Research Institute
Carbon pricing

February 2022

Marketing Material

Emission impossible: Opportunities in carbon

Authors: Murray Birt, Rob Bush, Michael Lewis, Jay Joshi

IN A NUTSHELL

- Carbon emissions are one of the biggest market failures as the damage caused to current and future generations and nature is not accounted for by entities causing emissions. A carbon tax or a cap-and-trade market internalizes this negative externality into business and investment decisions. Carbon pricing is a business opportunity, is a cost efficient and effective policy for cutting emissions and can be designed to be fair to all stakeholders[1].
- After many years of dormancy, global carbon markets have sprung to life with Europe at the heart of this awakening. EU Emissions Trading Scheme (ETS) carbon prices[2] have moved above EUR90/tonne, compared to EUR20/tonne in March 2020. EU allowances were by far the best performing asset class in 2021. We also find that carbon returns are normally distributed, have declining volatility, but, may not yet offer significant equity portfolio diversification benefits.
- Despite the risks of a price reversal, structural forces are likely to drive prices even higher over the medium term as carbon markets become an even more important tool for net zero targets. We project the EU price will stay around ~€80 for the next two years, reaching €100 in the second half of the 2020s. Policy intervention risk does exist which could undermine decarbonisation[3]. The EU ETS is not the main cause of power price spikes[4].
- Governments are introducing and strengthening carbon market schemes: China launched its national market last year, Europe plans to require importers of major manufactured products to buy carbon allowances and a new global carbon market agreement was reached at the UN climate summit COP26, which could help revive the international traded market in carbon[5].
- However, less than 4% of global emissions are regulated by a carbon price above US$40 per tonne CO_{2e} which is at the bottom range of what is deemed to be required to meet the Paris climate agreement[6]. The Bank of England has warned companies to be ready for US$150/t carbon price[7], while some companies internally[8] use US$200+/tonne. The cost of developing carbon capture and storage technologies may require carbon prices to be higher still[9].
- Institutional investors can access the EU carbon market through an exchange traded commodity (ETC) backed by EU allowances, that could be an important new component of net zero strategies. Investors also have a role to play encouraging governments to strengthen policies and expecting companies to lobby in favour of carbon markets.
- Compared to offsets and futures on carbon allowances, buying EU allowances may create a real-world emission reduction through a price effect and allowance cancellation through the EU Market Stability Reserve. Analysis of three separate reports[10] conclude that holding one EU allowance for nine years prevents 1.38 to 1.48 tonnes of CO_2 plus some delay to climate impacts. No assurance can be given that any forecast or target will be achieved.
- This report focuses on the EU ETS, EU carbon allowances as a distinct asset class and actions by governments, companies, and investors. To accompany this report, we are publishing a brief guide to carbon markets. In future months, we will examine the carbon price implications in real estate and infrastructure, whether stronger carbon prices and policies are reflected in equity market valuations and the relevance of carbon markets for bond investors.

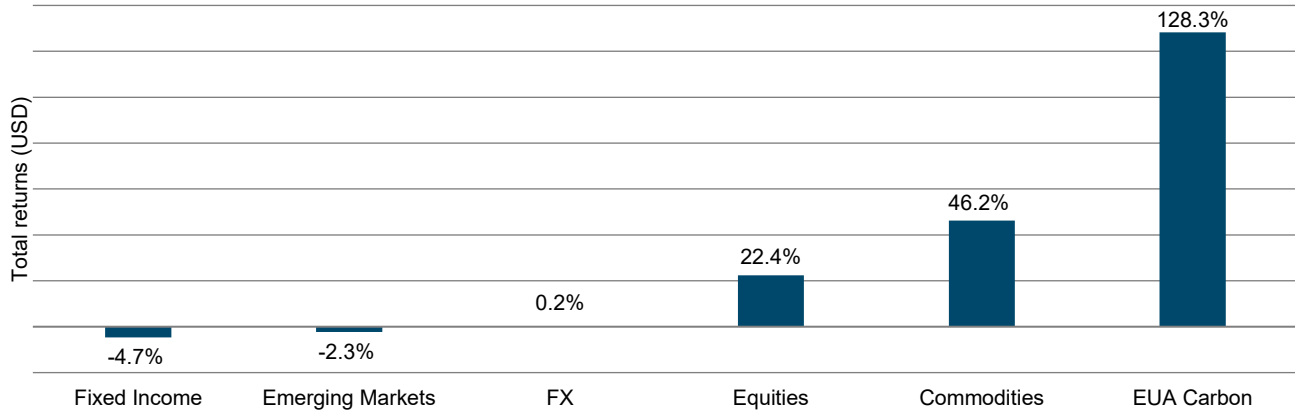
1 CPLC 2018 2 Bloomberg Finance LP (February 2022) 3 World Bank 2021 4 DWS 2021 5 Autonomy 2021 6 World Bank 2021 7 BoE 2021 8 CDP 2021 9 IEA 2021 10 SparkChange 2021 based on ICIS 2020 & LSE 2019

1 / Carbon prices & market developments

1.1 Carbon allowances were the highest returning asset class in 2021

2021 was a year when growth-proxy asset classes performed strongly with commodities and developed market equities being among the best performers, **Figure 1**. These asset classes were bolstered by still relatively accommodating central bank policy alongside Covid-vaccine optimism. Within the commodity complex, and not incorporated in benchmark commodity indices, the star performer was European carbon allowances, with the ICE European carbon total returns index posting gains in excess of 140% in euro terms compared to a year earlier and just shy of 130% in US dollar terms.

