. Installations that pollute more than the free allowances received can purchase additional allowances from other installations that have excess free allowances (i.e. the 'trade' component of the CAT schemes) or buy them via government auction or else be forced to throttle operations to reduce emissions. The maximum emissions cap and the corresponding number of allowances issued usually declines periodically in order to match the governments' climate goals. The traded price of the allowances depends on demand and supply factors and, if allowance prices rise above the cost of mitigating emissions, the largest polluters may be motivated to reduce their emissions. An example of a CAT scheme is the EU Emissions Trading System (ETS).

BAC schemes establish a pollution benchmark or baseline based on emissions intensity metrics; companies that pollute less than the baseline generate credits that can be sold for profit, which may incentivise companies to cut their emissions. An example of a BAC scheme is the China national ETS.

Carbon pricing instruments currently cover 23% of global GHG emissions; carbon pricing instruments include ETSs (which cover 17% of global GHG emissions) and carbon taxes (which cover 6% of global GHG emissions). The biggest ETS in terms of carbon coverage is the China ETS, followed by the EU ETS.

However, only 4% of global GHG emissions are covered by a direct carbon price (either a carbon tax or an ETS allowance price) that is within the range needed by 2030 in order to achieve the PA goals.

Section 6: Voluntary carbon markets (VCM)

VCMs are markets where carbon credits are voluntarily generated, sold and purchased, unlike compliance carbon markets (CCM) that are set up via government directive and regulation. Most buyers of voluntary carbon credits (VCC) are corporates that are motivated to offset their own emissions in order to achieve their publicly-announced carbon neutral or net zero goals.

Sellers of VCCs are typically entities that develop carbon avoidance, reduction or removal projects and sell the credits generated from them. Project developers that want to sell carbon credits typically have to go through 'crediting mechanisms', which are essentially frameworks, standards and registries that vet the projects to ensure compliance with the necessary standards before permitting the issue of credits.

The trading of VCCs typically take place on Over-the-Counter (OTC) markets, although a rising number of exchanges are being set up to organise the sale of VCCs in standardised contracts in order to improve market liquidity.

The two broad categories of VCM projects are carbon avoidance projects that avoid the release of GHG emissions and carbon removal projects that actively remove GHG emissions from the atmosphere. For instance, renewable energy (RE) projects and avoided deforestation projects are avoidance projects because they merely avoid the release of GHG. Conversely, reforestation and direct air capture (DAC) projects are removal projects because they actually suck CO_2 out of the air. VCM projects can also be alternatively classified as green energy projects (RE), nature-based carbon solutions (all kinds of forestry-related projects), technology-based solutions (such as DAC), and social benefit projects (e.g. clean cookstove projects).

VCCs can only be issued by crediting mechanisms; these are institutions that set out the requirements and quality standards that all VCM projects must follow in order to be certified before registering the projects under their wing. Independent crediting mechanisms, such as the standards managed by non-governmental entities, e.g. Verra's Verified Carbon Standard and the Gold

Standard, issued the greatest volume of VCCs in 2021. Forestry and land-use credits, otherwise known as nature-based solutions, dominated the volume and value of the VCM market in 2021.

In 2021, traded VCC volumes rose 143% from 202.7 MtCO2e in 2020 to 493.1 MtCO2e while the average traded price rose 57% from US$2.57/tCO2e in 2020 to US$4.03, which resulted in an almost quadrupling of VCMs' traded value in a single year from US$520m in 2020 to US$2bn. A paper written by McKinsey et. al. in October 2021 estimated that VCMs could explode in size to between US$5bn and US$180bn by 2030, with volume demand driven by corporate net zero targets and by a potential increase in the price of credits.

Before VCMs can scale up in transaction volumes, they need to meet key quality metrics in order to convince a sceptical community of buyers. These metrics include 1) the 'additionality' of the carbon mitigation; 2) the absence of carbon leakage; 3) the avoidance of double counting; 4) the permanence of the carbon abatement; and 5) verification by a recognised standard. The vintage of the credits, or the year that the credits were issued, is another important consideration for assessing the quality of credits; the general rule of thumb is that older credits are of lower quality and hence priced lower.

The growth of VCMs may be held back by 1) limited voluntary corporate demand; 2) excess supply of credits, which may lead to a collapse in VCC prices; 3) delays in the operation of PA's A6M; 4) environmental nationalism; and 5) blowback from authorities due to questionable carbon credit project deals.

Corporates can only use removal VCCs to offset their residual unabatable emissions under guidelines issued by the Science Based Targets Initiative (SBTi) and are required by SBTi to focus on aggressive mitigation actions to be in line with the PA. However, carbon neutrality targets are more lenient, with a gentler pace of mitigation activities (that is not necessarily in line with the PA) and corporates may use both removal and avoidance VCCs.

Section 7: Key stakeholders in carbon markets

In CCMs, the regulators impose carbon taxes or allocate pollution allowances to various polluting entities who may trade with each other. Carbon brokers, traders and institutional investors may also trade in allowances. Fund managers or stockbrokers may establish exchange-traded funds (ETF) to provide an avenue for retail investors to participate in the compliance carbon markets.

In VCMs, institutional investors and bankers provide funding support to project developers who initiate various carbon removal or avoidance projects. The credits are issued by crediting mechanisms using recognised standards and then registered with carbon registries. The VCCs are then marketed and sold wholesale by the project developers directly to corporates that have ambitions to voluntarily offset their own emissions. The project developers can also sell the credits to their institutional investors and intermediaries, who may resell them on OTC markets or exchanges that create standardised credits.

Section 8: International aviation emissions

The International Air Transport Association (IATA) has resolved for the global air transport industry to achieve net zero carbon emissions by 2050 to be aligned with the PA goals. IATA's four-pillar strategy to achieve this includes:

1. Improved technology, including the deployment of Sustainable Aviation Fuels (SAF);
2. More efficient aircraft operations;
3. Infrastructure improvements, modernised air traffic management systems; and
4. A single global market-based measure to fill the remaining emissions gap, which involves the use of offsetting under the International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

While CORSIA is not designed to replace legitimate mitigation measures, it has an important role to play in the immediate future because aviation is a hard-to-abate sector as there is no feasible alternative for fossil jet fuel.

As of 1 January 2022, 107 countries had volunteered to participate in the CORSIA scheme from 2021, with mandatory global participation only from 2027, although less developed countries (LDC), land-locked developing countries (LLDC), and small island developing states (SID) are exempt. BRIC nations (Brazil, Russia, India and China) and Vietnam will only participate from 2027 when CORSIA becomes mandatory.

The key facets of the CORSIA programme are as follows:

1. CORSIA addresses international aviation emissions only, not domestic emissions, as the latter are subject to individual countries' or a region's domestic carbon tax or domestic ETS
2. Only CO2 emissions are addressed by CORSIA
3. Only international emissions above the 2019 baseline need to be offset, not all emissions
4. In the voluntary periods of 2021-2023 and 2024-2026, only international emissions for air travel between CORSIA volunteer countries that are above the 2019 baseline need to be offset
5. Carbon offsets eligible to be purchased by airlines under the CORSIA programme must be CORSIA-approved
6. The burden of buying carbon offsets is weighted towards the larger emitters

Section 9: International shipping emissions

The UN's International Maritime Organization (IMO) and the EU have proposed regulations in order to reduce emissions from shipping operations, with both the IMO's and EU ETS's obligations becoming applicable from 2023.

The IMO regulations will apply to all shipping voyages for ships above a certain size. The EU ETS will apply to all intra-EU voyages and to 50% of emissions on voyages between non-EU ports and EU ports, for ships above a certain size. The focus of both regulatory regimes is to encourage specific and direct carbon mitigation and abatement measures. In both instances of the IMO regulations and the incoming EU ETS rules for maritime shipping, there is no role for carbon offsetting, unlike that of ICAO's CORSIA scheme for international aviation. Even so, this does not preclude shipping companies from voluntarily participating in VCMs to offset their residual emissions.

Section 10: ASEAN initiatives

ASEAN member states have submitted their NDRs to the UNFCCC secretariat and an analysis reveals that the climate targets are not comparable to each other as they have different bases and different time horizons; they also have different compositions between unconditional and conditional targets.

Indonesia has a target to reduce its GHG emissions unconditionally by 29% by 2030 *relative* to the BAU reference point but Malaysia targets to unconditionally reduce its GHG emissions *intensity* by 45% by 2030 relative to the 2005 intensity level. Singapore is the only country to have an absolute emissions target. It targets to peak emissions at no higher than 65 MtCO2e by around 2030 and then to halve its emissions to 33 MtCO2e by 2050. The Philippines has the weakest unconditional targets, planning to only reduce emissions unconditionally by a mere 2.71% against the 2020-2030 BAU. Vietnam also has rather modest targets for 2030. In terms of longer-term targets, Singapore and Vietnam have targeted to be net zero by 2050 while Indonesia has set a net zero target for 2060 and Thailand for 2065. Malaysia stands out as having no net zero target but rather a carbon neutral target for 2050.

The mish-mash of NDC targets makes it difficult to assess if the goals of the PA can be met. Bain & Company's analysis suggests that ASEAN's projected emissions in 2030 may not be on track to meet the PA's climate goals. The main issues centre on continued deforestation to make way for agricultural plantations and the continued construction of new coal-fired power plants.

In terms of carbon regulation, Singapore has a head start as it introduced a carbon tax regime in 2019 and has already set out a series of aggressive rate hikes up to 2030.

Indonesia's carbon tax was initially set to commence in April 2022 but this was pushed back to July 2022 and then delayed again to a future unspecified start date, although the Indonesian government has said that it wants the carbon tax to be in place before the G20 summit in Bali on 15-16 November 2022. In the longer term, the tax may operate alongside a mandatory ETS for coal-fired power plants, under a hybrid 'cap-and-trade-and-tax' system.

Malaysia announced in September 2021 that it was considering a VCM, domestic ETS and a carbon tax, although no details have emerged yet. Bursa Malaysia is in the process of developing a voluntary carbon exchange before end-2022, with credits offered from Malaysian and foreign sources.

In Thailand, the Thailand Voluntary Emission Trading Scheme (Thailand V-ETS) is currently being piloted for all sectors, except the power sector. The Thailand Greenhouse Gas Management Organization (TGO) has developed a voluntary domestic GHG crediting mechanism called the Thailand Voluntary Emission Reduction Program (T-VER). The credits from T-VER are applied against domestic emissions. Meanwhile, the Thailand Carbon Offsetting Programme (T-COP) encourages public and private organisations to calculate their carbon footprints and buy carbon credits to offset their unavoidable emissions.

Vietnam has a nationwide policy on Carbon Payment for Forest Environmental Services (C-PFES), which requires users of forest environmental services to make payments to suppliers of these services. In January 2022, Vietnam said it will develop a national ETS and establish a national crediting mechanism. The country hopes to run a pilot scheme in 2026 before launching a full ETS in 2028.

Brief highlights of appendices

Appendix 1: Greenhouse gases (GHG)

We describe the types of GHGs, i.e. carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), ozone (O3) and various fluorinated gases, like sulphur hexafluoride (SF6), nitrogen trifluoride (NF3), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). We also explain the concept of carbon dioxide equivalent (CO2e) and the global warming potential of different GHGs.

Appendix 2: How compliance carbon markets work

We provide numerical examples of a hypothetical CAT scheme and a hypothetical BAC scheme to illustrate how they might work.

Appendix 3: The EU Emissions Trading System (EU ETS)

A history of the EU ETS is described in this appendix, together with details of how the EU ETS actually works, and we explain concepts such as the emissions cap, free and auctioned allowances, the linear reduction factor (LRF), the Market Stability Reserve (MSR), and the European Commission's proposed 'Fit for 55' package that aims to increase the EU's climate targets.

Appendix 4: China's Emissions Trading System (China ETS)

We provide similar background information on China's ETS that started from 2021 and explain the differences between the EU's and China's ETSs.

Appendix 5: Carbon accounting

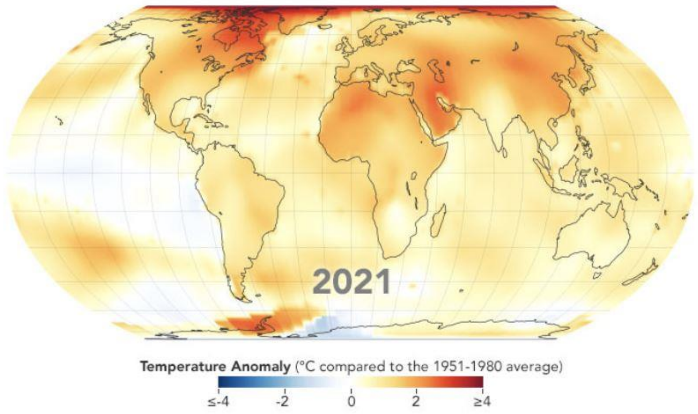
Scope 1, Scope 2 and Scope 3 emissions are categorised and explained here. We also discuss the two methods for Scope 3 emissions accounting, i.e. operational control accounting or equity share accounting. Finally, we discuss who is responsible to abate which type of emissions.

SECTION 1: ARE WE HEADED TOWARDS A GLOBAL CLIMATE CRISIS?

The world's average temperatures may rise by 1.5°C by around 2040 if the current trajectory remains unchanged

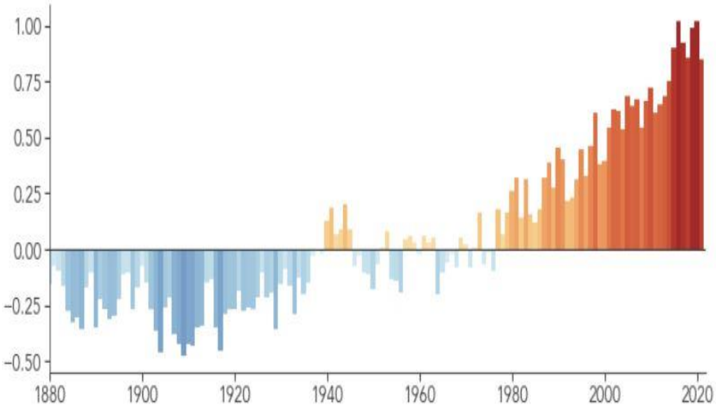
The National Aeronautics and Space Administration (NASA) of the US produced research that shows that since 2015 and to the most recent observation in 2021, the world's average temperature has risen by between 0.75°C and 1°C higher than the average during 1951-1980.

Figure 2: World temperatures have risen vs. the 1951-80 average, with the North Pole region, the Middle East and North Africa, North America, and China seeing the highest increases



SOURCE: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Figure 3: 2021 ties 2018 for the sixth warmest year on record; the chart below shows the global temperature anomaly (°C compared to the 1951-80 average)



SOURCE: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

The International Energy Agency (IEA) wrote in its World Energy Outlook (WEO) published in October 2021, that global average temperatures have already risen at least 1.1°C higher than the pre-industrial age, which is defined as the period 1850-1900.

According to a Special Report in 2018 (known as 'SR1.5') by the Intergovernmental Panel on Climate Change (IPCC), which is a United Nations (UN) body tasked with assessing the science related to climate change, the world will reach global warming of 1.5°C by around 2040, if the current rate of warming continues unabated.

If world temperatures can be kept well below 2°C higher than the pre-industrial age (or ideally within 1.5°C), the worst climate effects resulting from anthropogenic (i.e. resulting from human activity) emissions of greenhouse gases (GHG) can be kept at bay.

If global warming exceeds 1.5°C or 2°C, sea levels could rise due to the melting of the polar ice caps and threaten low-lying coastal regions and island nations. Extreme weather events may become more common, such as hurricanes, excess rainfall and flooding in some areas, and drought and fires in other areas.

GHGs are gases that trap the sun's heat in the Earth's atmosphere. GHGs are naturally present, but human activity has increased their concentration in the atmosphere, with rising levels of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3). In addition, human-made GHGs in the atmosphere include sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Please refer to Appendix 1 for a more detailed discussion of different types of GHGs and their Global Warming Potential (GWP).

Is the world doing enough?

The International Energy Agency (IEA), in its World Energy Outlook 2021 report ('WEO-2021', released in October 2021), set out four scenarios of the trajectory of carbon emissions until 2050.

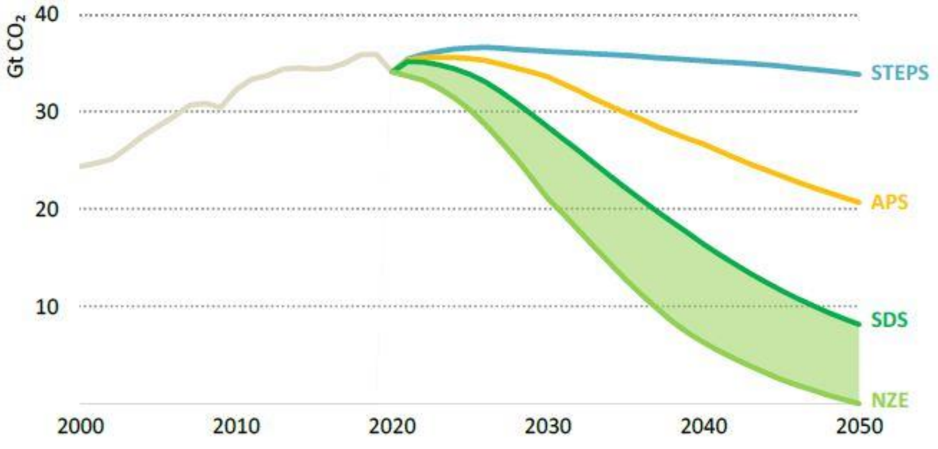
The **Stated Policies Scenario (STEPS)** reflects the current policy settings as well as those that have been announced by governments around the world.

The **Announced Pledges Scenario (APS)** assumes that all climate commitments made by governments will be met in full and on time, including countries' Nationally Determined Contributions (NDC) and their longer-term net zero targets.

The **Sustainable Development Scenario (SDS)** assumes that the key energy-related United Nations Sustainable Development Goals (UN SDG) related to universal energy access and major improvements in air quality are achieved, and the world reaches global net zero emissions by 2070.

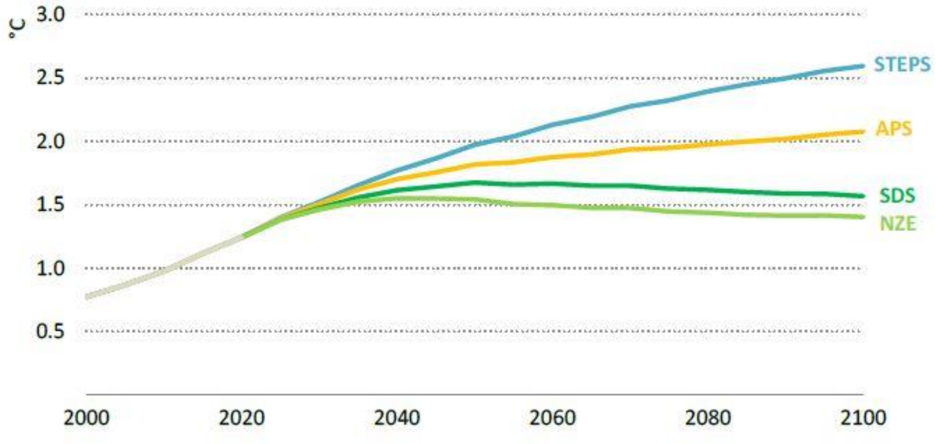
Finally, the **Net Zero Emissions by 2050 Scenario (NZE)**, assumes that the global energy sector will achieve net zero CO2 emissions by 2050.

Figure 4: CO2 emissions in the WEO-2021 scenarios over time



SOURCE: IEA

Figure 5: Global median surface temperature rises over time in the WEO-2021 scenarios (vs. the pre-industrial period)



SOURCE: IEA

If the world maintains its current trajectory under the STEPS scenario, annual CO2 emissions will barely change between 2020 and 2050, and temperatures will rise by 2°C by 2050 and by 2.6°C by 2100, compared to the pre-industrial period, according to the IEA.

The APS scenario will help annual CO2 emissions fall to just around 20 giga tonnes (Gt) by 2050, but will likely lead to temperature increases of 1.8°C by

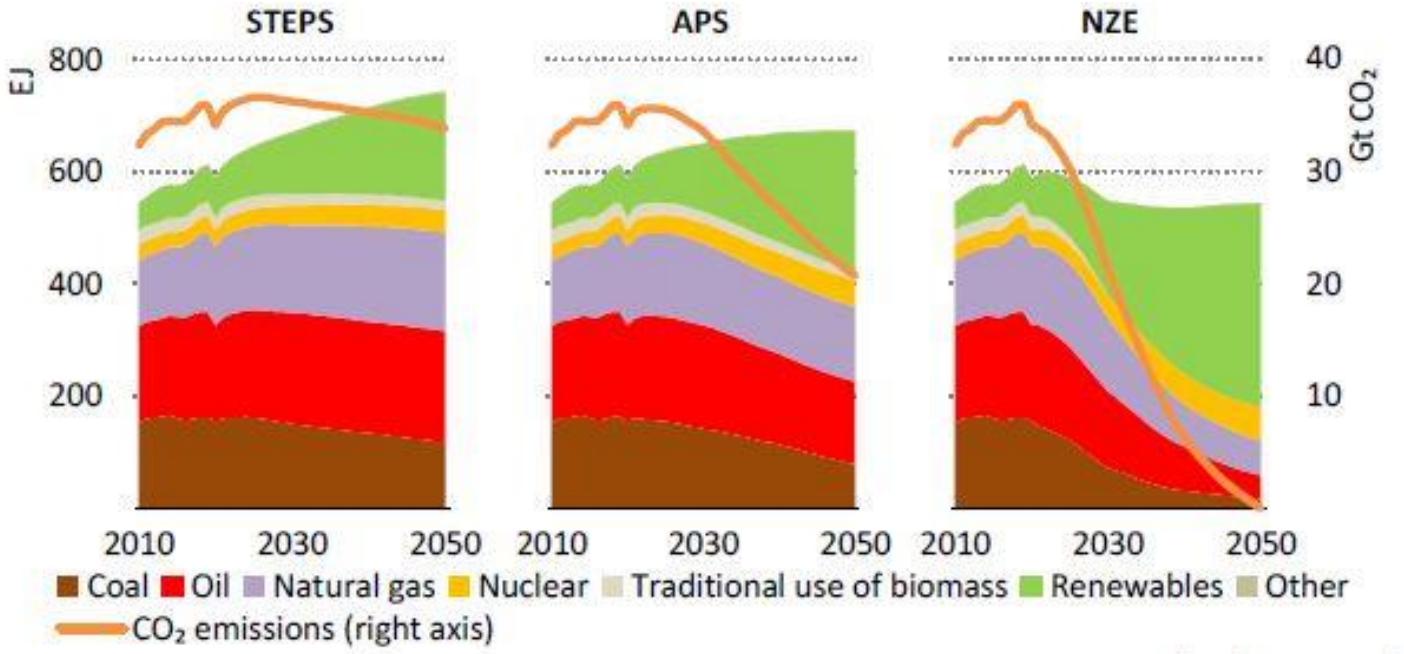
2050 and by 2.1°C by 2100, which may still put the world at risk of destructive climate change, even on the assumption that the APS is achieved in its entirety without any slippages.

Achieving the SDS and the NZE scenarios will significantly reduce CO2 emissions and help maintain the increase in temperatures at around 1.5°C by 2100.

The issue, therefore, is that governments' announced pledges (in the APS scenario) only cover less than 20% of the gap in emissions reductions by 2030 that are necessary to keep the world on its NZE pathway. By 2050, the APS will cover less than half of the emissions reductions necessary to achieve net zero. If net zero is not achieved, the world continues to be in danger of catastrophic climate outcomes.

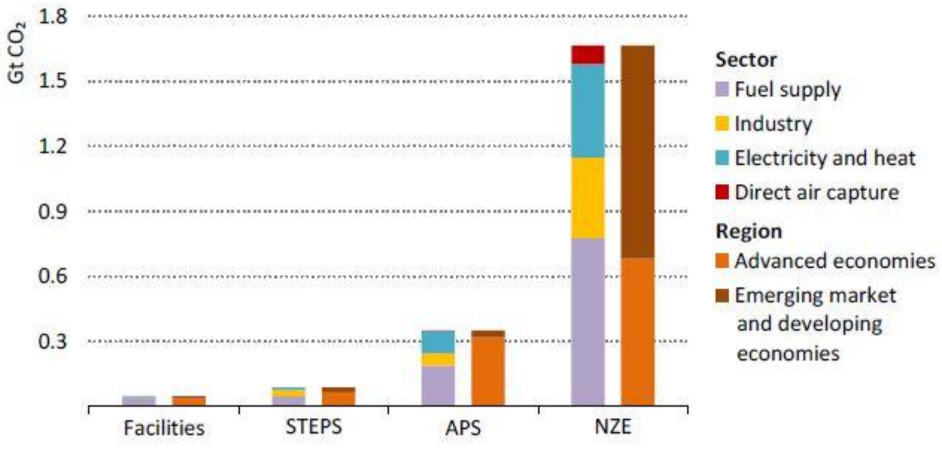
As an example of what needs to be done, the IEA noted that the share of renewables in the global energy production capacity mix needs to rise from nearly 30% in 2020, to over 40% in 2030 in the STEPS scenario, to 45% in the APS scenario, and to 60% in the NZE scenario. Also, the IEA believes that global carbon capture and utilisation (CCUS) projects need to pick up significantly.

Figure 6: Total primary energy supply by fuel and scenario – the world will need to increase renewable energy production and reduce fossil fuel production in the NZE scenario by even more than what is in the STEPS and APS scenarios in order to achieve Net Zero 2050



SOURCE: IEA

Figure 7: Global carbon capture and utilisation (CCUS) projects need to pick up



SOURCE: IEA

SECTION 2: THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

Global efforts to tackle climate change have centred on the UNFCCC

Global concerns over climate change led to the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) under the auspices of the UN in May 1992, and 154 states signed the framework at the 1992 Earth Summit in Rio de Janeiro, Brazil. The UNFCCC (otherwise known as the 'Convention') entered into force in March 1994 and there are currently 198 Parties to the Convention ('Parties' refer to member countries of the UN that have signed the framework and have agreed to participate in future discussions and initiatives).

The UNFCCC has since become the key coordinating body under the auspices of the UN to organise the global response to the growing problem of climate change. According to the IPCC, the Convention's ultimate objective is the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

Since the Convention came into force in 1994, regular annual meetings have been held, called the Conference of the Parties (COP). The first COP ('COP1') was held in 1995 in Berlin, Germany, and the most recent COP26 was held in Glasgow, UK. The next COP27 will be held in Egypt's Sharm El-Sheikh during 6-18 November 2022.

The UNFCCC practises consensual decision making, which unfortunately also means that the entire process in the early 1990s was held to ransom by the least committed Party. As a result of the resistance of the US, the UNFCCC of 1992 only included a non-binding goal to stabilise GHG emissions at the 1990 baseline levels by 2000. Such a weak and vague target led nowhere, and negotiations towards stronger goals took place in subsequent COP meetings.

The most significant developments were the Kyoto Protocol (KP) which arose out of the COP3 meetings in 1997, and then the Paris Agreement (PA) which emerged from the COP21 meetings of 2015; these two key benchmark treaties outlined the strategies with which the UNFCCC signatories were to achieve the principal goal of limiting global warming. Paris ultimately emerged as Kyoto's successor due to a plethora of issues with the KP.

We will describe and explain the essence of both the KP and the PA below; these have had an enormous impact on the development of global carbon markets.

The Kyoto Protocol (KP)

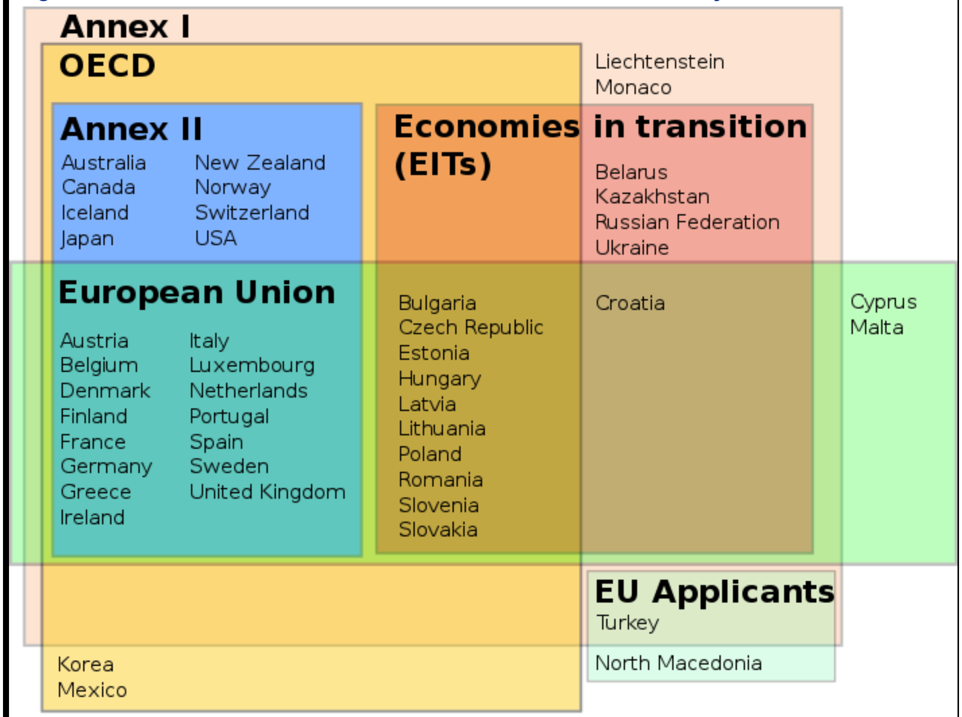
The Kyoto Protocol (KP) to the UNFCCC is an international treaty adopted in December 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties to the UNFCCC (COP3). Due to the complex ratification process, the KP only entered into force in February 2005.

In an effort to address the global warming problem, the KP focused on addressing legacy emissions by developed and industrialised nations. These developed and industrialised countries are also labelled as **Annex II countries**, which include the US, Canada, Australia, New Zealand, Japan, the European Union (EU, which included the UK at that time), and non-EU members of developed Europe such as Norway, Switzerland and Iceland.

Economies in Transition (EIT), which comprised the Former Soviet Union (FSU) countries, were also roped into the KP's climate commitments; the EITs together with the Annex II countries were grouped together as **Annex I countries**.

The KP did not place any burden on developing countries, or **'Non-Annex I' countries**, to reduce their GHG emissions, as the KP recognised that economic growth and poverty alleviation were greater priorities.

Figure 8: List of Annex I and Annex II countries under the 1997 Kyoto Protocol



SOURCE: UNFCCC

The KP of 1997 had set a goal for Annex I nations to reduce their GHG emissions by 5.2% from the 1990 baseline before end-2012, which was the last year of the First Commitment Period of 2008-2012, which ran for five years.

Each Annex I country was allocated a certain level of permitted emissions with respect to the First Commitment Period of 2008-2012 (i.e. the emissions cap), as represented by the equivalent number of **Assigned Amount Units (AAU)**; one AAU allowed a country to emit 1 tonne of CO2e.

A formal Quantified Emission Limitation or Reduction Objectives (QELRO) were ascribed to certain countries, in order to achieve the overarching KP goal of reducing Annex I countries' emissions by 5.2% between 1990 and 2012. For instance, the US was required to reduce GHG emissions by 7%; Japan, Canada, Hungary and Poland were to each reduce by 6%; and the EU was to cut by 8% (although Australia was permitted to increase its GHG emissions by 8%, while Russia and Ukraine were allowed to stabilise their emissions at 0% change).

As an example, if Country A emitted 500 MtCO2e in 1990 and was required to cut emissions by 5%, the country would be allocated 2,375m AAUs during the 5-year First Commitment Period of 2008-2012. This is calculated as 500 MtCO2e x (1-5%) x 5 years, which is equal to 2,375 MtCO2e.

These AAUs were tradeable among Annex I countries, under the **International Emissions Trading (IET)** scheme, which was the world's first cap-and-trade (CAT) compliance carbon market (CCM). Annex I countries that had too many AAUs because their actual emissions were lower than their assigned emissions caps were able to sell those excess AAUs to other Annex I countries that had insufficient AAUs.

In addition to the IET trading of AAUs between Annex I countries, the KP also provided three additional options for Annex I countries to meet their QELRO goals. The first was called the **Clean Development Mechanism (CDM)**, where Annex I countries could buy carbon credits created by emissions reductions projects in developing countries (Non-Annex I countries). In a 2018 report, the

World Bank noted that there were CDM projects in 112 countries, with most of the projects located in China and India.

The second was the concept of **Joint Implementation (JI)** projects, where Annex I countries can collaborate on emissions reductions projects in other Annex I countries; primarily, industrialised Annex II countries purchased carbon credits from projects in the EIT countries of the FSU. Most of the JI projects were located in Russia and Ukraine.

The third was the land use, land-use change and forestry (LULUCF) activities such as reforestation in Annex I countries that could generate Removal Unit (RMU) credits.

The CDM credits (also called Certified Emissions Reductions, or CER) could be purchased by Annex I countries in place of buying AAUs, for the purposes of offsetting their excess emissions in KP's First Commitment Period of 2008-2012. Alternatively, Annex I countries could buy JI credits (also called Emissions Reduction Unit, or ERU) or AAUs from other Annex I countries. This made economic sense if the cost of mitigating domestic emissions in Annex I countries was more expensive than funding mitigation projects in lower-cost locations elsewhere.

Why the KP ultimately failed to achieve the UNFCCC's climate goals

The KP was unsuccessful in achieving its climate goals, as demonstrated by the continued rise in global GHG emissions between 1997 and 2012, according to the IEA. By design, the KP focused on legacy emissions by developed and industrialised Annex I countries, and left out developing countries like China that were increasing their GHG emissions due to rapid industrialisation.

The KP was also undermined by the US Senate's refusal in 1997 to ratify the KP, as the US Senate was unable to accept that the KP exempted participation by developing countries (Non-Annex I countries); the US ultimately withdrew from the KP in 2001. This dealt a heavy blow to the KP, because the US was one of the world's largest emitters at that time, and remains so today. The US withdrawal left a small group of nations in the EU and Japan to hold up the KP's commitments to emissions reductions, which was unrealistic and untenable. According to the World Bank, the effective number of mitigating countries under the KP was merely 36, which accounted for just 21% of global emissions during the KP's First Commitment Period (2008-2012).

Another issue with the KP was the lack of political will to assign tougher emissions reduction targets to Annex I countries, resulting in a surplus of AAUs. The EIT countries were allocated AAUs in excess of their actual pollution levels right from the start, particularly for Russia, Ukraine, Poland and Romania. The surplus AAUs caused the price of AAUs to be low, making it very cheap for Annex I countries to buy their way out of more expensive GHG mitigation investments.

Furthermore, despite the collapse of the European Union Emissions Trading Scheme (EU ETS) allowance prices in the aftermath of the 2008 Global Financial Crisis, the EU was unwilling to remove the excess supply of EU ETS allowances. This caused a spillover effect into the CDM and JI, and caused their carbon credit prices to weaken. As a result, polluters in the EU could very easily offset their emissions by way of purchasing cheaply priced carbon credits from CDM and JI, disincentivising them from investing to reduce their actual emissions.

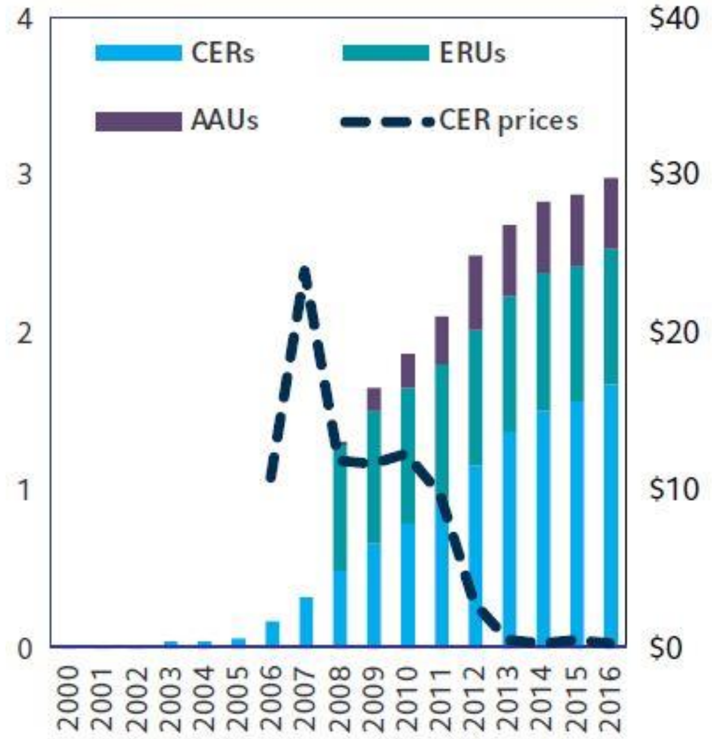
To make matters worse, there was also a significant surplus of CDM and JI carbon credits, with some projects of dubious quality and of "questionable environmental integrity", according to Carbon Market Watch.

The unfortunate result was a continued increase in global GHG emissions up to the end of the KP's First Commitment Period in 2012, and beyond, caused by what the World Bank described as "low political will".

At COP18 in December 2012, a new set of Parties to the Convention agreed to a Second Commitment Period of 2013–2020 under the KP, in which commitments were made to reduce GHG emissions by at least 18% below 1990 levels by end-2020. However, there were insufficient ratifications by the various Parties.

The KP was ultimately superseded by the Paris Agreement (PA), which is its successor.

Figure 9: Kyoto Mechanisms – cumulative volumes of carbon credits transacted (million tonnes of CO2e) and average prices (US$/tCO2e) from the IET scheme (AAUs), the CDM scheme (CERs), and the JI scheme (ERUs)



SOURCE: UNITED NATIONS ENVIRONMENTAL PROGRAMME (UNEP), WORLD BANK

Why CER prices crashed post-2012

The price crash for CDM credits post-2012, otherwise called Certified Emissions Reductions (CER) credits, was caused by two factors.

- The demand for CDM credits weakened after 2012, when the EC placed qualitative and quantitative limits on the use of international credits in Phase 3 of the EU ETS that ran between 2013 and 2020 (more on the EU ETS in Appendix 3).
- Japan shut down all of its nuclear power plants in the aftermath of the Fukushima earthquake of 2011, forcing it to burn fossil fuels for power generation, which resulted in a sharp increase in emissions. Consequently, Japan decided that it would no longer purchase CERs to offset its national emissions.

At end-2012, 1.2bn CDM credits (CERs) remained unsold, according to Kazunari Kainou, a member of the UNFCCC executive board, in an article dated 16 March 2022 published on the VoxEU website.

After 2012, the demand for CDM credits was revived by interest from US companies which could use the CERs to offset their obligations under the ETSs in California and 13 East Coast states, while developing countries (China, Mexico, and South Africa, etc.) also purchased CERs for their domestic ETS needs. One of the reasons was because the average price of CERs of less than US$3 each post 2012 was cheaper than the South African carbon tax of US$8/tCO2 emitted. Since 2013, 1,200 new CDM projects have been registered, with a cumulative total of 2bn CER units issued, according to Kainou. However, Kainou noted that CER prices remained low despite the demand from the US and developing countries, due to the robust supply.

From 2021 onwards, the EU ETS no longer permitted EU entities to buy CDM credits (CERs) or JI credits (Emissions Reduction Units, or ERUs) for the purpose of meeting the EU ETS obligations. As a result, the demand for CERs will have to come from other sources, including from voluntary corporate emissions reduction pledges.

The Kyoto Protocol (KP) led to the emergence of global carbon markets

Despite the KP's shortfall in achieving its goals, the 1997 KP made notable contributions towards the development of carbon markets.

As noted earlier, the 1997 KP introduced the world's first compliance carbon market (CCM), which is the **International Emissions Trading (IET)** scheme for the trading of Assigned Amount Units (AAU) between Annex I countries.

Subsequently, in 2005, the European Union introduced its **EU Emissions Trading System (EU ETS)** which targets emissions from specific installations or polluting entities within the EU in a cap-and-trade (CAT) CCM.

The distinction between the KP/IET and the EU ETS is that the KP/IET targeted the emissions of entire countries, while the EU ETS targets the emissions of individual polluting installations, such as power plants and heavy industry. Despite the distinction, if the EU ETS achieves the sum total of its installation-level objectives, the KP would also likely achieve its objectives at least for the EU. The EU ETS is linked to the KP/IET in the sense that when an EU ETS Allowance (EUA) is sold from an installation in Country A to another installation in Country B, Country B's inventory of AAUs is topped up by one unit while Country A's stock of AAUs is reduced by one unit (this describes the 'corresponding adjustment' of allowances to account for transfers between countries).

Meanwhile, the KP also established the basis and rationale for carbon crediting projects around the world, like those embodied by the **Clean Development Mechanism (CDM)** and the **Joint Implementation (JI)** projects. This was supported by the EU ETS, which permitted credits from CDM projects (called Certified Emissions Reductions, or CERs) and credits from JI projects (called Emissions Reduction Units, or ERUs) to be purchased and used as allowances by polluting EU installations until 2020.

While the CERs from CDM projects and ERUs from JI projects are no longer allowed to be used for the purposes of complying with the EU ETS from 2021 onwards, the CDM and JI projects built the foundation for the establishment of projects under future voluntary carbon markets (VCM).

The Paris Agreement (PA)

The Paris Agreement (PA) under the UNFCCC was adopted in December 2015 in Paris, France, at the 21st session of the Conference of the Parties (COP21). The PA was adopted by 196 Parties to the UNFCCC and entered into force in November 2016, covering approximately 98% of global emissions, according to the UNFCCC.

The PA is different from the KP in several ways. First, the scope of the 2015 PA is much wider than the 1997 KP. The KP had set the initial and limited goal of reducing Annex I countries' emissions by 5.2% before end-2012 against the 1990 base.

However, the **global ambition** of the PA is much broader, which is to:

- Hold the increase in global average temperatures to well below **2°C** above pre-industrial levels,
- Pursue efforts to limit it to **1.5°C**, and
- Facilitate the peaking of global emissions "as soon as possible" so that a balance can be maintained by 2100 between sources of GHG emissions and GHG sinks (like forests and oceans that can capture and store emissions).

Second, while the KP targeted legally-binding emissions reductions from a small number of developed and industrialised countries only, the PA requires **voluntary contributions from all countries and all signatories to the PA**. This means that both developed and developing countries voluntarily contribute to global climate goals, and declare their efforts through documents which set out their **Nationally Determined Contributions (NDC)**, which describe specific but non-binding efforts by individual nations to reduce their domestic GHG emissions. As a result, the PA is truly global in nature.

Third, the KP focused exclusively on the role of states (i.e. Parties to the Convention) in achieving the UNFCCC goals, but the PA also ropes in **non-state actors**, such as observer organisations (such as the World Bank, the OECD, etc.) and environmental non-governmental organisations (NGO), which can play a critical role to assist the states in achieving their climate goals.

