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Carbon Markets

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Marketing Material

Carbon markets: The why, what & where

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- In this paper we provide a guide to carbon and their trading systems. We pay particular attention to the scope and breadth of carbon schemes and why they are an important part of achieving net zero
- **Carbon price coverage is growing[1]:** 60+ carbon tax or trading policies exist around the world. These cover 21.5% of global GHG emissions compared to 5% coverage ten years ago. In addition, 97 countries representing 58% of emissions mention carbon pricing in their official climate plans
- **Carbon prices are low:** Half of emissions covered by a carbon price are priced at less than US$10 per ton of CO_2, while the IMF estimate the global average carbon price to be just US$3 per ton of CO_2[2]. The outlier is Europe where carbon prices are currently hitting fresh highs high at over EUR90/tonne[3]
- **Carbon prices may increase further:** In 2017, the Commission on Carbon Prices concluded that carbon prices of at least US$40–80/t$CO_2$ at the stary of this decade and US$50–100/t$CO_2$ by 2030 were necessary, along with other supportive policies, to have a meaningful impact in carbon emission reduction[4]. Currently, less than 5% of global emissions are priced at this level[1]
- **Carbon price revenues are significant:** In 2020, governments raised US$53 billion from carbon prices[1]. In 2019, approximately 50% of revenues went to environmental and development projects, 40% to general government budgets and 10% to tax cuts and revenue transfers
- **Carbon border taxes are a new area of activity:** Plans to introduce a European carbon border adjustment mechanism are in train. This would tax carbon at the point of consumption rather than production. It aims not just to curb carbon leakage, but hopefully incentivise exporting regions to decarbonise
- **Net zero goals are likely to demand Carbon Capture, Use and Storage technologies[5] but these necessitate higher carbon prices and government support for deployment:** The International Energy Agency estimates that captured CO_2 needs to grow 20x from around 40 million tonnes today to over 800 million tonnes by 2030. This represents annual retrofitting of around 20 coal power plants in Asia and more than 90 cement plants between 2025-2030

[1] World Bank (May 2021). 2021 State and Trends of Carbon Pricing
[2] IMF (June 2021). A proposal to scale up carbon pricing
[3] Bloomberg Finance LP (7 February 2022)
[4] World Bank (May 2017). Report of the High-Level Commission on carbon prices
[5] IEA (December 2020). Energy Technology Perspectives 2020

Index

1.1 Carbon – The origins and evolution of carbon emissions 04

1.1.1. What is the link between greenhouse gas emissions and climate change? 04

1.1.2. Which are the other greenhouse gases apart from carbon dioxide responsible for climate change? 06

1.1.3. How are emissions measured? 06

1.1.4. Who are the major emitters? 07

1.1.5. What are the key drivers when it comes to the growth in global emissions? 08

1.1.6. How can we reduce emissions in the future? 09

1.1.7. What are the types of approaches being adopted by the major emitters to reduce emissions? 10

1.1.8. Why net zero instead of gross zero? 11

1.1.9. How does the Paris Climate Agreement fit within the context of Net Zero? 12

1.1.10. What if we do not act now on reducing greenhouse gas emissions compared to if we do act? 12

2.1 Carbon markets: History and future trends 13

2.1.1 What are carbon markets? 13

2.1.2 What is the need for carbon pricing? 14

2.1.3 To what extent do carbon markets cover global GHG emissions? 14

2.1.4. Where are the major ETS markets globally? 15

2.1.5. How does the EU ETS carbon market work? 16

2.1.6. What is and how does the European Market Stability Reserve work? 16

2.1.7. What are Voluntary Carbon Offsets? 16

2.1.8. What is the indicative cost of carbon globally? 17

2.1.9. What is carbon leakage? 18

2.1.10. What are the pros and cons of carbon border taxes? 18

I / The why, what & where of carbon markets

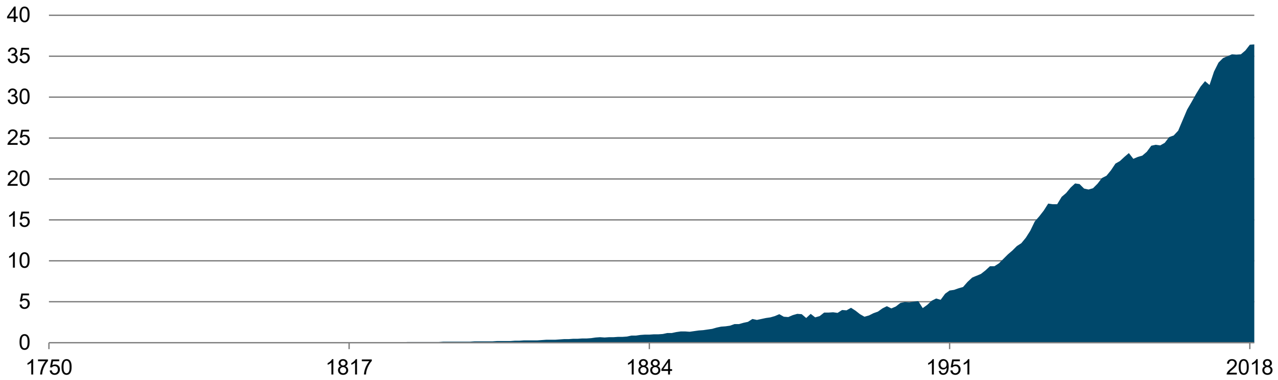
1.1 Carbon – The origins and evolution of carbon emissions

1.1.1. What is the link between greenhouse gas emissions and climate change?

Climate change manifests itself in extreme weather events such as floods, droughts and wildfires in all corners of the world. Greenhouse gas (GHG) emissions are the primary driver of climate change and these are predominantly made up of carbon dioxide, methane and nitrous oxide. To avoid the worst impacts of climate change, urgent action is therefore required to reduce these GHG emissions.

Figure 1 shows the growth of global carbon emissions since the mid-18th century. We see that prior to the Industrial Revolution in 1850, emissions were insignificant reflecting the agrarian nature of economic activity. However, as steam, railroad and steel production spread, so the level of carbon emissions growth started to increase. This growth then began to accelerate from 1950, in response to the spread of the internal combustion engine and the growth in the global aviation sector, alongside petrochemicals, electronics and others. By 1990, emissions had almost quadrupled to 22 billion tonnes from their 1950 levels. Currently, world carbon dioxide (CO_2) emissions are running at over 36 billion tonnes per year.