FIGURE 1: 2021 ASSET CLASS PERFORMANCE SCORECARD



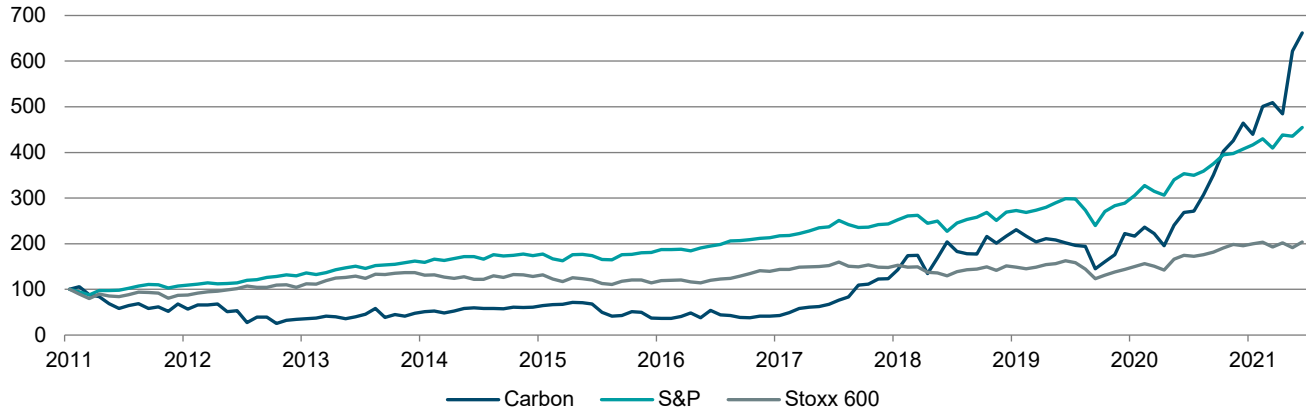
Source: DWS Research Institute, Bloomberg Finance LP (data capture performance statistics from 31-Dec-20 to 31-Dec-21)
Fixed income: Bloomberg Global Aggregate total returns index; Emerging markets: Bloomberg EM USD sovereigns (I12875US index); FX: Deutsche Bank currency returns index (DBFXDBCRE index); Equities: MSCI World (MXWO index); Commodities: Deutsche Bank Liquid Commodity index optimum yield (DBLCOYTR index); EUA carbon: ICE EUA carbon futures (ICEEUA index USD terms)

Behavioural finance theory provides a cautionary tale for investors trying to chase a rally since last year's winners have a habit of becoming this year's losers. Even so, in this report we examine the longer-term fundamentals likely to be important drivers for carbon markets around the world. Since net zero is a state in which some emissions that simply cannot be eliminated for example in the steel and cement industries, it necessitates the absorption and removal of greenhouse gases from the atmosphere. This requires the deployment of technologies such as Carbon Capture, Use and Storage (CCUS) and restoration and protection of the world's forests and oceans (see our October 2021 report Oceans and Climate – Exploring the Nexus) . However, deploying CCUS technologies will likely require much higher carbon prices.

1.2 Investor motivation for owning carbon allowances

There is nothing quite like a significant price increase for focusing investor attention on an asset class, and, as **Figure 2** demonstrates, the price of carbon has behaved accordingly in recent years, initially lagging U.S. and European stock markets, and then, more recently, accelerating past them. This is likely largely attributable to more ambitious emission reduction targets being set in Europe alongside certain structural changes to the supply of carbon allowances within the ETS. In addition, policymakers have signaled their desire for a higher carbon price, one that will inject the requisite pain into corporate income statements to make meeting long-term emission reductions viable.

FIGURE 2: MONTHLY RETURNS TO CARBON, S&P 500, AND STOXX 600 (TOTAL RETURNS, REBASED TO 100)



Source: DWS Research Institute, Bloomberg Finance LP (Data 29-Jul-11 to 31-Dec-21)

Of course, investors must also recognize that few assets are so tractable that they do exactly as they are told (or, as policymakers wish them to), and carbon is no exception. In fact, one of the most critical requirements for anyone considering dipping their toes into the emissions market will be forming a view on the likely direction, and extent, of changes to the market's structure.

Issues such as the size of the fine that will be levied on companies for exceeding carbon emissions (which is currently set at EUR 100 per tonne, but must presumably change if the carbon price nears, or exceeds, that level), the amount, range, and reduction schedule of allowances that are made available in a given year, and the composition of the Market Stability Reserve (MSR, effectively an inventory of off-market credits that form a strategic reserve, with automatic rules to help manage supply and demand of EU allowances), will all need careful scrutiny. Many of these issues are discussed in our accompanying carbon markets primer report.

It will not be lost, at least on financial economists, that today's price is, in theory, already building in many, or all, of these assumptions. However, with these provisos in place, we still believe that it is helpful for investors trying to understand carbon markets to study some of the empirical features of the asset class to date, and to think about one or two of the potential rationales for investing in carbon given that context. As such, we briefly examine:

(i) The distribution and statistics of one of the most liquid carbon markets, the European futures market.

(ii) Whether an investment in carbon is warranted for any of the following reasons:

a. As a diversifying asset in combination with the US or European stock markets
b. As a standalone speculative asset
c. As part of a portfolio hedging programme, on the premise that companies will be increasingly required to pay for the right to emit carbon, and be less profitable as a result (ceteris paribus)
d. As a means for a net zero focused investor to potentially accelerate reduce emissions

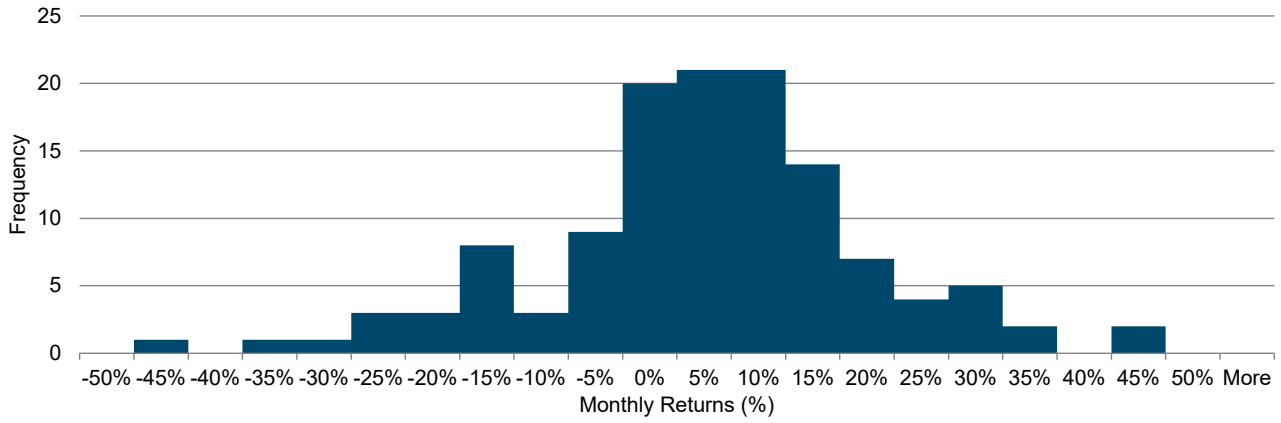
1.3 Financial statistics on EU carbon allowances

As we have already made clear, the carbon market is globally fragmented with different implementations, and trading venues, and, as a result of that, multiple prices. All of which makes it challenging for an investor to decide which price series to use. In this section we continue the approach adopted throughout this paper, which is to use the generic front month of the ICE carbon futures contract. That represents the approximate experience that an investor would have if they held the future with the earliest available delivery date and rolled that position each month, as required by the expiry of the prior month contract. So, put simply, it can be thought of as a buy and hold position in carbon. We used monthly returns from the

earliest available date (7/11 to 12/21), sourced from Bloomberg. **Figure 3** shows the distribution of these 125 monthly returns.