Fourth, the focus of the KP was almost solely in mitigating GHG emissions, but the PA's focus is on a **broader combination of mitigation, adaptation and finance**. GHG mitigation refers to the reduction of GHG emissions from anthropogenic activities, through technological solutions, nature-based solutions, etc. Adaptation is in reference to measures taken to help communities and environments to adapt to inevitable climate change that is already taking place as a result of legacy emissions, for example by helping communities living in flood-prone areas to build defences against future floods caused by climate change. Finance refers to the raising of funds to be channelled towards both mitigation and adaptation measures.

While the scope of the PA is global in nature, countries' NDCs are very varied, with some emissions targets based on historical baselines, some based on future 'business as usual' (BAU) baselines, some based on emissions intensity targets, and some on renewable energy (RE) targets. The mish-mash of different types of NDC targets makes it difficult to determine if the aggregated NDCs will or will not be sufficient to achieve the goals of the PA.

Figure 10: Varieties of nationally determined contributions (NDC)

Type	Features of NDCs	Number of NDCs	Share of global emissions
GHG targets	Absolute GHG target	43	41%
	GHG target relative to BAU	74	16%
	GHG intensity targets	10	33%
	Other or No GHG target	36	6%
Non-GHG targets	Multiple non-GHG targets	17	32%
	Renewable energy	63	13%
	Energy efficiency	1	0%
	Forestry target	10	2%
Conditionality	Unconditional target	34	68%
	Conditional	49	12%
	Unconditional & conditional	80	16%
Base year	Historic year or fixed level	53	74%
	Projected BAU emissions	79	16%
	Not specified	31	6%
Target year	Single year (other years)	117	89%
	Multiple years	11	1%
	Not specified	35	6%
Carbon markets	Participation in international carbon markets	80	25%
	No participation	17	32%
	Not specified	66	39%
Total NDCs analyzed		**163**	**96**

SOURCE: WORLD BANK

According to a study by the IEA, the ambitions of the Parties need to be ratcheted upwards in order to achieve the IEA's 'Net Zero 2050' target. In Section 1 of this report, the IEA highlighted that under the Announced Pledges Scenario (APS), which incorporates all of the world's climate pledges, including net zero targets and individual countries' NDCs, the resultant emissions reductions will still be insufficient to take the world to net zero by 2050. Given the increasingly visible pace of climate change, the window is narrowing for effective solutions to achieve the PA's goals, in our view. Ultimately, states cannot be compelled to ratchet up their NDCs, and the success or otherwise of the PA depends entirely on the Parties' voluntary efforts.

The first of the PA's global carbon stocktakes is planned for 2023, which will be repeated every five years thereafter. These stocktakes will offer comparisons across countries of their emissions performance. In the best-case scenario, this 'naming-and-shaming' may push the laggards to increase their climate ambitions; in the worst-case scenario, countries may disagree over how their GHG emissions are counted, how those emissions are monitored, reviewed and verified (MRV), and may point fingers at other Parties for failing to live up to their respective NDC commitments. The realistic scenario is for some states to push hard to live up to their NDCs, and for others to seek to postpone or dilute their commitments. The UNFCCC then becomes the forum at which states are encouraged to pursue climate mitigation action for the common good.

Article 6 Mechanism (A6M) of the Paris Agreement is the new rulebook for governing carbon markets

Article 6 of the PA is a broad framework which enables countries to pursue international collaboration to achieve each other's NDC goals, including purchasing carbon credits from each other. The Article 6 Mechanism (A6M) was approved at the COP26 at Glasgow.

The first five paragraphs of Article 6 are reproduced below.

Article 6.1

"Parties recognise that some Parties choose to pursue voluntary cooperation in the implementation of their NDCs to allow for higher ambition in their mitigation and adaptation actions and to promote **sustainable development (SD)** and environmental integrity."

Article 6.2

"Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of **internationally transferred mitigation outcomes (ITMO)** towards NDCs, promote SD and ensure environmental integrity and transparency, including in governance, and shall apply **robust accounting** to ensure, inter alia, the **avoidance of double counting**..."

Article 6.3

"The use of ITMO to achieve NDCs under this Agreement shall be voluntary and authorised by participating Parties."

Article 6.4

"A mechanism to contribute to the mitigation of GHG emissions… shall aim:

(a) To promote the mitigation of GHG emissions while fostering sustainable development;

(b) To incentivise and facilitate participation in the mitigation of GHG emissions by public and private entities authorised by a Party;

(c) To contribute to the reduction of emission levels in the host Party, which will benefit from mitigation activities resulting in **emission reductions that can also be used by another Party to fulfil its NDC**; and

(d) To deliver an overall mitigation in global emissions."

Article 6.5

"Emission reductions resulting from the mechanism referred to in paragraph 4 of this Article shall not be used to demonstrate achievement of the host Party's NDC if used by another Party to demonstrate achievement of its NDC."

The Article 6 Mechanism (A6M) of the PA essentially says that Party A (i.e. Country A) can engage in domestic projects or activities that mitigate (i.e. reduce) its in-country GHG emissions, and either:

- Claim those reductions against Party A's own emissions reductions targets (as offered in its NDC), or
- Transfer those "mitigation outcomes" internationally, e.g. sell the carbon credits to Party B so that Party B can claim those emissions reductions against its NDC.

The conditions underlying the use of ITMO transfers are that the transfers:

- Must be voluntary under "cooperative approaches",
- Must be authorised by the Parties involved, and
- The ITMOs can only be used once to demonstrate achievement of a specific Party's NDCs, meaning that the mitigation outcomes or carbon credits must be subject to "robust accounting" in order to avoid being double counted towards achieving the NDCs of more than one Party. In order to prevent double counting, and in order to ensure the integrity of the international GHG accounting system, cross-boundary emissions transfers must be accounted for by a system of "corresponding adjustments", which transfers the GHG

emissions reductions from the host country's account and adds them to the importing country's account.

The PA established a new market mechanism to replace the KP's CDM scheme after the end of the KP's Second Commitment Period in 2020. In principle, the A6M is no different from its predecessors under the KP, which also facilitated the global trade in carbon credits through VCMs for the purposes of meeting PA commitments in the most cost-efficient way. Hence, existing CDM projects may be continued in some way or form under the A6M, as long as the request to transition the CDM activity to A6M is made by 31 December 2023, and host country approval for such transitions is received by 31 December 2025.

In an article dated 16 March 2022, Kazunari Kainou, a member of the UNFCCC executive board noted that negotiations for the application of the A6M have remained deadlocked due to the EU's proposal to restrict the carryover of CERs to the PA regime. Kainou wrote that "companies in developing countries such as China, Mexico, and South Africa have been major investors in CDM projects since 2013. They have assiduously amassed holdings of CER credits for future use, in anticipation of their upcoming participation in the PA. Naturally, the EU's proposal to invalidate CER credits all at once in the name of 'environmental integrity' has invited a firestorm of opposition. As long as the EU tries to bind the hands of developing countries under the pretext of environmental integrity, the negotiations over the PA will continue to become more complicated and the conclusion will remain out of reach."

The World Bank noted that "countries looking to become Article 6 hosts have started to develop their engagement strategies and needed processes, including for ITMO authorisations, with potential buyer countries participating in Article 6 transactions. Today, Article 6 readiness activities focus on strengthening participants' capacities, developing policy frameworks, and building the necessary infrastructures for Article 6 transactions. Independent crediting standards such as the Gold Standard are getting more engaged in Article 6 activities and are taking steps to facilitate Article 6 transactions."

SECTION 3: HOW CAN CARBON EMISSIONS BE REDUCED?

Ways to mitigate CO2e emissions

Carbon emissions can be reduced by employing multiple tools, such as:

6. Direct government regulation
7. Voluntary efforts by individual polluters
8. Carbon taxes
9. Compliance carbon markets (CCM), and
10. Voluntary carbon markets (VCM).

1. Direct government regulation

The first way of addressing emissions is via direct regulation, enforcing new mandates, or intervention by setting up new standards. For instance, regulators can promulgate new laws on the permissible levels of emissions by various power generation or industrial entities, and sanction those that exceed those emission levels by threatening the closure of those offending facilities, or by way of financial penalties. Regulators can raise transportation fuel quality standards, or mandate the blending of fossil fuels with biofuels, in order to reduce the net emissions of various GHGs and pollutants upon combustion; these standards place the burden on oil refineries to produce and blend the fuels in order to meet the regulatory requirements.

Entities that outperform their peers by reducing emissions by more than the regulatory requirements are not rewarded relative to those that merely do the bare minimum. This may lead to low motivation to voluntarily reduce emissions by more than that required by the regulations. Direct regulation may not be able to achieve the lowest-cost pathway to mitigation, since governments are unlikely to have all the information necessary to optimise their regulatory decisions on which emissions are the cheapest and least economically disruptive to address first.

2. Voluntary efforts by individual polluters

According to a report by the World Bank, the growth in corporate net zero targets has accelerated rapidly over the past years. The UNFCCC's Race to Zero initiative reported that 5,235 companies have made a commitment of this type, and pledges by Global Fortune 500 companies grew 17% between 2020 and the end of 2021. The International Air Transport Association (IATA) already announced a voluntary net zero target for the aviation sector by 2050.

Companies with net zero targets are likely to work towards mitigation and abatement measures, such as investing in improving the efficiency of their operations so as to be less emission intensive, self-generate or buy more renewable energy in place of fossil-fuel-based electricity, invest in carbon capture and storage (CCS) solutions, and invest in new low-carbon technology that can use blue fossil fuels (fossil fuels that have been produced with CCS), or green fuels such as biogas (natural gas produced from renewable sources), green hydrogen, green ammonia, and green methanol.

3. Carbon taxes

Another way is for governments to introduce carbon taxes to be collected for every tonne of CO2e emitted. Governments determine an appropriate price for carbon, and the market determines how much emissions to reduce, taking into account the relative cost of mitigation actions vs. the price of the carbon emissions. As such, governments do not have visibility on the volume of emissions, as this depends on the degree to which polluting entities are willing to bear the tax.

Revenues are collected by governments from polluting facilities by way of a charge per tonne of CO2e emitted. The carbon tax may be set at a low rate at the onset in order to give time for the facilities to adjust, and then be progressively increased. Governments can also provide free allowances to trade-exposed industries that may be competitively disadvantaged by local carbon taxes (relative to overseas peers that may not have to pay carbon taxes) and reduce those allowances over time.

Once carbon taxes are high enough, the polluting facilities may be economically motivated to curb GHG emissions, especially if the cost of mitigating emissions is lower than the rising cost of the carbon taxes. Carbon tax revenues collected by governments can either be placed in their consolidated funds or be earmarked for specific domestic carbon mitigation and climate adaptation efforts.

Indirect carbon taxes include excise duties on fuel, which are charged against the volume of fuel sold, and are indirectly linked to CO2e emissions per se. Fuel subsidies represent a negative indirect carbon tax, which encourages the use of more fuel and hence greater emissions. Even if governments do not impose an explicit carbon tax, the act of removing fuel subsidies or increasing the excise duties may have the same beneficial effect of reducing emissions.

4. Compliance carbon markets (CCM)

Governments can also use the mechanism of CCMs to achieve the goal of reducing domestic emissions. There are two types of CCMs:

- Cap-and-trade (CAT) schemes, and
- Baseline-and-credit (BAC) schemes.

The essence of both schemes is for governments to reduce the total emissions for the targeted industries over a period of time, either by tightening the emissions cap or by reducing the baseline.

CAT schemes set a fixed emissions cap, which is distributed as allowances to polluting entities. These allowances can either be distributed by governments for free, be sold via auctions, or a mix of both. Entities need to surrender one allowance for each tonne of CO2e emitted. Entities that emit less than free allowances distributed to them can sell their excess allowances to other entities that emit more than the free allowances that they have been given, which is the ‘trade’ part of the CATs. If the latter entities still do not have enough allowances to surrender back to the government, then they will have to buy additional allowances from government auctions. If there are still not enough allowances available, then the entities in question will have to curtail their emissions in the short term by reducing their plant utilisation rates, or in the long term by investing in energy-saving or emissions-reducing devices.

BAC schemes set a certain baseline of emissions for each polluting entity using, for example, emissions intensity standards. Entities that emit less than the baseline are awarded emissions credits that can be traded with entities that need additional credits to offset their emissions that are above the baseline. If there are insufficient credits in the secondary market, the latter entities may tap on the voluntary carbon credit markets for additional credits. Some BACs do not require entities that emit above their baselines to completely offset their excess emissions, focusing instead on rewarding the outperforming entities. BAC schemes do not have a fixed emissions cap; by focusing on emissions intensity benchmarks, absolute emissions may still increase if industrial output increases.

5. Voluntary carbon markets (VCM)

VCMs can help companies (or countries) to offset, though not reduce, their carbon emissions. A project developer can invest in a certain emissions reduction project, e.g. a reforestation project, a renewable energy project, or a clean cookstove project, and sell the resulting carbon credits to domestic or international corporate or institutional buyers that are keen to offset their own emissions.

The demand for voluntary carbon credits typically comes from private companies that are interested to demonstrate commitment towards their publicly-declared climate goals (such as carbon neutral or net zero targets), especially for hard-to-mitigate emissions, or emissions that do not have a viable pathway to abatement due to the absence of an immediately-available technological solution.

VCMs can also help countries achieve their NDCs; credits sold to and retired by domestic buyers can be counted towards reducing a country's net emissions, while credits sold to and retired by international buyers count towards offsetting the buyer country's net emissions.

Demand for voluntary carbon credits (VCC) can also arise from the linkage between certain carbon tax or CCM regimes with VCMs. For instance, governments may permit polluting entities to use domestic and/or international voluntary carbon credits to offset a part of their domestic carbon tax obligations or as an alternative to buying government-issued carbon allowances. However, the World Bank noted that CCM-origin demand for VCCs is generally low, with VCC demand largely centred on private and corporate demand.

As a result of the voluntary nature of demand, VCC prices tend to be low. VCC supply is heterogenous and of varying quality and vintages. Quality issues abound and only VCCs that have been audited by strict standards can command better prices.

Market-based measures may be the most cost-efficient way of reducing emissions

CCMs and VCMs are market-based measures, because they specifically involve the trading of pollution allowances or carbon credits. They are superior to direct government regulation in the sense that the market is given a free hand to determine the lowest-cost pathway to abatement.

For example, if the price of CAT carbon allowances is higher than the cost of abatement for Company A, Company A will invest to mitigate its GHG emissions and sell the excess CAT allowances to Company B. Company B agrees to buy the CAT allowances to cover its excess emissions because the cost of the CAT allowances is lower than the abatement cost for Company B. This means that Company A undertakes emissions abatement first, as it is the cheaper pathway.

In the case of direct regulation, governments are unlikely to have full and perfect information about the cost of abatement for different companies and industries, and hence, may fail to reduce total GHG emissions at the lowest-possible cost.

Regardless of whether direct regulation, carbon taxes or carbon markets measures are used, all these are only as a means to an end; the desired end result is the mitigation of emissions so that the PA goals can be met.

Figure 11: The matrix of carbon mitigation measures

	COMPLIANCE ABATEMENT MEASURES	VOLUNTARY ABATEMENT MEASURES
NON MARKET-BASED MEASURES	Direct regulation Carbon tax	Internal efforts to mitigate emissions from own operations
MARKET-BASED MEASURES	Compliance carbon markets	Voluntary carbon markets

SOURCE: CGS-CIMB RESEARCH

Figure 12: The features of CCMs and VCMs

	Nature of credits	Liquidity	Market value potential	Market dynamics and regulations
Compliance markets (CCMs)	Credits obtained by regulated entities in order to meet predetermined regulatory targets Credits are mainly available under **cap-and-trade schemes from both primary and secondary markets**	Relatively **high liquidity** with direct relationship with volatile power, gas and coal prices	**Large market value** (e.g. ~$260bn in 2020 with ~$30bn from Europe and ~$25bn from North America)	**Highly regulated,** with robust monitoring, reporting and clear quality verification standards
Voluntary carbon markets (VCMs)	Credits voluntarily purchased by companies and individuals (purchased funds are used for project development) Credits are mainly available from **private project developers and OTC brokers**	**Low liquidity** with limited trading potential in secondary markets where most buyers surrender and use the credit	**Limited market value in current status with strong growth potential** (i.e. ~$300m in 2020, est. ~15x growth potential to reach $5bn–$180bn by 2030 depending on scenarios materialising)	**Fragmented and complex market with low to no regulation,** different accounting methodologies with varying degrees of rigor and a variety of industry-created standards

Compliance and voluntary carbon markets operate largely independently with limited overlaps existing within and across markets (eg certain compliance markets allow the use of a small % of voluntary credits to meet compliance targets)

SOURCES: GIC, EDB SINGAPORE, MCKINSEY & COMPANY

SECTION 4: CARBON TAXES

Carbon tax regimes around the world

Carbon taxes, which are expressed in terms of dollars per tonne of CO2e, have been implemented in North America (Canada, Mexico), in South America (Columbia, Argentina, Chile, Uruguay), in Europe (UK, France, Ireland, Spain, Portugal, Iceland, Netherlands, Denmark, Norway, Sweden, Finland, Poland, Ukraine, Latvia, Estonia), in Africa (South Africa), and in Asia (Singapore, Japan). Indonesia also plans to impose a carbon tax but has not implemented it yet.

We will selectively discuss several carbon tax regimes below.

Figure 13: Carbon tax regimes around the world – as at 1 September 2022

SOURCE: WORLD BANK

Japan carbon tax, officially known as the Tax for Climate Change Mitigation

Japan implemented its carbon tax in 2012, at a ¥289/tCO2e (US$2/tCO2e) charge against the CO2 content of all fossil fuels, imposed on producers of those fuels. The tax has a 75% coverage with some exemptions for the industry, power, agriculture and transport sectors. The World Bank estimated that 953 MtCO2 were subjected to the Japan carbon tax in 2018, amounting to 75% of Japan's GHG emissions.

South Africa carbon tax

The South Africa carbon tax came into effect in 2019, and taxes CO2 emissions from large businesses in the industry, power, and transport sectors at a rate of US$10/tCO2e in 2022. However, companies receive tax-free allowances that will offset a substantial portion of their emissions, resulting in a much lower effective carbon tax. Companies can also use domestic voluntary carbon credits to offset up to 10% of their emissions. According to the World Bank, the government is considering raising the carbon tax rate by at least US$1/tCO2e p.a. to reach US$20/tCO2e by 2026, at least US$30/tCO2e by 2030, and up to US$120/tCO2e beyond 2050. The South Africa carbon tax imposes a price on carbon on about 460 MtCO2e (using 2018 numbers), according to the World Bank, representing some 80% of its CO2e emissions.

UK carbon tax, officially known as the UK Carbon Price Support

The UK carbon tax was implemented in 2013, and covers the combustion of fossil fuels in the power sector. Despite the overlap with the EU ETS, UK carbon tax was introduced because the EU allowance price had not been high enough to encourage sufficient investment in low-carbon electricity generation in the UK. A carbon price of £18/tCO2e (US$21/tCO2e) was imposed from 2016 and will remain until March 2024, or until unabated coal-fired power generation is phased out by the promised date of October 2024, according to the UK government. The UK carbon tax covered 97 MtCO2e of emissions in 2018, representing about 21% of its CO2e emissions.

Singapore carbon tax

The Singapore carbon tax was implemented from 1 January 2019 on all facilities with annual direct GHG emissions of 25 ktCO2e or more, with no exemptions; these include power stations and other industrial installations. This is in addition to the excise duties that have traditionally been levied on transportation fuels.

The current and proposed carbon tax rates are as follows:

- 2019-2023 (five years): S$5/tCO2e (~US$4)
- 2024-2025 (two years): S$25/tCO2e (US$18)
- 2026-2027 (two years): S$45/tCO2e (US$32)
- 2028-2030 (three years): To be progressively increased to a range of between S$50/tCO2e and S$80/tCO2e (US$36-57)

Currently, companies subject to the tax are not allowed to use carbon credits to offset their tax liabilities, but this will change from 2024 onwards, when companies will have the option of offsetting 5% of their carbon tax liabilities by buying international carbon credits. We expect companies to use carbon offsets if they are cheaper than the rate of carbon tax.

The Singapore government is currently engaging with companies that will be affected by the proposed hike in carbon tax in 2024, and may introduce a ‘transition framework’ that will see existing emissions-intensive trade-exposed (EITE) companies (that are subject to carbon leakage) receive ‘transitory allowances’ based on efficiency standards and decarbonisation targets. However, new investments will not qualify for the transition framework.

The Singapore carbon tax imposes a price on carbon, i.e. on about 57 MtCO2e (using 2018 numbers), according to the World Bank. About 80% of Singapore’s GHG emissions will be covered by the carbon tax.

Indonesia’s proposed carbon tax

In October 2021, Indonesia set out its Carbon Pricing Roadmap, which aims to set up an ETS and carbon crediting mechanism, and also introduce a carbon tax.

Initially, the carbon tax rate will be at Rp30,000/tCO2e (US$2), and will be charged against emissions of coal-fired power plants above a certain limit. The carbon tax may be expanded to other sectors in 2025.

The carbon tax was initially set to commence in April 2022, but was pushed back to July 2022 due to the rise in oil prices after the Russia-Ukraine war started in February 2022, and then delayed again to a future unspecified start date, although the Indonesian government had said that it wants the carbon tax to be in place before the G20 summit in Bali on 15-16 November 2022.

In the longer term, the tax may operate alongside a mandatory ETS for coal-fired power plants, under a hybrid “cap-and-trade-and-tax” system, whereby facilities that exceed their emissions cap will have the option to compensate the excess emissions through three options, i.e. the trading of carbon allowances, offsetting via voluntary carbon credits, or by simply paying the applicable carbon tax.

The proposed Indonesian carbon tax imposes a price on carbon, i.e. on about 279 MtCO2e (using 2018 numbers), according to the World Bank. About 26% of Indonesia’s GHG emissions will be covered by the carbon tax.

A future carbon tax in Malaysia?

In September 2021, Malaysia mooted the introduction of a carbon tax, however, no details have emerged yet.

Figure 14: Carbon tax rates have risen in the past few years, and are scheduled to rise further

SOURCE: WORLD BANK

NOTES: Dotted line indicates scheduled price increases for those jurisdictions that have communicated future price trajectories.

*Estimated path based on the government's ambition to increase the tax rate by at least US$1/year, and to increase the rate more rapidly from 2026 to reach US$30/tCO2e in 2030 and US$120/tCO2e beyond 2050.

**This is a low range projection as the Singapore government plans to reach a carbon tax rate of S$50-80/tCO2e (US$36-58/tCO2e) by 2030.

***British Columbia has committed to meeting or exceeding the federal benchmark carbon price.

International carbon taxes are on the radar

Carbon tax regimes are generally imposed on emissions from domestic fixed installations, such as power plants or industrial facilities only, most commonly on the emissions from the combustion of fossil fuels within the borders of the countries.

However, international carbon taxes are already being proposed:

1. The EU's proposed Carbon Border Adjustment Mechanism (CBAM) aims to impose carbon taxes across borders, and
2. The UN's International Maritime Organization (IMO) is considering proposals by various parties to impose carbon taxes on international pollution, i.e. a proposed carbon tax on marine fuels.

The EU's proposed CBAM envisions a carbon tax to be charged against imported high-emissions products manufactured in non-EU countries in which carbon taxes or CCMs either do not exist, or are imposed at rates lower than the EU equivalents. The CBAM will initially apply only to a limited set of sectors deemed at high risk of carbon leakage, i.e. iron and steel, cement, fertiliser, aluminium and electricity generation. The CBAM is meant to ensure equal treatment for those products made in the EU and imports from elsewhere. Once the CBAM takes effect from 2026, importers of those goods into the EU will have to buy carbon certificates to cover the embedded emissions in the imported products, at a price that is equivalent to the prevailing weekly average EU ETS allowance (EUA) auction price.

On the shipping side, in mid-2021, shipping company Maersk proposed to impose a global carbon tax of US$150/tCO2, while the Marshall Islands delegation to the IMO had proposed a US$100/tCO2 tax on marine fuels effective 2025.

The Getting to Zero Coalition, which is an industry group led by think-tank Global Maritime Forum, released a study in January 2022 that concluded the following:

- In order to achieve 50% GHG emissions reduction by 2050 compared to 2008, a marine fuel carbon tax should start at US$11/tCO2 if introduced in 2025, rise to US$100/tCO2 in the early-2030s (at which point emissions start to decline), and rise above US$250/tCO2 in the 2040s, for an average of US$173/tCO2.
- In order to achieve 100% GHG emissions reduction by 2050 compared to 2008, a marine fuel carbon tax should rise above US$360/tCO2 in the mid-2040s, for an average of US$191/tCO2.

So far, the IMO has not made any decision on the imposition of carbon taxes on marine fuels.

SECTION 5: COMPLIANCE CARBON MARKETS (CCM)

What are CCMs?

Compliance carbon markets (CCM) are tied to regulatory regimes that seek to control or reduce the volume of GHG emissions. There are two types of CCMs:

- Cap-and-trade (CAT), and
- Baseline-and-credit (BAC) schemes.

CCMs are also called Emissions Trading Systems (ETS).

According to the International Carbon Action Partnership (ICAP), at end-2021, ETSs covered 17% of global GHG emissions.

For jurisdictions that have enshrined their net-zero targets in law, their respective ETSs cover 37% of their emissions on average; while for jurisdictions where net-zero targets are under development or discussion, their respective ETSs cover 17% of emissions.

Cap-and-trade (CAT) schemes

For CAT schemes, governments first determine the maximum permitted emissions over a period of time, via a fixed emissions cap for the various industries subject to the scheme; this is a top-down decision. The cap usually falls annually, based on the governments' climate goals.

Polluting entities within a specific industry are allocated free allowances (permits to pollute) based on a targeted emissions intensity benchmark for the industry, i.e. emissions per unit of output. One allowance unit typically allows the holder of the unit to emit 1 tonne of CO2e.

Governments allocate free allowances to some industries and installations to give them the time to adjust to the CAT or time to invest in carbon mitigation, and also because some industries are at risk of carbon leakage. The latter means that the burden of having to bear the cost of carbon allowances may force certain industries to leave the region with the CAT regime and set up somewhere else that does not have a CAT regime; thus merely transferring the pollution from one regulated region to another unregulated region.

Some installations may be allocated more free allowances than they actually need to cover their pollution levels because they emit less GHG per unit of output volume than the benchmark, while other installations may be allocated fewer free allowances than their absolute GHG emissions, due to the nature or design of the plant, or perhaps due to the plants' age or inefficiencies. Under these circumstances, the more-efficient installations can sell their excess free allowances to the less-efficient installations. This is the 'trade' part of the CAT scheme.

Entities that pollute more heavily than the free allowances given to them under CAT schemes will be penalised by being required to buy additional allowances (permits to pollute), either via government auctions or from other entities.

The cost of the allowances penalises the heavy polluters (and rewards the less-polluting installations) and may incentivise their efforts to reduce their emissions, if the price of the allowances is higher than the cost of investing to mitigate the emissions. If the volume of free allowances available for sale and purchase between installations is less than what the economy as a whole requires to cover its GHG emissions, then the specific installations that are short of allowances will have to buy them from the government directly, perhaps via auctions, or from the secondary market from financial intermediaries. If the volume of allowances available for purchase via government auction is still insufficient to cover the residual emissions, then the affected installations may have to throttle their output in order to cap their individual emission levels, or else risk financial penalties.

Governments can incentivise emissions reduction in two ways:

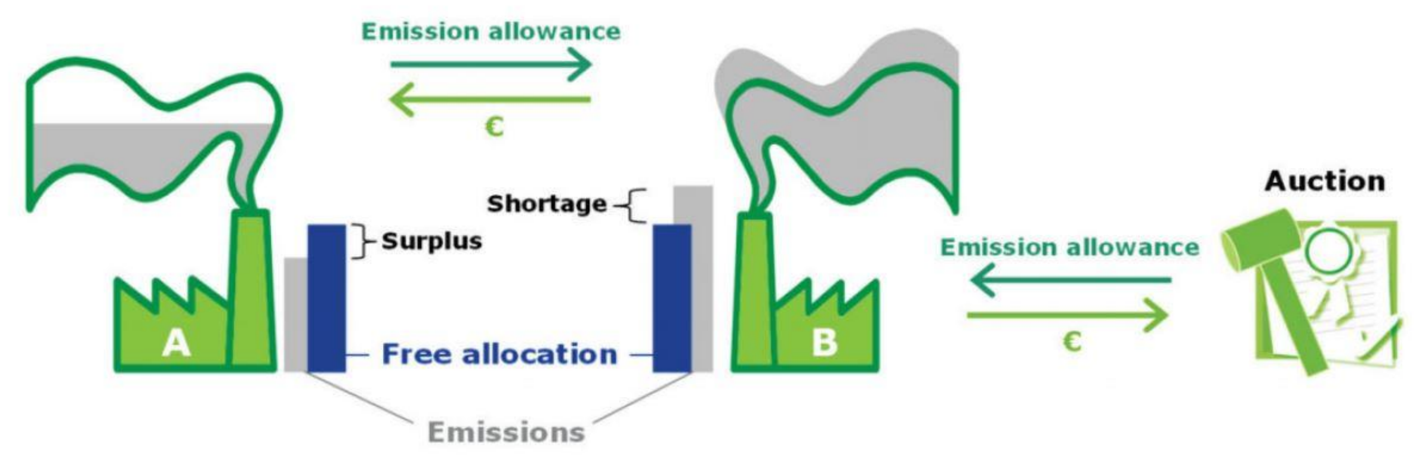
- First, by gradually reducing the volume of allowances issued over time, as noted earlier; and
- Second, by reducing the proportion of free allowances issued, irrespective of whether the total volume of issued allowances is reduced or not.

Even without any change in the volume of allowances issued, a lowering of the proportion of free allowances issued simply means that polluting industries will have to pay up for a larger proportion of their pollution than otherwise, increasing the financial burden on them, and potentially incentivising investments towards emissions mitigation. For instance, if the government issues 98% of its carbon allowances free, then only 2% of allowances will need to be paid for by the participants of the CAT scheme as a whole; but this rises to 10% if 'only' 90% of carbon allowances are issued free. Some industries and installations may not be given any free allowances at all, which forces an accelerated transition to low emissions. Ultimately, in the long term, there should be no carbon allowances issued free to any installation or industry in order to hasten the global move to net zero.

Because CAT schemes set maximum emissions caps, governments have visibility on the pollution levels. The price of the traded allowances fluctuates based on demand and supply. There will be greater demand if emissions increase, and lower supply if governments set a lower emissions cap.

An example of a CAT scheme is the EU Emissions Trading System (ETS).

Figure 15: The EU ETS is an example of a cap-and-trade (CAT) scheme



SOURCE: EUROPEAN UNION (EU)

The price of CAT allowances

The demand for carbon allowances is based on the level of pollution by the installations that are part of the CAT scheme. Governments can increase the demand for allowances by including more industries and installations into the CAT scheme.

The demand for CAT allowances depends on how successfully an economy mitigates its GHG emissions. The power sector's greater use of natural gas for electricity generation, for instance, can reduce the demand for CAT allowances because the combustion of natural gas releases less GHGs. The converse is true if the power sector switches to the use of more coal. The demand for allowances is also affected by the economic cycle, as a downturn that causes a reduction in economic output naturally results in lower emissions and reduces the demand for allowances.

The total supply of allowances is based on what the government sets as its top-down emissions cap for the period. A tighter emissions cap means less allowances as a whole relative to the emission levels of the CAT participants. The government may increase the supply of allowances on a one-off basis when it includes new industries into the CAT scheme, and then gradually reduce the supply of allowances over time as it increases its climate ambitions.

The supply of carbon allowances is controlled entirely by government decisions, and has a large impact on CAT allowance prices. If a government allocates more allowances than the industry needs to cover its GHG emissions, then the aggregate excess supply of allowances will cause allowance prices to fall or remain low. However, if the supply of CAT allowances is tightened in the future, allowance prices may rise, all else being equal. Therefore, the price of CCM allowances is driven by governments' decarbonisation policy and political will to a large extent.

The balance of demand for and supply of carbon allowances ultimately determines the price of the free allowances when they are traded between entities, and the price of the allowances that are purchased directly from the government via auction.

As the supply of CAT allowances is tightened by the government over time, the price of those allowances may rise above the cost of mitigation. This gives industries the financial motivation to make progress on their mitigation strategies, which may result in less future demand for allowances.

Hence, the long-term price trajectory of CAT allowances depends on the relative speed of the progressively shrinking supply of allowances, and the also-shrinking demand for allowances assuming that industry makes progress on the decarbonisation of their operations.

Whatever happens to CAT allowance prices, what is clear is that a successful CAT scheme will lead to fewer and fewer allowances issued and traded over time, which reflects falling levels of GHG emissions.

The key benefit of CAT schemes from the perspective of regulators and governments, is that there is visibility on total emissions, which is represented by the number of allowances issued. As the government's climate ambitions increase, the supply of allowances can be reduced, which directly reduces the volume of emissions, and the supply of free allowances as a proportion of total allowances can also be reduced, which increases the financial incentive for the polluters to mitigate their GHG emissions.

The uncertainty from the government's perspective, is how much it can collect as revenue from the sale or auction of allowances, because the price of allowances is not fixed and is permitted to fluctuate based on market demand and supply.

Baseline-and-credit (BAC) schemes

In BAC schemes, polluting entities are given a baseline of pollution that they are allowed to emit, which may be set in terms of GHG intensity metrics. GHG intensity metrics are calculated based on the level of pollution in relation to the industry's output; for instance, GHG emissions per tonne of steel production, or GHG emissions per KWh of electricity generated. The baseline may also be set in terms of projected future emissions under 'business as usual' (BAU) scenarios, which incorporate rising emissions due to increased economic activity.

Governments do not set caps or absolute/maximum levels of permitted emissions for the various industries under BACs. Under BAC schemes, entities that pollute less than the benchmark will generate credits that can be sold to other entities that need those credits to meet regulatory requirements. Entities that pollute more than the benchmark may or may not be required by governments to buy credits.

An example of a BAC scheme is the China national ETS.

For numerical illustrations on how hypothetical CAT and BAC schemes may work, please refer to Appendix 2.

A detailed description of the EU ETS is in Appendix 3.

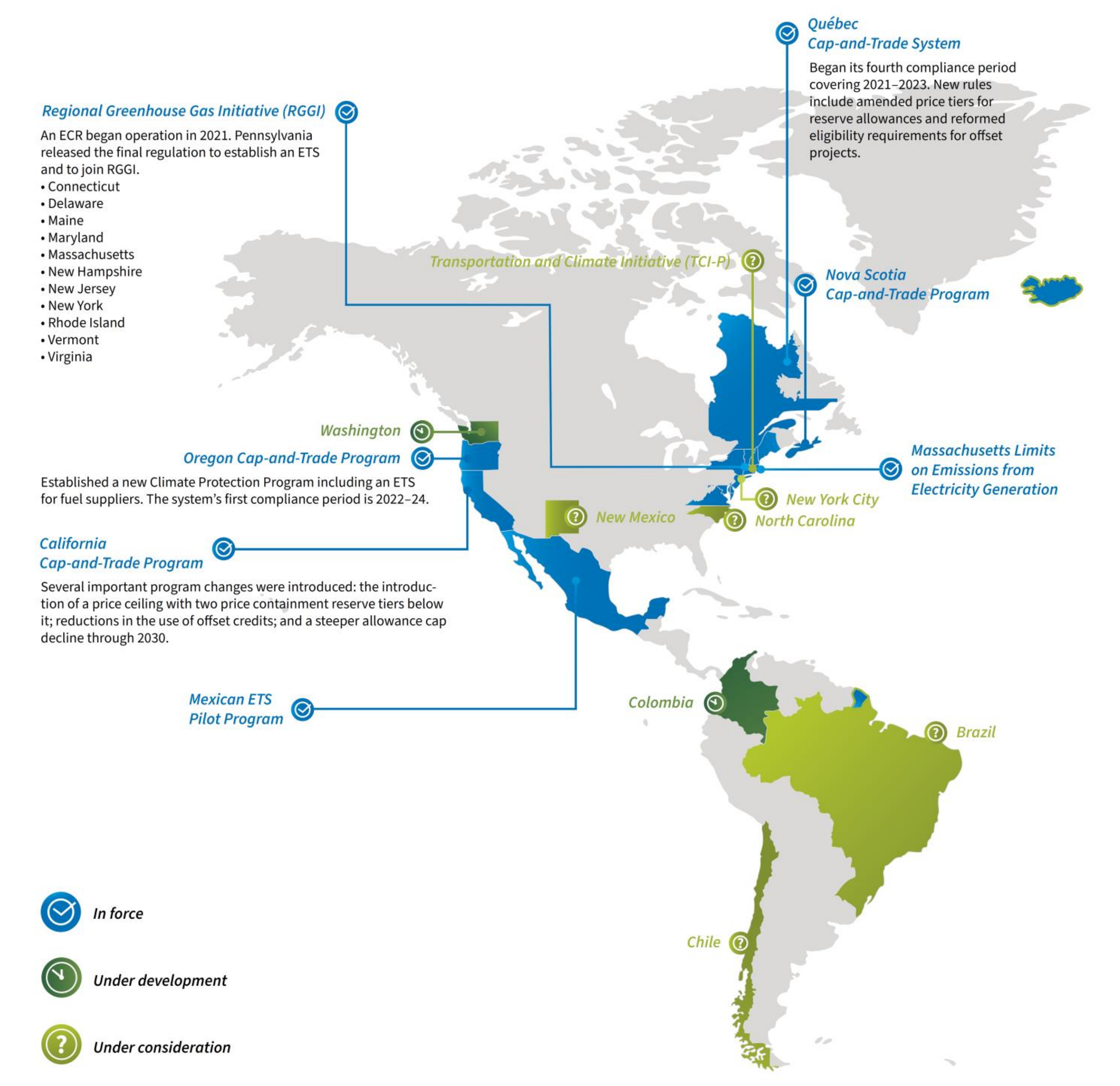
Appendix 4 describes the major features of the China ETS.

The geographical spread of CCMs

CCMs have been implemented in the EU (including Iceland, Lichtenstein, and Norway), Switzerland, the UK (post-Brexit), Mexico (under a pilot programme), Kazakhstan, China (national ETS, plus regional pilot schemes), South Korea, New Zealand, parts of the US (state of California and Oregon, and the Regional Greenhouse Gas Initiative, or RGGI, in the US East Coast), parts of Canada (Quebec and Nova Scotia), and parts of Japan (Tokyo and Saitama).

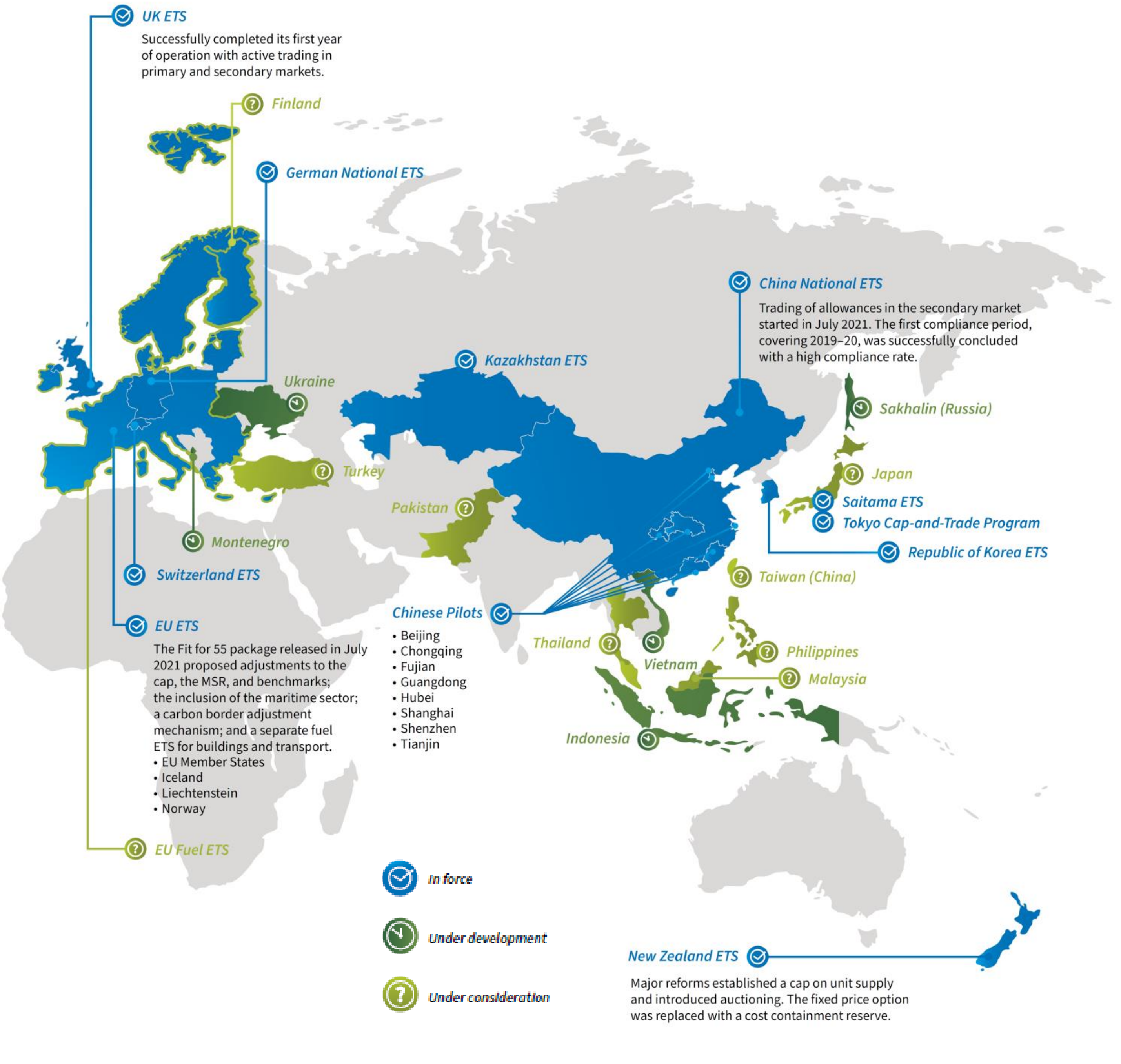
CCMs are under development in Columbia, Indonesia, Vietnam, and in the US state of Washington. Meanwhile, CCMs are under consideration in Brazil, Chile, Turkey, Pakistan, Thailand, Malaysia, the Philippines, for Japan as a whole, and in parts of the US, i.e. New Mexico, New York City, North Carolina, and with respect to the Transportation and Climate Initiative (TCI), which is a regional collaboration of 13 US Northeastern and Mid-Atlantic states.