FIGURE 1: ANNUAL CO2 EMISSIONS (BILLION TONNE)

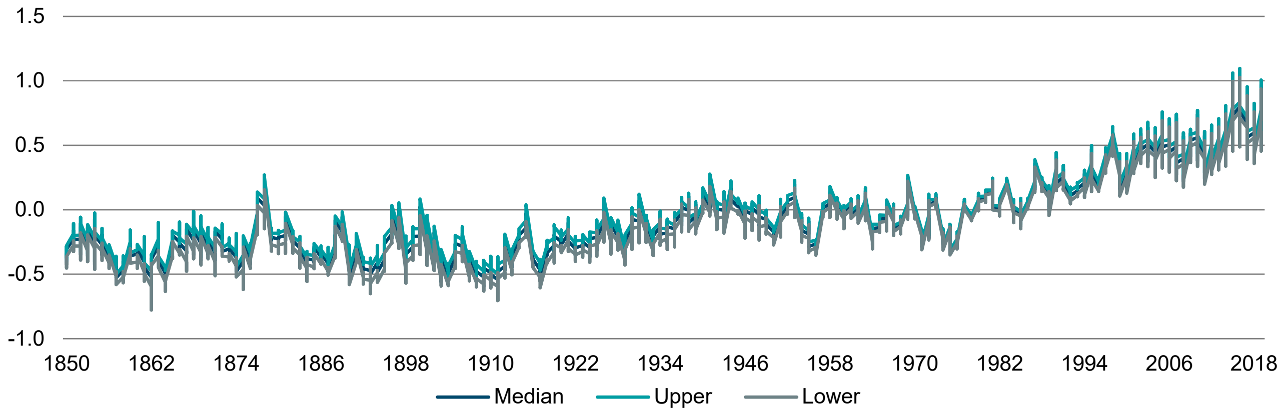


Source: DWS Research Institute, Global Carbon Project, Carbon Dioxide Information Analysis Centre (CDIAC), Hannah Ritchie and Max Roser (2020). Carbon dioxide (CO_2) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.

The link between carbon emissions and climate change is temperature rise, which is illustrated in Figure 2. This tracks the global average temperature relative to the average of the period from 1850. We see that over the last few decades, global temperatures have risen sharply — to approximately 0.7℃ higher than 1961-1990 baseline. When extended back to 1850, we see that temperatures then were 0.4℃ colder than they were compared to the baseline. Overall, this amounts to an average temperature rise of 1.1℃ compared to pre-industrialised levels[6]. **Putting the data shown in Figure 1 and 2 together, we find an 89.7% correlation between carbon dioxide emissions and median average temperature change**.

[6] As of November 2021, Climate Action Tracker analysis estimates that global average temperatures are now 1.2ºC above pre-industrial levels

FIGURE 2: GLOBAL AVERAGE LAND-SEA TEMPERATURE ANOMALY RELATIVE TO THE 1961-1990 AVERAGE TEMPERATURE

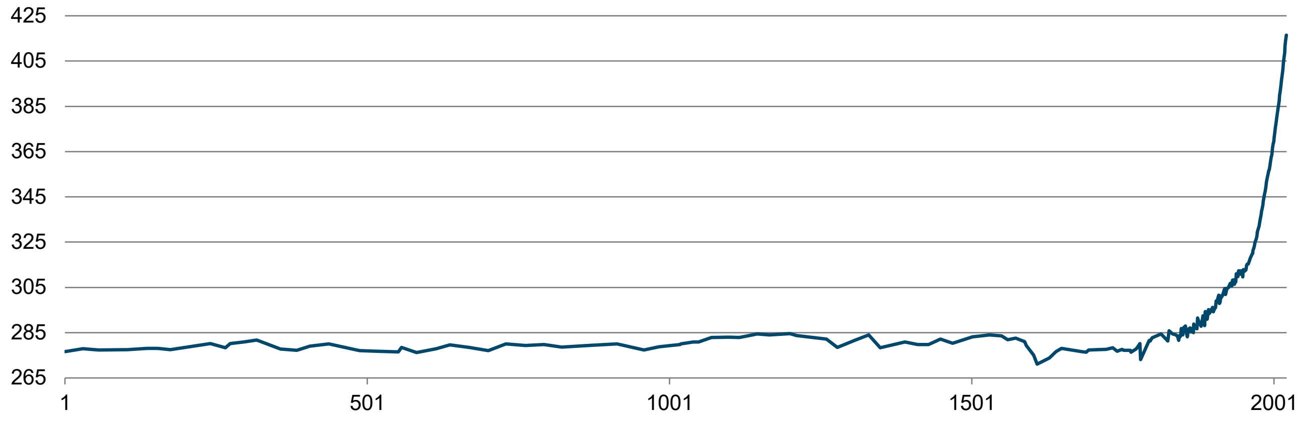


Source: DWS Research Institute, Hadley Centre (HadCRUT4), Hannah Ritchie and Max Roser (2020). The three lines represent the median average temperature change along with upper and lower 95% confidence intervals

Needless to say, the rapid growth in global CO2 emissions has had a significant impact on the concentrations of CO2 in the Earth's atmosphere. Figure 3 shows atmospheric concentrations of CO2 over the past 2,000 years. Over these two millennia, the concentration of carbon was relatively stable at 270 to 285 parts per million (ppm) right up until the middle of the 18th century at which point global CO2 concentrations have risen rapidly.

Climate change can be considered a bathtub problem: Society must slow the inflow rate by reducing emissions to zero as soon as possible (helping to limit temperature rise outlined in Figure 2), but also work to drain the tub by reducing the concentration of carbon in the atmosphere through 'nature-based solutions' to store carbon in biomass as well as direct air capture, so helping to lower CO2 concentration as illustrated in Figure 3.

FIGURE 3: GLOBAL MEAN ANNUAL CONCENTRATION OF CO_2 MEASURED IN PARTS PER MILLION (PPM) IN THE COMMON ERA



Source: DWS Research Institute, NOAA/ESRL, Hannah Ritchie and Max Roser, last update 2021.

1.1.2. Which are the other greenhouse gases apart from carbon dioxide responsible for climate change?

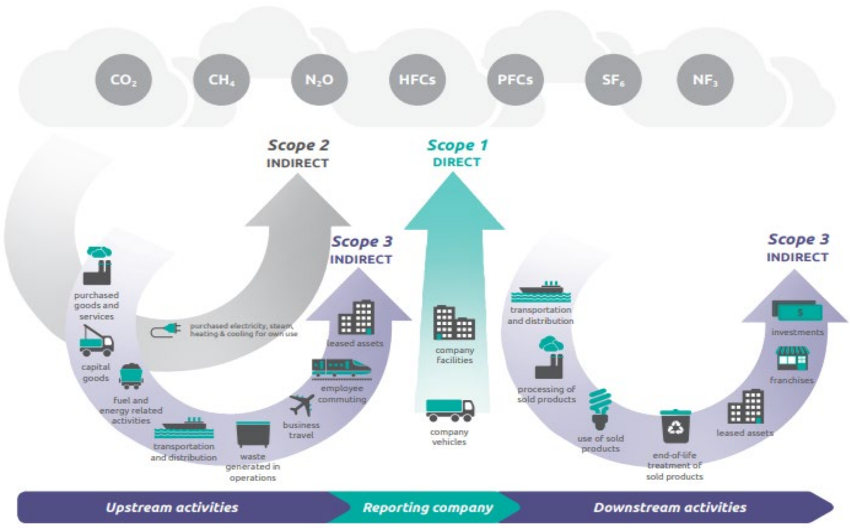
When it comes to the emissions responsible for climate change, these have typically been focused primarily around the emissions of CO_2. This reflects its presence in the burning of fossil fuels, industrial production and land use change. However, there are a number of other gases such as methane, nitrous oxide, and trace gases such as the group of 'F-gases' which are also contributing to a significant amount of warming to date. These gases have different warming potentials and over different time horizons. For example, emitting one tonne of methane creates 28 times[7] the amount of warming as one tonne of CO_2 over the next 100 years. Hence in the case of methane, emissions in tonne are multiplied by 28 to arrive at Carbon dioxide equivalent (CO_2e) emissions. CO_2e attempt to convert the warming impact of the range of greenhouse gases into a single metric. In 2019, total greenhouse gas emissions reached 59.1 gigatonnes of CO_2e - the highest level in history[8]. To stabilize or even reduce concentrations of CO_2 in the atmosphere, necessitates a significant transformation in how businesses and governments operate over the coming decades.