For a relatively nascent market, it doesn't seem unreasonable to conclude that carbon returns are approximately normally distributed with a monthly mean of 2.68% (which annualizes to 19.89%), and a monthly volatility of 14.9% (which annualizes to 51.8%). The distribution is slightly negatively skewed (i.e., a longer tail to the left), but, overall, given the relatively small amount of historical data, we are comfortable concluding that carbon returns appear to have reasonably similar properties to some other major asset class returns, in the sense of being approximately normally distributed. This is important because it means that we can sensibly evaluate the inclusion of carbon in a portfolio using the tools of the mean variance framework.

FIGURE 3: THE DISTRIBUTION OF MONTHLY RETURNS TO THE ICE CARBON FUTURES MARKET (GENERIC CONTRACT)

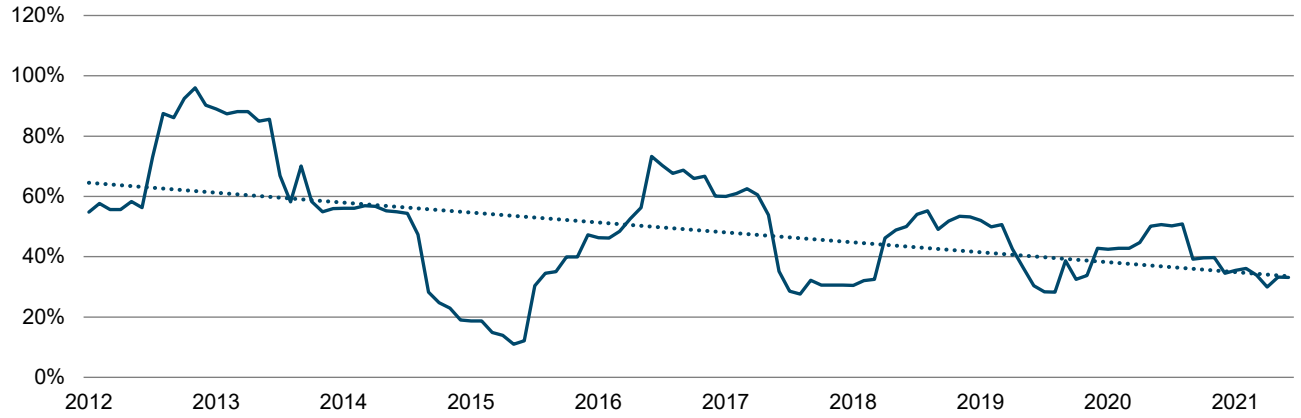


Source: DWS Research Institute, Bloomberg Finance LP (Data 29-Jul-11 to 31-Dec-21)

One of the most useful insights from this approach comes from identifying assets that can be added to a portfolio in order to reduce risk. Unfortunately, over the period we looked at (7/11 – 12/21), carbon prices were so volatile (c. 52% annualized) that, despite the quite low overall correlation to the S&P 500, and to the EURO STOXX 600 (0.19 and 0.25 respectively), they were not able to meaningfully reduce the risk of those stock-only portfolios.

Of course, one can argue, quite reasonably, that, as trading volumes and investor interest in carbon markets increase (i.e., as the market matures, and price discovery, and liquidity, increase), volatility might be expected to come down. **Figure 4** shows the rolling volatility of carbon prices, and the trendline indicates that this has been the case so far. The question then would be, how low must carbon risk go so that it becomes worth considering from an overall risk reduction standpoint? Well, leaving the correlation numbers unchanged, the answer is below around a 40% annualised volatility to diversify against the S&P, and below around a 43% volatility for the EURO STOXX 600 (this latter market has been riskier over the years in question, hence a lower barrier to carbon inclusion). Even then inclusion for risk reduction purposes alone would be questionable.

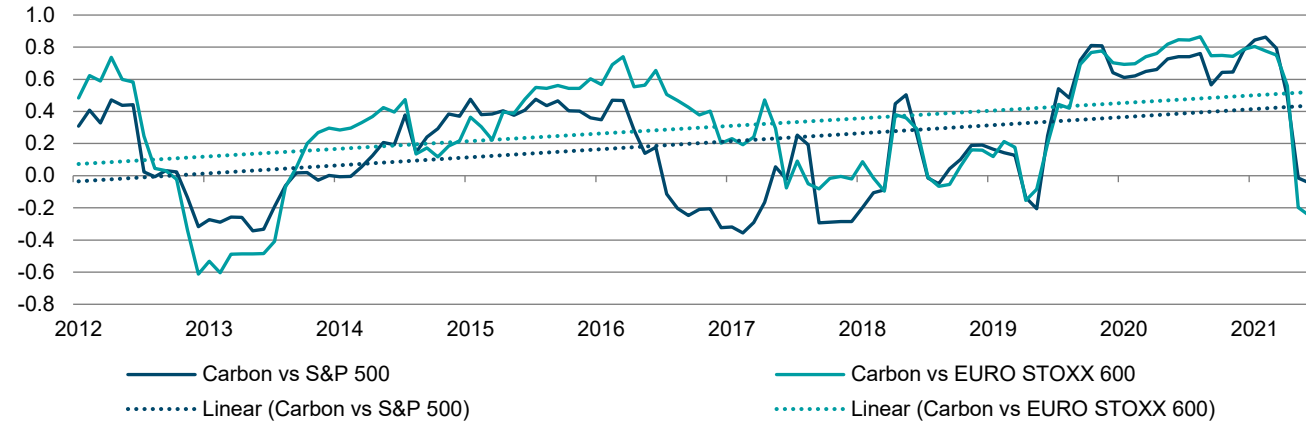
FIGURE 4: ROLLING VOLATILITY OF CARBON RETURNS, AND TRENDLINE (12M RETURNS, ANNUALISED)



Source: DWS Research Institute, Bloomberg Finance LP (Data 29-Jul-11 to 31-Dec-21)

In addition to the high volatility of carbon prices, investors that analyze matters quantitatively will need to think about the slightly troubling correlation profile that carbon prices seem to exhibit when compared to equity markets. **Figure 5** unpacks this relationship, showing not the whole period numbers reported above (0.19 vs S&P 500, and 0.25 vs EURO STOXX 600), but, instead, the rolling correlations over the same period. It's clear that as well as being very changeable, the markets appear to be increasing in their tendency to co-move (and therefore less useful for diversification as a result), even despite the recent extreme move lower. Overall, our take on adding carbon to a stock portfolio based on empirical numbers would be that it's simply not there yet. Investors should wait to see if the standalone volatility comes down, and if the desired low correlation is sustainably low.