Figure 16: Emissions trading systems (ETS) in North and South America – as at 1 September 2022



SOURCE: INTERNATIONAL CARBON ACTION PARTNERSHIP (ICAP)

Figure 17: Emissions trading systems (ETS) in Europe, Asia, and Southwest Pacific – as at 1 September 2022

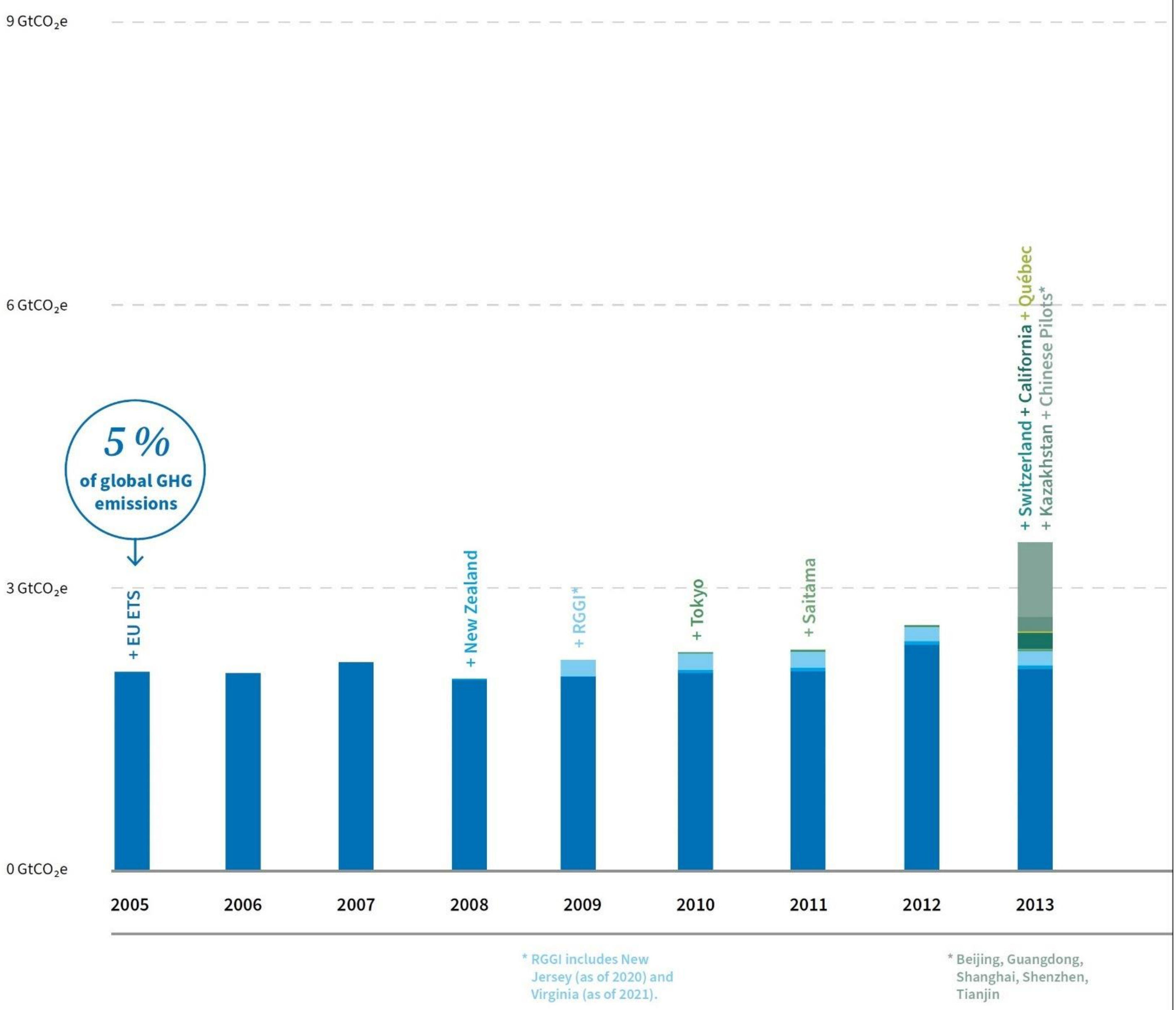


SOURCE: INTERNATIONAL CARBON ACTION PARTNERSHIP (ICAP)

Figure 18: The global ETS market started in 2005 with the launch of the EU ETS, covering 5% of global GHG emissions; the Regional Greenhouse Gas Initiative (RGGI) in the US East Coast started in 2009; California, Kazakhstan and the Chinese ETS pilots (Beijing, Tianjin, Shanghai, Guangdong, and Shenzhen) started from 2013

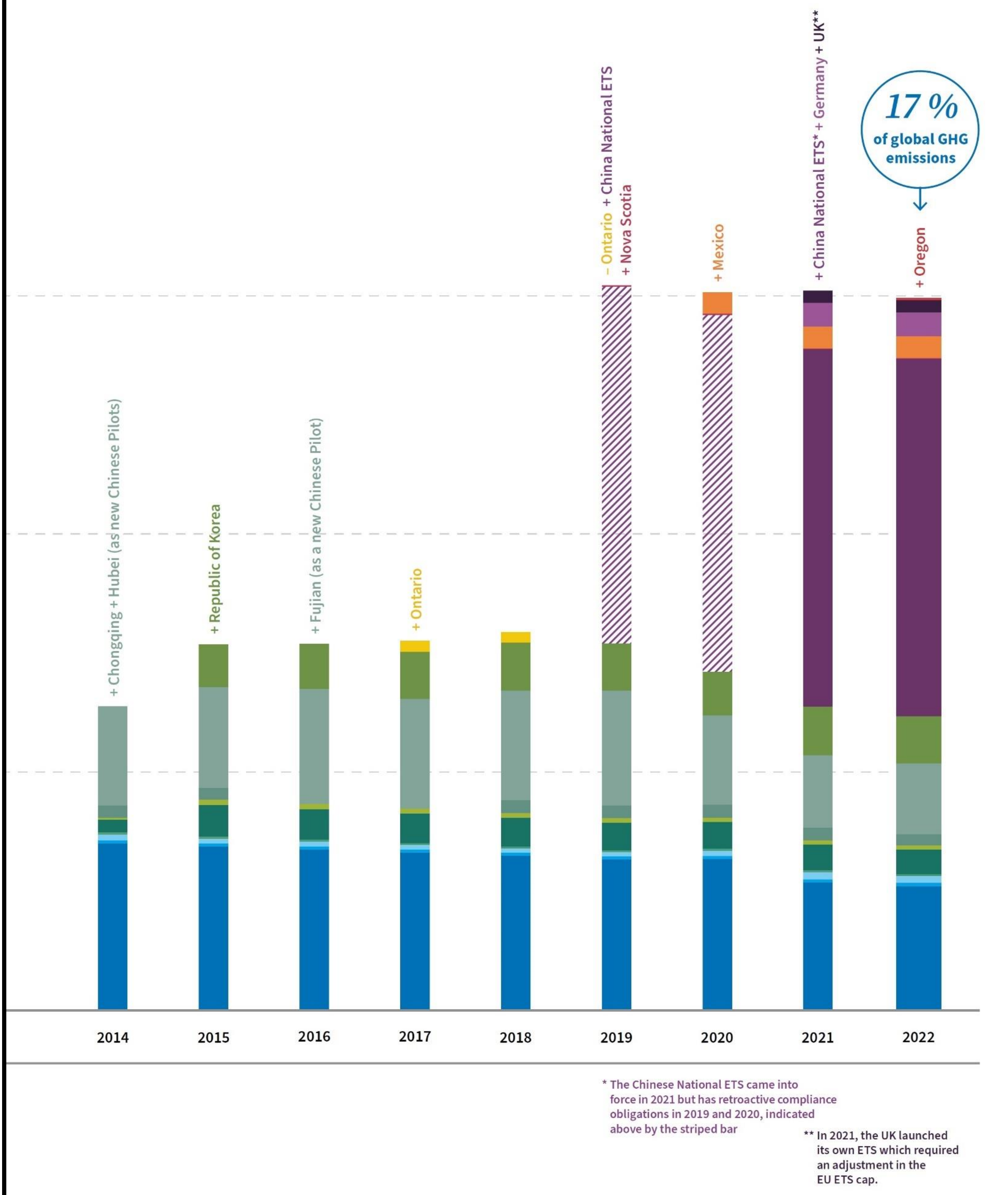
The share of global GHG emissions under an ETS tripled since 2005

The graphic depicts the worldwide growth of emissions trading over time. Systems are spreading around the world. With a new addition this year in Oregon, the share of global GHG emissions covered by emissions trading has reached 17 %, more than triple the amount when the EU ETS was launched in 2005. Changes over time are driven by the addition of new sectors and systems, as well as by the counter-acting trends of declining caps in many systems and growing global emissions.



SOURCE: INTERNATIONAL CARBON ACTION PARTNERSHIP (ICAP)

Figure 19: The Chongqing and Hubei Chinese ETS pilots started in 2014; South Korea's entry was in 2015; while China's national ETS officially commenced in 2021, compliance requirements were backdated to 2019; Mexico entered in 2020; the UK ETS started in 2021 with a corresponding reduction in the coverage of the EU ETS; in 2022, 17% of global GHG emissions are covered by a CCM or ETS regime

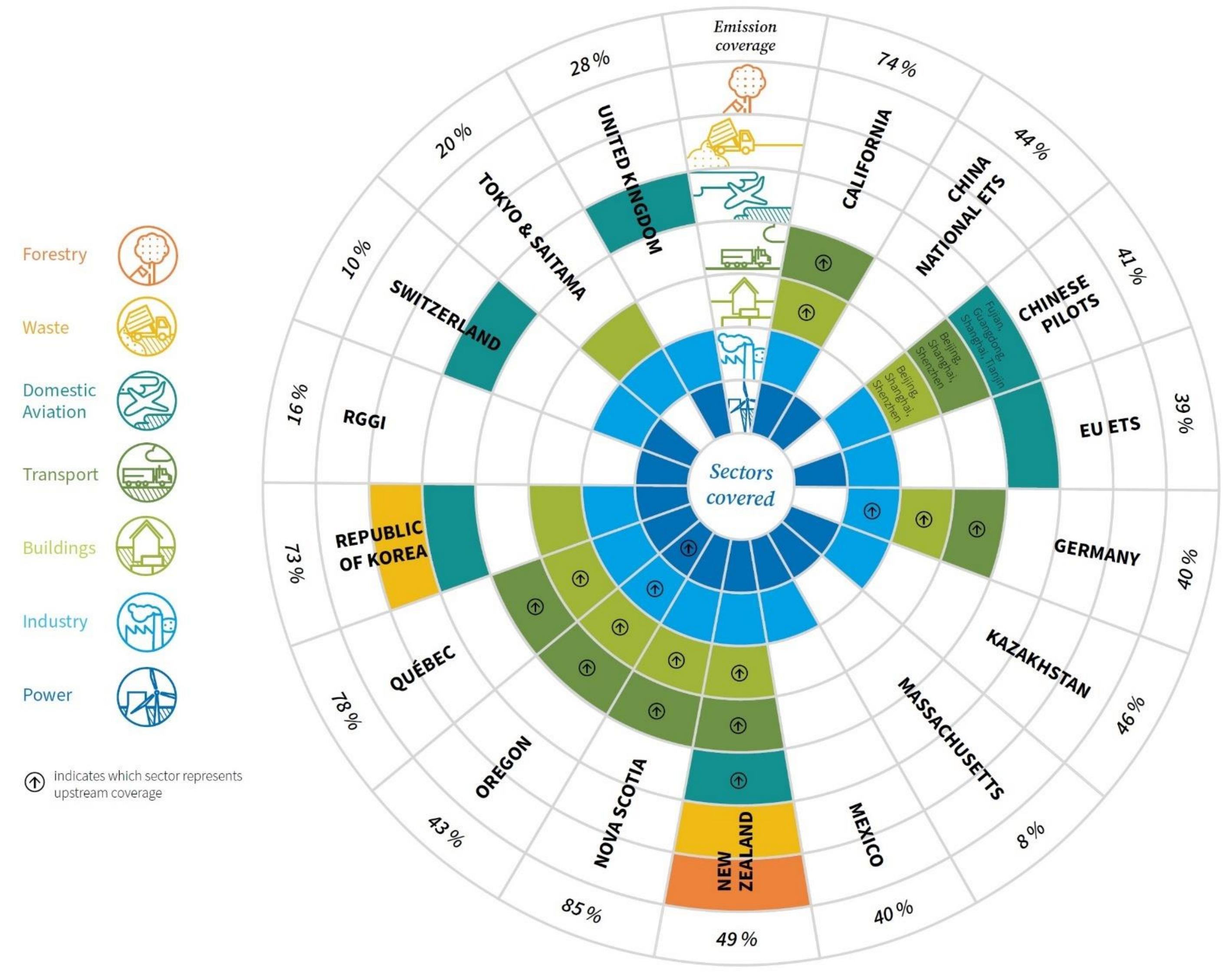


SOURCE: INTERNATIONAL CARBON ACTION PARTNERSHIP (ICAP)

Overview of global ETS regimes

Using data from ICAP, we list down here the ETS regimes currently operating today, and their relative size in terms of their emissions caps.

Figure 20: A majority of ETSs cover emissions from the power and industrial sectors, with a handful of ETSs covering emissions from the buildings, land transport and domestic aviation sectors; most of the existing ETSs cover GHG emissions, except for the China national ETS and the RGGI which cover only CO2 emissions – as at 1 September 2022



SOURCE: INTERNATIONAL CARBON ACTION PARTNERSHIP (ICAP)

Figure 21: Selected Emissions Trading Systems (ETS) currently operating, sorted by size of emissions cap (not exhaustive) – as at 1 September 2022

No	Region or country	Emissions cap (m tonnes)	Emissions cap year	CO2 / CO2e	<---------- Coverage						---------->
		m tonnes			Power	Industry	Buildings	Transport	Aviation (domestic)	Waste	Forestry
1	**China**	**5,426.9**									
	(a) China's regional pilot ETSs	**926.9**									
	- Beijing pilot ETS	35.0	2021	CO2	❶	√	√	√			
	- Tianjin pilot ETS	120.0	2020	CO2	❶	√			√		
	- Shanghai pilot ETS	105.0	2020	CO2	❶	√	√	√	√		
	- Guangdong pilot ETS	265.0	2021	CO2	❶	√			√		
	- Shenzhen pilot ETS	31.5	2015	CO2	❶	√	√	√			
	- Hubei pilot ETS	166.0	2020	CO2	❶	√					
	- Chongqing pilot ETS	78.4	2020	CO2e	❶	√					
	- Fujian pilot ETS	126.0	2020	CO2	❶	√			√		
	(b) China national ETS	**4,500.0**	2020	CO2	√						
	Note: ❶ Power emissions originally covered until transfer to China's national ETS effective 1 January 2021										
2	**Europe**	**2,054.9**									
	(a) EU ETS	1,596.5	2021	CO2e	√	√			√		
	- Stationary installations	1,572.0	2021	CO2e	√	√					
	- Aviation	24.5	2021	CO2e					√		
	(b) Germany ETS	301.0	2021	CO2			√	√			
	(c) United Kingdom ETS	151.4	2022	CO2	√	√			√		
	(d) Switzerland ETS	6.0	2020 / 2021	CO2e	√	√			√		
3	South Korea ETS	589.0	2022	CO2	√	√	√		√	√	
4	**USA**	**431.5**									
	(a) California Cap-and-Trade	307.5	2022	CO2	√	√	√	√			
	(b) Regional Greenhouse Gas Initiative (RGGI) ETS - 11 member states in Northeast USA	88.0	2022	CO2e	√						
	(c) Oregon ETS	28.0	2022	CO2e	√	√	√	√			
	(d) Massachusetts ETS	8.0	2022	CO2	√						
5	Mexico ETS	273.1	2021	CO2	√	√					
6	Kazakhstan ETS	140.3	2022	CO2	√	√					
7	**Canada regional ETSs**	**66.1**	2022	CO2e							
	- Quebec Cap-and-Trade	54.0	2022	CO2e	√	√	√	√			
	- Nova Scotia Cap-and-Trade	12.1	2022	CO2e	√	√	√	√			
8	New Zealand ETS	34.5	2022	CO2e	√	√	√	√	√	√	√
9	**Japan regional ETSs**	**19.4**	2019	CO2							
	- Tokyo Cap-and-Trade	12.1	2019	CO2		√	√				
	- Saitama ETS	7.3	2019	CO2		√	√				

SOURCE: INTERNATIONAL CARBON ACTION PARTNERSHIP (ICAP)

Carbon tax rates and ETS allowance prices globally

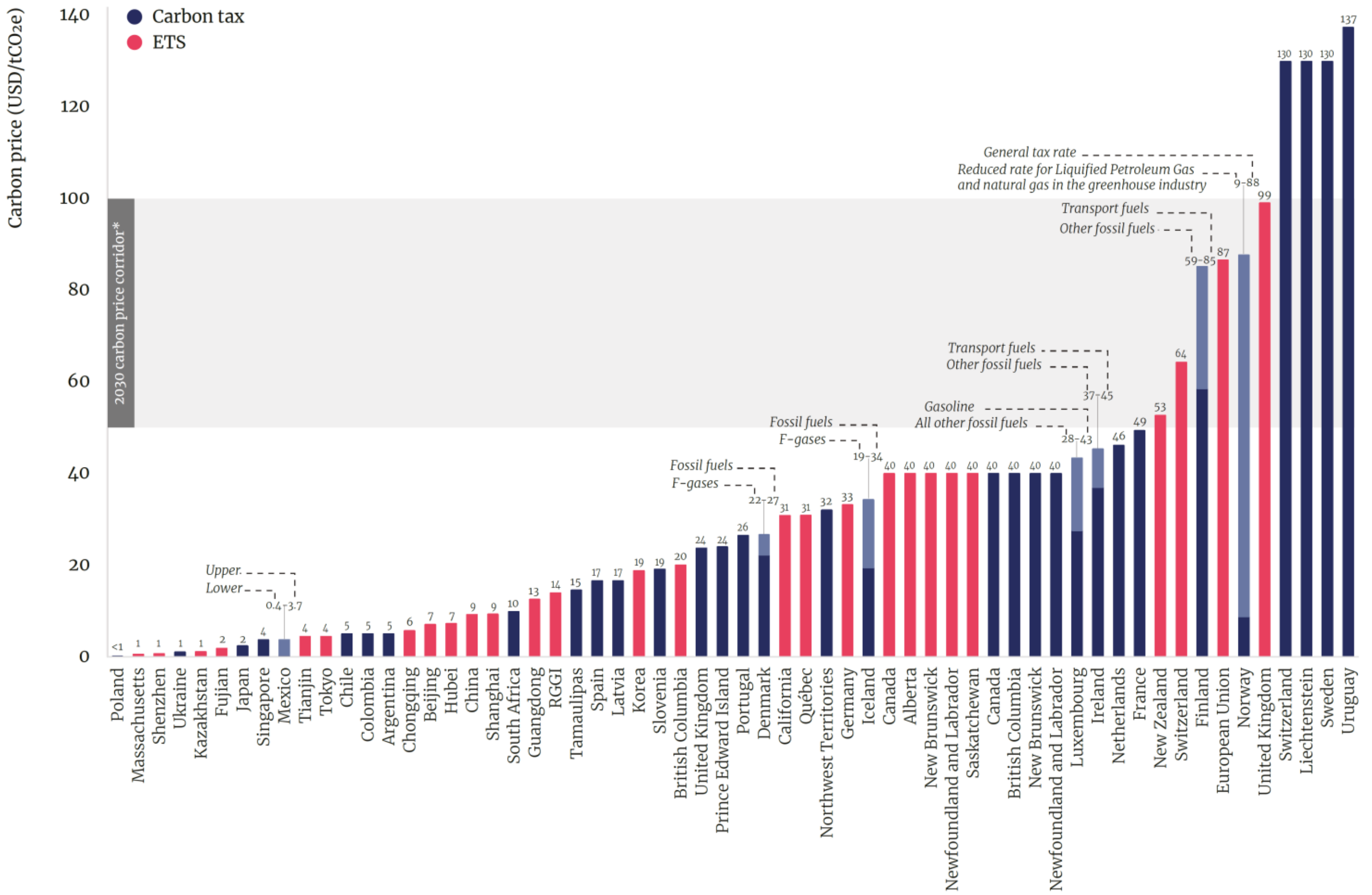
According to the World Bank, 23% of global GHG emissions were covered by a total of 68 carbon-pricing instruments globally as at May 2022, including carbon tax and ETS regimes in 46 national jurisdictions and 36 subnational jurisdictions.

However, only 4% of global GHG emissions are covered by a direct carbon price that is within the range needed by 2030 in order to achieve the PA goals. The ‘High-Level Commission on Carbon Prices’, which is part of the Carbon Pricing Leadership Coalition (CPLC), administered by the World Bank, estimated in 2017 that prices of carbon credits should have hit US$40-80/tCO2 by 2020 and should reach US$50-100/tCO2 by 2030, if the PA goals are to be reached.

The chart below shows that most jurisdictions which have implemented carbon tax or ETS regimes have carbon prices that are still below the US$50-100/tCO2 range, including major polluters such as China.

As of 1 April 2022, only the ETS regimes of the EU, the UK, Switzerland, and New Zealand, and the carbon tax regimes of Finland, Norway, Liechtenstein, Sweden, Switzerland and Uruguay have prices exceeding that range.

Figure 22: Carbon prices as at 1 April 2022; red bars show the prices of ETS allowances in different regimes, while the blue bars show the carbon tax price in different jurisdictions



Nominal prices on April 1, 2022 are shown for illustrative purpose only. Prices are not necessarily comparable between CPIs because of (for example) differences in the sectors covered and allocation methods applied, specific exemptions, and compensation methods.

*The 2030 carbon price corridor is based on the recommendations in the report of the High-Level Commission on Carbon Prices.

**Several jurisdictions apply different carbon tax rates to different sectors or fuels. In these cases, we have indicated the range of tax rates applied, with the dark blue shading showing the lower rate and the combined dark blue and light blue shading representing the higher rate.

SOURCE: WORLD BANK

SECTION 6: VOLUNTARY CARBON MARKETS (VCM)

What are VCMs?

Voluntary carbon markets (VCM) are markets where carbon credits are voluntarily generated, sold and purchased, unlike compliance carbon markets (CCM) which are set up via government directive and regulation.

Buyers

The buyers of voluntary carbon credits (VCC) may be voluntary buyers, or compliance buyers.

Corporates or entities with polluting facilities which are interested to voluntarily offset those GHG emissions may buy and retire the credits. Retiring credits means that the credits are offset against emissions, and hence the credits are cancelled and are never to be used again. Buyers of VCCs may be motivated by their internal desire and objective to achieve net zero targets on a voluntary basis. Oil and gas companies are at the forefront of buying VCCs, to be used as offsets against the emissions of the fossil fuels that they are selling. Shipping company Maersk has committed to reducing its emissions by 90%, and then to offset the remaining 10% by buying VCCs to achieve Net Zero 2050.

Some CCM-based entities may be subject to **regulatory regimes** in which they are permitted to use VCCs to offset carbon tax obligations or as an alternative to buying a CCM allowance to pollute. For instance, the China ETS and California CAT allow the use of domestic VCCs to meet up to 5% and 4% of their annual compliance market obligations, respectively. In Singapore, from 2024 onwards, entities subject to its carbon tax will be permitted to offset up to 5% of their taxable emissions via the purchase of international VCCs. According to the World Bank, the demand for VCCs from CCM-based buyers is low because most CCMs restrict the degree to which VCCs can be used, and most also limit their use to domestically-generated VCCs. Furthermore, the Swiss ETS and EU ETS had prohibited the use of VCCs from 2021 onwards.

Separately, **airlines** in countries that have signed up for the International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) will also have to enter the VCMs to source for CORSIA-eligible credits. This is another source of compliance-based demand for VCCs, although the demand for credits is currently very low because of the impact of the Covid-19 pandemic on global travel demand. We discuss CORSIA in greater detail in Section 8 below.

Finally, **governments** can also buy carbon credits for the purpose of incentivising climate change mitigation, or to meet national and NDC targets; this is called 'results-based finance'. Countries that buy VCCs from other countries under the Kyoto Protocol's Clean Development Mechanism (KP's CDM) or the PA's Article 6 Mechanism (A6M) can use those credits to reach their emissions reduction targets or achieve their NDCs.

Sellers

The sellers of VCCs would typically be project developers which set up carbon avoidance, reduction or removal projects. The revenues received from the sale of the VCCs would be used by the project developers to recoup their costs and perhaps earn a profit.

Project developers that want to issue carbon credits typically have to go through 'crediting mechanisms', which are essentially frameworks, standards and registries that have to vet through the projects to ensure compliance with the standards before permitting the issue of credits.

Credits for individual projects may be issued over a certain time period, and there are usually two options for project developers: either a fixed 10-year time horizon, or a 7-year horizon, renewable twice for a total of 21 years. Forestry-based projects typically have even longer time horizons of some 30 years, as trees take a longer time to grow. The issuance of VCCs from individual projects is time limited in order to redirect fresh funds from credit buyers to new VCM projects that are 'additional' to carbon abatement and mitigation.

Financial intermediaries

Financial intermediaries such as brokers, retailers, or banks and institutional investors may participate in VCMs by funding the initial set-up of the mitigation projects, securing the resulting VCCs from the project owners, and then reselling them to potential buyers.

Retail traders purchase large amounts of credits directly from the supplier, take ownership of those credits, bundle those credits into portfolios, and sell those bundles to the end buyers, typically with some commission.

Brokers remarket carbon credits to end buyers, usually with some commission.

Trading

Trading of VCCs is traditionally on over-the-counter (OTC) markets, due to the bespoke and custom-tailored requirements of the buyers. However, there is an increasing number of exchanges that have been set up to organise the sale of VCCs in standardised contracts, which group together credits of the same type (i.e. nature-based solutions, or technology-based solutions), of roughly the same vintage (the more recent the better), and of the same origin (local or international), all certified by a restricted group of standards.

In New York, Xpansiv CBL is one such exchange, while in Singapore, AirCarbon Exchange (ACX) plays a similar role. Climate Impact X (CIX) is also being set up in Singapore (by DBS Bank, Singapore Exchange, Standard Chartered and Temasek) to facilitate the trade of VCCs in standardised contracts without counterparty risk. However, the CIX also hosts an OTC platform with a "list of curated projects, ideal for corporate buyers and institutional investors looking to discover, browse and compare quality carbon credit", in a nod to the variability and uniqueness of individual projects in the VCM ecosystem. In Malaysia, Bursa Malaysia is in the process of setting up a carbon exchange.

Types of VCM projects

The two broad categories of VCM projects are carbon avoidance projects that avoid the release of GHG emissions, and carbon removal projects that actively remove GHG emissions from the atmosphere.

Examples of **carbon avoidance** projects include:

- Renewable energy (RE) developments (solar photovoltaic, wind, hydroelectricity dams) that are set up in place of projects that involve the combustion of fossil fuels (coal, oil, natural gas). Such RE projects avoid GHG emissions by replacing conventional power plants that may be set up in the absence of those RE projects.
- Avoided deforestation projects which 'save' existing forests from being cleared by providing economic assistance to communities that would otherwise be compelled to clear forests to support their livelihoods. This then avoids the release of GHG emissions when the trees that store carbon are preserved.
- Carbon capture and storage (CCS) projects which involve the use of technological solutions to capture CO2 and other GHG emissions that are emitted from combustion at industrial facilities, or the CO2 and CH4 gases that are released during the mining of coal, oil and gas.
- Bioenergy with carbon capture and storage (BECCS) projects that blend fossil fuels with renewable fuels like vegetable oils or used cooking oils (UCO) with the biofuels production process itself subject to CCS. Bioenergy is carbon neutral to the extent that renewable fuels are used, and avoids the release of GHG emissions because less fossil fuels are mined and combusted.

- Clean cookstove projects in developing countries that replace inefficient, wood-fired cookstoves with efficient gas-burning ones. These avoid emissions by reducing deforestation and by reducing the emission of pollutants from inefficient combustion of wood for cooking. Clean cookstove projects have social co-benefits in addition to environmental benefits, for instance by improving the lives of local women who no longer have to walk far distances on a daily basis to collect wood for cooking and who no longer have to endure heavy cooking fumes in the confines of their small homes.

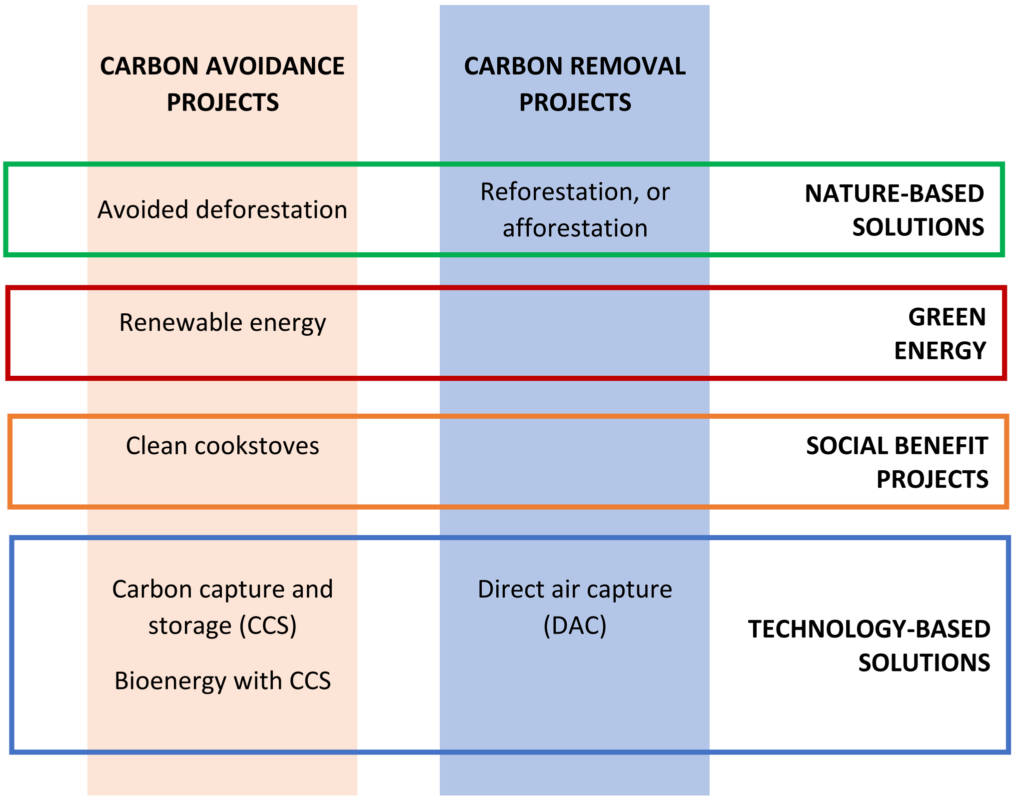
Examples of **carbon removal** projects include:

- Reforestation projects that plant trees in areas that previously had their forests cleared, or afforestation projects that plant trees in areas that previously had no tree cover. As the trees grow, CO2 is absorbed from the air and stored in the organic material. Reforestation and afforestation projects are long lead-time projects, which may require 2-3 years to activate the project, and 5-7 years before the first credits are issued, according to McKinsey.
- Direct air capture (DAC) projects that involve sucking the CO2 directly from the atmosphere and storing them underground in deep geological formations where the CO2 ultimately turns into rock.

Another way of classifying VCM projects is:

- **Green energy projects** – projects that involve RE,
- **Nature-based carbon solutions (NBS)** – projects that involve forests or land-use management,
- **Technology-based solutions** – these include CCS, BECCS and DAC projects, and
- **Social benefit projects** – these encompass projects that have social co-benefits in addition to environmental benefits, for instance clean cookstove projects that can improve the lives of women.

Figure 23: The matrix of voluntary carbon market crediting projects and solutions



SOURCE: CGS-CIMB RESEARCH

Who issues the voluntary carbon credits?

Crediting mechanisms are institutions that set out the requirements and quality standards that all VCM projects must follow in order to be certified, and before registering the projects under their wing.

Quality standards include factors such that the projects reduce one of the three GHGs (CO2, CH4 or N2O) and contribute to sustainable development goals, that the carbon mitigation must be 'additional', the removal must be permanent, there must not be any carbon leakage, and the credits must not be double counted. We will discuss these quality criteria in more detail shortly.

The supply of VCCs comes through three different categories of crediting mechanisms:

1. **International crediting mechanisms**, which were established under the UNFCCC, such as the KP's CDM, and in the future, the PA's A6M;
2. **Domestic crediting mechanisms**, such as the California Compliance Offset Program and the Australia Emissions Reduction Fund (as shown in the table and map below); and
3. **Independent crediting mechanisms**, which include standards managed by non-governmental entities, such as the Verified Carbon Standard (VCS, administered by Verra) and the Gold Standard.

International crediting mechanisms facilitate the transfer of credits from one country to another for the purposes of meeting voluntary NDC targets under the PA (or under the KP prior to the PA's A6M).

Domestic crediting mechanisms help companies that are subject to domestic ETSs or carbon taxes to reduce the cost of compliance; typically domestic credits are limited to use by domestic regulated entities only.

Independent crediting mechanisms facilitate both domestic and international transfers of credits.

Figure 24: VCCs issued in 2021 by the different crediting mechanisms, their registered activities, their average 2021 VCC prices, and sectors covered

Name of the mechanism	Credits issued ($MtCO_2e$)	Registered activities	Average price (USD)	Sectors covered
American Carbon Registry	8.8	18	11.4	Agriculture, Carbon capture and storage and Carbon capture and utilization, Energy efficiency, Forestry, Fuel switch, Industrial gases, Manufacturing, Renewable energy, Transport, Waste
Climate Action Reserve	4.8	44	2.1	Agriculture, Forestry, Industrial gases, Other land use, Waste
Gold Standard	43.8	51	3.9	Agriculture, Energy efficiency, Forestry, Fuel switch, Fugitive emissions, Renewable energy, Waste
Verified Carbon Standard	295.1	110	4.2	Agriculture, Energy efficiency, Forestry, Fuel switch, Fugitive emissions, Industrial gases, Manufacturing, Renewable energy, Transport, Waste
Plan Vivo	0.01	1	11.6	Agriculture, Forestry, Other land use, Blue carbon
Clean Development Mechanism	59.5	0	1.1	Carbon capture and storage and Carbon capture and utilization, Energy efficiency, Forestry, Fuel switch, Fugitive emissions, Industrial gases, Manufacturing, Renewable energy, Transport, Waste
Alberta Emission Offset System	0.4	33	32	Agriculture, Carbon capture and storage and Carbon capture and utilization, Energy efficiency, Forestry, Fugitive emissions, Industrial gases, Manufacturing, Renewable energy, Waste
Australia Emission Reduction Fund	17.1	142	11.9 - 12.7	Agriculture, Carbon capture and storage and Carbon capture and utilization, Energy efficiency, Forestry, Fuel switch, Fugitive emissions, Industrial gases, Manufacturing, Other land use, Renewable energy, Transport, Waste, Blue carbon
Beijing Forestry Offset Mechanism	-	0	8.9	Forestry
Beijing Parking Offset Crediting Mechanism	0.002	0	7.6	Transport
British Columbia Offset Program	-	0	N/A	Energy efficiency, Forestry, Fuel switch, Waste
California Compliance Offset Program	17.4	38	14.9	Agriculture, Forestry, Fugitive emissions, Industrial gases
China GHG Voluntary Emission Reduction Program	-	0	0.6 - 8.2	Energy efficiency, Forestry, Fuel switch, Renewable energy, Waste
Chongqing Crediting Mechanism	-	7	2.7 - 4.6	Energy efficiency, Forestry, Fuel switch, Renewable energy, Waste
Fujian Forestry Offset Crediting Mechanism	0.3	3	1.6 - 3.1	Forestry
Guangdong Pu Hui Offset Crediting Mechanism	0.3	20	3.5 - 6.6	Forestry, Renewable energy
J-Credit Scheme	0.9	44	13 - 20.8	Energy efficiency, Forestry, Fuel switch, Renewable energy, Waste
Kazakhstan Crediting Mechanism	0.1	3	N/A	Agriculture, Energy efficiency, Forestry, Fuel switch, Industrial gases, Manufacturing, Renewable energy, Transport, Waste
Québec Offset Crediting Mechanism	0.2	3	15.5	Industrial gases, Waste
Republic of Korea Offset Credit Mechanism	5.2	28	10.7 - 29	Energy efficiency, Industrial gases, Manufacturing, Renewable energy, Transport, Waste
RGGI CO2 Offset Mechanism	-	0	N/A	Renewable energy
Saitama Forest Absorption Certification System	0	15	N/A	Forestry
Saitama Target Setting Emissions Trading System	6.4	592	3.8	Energy efficiency
Spain FES-CO2 program	0.9	0	8.8	
Switzerland CO2 Attestations Crediting Mechanism	1.4	13	128.2	Energy efficiency, Forestry, Fuel switch, Renewable energy, Transport
Taiwan GHG Offset Management Program	12.4	20	N/A	
Thailand Voluntary Emission Reduction Program	3	32	N/A	Agriculture, Energy efficiency, Forestry, Renewable energy, Transport, Waste
Tokyo Cap-and-Trade Program	0.01	5	39 - 52.4	Energy efficiency, Renewable energy
Joint Crediting Mechanism	0.001	6	N/A	Energy efficiency, Renewable energy, Transport

Agriculture
Carbon capture and storage and Carbon capture and utilization
Energy efficiency
Forestry
Fuel switch
Fugitive emissions
Industrial gases
Manufacturing
Other land use
Renewable energy
Transport
Waste
Blue carbon

Crediting mechanisms:
- Independent (American Carbon Registry, Climate Action Reserve, Gold Standard, Verified Carbon Standard, Plan Vivo)
- International (Clean Development Mechanism)
- Domestic (all other mechanisms listed)

SOURCE: WORLD BANK

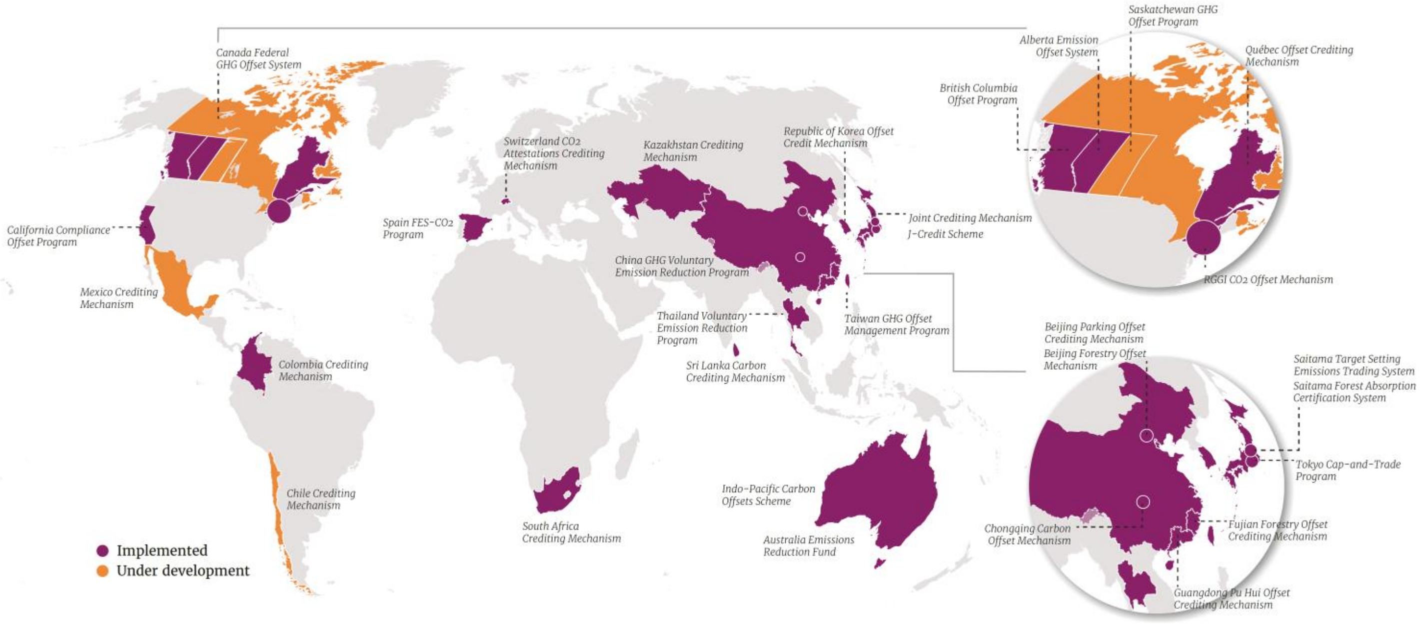
As can be seen in the table on the previous page, the biggest issuer of VCCs in 2021 was the **Verified Carbon Standard (VCS)**, which is an independent crediting mechanism administered by a global organisation named **Verra**. VCS issued 295.1m credits in 2021 at an average price of US$4.20/credit, corresponding to 295.1 MtCO2e of carbon offsets, including from 110 newly-registered projects (‘registered activities’) in sectors such as agriculture, energy efficiency, forestry, fuel switch, fugitive emissions, industrial gases, manufacturing, RE, transport and waste.

The second-largest issuer in 2021 was the **CDM**, which comes under the auspices of the UNFCCC and is an international crediting mechanism. The CDM did not register any new activities in 2021, hence the CDM credits were issued from legacy projects. CDM credits only sold for an average price of US$1.10/tCO2e in 2021, suggesting that buyers may be wary of the quality of CDM-issued credits. The CDM is being phased out and will eventually be replaced by the PA’s A6M.

The third-largest VCC issuer in 2021 was the **Gold Standard**, which is an independent crediting mechanism. Gold Standard’s VCCs sold for an average price of US$3.90/tCO2e, and it registered 51 new activities in 2021.

In fourth and fifth place are the **California Compliance Offset Program** and the **Australia Emissions Reduction Fund**, respectively, which are domestic crediting mechanisms. Each issued about 17m credits in 2021.

Figure 25: Map of national and subnational domestic crediting mechanisms as at 1 September 2022



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

SOURCE: WORLD BANK

'Forestry and Land Use' projects dominate volume and value of the VCM market

The **'Forestry and Land Use' category** of projects which include avoided deforestation, reforestation and afforestation projects, make up 46% of the total volume and 67% of the total value of VCCs transacted in 2021, according to Ecosystem Marketplace data. Around 70% of Forestry and Land Use credits were generated in Asia, primarily in Cambodia, Indonesia and China, according to the World Bank, with most of the remainder generated in Brazil and Peru. The price of the Forestry and Land Use credits was also the highest at an average of US$5.80/tCO2e, vs. the overall VCM average of US$4.03/tCO2e.

Within the Forestry and Land Use credits segment, credits with additional 'co-benefits' such as maintaining biodiversity, promoting the social welfare of surrounding communities, or by achieving one of the UN's 17 Sustainable Development Goals (SDG) will usually be priced higher than credits without those co-benefits. Forestry and Land Use credits are becoming very popular among corporates that want to offset their emissions voluntarily.