1.1.3. How are emissions measured?

The GHG Protocol is the most commonly used standard for greenhouse gas accounting. The organisation provides guidance on how to measure Scope 1 and 2 emissions, and how to account for emissions from the entire value chain. Once emissions have been calculated, third-party verifiers can be used to provide reassurance on the reliability of the data.
There are 3 categories of greenhouse gas/ carbon emissions:

_ Scope 1: direct GHG emissions from sources owned or controlled by the company, for example vehicles and industrial processes.
_ Scope 2: Indirect GHG emissions from electricity that has been purchased and consumed by the company.
_ Scope 3: indirect greenhouse gas emissions that occur in both the upstream and downstream parts of the company's value chain. In the GHG Protocol Corporate Standard, there are 15 categories within Scope 3.

FIGURE 4: GLOBAL GREENHOUSE GAS EMISSIONS – SECTORAL SPLIT



Source: GHG Protocol (April 2016).

Disclosure of Scope 1 and 2 emissions is highest amongst European companies. In 2019, 84% of MSCI Europe constituents reported Scope 1 and 2 emissions and 68% reported Scope 3. Asia Pacific reporting has been improving quickly over time

[7] Our World in Data. Greenhouse gas emissions. Note: this figure does not consider climate feedback. If climate feedback effects are included, this increases to 34 times that of CO2.

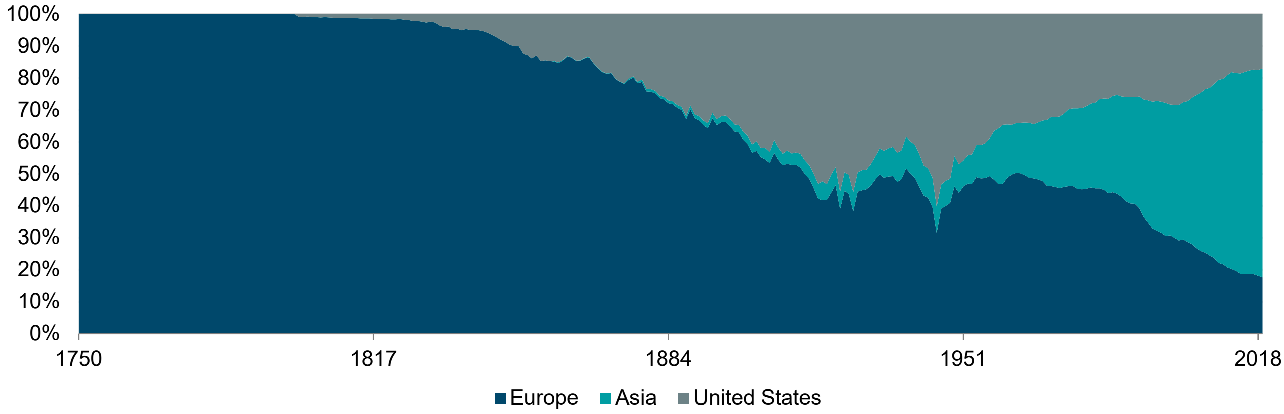
[8] UNEP (December 2020) Emissions gap report 2020

- Scope 1 and 2 reporting has doubled in the past 10 years or so. Just over 50% of companies in the U.S. disclosed Scope 1 and 2 carbon emissions in 2019, whilst only 34% disclosed Scope 3[9].

1.1.4. Who are the major emitters?

Historical fossil fuel CO_2 emissions can be reconstructed back to 1750 based on global energy statistics. These reconstructions detail the production quantities of various forms of fossil fuels (coal, brown coal, peat and crude oil), which when combined with trade data on imports and exports, allow for national-level reconstructions of fossil fuel production and the resultant CO_2 emissions. In figure 5, the share of carbon emissions of Europe, Asia and United States is plotted, which combined accounted for 85% of total carbon emissions in 2019. We see that until well into the 20th century, global emissions were dominated by Europe and the United States. In 1900, more than 90% of emissions were produced in Europe or the U.S.; and even by 1950, the two regions accounted for more than 85% of emissions every year. But in recent decades this has changed significantly. In the second half of the 20th century, we see a significant rise in emissions in the rest of the world, particularly across Asia, and most notably, China such that the U.S. and Europe now account for just under one-third of global emissions.

FIGURE 5: GLOBAL CARBON EMISSIONS % SHARE OF EUROPE, ASIA AND THE UNITED STATES

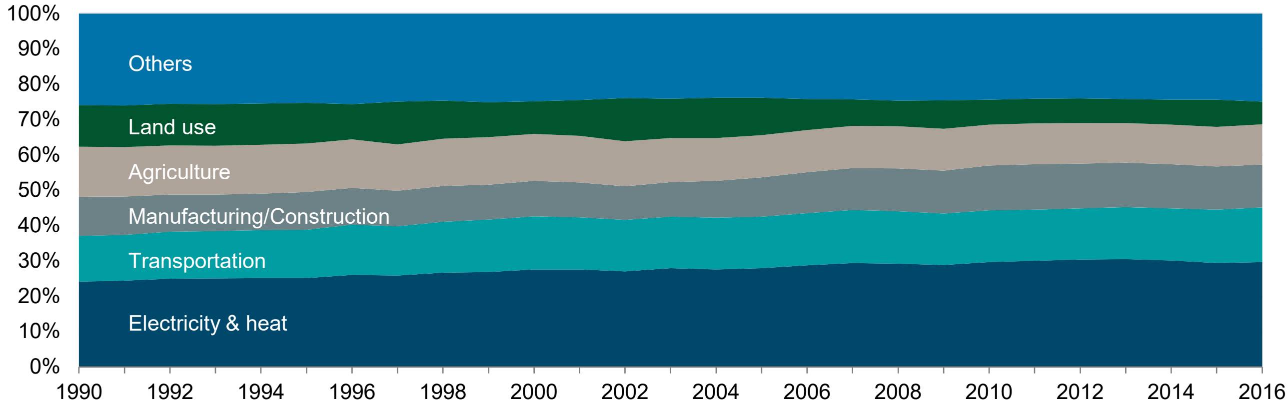


Source: DWS Research Institute, Global Carbon Project, Hannah Ritchie and Max Roser (2020). This measures CO_2 emissions from fossil fuels and cement production only – land use change is not included. 'Statistical differences' (included in the GCP dataset) are not included here.

When it comes to sectors, figure 6 shows the breakdown of total greenhouse gases by sector (the sum of all greenhouse gases, measured in tonnes of carbon dioxide equivalents). We find that electricity and heat production are the largest contributors to global emissions. This is followed by transport, manufacturing and construction (largely cement and similar materials), followed by agriculture. But this composition of sector emission inevitably varies between countries. For example, in the U.S., transport is a much larger contributor than the global average while in Brazil, the majority of GHG emissions originate from agriculture and land use change.