FIGURE 5: ROLLING CORRELATIONS OF CARBON RETURNS VS S&P 500, AND EURO STOXX 600, AND TRENDLINES (12M ROLLING CORRELATIONS OF MONTHLY RETURNS)



Source: DWS Research Institute, Bloomberg Finance LP (Data 29-Jul-11 to 31-Dec-21)

1.3 Other rationales for owning carbon allowances: short term returns, longer term portfolio hedging and real-world emission reduction

Of course, not every investor operates within the strict requirements of the mean variance world (which, in any case, despite its ostensibly rigorous inputs, clearly relies upon quite a high degree of subjectivity in terms of forecasting those numbers). To some investors exposure to carbon prices may be justified on other grounds, amongst including shorter term price appreciation and returns, longer term portfolio hedging benefits, and opportunities to accelerate emissions.

The first of these is covered in the first section of this paper where we argue that, despite the inherent difficulties of forecasting any asset price, let alone the relatively recent one of emissions allowances, there are some potential features of carbon markets that make a bullish outlook reasonable. After all, this is a market where not only is supply being deliberately constrained, but indeed it is also being reduced by design. Put another way, unless investors have reason to doubt the structure and intent of the market, then it has been announced that the outstanding numbers of allowances will reduce over time according to a schedule which, so far at least, has accelerated. When one adds to that the potential for a price floor, and the clear signaling from policy makers that their preferred clearing price for carbon is higher, then we can at least see a path to a reasoned ownership position from a return standpoint.

Another argument for potential carbon exposure that is quite interesting runs as follows. If companies - as many currently do, and more may need to - are going to be required to own and trade carbon allowances that offset all of their emissions then surely, other things equal, that has to represent a drag on profitability that simply didn't exist in the past. Or, put another way, and which is the stated intent of these carbon policies, the externality of polluting, once free, must now be paid for by companies that want to continue their operations as before.

Of course, in the very long run that is likely to mean an end to much of this polluting activity (the policy goal), but, in the meantime, it could simply mean an additional expense item on the income statement, as a longer-term intent (eliminate carbon emitting activities) is met with a shorter-term solution (pay for the right to emit until business models can adapt). For investors who believe that this pragmatic, but ultimately unsustainable middle ground will exist, then owning exposure to carbon allowances may provide a natural hedge to their portfolios.

Of course, there are a number of considerations with this approach, and the two most obvious are, the extent to which portfolio companies are themselves hedging their carbon price exposures, and the extent to which companies are either exposed to emissions requirements and/or have the ability to pass those costs onto their customers. So, some sort of "emissions elasticity". A detailed analysis of how that might look for every company in question is beyond the scope of this paper, but we hope it's not remiss to point out that these are exactly the type of detailed, company specific, issues that any asset manager worth their salt will examine as part of their investing due diligence.

Finally, there is one last motivation for holding carbon allowances that is, in our view, quite interesting, but probably not within the remit of too many investors. The simple fact is that, by buying carbon permits, either through the actual allowances market itself (the equivalent of the "physical" market in commodities), or via futures which can be rolled, or held to expiry (at which point they will morph into physical holdings of allowances), anyone with the required capital and infrastructure can remove from the marketplace the ability of emitters in aggregate, to produce a ton of carbon.

It sounds obvious, but it simply means that deep pockets could be used for real world change. And the carbon allowances market is quite distinct from some other commodity markets, for two key reasons. Firstly, it puts a price on a disbenefit as opposed to, say, pricing the benefit, or need, for many other commodities, and, secondly, because, unlike some of those other commodities, there is likely to be less outcry if non-commercial users (those that don't actually intend to use the allowances for the right to pollute) are believed to be causing the price of carbon to appreciate.

So, unlike, for example, some of the outcry that we witnessed during the ramp up in global food prices shortly before the 2008 financial crisis, we would instead expect to see a situation in which most non-commercial players involved in this market were welcomed (except of course by those with the need to emit). The extent to which this behavior will occur, and whether it will be driven by a profit motive, or by altruism, remains to be seen.

1.4 EU carbon price market consensus forecasts

While there are multiple drivers behind the recent sharp increase in European carbon prices, two attributes stand out. First, a tightening in allowances which have been reduced by 2.4% through the market stability reserve (MSR) mechanism. The second driver is slightly more tactical in nature, namely strong natural gas prices. Typically, a gas power plant emits about

half the CO_2 than one burning coal. Strong advances in natural gas prices make it cheaper for power plants to burn coal, which means higher emissions and increased demand for carbon allowances.

Alongside strengthening fundamentals in the European ETS and more ambitious climate targets announced by the European Commission last summer, these have encouraged a more bullish assessment among the investor community towards European carbon prices to emerge. **Figure 6** illustrates the range of carbon price forecasts published by a variety of agencies including investment bank sell-side analysts. We believe there are some interesting observations from these carbon price forecasts:

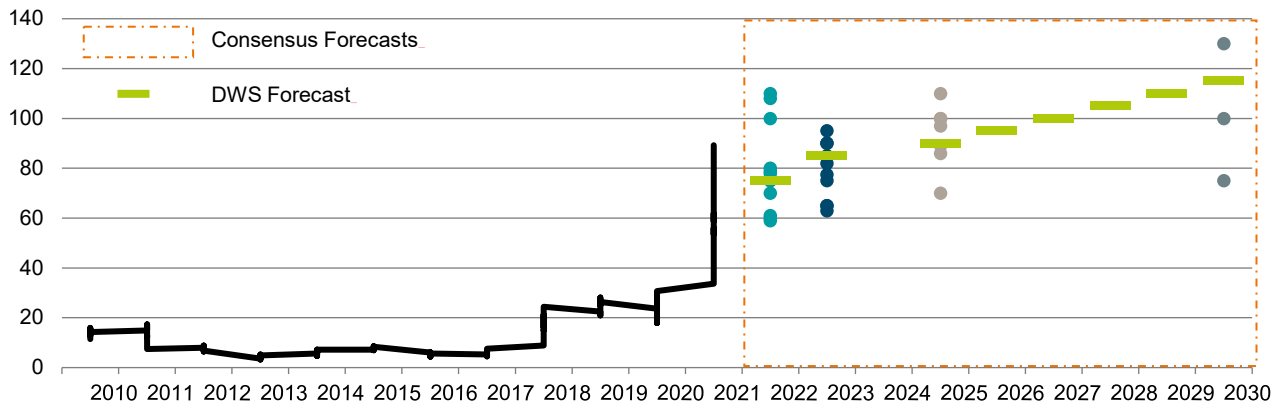
(i) The most divergent opinion on the carbon price outlook is in the short term (2022) and the long term (2030). The wide dispersion of forecasts for this year is most likely a reflection of the high risk of a price pull-back following the powerful rally over the past two years