RE credits are the second largest in terms of volume, making up 43% of total transacted VCC volume in 2021, but at a relatively low price of US$2.26/tCO2e; hence, the value of RE credits amounted to just 24% of the total transacted value. The average price of RE credits is generally low because most RE projects are economically viable without revenues from the sale of carbon credits, and the projects would have gone ahead on their own merits. This increases the supply of carbon credits from RE projects and hence depresses the price. Another possible reason is because RE-origin carbon credits are not viewed as high quality by some VCC buyers, since they merely avoid GHG emissions rather than remove CO2, and because many RE projects may fail the 'additionality' test, which means that since the projects would have gone ahead anyway on their own financial merits, buyers of those carbon credits may not be making additional contributions to the climate goals of the PA.

The two major independent crediting mechanisms, i.e. VCS and Gold Standard, have since 2020 only accepted registrations of new large-scale RE projects located in least-developed countries (LDC) due to these projects elsewhere not requiring carbon finance to be economically feasible, according to the World Bank.

DAC projects and other **technology-based solutions** are usually some of the more-expensive carbon mitigation projects due to the high upfront capex and high running opex, and are hence not available in significant quantities for purchase.

Beyond the type of underlying project, the price of carbon credits is also influenced by the volume of credits traded at a time (the higher the volume, typically the lower the price), the geography of the project, its vintage (usually, the older the vintage the cheaper the price), and the delivery time.

Figure 26: Voluntary carbon market transaction volumes, prices, and values by category of carbon credits (2020 – 2021)

	2020			2021		
	VOLUME (MtCO2e)	PRICE (USD)	VALUE (USD)	VOLUME (MtCO2e)	PRICE (USD)	VALUE (USD)
FORESTRY AND LAND USE	57.8M	$5.40	$315.4M	227.7M	$5.80	$1,327.5M
RENEWABLE ENERGY	93.8M	$1.08	$101.5M	211.4M	$2.26	$479.1M
CHEMICAL PROCESSES / INDUSTRIAL MANUFACTURING	1.8M	$2.15	$3.9M	17.3M	$3.12	$53.9M
WASTE DISPOSAL	8.5M	$2.69	$22.8M	11.4M	$3.62	$41.2M
ENERGY EFFICIENCY / FUEL SWTICHING	30.9M	$0.98	$30.4M	10.9M	$1.99	$21.9M
HOUSEHOLD / COMMUNITY DEVICES	8.3M	$4.34	$36.2M	8.0M	$5.36	$43.3M
TRANSPORTATION	1.1M	$0.64	$0.7M	5.4M	$1.16	$6.3M
AGRICULTURE	0.5M	$10.38	$4.7M	1.0M	$8.81	$8.7M
TOTAL/AVERAGE	202.7M	$2.57	$520M	493.1M	$4.03	$1,985M

SOURCE: ECOSYSTEM MARKETPLACE

Platts reports price assessments for VCCs

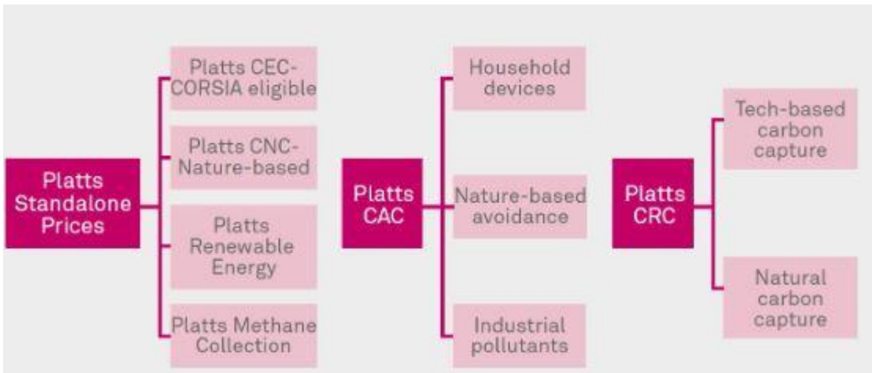
Data provider Platts produces four standalone carbon credit prices:

1. CORSIA-eligible credits (CEC), which reflect the prices of CORSIA Eligible Emissions Units that are approved by ICAO for use to offset airline emissions,
2. Nature-based carbon credits (CNC), which reflect vintages for each of the past five years and includes both avoidance and removal credits,
3. Renewable Energy Carbon credits price (vintage of each of the last three years), and
4. Methane Collection price, which reflects credits generated by projects aimed at reducing methane emissions such as landfill gas collection, waste gas, and livestock waste management projects (vintage of each of the last three years).

Platts also produces two baskets of prices:

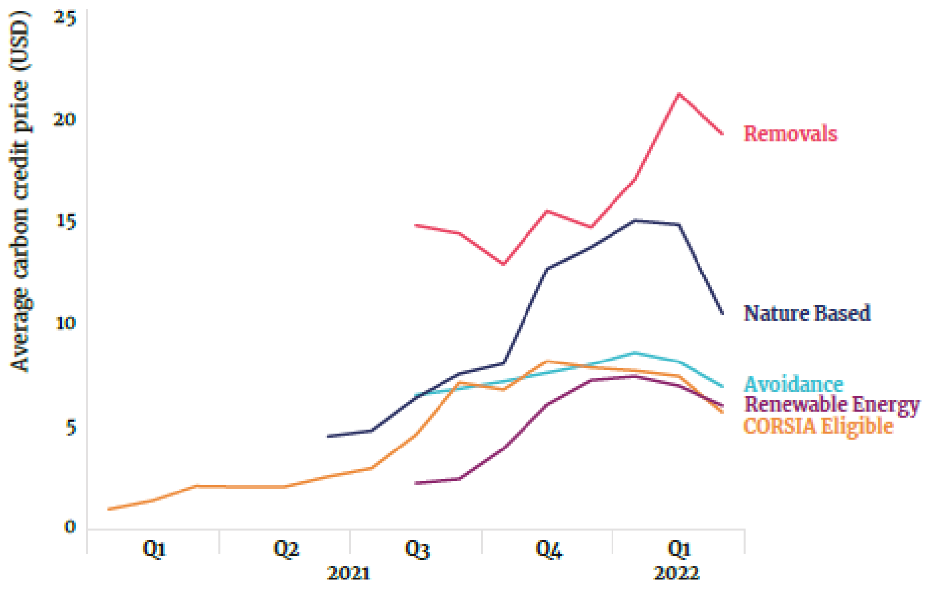
1. The Platts Carbon Avoidance Credit (CAC) prices, which include the Platts Household Devices price, Platts Industrial Pollutants price, and Platts Nature-based Avoidance price.
2. The Platts Carbon Removal Credit (CRD) prices, which include the Platts Tech Carbon Capture price, and the Platts Natural Carbon Capture price.

Figure 27: Platts voluntary carbon credit price assessments are grouped into various categories



SOURCE: PLATTS

Figure 28: Platts quotes for standardised carbon credit contracts (US$/tCO2e)



SOURCE: PLATTS, WORLD BANK

VCMs have the potential to scale up significantly

Data from Ecosystem Marketplace show that the VCM market had an exceptional year of growth in 2021.

The traded market value of VCMs almost quadrupled in a single year from US$520m in 2020 to US$2bn in 2021 (Figure 29).

Traded volumes rose 143% from 202.7 MtCO2e in 2020 to 493.1 MtCO2e in 2021, while the average traded price rose 57% from US$2.57/tCO2e in 2020 to US$4.03/tCO2e in 2021 (Figure 26).

Figure 29: Voluntary carbon market size, by value of traded carbon credits (pre-2005 to 31 December 2021)

SOURCE: ECOSYSTEM MARKETPLACE

Despite the outstanding growth in 2021, VCMs are small compared to CCMs, according to a joint paper released in October 2021 by Singapore's GIC, the Singapore's Economic Development Board (EDB) and McKinsey.

The paper estimated that in 2020, CCMs had a market value of over US$100bn (of which the EU ETS made up c.90% of the value), but VCMs had a market value of just US$300m. Note that the Ecosystem Marketplace had a different estimate for VCM market value at US$520m in 2020.

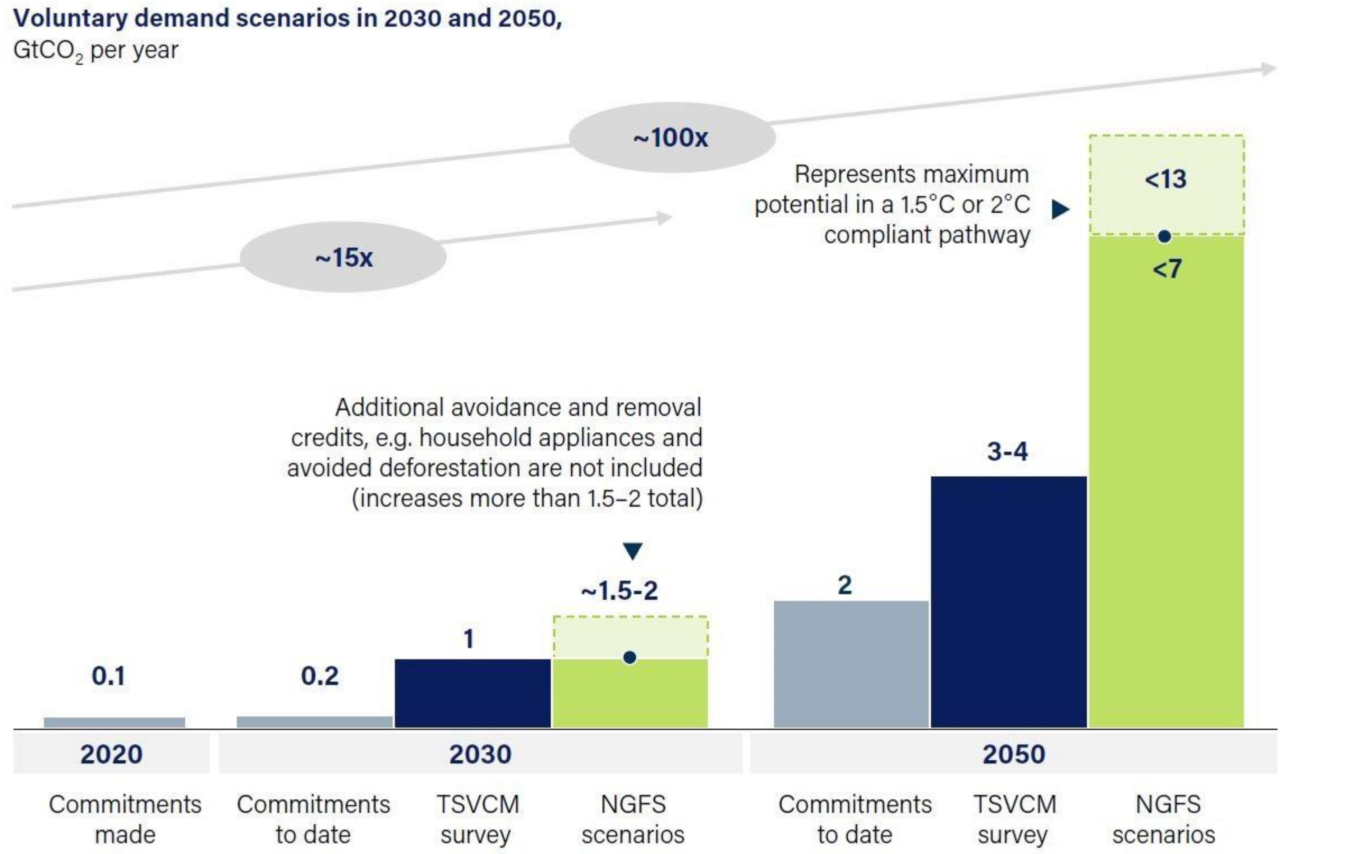
However, the paper estimated that VCMs could explode in size to **between US$5bn and US$180bn by 2030**, with volume demand driven by corporate net zero targets, and by a potential increase in the price of credits.

- In terms of volume alone, the demand for VCCs in 2020 totalled 0.1 GtCO2, or 100 MtCO2 (1Gt is equivalent to 1bn tonnes). By 2030, the Taskforce on Scaling Voluntary Carbon Markets (TSVCM) forecasts that VCC demand may rise to **1 GtCO2 p.a.**, while the Network for Greening the Financial System (NGFS) forecasts demand to rise to between 1.5 and **2 GtCO2 p.a.**
- In the GIC/EDB/McKinsey paper, the authors believed that VCC prices in 2030 may range from **US$5 to US$15/tCO2** (if buyers prefer to buy global VCCs at the lowest-possible costs) to **US$50 to US$90/tCO2** (if buyers have a preference for higher-cost technology-based solutions, or a preference for local supply of VCCs and do not mind paying higher prices). This compares to the average 2021 price of US$4.03/tCO2e, as estimated by Ecosystem Marketplace.

Therefore, in terms of the future market value of VCMs in 2030:

- At the low end of the range, assuming VCC demand of 1 GtCO2 p.a. at a price of US$5/tCO2, the value of VCMs may reach **US$5bn p.a.** (from US$2bn in 2021, based on estimates by Ecosystem Marketplace).
- At the top end of the range, assuming 2 GtCO2 p.a. of VCC demand at a high price of US$90/tCO2, the value of VCMs may reach **US$180bn** by 2030.

Figure 30: Demand for voluntary carbon credits (in terms of gigatones of CO2 p.a.)



SOURCE: MCKINSEY & COMPANY

Quality of VCM credits is key to broaden and deepen the market

Before VCMs can scale up in transaction volumes, they need to meet key quality metrics in order to convince a sceptical community of buyers.

According to the GIC/EDB/McKinsey paper, there are five key metrics that determine the quality of VCM credits: 1) the 'additionality' of the carbon mitigation; 2) the absence of carbon leakage; 3) the avoidance of double counting; 4) the permanence of the carbon abatement; and 5) verification by a recognised standard. These are described in detail below.

1. The 'additionality' of the carbon mitigation

A project contributes to 'additional' carbon mitigation if, in the absence of the project, net emissions would have been higher. For instance, if plans to set up a coal-fired power plant are abandoned in exchange for a new RE plant, then the RE plant will likely be contributing to 'additional' carbon mitigation in the future.

There is also the principle of 'financial additionality' that should be satisfied before VCCs are considered to be of good quality, which is that the mitigation project would not have gone ahead without the revenues generated from the sale of VCCs. Projects that would have gone ahead anyway without VCC revenues are economically viable in their own right and VCC sales merely increase the financial returns to the project developer; in this case, there is no 'additional' carbon mitigation, as the carbon mitigation would have happened regardless of whether VCMs existed or not.

VCM projects of dubious additionality have dissuaded potential VCC buyers in the past, and many RE projects may fall into this category, which explains why RE VCCs are priced at the lower end of the range. 'Additionality' can only be measured against a hypothetical and unobservable 'what if' baseline; hence, whether a project is 'additional' or otherwise may lie in the eye of the beholder. Also, in practice, banks and financial institutions are unlikely to finance projects that would not pass the threshold of financial viability without the contribution of VCC revenues. Hence, it may not be possible for VCM projects to completely fulfil the 'additionality' criteria in the strictest sense.

2. The absence of carbon leakage

Carbon leakage occurs when a VCM project in one place results in increased emissions elsewhere. For example, a REDD+ project that avoids deforestation in location A may cause illegal loggers to pursue deforestation in location B, which may not be protected. REDD+ refers to reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks. In practice, it may be difficult to assess if carbon leakage has occurred or not, as reference is made to a hypothetical scenario.

3. The avoidance of double counting

Double counting of a VCM project's emission reduction means that some polluters are merely free riders and the world's net emissions are actually higher than what is claimed to be the case. When project developers sell their VCCs abroad, the country that is hosting the project cannot also claim those credits against their domestic emissions, as is sometimes the case.

Under the Article 6 Mechanism (A6M) of the Paris Agreement (PA), corresponding adjustments in the GHG accounting framework have to be made in order to transfer the emissions reductions from the project's host country to the country that purchased the carbon credits from the project.

4. The permanence of the carbon abatement

A project's carbon abatement and emissions removal is 'permanent' when the abatement lasts for at least 100 years. For example, REDD+ forestry projects may be impermanent if the forest is subsequently burned down via climate disasters or via deliberate human intervention. CCS projects may become impermanent if the underground CO2 storage in depleted gas wells or geological formations sprout leaks. In order to increase the probability of permanence, VCM projects need to mitigate against the risks of impermanence, through actions such as physical security and monitoring, as well as via mandatory buffer accounts. Industry best practice requires project developers to set aside a portion of the carbon credits to be placed in mandatory buffer accounts, which means that the developers should not sell all of their carbon credits; in the event of reversals of carbon storage (i.e. non-permanence), carbon credits in the mandatory buffer accounts are written off.

5. Verification by a recognised standard, and registered with a recognised registry

A high-quality carbon credit should be verified by an internationally-recognised standard, and registered with an internationally-recognised registry. The standards set out all the requirements that VCM projects must follow in order to be certified to be of good quality.

The carbon credit also needs to be registered by carbon offset registries in order to ensure that newly-generated credits are created just once, that the ownership of the credits are tracked upon sale (sale of credits can happen more than once if at least one of the buyers is an intermediary rather than the polluter), and that the credits are properly retired once they are used to offset the end-buyer's emissions.

Buyers of VCCs require such verification and registration in order to obtain assurance that the carbon credit meets all the criteria for quality. The verification process is analogous to that of an annual audit of companies' financial statements by independent financial auditors. Ongoing monitoring, reporting and verification (MRV) is needed to ensure that projects are performing as expected.

Some of the popular independent standards by which projects should be designed include:

- The **Verified Carbon Standard (VCS)**, which is administered by a global organisation named Verra, sets out the requirements that all VCM projects must follow in order to be certified.
- The **Gold Standard** ensures that global carbon mitigation projects must contribute to sustainable development goals and reduce one of the three GHGs (CO2, CH4 or N2O).
- The **Climate Action Reserve (CAR)**, which is a US-based organisation overseeing a number of independent third-party bodies, that verifies credits from North American projects.
- The **American Carbon Registry (ACR)** registers and verifies VCM projects globally.

According to the Carbon Offset Guide, there are several registries in the voluntary offset market, and the following voluntary registries are currently operating:

- American Carbon Registry (ACR)
- The Gold Standard Registry, and the Climate Action Reserve (CAR), which are administered by APX Inc.
- The Social Carbon Registry, and the Plan Vivo Registry, which are administered by IHS Markit (now part of S&P Global).
- The Verified Carbon Standard (VCS) Registry, and the Climate, Community, & Biodiversity Standards (CCBS) Registry, which are administered by Verra.

Does vintage affect quality?

Vintage refers to the year in which credits are issued after third-party verification, and may or may not correspond to the period in which the GHG emissions were removed or avoided, because some credits are issued only after a few years when the verifier is sure that carbon abatement has taken place.

VCC buyers may not want to buy (or may not be allowed by regulatory requirements to buy) VCCs that were issued before a certain year; hence, the vintage of carbon credits is a key characteristic of VCCs that credit buyers will note. The older the vintage, typically the cheaper the VCC will be, as a rule of thumb. This may be because certain projects may have had difficulty selling their credits, and may have accumulated a significant volume of unsold credits, indicating that the project may be of lower quality.

Nevertheless, according to consultancy Consequence, the vintage of a carbon offset does not definitively indicate a low-quality offset project. The verification body Gold Standard, holds the view that the vintage should not matter, because of the urgency of climate mitigation efforts (hence, the earlier action is taken, the better), and because older vintages which had reduced GHG emissions in the past are benefitting the climate today.

On the other hand, older vintages are emission mitigations that had taken place in the past, and will not help with the increased urgency of further abatement required from now onwards for the world to stand a chance of meeting the PA goals. VCC buyers that mop up cheaper vintages may be 'greenwashing' in the sense that they may appear to be offsetting their emissions without actually doing anything additional for the climate.

Consultancy CarbonBetter.com suggested VCC buyers "find carbon offsets with a vintage that is within a few years of [the buyer's] GHG emissions. Typically, those issued 1-3 years of the emissions to be cancelled are the most desirable, whereas those with a vintage of 5 years or greater are less desirable." Also, "don't use vintage as the only criteria when shopping – consider vintage within the context of other factors such as its co-benefits for economic, social, and environmental sectors. These co-benefits can include additionality, job creation, renewable energy generation, biodiversity enhancement, restoration of land and forests, gender empowerment, pollution mitigation, access to education, and more. Quality offset projects should have these co-benefits listed so you can see exactly how the project benefits certain goals, such as the United Nations Sustainable Development Goals (SDGs)."

What could hold back the development of VCMs?

Demand from corporates may be limited in the absence of government compliance regimes or pressure from their institutional investors

According to the World Bank, 99% of the demand for VCCs comes from corporates that voluntarily want to partially offset their GHG footprint. Purchasing VCCs directly impacts their bottomlines, and many corporates may not be willing to offset a significant part of their emissions in the absence of government regulations such as carbon taxes or CCMs.

We believe that VCMs may thrive better in an environment where there is policy support, such as in Singapore, where from 2024 onwards, 5% of carbon tax obligations can be satisfied by the purchase of international VCCs. China's national ETS also permits power companies to use CCERs to offset 5% of its excess emissions, although we expect limited China ETS compliance demand for CCERs, due to very generous parameters for the ETS.

Supply of credits may exceed demand, leading to a collapse in prices

Also, while voluntary corporate demand for carbon credits may grow, they may not grow quickly enough to offset ongoing supply from existing projects. The upshot is that VCC prices may fall to levels that are too low to support the opex costs of current projects, risking their continuation. This situation may discourage the set-up of new mitigation and abatement projects, potentially dealing a blow to the further development of VCMs, which are especially important to offset hard-to-abate emissions.

In June 2022, Gabon, a Central African country, said that it plans to create 187m new carbon credits and sell 90m on the offset market before November 2022's COP27. Bloomberg estimated that Gabon could pocket US$291m in revenue. This planned sale of 90m of forestry credits is very large, amounting to 40% of the forestry credit sales in 2021, using data from Ecosystem Marketplace, which could overwhelm the market and cause prices to fall.

The Article 6 Mechanism (A6M) of the PA is still not operational

As noted earlier, the Article 6 Mechanism (A6M) of the PA is a broad framework which enables countries to pursue international collaboration to achieve each other's NDC goals, including purchasing carbon credits from each other. The principles of the A6M were approved at COP26 in November 2021.

However, there is ongoing disagreement among the UNFCCC Parties about the application of the A6M for the international transfer of mitigation options (ITMO), given that developing countries are objecting to the EU's proposal to restrict the carryover of the Kyoto Protocol CDM's CERs to the PA regime in the name of 'environmental integrity'.

Environmental nationalism

According to Platts, host countries of carbon offset projects are concerned that if too many of the credits are sold abroad, either through VCM programmes or via the PA's A6M, not enough will be left for them to fulfill their own NDCs. As a result, host countries such as Indonesia and Honduras have introduced moratoriums on carbon crediting activities. In April 2022, Indonesia put a temporary halt on some carbon activities, including non-nature-based ones, saying that it intended to align all activities taking place on its soil with national policies. In June 2022, Honduras also introduced a moratorium on all nature-based voluntary carbon projects.

Questionable carbon credit project deals; blowback from authorities

On 2 February 2022, the attorney general of the Malaysian state of Sabah said that she will not permit a 2m hectare, 100-year forestry carbon credit project in the state to proceed due to certain controversial elements, including the failure to engage in consultation with local communities, and a hefty 30% commission of the carbon credit revenues to be paid to the project developer. The project was reportedly signed secretly in October 2021 between the Sabah state government and the project developer, according to Al Jazeera.

On 2 March 2022, Papua New Guinea placed a moratorium on new forestry-related projects under the UNFCCC's Reducing Emissions from Deforestation and Forest Degradation (REDD+) category, apparently to give the government time to create a regulatory framework for future and existing deals after industry watchdog group Carbon Market Watch raised "significant red flags" about a 100-year carbon credit deal in Oro province, reported environmental news website Mongabay.

Corporate climate targets: the differences between 'carbon neutral' and 'net zero', and how VCMs fit into the picture

Corporates can either declare carbon neutral or net zero targets, and use VCMs to achieve their goals. However, there are important points that we would like to highlight.

The most important point is that corporate entities need to first and foremost make efforts to progressively mitigate or abate their own emissions over a period of time. Abatement includes measures that entities take to prevent, reduce or eliminate sources of GHG emissions within its value chain.

According to the Science Based Targets initiative (SBTi), **net zero pathways** require entities to fully abate all their in-house emissions that are technically possible to abate, and at a pace which is consistent with the Paris Agreement (PA). However, despite best efforts, corporates are unlikely to be able to mitigate or abate all their emissions, leaving behind residual emissions. Entities are then permitted to use VCCs to offset the residual unabatable emissions. But only the use of removal credits is permitted by the SBTi; avoidance credits are not allowed to be used.

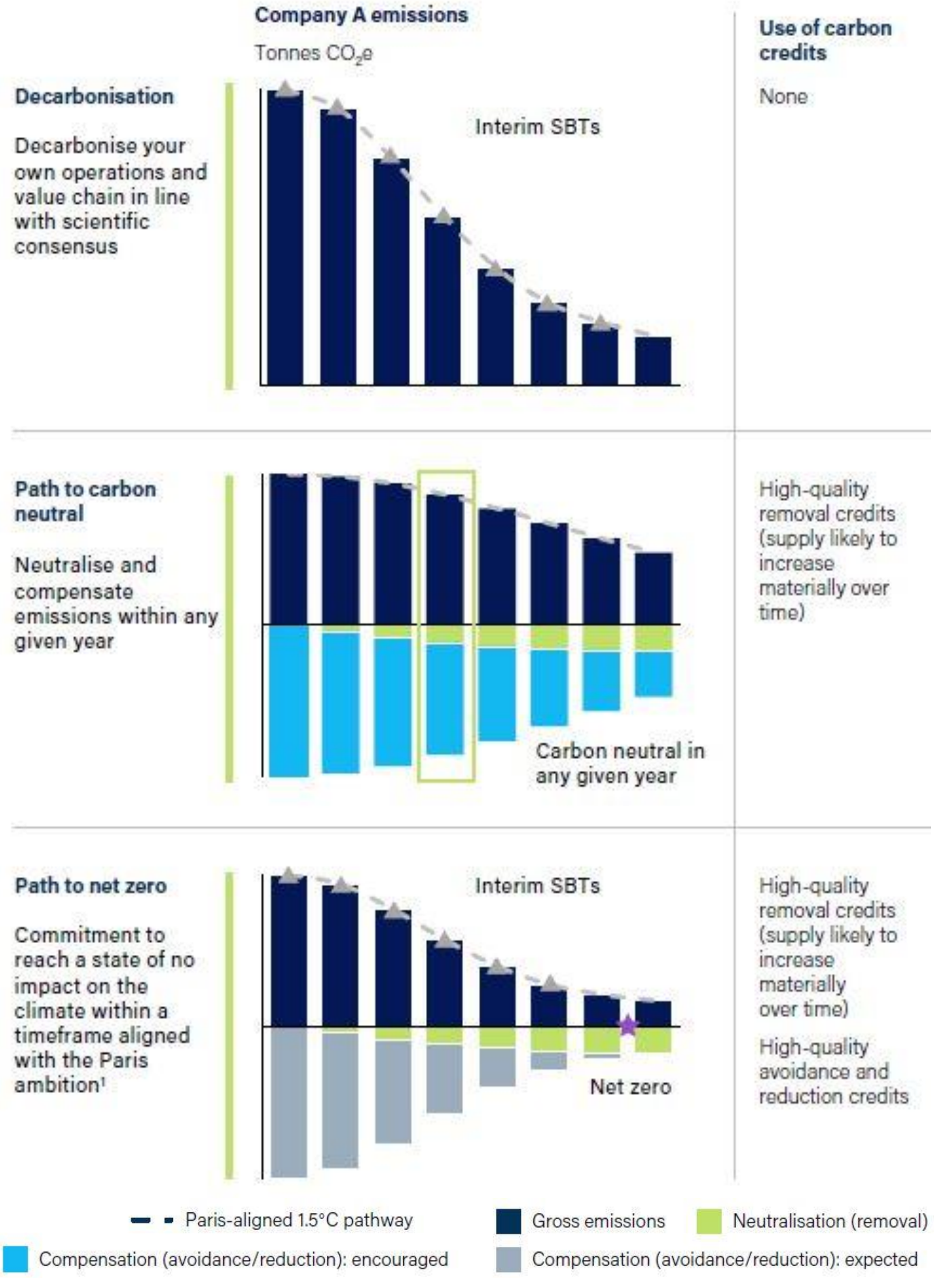
Carbon neutrality pathways do not require corporates to abate or mitigate all of their in-house emissions to levels which are consistent with the PA, and certainly not at a pace that is consistent with the PA. To declare carbon neutrality, these corporates may use VCCs to offset their emissions. These VCCs can either be compensation carbon credits (that involve avoidance and reduction credits), or neutralisation credits (credits from removal projects).

In summary, carbon neutrality is less stringent on the scope and extent of mitigation or abatement responsibilities, and is also less stringent on the type of VCCs permitted for offsetting. Conversely, net zero targets can only be seen to be achieved if polluting entities abate all their emissions to the maximum amount possible, at a pace consistent with the goals of the PA, and then select only high-quality neutralisation or removal credits to offset the residual emissions (with avoidance credits disqualified).

Some corporates have announced targets such as to be carbon neutral by 2030 and to be net zero by 2050. In the run-up to those specific dates, the Taskforce on Scaling Voluntary Carbon Markets (TSVCM) encourages corporates to start using VCCs immediately and to increase the use of VCCs over time to offset their emissions in any particular year.

Appendix 5 discusses the topic of 'carbon accounting' including the concept of Scope 1, Scope 2, and Scope 3 GHG emissions, operational control accounting vs. equity share accounting, and who is responsible to abate which type of emissions.

Figure 31: Carbon neutral pathways include the use of compensation carbon credits (avoidance/reduction credits); to achieve Net Zero, the use of compensation credits is not permitted as only neutralisation (removal) credits are permitted to offset residual emissions



SOURCES: GIC, EDB SINGAPORE, MCKINSEY & COMPANY

SECTION 7: KEY STAKEHOLDERS IN CARBON MARKETS

The players and the flow of transactions in carbon markets

Compliance carbon markets (CCM)

In CCMs, **regulators** determine the level of pollution they are willing to tolerate (i.e. the emissions cap), and allocate for free or auction the right to pollute via the issue of allowances to various **polluting entities, corporates, and facilities**. Alternatively, regulators impose a carbon tax on the entities that pollute above their permitted thresholds.

Polluters with excess allowances sell them to other polluters who need more allowances than they have been allocated to cover their volume of GHG emissions.

The excess allowances may also be sold to **carbon brokers, traders and institutional investors** who acquire them with the aim of holding them while waiting for prices to increase, before reselling them in the secondary market for a profit to other polluters in need of additional allowances. This is the ‘trade’ portion of the cap-and-trade CCM regimes.

Fund managers or stockbrokers may also establish **exchange-traded funds (ETF)** to provide an avenue to retail investors to participate in the carbon markets.

Voluntary carbon markets (VCM)

In VCMs, **institutional investors** and **bankers** provide funding support to **project developers** who initiate various carbon removal or avoidance projects.

VCCs engendered by these projects are issued by crediting mechanisms using recognised **standards** and then registered with **carbon registries**.

The VCCs are then marketed and sold wholesale by the project developers directly to **corporates** that have ambitions to voluntarily offset their own emissions.

Institutional investors in the carbon projects will also get their equity share of the VCCs, who may then resell those credits to the corporate market for profit.

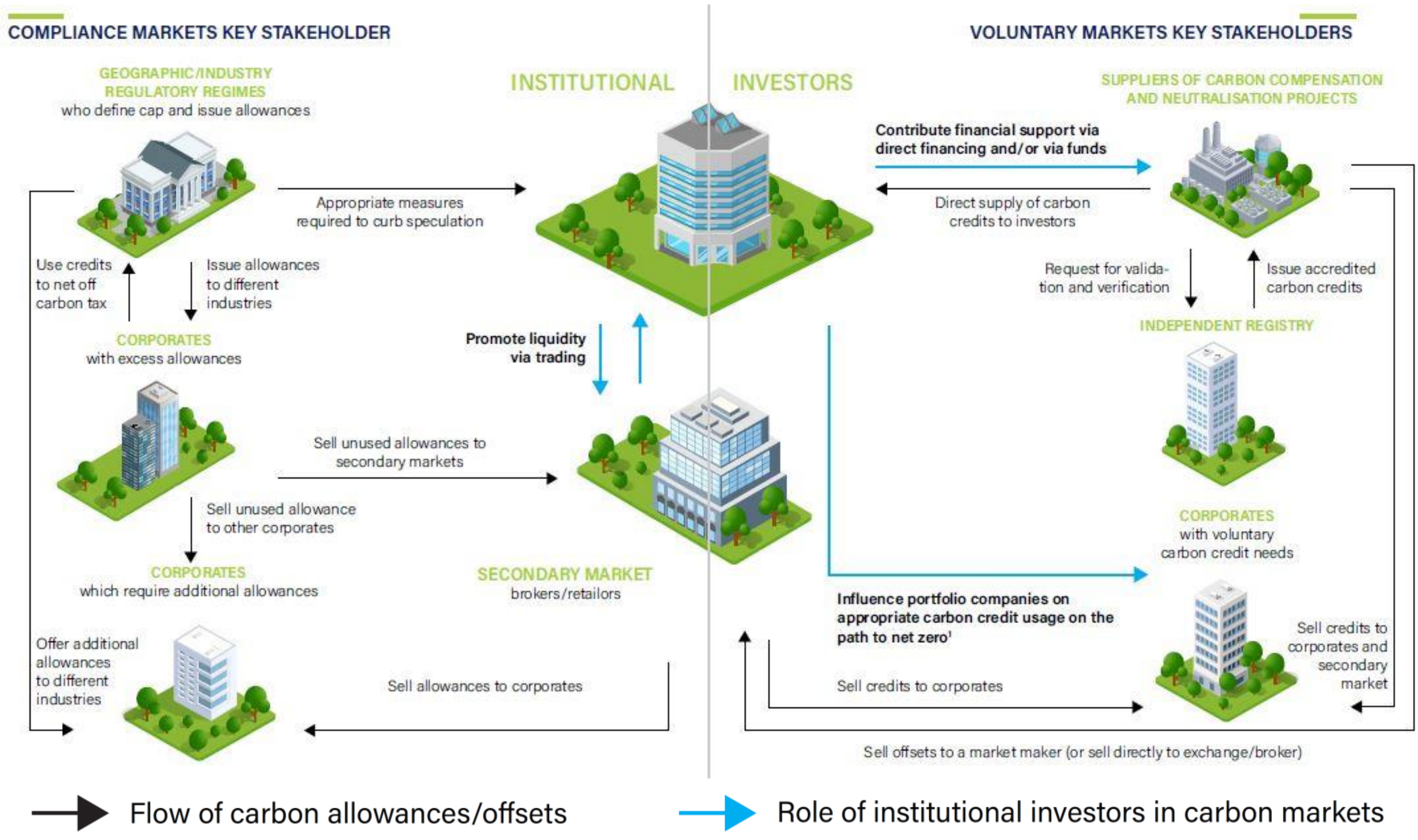
The project developers can also sell the credits to intermediaries, such as **retailers**, who take ownership of the credits, and then resell them in the secondary market for profit.

The trading of VCCs usually takes place on **OTC markets**, due to the heterogeneity of projects in VCMs.

Alternatively, wholesale brokers or **exchanges** (such as Singapore’s AirCarbon Exchange, or Bursa Malaysia) facilitate transactions between project developers and end buyers for a fee without taking ownership of the credit. Exchanges may also create standardised credits by grouping together carbon credits products with similar characteristics, such as type of project, vintage of the credit, etc. so as to increase trading liquidity by reducing the complexity of the credits.

Project developers or intermediaries may also sell the VCCs to **entities that are subject to compliance requirements**, such as carbon tax regimes, cap-and-trade (CAT) regimes and baseline-and-credit (BAC) schemes, if the regulated entities are permitted to offset part of the carbon tax obligations with VCCs, and if the entities are permitted to purchase VCCs in place of buying regulatory emissions allowances.

Figure 32: Stakeholders in CCMs and VCMs, and the role of institutional investors and secondary market intermediaries in the value chain of carbon allowances and carbon credits



SOURCES: GIC, EDB SINGAPORE, MCKINSEY & COMPANY

SECTION 8: INTERNATIONAL AVIATION EMISSIONS

International aviation emissions controls

According to the International Air Transport Association (IATA), the aviation industry contributed to about 2% of global anthropogenic emissions, before the Covid-19 pandemic hit. While this percentage looks small, there is still great urgency to address aviation emissions because global air transport will likely grow significantly in the post-Covid-19 era, in our opinion.

In October 2021, the International Air Transport Association (IATA) resolved for the global air transport industry to achieve net-zero carbon emissions by 2050 ('Net Zero 2050'), in order to be aligned with the Paris Agreement (PA) goals.

IATA's **Four-Pillar Strategy** sets out several ways to gradually achieve the Net Zero 2050 goal:

Pillar 1: Improved technology, including the deployment of Sustainable Aviation Fuels (SAF)

This involves airlines purchasing a modern fleet of fuel-efficient, next-generation aircraft which are also lighter and can fly further with the same amount of fuel compared with legacy aircraft models. Aircraft and engine manufacturers can work together with airlines to bring new technologies to the market. Airlines can also engage in preventative maintenance in order to reduce drag and improve engine efficiency.

Meanwhile, the use of SAF can reduce lifecycle carbon emissions by up to 80% compared to using fossil jet fuel, according to Air bp. This is because SAF is derived from used cooking oil (UCO), household food waste, and forestry waste, hence the burning of SAF merely releases CO2 that was absorbed by those biological sources in the first place. Hence, SAF itself is carbon neutral, although the process of producing SAF will result in the release of some CO2 emissions. Up to 50% of the SAF is blended with fossil jet fuel to make it suitable for use for jet aircraft. However, certain standards need to be met in order for a fuel to qualify as sustainable; there are recognised standards such as those of the Round Table on Sustainable Biomaterials (RSB).

Refineries need to be encouraged to build large scale and cost competitive SAF production facilities, so that the large price premium of SAF relative to traditional fossil jet fuels can be reduced. National flag carriers, as well as privately-owned airlines, should be encouraged by their governments to lead the way by using some SAF, in order to create a baseline of demand that can encourage SAF producers to set up production facilities.

Pillar 2: More efficient aircraft operations

Airlines can optimise their flight routes (by taking more direct paths), taxi on runways, taxiways and aprons with only one engine switched on, use continuous descent operations (rather than the traditional step-down approach), and reduce the weight of the aircraft to reduce the voyage's fuel consumption (e.g. by not uplifting more jet fuel than is necessary for the voyage, by using lightweight galley service equipment, and others). Some airlines, especially low-cost carriers, may increase the seat density within an aircraft to reduce emissions per available seat capacity and/or emissions per passenger.

Pillar 3: Infrastructure improvements; modernised air traffic management systems

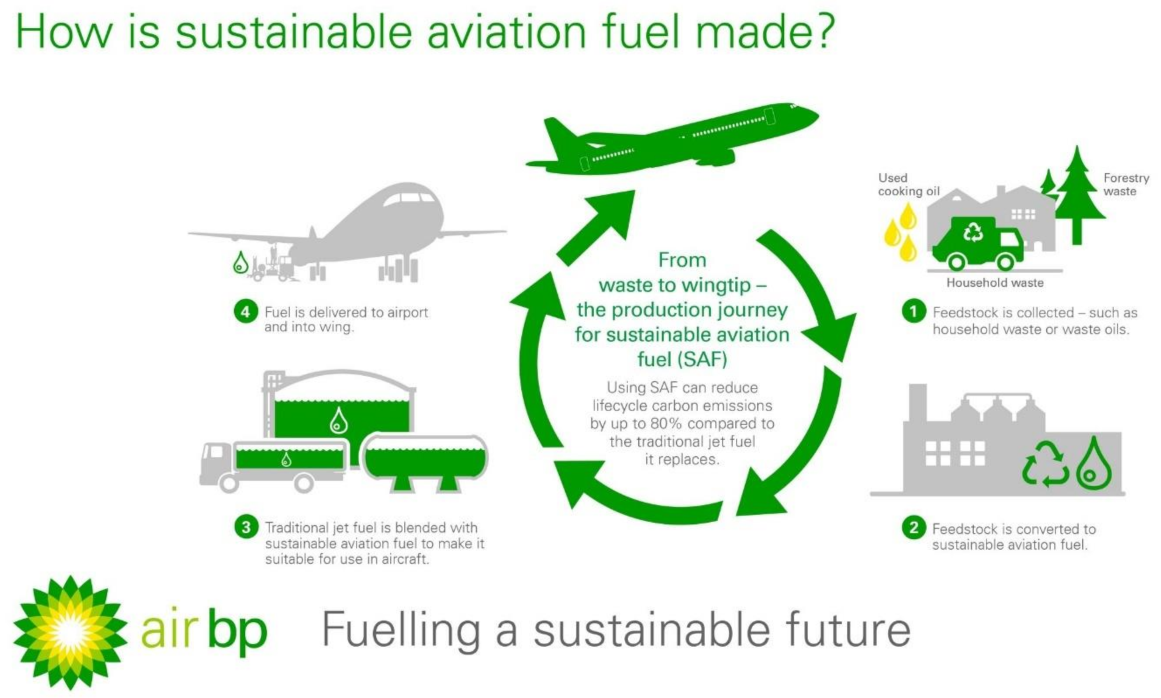
Governments and air navigation service providers (ANSP) can work together with airlines to eliminate inefficiencies in air traffic management and airspace infrastructure. This includes improving runway productivity and airspace efficiency, which can help airlines reduce their time circling in the air while waiting for a runway landing slot and reduce time at the tarmac waiting for a takeoff slot; these measures can reduce fuel burn.

Pillar 4: A single global market-based measure to fill the remaining emissions gap

The International Civil Aviation Organization's (ICAO) **Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)**, is one of the key actions that the aviation industry can take in the short and medium term to stabilise international airline emissions at 2019 levels.

The use of carbon offsets is necessary because there are limits to how much airlines can reduce their actual emissions in the near future, because of the high cost of SAF and its limited availability around the world; the fact that even if SAF is used, fossil jet fuel still needs to comprise at least 50% of the ultimate fuel blend; and the high cost of investing in newer, more fuel-efficient planes.