[9] Morgan Stanley (March 2021). Global Carbon Primer; MSCI, Datastream

FIGURE 6: GLOBAL GREENHOUSE GAS EMISSIONS – SECTORAL SPLIT

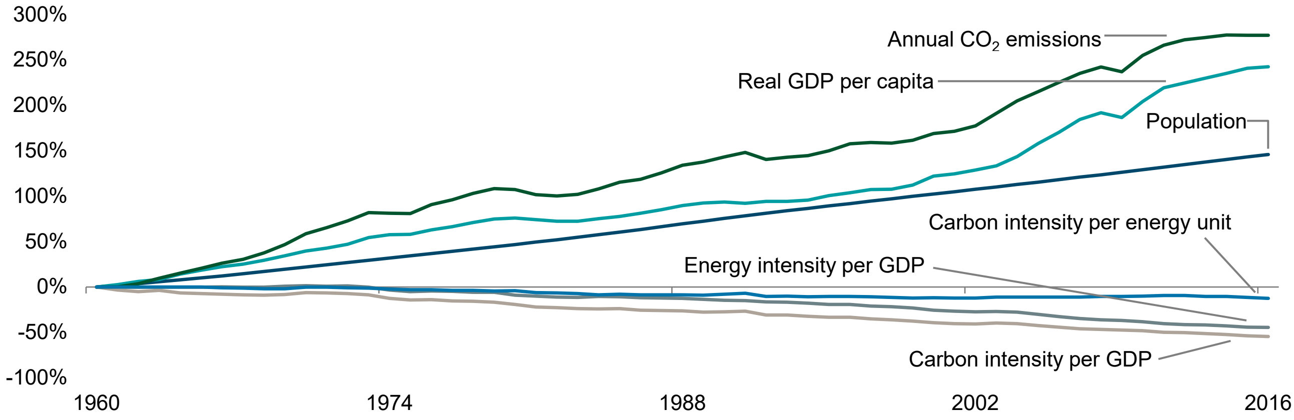


Source: DWS Research Institute, CAIT Climate Data Explorer via. Climate Watch, Hannah Ritchie and Max Roser (2020). Last updated July 2021.

1.1.5. What are the key drivers when it comes to the growth in global emissions?

There are four key drivers of global emissions: population, GDP per capita, energy intensity (energy per unit of GDP), and carbon intensity (CO_2 per unit of energy). Figure 7 examines these four factors over time. **It is commonly argued that 'uncontrolled' population growth lies at the root of rising CO_2 emissions. However, carbon emissions are much more sensitive to changes in GDP, energy & carbon intensity than they are to population.** That does not mean population does not play a role in emissions, but it is typically not the strongest driver. What largely determines whether CO_2 emissions have increased, stabilized, or declined is whether energy and carbon intensity can be reduced fast enough to offset the increase in GDP as well as population. On further inspection, we see that it is the energy intensity component, which is responsible for lowering carbon intensity per GDP, with carbon intensity per energy unit relatively flat. It is therefore carbon intensity per energy unit which needs to be the focus for any meaningful reduction in overall emissions (see 1.1.6).

FIGURE 7: KEY DRIVERS OF CARBON EMISSIONS, WORLD



Source: DWS Research Institute, *Global* Carbon Project; UN; BP; World Bank; Maddison Project Database, Hannah Ritchie and Max Roser (2020). Last updated July 2021. Note: GDP per capita is measured in 2011 international-$ (PPP). This adjusts for inflation and cross-country price differences.

Figure 8 provides population and emission share in the context of Gross National Income per capita globally. Production based emissions are on a 'territorial' basis, that is those emitted within a country's borders. However, these emissions do not account for traded goods (for which CO_2 was emitted for their production). If a country is a large importer of goods, its production-based emissions would underestimate the emissions required to support its standard of living. Conversely, if a country is a large goods exporter, it includes emissions within its accounts which are ultimately exported for use or consumed elsewhere. 'Consumption-based' emissions correct for this by adjusting for trade. Consumption-based emissions are therefore: production-based emissions less embedded CO_2 in exported goods plus embedded CO_2 in imported goods. The Global Carbon Project (GCP) publishes estimates of these adjustments in their carbon budget.

FIGURE 8: GLOBAL EMISSION VS POPULATION SHARE BY INCOME GROUPS*

	Population Share	Production based CO2 share	Consumption based CO2 share
High-income countries	16%	39%	46%
Upper-middle income countries	35%	48%	41%
Lower-middle income countries	40%	13%	13%
Low-income countries	9%	0.4%	0.4%

Source: DWS Research Institute, Global Carbon Project, World Bank; Hannah Ritchie and Max Roser (2020). *The data distributed based on World Bank Income Groups (2016). High income regions represent countries with GNI per capita in US$ > 12,235; Upper-middle income GNI per capita in US$ = 3,956-12,235; Lower-middle income GNI per capita in US$ = 1,006-3,955 and Low income GNI per capital in US$ <= 1,025.

1.1.6. How can we reduce emissions in the future?

The key conclusions to be drawn from Figures 7 and 8 are first, if improvements in energy or carbon intensity are slow or in some cases non-existent, then CO_2 emissions will grow rapidly. Second, high income regions emit carbon significantly higher than their share of the population would suggest and third, upper-middle income countries (likely net exporters) also contribute as much to carbon emissions through production-based carbon emissions.

Focusing on the first of these, energy intensity can be reduced through improving energy efficiency and switching to less carbon-emitting intensive industries. **However, it is the reduction in carbon intensity of energy which is one of the most critical goals. While there are multifold ways to reduce the carbon intensity of energy for example switching to renewable energy, substituting gas for coal, capturing and storing carbon, it is important that carbon emissions are measured and priced**. The prime objective of having a price for carbon is the principle of the emitter pays. A price on carbon and at an appropriate level will help to ensure carbon-emitters can take effective action to reduce their emissions.

Carbon pricing can therefore play a role in incentivizing low-carbon action by internalizing the cost of greenhouse gas emissions. Effectively, this path should lead us to a low-carbon economy. Figure 8 highlights the need for some level of parity in global pricing of carbon. This is to encourage net-exporters to reduce the carbon intensity of production and to disincentivise imports of cheaper goods with a high carbon footprint.

1.1.7. What are the types of approaches being adopted by the major emitters to reduce emissions?

Figure 9 examines the respective top four emitters across Advanced (AE) and Emerging Economies (EE) and their commitment to reducing emissions covered in their respective "nationally determined contributions" (or NDC). Collectively, these eight economies account for 70% of global CO_2 emissions. One immediate observation is that AEs have more explicit intentions to reach net zero by 2050 with a focus on an absolute reduction in the level of emissions, while EEs fall short on both these counts.

FIGURE 9: NATIONALLY DETERMINED CONTRIBUTIONS (NDC) OF TOP 4 EMITTERS ACROSS ADVANCED & EMERGING ECONOMIES

Country	% of global Carbon emission	Net Zero Commitment	2030 Commitment	Last Update
United States	15%	Net zero goal for 2050	50-52% reduction by 2030 vs 2005	November 2021
EU-27	8%	Net zero goal for 2050	At least 55% reduction by 2030 vs 1990	July 2021
Japan	3%	Net zero goal for 2050	46% reduction by 2030 vs 2013	April 2021
Canada	2%	Net zero goal for 2050	Cut its GHG by 40-45% below 2005 levels by 2030	July 2021
China	28%	Aim to be carbon neutral by 2060	Over 65% reduction in CO2 per unit GDP by 2030 vs 2005	October 2021
India	7%	Aim to achieve Net-Zero emissions by 2070*	33%-35% reduction in intensity vs 2005	November 2021
Russia	5%	Net zero target by 2060*	30% reduction by 2030 vs 1990	November 2020
Indonesia	2%	Net zero target by 2060*	29%-41% reduction by 2030 vs 2010	July 2021

Source: DWS Research Institute, UNFCC NDC Registry. * yet to formally adopt it and/or few details are available.