(ii) Compared to the end January 2022 spot price, the majority of the analyst community is adopting a bullish view towards carbon prices out to 2025 and beyond

(iii) There is also a healthy divergence among this bullish analyst community. This is fortunate since we would be wary of price forecasts clustered in a tight range as market prices typically frustrate a consensus view

(iv) The small number of published price forecasts indicates either a lack of expertise or priority towards carbon market analysis across the analyst community. Something we expect to change dramatically in the years ahead

FIGURE 6: EUROPEAN CARBON PRICES AND MARKET CONSENSUS FORECASTS



Source: DWS Research Institute, Bloomberg Finance LP (January 2022), various sell-side research firms. The historical data series capture month end closing of the EUA futures from January 29, 2010 to January 31, 2022.

From our perspective, we believe it is worth examining and monitoring the levelised cost of CO_2 capture by sector to provide a potential long-term price target for carbon prices. While these costs vary substantially, as illustrated in **Figure 6**, they suggest carbon may have potentially further upside ahead. In fact, as outlined earlier, prices moving as high as €100/tCO2 in the second half of this decade may be required, along with other supportive policies, to help drive carbon emission reduction.

Since half of emissions covered by a carbon price are priced at less than US$10 per ton of CO_2 and that the IMF estimates the global average carbon price to be just US$3 per ton of CO_2 it shows the significant upside potential of carbon prices outside Europe that might be achievable before the end of this decade.

1.5 Ways to invest in carbon

Figure 7 shows the difference between buying carbon allowances, investing in a futures market for carbon allowances, carbon offsets and corporate renewable energy project funds.

FIGURE 7: DIFFERENCES BETWEEN CARBON ALLOWANCES, FUTURES, OFFSETS AND PROJECT FUNDS

	Carbon Allowances: "Net zero" Carbon	**Rolled Futures on Allowances: Carbon risk hedged**	**Carbon offsets: Secondary market for climate-action projects**	**Corporate renewable project funds: Primary market for climate projects**
What is it?	A Special Purpose Vehicle (SPV) holds EU carbon allowances and issues a note which may be bought by an Exchange Traded Commodity Portfolio gains exposure to current carbon allowance prices directly and indirectly owns those allowances via the purchase of such note/ETC	Futures are rights to purchase allowances at predetermined date and price Futures are rolled regularly and not settled into allowances	Purchasing offset credits from climate-action projects such as nature restoration, encouraging energy efficiency/fuel switching, renewables Voluntary system	An asset manager creates a turn-key financial vehicle to outsource the financing & construction of new renewable or other climate or nature restoration projects for corporates, supply chain companies & investors
Pros	Due to the EU's Market Stability Reserve the quantity of allowances is reduced by withholding the allowances from polluting companies	Unfunded investment – portfolio remains 100% invested in equities Established futures market	May provide positive externalities such as impact on biodiversity or job creation Transparency of the projects. Relatively easy to explain projects to retail clients	Buying offset credits are an expense while project funds yield a return and emission reductions and would generally comply with asset manager fiduciary duties Outsourcing can help address corporates', supply chain companies' & some investors' lack expertise in project finance and renewables procurement
Cons	If held within an equity portfolio there could be Equity Dilution due to ownership of allowance contracts Reliant on listed debt securities	No direct ownership of allowances and hence the direct physical impact on carbon emissions is uncertain Incurs contango* costs [1-2]% p.a. Uncertain if there is a material impact on allowance prices as futures are rolled	Buying offset credits are an expense for asset managers and may not be consistent with fiduciary role unless client requests such investments Fragmented market and limited data render pricing untransparent Actual carbon reduction can be questionable and may be difficult to establish ex ante	Corporates & supply chain companies investing into a fund may require a mentality change Project development can take time Likely not investable in liquid portfolios

Source: DWS Research Institute (February 2022)

* Contango is where the futures market price of a commodity is higher than the spot price. In futures markets, prices will usually converge toward the spot prices as the contracts approach expiration.

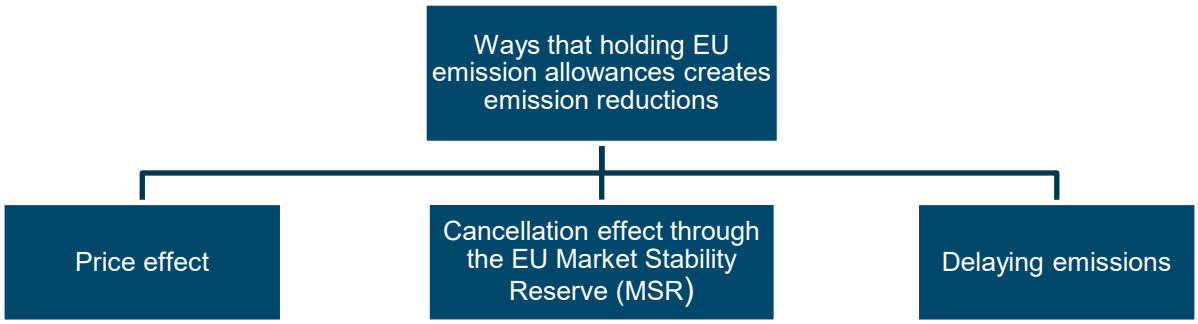
1.6 How owning carbon allowances may create emission reductions

As an EU allowance represents a permit to emit one tonne of emissions, buying and retiring an EU allowance gives certainty that an emission reduction is created. The EU's declining regulatory cap on emissions means that a retired allowance is not available to be used by a regulated carbon emitting company. However, mass retirement of allowances may not be an option for many institutional investors seeking returns to meet their financial obligations.

However, even if allowances are held for several year and then sold back to the market, there may be real world emission reductions caused by three effects shown in **Figure 8.** Three separate reports[1] have been written analysing the price effect and cancellation factors using a scenario where 10 million allowances are bought in 2021 and sold in 2030. The table shows the potential impact over the 2021-2030 period from the three reports written by a researcher at the London School of Economics, analysts at ICIS – Independent Commodity Intelligence Services and SparkChange - a provider of specialist carbon investment products and data that is helping investors gain access to the EU carbon market.

No assurance can be given that any forecast or target will be achieved. Forecasts are not a reliable indicator of future returns. Forecasts are based on assumptions, estimates, views and hypothetical models or analyses, which might prove inaccurate or incorrect.