Figure 33: SAF is produced using used cooking oil (UCO), household food waste, and forestry waste; up to 50% of the SAF is blended with fossil jet fuel to make it suitable for use for jet aircraft; SAF itself is carbon neutral, and can reduce lifecycle carbon emissions by up to 80% compared to fossil jet fuel



SOURCE: AIR BP

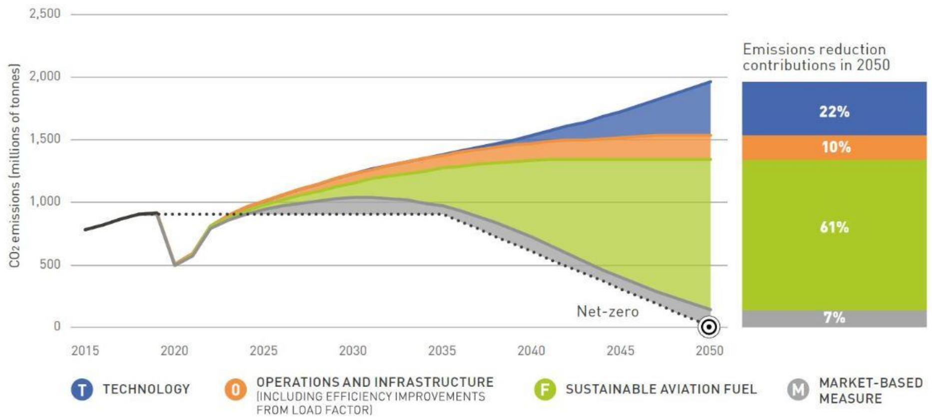
According to IATA, one potential scenario in 2050 under the Net Zero target is that:

- 65% of aviation's emissions will be abated through SAF;
- 13% will be abated through the use of alternative propulsion technologies, such as hydrogen;
- 11% to be reduced via carbon capture and storage (CCS);
- 3% to be mitigated via efficiency improvements; and
- 8% to be offset using CORSIA-approved carbon credits.

On its website, the Air Transport Action Group (ATAG) published three scenarios reflecting three different pathways for the aviation industry to achieve Net Zero 2050. In one of the scenarios, technology-based solutions may account for 22% of the emissions reduction (vs. IATA's 24%), efficiency improvements 10% (IATA: 3%), SAF 61% (IATA: 65%), and CORSIA offsets 7% (IATA: 8%).

ATAG expects that over the next 13 years to 2035, operations efficiency and the use of SAF will likely contribute the majority of the emissions savings in the aviation industry. It is only after 2035 that technology solutions may contribute to emissions savings.

Figure 34: One potential pathway for aviation to achieve Net Zero 2050



SOURCE: AIR TRANSPORT ACTION GROUP (ATAG)

Although the use of CORSIA carbon credits is forecast by IATA to offset only 8% of aviation's emissions in 2050, we highlight that this scenario assumes widespread availability and adoption of SAF over the next three decades to 2050.

Over the course of the next three decades, the use of carbon credits may make a bigger-than-8% contribution towards the offsetting of aviation's emissions; in essence, because SAF may take some time to be made available in sufficient volumes, and SAF pricing will also need to decline to an acceptable level before the use of the SAF-fossil-jet-fuel blend is economical against the alternative use of potentially cheaper carbon offsets.

Background of CORSIA

In 2016, the UN's aviation agency, ICAO and its member states agreed on an international carbon offsetting scheme, known as CORSIA.

CORSIA has an important role to play in the immediate future, because aviation is a hard-to-abate sector, as there is no feasible alternative to eliminating the use of fossil jet fuel, since batteries (electric power) are too heavy to be installed in planes, hydrogen is technically challenging to use due to the cryogenic temperatures needed to liquefy it and the lack of infrastructure to supply hydrogen to aircraft, and the availability of SAF is limited.

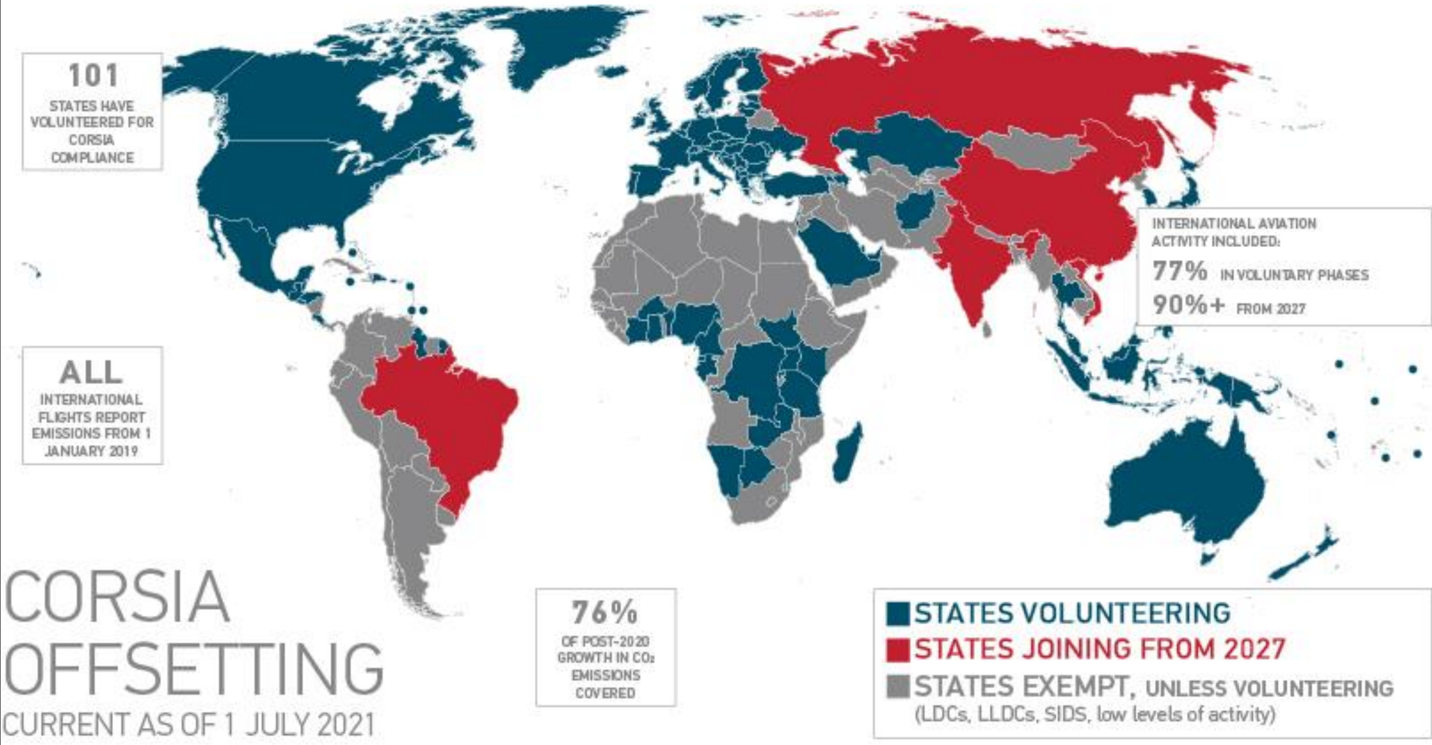
As IATA noted, "CORSIA was designed to be a short- to medium-term strategy (2021-2035) to achieve carbon neutral growth in international aviation until low-emission technology such as SAF can be scaled up, and electric and hydrogen-powered technology is fully developed in the coming decades. Offsetting is not intended as an alternative to new technology but as part of a suite of measures to stabilise and reduce emissions."

As of 1 January 2022, 107 countries have volunteered to participate in the CORSIA scheme from 2021, with mandatory global participation only from 2027, although less developed countries (LDC), land-locked developing countries (LLDC), and small island developing states (SID) are exempt.

Eight more states (Cambodia, Cuba, Micronesia, Iraq, Maldives, Saint Vincent and the Grenadines, Timor-Leste, and Zimbabwe) have announced their intention to participate in CORSIA from 1 January 2023.

Note that BRIC nations (Brazil, Russia, India and China) and Vietnam will only participate from 2027 when CORSIA becomes mandatory.

Figure 35: Participation in the CORSIA offsetting scheme as of 1 July 2021



SOURCE: AIR TRANSPORT ACTION GROUP (ATAG)

Figure 36: List of 107 CORSIA volunteers as of 1 January 2022 - arranged from the Western Hemisphere (left) to the Eastern Hemisphere (right)

North America	Central America	South America	Western Europe	Eastern Europe	Central Asia	Africa	Middle East	South Asia	Southeast Asia	Northeast Asia	Southwest Pacific	Pacific Islands
Canada	Bahamas	Guyana	Austria	Albania	Azerbaijan	Benin	Afghanistan	*None*	Indonesia	Japan	Australia	Kiribati
US	Belize	Suriname	Belgium	Armenia	Kazakhstan	Botswana	Israel		Malaysia	South Korea	Cook Islands	Marshall Is.
	Costa Rica		Cyprus	Bosnia and Herzegovina		Burkina Faso	Oman		Philippines		New Zealand	Nauru
	Dominican Republic		Denmark	Bulgaria		Cameroon	Qatar		Singapore		PNG	Palau
	El Salvador		Finland	Croatia		Côte d'Ivoire	Saudi Arabia		Thailand			Tonga
	Grenada		France	Czechia		Congo	Turkey					Vanuatu
	Guatemala		Germany	Estonia		Eq. Guinea	UAE					Tuvalu
	Honduras		Greece	Georgia		Gabon						
	Jamaica		Iceland	Hungary		Gambia						
	Saint Kitts and Nevis		Ireland	Latvia		Kenya						
	Trinidad and Tobago		Italy	Lithuania		Madagascar						
			Luxembourg	Montenegro		Mali						
			Malta	Poland		Namibia						
			Monaco	Moldova		Nigeria						
			Netherlands	Romania		Rwanda						
			Norway	Serbia		South Sudan						
			Portugal	Slovakia		Tanzania						
			San Marino	Slovenia		Zambia						
			Spain	Macedonia								
			Sweden	Ukraine								
			Switzerland									
			United Kingdom									

SOURCE: AIR TRANSPORT ACTION GROUP (ATAG)

How does CORSIA work?

The key facets of the CORSIA programme are as follows:

1. CORSIA addresses international aviation emissions only, not domestic emissions

CORSIA's role is to tackle aviation emissions from international flights by requiring airlines to buy a certain volume of carbon offsets. It does not tackle emissions from domestic flights, because these come under countries' Nationally Determined Contributions (NDC) submitted to the UNFCCC, and hence, will be managed via their respective national mitigation plans. For instance, the EU ETS, the UK ETS, and the Swiss ETS all have emissions caps for their intra-European Economic Area (EEA) flights or domestic flights, but the responsibility for addressing CO2 emissions from international flights is left to ICAO's CORSIA programme.

2. Only CO2 emissions are addressed by CORSIA

CORSIA does not yet address non-CO2 GHGs, unlike the EU ETS which includes aviation sector CO2e gases in its emissions cap. If in the future, N2O emission are counted, CORSIA's offsetting requirements may be greater.

Airlines with emissions greater than 10,000 tonnes of CO2 are required to monitor, report and verify (MRV) their CO2 emissions from 1 January 2019 in the run-up to the start of the scheme on 1 January 2021. This includes all aircraft operators, from passenger and cargo airlines, to business aviation operators, and even private jets.

3. Only international emissions above the 2019 baseline need to be offset, not all emissions

Not all emissions on international flights need to be offset using CORSIA-approved credits, but only the portion of the international emissions above the 2019 baseline. Hence, CORSIA's aim is to stabilise net emissions at the 2019 baseline, until such a time that more widespread use of SAF can reduce the volume of CO2 emissions from fuel combustion, and technology solutions are available to permanently eliminate CO2 emissions from flights.

CORSIA had originally planned to use the 2020 emissions baseline for the first voluntary pilot period of 2021-2023 but decided to use the 2019 baseline instead as the onset of the Covid-19 pandemic in 2020 decimated flights around the world.

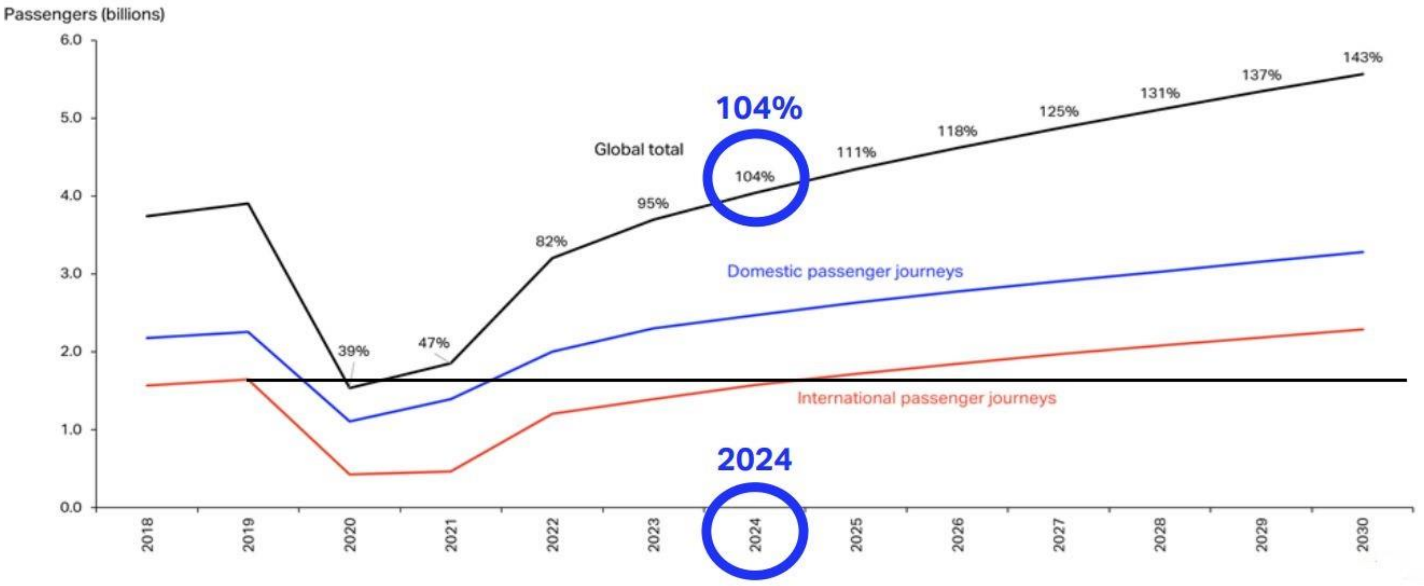
Using IATA's long-term forecasts, international passenger traffic may exceed the 2019 level only very slightly in 2025. Hence, we expect that it is only from 2026 onwards that the aviation industry may have to purchase CORSIA-approved carbon credits more substantively.

4. In the voluntary periods of 2021-2023 and 2024-2026, only international emissions for air travel between CORSIA volunteer countries that are above the 2019 baseline need to be offset

CORSIA will be implemented in a pilot phase in 2021-2023 and the first phase in 2024-2026, among volunteer nations only. Only international flights between two countries voluntarily participating in CORSIA will be subject to offsetting requirements, even if the airlines operating the flights are domiciled in non-participating states, in what ICAO calls the 'route-based approach'.

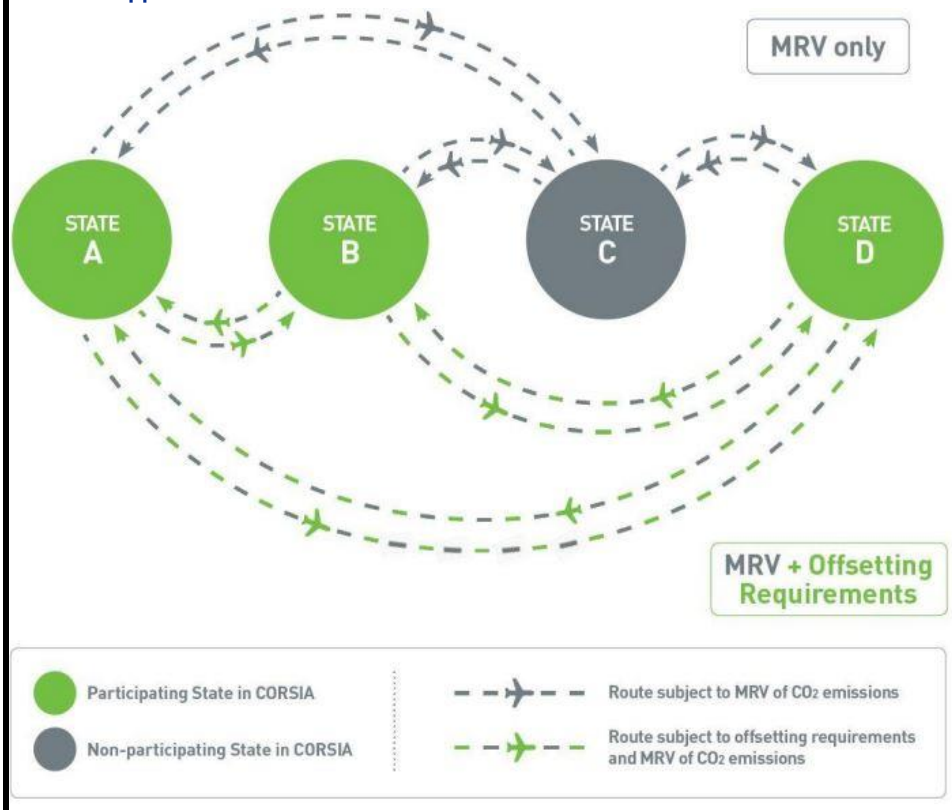
Flights between a participating country and a non-participating nation will not have to offset emissions, although they will be required to monitor, report and verify (MRV) their CO2 emissions.

Figure 37: IATA forecasts the aviation industry's international passenger traffic to exceed the 2019 level only very slightly in 2025, but for total air passenger traffic (both domestic and international) to exceed the 2019 level by 4% in 2024, given that domestic passengers already exceeded the 2019 level in 2023 – these IATA forecasts were published in May 2022



SOURCE: IATA

Figure 38: How the responsibility of buying carbon credits is calculated in the 100% 'sectoral approach'



SOURCES: CGS-CIMB RESEARCH, ICAO

For instance, flights between Malaysia and Singapore will have to comply with CORSIA as both countries have voluntarily signed up with CORSIA. However, flights between Malaysia and India or China will not have any offsetting requirements, because neither India nor China have volunteered their participation between 2021 and 2026, even if Malaysia is a participating nation.

CORSIA will become mandatory from 2027 onwards for all nations except for those that are exempted due to their status as LDCs, LLDCs, or SIDs. From

2027 onwards, i.e. CORSIA's second phase, all international flights between all the participating nations must offset their emissions above their 2019 baselines. ICAO will review CORSIA in 2032 to assess if it should be extended or improved after 2035, when the second phase ends.

Figure 39: The three phases of CORSIA implementation

SOURCE: AIR TRANSPORT ACTION GROUP (ATAG)

5. Carbon offsets eligible to be purchased by airlines under the CORSIA programme must be CORSIA-approved

CORSIA-approved carbon credits are also called CORSIA Eligible Emissions Units (CEEU). Only credits with a vintage year of 1 January 2016 or later are accepted for the 2021-2023 compliance cycle, and CORSIA accepts carbon credits from the following registries:

- American Carbon Registry (ACR) – for credits generated during 1/1/2016-31/12/2023 only
- Architecture for REDD+ Transactions (ART) – 1/1/2016-31/12/2023 credits only
- China GHG Voluntary Emission Reduction Program – 1/1/2016-31/12/2020 credits only
- Clean Development Mechanism (CDM) – 1/1/2016-31/12/2020 credits only
- Climate Action Reserve (CAR) – 1/1/2016-31/12/2020 credits only
- Global Carbon Council (GCC) – 1/1/2016-31/12/2020 credits only
- The Gold Standard (GS) – 1/1/2016-31/12/2020 credits only
- Verified Carbon Standard (VCS) – 1/1/2016-31/12/2020 credits only

To be eligible as carbon credits under CORSIA, the carbon offsets need to be additional to BAU activity, must be permanent, with no carbon leakages, and a baseline must be determined to represent what would have happened if the project had not been implemented. The credits must also be accurately measured, independently verified and audited, and cannot be double counted.

Except for forestry projects under the ART registry, most forestry projects do not have CORSIA-approved status and cannot be used by airlines to offset their excess emissions.

6. The burden of buying carbon offsets is weighted towards the larger emitters

Carbon offsets should be purchased at the end of each phase to offset the excess emissions above the 2019 baseline for the past three years. For example, for the pilot phase which ends in 2023, airlines must purchase offsets for 2021-2023 by January 2025 and submit a report to ICAO by April 2025 to prove that they have done so. The offsets purchased are then retired. However, the burden of buying carbon offsets is not evenly spread out, and a greater burden is placed on the larger airline emitters.

For the pilot phase in 2021-2023, the first phase in 2024-2026, and in the first triennial of the second phase in 2027-2029, i.e. the first nine years of CORSIA, the burden of carbon offsetting is allocated among the participating airlines using a 100% 'sectoral approach'.

- Using the example of the 2021-2023 pilot phase, all participating countries will have their aviation industries measure their CO2 emissions growth from the 2019 baseline. That emissions growth will have to be offset using CORSIA Eligible Emissions Units (CEEU).
- After the end of the pilot phase, each airline will buy CEEUs based on their proportion of CO2 emissions in the baseline year of 2019 (relative to all other participating airlines) multiplied by the CO2 emissions growth between 2019 and 2023.

This means larger airlines may have to bear a disproportionate share of offsetting responsibilities, compared to smaller and younger airlines.

From 2030 onwards, this approach will gradually transition to one based on each airline's individual rate of growth.

- In 2030-2032, 80% of offsets will be calculated according to this 'sectoral approach', with the remaining 20% calculated by the 'individual approach'.
- In 2033-2035, the proportion of offset requirements based on the 'sectoral approach' falls to 70%, with the 'individual approach' rising to 30%.
- From 2036 onwards, offsetting responsibilities are calculated using the 'individual approach' only.

Figure 40: Calculation of offsetting requirements under CORSIA

SOURCE: ICAO

In the example below, assume that there are only two airlines participating in CORSIA, and we have just completed 2021, the first year of the pilot phase. Airline A did not increase its emissions between 2019/2020 and 2021, and Airline B contributed to the sector's entire emissions increase of 200 tonnes.

Since Airline A comprised 70% of total emissions in 2019/2020, it is allocated the responsibility to purchase 140 units of carbon offsets (70% x 200 tonnes), while Airline B is only required to purchase 60 units of carbon offsets (30% x 200 tonnes).

Even though Airline A did not increase its emissions at all between 2019/2020 and 2021, it is still required to purchase 140 units of carbon offsets. Although Airline B contributed all of the growth in emissions for the aviation industry, it merely has to buy 60 units of carbon offsets under the 100% 'sectoral approach'.

Figure 41: How the responsibility of buying carbon credits is calculated in the 100% 'sectoral approach'

	CO2 emissions (tonnes)			
	Airline A	Airline B	Total	
Average of 2019 and 2020	700	300	1000	
In 2021	700	500	1200	
Growth in pilot phase CO2 emissions between 2021 and 2019-2020 (tonnes)	0	200	200	❶
	Proportion of emissions (%)			
	Airline A	Airline B	Total	
Average of 2019 and 2020	70%	30%	100%	
	❷	❸		
Share of CORSIA emissions credits to be purchased using the 100% 'sectorial approach' (units)	140	60	200	
	❶ x ❷	❶ x ❸		

SOURCES: CGS-CIMB RESEARCH, ICAO

An illustration of the calculations for 2030 are shown below, using the same emissions assumptions, but using the 80% 'sectoral approach' and 20% 'individual approach' weighting. In this example, Airline A's carbon offset requirement will be 112 units, vs. 140 units under the 100% 'sectoral approach'. The calculations are repeated for 2031 and 2032, with respect to the second triennial of CORSIA's second phase.

Figure 42: How the responsibility of buying carbon credits is calculated in the 80% 'sectoral approach' and 20% 'individual approach' in the first triennial of the CORSIA second phase in 2030-2032

	CO2 emissions (tonnes)			
	Airline A	Airline B	Total	
In 2029	700	300	1000	
In 2030	700	500	1200	
Growth in CO2 emissions between 2029 and 2030 (tonnes)	0	200	200	❶
Contribution to emissions growth (%)	0%	100%		
	❹	❺		
	Proportion of emissions (%)			
	Airline A	Airline B	Total	
In 2029	70%	30%	100%	
	❷	❸		
Share of CORSIA emissions credits to be purchased using the 100% 'sectorial approach' (units)	140	60	200	Row 1
	❶ x ❷	❶ x ❸		
Share of CORSIA emissions credits to be purchased using the 100% 'individual approach' (units)	0	200	200	Row 2
	❶ x ❹	❶ x ❺		
Share of CORSIA emissions credits to be purchased using the 80% 'sectoral approach' and 20% 'individual approach' (units)	112	88	200	(80% x Row 1) + (20% x Row 2)

SOURCES: CGS-CIMB RESEARCH, ICAO

SECTION 9: INTERNATIONAL SHIPPING EMISSIONS

International shipping emissions regulations do not have a direct role for carbon offsetting

The UN's International Maritime Organization (IMO) and the EU have proposed regulations in order to reduce emissions from shipping operations, with the IMO's rules to take effect from 2023, and the EU ETS obligations applying to shipping also from 2023.

The IMO's rules are based on the carbon intensity of shipping work, and are designed to:

1. Force ships to throttle their sailing speeds to reduce fuel consumption per tonne of cargo carried, and hence reduce CO_2 emissions, if the ships are unable to meet the required *shipbuilding design* levels of carbon intensity; and/or
2. Stop trading altogether (either immediately or after a certain period of time) if the ships cannot meet the required *operational* levels of carbon intensity that will be tightened progressively.

The EU ETS, if applied to maritime shipping, will require shipping companies to buy and surrender EUAs corresponding to a rising proportion of their domestic and international emissions.

In both instances of the IMO regulations and the incoming EU ETS rules for maritime shipping, there is no role for carbon offsetting, unlike that of ICAO's CORSIA scheme for international aviation.

The focus of both regulatory regimes is on specific and direct carbon mitigation and abatement measures. Shipping companies will be pushed to gradually retire their older vessels, and to transition to vessels that are able to burn lower- or zero-carbon fuels, such as liquefied natural gas (LNG), or ammonia or methanol that are produced using fossil fuels with CCS or produced from green hydrogen.

Although the above maritime regulations do not have an explicit role for carbon offsetting, this does not preclude shipping companies from voluntarily participating in VCMs to offset their residual emissions.

Emissions regulations under the International Maritime Organization (IMO)

The IMO, which is part of the UN, has been at the forefront of maritime regulation since it was established in 1948.

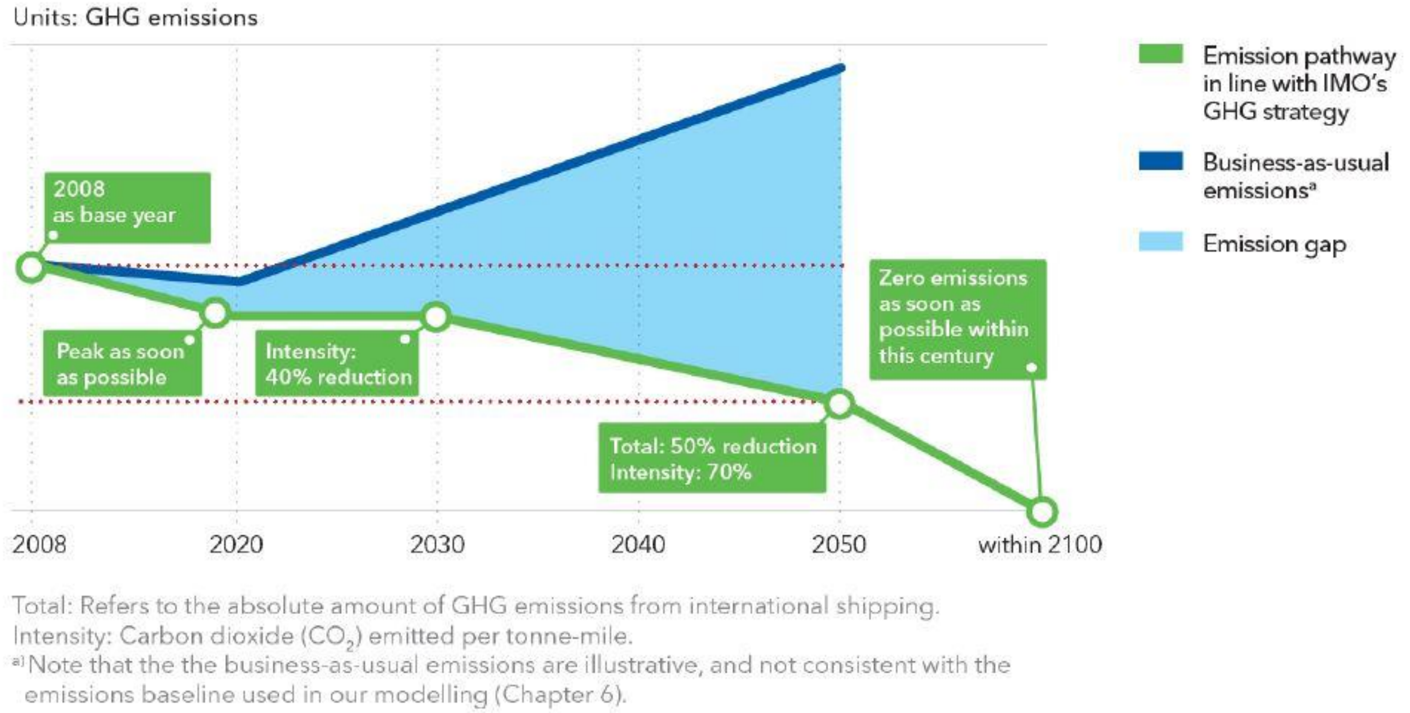
In 2018, the Marine Environment Protection Committee (MEPC), which is part of the IMO, adopted its initial strategy for the reduction of emissions from ships. The main thrust is to reduce carbon intensity of shipping transport work, as well as to reduce absolute GHG emissions.

- The target is to reduce **carbon intensity** of shipping by at least 40% by 2030, and by at least 70% by 2050, relative to levels prevailing in 2008.
- Meanwhile, **absolute GHG emissions** should be reduced by at least 50% by 2050, relative to levels prevailing in 2008.

Carbon intensity of shipping transport work is measured in terms of grams of CO_2 emissions, divided by the tonnage of cargo carried, and divided again by the nautical miles (nm) travelled, i.e. gCO_2/cargo tonne-nm.

The carbon intensity measure only concerns itself with CO_2 emissions and does not include emissions of other GHGs such as CH_4 and N_2O. However, the absolute GHG reduction target for 2050 concerns itself with all GHG emissions including CO_2, CH_4 and N_2O. According to IMO, CO_2 emissions generally account for 97% of all GHG emissions from ships, with CH_4 about 2% and N_2O about 1%.

Figure 43: IMO's initial strategy on the reduction of GHG emissions from ships, adopted in 2018



SOURCES: IMO, DNV

In November 2020, during the 75th session of the IMO's MEPC meetings, also known as MEPC 75, the IMO proposed a framework for the adoption of concrete short-term measures to meet its carbon emission goals:

1. A new index called the **Energy Efficiency Existing Ship Index (EEXI)** would be established, which are technical standards of carbon intensity that all existing ships above 400 gross tonnage must comply with from 1 January 2023. The EEXI is an extension of similar existing regulations for newbuildings, called the Energy Efficiency Design Index (EEDI), which came into effect from 1 January 2013.
2. All ships above 5,000 gross tonnage will also need to comply with the **Carbon Intensity Indicator (CII)** measure, which are operational standards of carbon intensity, from 2023 onwards.

The EEXI and CII requirements were adopted at the MEPC 76 meetings in June 2021 and will be enforced from 1 January 2023.

What shipping companies need to do to meet IMO rules

Energy Efficiency Existing Ship Index (EEXI)

The EEXI regulations will require shipping companies to ensure that its vessels have technical Attained EEXI levels of CO2 emissions below the Required EEXI levels. The calculations must be done by classification societies and verified by flag state administrations on the first annual, intermediate (every 2½ years), or 5-year renewal/special survey, so that each ship can secure its own International Energy Efficiency Certificate (IEEC) that will be valid for the rest of the vessel's useful life.

If any vessel fails to achieve the Required EEXI levels, then the vessel must adopt Engine Power Limitation (EPL) by restricting the amount of fuel that can be injected into the main engine per unit of time, effectively forcing a speed limit on the vessel, as lower sailing speeds have a more-than-proportionate impact of reducing fuel consumption and cutting CO2 emissions. Alternatively, the shipowner can explore the installation of energy-saving devices on the vessel which can reduce fuel consumption. Finally, shipowners can dispose or scrap the least energy-efficient ships and replace them with new or newer vessels.

Carbon Intensity Indicator (CII)

In terms of the CII requirements, shipowners need to calculate their ships' Attained CII, which is a measure of real-life operational carbon emissions (as opposed to merely technical emissions represented by the EEXI metric). The Attained CII for a specific year is compared to the Required CII level, and ships are then rated 'A', 'B', 'C', 'D' or 'E'. Ships that are rated 'E' must stop trading in the following year unless the relevant shipowners produce a corrective action plan to bring the ship back to a 'C' rating or better. Ships that are rated 'D' can continue trading, but if the 'D' rating persists for three consecutive years, the ships will have to stop trading in the following year unless a corrective action plan is produced. The Required CII starts in 2023 at 5% below each ship's 2019 level of carbon intensity, but is tightened 2% p.a. until 2026, for a cumulative reduction in the Required CII of 11% between 2019 and 2026. The Required CII levels for 2027 and beyond will be decided by the IMO at a future MEPC meeting.

For more information on the IMO's environmental initiatives, please refer to our 6 July 2021 report on MISC (MISC MK, SP: RM7.13, Add, TP: RM8.04).

The EU ETS may include shipping emissions from 2023

The EC's 'Fit for 55' package of 14 July 2021 proposed to gradually phase-in maritime emissions for the first time from 2023, which would cover around two-thirds of its maritime emissions; it is intended to incentivise energy efficiency improvements, low-carbon technologies, and the use of more-expensive alternative low- or zero-carbon maritime fuels.

CO2 emissions from large ships above 5,000 gross tonnage will be covered, with respect to all CO2 emissions from intra-EU voyages, all emissions occurring when ships are at berth in an EU port, but applicable to only 50% of emissions for voyages between non-EU ports and EU ports ('extra-EU voyages'). Maritime emissions will be progressively phased into the EU ETS, i.e. 20% of the applicable maritime emissions will have to surrender allowances in 2023, rising to 45% in 2024, 70% in 2025, and 100% from 2026 onwards.

On 22 June 2022, the European Parliament made significant counter-proposals to the 'Fit for 55' proposal of the EC. For shipping, the Parliament proposed to include 100% of the emissions in extra-EU voyages in the EU ETS, and to abandon the phase-in approach, instead applying the ETS for 100% of emissions from 2024. The Parliament proposed expanding the coverage to emissions of CH4 and N2O, and introduced the concept of a 'port at risk of carbon leakage' by proposing to apply the ETS carbon price to ports within 300 nautical miles of the EEA that also have a transshipment share of more than 60%. From 2027 onwards, the Parliament proposed to expand the EU ETS to cover emissions from ships above 400 gross tonnage.

Negotiations are still underway between the European Parliament (comprising directly-elected representatives) and the Council of the European Union (comprising EU member state government ministers), under the auspices of the EC, before a final package of ETS measures can be adopted.

SECTION 10: ASEAN INITIATIVES

Background to NDCs and BURs

The UNFCCC's Paris Agreement (PA) in 2015 requires each Party (i.e. member country) to prepare nationally determined contributions (NDC) that are, in aggregate, designed to help achieve the PA's climate goals. NDCs targets represent each Party's post-2020 ambition in its emissions mitigation and climate adaptation efforts. NDCs are submitted every five years to the UNFCCC secretariat, beginning in 2020, and each successive NDC submission should have more ambitions mitigation and adaptation goals than the preceding one. NDCs are essentially each Party's statement of intent about their climate targets.

Biennial Update Reports (BUR) are detailed reports submitted by non-Annex I Parties (i.e. developing countries) to the UNFCCC secretariat, containing updates of national GHG inventories, the status of its GHG removals and sinks, and various mitigation and adaptation measures taken. BURs are akin to companies' Annual Reports, which give a detailed account of what has happened in the reporting period. The first BURs were submitted before December 2014, and are required to be submitted every two years thereafter.

ASEAN member states have a mish-mash of incomparable NDR targets; hard to determine if the PA's goals can be met

We have summarised some of the pertinent highlights of a selection of ASEAN member states' NDRs and BURs in the tables below (not exhaustive as we have excluded Brunei, Cambodia, Laos and Myanmar). Here are our key observations.

Figure 44: Selected ASEAN member states' Nationally Determined Contributions (NDC) under the Paris Agreement (PA)

No	Country	GHG emissions in 2018	Mitigation type	Mitigation target			Reference point	Target year	Carbon neutral / Net zero target	Share of RE generation capacity	Forestry targets
		MtCO2e		Uncondi-tional	Condi-tional	Total					
1	Indonesia	1,700	Relative emissions reduction	29%	12%	41%	BAU	2030	Net zero by 2060	48% by 2030	Protect 5.8m ha of forests and 1.9m ha of peatlands by 2030
2	Malaysia	390	Carbon intensity reduction (CO2e per ringgit of GDP)	45%	-	45%	2005	2030	Carbon neutral by 2050 at the earliest; no net zero target	31% by 2025, 40% by 2035	At least 50% of Malaysia's land mass remains forested by 2030 (vs. 55% in May 2022)
3	Philippines	240	Relative emissions reduction	2.71%	72.29%	75%	BAU (during 2020-2030)	2020-2030	No target	35% by 2030	Eliminate net loss in natural forests, mangrove, seagrass, coral cover by 2028
4	Singapore	70	(a) Absolute emissions peaking	Peak emissions at no higher than 65 MtCO2e around 2030			-	2030	Net zero by/around 2050	15% by 2030	Plant 1m more trees and add 130 ha of new parks by 2030
			(b) Relative emissions reduction	Halve emissions from its peak to 33 MtCO2e by 2050			Peak emissions	2050	-	-	-
5	Thailand	430	Relative emissions reduction	20%	5%	25%	BAU	2030	Carbon neutral in 2050; net zero by 2065	20% by 2036	Increase forest cover to 55% of total area by 2037
6	Vietnam	360	Relative emissions reduction	9%	22%	27%	BAU	2030	Net zero by 2050	32% by 2030	Increase forest cover to 42% of total area by 2030

SOURCES: CGS-CIMB RESEARCH, UNFCCC, ASEAN STATE OF CLIMATE CHANGE REPORT, BAIN & COMPANY

Indonesia is the single largest GHG emitter by a huge margin, at 1,700 MtCO2e, by virtue of its land size. Thailand, Malaysia, and Vietnam have broadly similar emission levels at between 360 and 430 MtCO2e. The numbers above are gross GHG emissions estimates for 2018, as published by Bain & Company. The countries' net GHG emissions are lower, once carbon removals from carbon sinks like forests are taken into account.

The NDC targets of the different ASEAN member states may not be fully comparable to each other, as they have different bases and different time horizons; they also have a different composition of unconditional and conditional targets.

There are three types of emissions reduction targets:

1. Relative emissions reductions against the 'business as usual' (BAU) projections;
2. Carbon intensity reduction targets; and
3. Absolute targets.

As an example of a relative emissions reductions target, Indonesia has a target to reduce its GHG emissions unconditionally by 29% by 2030 *relative* to the BAU reference point. If Indonesia secures foreign assistance, it may be able to reduce its GHG emissions by a further 12%, for a total reduction of 41% by 2030, also by reference to the BAU scenario. Forecasting the BAU scenario is tricky, like any other long-term forecasts. As a general comment, if the BAU emissions growth forecasts are very aggressive, a country may claim to have met its NDC targets without reducing actual emissions by very much. Thailand, Vietnam and the Philippines also have relative emissions targets.

Malaysia's NDC target is not comparable to Indonesia's. Malaysia defines its target on the basis of carbon intensity; it targets to unconditionally reduce its GHG emissions *intensity* by 45% by 2030 relative to the 2005 intensity level. Intensity is measured as CO2e emissions per ringgit of GDP. If we assume that Malaysia's economy grows in the coming eight years, absolute carbon emissions in 2030 will not decline by as much as 45%, even if Malaysia meets its 45% intensity reduction target.

Singapore is the only country to have an absolute emissions target. It targets to peak emissions at no higher than 65 MtCO2e by around 2030, and then to halve its emissions to 33 MtCO2e by 2050, according to official sources. Absolute emissions targets are the most transparent and useful for assessing whether PA goals are achievable, although it is perhaps Singapore's city-state status that makes it easier for it to set such a target.

The Philippines has the weakest unconditional targets, planning to only reduce emissions unconditionally by a mere 2.71% against the 2020-2030 BAU; while Vietnam also has rather modest targets for 2030.

In terms of longer-term targets, Singapore and Vietnam have targeted to be net zero by 2050, while Indonesia has set a net zero target for 2060, and Thailand for 2065. Malaysia stands out as having no net zero target, but rather a carbon neutral target for 2050; carbon neutrality permits a generous use of carbon avoidance credits to offset emissions that could have been abated with more investment, whereas net zero insists on using only carbon removal credits to offset emissions that are unabatable using technologies available at that time.

Figure 45: Selected ASEAN member states' Nationally Determined Contributions (NDC) under the Paris Agreement (PA)

No	Country	Compliance carbon market initiatives: Carbon tax	Compliance carbon market initiatives: ETS	Voluntary carbon market initiatives
1	Indonesia	Carbon tax of Rp30,000/tCO2e (US$2) from 2022 proposed for coal-fired power plants, to be expanded to all sectors by 2025	Pilot ETS for coal-fired power plants in Apr-Aug 2021; may be progressed to mandatory ETS in 2024	Under consideration; to utilise emission reduction certificates or Indonesia Certified Emission Reduction (ICER)
2	Malaysia	Under consideration	Under consideration	Bursa Malaysia to host a voluntary carbon credit exchange by end-2022
3	Philippines	Under consideration	Under consideration	Unknown
4	Singapore	Carbon tax of S$5/tCO2e since 2019; 2024-2025: S$25; 2026-2027: S$45; 2028-2030: progressively increased to S$50-80	Unknown	Unknown
5	Thailand	-	Thailand Voluntary Emission Trading Scheme (Thailand V-ETS) (currently a pilot for economy-wide use except power sector)	Thailand Voluntary Emission Reductions (T-VER) scheme (project based) Thailand Carbon Offsetting Programme (T-COP) (public and private organisations)
6	Vietnam	Carbon Payment for Forest Environmental Services (C-PFES) pilot	Pilot carbon exchange from 2026; full ETS in 2028	Unknown

SOURCES: CGS-CIMB RESEARCH, UNFCCC, ASEAN STATE OF CLIMATE CHANGE REPORT, BAIN & COMPANY

The table above sets out selected ASEAN member states' CCM and VCM initiatives.