It is not just governments who are making carbon emission reduction commitments. The private sector is also stepping up in this regard. We can examine the commitment of the private sector through the data sourced from the Science Based Targets initiative (SBTi). The SBTi drives ambitious climate action in the private sector by enabling companies to set science-based emissions reduction targets. Over 2,000 organisations have either committed to, or set, science-based targets. As of December 2021, more than 40% of companies with approved targets had set them in line with the goal of limiting warming to no more than 1.5℃ above pre-industrial levels. Through the SBTi’s Business Ambition for 1.5℃ campaign, companies also committed to achieving net-zero emissions by 2050.

FIGURE 10: SCIENCE BASED TARGETS (SBT)

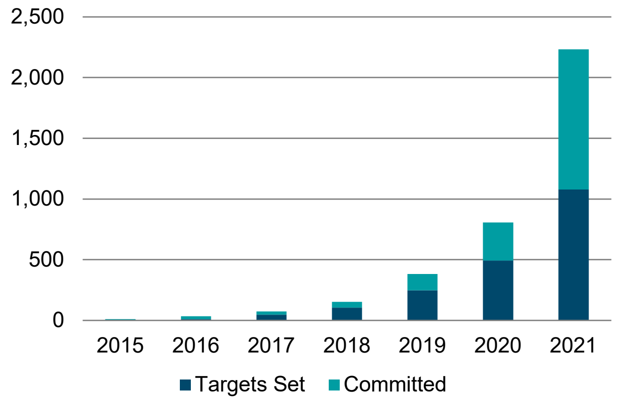
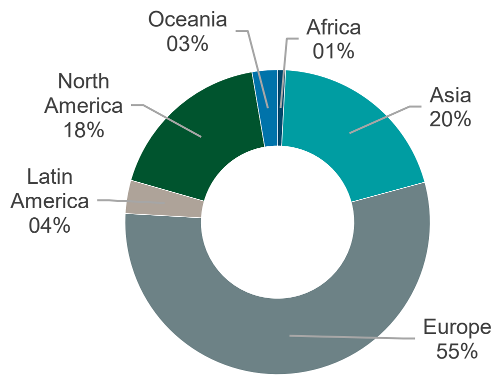


FIGURE 11: SBT SET & COMMITTED, BY REGION



Source: DWS Research Institute, Science Based Targets Initiative (SBTi) (December 2021)

1.1.8. Why net zero instead of gross zero?

From a climate perspective, the ideal scenario is one where we stop all GHG emissions and achieve a state of gross zero. However, achieving gross zero across all sectors of industry and the economy is difficult to implement. Even with best efforts to reduce them, there will still be some emissions, for example, in activities which simply do not have an alternative production process.

Net zero is therefore a state in which emissions that simply cannot be eliminated are compensated by absorption and removal of greenhouse gases from the atmosphere. And it is the absorption and removal of GHGs or Carbon Capture, Use and Storage (CCUS) which will likely be almost indispensable to achieve net zero, but its viability is yet unknown.

Since net zero goals are therefore likely to be unreachable without CCUS, and since the cost of this technology is so high, it will require much higher carbon prices and government support to facilitate their deployment. The International Energy Agency (IEA) estimates that captured CO_2 needs to grow 20 times from around 40 million tonnes today to over 800 million tonnes by 2030. This would represent the annual retrofitting of approximately 20 coal power plants in Asia and at least 90 cement plants between 2025-2030. Direct Air Capture is another technology which requires more deployment. The following figure provides a comparison of the cost of carbon capture technologies.

FIGURE 12: EUROPEAN CARBON ABATEMENT CURVE (EUR/TONNE)

Source: Morgan Stanley (January 2022). Carbon in 2022. Time to consolidate

As can be seen, these costs vary substantially, necessitating public and private technology innovation. Investors have a role to play to encourage companies and governments to cooperate in developing policy frameworks and investing in carbon capture. Moving beyond corporate carbon neutrality to carbon negative means some corporates are investing in carbon capture. For example, two major technology companies have set the first 'carbon negative' targets. One of the companies aims to remove more carbon than they emit by 2030 and by 2050 will aim to remove all the carbon the company has emitted since the company was founded in 1975[10].

1.1.9. How does the Paris Climate Agreement fit within the context of Net Zero?

The Paris Agreement is a legally binding international treaty adopted by 196 Parties at the 21st Conference of the Parties (COP 21) in 2015. Following individual country ratification, it then entered into force in November 2016. Its goal is to limit global warming to well below 2ºC, but preferably to keep it below 1.5ºC compared to pre-industrial levels. To achieve this, global greenhouse gas emissions need to be at or around net zero by 2050.

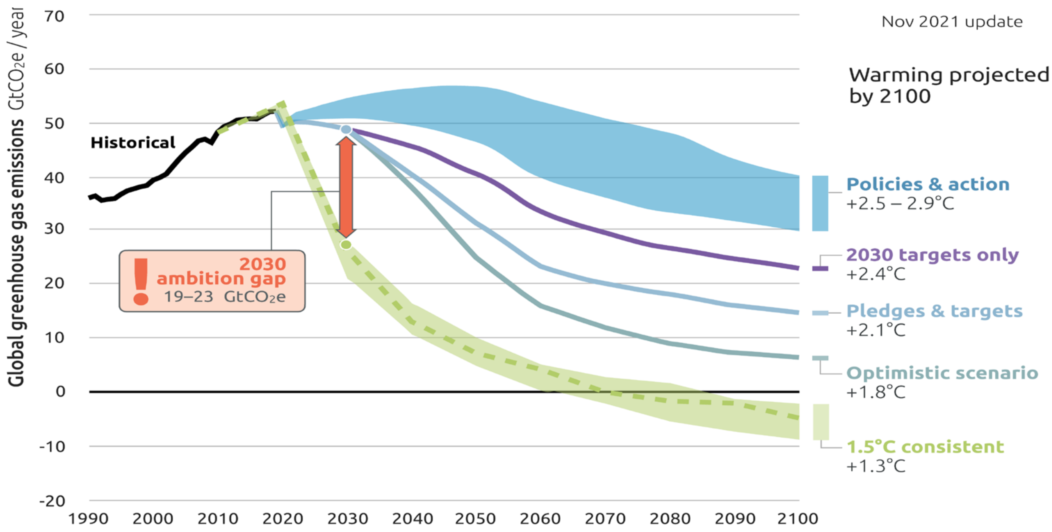
"In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty." (Article Four of the Paris Agreement)

1.1.10. What if we do not act now on reducing greenhouse gas emissions compared to if we do act?

Figure 13 maps out future greenhouse gas emissions scenarios under a range of assumptions: if existing policies and actions are maintained, if all countries achieved their current future pledges and targets for emissions reductions; and necessary pathways which are compatible with limiting warming to 1.5℃ or 2℃ of warming this century. As things stand today, the planet is on course to warm by an average of 2.7℃ by the end of the century, significantly above the target set out in Paris.