FIGURE 8: POTENTIAL IMPACT FROM WITHOLDING EMISSION ALLOWANCES FROM THE MARKET



Source: DWS Research Institute (February 2022) based on LSE 2019 &ICIS 2020 & SparkChange 2021

The impact of delaying emissions is not estimated in these models, however delaying emissions can be important environmentally as it delays increases in the concentration of carbon emissions in the atmosphere.

All other factors being equal, increasing the demand for allowances increases the price which may create stronger incentives for companies to reduce emissions.

A strong cancellation effect is created by an EU law that created the Market Stability Reserve (MSR)[2]. The MSR was created to address a surplus of allowances that had been building up in the EU market since 2009. The surplus was due to the 2008 economic crisis (which reduced emissions more than anticipated) and (at the time) high imports of international carbon credits which kept EU carbon prices low and reduced the incentive to reduce emissions within the EU.

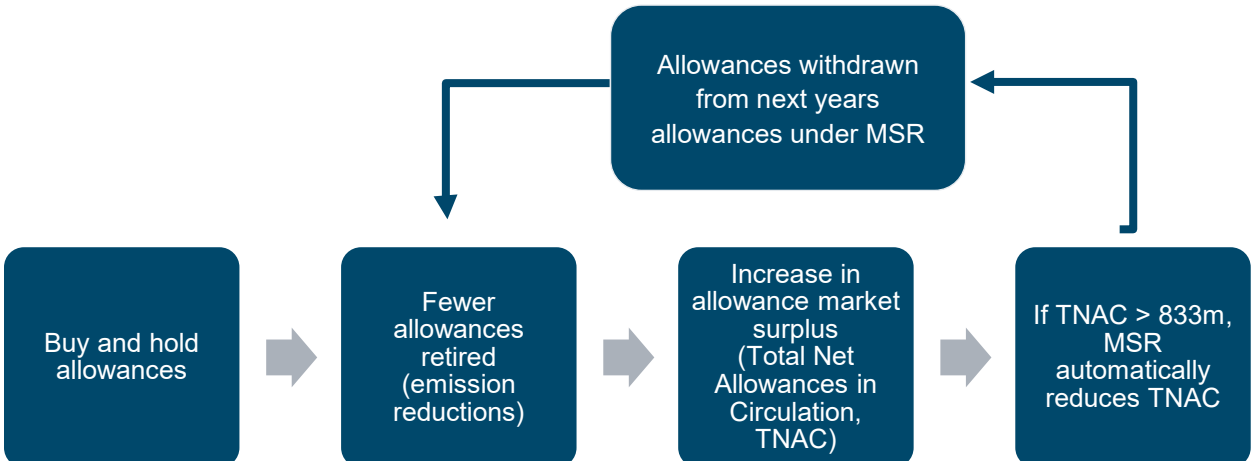
The MSR began operating in January 2019 by creating a set of pre-defined rules for automatically adjusting the supply of allowances to be auctioned, as illustrated in **Figure 9**. No discretion is possible by the EU Commission or Member States in running the MSR.

[1] LSE 2019 &ICIS 2020 & SparkChange 2021

[2] EU Commission 2021 https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/market-stability-reserve_en

If the Total Net Allowances in Circulation or TNAC is above 833 million allowances (caused for instance by investors withholding allowances), then the MSR will cause fewer allowances to be sold in the following year's allowance auctions. This is the cancellation effect.

FIGURE 9: OPERATION OF THE MARKET STABILITY RESERVE



Source: Spark Change 2021

SparkChange notes that "*Creating environmental impact by investing in EUAs is not a 'silver bullet'. Nor does it replace individual action to reduce emissions as fast as possible. Nevertheless, it is a powerful tool to reduce emissions faster, as it removes permits to pollute and thus permanently prevents emissions from occurring. EUA investing should not be used to slow down efforts to reduce emissions; it is a transitionary tool to accelerate decarbonisation through a market-based mechanism that is used temporarily until the economy is structurally decarbonised.*"

We agree with this conclusion.

1.7 Policy intervention risk

Surging energy, carbon and commodity prices, alongside global logistics delays are contributing to increased inflation and higher living costs for citizens[3]. This is causing some politicians to call for reforms or a weakening of the EU ETS. For instance, in December 2021 the Polish parliament passed a resolution calling for the EU ETS to be suspended. The Czech energy minister agreed that the carbon price was causing impacts and favoured the idea of additional allowances being sold[4].

However, EU carbon prices are not the main cause of electricity price increases in Europe. The strongest contributor to the power-price increase is the natural gas price, as a DWS Chart of the Week[5] highlighted in October 2021. The increase in natural gas prices has been driven by a combination of events, including the strong rise in global gas demand, supply constraints in the global liquified-natural gas (LNG) market, and lower-than-anticipated gas exports from Russia to Europe leading to increased competition between Europe and Asia for LNG.

A meeting of European Energy Ministers[6] in October 2021 did not include any proposals or agreement to change the EU ETS rules, indicating that most Member States may view renewable energy and energy efficiency supporting policies like

[3] DWS Investment GmbH 2021 and 2022
[4] Euractive December 2021 www.euractiv.com/section/politics/short_news/czech-minister-would-support-polands-call-for-suspension-of-eu-ets/
[5] DWS October 2021 Don't just blame CO2 for higher power prices
[6] EU Energy Council October 2021 www.consilium.europa.eu/en/meetings/tte/2021/10/26/

the EU ETS as solutions to reducing fossil fuel exposure and thus reducing the economic and societal impact of higher energy prices over the medium term.

Currently the EU carbon market is oversupplied with allowances, but, market anticipation that the Market Stability Reserve (MSR) might be deployed to remove this surplus has given impetus to a higher ETS price. Any thought that the rules governing the ETS and specifically the MSR would, in our view, harm market confidence and elevate carbon price volatility.

However, the EU ETS does have an in-built mechanism[7] (Article 29a in the ETS Directive) for addressing rapid price increases. The article states "*If for more than 6 consecutive months, the allowance price is more than 3x the average prices within the preceding 2 years ….".*

However, the definition of 'preceding 2 years' is open to interpretation. A range of price triggers is possible.

Article 29a states that if the trigger is reached, the EU Commission would immediately convene a committee meeting. If the committee agreed that prices do not correspond to changing market conditions, then an additional supply of allowances could be made available. The additional allowances could come from one or a combination of actions:

- Auctioning 25% of a pool of allowances that are set aside for new companies entering the EU ETS (New Entrants Reserve or NER),
- 'Front loading' of auction volumes
- Releasing 100m EUAs from the MSR (Market Stability Reserve)

Providing additional allowances in this way could cool a price rally and need not be disruptive to overall market functioning.