Indonesia is relatively advanced in this regard, with a carbon tax regime supposedly in place before November 2022. It had also conducted a pilot ETS for coal-fired power plants in April to August 2021, which may be progressed to a mandatory ETS in 2024. Also, Indonesia is considering setting up a domestic voluntary carbon market.

Malaysia announced in September 2021 (at the tabling of the 12th Malaysia Plan in Parliament) that it was exploring the introduction of a carbon tax and a domestic ETS; however, no details have yet emerged. Bursa Malaysia is in the process of developing a voluntary carbon exchange before end-2022, with credits offered from Malaysian and foreign sources.

The Philippines is the country most behind the curve with no plans announced or pathways stated.

Singapore has had a carbon tax regime in place since 2019, and the carbon tax rates will rise significantly in the years to come.

Thailand had set up a pilot CCS scheme (the Thailand Voluntary Emissions Trading Scheme), and also has a VCM initiative in place (the Thailand Voluntary Emissions Reductions scheme). The Thailand Carbon Offsetting Programme (T-COP) encourages public and private organisations to calculate their carbon footprint and buy carbon credits to offset their unavoidable emissions.

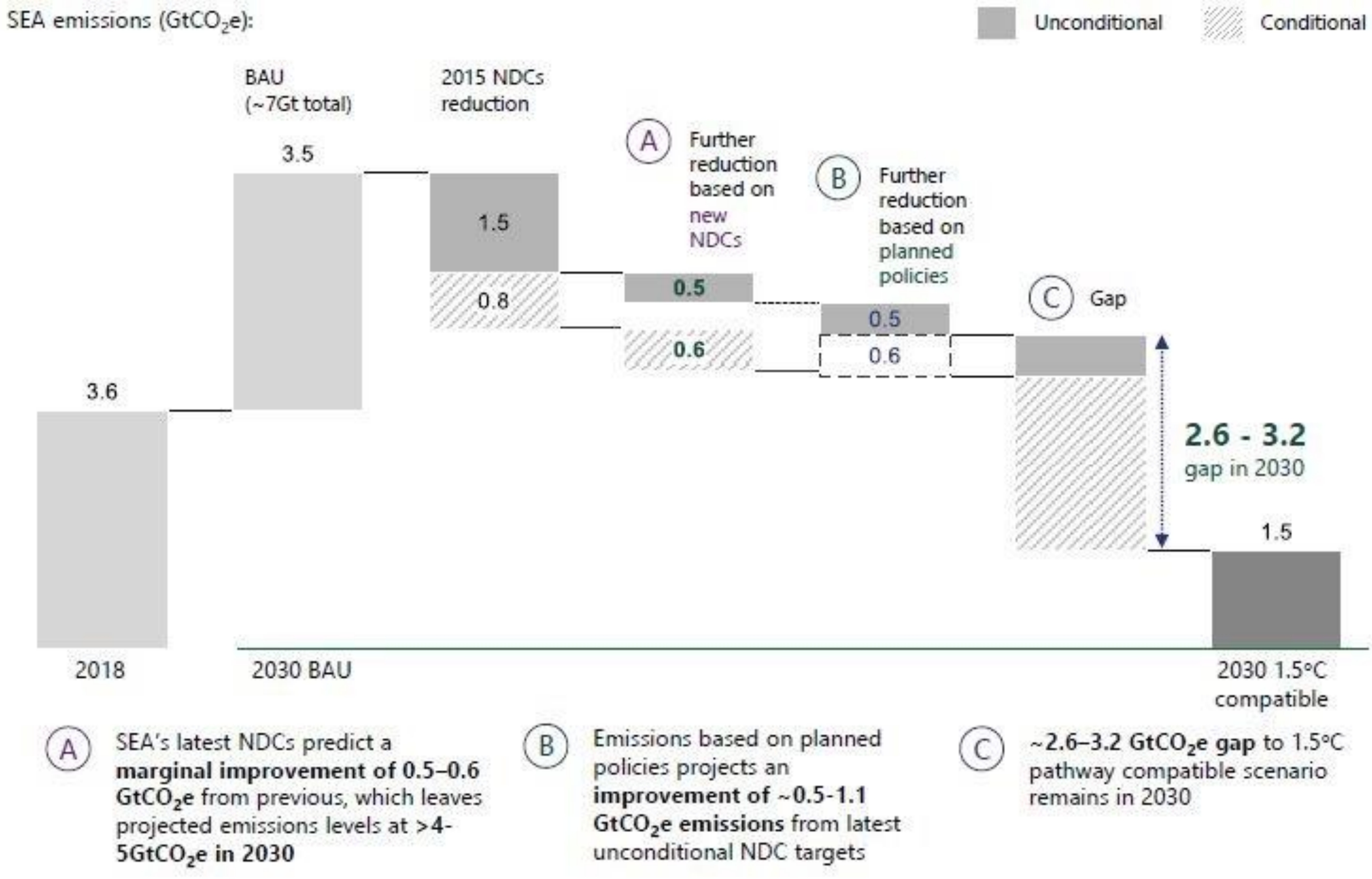
Finally, Vietnam has a CAT pilot scheme called the Carbon Payment for Forest Environmental Services, and plans to have a pilot ETS from 2026 and a full ETS from 2028.

ASEAN's climate risks and commitment gap

Bain & Company published an analysis of ASEAN member states' NDC targets in June 2022, and the conclusion was that ASEAN needs to have more ambitious mitigation goals in order to meet the PA's goals of keeping global warming to below 1.5°C above pre-industrial levels.

On a BAU basis, ASEAN's emissions may reach 7.1 GtCO2e by 2030. ASEAN's 2015 NDC targets suggest that emissions may reduce by 1.5 GtCO2e unconditionally, with a further unconditional reduction of 0.5 GtCO2e based on the latest NDCs, and another unconditional reduction of 0.5 GtCO2e based on planned governmental policies. This will take ASEAN's emissions to a net of 4.7 GtCO2e in 2030, against the 1.5 GtCO2e that is compatible with the PA's goals, or an unfavourable gap of 3.2 GtCO2e. Assuming full achievement of conditional emissions reduction targets, the unfavourable gap is narrower at 2.6 GtCO2e, but remains substantial nevertheless.

Figure 46: ASEAN's estimated emissions in 2030 may be too high to be in line with the Paris Agreement's goals

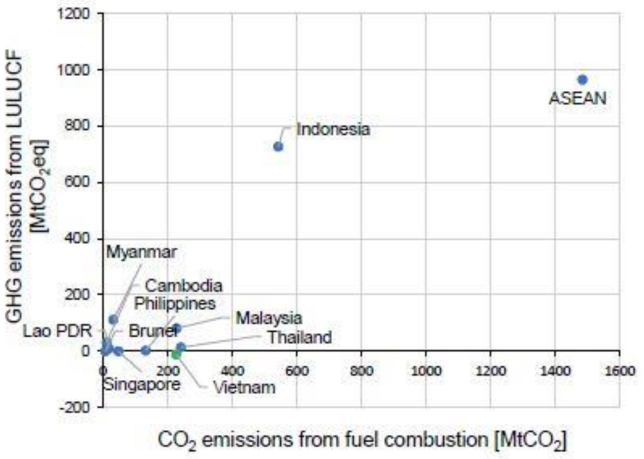


SOURCES: CLIMATE WATCH, CLIMATE ACTION TRACKER, CLIMATE ANALYTICS, UNFCCC, BAIN & COMPANY, TEMASEK

Deforestation for agriculture and the build-up of coal-fired power plants are the main issues

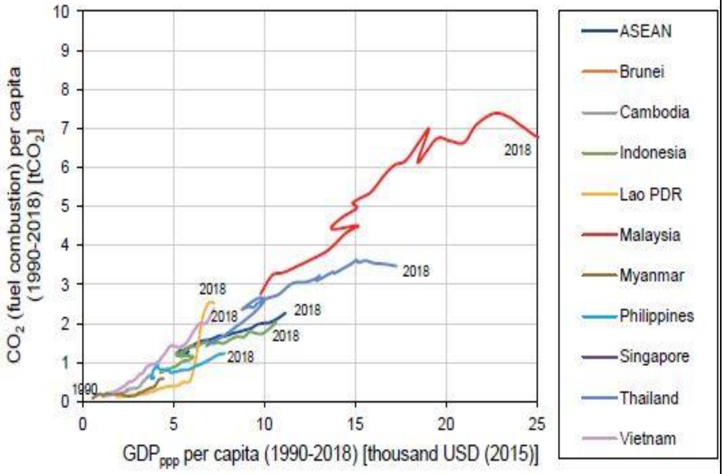
The figure below shows CO2 emissions from fuel combustion and GHG emissions from Land Use, Land Use Change and Forestry (LULUCF) in 2016. According to the ASEAN State of Climate Change report dated October 2021, the ASEAN region emitted substantial GHG emissions from fossil fuel combustion (1,485 MtCO2) and LULUCF (965 MtCO2e), mainly due to Indonesia's deforestation and peatland exploitation, which will need to pause if there is any hope of meeting the PA's goals.

Figure 47: CO2 emissions from fuel combustion and GHG emissions from LULUCF by country/region in 2016



SOURCE: ASEAN STATE OF CLIMATE CHANGE REPORT, OCTOBER 2021

Figure 48: Relationship between GDP (2010 USD) per capita and CO2 per capita during the period from 1990 to 2018



SOURCE: ASEAN STATE OF CLIMATE CHANGE REPORT, OCTOBER 2021

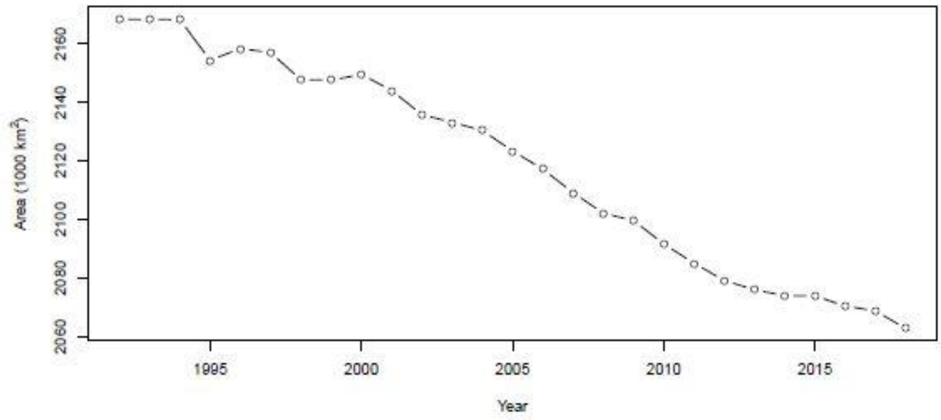
According to the Center for People and Forests (RECOFTC), forests in the ASEAN region have declined by almost 7m hectares, or 3.4%, since 2013. Cambodia, Indonesia, Malaysia and Myanmar have undergone significant reductions in forest cover since 2013. Agricultural production is the main driver of deforestation in Southeast Asia.

Figure 49: Forest cover in ASEAN member states (2010–2019)

Country	Baseline 2010 (ha)	Situational analysis 2019 (ha)	Annual deforestation (ha)	Share of annual deforestation in the region (%)	Rate of deforestation (%/year)
Brunei Darussalam	380,000	322,195	9,634	0.4	2.5
Cambodia	10,094,000	8,742,401	150,178	6.8	1.5
Indonesia	94,432,000	85,622,000	978,889	44.5	1.0
Lao PDR	15,751,000	13,732,282	224,302	10.2	1.4
Malaysia	20,456,000	18,123,501	259,167	11.8	1.3
Myanmar	31,773,000	29,041,000	303,556	13.8	1.0
Philippines	7,665,000	7,014,154	72,316	3.3	0.9
Singapore	2,300	16,347	- 1,561	- 0.1	- 67.9
Thailand	18,972,000	16,398,128	285,986	13.0	1.5
Vietnam	13,797,000	14,491,295	- 77,144	- 3.5	- 0.6
Total	213,322,300	193,503,303	2,202,111	100.0	1.0

SOURCES: RECOFTC (THE CENTER FOR PEOPLE AND FORESTS), REGIONAL PROJECT ENERGY SECURITY AND CLIMATE CHANGE ASIA-PACIFIC (RECAP)

Figure 50: The forest cover area in Southeast Asia has dropped over 1992-2018



SOURCE: REGIONAL PROJECT ENERGY SECURITY AND CLIMATE CHANGE ASIA-PACIFIC (RECAP)

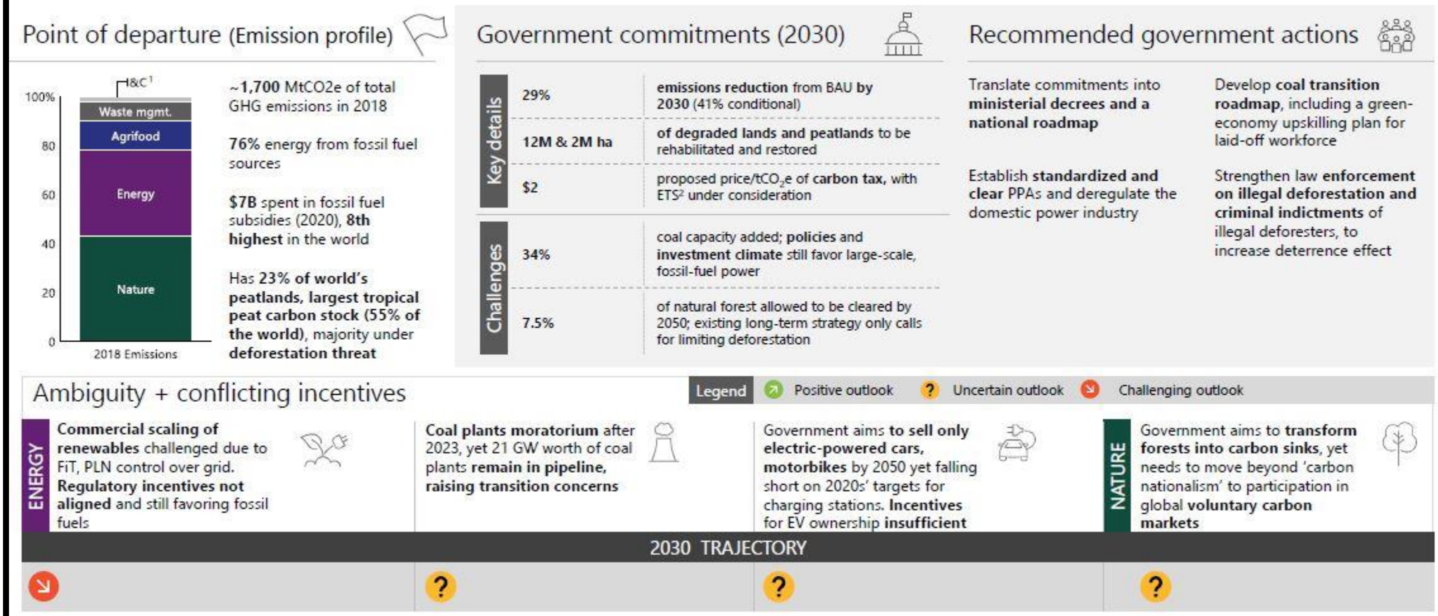
Meanwhile, per capita CO2 emissions from fuel combustion during 1990–2018 increased with economic growth in the ASEAN region and in most member states, especially Vietnam, Indonesia and the Philippines, which more than offset the decline in per capita emissions from Malaysia. ASEAN may need to accelerate the adoption of lower-emissions sources of energy for power generation and transportation.

According to NGO Global Energy Monitor, ASEAN is one of the few regions where the share of coal has steadily risen, in contrast to global trends, and the IEA projects it to continue to rise over the next 20 years, by approximately 3% per year. The Philippines is an exception as it announced in 2020 a moratorium on the development of new greenfield coal power plants. There is still more than 95,000 MW of new capacity planned or in construction across the region – predominantly in Indonesia and Vietnam, and without a concerted effort to transition to clean energy sources, energy-related GHG emissions across ASEAN will almost double by 2040, according to research from Global Energy Monitor.

Figure 51: Coal-fired power plants pipeline in eight ASEAN member states, as at July 2021

SOURCES: GLOBAL ENERGY MONITOR, ASEAN GREEN FUTURE PROJECT PHASE 1 REPORT, NOVEMBER 2021

Figure 52: Indonesia has announced bold net zero ambitions; however, the path is unclear as to how it will deliver results with inconsistencies on many market practices (Bain & Company, June 2022)

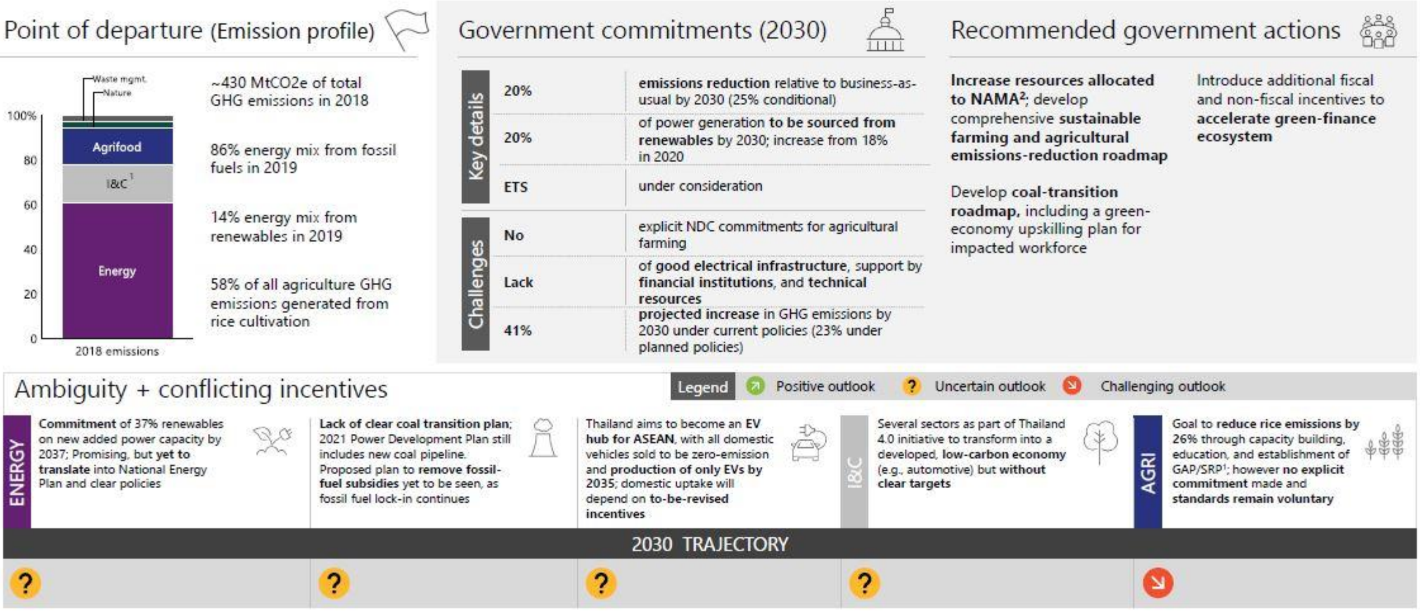


SOURCES: BAIN & COMPANY, TEMASEK

Figure 53: Malaysia's push for new carbon initiatives encouraging, but greater clarity on timeline and actionable goals needed to deliver results in line with ambitions (Bain & Company, June 2022)

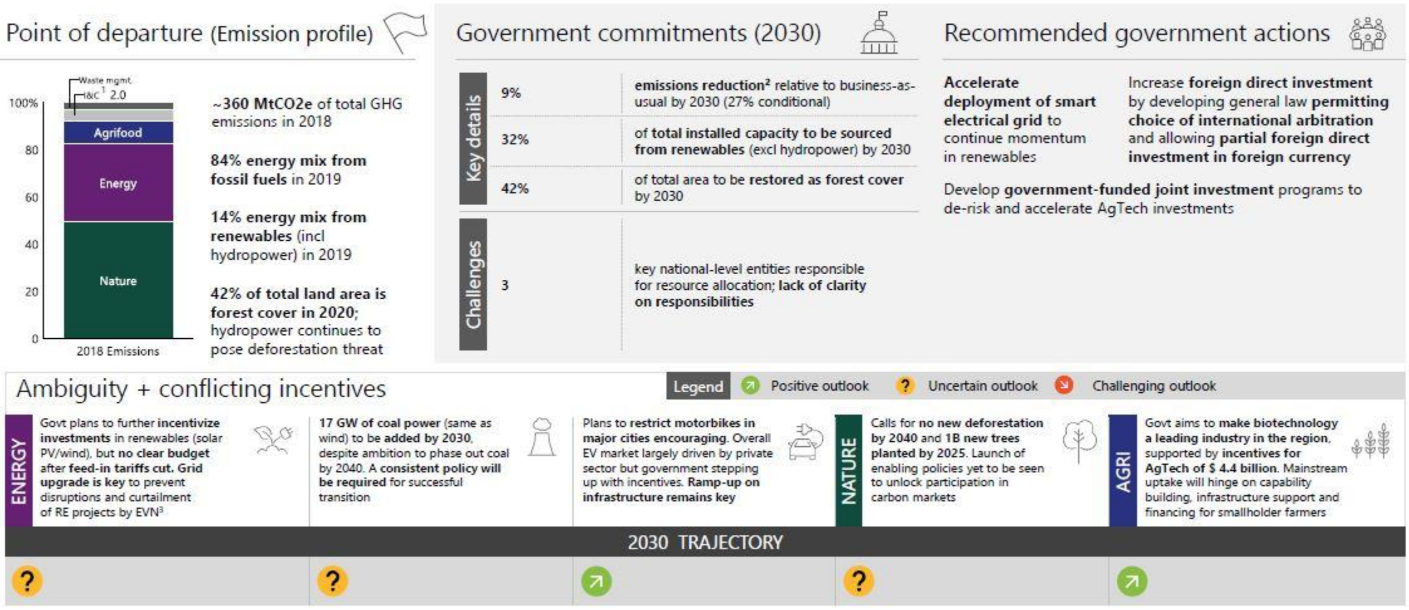
SOURCES: BAIN & COMPANY, TEMASEK

Figure 54: Thailand needs to raise its carbon ambition and add concrete measures to transition (Bain & Company, June 2022)



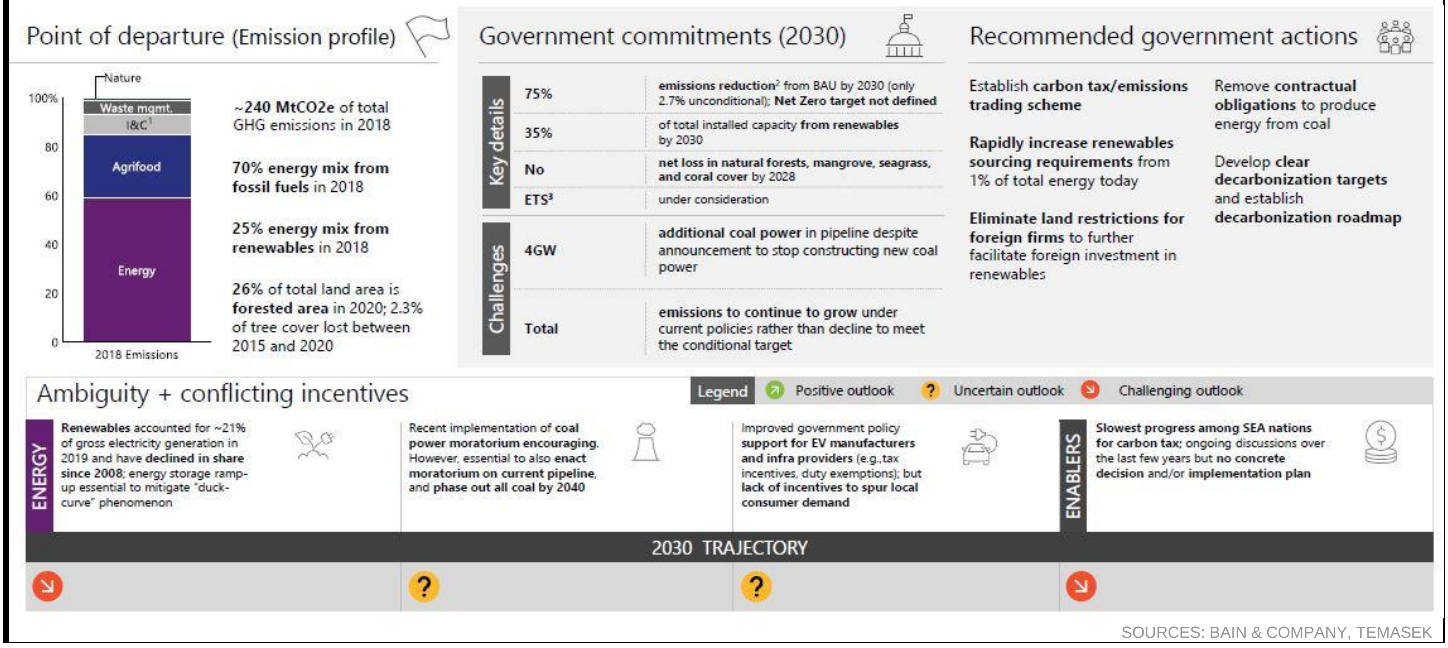
SOURCES: BAIN & COMPANY, TEMASEK

Figure 55: Vietnam's higher NDC target is modest in scale; greater clarity on coal phase-out and renewables phase-in plan needed to define how goals will be delivered (Bain & Company, June 2022)



SOURCES: BAIN & COMPANY, TEMASEK

Figure 56: Philippines ambition lags behind ASEAN peers; few concrete plans or policies (Bain & Company, June 2022)



SOURCES: BAIN & COMPANY, TEMASEK

Figure 57: Singapore leading SEA green transition journey; recent carbon tax increase strengthens forward trajectory (Bain & Company, June 2022)

SOURCES: BAIN & COMPANY, TEMASEK

Indonesia's carbon tax and carbon market regulations

Indonesia's proposed carbon tax

In October 2021, Indonesia set out its Carbon Pricing Roadmap, which aims to set up an ETS and carbon crediting mechanism, and also introduce a carbon tax.

Initially, the carbon tax rate will be at Rp30,000/tCO2e (US$2), and will be charged against emissions of coal-fired power plants above a certain limit. The carbon tax may be expanded to other sectors in 2025.

The carbon tax was initially set to commence in April 2022, but was pushed back to July 2022 due to the rise in oil prices after the Russia-Ukraine war started in February 2022, and then delayed again to a future unspecified start date, although the Indonesian government had said that it wants the carbon tax to be in place before the G20 summit in Bali on 15-16 November 2022.

In the longer term, the tax may operate alongside a mandatory ETS for coal-fired power plants, under a hybrid "cap-and-trade-and-tax" system, whereby facilities that exceed their emissions cap will have the option to compensate the excess emissions through three options, i.e. the trading of carbon allowances, offsetting via voluntary carbon credits, or by simply paying the applicable carbon tax.

The proposed Indonesian carbon tax imposes a price on carbon on about 279 MtCO2e (using 2018 numbers), according to the World Bank, representing 26% of Indonesia's GHG emissions.

Pilot and proposed ETS

In March 2021, Indonesia launched a voluntary emissions trading trial for the power sector for up to 80 coal-fired power plants. The voluntary intensity-based ETS pilot for the power sector took place between April and August 2021. The voluntary programme is expected to be succeeded by a mandatory domestic ETS. The ETS will likely be combined with the carbon tax and carbon offset mechanisms.

Malaysia's carbon tax and carbon market regulations

In September 2021, Malaysia's Environment and Water Ministry (KASA) said that the cabinet has in principle agreed to KASA's proposal to develop a **VCM** and a **domestic ETS (DETS)**. The government plans to roll out DETS in phases and a single business platform will be developed, which would enable state authorities and the private sector to leverage DETS to execute carbon credit transactions at the domestic level.

In the context of the 12th Malaysia Plan, Malaysia also said in September 2021 that it was exploring the introduction of a **carbon tax**; however, no details have emerged yet.

Bursa Malaysia is in the process of developing a **voluntary carbon exchange** before end-2022, with credits offered from Malaysian and foreign sources.

Thailand's carbon tax and carbon market regulations

The **Thailand Voluntary Emission Trading Scheme (Thailand V-ETS)** is currently a pilot ETS for all sectors, except for the power sector. The first phase of the voluntary ETS consisted of Phase 1 during 2015-2017. In 2020, sector-specific guidelines were developed for the beverage and sugar, textiles, and flat glass industries. Since 2021, Thailand is developing a strategic plan for ETS implementation in Thailand's Eastern Economic Corridor region.

Since 2013, Thailand Greenhouse Gas Management Organization (TGO) has developed a voluntary domestic GHG crediting mechanism called the **Thailand Voluntary Emission Reduction Program (T-VER)**. The credits from T-VER are applied against domestic emissions.

Following COP26, the government is developing rules and guidelines for carbon credit trading, expected to be released in 2022. As part of this work, the TGO is collaborating with the Federation of Thai Industries to develop a carbon credit trading platform.

The **Thailand Carbon Offsetting Programme (T-COP)** encourages public and private organisations to calculate their carbon footprint and buy carbon credits to offset their unavoidable emissions.

Vietnam's carbon tax and carbon market regulations

According to the Center for International Forestry Research (CIFOR), in 2010, Vietnam's government became the first country in Asia to institutionalise a nationwide policy on **Carbon Payment for Forest Environmental Services (C-PFES)**. The PFES policy requires users of forest environmental services to make payments to suppliers of these services. Such services include: watershed protection; natural landscape beauty protection and biodiversity conservation for tourism; forest carbon sequestration and the reduction of greenhouse gas emissions through the prevention of deforestation and forest degradation; and the provision of the forest hydrological services for spawning in coastal fisheries and aquaculture. Vietnam's Ministry of Agriculture and Rural Development (MARD) has established fixed payments for watershed and landscape beauty protection services.

In January 2022, the government of Vietnam issued a decree which sets forth rules for monitoring, reporting, and verification (MRV) systems and includes provisions for developing a **national ETS** with a declining cap corresponding to Vietnam's NDC and the establishment of a **national crediting mechanism**. Vietnam anticipates launching a pilot ETS in 2026, before launching a full ETS in 2028.

Singapore's carbon tax regulations

The **Singapore carbon tax** was implemented from 1 January 2019 on all facilities with annual direct GHG emissions of 25 ktCO2e or more, with no exemptions; these include power stations and other industrial installations. This is in addition to the excise duties that have traditionally been levied on transportation fuels.

The current and proposed carbon tax rates are as follows:

- 2019-2023 (five years): S$5/tCO2e (~US$4)
- 2024-2025 (two years): S$25/tCO2e (US$18)
- 2026-2027 (two years): S$45/tCO2e (US$32)
- 2028-2030 (three years): To be progressively increased to a range of between S$50/tCO2e to S$80/tCO2e (US$36-57)

Currently, companies subject to the tax are not allowed to use carbon credits to offset their tax liabilities, but this will change from 2024 onwards, when companies will have the option of offsetting 5% of their carbon tax liabilities by buying international carbon credits. We expect companies to use carbon offsets if they are cheaper than the rate of carbon tax.

The Singapore government is currently engaging with companies that will be affected by the proposed hike in carbon tax in 2024, and may introduce a 'transition framework' that will see existing 'emissions-intensive trade-exposed' (EITE) companies (that are subject to carbon leakage) receive 'transitory allowances' based on efficiency standards and decarbonisation targets. However, new investments will not qualify for the transition framework.

The Singapore carbon tax imposes a price on carbon on about 57 MtCO2e (using 2018 numbers), according to the World Bank. About 80% of Singapore's GHG emissions will be covered by the carbon tax.

Appendices…

APPENDIX 1: GREENHOUSE GASES (GHG)

What are GHGs?

What are GHGs and why do they cause global warming? According to NASA, the earth's temperature depends on how much energy is absorbed from the sun and how much is radiated back into space, but the presence of GHGs change the chemical composition of the atmosphere and trap the heat from the sun.

GHGs are naturally present, but human activity has increased their concentration in the atmosphere, with rising levels of carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), and ozone (O3). In addition, human-made GHGs in the atmosphere include sulphur hexafluoride (SF6), nitrogen trifluoride (NF3), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Carbon dioxide (CO2) is emitted from the burning of fossil fuels (oil, natural gas, coal, etc.) for transportation and electricity generation; from certain manufacturing processes (such as the production of cement and chemicals); and from land-use changes such as the clearing and draining of carbon sinks, e.g. peatland. CO2 is the primary GHG that is emitted by anthropogenic activity; the US Environmental Protection Agency (EPA) estimates that almost 80% of the GHG emissions in the US are of CO2.

Methane (CH4) is released during the process of extracting natural gas, oil, as well as coal, or arising from leaks in the natural gas piping infrastructure. CH4 is also released by livestock as part of their natural digestive process, and by the decay of organic waste in landfills.

Nitrous oxide (N2O) is emitted by the combustion of fossil fuels, and released as a result of agricultural activities such as the application of nitrogen-based fertilisers (e.g. urea) which interact with soil microbes to produce N2O.

Fluorinated gases are almost entirely man-made, and include sulphur hexafluoride (SF6), nitrogen trifluoride (NF3), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) that are emitted from a variety of household and industrial equipment and applications. HFCs are used as refrigerants for air conditioning systems, aerosol propellants, foam blowing agents, solvents, and fire retardants. According to the US EPA, PFCs are produced as a by-product of aluminium production and are used in the manufacture of semiconductors, SF6 is used in magnesium processing and semiconductor manufacturing, while NF3 is used in semiconductor manufacturing. While fluorinated gases are emitted in small quantities, they are potent GHGs with very high global warming potential, and can stay in the atmosphere for thousands of years.

The Global Warming Potential (GWP) of GHGs

GWP is a measure to standardise the measurement of different GHGs in terms of how they contribute to global warming by comparison with CO2, taking into account the effects of time. CO2 will always have a GWP of 1 because that is the benchmark against which all other GHGs are compared against. CH4 is a much more potent GHG than CO2, with a GWP of 81 over a 20-year time horizon, declining to 28 over a 100-year horizon, and to 8 over a 500-year horizon. Although CH4 will remain in the atmosphere for just 12 years after its initial release into the air, its greenhouse effects last much longer than that, because after 10 years, most of the emitted methane will have reacted with ozone to form CO2 and water. This CO2 will continue to warm the environment for hundreds of years after that.

The concept of **carbon dioxide equivalent (CO2e)** follows from the GWP metrics. One tonne of CH4 is equivalent to 81 tonnes of CO2 on a 20-year horizon basis, and is equivalent to 28 tonnes of CO2 on a 100-year basis. The 100-year time horizon is used as the standard measure when computing CO2e for the purpose of declaring CH4 emissions. Hence, one tonne of CH4 is said to be equivalent to 28 tonnes of CO2e. However, using a 100-year horizon underestimates the near- and medium-term warming impact of CH4 emissions, which is almost three times more potent over a 20-year period.

Figure 58: Greenhouse gases (GHG) and their Global Warming Potential (GWP)

No	Type of GHG	Lifetime	GWP for a given time horizon		
		(years)	20-year	100-year	500-year
1	Carbon dioxide (CO2)	Note [a]	1	1	1
2	Methane (CH4)	12	81	28	8
3	Nitrous oxide (N2)	109	273	273	130
4	Sulphur hexafluoride (SF6)	3,200	18,300	25,200	34,100
5	Nitrogen trifluoride (NF3)	569	13,400	17,400	18,200

Note a Between 65% and 80% of CO2 released into the air dissolves into the ocean over a period of 20–200 years. The rest is removed by slower processes that take up to several hundreds of thousands of years. (Source: Guardian)

SOURCE: IPCC SIXTH ASSESSMENT REPORT

APPENDIX 2: HOW COMPLIANCE CARBON MARKETS WORK

Cap-and-trade (CAT): Numerical examples

The examples below, from Scenarios A1 to A4, are based on a hypothetical CAT regime, and is merely an illustration of the way that CATs may work, in general.

In Scenario A1, an emissions cap of 100 tCO2 was established by the government for the year, with 90% of the allowances to be provided free to the only three companies operating in the same industry subject to the CAT. Free allowances amounting to 90 tCO2 are then allocated to Companies A, B and C at the start of the year based on their expected production output.

Company A calculated that if it produced according to its business plan, it will only emit 30 tCO2 for the year, lower than the 45 tCO2 of free allowances received. Hence, it will be in a position to sell an excess 15 tCO2 free allowances to other companies who might emit more than the free allowances allocated to them.

Because Company C has an inefficient plant and is a heavy emitter, if it produced according to plan, it will likely be short of 30 tCO2 of allowances at the end of the year, even after buying whatever Company A might have to sell of its excess free allowances. As a result, Company C calculated that it will have to buy allowances from the government via auction. However, only 10 tCO2 of allowances will be available for sale, which is the difference between the emissions cap of 100 tCO2 and the already-allocated free allowances of 90 tCO2. As a result, Company C decided during the year that it will have to emit 20 tCO2 less than its original business plan, which means that it will have to throttle output in the absence of any additional emissions mitigation.

This may motivate Company C to invest in emissions mitigation, because it currently emits 30 tCO2/unit of production, vs. Company A's 6 tCO2/unit and Company B's 10 tCO2/unit. Alternatively, Company C may just shut down its inefficient plant and build a new one, or simply cede the market to its competitors.

Figure 59: Cap-and-trade (CAT) scheme: Scenario A1 only (base case)

Scenario A1: Emissions cap at 100 tCO2, free allocation rate of 90%						
Emissions cap	tCO2	100				
Benchmark emissions	tCO2/unit	10				
Free allocation rate	%	90%				
		Company A	Company B	Company C	Total	Notes
Production output	units	5	3	2	10	
Actual emissions	tCO2	30	30	60	120	
Allocated free allowances	tCO2	45	27	18	90	Total no of free allowances = Emissions cap x Free allocation rate Free allowances allocated between companies by expected production output
Excess/(shortfall) of free allowances	tCO2	15	-3	-42	-30	
Purchase/(sale) of free allowances	tCO2	-15	3	12	0	Transfer of allowances from one company to another via sale and purchase transactions
		0	0	-30	-30	
Purchase of government-auctioned allowances	tCO2	0	0	10	10	The government auctions the remaining allowances not allocated for free
		0	0	-20	-20	
Production curtailment	tCO2	0	0	20	20	Production curtailment is necessary for the least-efficient producer because the actual emissions is above the emissions cap
Differential between actual emissions and emissions cap	tCO2	0	0	0	0	

SOURCE: CGS-CIMB RESEARCH

In Scenario A2, the only difference with Scenario A1 is that the emissions cap is reduced to 90 tCO2 for the year. This reduces the number of free allowances allocated to each company. Hence, Company A may end up with only 11 tCO2 of extra free allowances to sell, down from 15 tCO2 previously. Company B may have to buy an extra 3 tCO2 of allowances from Company A, leaving only 5 tCO2 left for Company C.

Company C plans to buy all of the available government auction of 9 tCO2 of allowances, but it will still have to curb its emissions by 30 tCO2, rather than the 20 tCO2 in the original scenario. This shows that a reduction in emissions cap will force the burden of compliance to the least-efficient producer. However, a lower emissions cap also lowers the number of free options that the most-efficient producer is able to sell for a profit. Hence, it will have to continuously improve its emissions intensity even more to preserve its earlier advantage.

Figure 60: Cap-and-trade (CAT) scheme: Scenario A1 (base case) vs. Scenario A2

Scenario A1: Emissions cap at 100 tCO2, free allocation rate of 90%						Scenario A2: Emissions cap reduced to 90 tCO2				
Emissions cap	tCO2	100				90				
Benchmark emissions	tCO2/unit of output	10				9				
Free allocation rate	%	90%				90%				
		Company A	Company B	Company C	Total	Company A	Company B	Company C	Total	Notes
Production output	units	5	3	2	10	5	3	2	10	
Actual emissions	tCO2	30	30	60	120	30	30	60	120	
Allocated free allowances	tCO2	45	27	18	90	41	24	16	81	The number of free allowances drops between Scenario A and B because the emissions cap is reduced
Excess/(shortfall) of free allowances	tCO2	15	-3	-42	-30	11	-6	-44	-39	
Purchase/(sale) of free allowances	tCO2	-15	3	12	0	-11	6	5	0	Transfer of allowances from one company to another via sale and purchase transactions
		0	0	-30	-30	0	0	-39	-39	
Purchase of government-auctioned allowances	tCO2	0	0	10	10	0	0	9	9	The government auctions the remaining allowances not allocated for free
		0	0	-20	-20	0	0	-30	-30	
Production curtailment	tCO2	0	0	20	20	0	0	30	30	Production curtailment increases for the least-efficient company between Scenario A and B because the emissions cap is reduced
Differential between actual emissions and emissions cap	tCO2	0	0	0	0	0	0	0	0	

SOURCE: CGS-CIMB RESEARCH

In Scenario A3, the only change from the base-case Scenario A1 is that the free allocation rate has been reduced from 90% to 80%. This will reduce the excess free allowances that Company A will have available to sell, and increase the number of allowances that Company C will have to buy via auction.

Figure 61: Cap-and-trade (CAT) scheme: Scenario A1 (base case) vs. Scenario A3

Scenario A1: Emissions cap at 100 tCO2, free allocation rate of 90%						Scenario A3: Free allocation rate reduced to 80%				
Emissions cap	tCO2	100				100				
Benchmark emissions	tCO2/unit of output	10				10				
Free allocation rate	%	90%				80%				
		Company A	Company B	Company C	Total	Company A	Company B	Company C	Total	Notes
Production output	units	5	3	2	10	5	3	2	10	
Actual emissions	tCO2	30	30	60	120	30	30	60	120	
Allocated free allowances	tCO2	45	27	18	90	40	24	16	80	Total number of free allowances reduced because of the lower free allocation rate
Excess/(shortfall) of free allowances	tCO2	15	-3	-42	-30	10	-6	-44	-40	
Purchase/(sale) of free allowances	tCO2	-15	3	12	0	-10	6	4	0	
		0	0	-30	-30	0	0	-40	-40	
Purchase of government-auctioned allowances	tCO2	0	0	10	10	0	0	20	20	The number of auctioned allowances increases because the total number of free allowances was reduced
		0	0	-20	-20	0	0	-20	-20	
Production curtailment	tCO2	0	0	20	20	0	0	20	20	No change to production curtailment because the emissions cap did not change
Differential between actual emissions and emissions cap	tCO2	0	0	0	0	0	0	0	0	

SOURCE: CGS-CIMB RESEARCH

In Scenario A4, the CAT regulatory inputs remain unchanged from Scenario A1, but Company A improved its productivity and it will be in a position to increase its output from 5 units to 6 units. As a result of Company A's new business plan, it will emit more CO2, be allocated more free allowances, and will have fewer excess free allowances to sell to other companies during the year.