[10] Microsoft (16 January 2020). Microsoft will be carbon negative by 2030

FIGURE 13: GLOBAL GREENHOUSE GAS EMISSIONS AND WARNING SCENARIOS



Source: DWS Research Institute, Climate Action Tracker (based on national policies and pledges as of November 2021).

2.1 Carbon markets: History and future trends

2.1.1. What are carbon markets?

As the name suggests, carbon markets enable a pricing mechanism for carbon. There are two main types of carbon pricing: emissions trading systems (ETS) and carbon taxes.

_ An ETS – sometimes referred to as a **cap-and-trade system** – caps the total level of greenhouse gas emissions and allows those industries with low emissions to sell their extra allowances to larger emitters. By creating supply and demand for emissions allowances, an ETS establishes a market price for greenhouse gas emissions. The cap helps ensure that the required emission reductions will take place to keep the emitters (in aggregate) within their pre-allocated carbon budget.

_ A carbon tax directly sets a price on carbon by defining a tax rate on greenhouse gas emissions or – more commonly – on the carbon content of fossil fuels. It is different from an ETS in that the emission reduction outcome of a carbon tax is not pre-defined but the carbon price is.

The choice of the instrument will depend on national and economic circumstances. The above two are examples of explicit carbon pricing instruments. These operate within a broad incentive structure that includes other policies, from which a carbon price can be derived.

On the other hand, implicit carbon pricing policy does not directly apply a cost to emitting carbon and are usually put in place to address other climate objectives and tackle non-price barriers. Policies like feed-in tariffs (subsidy for renewables) and renewable obligations (requiring utilities to invest) are policies that have helped to accelerate the decline in renewable power technology costs.

Combining carbon prices alongside technology R&D and deployment support is more cost-effective than adopting either approach alone. In other words, combining the positives from both implicit and explicit carbon policies is a better proposition than either policy on its own. Depending on their design, carbon pricing schemes also generate development benefits by raising revenue for public investment, create new industries and jobs, boost low-carbon investment, improve air quality, and enhance energy security. In 2020, initiatives around the world generated USD53 billion in revenue (USD 45 billion in 2019). In 2019, around 50% of revenues went to environmental and development projects, 40% to general government budgets and approximately 10% to tax cuts and revenue transfers[11].

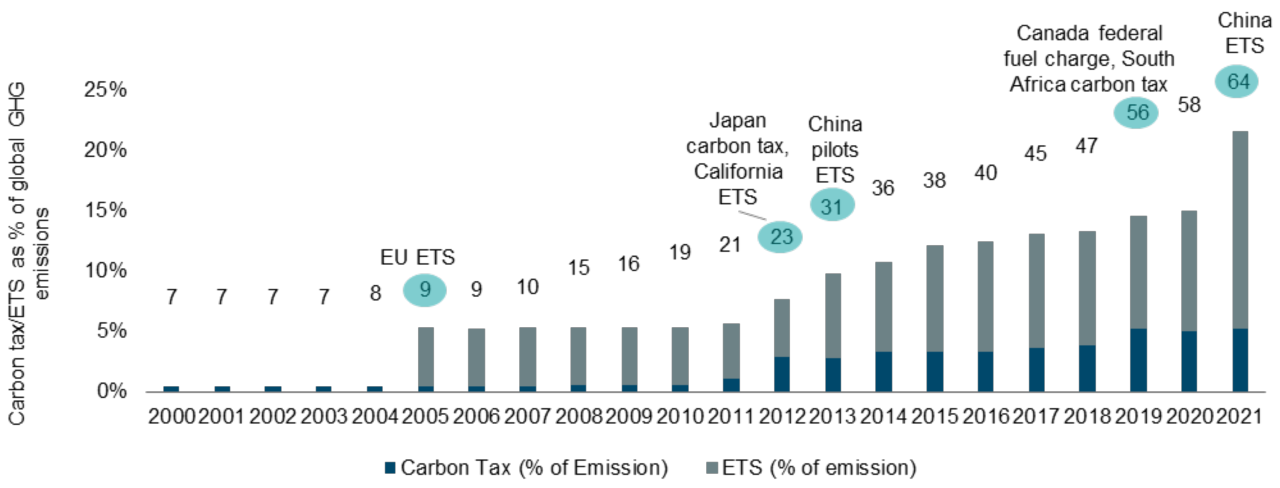
2.1.2. What is the need for carbon pricing?

Today, the science is unequivocal: Humans have been driving global warming through the extensive burning of fossil fuels. We are already seeing changes in the climate as a result of this burning. For example, 20 of the 21 hottest years since records began over 130 years ago have occurred since the turn of this century[12]. A price on carbon helps shift the burden for the damage back to those who are responsible for it, and to those who can take action to reduce it. Instead of dictating who should reduce emissions where and how, a carbon price gives an economic signal and polluters decide for themselves whether to discontinue their polluting activity, reduce emissions, or continue polluting and pay for it. In this way, the overall environmental goal is achieved in the most flexible and least-cost way to society. At an appropriate level, a carbon price also stimulates clean technology and market innovation, spurring new, low-carbon drivers of economic growth.

2.1.3. To what extent do carbon markets cover global GHG emissions?

In April 2021, 21.5% of global GHG emissions were covered by carbon pricing instruments[13], representing a significant increase on 2020, when only 15.1% of global emissions were covered, Figure 14. This increase is largely due to the launch of China's national ETS last year to become the world's largest carbon market. **Figure 14 also highlights that carbon taxes were introduced much earlier than ETS but today ETS are more prevalent when measured by per cent of emissions covered.** Another point to note is of the 64 global carbon price initiatives, there is only one regional initiative, namely the European ETS, the remaining schemes are either national or sub-national.

FIGURE 14: NUMBER, TYPE AND SCOPE OF GLOBAL CARBON PRICE INITIATIVES



Source: DWS Research Institute, World Bank, April 2021. The GHG emissions coverage for each jurisdiction is based on official government sources and/or estimates

[11] World Bank (May 2021). 2021 State and Trends of Carbon Pricing
[12] Nasa (2022). Global Climate Change. Vital signs of the planet
[13] World Bank (May 2021). 2021 State and Trends of Carbon Pricing

2.1.4. Where are the major ETS markets globally?

Figure 15 summarises the characteristics of the major ETS markets globally. China's national ETS became operational in July 2021, to be the world's largest carbon market. What makes China's scheme different from those operating in other countries and regions, such as the European Union, Canada and Argentina, is that China has chosen to focus on reducing the intensity of emissions generation, rather than absolute emissions. Power companies in China are incentivized to reduce the intensity of emissions, which means producing the same or greater amount of energy while reducing their emissions or keeping them at the same level. That means absolute emissions can still increase as energy output increases, so long as the companies are reducing the volume of emissions per unit of energy output.

Conversely, the EU ETS is the most liquid carbon market globally. More than 15 years since the EU ETS scheme was launched, carbon prices have risen substantially. The EU ETS operates in all EU countries plus Iceland, Liechtenstein and Norway (EEA-EFTA states). It limits emissions from around 10,000 installations in the power sector and manufacturing industry, as well as airlines operating between these countries.