Other restraining measures on price could involve attempting to curtail the financial element of EUA demand through limiting registry accounts or position size or other measures. However, we believe that restricting the ability of certain types of ETS market participants to buy and sell allowances would be seen very negatively by the market.

It is fair to say that any carbon market involves setting a limit on the number of supply of allowances in order to restrict carbon emissions. However, the EU has learned from experience that it is beneficial to have some flexibility in the supply of allowances, which is regulates through the MSR. For instance, the MSR was created to handle the consequences of the 2008 financial crisis which led to lower economic growth and emissions than previously anticipated. As well, having an ability to release additional allowances into the market if certain trigger prices are met, seems a sensible approach as this could help reduce large price spikes but not undermine the general trend toward increasing carbon prices.

In fact, we believe that more of the regulated carbon markets (such as in California or Korea) should allow investor participation, to provide liquidity and help with price discovery which can facilitate emission reductions.

While policy intervention risk exists in all markets, we believe that the strong EU support for climate targets and the existing mechanisms to react to price spikes mean that the risk of serious and sudden change to EU rules is relatively low.

[7] Primary source for this section is Morgan Stanley 25 January 2022 "Carbon in 2022: Time to Consolidate" p.15

2 / Stakeholders and market developments

2.0 Market developments

The past year has been a critical period for global carbon markets. This reflects important developments such as:

(i) The number of carbon tax or trading schemes has increased to a new high of 64, covering approximately just over 20% of global GHG emissions[8]

(ii) 97 countries representing 58% of global emissions are now mentioning carbon pricing in their official climate plans[3]

(iii) European carbon prices have increased over fourfold since the pre COVID-19 levels, to exceed €90/tonne[9]

(iv) China's national carbon market became operational in July 2021

(v) The IMF has proposed the introduction of an International Carbon Price Floor across a small number of large-emitting countries[10]

(vi) The US had pledged to reach net zero carbon emissions by 2050 meaning that national net zero targets now cover just over 80% of global GDP and 77% of global GHG[11]

(vii) A new Global Carbon Market Mechanism under the Article 6 rulebook was agreed at COP26 and which could help revive the international traded market in carbon

What began in 2005 with the first carbon trading scheme in Europe, has grown such that there are now 64 carbon pricing instruments in operation around the world. This represents a threefold increase over the past decade. In 2021, 21.5% of global GHG emissions were therefore covered by some form of carbon pricing instrument, an increase from 15.1% of global emissions in 2020, boosted by China's national scheme which became operational last year[3].

While some countries are moving ahead aggressively, ambition varies country-by-country since four-fifths of global emissions remain unpriced and the global average emissions price is a paltry US$3 per ton[12]. This is significantly lower than the price levels required to induce meaningful emissions reduction.

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/tCO2 by 2020 and US$50–100/tCO2 by 2030 are necessary, along with other supportive policies, to help drive carbon emission reduction[13].

The only major region where carbon prices are at this level is Europe and this has only occurred relatively recently. Our accompanying carbon market primer report explains some of the key drivers of higher European carbon prices over the past year. A record high of nearly €90/tonne was set last year, which marks a more than fourfold increase in prices since the start of the pandemic. With additional policy reforms in the pipeline, further price increases are likely over the medium term.

[8] World Bank. 2021 State and Trends of Carbon pricing

[9] Bloomberg Finance LP (7 February 2022)

[10] IMF (June 2021). Proposal for an international carbon price floor among large emitters

[11] Net Zero Tracker (October 27, 2021). G20 net zero stocktrade

[12] IMF (June 2021). A proposal to scale up carbon pricing

[13] World Bank (May 2017). Report of the High-Level Commission on carbon prices

2.1 Government policy

On current policies, the world is still forecast to warm by approximately 2.7ºC by the end of the century compared to the 1.5ºC target set out in the Paris Agreement[14]. Yet more than 130 nations have or are working towards setting in law their commitment towards net zero emissions by 2050, with China and India the outliers at 2060 and 2070 respectively. This will require radical changes in our societies with business and government working together to reduce carbon emissions. However, it naturally begs the question as to when, what and the degree to which climate policy will tighten over the coming years.

Some of the policy steps taken by governments to meet climate goals include phasing out coal fired power generating plants, bans on internal combustion engine car sales, improvements to building energy efficiency, and carbon pricing. According to the World Bank[15], 97 countries representing 58% of global emissions are now mentioning carbon pricing in their official climate plans suggesting the spread of carbon markets and prices is only set to increase.

The launch of the Chinese national carbon trading market in July last year is one such example. First mooted in 2011, the next step was the piloting of seven regional carbon markets from 2013. The current scope of the carbon market is limited to coal and gas power plants, covering approximately 2,200 emitters and representing 40% of the country's emissions. The plan is to extend sector coverage to encompass five times as many emitters across the iron and steel, petrochemicals, building materials and paper sectors among others. While prices are still trading below US$10/tonne, this initiative is an important step if the country has a chance of meeting its ambition of carbon emissions peaking by 2030 and reaching net zero by 2060.

Looking to Europe, the planned expansion of the EU's Emission Trading System scheme to cover shipping, road transportation and buildings illustrates that a carbon pricing scheme can start off simple, as it did in 2005, and grow over time to allow for growth. As part of the EU's Green Deal, Europe is embarking on introducing a carbon border adjustment mechanism, that is a tax which will be a function of the carbon intensity of the product. This is being used as a means of increasing support for domestic climate action through the protection of local industry and secondly incentivizing other countries, most notably in weaken environmental jurisdictions, to implement their own climate policies to remain competitive.

In the US, the Biden administration's re-entry into the Paris Agreement and decision to place sustainability at the core of US trade policy so early on in his presidency illustrates that governments can move quickly when climate change and sustainability have become table stakes for the world.