Company A's improved productivity impinges on the number of free allowances allocated to Companies B and C, both of whom do not plan to increase their production output. As a result of the lower number of free allowances, Company B will have to purchase more of Company A's excess free allowances, leaving very little left for Company C.

Company C will have no choice but to plan ahead and curb its output for the year by even more so than in the base-case scenario, since the annual emissions cap remains fixed at 100 tCO2, and the number of auctioned allowances remains unchanged at 10 tCO2.

This shows that CAT regimes provide efficient companies with the competitive advantage to drive its least-efficient rivals out of business.

Figure 62: Cap-and-trade (CAT) scheme: Scenario A1 (base case) vs. Scenario A4

Scenario A1: Emissions cap at 100 tCO2, free allocation rate of 90%						Scenario A4: Company A increases production from 5 units to 6 units in following year				
Emissions cap	tCO2	100				100				
Benchmark emissions	tCO2/unit of output	10				9.1				
Free allocation rate	%	90%				90%				
		Company A	Company B	Company C	Total	Company A	Company B	Company C	Total	Notes
Production output	units	5	3	2	10	6	3	2	11	Only Company A increases production from 5 units to 6 units
Actual emissions	tCO2	30	30	60	120	36	30	60	126	Actual emissions may increase due to higher production from Company A, if this is not offset by a higher production curtailment at the least-efficient producer, Company C, later on
Allocated free allowances	tCO2	45	27	18	90	49	25	16	90	Total number of free allowances remains the same, but the allocation across installations changes due to the change in production output at Company A
Excess/(shortfall) of free allowances	tCO2	15	-3	-42	-30	13	-5	-44	-36	
Purchase/(sale) of free allowances	tCO2	-15	3	12	0	-13	5	8	0	Transfer of allowances from one company to another via sale and purchase transactions
		0	0	-30	-30	0	0	-36	-36	
Purchase of government-auctioned allowances	tCO2	0	0	10	10	0	0	10	10	No change to the volume of auctioned allowances because the free allocation rate and the emissions cap did not change
		0	0	-20	-20	0	0	-26	-26	
Production curtailment	tCO2	0	0	20	20	0	0	26	26	A higher production curtailment at the least-efficient producer is necessary because of higher output at more-efficient producer(s)
Differential between actual emissions and emissions cap	tCO2	0	0	0	0	0	0	0	0	

SOURCE: CGS-CIMB RESEARCH

Baseline-and-credit (BAC): Numerical examples

In the examples below of the application of a hypothetical BAC regime, we use the same industry metrics as with the CAT examples above.

Governments do not set emissions caps for BAC schemes, but only announce a benchmark emissions level for specific industrial products. Assuming that the benchmark is 10 tCO2/unit of output, then the most efficient producer, Company A will have emitted 20 tCO2 less than its benchmark entitlement. It is then able to sell these 20 credits to other companies. BAC schemes focus on rewarding the most efficient producers with the opportunity to sell its carbon credits in excess of the government-set benchmark.

Company B does not need to buy any credits, as its emissions intensity is at the benchmark level. Company C buys 20 credits from Company A, but Company C's emissions will still be 20 tCO2 above its benchmark. Some BAC regimes do not require Company C to offset the remaining excess emissions, but others may require Company C to buy, at least to some degree, credits from the voluntary carbon markets (VCM).

Unlike for CAT regimes, governments in BAC schemes do not auction allowances.

Figure 63: Baseline-and-credit (BAC) scheme: Scenario B1 only (base case)

Scenario B1: Benchmark emissions at 10 tCO2/unit of output						
Benchmark emissions	tCO2/unit of output	10				
		Company A	Company B	Company C	Total	Notes
Production output	units	5	3	2	10	
Actual emissions	tCO2	30	30	60	120	
Benchmark emissions	tCO2	50	30	20	100	Benchmark emissions is based on the actual production output
Out/(under) performance against benchmark	tCO2	20	0	-40	-20	
Purchase/(sale) of free allowances	tCO2	-20	0	20	0	Transfer of allowances from one company to another via sale and purchase transactions
Remaining excess emissions	tCO2	0	0	-20	-20	Some BAC schemes may require some, but not all, of the remaining excess emissions to be covered by voluntary carbon credits

SOURCE: CGS-CIMB RESEARCH

In Scenario B2, the benchmark emissions rate is reduced from 10 to 7 tCO2/unit of production. As a result, Company A's outperformance against the benchmark is reduced, leaving it with fewer credits to sell to other companies. Company B buys 5 credits from Company A, but that still leaves it with 4 tCO2 of excess emissions, vs. none in the original Scenario B1. Company C's excess emissions will increase compared to the base case. This shows that a lower benchmark emissions rate will likely cause an increase in demand for VCM credits.

Figure 64: Baseline-and-credit (BAC) scheme: Scenario B1 (base case) vs. Scenario B2

Scenario B1: Benchmark emissions at 10 tCO2/unit of output						Scenario B2: Benchmark emissions rate reduced from 8 to 7 tCO2/unit of output				
Benchmark emissions	tCO2/unit of output	10				7				
		Company A	Company B	Company C	Total	Company A	Company B	Company C	Total	Notes
Production output	units	5	3	2	10	5	3	2	10	
Actual emissions	tCO2	30	30	60	120	30	30	60	120	Actual emissions increase due to higher production from Company A
Benchmark emissions	tCO2	50	30	20	100	35	21	14	70	Benchmark emissions decline due to lower regulatory rate
Out/(under) performance against benchmark	tCO2	20	0	-40	-20	5	-9	-46	-50	
Purchase/(sale) of free allowances	tCO2	-20	0	20	0	-5	5	0	0	Transfer of allowances from one company to another via sale and purchase transactions
Remaining excess emissions	tCO2	0	0	-20	-20	0	-4	-46	-50	A lower benchmark emissions rate increases offsetting requirements, if any

SOURCE: CGS-CIMB RESEARCH

In Scenario B3, Company A increases its production from 5 units to 6 units, compared with the base case. Total industry emissions increase from 120 tCO2 to 126 tCO2 in the absence of an emissions cap, which is not a feature of BAC regimes.

With higher output, Company A also has a higher level of benchmark emissions attributed to it, and its outperformance against the benchmark increases from 20 tCO2 to 24 tCO2. This gives its more credits to sell, showing that BAC regimes reward the most efficient producers. The presence of this reward may motivate Company B to improve the emissions of its production so that it too can outperform the benchmark.

For Company C, the increased output from Company A may put the former under increased competitive pressure. Furthermore, Company C may be required by the regulators to buy VCCs from VCM markets, which represents a penalty of sorts. Because Company C's emission intensity is so much higher than the benchmark, it may not be technically possible to reduce emissions to match the benchmark. Hence, it may opt to shut the plant instead of incurring VCC costs year after year.

Figure 65: Baseline-and-credit (BAC) scheme: Scenario B1 (base case) vs. Scenario B3

Scenario B1: Benchmark emissions at 10 tCO2/unit of output						**Scenario B3: Company A increases production from 5 units to 6 units, no other changes**				
Benchmark emissions	tCO2/unit of output	10				10				
		Company A	Company B	Company C	Total	Company A	Company B	Company C	Total	Notes
Production output	units	5	3	2	10	6	3	2	11	
Actual emissions	tCO2	30	30	60	120	36	30	60	126	Actual emissions increase due to higher production from Company A
Benchmark emissions	tCO2	50	30	20	100	60	30	20	110	Benchmark emissions increase due to higher production from Company A
Out/(under) performance	tCO2	20	0	-40	-20	24	0	-40	-16	
Purchase/(sale) of free allowances	tCO2	-20	0	20	0	-24	0	24	0	Transfer of allowances from one company to another via sale and purchase transactions
Remaining excess emissions	tCO2	0	0	-20	-20	0	0	-16	-16	Higher production from the most-efficient producer, Company A, reduces offsetting requirements, if any

SOURCE: CGS-CIMB RESEARCH

APPENDIX 3: THE EU EMISSIONS TRADING SYSTEM (EU ETS)

The EU ETS is the grand dame of CCMs

The European Union Emissions Trading System (EU ETS) is the world's oldest and one of the world's largest ETS in terms of the volume of emissions covered, but was displaced by China's national ETS when it became officially operational from 2021. However, in terms of the value of carbon allowances traded, the EU ETS is still the undisputed leader of the pack given the high price of EU ETS Allowances (EUA), compared against the low price of China's ETS allowances, for now at least.

In 1992, the European Commission (EC) had initially proposed to set up a combined carbon tax and carbon market proposal. The carbon tax proposal could not secure unanimous agreement of EU member states, and so the EC moved to set up a CCM instead, in the shape of the EU ETS.

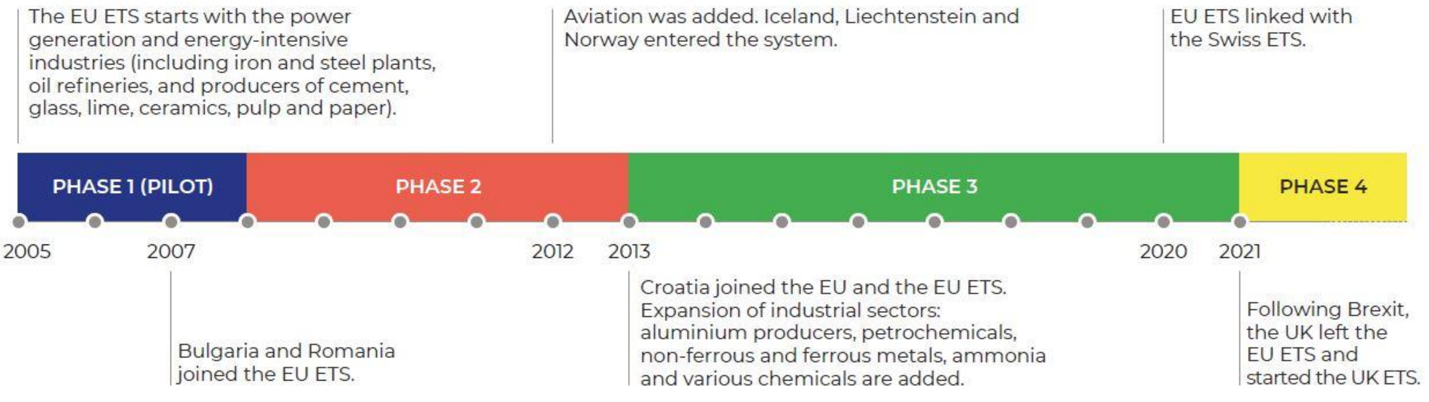
The EU ETS started off as a 3-year pilot phase over Phase 1: 2005-2007, followed by Phase 2: 2008-2012 (5 years), and Phase 3: 2013-2020 (8 years). The EU ETS is currently in Phase 4: 2021-2030 (10 years).

According to the EU, the EU ETS operates in all EU countries plus Iceland, Liechtenstein and Norway, i.e. in the European Economic Area (EEA) and European Free Trade Association (EFTA) states, and is linked to the Switzerland ETS since 1 January 2020. After the UK left the EU, it started its own ETS from 1 January 2021, which is also linked to the EU ETS. It limits emissions from around 10,000 installations in the power sector and manufacturing industry, as well as airlines operating between these countries, and covers around 40% of the EU's GHG emissions.

The EU ETS covers the emissions of carbon dioxide (CO2), nitrous oxide (N2O), and perfluorocarbons (PFCs), from various industries. CO2 emissions from electricity and heat generation, energy-intensive industry sectors (oil refineries, steel works, and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals), and commercial aviation within the EEA are regulated. N2O emissions from the production of nitric, adipic and glyoxylic acids and glyoxal are regulated, as with PFCs from the production of aluminium. For the aviation sector, the EU ETS will only apply to emissions from flights between airports in the EEA.

The EUAs represent the emissions cap that is issued for free, or auctioned, in any specific year, to various installations covered by the EU ETS. One EUA represents the right to emit 1 tonne of CO2e. When an installation emits 1 tonne of CO2e, one EUA is returned to the EC. Each EU member state must ensure that, by 30 April every year, each regulated installation surrenders a sufficient number of allowances to balance its total emissions from the preceding year. Unused or excess EUAs from previous years can be accumulated and used in future years, otherwise called the 'banking' of allowances.

Figure 66: Main changes to the coverage of the EU ETS



SOURCE: EMISSIONS TRADING EXTRA (ETX)

The overall emissions cap, and the number of EUAs issued, falls every year by a certain predetermined rate called the 'linear reduction factor' (LRF). This LRF was set at the start of the EU ETS Phases 3 and 4.

- Phase 1 started with a cap of 2,096 MtCO2e in 2005, Phase 2 started with a cap of 2,049 MtCO2e in 2009, while Phase 3 began with a single EU-wide cap of 2,084 MtCO2e in 2013 for stationary installations (there is a separate cap for airlines).
- For Phase 3 (2013-2020), the LRF was set at 1.74% p.a. from the 2008-2012 baseline emissions (representing an annual decline of some 38.3m EUAs during Phase 3).
- Due to the application of the Phase 3 LRF of 1.74% p.a. and the cancellation of allowances due to oversupply, the cap for stationary installations had declined to only 1,572 MtCO2e at the start of Phase 4 in 2021 (excluding a separate cap of 24.5 MtCO2e for airlines).
- For Phase 4 (2021-2030), the LRF was initially set at 2.2% p.a. (which amounts to an annual drop of some 43m EUAs), but the EC later proposed to increase the LRF to 4.2% from 2024 onwards under April 2021's 'Fit for 55' proposal.

Brief history of the EU ETS

Phase 1 (2005-2007)

The EU ETS began as a pilot in Phase 1 (2005-2007), and it regulated emissions from the power generation and energy-intensive industries, such as iron and steel plants, oil refineries, and manufacturers of cement, glass, lime, ceramics, and pulp and paper.

The EU emissions cap was determined by the summation of individual EU member states' emissions caps, which are also called National Allocation Plans (NAP). Virtually all EUAs were issued for free during Phase 1. Furthermore, a large supply of international carbon credits could be used to comply with the emissions cap. The net result was a large surplus of allowances, although it had a limited impact on the functioning of the EU ETS as the excess allowances in Phase 1 were not carried over into Phase 2.

Phase 2 (2008-2012)

During Phase 2 (2008-2012), the total EU emissions cap was still determined as a sum total of individual NAPs, but the proportion of EUAs allocated for free was reduced to 90%, and the first auctions were held. Airlines' emissions for flights within the EEA region became subject to emissions caps from 2012 onwards.

International offsets were allowed as an alternative to buying EUAs, and a total of 1bn international credits were permitted over Phase 2. Because the EU ETS's Phase 2 overlapped with the KP's First Commitment Period, the participating installations in the EU ETS often purchased credits from the CDM and JI schemes in place of buying EUAs during Phase 2 (and also Phase 3, although international credits were no longer permitted from 2021 onwards).

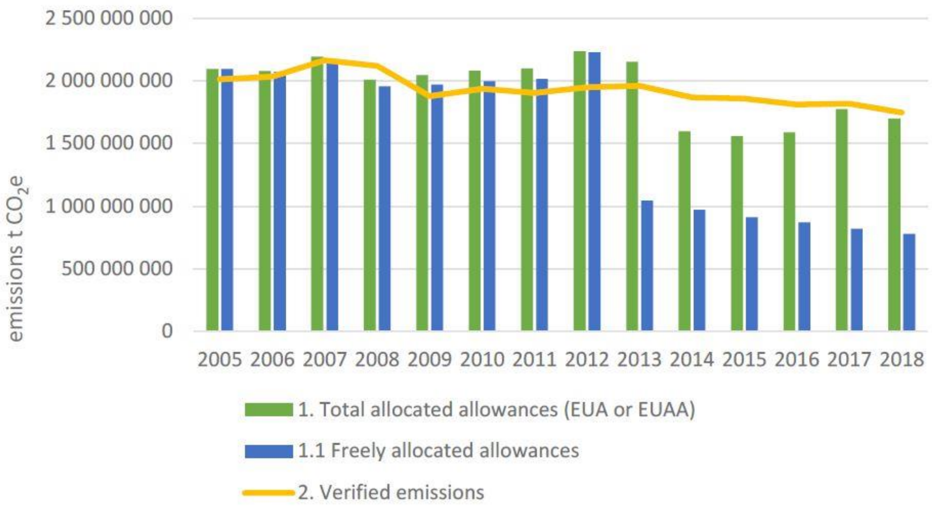
During Phase 2, there was a significant oversupply of EUAs due to the 2008 Global Financial Crisis which reduced economic output and emissions, and also due to the use of CDM/JI credits. The EC neither reduced the emissions cap nor cut the EUA issuances during Phase 2 despite the oversupply. The net result was that EUA prices traded to very low levels, from €30/tCO2e in 2008 to €2.75/tCO2e in April 2013, according to the EC. This oversupply situation lasted until the Market Stability Reserve (MSR) mechanism began removing excess EUAs from 1 January 2019 (more on this later).

Phase 3 (2013-2020)

In Phase 3 (2013-2020), the EU ETS extended its reach to cover emissions from other industrial sectors, i.e. the aluminium producers, petrochemicals, non-ferrous and ferrous metals, ammonia and other chemicals. A single, EU-wide cap was adopted, and the NAP methodology was abandoned. Auctioning EUAs also became the default method of allocating EUAs.

In Phase 3, power plants stopped receiving free allowances and had to pay for all the EUAs necessary to cover their GHG emissions, although free EUA allocations to industrial installations still covered most of their emissions.

Figure 67: Virtually all of the EU ETS Allowances (EUA) were allocated for free during Phase 2, but less than half were allocated for free in Phase 3 as power plants stopped receiving free allowances



SOURCE: EUROPEAN UNION (EU)

During Phase 3, the LRF was set at 1.74% p.a. from the 2013 emissions cap, which amounted to some 38.3m EUAs p.a.

For Phase 3, the EU had planned to reduce emissions targeted by the ETS by 21% by 2020 compared to the 2005 base. Ultimately, the EU ETS outperformed its objectives by successfully cutting emissions in the sectors it covered by 41%. The emissions reductions over Phase 3 were almost single-handedly attributable to the power sector, which had to pay for all of its emissions, whereas the GHG emissions from industry were more or less stagnant and emissions from domestic aviation actually rose, according to Emissions Trading Extra (ETX), due to the massive allocation of free allowances to industry and aviation that effectively disincentivised those industries from decarbonisation.

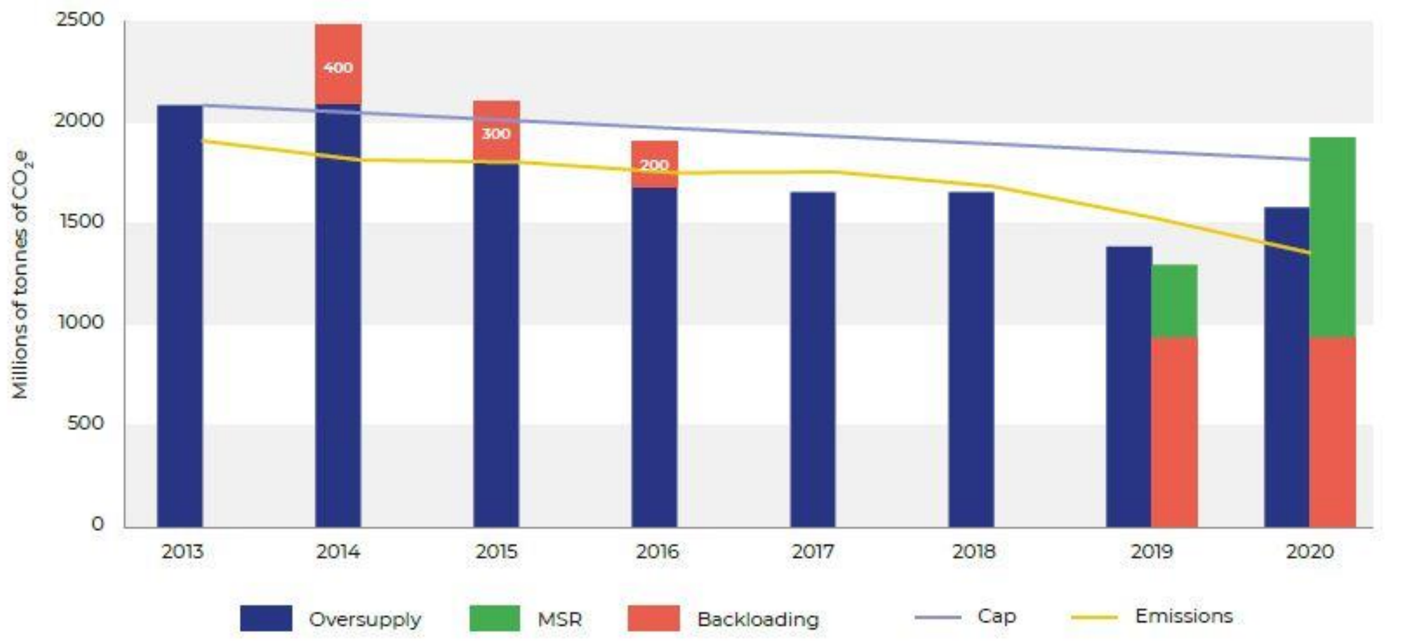
At end-2020, the EU ETS covered over 10,400 industrial and power installations, and approximately 350 airlines, across the 27 EU member states, Iceland, Norway, Liechtenstein (the data above includes participating installations in the UK, which transitioned to a new UK ETS on 1 January 2021). These installations and airlines made up 36% of the EU's emissions at end-2020, vs. c.50% of the grouping's emissions in 2013, because the EU ETS sectors, in combination, had reduced their emissions faster than the rest of the economy, according to ETX.

In terms of international credits, these were still permitted in Phase 3, but the EC had put in place quantitative and qualitative limits to their use. For instance, nuclear energy projects and afforestation or reforestation projects were not allowed. The use of new CDM project credits after 2012 was also prohibited, unless the project was registered in one of the least developed countries (LDC). The EC also reduced the permitted use of international credits from Phase 2's 1bn units to Phase 3's 500m units, and required the use of international credits to be accompanied by a one-for-one exchange for EUAs, therefore preventing the use of international credits from adding to the oversupply of allowances.

Despite the EC's best efforts, EUA prices during the first five years of Phase 3 continued to trade at low levels, because of the generous allocation of free EUA allowances which continued the oversupply situation from Phase 2.

In 2015, the **Market Stability Reserve (MSR)** was established to address the structural oversupply in the EU ETS. The MSR's first action was to postpone to 2019, the auctioning of 900m EUAs that were originally intended to be issued between 2014 and 2016. EUA prices began a steady upward climb from 2018 onwards in anticipation of the 2019 absorption and cancellation of a large volume of excess EUAs. Despite the contribution from the MSR in reducing the oversupply in 2019, the EUA oversupply increased in 2020 due to the impact of the Covid-19 pandemic.

Figure 68: The cumulative oversupply of EUAs at the end of every year during the Phase 3 of the EU ETS is shown in the blue bars; the red bars in 2014-2016 represent the postponement of individual year EUA auctions; the red bars in 2019-2020 represent the cumulative 'backloaded' 900m EUAs from 2014-2016; the green bars in 2019-2020 represent the MSR which ultimately absorbed the 900m EUAs



SOURCE: EMISSIONS TRADING EXTRA (ETX), EUROPEAN COMMISSION

Phase 4 (2021-2030)

In Phase 4 (2021-2030), the original ambition of the EU ETS is to reduce emissions from the sectors it covers by 40% by 2030, compared to the 1990 base (or down 43% compared to 2005 levels).

For Phase 4, the LRF was set at 2.2% p.a. From 2021 onwards, 57% of the allowances are to be auctioned. The EC no longer permits international carbon credits from CDM or JI to be used in place of buying EUAs. As for the MSR mechanism, it was strengthened by cancelling EUAs above a threshold.

Separately, the EC has also established two funds to help with the technical aspects of emissions mitigation and abatement.

1. The **EU Innovation Fund** was launched in 2017, and will support 60% of the capex and opex costs of large-scale projects that demonstrate innovative low-carbon technologies, such as carbon capture, utilisation and storage (CCUS), innovative renewable energy (RE) and energy storage technologies. Seven projects were selected in November 2021.
2. The **EU Modernisation Fund** will be operational throughout the entire Phase 4, and intends to help lower-income member states to modernise their energy sector and improve their energy efficiency. The total budget of the EU Innovation Fund and the EU Modernisation Fund depends on the volume of EUAs allocated to the funds, and the prices at which they are auctioned.

Proposed changes to Phase 4 from the 'Fit for 55' package of 14 July 2021

The European Green Deal was approved by EU member states in 2020, and it intends to make the EU as a whole 'climate neutral' in 2050 (although not every EU member state will be individually required to achieve carbon neutrality), and the EU aims to be net carbon negative beyond 2050.

In this context, the EC presented the **'Fit for 55' package** on 14 July 2021, which legally requires the EU as a whole, as well as its EU member states individually, to **reduce net GHG emissions by at least 55% by 2030, compared to 1990 levels**, or **by 61% by 2030, compared to 2005 levels**. The EU's 2030 target represents a gross emissions reduction of 52.8%, but including carbon removals from agriculture and forestry, the net removal actually rises to 57%.

This means that the EC has proposed to raise the ambition for Phase 4 of the EU ETS to at least 55% reduction in GHG emissions by 2030 vs. the 1990 base, compared to the initial target of 40% reduction (alternatively, a reduction of 61% by 2030 vs. the 2005 levels).

As noted earlier, the LRF during Phase 4 was initially set at 2.2% p.a., but the EC later proposed to increase the LRF to 4.2% from 2024 onwards under the 'Fit for 55' package. In addition, the emissions allowances cap would be adjusted downwards on a one-off basis by 117m allowances, as if the increased LRF had applied from 2021 ('rebasing').

We highlight that the EC's 'Fit for 55' package has yet to be adopted in the EU. According to Danish shipping company Maersk, the legislative process in the EU requires that the Council of the European Union (comprising EU member state government ministers) and the European Parliament (comprising directly-elected representatives) must both agree on a joint legislative text. This process requires that agreement is first reached internally within each of the two bodies. After that, the Council and the Parliament, together with the EC, need to reach a compromise before the proposal becomes legislation. Maersk expect the process to be completed by end-2022.

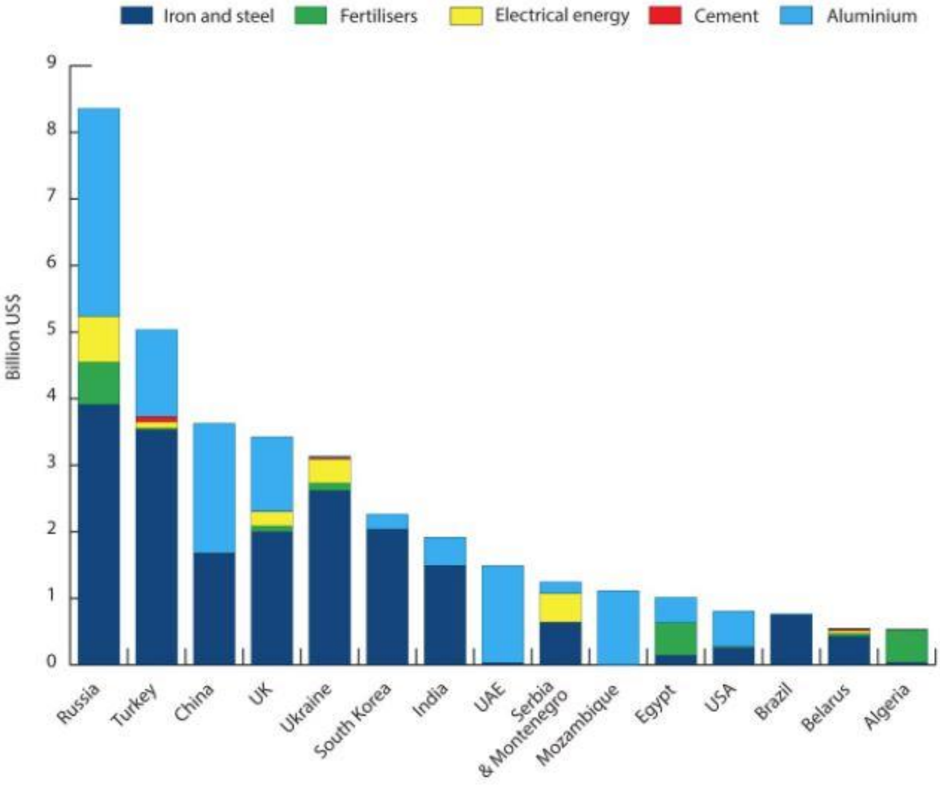
Other measures proposed under the 'Fit for 55' package

The EC's 'Fit for 55' package of 14 July 2021 envisages implementing the **Carbon Border Adjustment Mechanism (CBAM)** from 2026 for imported high-emissions products manufactured in non-EU countries in which carbon taxes or CCMs either do not exist, or are imposed at rates lower than the EU equivalents. The CBAM will initially apply only to a limited set of sectors deemed at high risk of carbon leakage, i.e. iron and steel, cement, fertiliser, aluminium and electricity generation. The CBAM is meant to ensure equal treatment for those products made in the EU and imports from elsewhere. Once the CBAM takes effect from 2026, importers of those goods into the EU will have to buy carbon certificates to cover the embedded Scope 1 emissions in the imported products, at a price that is equivalent to the prevailing weekly average EUA auction price. Embodied Scope 2 emissions from electricity consumption will only need to be reported to the EC by importers, for now.

Imports from countries that participate in the EU ETS or have a domestic ETS linked to the EU ETS will be fully exempt from the CBAM. Goods that are subject to a carbon tax or ETS price in their country of origin will be eligible for a rebate of the CBAM that is equal to the carbon price already paid prior to export.

For the EU-based producers of the products that are covered by the CBAM, the free allowances allocated to those producers will be gradually abolished from 2026 onwards, as the CBAM is intended to replace free allowances as the principal way of preventing carbon leakage. In 2026, the affected installations will receive 90% of their free allowances (instead of 100% in 2025), falling to 80% in 2027, 70% in 2028, 60% in 2029, 50% in 2030, 40% in 2031, 30% in 2032, 20% in 2033, 10% in 2034, and finally to zero in 2035, when the allocation of free allowances to the affected manufacturing industries will be fully abolished.

Figure 69: Value of goods affected by the EU CBAM in 2019 for the 15 most-exposed countries (€ bn)



SOURCES: CENTRE FOR EUROPEAN REFORM, CARBON BRIEF

Maritime emissions will be gradually phased-in for the first time from 2023, which will cover around two-thirds of maritime emissions; it is intended to incentivise energy efficiency improvements, low-carbon technologies, and the use of more expensive alternative low- or zero-carbon maritime fuels. CO2 emissions from large ships above 5,000 gross tonnage will be covered, with respect to all CO2 emissions from intra-EU voyages, all emissions occurring when ships are at berth in an EU port, but applicable to only 50% of emissions for voyages between non-EU ports and EU ports ('extra-EU voyages'). Maritime emissions will be progressively phased into the EU ETS, i.e. 20% of the applicable maritime emissions will have to surrender allowances in 2023, rising to 45% in 2024, 70% in 2025, and 100% from 2026 onwards.

Airline emissions for intra-EU flights have been included in the EU ETS since 2012, but the EC proposed to cap the total number of aviation allowances in the ETS at current levels, and to then reduce allowances annually using the proposed ETS LRF of 4.2%. The number of free allowances allocated to aircraft operators will also gradually reduce to reach full auctioning by 2027. The EC proposed to align the EU ETS with the global Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The EU ETS will apply for intra-EU flights (including to/from post-Brexit UK and Switzerland), while CORSIA will apply to EU airline operators for extra-EEA flights to and from third countries participating in CORSIA. When emissions from flights to/from countries outside the EEA reach levels above 2019, they will have to be offset with corresponding carbon credits. Section 8 of this report describes CORSIA in greater detail.

A **separate ETS system ('ETS II') for buildings and the road transport sector** will be established, starting from 2025. The regulated entities would be the distributors of fuel, rather than end-consumers, which will have to surrender allowances from 2026 onwards corresponding to the carbon intensity of the fuels. A to-be-determined linear cap on emissions will be set for 2026. The target is for emissions for buildings and road transport to decline by 43% by 2030, relative to the 2005 baseline. One-quarter of the revenues from the auction of allowances for the ETS II will be placed into a to-be-established Social Climate Fund, which will support vulnerable groups from the impact of higher heating and fuel costs.

Other measures to be taken in the 'Fit for 55' package include banning the sale of internal combustion engine (ICE) cars by 2035, requiring a 55% reduction in CO_2 emissions from automobiles in 2030 compared with 2021, etc.

Recent developments

As noted earlier, the legislative process in the EU requires that the European Parliament and the Council of the European Union must both state their respective positions, and then agree on a joint legislative text, before the EC's 'Fit for 55' package and any amendments to the package, can become legislation. Both the Parliament and the Council have subsequently stated their positions, which are summarised below.

On 22 June 2022, the **European Parliament** (comprising directly-elected representatives) adopted its version of the legislation, with significant counter-proposals to the 'Fit for 55' proposal of the EC:

- In terms of the annual LRF, the EC had proposed to lift the LRF to 4.2%, but the Parliament counter-proposed to raise it to 4.4% in 2024 and 2025, rising to 4.5% from 2026 and to 4.6% from 2029, which would reduce emissions in the ETS sectors by 63% below 2005 levels by 2030, compared to 61% in the EC proposal.
- For the CBAM, the free allowances in the ETS sectors would be phased out at a faster pace, i.e. to 93% in 2027, 84% in 2028, 69% in 2029, 50% in 2030, 25% in 2031 and 0% in 2032.
- A bonus-penalty system will be established to reward the most efficient installations in a sector with additional free allowances, while installations that refuse to implement improvement plans may lose some or even all of their free allowances.
- For shipping, 100% of the emissions in extra-EU voyages will be covered by the EU ETS, and to abandon the phase-in approach, instead applying the ETS for 100% of emissions from 2024. The Parliament proposed expanding the coverage to emissions of CH_4 and N_2O, and introduced the concept of a 'port at risk of carbon leakage' by proposing to apply the ETS carbon price to ports within 300 nautical miles of the EEA that also have a transshipment share of more than 60%. From 2027 onwards, the EU ETS will be expanded to cover emissions from ships above 400 gross tonnage.
- The ETS II for road transport and buildings would be established on 1 January 2024, and allowances would be auctioned from 2025 – one year earlier than proposed by the EC. However, before 2029 it would only apply to commercial buildings and commercial road transport. Residential buildings and private transport may be included from 2029, subject to an EC review.

On 29 June 2022, the **Council of the European Union** (comprised of EU member state government ministers) stated its counterproposals on the EC's 'Fit for 55' package, among others:

- For the CBAM, the phase-out of free allowances would be slower at the beginning, and accelerated at the end of the 10-year phase-in period.
- The auctioning of ETS II allowances would start in 2027 and surrender obligations in 2028 – a year later than proposed by the EC.

On 5 September 2022, the European Parliament rejected proposals to include shipping and road transport in the EU ETS. Negotiations are underway to find a compromise solution.

EU ETS Allowance (EUA) prices increased after oversupply absorbed by the Market Stability Reserve (MSR) from 2019

Phase 2 of the EU ETS in 2008-2012 was marked by very low EUA prices, due to a combination of factors:

- The 2008 Global Financial Crisis (GFC) caused emissions to fall, reducing the demand for allowances, for which the volume of issuances had been decided before the GFC.
- The EC was reluctant to reduce the issuance of free allowances despite the resultant oversupply.
- This situation enabled a high level of compliance by EU installations at a very low cost that acted as a disincentive for serious emissions reductions investments. In fact, many industrial installations over the course of Phase 2 received more EUAs than they actually required, and were able to sell their excess EUAs in the market. Perversely, those industrial installations were actually paid to pollute.
- The problem of surplus EUAs was compounded by the availability of cheap international credits from the KP's CDM and JI programmes (Phase 2 of the EU ETS coincided with the KP's First Commitment Period), which could be used as a licence to pollute in place of the EUAs. Some installations, while requiring allowances to cover their emissions, executed profitable arbitrages by selling more expensive EUAs in exchange for buying cheaper CERs and ERUs from the CDM and JI mechanisms, respectively, and made positive spreads from the trade.

Phase 3 of the EU ETS in 2013-2020 continued to see the EC over-allocate free allowances to installations every year. As a result, the price of EUAs continued to languish, and the use of cheap international credits continued to be permitted. The low EUA prices prompted the EC to consider introducing structural reforms to strengthen the price signal for decarbonisation.

Why and how free allowances are allocated

The allocation of free allowances is intended to protect against the risk of carbon leakage, which is the risk that manufacturing installations in the EU may shut its doors and relocate to another jurisdiction that does not charge a price for carbon emissions.

While power plants were no longer allocated free allowances from 2013 onwards, i.e. from the start of Phase 3 of the EU ETS, manufacturing installations representing 98% of industrial emissions in the EU continued to receive free allowances during Phase 3 (2012-2020).

From Phase 3 onwards, the allocation of free allowances is based on specific industries' emissions intensity benchmarks, which are separately calculated for each product. The average emissions intensity of the best 10% of installations producing that product in the EU will be used as the benchmark. According to the EU, "the benchmarks are based on the principle of 'one product = one benchmark'. This means that the methodology does not vary according to the technology or fuel used, the size of an installation or its geographical location." The EU has made emissions intensity benchmark calculations for 54 different products. In principle, installations that meet the benchmarks are among the most efficient in the EU and will receive all the allowances they need to cover their emissions. Installations that do not reach the benchmarks will receive fewer allowances than they need, and will have to reduce their emissions, and/or buy additional allowances or credits to cover their emissions.

During Phase 3, the manufacturing industry received 80% of its allowances for free in 2013, which declined gradually year-on-year to 30% in 2020, according to the EU.

In Phase 4 (2021-2030), manufacturing installations representing 94% of industrial emissions in the EU were allocated some amount of free allowances, down from 98% in Phase 3. However, because the EU mandates the auction of

57% of all allowances in Phase 4, the volume of free allowances will be less in Phase 4 than it was in Phase 3. From 2021 onwards, 57% of the EUAs will be auctioned.

Sectors that are at the highest risk of relocating their production outside of the EU will receive 100% of their allowances for free, while for less-exposed sectors, free allocation is targeted to be phased out from a maximum allocation of 30% of allowances between 2021 and 2026, down to zero at the end of phase 4 in 2030.

The EU also put in place rules to better align the level of free allocation with actual production levels, including adjusting allocations to individual installations annually by ±15% on the basis of 2-year rolling average production levels. This is to prevent excess supply of allowances (alternatively, shortages of allowances) that had bedevilled the EU ETS in the past.

In addition, the emissions intensity benchmark values for the 54 different products that are used to determine the level of free allocation to each installation will be updated twice in Phase 4 (first benchmark applicable to the 2021-2025 period; second benchmark for 2026-2030) to avoid windfall profits and reflect technological progress since 2008. An annual reduction rate will be determined for each benchmark; with a minimum annual reduction rate of 0.2% for the sectors with lower innovation uptake, and a maximum annual reduction rate of 1.6% for the sectors with higher innovation uptake.

However, the allocation of free allowances to industry may be abolished if the Carbon Border Adjustment Mechanism (CBAM) is introduced, which is also intended to protect against carbon leakage.

How the Market Stability Reserve (MSR) works

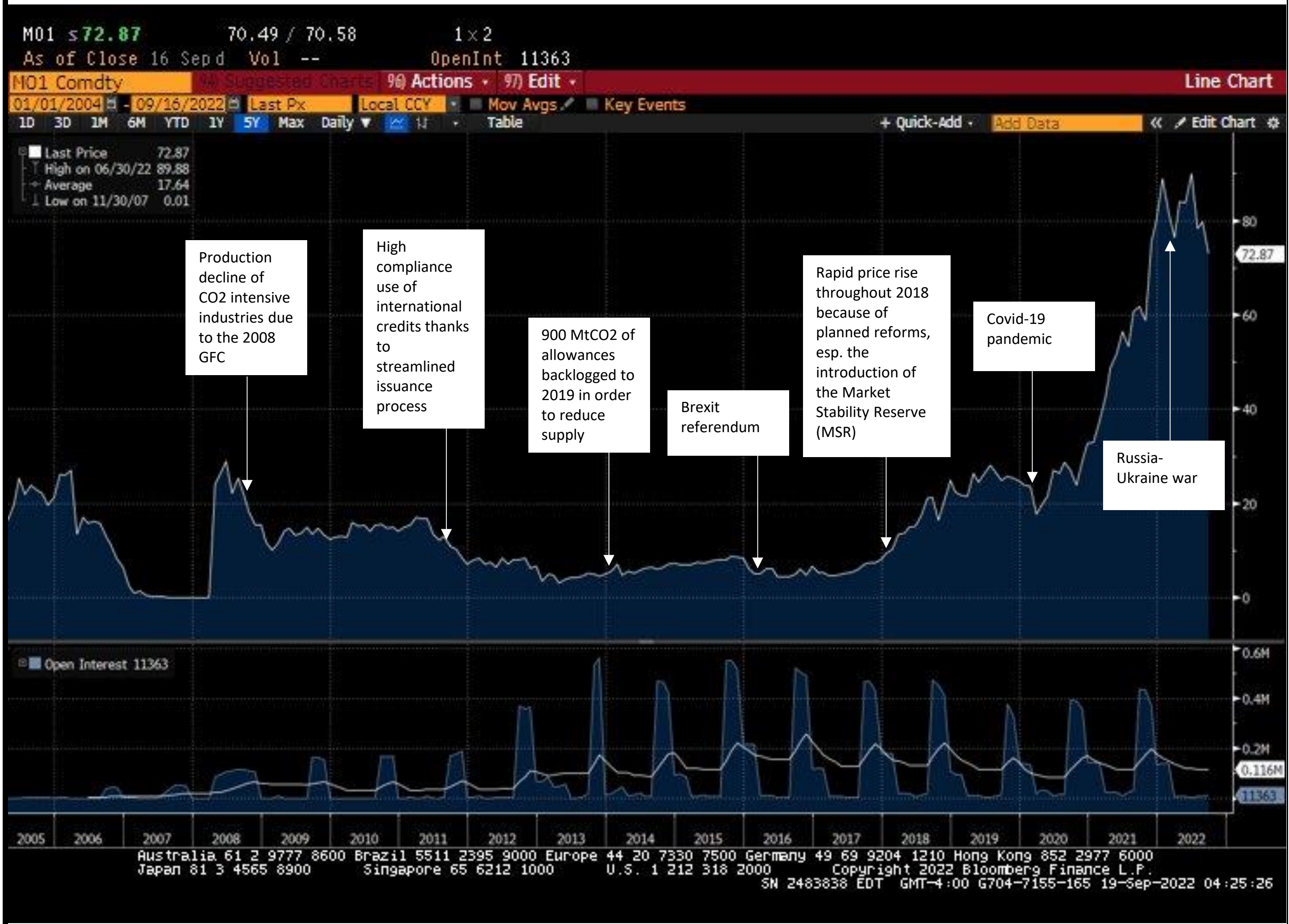
As noted earlier, in 2015, the MSR was established to address the structural oversupply in the EU ETS. It began by postponing the auctioning of EUAs in 2014, 2015 and 2016 (amounting to a cumulative total of 900m EUAs) to 2019, although this did not have an immediate impact on EUA prices as the structural oversupply already in existence at that time was left untouched. It was really only from 2018 onwards that EUA prices began a steady upward climb, in anticipation of the start of the MSR mechanism from 1 January 2019, which absorbed and cancelled a large volume of excess EUAs. According to McKinsey, the MSR withdrew 397m EUAs in 2019, equivalent to 24% of EUAs in circulation at that time. Additional withdrawals were made in 2020 and 2021.