FIGURE 15: MAJOR ETS CARBON MARKETS

ETS market	Launch year	% of jurisdiction's emissions	% of global emissions covered	Sector coverage	Emission target	Use of offsets
EU ETS	2005	39%	3.14%	Power and heat generation; energy-intensive industry sectors (e.g. oil refineries, steel, aluminium, cement, chemicals); commercial aviation between member states.	Absolute emission reduction	From 2021, the use of offsets is not envisaged.
UK ETS	2021	33%	0.36%	Energy-intensive industry sectors (e.g. oil refineries, steel, aluminium, cement, chemicals); commercial aviation.	Absolute emission reduction	Not applicable
China ETS	2021	30%	7.38%	Initially just coal and gas fired energy plants. Aim is to expand the plan to industries including construction, oil and chemicals in coming years.	**Emission intensity reduction**	Up to 5% of entities' allowance obligations
California ETS	2012	80%	0.65%	Large industrial facilities (e.g. Cement, glass, hydrogen, iron and steel, chemicals, pulp and paper); Electricity generation & imports; Suppliers of natural gas and petroleum products.	Absolute emission reduction	4% offsets for compliance (2021-2025)
Korea ETS	2015	74%	0.95%	Power, industry, building, waste, transportation, heat, public sector and construction.	Absolute emission reduction	5% offsets for compliance

Source: DWS Research Institute, World Bank, April 2021.

2.1.5. How does the EU ETS carbon market work?

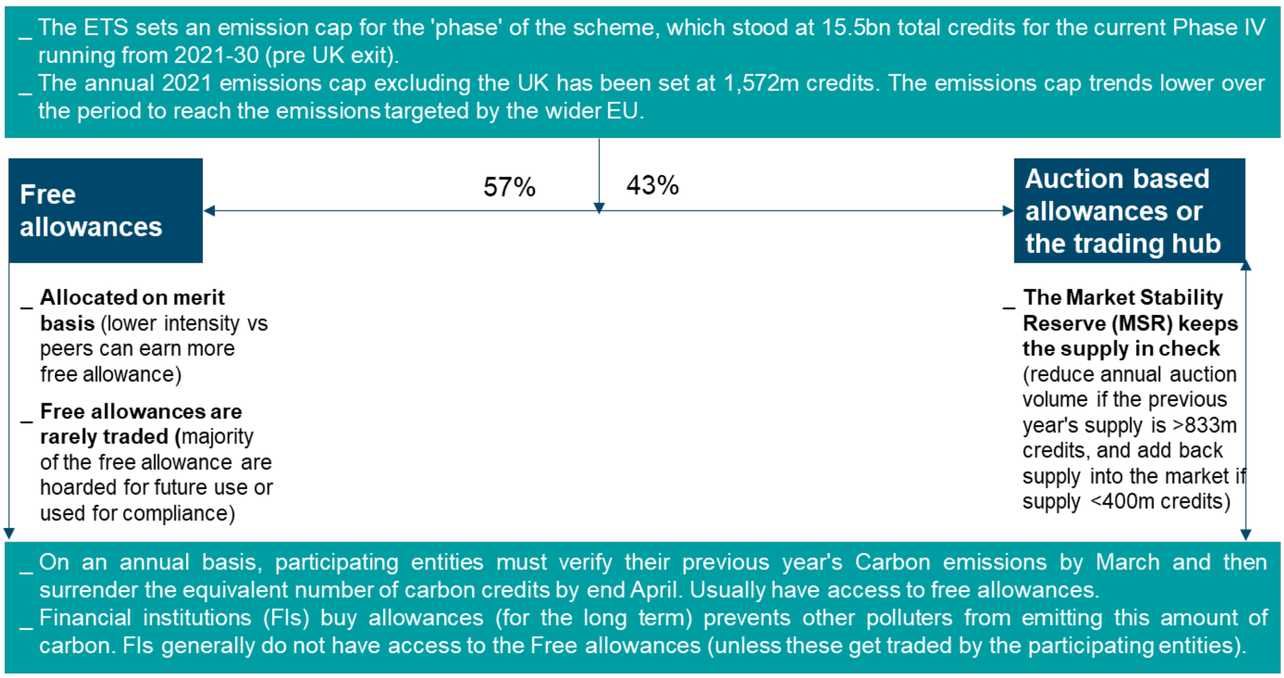
The EU ETS works on the 'cap and trade' principle. A cap is set on the total amount of certain greenhouse gases that can be emitted by the installations covered by the system. The cap is reduced over time so that total emissions fall. Currently, the EU ETS is in its fourth trading period (2021-2030). This phase focuses on reducing the total number of emission allowances, specifically by 2.2% annually, to ensure 43% lower emissions in 2030, relative to 2005. The European Green Deal strategy proposes to be more stringent, targeting 61% lower emissions in 2030, relative to 2005 (increase of 18 percentage points). This translates into cutting down the supply by 4.2% annually (instead of 2.2%).

Within the cap, installations buy or receive emissions allowances, which they can trade with one another as needed. The limit on the total number of allowances available ensures that they have a value. After each year, an installation must surrender enough allowances to cover fully its emissions, otherwise heavy fines are imposed. If an installation reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another installation that is short of allowances. In most of the major carbon ETS markets globally, institutions can also rely upon Voluntary Carbon Offsets in lieu of the emission allowance.

2.1.6. What is and how does the European Market Stability Reserve work?

The Market Stability Reserve started operating in 2019. Its creation was aimed at addressing the surplus of allowances that were occurring in the EU's carbon market. The MSR is a ruled-based mechanism, which means it prohibits any interference by the Commission in how it operates. Rather, it automatically places allowances in the reserve or releases them in case pre-defined thresholds are crossed.

FIGURE 16: BROAD CONTOUR OF THE EUROPEAN EMISSIONS TRADING SYSTEM (ETS)



Source: DWS Research Institute, European Commission. This exhibit and the data are only indicative representation of the ETS.

2.1.7. What are Voluntary Carbon Offsets?

Carbon offsets act as a compensation for carbon emissions. Simply put, carbon offsetting compensates for emissions by ensuring that there is less CO_2 in the atmosphere, either by soaking up emissions directly (also known as sequestering), or reducing future emissions. Carbon offset credits therefore allow individuals, companies and nations to reduce their 'net' carbon footprint, without reducing the actual footprint of their activities. One carbon offset credit equates to one tonne of carbon emission not emitted into the atmosphere. Projects include reforestation, renewable energy and household devices amongst many others. There are three main types of carbon offset:

- Absorption of emissions such as forestry projects
- Avoidance of emissions that would occur according to base case such as projects that enable the adoption of clean energy
- Preservation of carbon sinks such as projects that protect ecosystems that hold carbon such as peatlands and forests

2.1.8. What is the indicative cost of carbon globally?

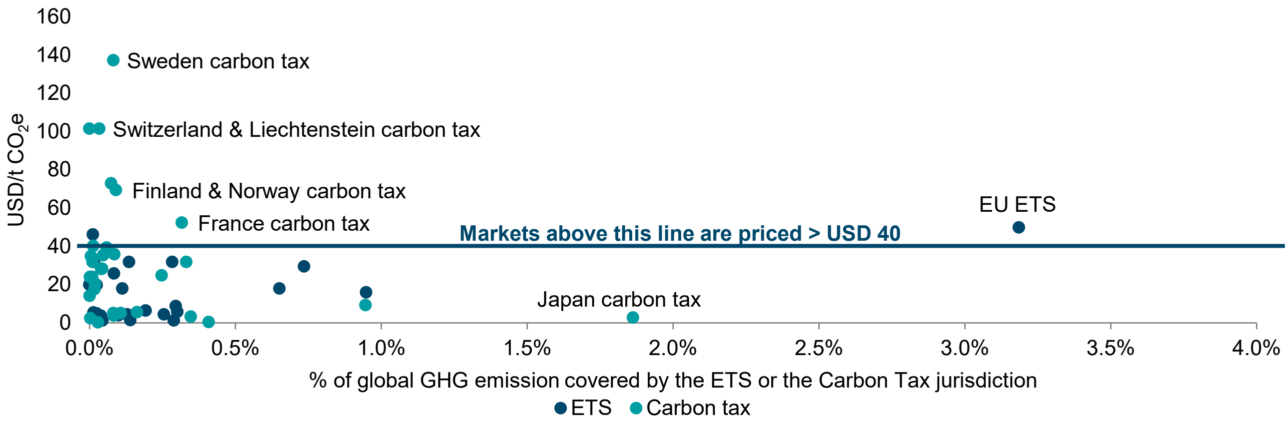
Carbon prices are not necessarily comparable between carbon pricing initiatives because of differences in the number of sectors covered and allocation methods applied, specific exemptions, and different compensation methods. With that caveat, Figure 17 provides an overview of carbon prices around the world in 2021 and the corresponding coverage of global GHG emissions. The weighted average of carbon prices globally works out at around USD3 per tonne of CO_2 equivalent of emissions (including jurisdictions where there is no explicit pricing for carbon). Despite low overall coverage of the global ETS and carbon markets, just 21.5% of the global GHG emissions are covered by a carbon price, nearly half of the largest 500 companies in the world by market value already have an internal carbon price or intend to adopt one in the coming two years[14]. While these internal carbon prices fall short of Paris Agreement aligned prices, they often exceed regulatory prices which are typically much lower.

Indeed, one of the main problems relating to carbon prices has been they have been too low for too long. In 2017, the World Bank supported Commission on Carbon Prices led by Professors Joseph Stiglitz and Nick Stern concluded that carbon prices of at least US$40–80/t$CO_2$ by 2020 and US$50–100/t$CO_2$ by 2030 are necessary, along with other supportive policies to have a meaningful impact in carbon emission reduction. We can see from Figure 17 that only a handful of markets are priced at these levels and secondly the ones who are priced at these levels are relatively low-emitters when measured as a share of total GHG emissions globally, with the exception of the EU ETS.

The European Union ETS is the only major market, that is where emissions are in excess of 1% of global GHGs, where the carbon price is trading in double-digits. Given the strong rally in EU ETS prices since the beginning of 2020, this threatens to hamper the competitiveness of those entities operating withing the EU ETS scheme and in turn increased the risk of carbon leakage.

[14] CDP (April 2021). Nearly half of the world's biggest companies factoring cost of carbon into business plans

FIGURE 17: CARBON PRICE ACROSS ETS AND CARBON TAX JURISDICTIONS GLOBALLY



Source: DWS Research Institute, World Bank, Prices as of April 1, 2021.

2.1.9. What is carbon leakage?

Carbon leakage refers to companies transferring production outside their home markets to operate in geographies with weaker environmental regulation and so circumvent more stringent climate policies at home. Given the rising price of carbon in Europe, carbon leakage is viewed as specifically relevant for carbon-based production in Europe. To address these risks the European Union has proposed the introduction an import levy for steel, cement and aluminium produced in other countries where lower environmental standards prevail. This will mean importers will have to buy special certificates at a price linked to the ETS.

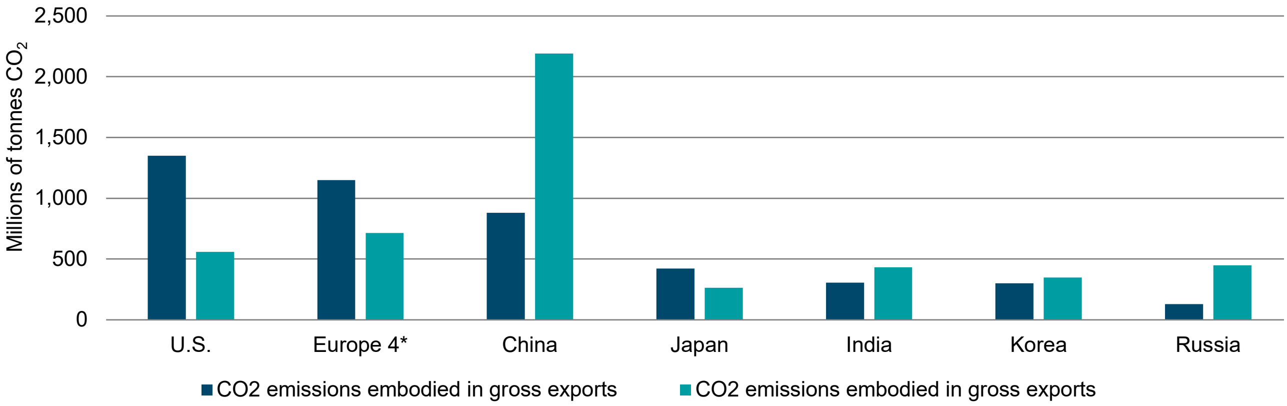
Such cross-border carbon adjustments aim to ensure that the price of imports is adjusted to accurately reflect the imports' carbon content. In 2019, the EU Commission identified a list of 63 sectors and sub-sectors covering approximately 94% of industrial emissions within the EU ETS that are eligible to receive a declining share of free carbon allowances. In June 2021, the EU Commission proposed a carbon border adjustment mechanism to level the playing field for manufacturers. For some sectors, a Carbon Border Adjustment could potentially help address competitiveness concerns and offshoring risk. However, such an approach does pose a risk in terms of a disruption to global trade, which has already been significantly dented by Covid-19 and rising protectionism.

2.1.10. What are the pros and cons of carbon border taxes?

Burdening domestic companies with a CO_2 tax while leaving imports untouched would encourage so-called carbon leakage. That means encouraging energy intensive companies to shift production to countries with less stringent carbon policies, which would undermine any efforts to reduce carbon emissions on a global basis. That is why taking a holistic approach when it comes to CO_2 may be important. A carbon border tax would both help to create a level playing field for companies as well as encourage consumers to opt for less CO_2 intensive products. It might also reduce the volume of goods that are only shipped around the world as a result of exploiting different environmental standards. But as well-intended as such a tax might be, it is likely to create relative winners and losers.

As Figure 18 reveals, it makes a substantial difference for some countries whether you look at how much CO_2 they produce and how much CO_2 they consume. Or in other words: how much CO_2 emissions they export and import. The chart shows that the United States, being a service-oriented country, must import many of the goods it consumes, and as such it is importing significantly more CO_2 than it exports. The same, albeit to a smaller degree, is true for Europe and Japan. On the other side of the equation is China and Russia, exporting goods and natural resources respectively. Applying a consumption-based approach would cause developed countries' emissions to be 13% higher[15].

FIGURE 18: CARBON EMISSIONS EMBODIED IN EXPORTS AND IMPORTS



Source: DWS Research Institute, OECD 202. as of 7/6/21. *Europe 4: Germany, UK, France, Italy.

[15] DWS Investment UK Ltd analysis of https://stats.oecd.org/Index.aspx?DataSetCode=IO_GHG_2019

IMPORTANT INFORMATION – EMEA, APAC & LATAM

IMPORTANT INFORMATION – NORTH AMERICA

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