In Phase 4 (2021-2030), the MSR mechanism was strengthened by formulating the cancellations of EUAs above a threshold. For instance, each year, the EC calculates the ‘total number of allowances in circulation’ (TNAC), which represents the cumulative oversupply of EUAs in the market. Recall that EUAs that have been allocated free to installations, or which have been purchased by installations from the primary auction or secondary markets, must be surrendered back to the EC once the emissions are released into the atmosphere (one EUA must be surrendered for 1 tonne of CO_2e emitted). Hence, the TNAC represents the un-surrendered and unused EUAs that are in excess of emission levels.

If the TNAC is greater than an absolute level of 833m EUAs, then a percentage of the oversupply is transferred into the MSR, with the intake rate originally set at 12%, but later doubled to 24% until 2023, with the intake rate returning to 12% from 2024 onwards. The post-2023 intake rate may be revised to 24% until 2030 under the ‘Fit for 55’ proposal. However, since the excess EUAs are not in the hands of the EC (they are in the hands of the installations that have already been allocated to them for free or have purchased them from the primary auction or secondary markets), the EC cannot just recall the EUAs from private hands. What the EC will do, however, is to reduce the future supply by reducing the planned auctions of EU member states; this reduced future supply is then put into the MSR.

In addition, the MSR will also cancel the EUAs above a certain threshold in the MSR from 2023 onwards, and the number of allowances in the MSR will be limited to 400m. All EUAs held in the MSR that are above the preceding year's volume of auctioned EUAs will be automatically cancelled. Conversely, if the MSR holds less than 400m EUAs, implying a tight market, the EC will withdraw 100m EUAs from the MSR in the following year to be auctioned.

Figure 70: Price development of EU ETS allowances (€/tCO2e, monthly averages)



SOURCES: BLOOMBERG, MCKINSEY & COMPANY, INTERCONTINENTAL EXCHANGE

Lessons to be learnt from the EU ETS

The EU ETS paved the way for climate action in Europe, and set the pace for the rest of the world. As other ETSs take off, such as that in China and potentially in Southeast Asia in the future, the key lessons from the EU ETS are that emissions caps and allowances should be ambitious enough in order to ensure that allowance prices are sufficiently high to spur abatement by the regulated entities, which also means that the quantity of free allowances needs to be managed.

Regulatory flexibility is key to ensure that any surplus of allowances is periodically mopped up in order to prevent legacy issues from putting undue downward pressure on future allowance prices. While ETS regimes can allow the use of carbon credits from voluntary projects, their use should be subject to limits so that polluters do not inadvertently get a cheap way to escape their mitigation obligations. Also, the proceeds from auctioning allowances should be set aside by governments to invest in climate mitigation efforts, such as by investing in new technologies and renewable energy, and in the modernisation of aged, energy-inefficient or emissions-intensive facilities.

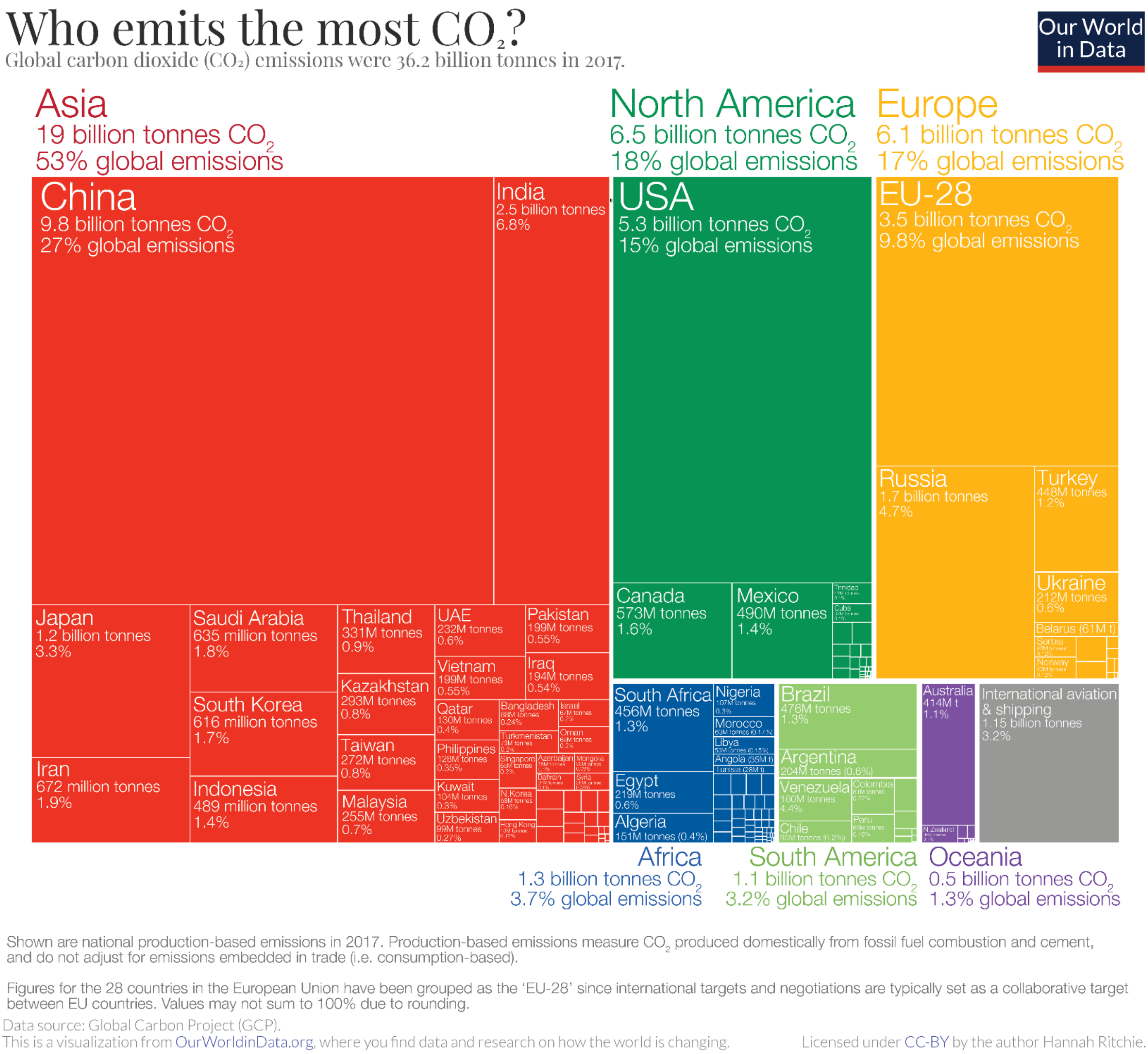
APPENDIX 4: CHINA'S EMISSIONS TRADING SYSTEM (CHINA ETS)

China's ETS is a key emissions control tool for the world's largest polluter

China is the world's largest energy consumer and carbon emitter, and will play a critical role in helping the world address its emerging climate crisis. In September 2020, China announced its 'Dual Carbon' goals to 1) peak its CO2 emissions before 2030, which is included in its NDC, and to 2) achieve carbon neutrality (or net zero) status by 2060. China's 2030 goal references only CO2 emissions, while its 2060 goal covers all GHG emissions.

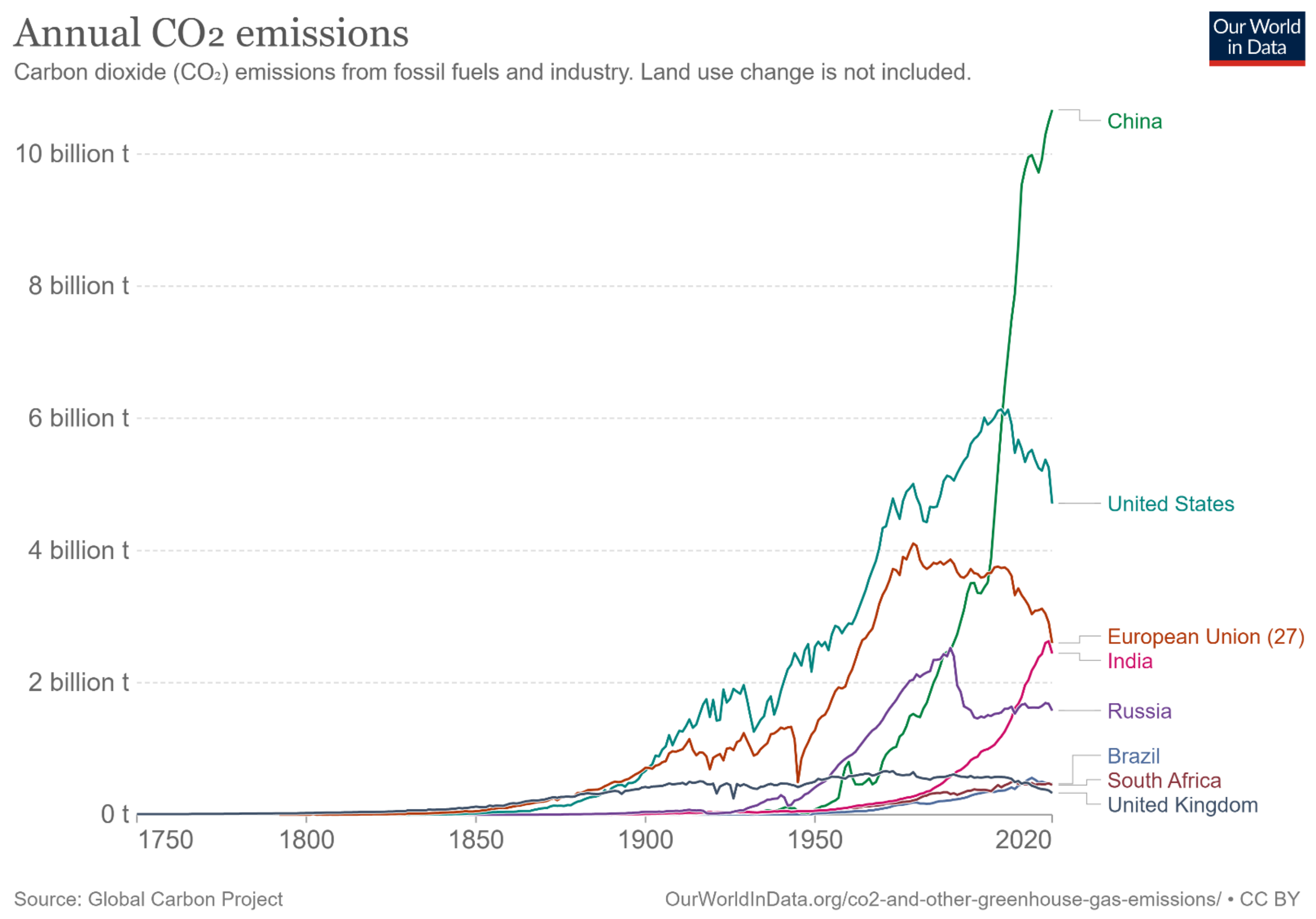
In order to achieve its goals, China targets to increase the RE share of its total energy supply to 20% by 2025, up from 16% in 2020. The introduction of the China Emissions Trading Scheme (China ETS) is another key pillar of China's climate goals.

Figure 71: China emitted the largest volume of CO2 emissions in 2017 by country, larger than the US and the EU-28 combined



SOURCES: GLOBAL CARBON PROJECT, OUR WORLD IN DATA

Figure 72: China's annual CO2 emissions has exceeded the EU-27 block's emissions since 2002, and exceeded the US's emissions since 2006



SOURCES: GLOBAL CARBON PROJECT, OUR WORLD IN DATA

Background information on the China ETS

China's national ETS scheme is run by the Ministry of Ecology and Environment (MEE) and officially began its first phase on 1 January 2021; the duration of the first phase has not been made known. In this initial phase, the ETS includes only CO2 emissions from the power sector (and also captive power plants that serve industrial sites), comprising 2,225 companies, which made up about 40% of its domestic emissions in 2019, or 4,569 MtCO2. Only entities with emissions in excess of 26,000 tCO2 p.a. are included in the national ETS.

In 2019, China's industrial emissions made up 29% of the country's total emissions, while emissions from other sectors, including aviation, made up the remaining 31%. Industrial emissions may be included in a future phase of the China ETS, particularly for heavy emitters from the cement, aluminium, iron and steel, and paper industries.

The current China ETS that covers only its power sector also represents coverage of 12% of global CO2 emissions, according to Carbon Brief. This is larger than the EU ETS that covers c.3% of global CO2 emissions, according to the EU (or 36-40% of the EU's own GHG emissions). Therefore, the China ETS has taken over the EU ETS's place as the largest ETS globally, in terms of CO2 coverage.

China's intention to launch a ETS was first mooted in 2011 and confirmed in 2015, although the actual launch was postponed multiple times, before finally launching in 2021.

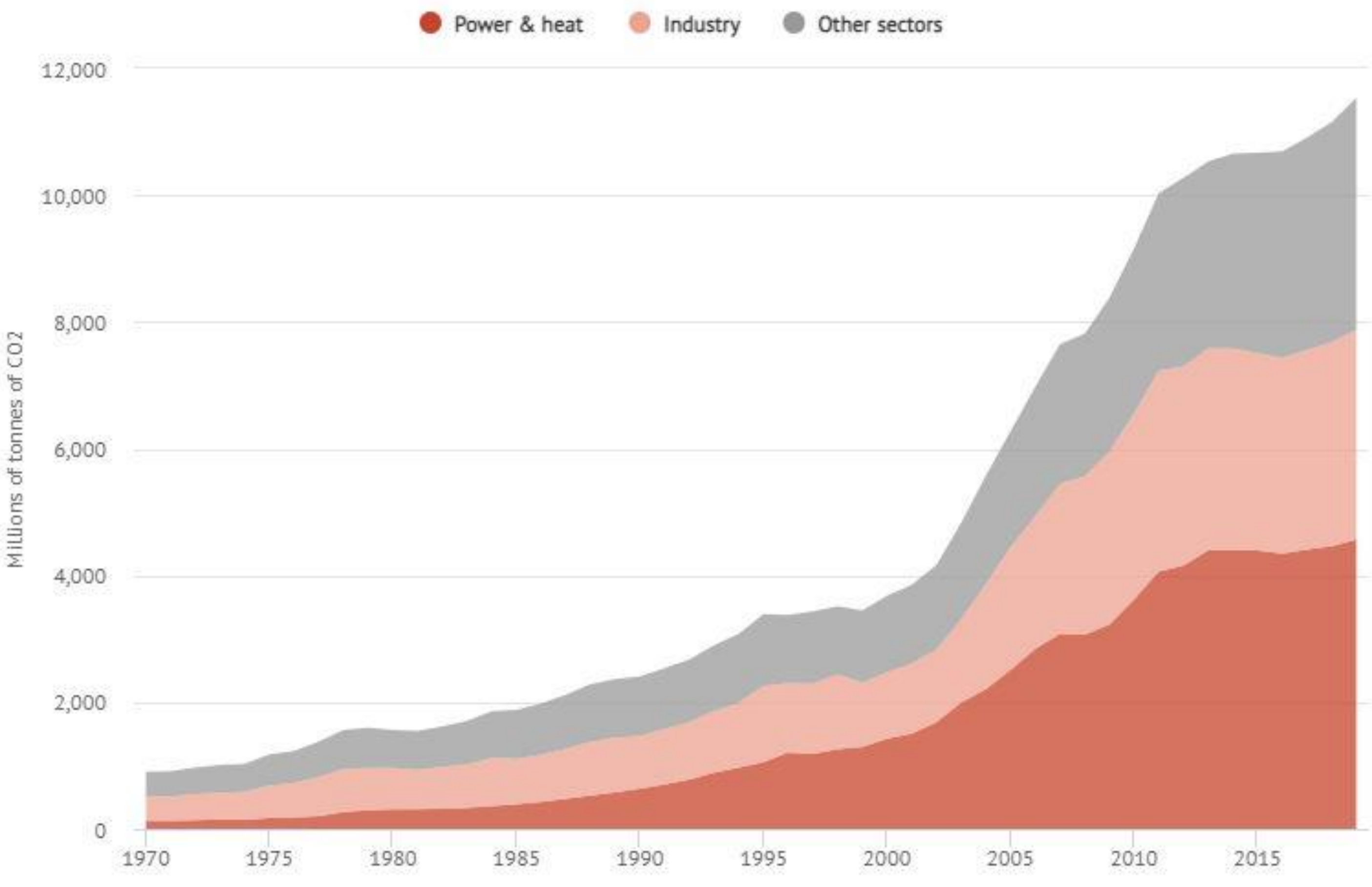
While waiting for the launch of the national ETS, China launched regional pilot carbon trading schemes in seven areas:

1. The Beijing ETS was launched in 2013
2. Tianjin ETS, 2013
3. Shanghai ETS, 2013
4. Guangdong ETS, 2013
5. Shenzhen ETS, 2013
6. Hubei ETS, 2014
7. Chongqing ETS, 2014
8. Fujian ETS, 2016

These pilots covered 35-60% of the CO_2 emissions in each region, and roped in the power, steel, cement and aviation sectors.

With the launch of China's national ETS in 2021, the power sector came under the coverage of the national ETS, while the local ETS schemes continue to cover the industrial sectors that are not yet part of the national ETS.

Figure 73: China's ETS will initially cover nearly 40% of its domestic CO_2 emissions in the power generation sector, and may cover more than two-thirds of CO_2 emissions when expanded to cover industrial sectors in the future



SOURCES: EUROPEAN COMMISSION JOINT RESEARCH CENTRE, CARBON BRIEF

How China's national ETS works

China's national ETS officially started its first annual 'implementation cycle' on 1 January 2021. In preparation for the launch of the national ETS, all regulated entities – power plants and captive power plants – have had their emissions monitored, reported, and verified (MRV) in 2019 and 2020.

China's national ETS has a **benchmark-based design** and does not have a firm cap on emissions. This means that each power company will be allocated all the free allowances that correspond to its electricity output multiplied by the industry emissions-intensity benchmark of CO2 emissions per MWh generated.

The benchmark varies by the type and size of the power plants. According to Carbon Brief, coal power plants are divided into three benchmark categories:

- 0.877 tCO2/MWh for conventional coal-fired power plants over 300 megawatts (MW);
- 0.979 tCO2/MWh for conventional coal-fired power plants below 300MW; and
- 1.146 tCO2/MWh for unconventional coal-fired power plants.

Unconventional coal sites – those burning coal wastes or a mix of coal and biofuel, including biowaste – will receive 30% more allowances than large conventional coal plants.

Meanwhile, all gas-fired power plants follow a single benchmark of 0.392 tCO2/MWh.

The China ETS leaves the window open for the allocation of additional allowances for companies that operate at low utilisation rates; these power plants may be allocated bonus allowances to compensate for their high emissions intensity metrics.

At the moment, the China ETS does not incorporate a mechanism for the industry emissions benchmarks to be tightened over time.

The benefit of having emissions-intensity benchmarks is that it may not constrain economic growth by imposing a heavy financial burden on power installations. If power installations increase their electricity output, the number of free allowances it will receive will also increase. However, the emissions-intensity benchmarks may still incentivise efficiency improvements at the polluting installations, at least in theory.

The downside is that absolute CO2 emissions levels may still continue to increase post the introduction of the ETS if economic growth is strong enough to increase overall demand for power generation, and if the effect of the latter outpaces any emissions mitigation measures by the power industry.

If a specific power company is less emissions intensive than the industry benchmark, it will receive more allowances than it actually needs to surrender for its emissions; hence, it will be able to sell the excess allowances to other power companies that are more emissions intensive than the benchmark.

Less-efficient companies have two options to cover their emissions that are in excess of the free allowances:

- By buying allowances from more-efficient companies that do not need all of the free allowances the latter received; or alternatively
- By buying voluntary carbon credits (also called the China Certified Emissions Reduction certificates, or CCER) from China's domestic VCM, the Beijing Green Exchange, to offset a maximum of 5% of allowances that need to be purchased. The CCER programme was launched in 2012, suspended in March 2017 (due to low trading volumes), but was later relaunched to meet demand for carbon credits in the pilot and national ETSs.

At the end of each implementation cycle, the regulated entities must hand over or surrender back to the government an equivalent number of allowances that corresponds to the verified emissions to comply with the ETS.

For the first implementation cycle in 2021, the regulated companies will need to surrender sufficient allowances to cover their emissions since 1 January 2019, which means that allowances to cover their CO2 emissions for 2019, 2020 and 2021 need to be surrendered.

However, the compliance obligations are softened by two significant indulgences:

- For coal-fired power plants, the compliance obligation is limited to 20% above their verified emissions. This means that if a plant was granted 10m free allowances, but its emissions totalled 15 MtCO2, the plant would have exceeded its free allowances by 5m allowances, but would only need to buy an additional 3m allowances, representing a compliance cap of 20% of the actual emissions. The plant will not be required to buy the remaining 2m additional allowances.
- For gas-fired power plants whose verified emissions exceed their free allowances, they are not required to buy any additional allowances, which effectively means that compliance with the national ETS is optional (gas-fired power plants are still permitted to sell their excess free allowances, if available).

Comparison of the China ETS with the EU ETS

The EU ETS determines a fixed GHG emissions cap at the start of a certain phase, and the allowances that correspond to that fixed emissions cap is then divided into free allowances (which will be distributed to installations at no charge), and allowances that will be auctioned. China's ETS applies a CO2 emissions intensity benchmark that does not establish a firm emissions cap. Note that China's ETS covers only CO2 emissions for now, whereas the EU ETS covers all GHG emissions.

China does not auction any of its allowances for the time being, unlike in the EU, issuing all of the allowances for free. This means that the Chinese government does not generate any revenue from the sale of carbon allowances. In the EU, revenues from the auction of allowances are partly used for emissions mitigation and abatement efforts, such as for the funding of the EU Innovation Fund and the EU Modernisation Fund.

Also, the EU ETS sets the linear reduction factor (LRF) in advance, which is the rate at which the fixed emissions cap will reduce on an annual basis. The China ETS does not incorporate the concept of an LRF for now.

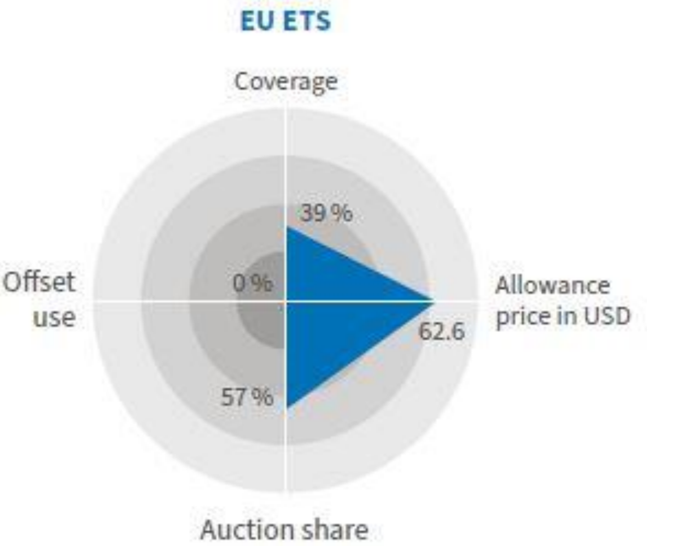
Penalties for non-compliance are low for the China ETS; for failure to submit an emissions report in time, or failure to surrender sufficient allowances, each entity may be subject to a maximum fine of only Rmb30,000 per annual implementation cycle. This contrasts with the EU ETS penalty of €100/tCO2e emitted in excess of the allowances surrendered.

China's carbon allowances have so far traded at a low average of just US$7.20/tCO2 in 2021 (Rmb43.85/tCO2), in contrast with the average EU ETS Allowance (EUA) price of US$62.60/tCO2e (€53/tCO2e). The low carbon price in China may be due to an oversupply of allowances due to generous emissions-intensity benchmarks, capped compliance requirements for coal-fired power plants, and zero compliance requirements for gas-fired power plants. Refinitiv estimated that a surplus of 360m allowances exited the first year of 2021, and added to the available supply for the 2022 compliance year.

At the moment, the trading of the carbon allowances on the Shanghai Environment and Energy Exchange which started on 16 July 2021, is allowed only between participating companies. Financial market intermediaries and institutional investors are not permitted to participate, unlike in the case of the EU ETS. As a result, liquidity in the China ETS allowances secondary market is currently low.

While the China ETS emissions targets, cost of compliance, and penalties for non-compliance are relatively relaxed compared to the EU ETS, they may be tightened in the future once the system achieves operational stability.

Figure 74: The EU ETS covered 39% of the EU's GHG emissions in 2021, auctioned 57% of the 2021 allowances, does not permit the use of carbon offsets, and the average EUA price was US$62.60/tCO2e

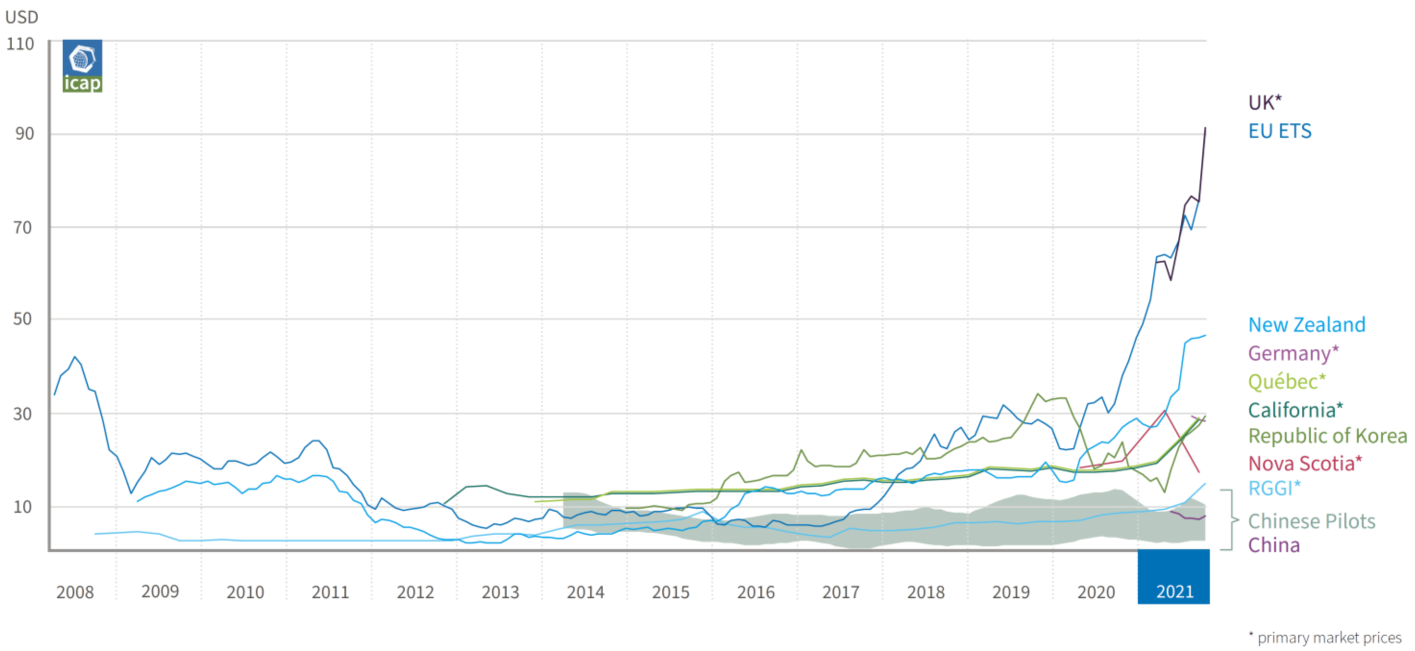


SOURCE: ICAP

Figure 75: The China national ETS covered 44% of China's CO2 emissions in 2021, auctioned none of its allowances (all were given free), permits the use of domestic carbon credits to offset 5% of excess emissions, and the average ETS allowance price was US$7.20/tCO2e

SOURCE: ICAP

Figure 76: The long-term development of carbon prices in the EU ETS, China national ETS, China pilots, etc. up to end-2021



SOURCE: INTERNATIONAL CARBON ACTION PARTNERSHIP (ICAP)

China ETS traded volumes and prices

The trading of China's national ETS allowances on 16 July 2021 began with an opening price of Rmb48/tCO2, and ended 2021 at Rmb54.22/tCO2, for an average price of Rmb43.85/tCO2. There is a daily price fluctuation limit of 30% for the over-the-counter (OTC) market and 10% fluctuation limit for online exchange trades, while only covered entities may trade (i.e. no financial intermediaries, investors, or speculators are permitted to trade).

According to Refinitiv, China traded a total of 412.05m tonnes of allowances in 2021, including for the national ETS (178.79m tonnes), the regional pilot schemes (63.58m tonnes), and the domestic voluntary CCER offsets (169.68m tonnes). This is a modest volume of trading considering the national ETS alone covers 4-5 GtCO2 of emissions, probably due to the large volume of free allowances allocated to power companies in the first year of implementation.

The relatively higher traded volume of CCERs may point to the fact that many companies had banked their national ETS allowances in 2021 for use in future years, and instead purchased cheaper CCERs for compliance purposes, limiting the available supply of national ETS allowances.

Figure 77: China's national ETS – trading volumes and prices for carbon allowances since trading started on 16 July 2021

SOURCE: REFINITIV

APPENDIX 5: CARBON ACCOUNTING

What are Scope 1, Scope 2 and Scope 3 GHG emissions?

GHG emissions can be classified into three different categories for the purposes of reporting them.

Scope 1 emissions refer to direct emissions from the operations of companies' owned and controlled facilities, as well as the companies' fleet of vehicles. For instance, an electricity generation company's Scope 1 emissions would include the GHG emissions from the combustion of coal, oil and natural gas for the purposes of power generation. It would also include the vehicular emissions from its own lorries and trucks that transport the thermal coal from the nearby port to its coal-fired power plant.

Scope 2 emissions refer to indirect emissions from electricity, heating, steam and cooling purchased or acquired for the polluting entity's operational use. For example, a manufacturing plant may purchase electricity from a third-party power plant to operate its machinery and to power its corporate offices. The GHG emissions arising from the production of that purchased electricity are counted as the manufacturing plant's Scope 2 emissions, and these overlap with the power plant's Scope 1 emissions. However, if the manufacturing plant owns and operates its in-house power plants, then the emissions from those power plants are the manufacturing company's Scope 1 emissions.

Scope 3 emissions are also indirect emissions, are very broad and encompass a whole range of emissions from sources that are not owned or controlled by the reporting entity, but which form part of the polluter's upstream and downstream value chains.

Upstream Scope 3 emissions are classified into eight categories:

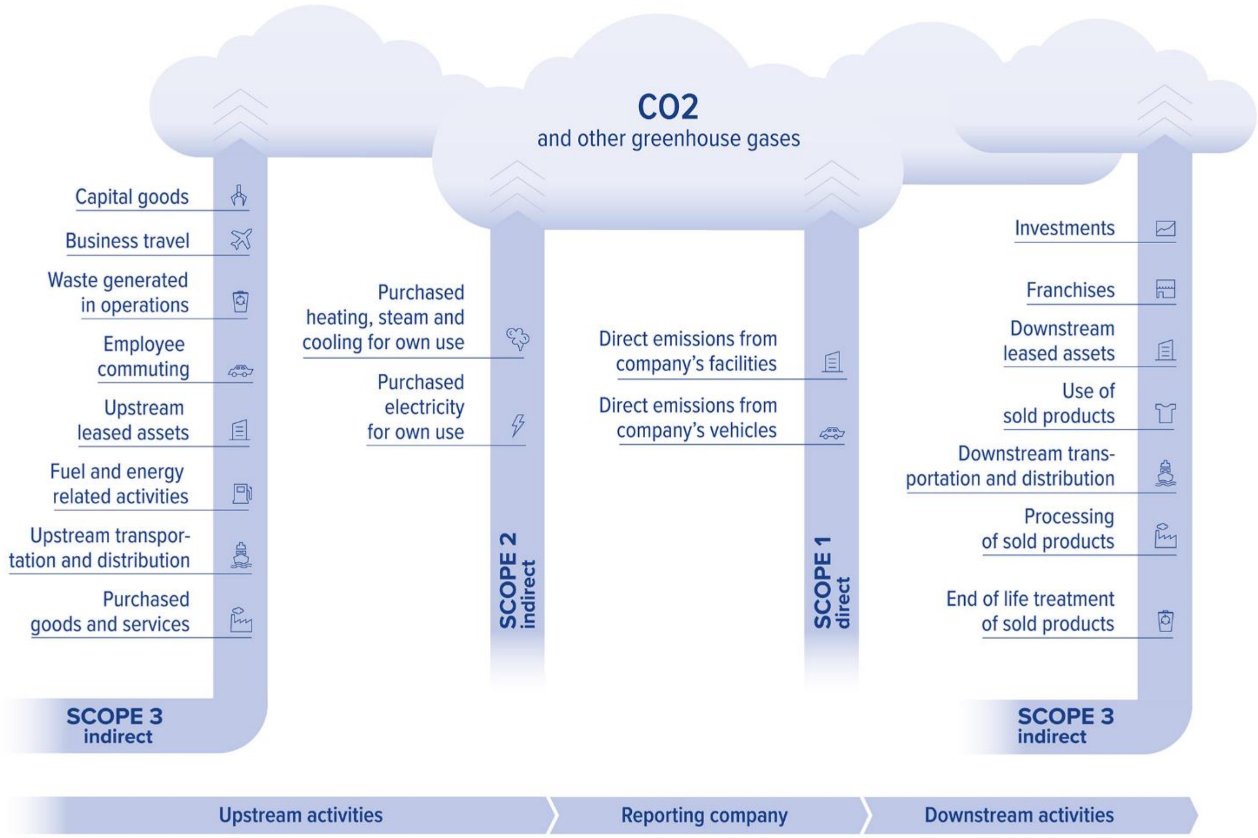
- **Category 1: Purchased goods and services** – emissions from the production of goods and services that are purchased by the reporting entity for use as its raw materials or to facilitate its normal business operations;
- **Category 2: Capital goods** – emissions from the production of capital goods, such as production machineries, that are purchased by the reporting entity;
- **Category 3: Fuel and energy-related activities** – emissions arising from the production of fuel and energy that are purchased by the reporting entity (note that the combustion of coal, oil or natural gas within the polluter's facility is counted as its Scope 1 emissions);
- **Category 4: Upstream transportation and distribution** – emissions generated by third-party suppliers' vehicles that deliver purchased goods to the polluter's facility;
- **Category 5: Waste generated in operations** – emissions from the decomposition or incineration of the polluter's waste products generated from its production facilities or business operations;
- **Category 6: Business travel** – emissions from vehicles, ships or aircraft used by employees on their business travels;
- **Category 7: Employee commuting** – emissions from vehicles used by employees to travel to work daily; and
- **Category 8: Upstream leased assets** – emissions from the assets that are legally owned by third parties, but which are leased by the reporting entity which is also the lessee. In a situation where the lessor controls the asset and enjoys the primary risks and rewards from the ownership of the asset, and also operationally controls the asset, the direct emissions from the asset would be the lessor's Scope 1 emissions. If the reporting entity is the lessee, then it would be counted as its Scope 3 emissions. For example, in a case where a reporting entity leases a single floor of a skyscraper to house its office, and does not enjoy the primary risk and rewards of the building's ownership, the Scope 1 and Scope 2 emissions from that single floor would be counted as the lessee's Scope 3 emissions.

Downstream Scope 3 emissions are classified into seven categories:

- **Category 9: Downstream transportation and distribution** – emissions generated by third-party vehicles contracted by the reporting entity to deliver sold goods to customers;
- **Category 10: Processing of sold products** – emissions from the intermediate processing of sold products prior to sale to end-customers;
- **Category 11: Use of sold products** – emissions arising from the use of sold products by end-customers, for instance, emissions from the combustion of gasoline by car users are Scope 3 emissions for the fuel retailer;
- **Category 12: End-of-life treatment of sold products** – emissions from the recycling, disposal, or incineration of sold products;
- **Category 13: Downstream leased assets** – emissions from the assets that are legally owned by the reporting entity and which are leased to third party lessees; these third-party lessees ultimately control how those assets will be used or deployed and enjoy the economic rewards and risks from using those assets for their intended purposes. The direct emissions from those assets would be the lessee's Scope 1 emissions, but the lessor's and reporting entity's Scope 3 emissions. The lessee's Scope 2 emissions arising from the use of the assets subject to the lease would also be counted as part of the lessor's and reporting entity's Scope 3 emissions.

  For instance, the reporting entity may own a floating production storage and offload (FPSO) ship for long-term lease to an upstream oil company; the upstream oil company accounts for the FPSO ship's direct emissions as its Scope 1 emissions because it directs the operations of the FPSO ship, enjoys the economic benefits from leasing the ship (i.e. it will ultimately receive the proceeds from selling the oil that is produced from the FPSO ship), and also accepts the risks from leasing the ship (i.e. it is committed to continue paying for the lease of the ship even though there is the risk that oil prices may decline sharply in the future). The FPSO-owning reporting entity would treat the FPSO ship's direct emissions as its Scope 3 emissions, not its Scope 1 emissions.
- **Category 14: Franchises** – franchisors should account for the Scope 1 and Scope 2 emissions that occur from the operation of franchises as part of their Scope 3 emissions; and
- **Category 15: Investments** – investors who do not have operational control over investee companies should treat the latter's Scope 1 and Scope 2 emissions as part of its Scope 3 emissions.

Figure 78: Sources of Scope 1, Scope 2 and Scope 3 GHG emissions



SOURCE: GHG PROTOCOL

Operational control accounting vs. equity share accounting for Scope 3 emissions

Operational control accounting

Underlying our GHG accounting discussion above is the assumption that the reporting entity counts as its Scope 1 and Scope 2 emissions, the Scope 1 and Scope 2 emissions of the assets where it has operational control.

However, if the reporting entity does not have operational control, then the Scope 1 and Scope 2 emissions of the assets will be included in the reporting entity's Scope 3 emissions.

For 'Category 8: Upstream Leased Assets', the reporting entity (lessee) does not have control over the emissions of the leased asset, hence, the Scope 1 and Scope 2 emissions of the asset will be the reporting entity's Scope 3 emissions. In the case of 'Category 13: Downstream Leased Assets', the reporting entity (lessor) does not operationally control the leased asset, hence, the Scope 1 and Scope 2 emissions of the asset will be the reporting entity's Scope 3 emissions.

Applying operational control accounting to non-wholly-owned assets

For non-wholly-owned assets, the application of operational control GHG accounting can be tricky. As an example of Scope 3 emissions accounting for 'Category 13: Downstream Leased Assets', we bring up the case of Yinson Holdings (YNS MK, SP: RM2.30, Add, TP: RM3.23), a Malaysian FPSO lessor. During FY1/21, Yinson wholly-owned some of its FPSO ships, owned 76% of one FPSO, and owned 49% of two FPSOs; these refer to FPSOs that were operated during the financial year and excluded FPSOs that were still in construction stage. All (i.e. 100%) of the Scope 1 and Scope 2 emissions of each of its FPSOs were included in Yinson's Scope 3 emissions, even though Yinson did not wholly-own all of its FPSOs. Hence, all of the Scope 1 and Scope 2 emissions from the 76%-owned FPSO, and all of the Scope 1 and Scope 2 emissions from the two 49%-owned FPSOs, were counted into, and reported as part of, Yinson's Scope 3 emissions.

However, the treatment for non-wholly-owned assets under 'Category 15: Investments' may be different. Based on GHG Protocol's technical guidance notes, if Company A (the reporting entity) invests in 49% of Company B's voting shares, but does not have operational control over Company B, then Company A should include 49% of Company B's Scope 1 and Scope 2 emissions as part of Company A's Scope 3 emissions.

Equity share accounting

As an alternative, reporting entities have the option of using equity share accounting for reporting Scope 3 GHG emissions. In Yinson's case, this would mean including only 49% of the Scope 1 and Scope 2 emissions from its two 49%-owned FPSOs into its Scope 3 emissions. This was, in fact, the methodology adopted by Yinson in FY1/21, before it switched over to the operational control accounting methodology in FY1/22.

Who is responsible to abate which type of emissions?

Polluting entities are solely responsible for abating or mitigating the Scope 1 emissions, which are directly linked to the operations of the polluter in question. As the technical solutions to abate Scope 1 emissions may not be immediately available, or remain prohibitively expensive, polluters may voluntarily choose to offset those Scope 1 emissions via the use of carbon credits in Voluntary Carbon Markets (VCM).

Polluters should also endeavour to reduce their Scope 2 emissions, by say, switching over to cleaner sources of electricity, such as buying power from gas-fired power plants or RE plants, rather than from coal- or oil-fired power plants, or by working together with the national power generation company to increase the proportion of RE in the generation mix.

In the case of Scope 3 emissions, however, the primary responsibility for abatement lies with the other parties that account for those Scope 3 emissions as their Scope 1 or Scope 2 emissions. In the case of FPSO lessors, the responsibility for abating or reducing FPSO emissions lies with lessees, i.e. the oil and gas companies that lease and control the operations of those FPSOs. The lessees should pay for the cost of abatement. However, FPSO lessors can play their part by encouraging the lessees to abate and by proposing potential technical solutions for that purpose.

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Distribution of stock ratings and investment banking clients for quarter ended on 30 June 2022		
643 companies under coverage for quarter ended on 30 June 2022		
	Rating Distribution (%)	Investment Banking clients (%)
Add	68.4%	0.8%
Hold	24.6%	0.0%
Reduce	7.0%	0.2%

Recommendation Framework

Stock Ratings	Definition:
Add	The stock's total return is expected to exceed 10% over the next 12 months.
Hold	The stock's total return is expected to be between 0% and positive 10% over the next 12 months.
Reduce	The stock's total return is expected to fall below 0% or more over the next 12 months.

The total expected return of a stock is defined as the sum of the: (i) percentage difference between the target price and the current price and (ii) the forward net dividend yields of the stock. Stock price targets have an investment horizon of 12 months.

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Underweight	An Underweight rating means stocks in the sector have, on a market cap-weighted basis, a negative absolute recommendation.

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Underweight	An Underweight rating means investors should be positioned with a below-market weight in this country relative to benchmark.

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