2.2 IMF International carbon price floor proposal

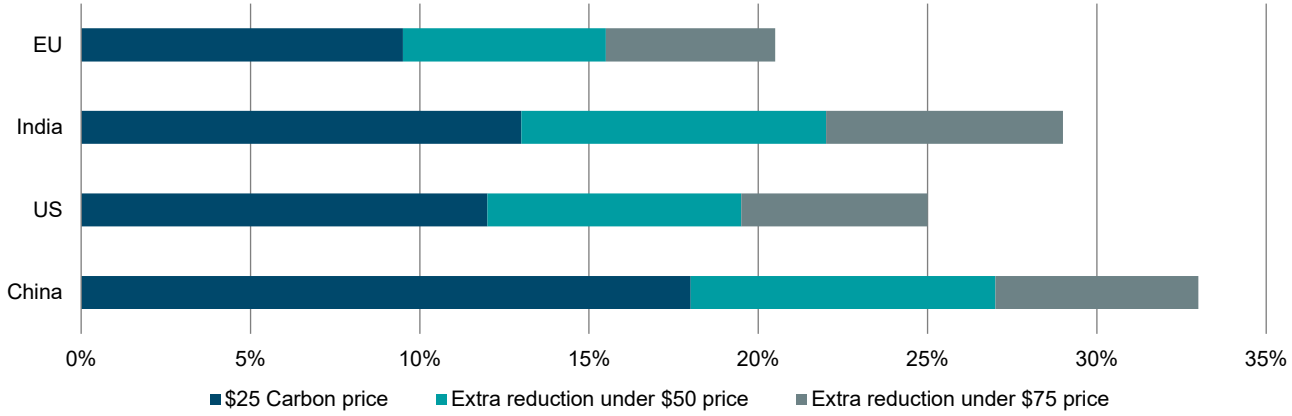
With just 4% of global emissions priced at a level which the World Bank views as compatible to accelerate the low carbon transition, carbon emission prices need to be much higher and encompass more regions, countries and sectors[9]. Inevitably, the main focus of carbon emission reduction efforts must be focused on the key emitters of China, the US, India and Europe since combined these countries and regions are estimated to account for just over 60% of global CO2 emissions by 2030.

To address this issue, in June 2021, the IMF issued a proposal[16] for an International Carbon Price Floor (IPCF). The idea was to complement and reinforce the Paris Agreement as the IMF views an ICPF as the fastest and most practical way to achieve a significant reduction in carbon emissions over the next decade. Precedents for this type of international cooperation include tax floors for indirect taxes in the European Union and the OECD and the recent 15% minimum corporation tax agreement reached by G7. As a starting point, the ICPF plan could initially be limited to a core group of high emitting countries.

[14] Climate Action Tracker (November 9, 2021)
[15] World Bank (May 2021). 2021 State and Trends of Carbon Pricing
[16] IMF (June 2021). Proposal for an international carbon price floor among large emitters

Figure 10 provides an illustrative example of different scenarios where advanced and emerging market countries are subject to price floors of US$25, US$50 and US$75 and the respective impact on CO_2 emission reduction. It shows that among advanced economics, the US would have slightly higher emission reductions than Europe. This reflects the US's larger carbon intensity of GDP and hence the greater emissions responsiveness to higher prices. In China and India, the impact on emissions would be even greater.

FIGURE 10: EMISSION REDUCTION IMPACT UNDER DIFFERENT CARBON PRICE ASSUMPTIONS



Source: IMF (June 2021). Proposals for an international carbon price floor among large emitters

2.3 Carbon prices and corporates

A review of academic research on carbon markets[17] finds that carbon pricing schemes in the EU, New Zealand, British Columbia and the Nordic countries resulted in companies making short-term operational decisions to reduce carbon emissions, but, there was no evidence yet of carbon pricing stimulating innovation and technology development. The authors of the academic research concluded that carbon pricing is not sufficient and needs complementary policies. We note that governments have enacted a wide variety of policies to promote technology development, including feed-in tariffs and renewable portfolio standards that have helped to reduce the cost of solar and wind technologies.

In addition, to companies participating in mandatory carbon pricing schemes, as of last year, around 850 companies were using an internal carbon price by assigning a monetary value to the GHG emissions associated with individual actions to better inform the decision-making process[18]. As well, nearly 1,200 companies are planning to implement internal carbon pricing in the next two years. The growth in the number of companies using carbon prices is encouraging but there is significant variation in the magnitude of internal carbon pricing used as can be seen in the table in **Figure 11.**

[17] Lilliestam et al. September 2020 https://wires.onlinelibrary.wiley.com/doi/10.1002/wcc.681
[18] CDP 2021 www.cdp.net/en/climate/carbon-pricing

FIGURE 11A: NUMBER OF COMPANIES USING CARBON PRICING

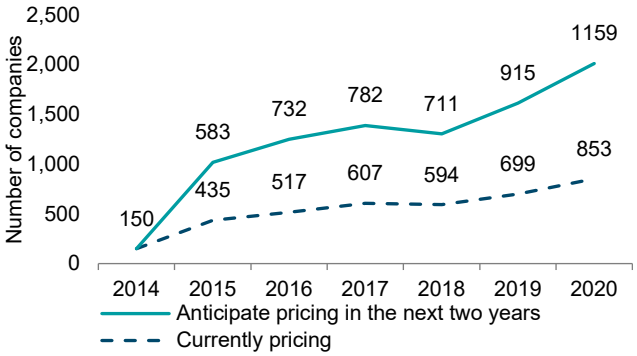


FIGURE 11B: CARBON PRICE ASSUMPTIONS BY REGION

Price range per region	Median price USD	Maximum price USD
Africa	8	120
Asia	28	918
Europe	28	532
Latin America	8	100
North America	23	769
Oceania	17	297

Source: CDP (April 2021), Putting a price on carbon

Work by the World Bank[19] shows that companies are seven times more likely to put an internal price on carbon if they operate in a jurisdiction regulated under a carbon pricing initiative, illustrating the power of government policy on corporate behavior.

Meanwhile the investor supported Transition Pathway Initiative (TPI)[20] publishes public assessments of the most carbon companies. TPI is supported by 118 investors representing over USD 40 trillion combined Assets under Management and Advice. TPI's assessment of companies' climate management quality includes a question regarding if the company discloses an internal carbon price. Only 35% or 173 of 492 of the most carbon intensive companies disclose an internal carbon price. As well, TPI finds that only 15% of the 492 companies assessed (as of January 2022) are aligned with a below 2°C 2050 benchmark, 2% of companies are aligned with 2°C, 47% of companies do not align with any of the benchmarks and 16% of companies make insufficient disclosures to be assessed.

2.4 Investor expectations for carbon pricing and corporate policy lobbying

In November 2021, a record 733 institutional investors with US$52 trillion in assets issued a statement to governments on the climate crisis[21]. DWS has been a signatory to this annual statement since it was first published in 2009. The statement calls for governments to set mid-century net zero emissions targets with ambitious interim targets with clear decarbonization roadmaps for each carbon intensive sector. Investors called on governments to implement robust carbon pricing, remove fossil fuel subsidies, phase out thermal coal power, avoid new carbon intensive infrastructure and develop just transition plans for accepted workers and communities.

Investors also have expectations for how companies lobby on climate policies. The investor engagement initiative Climate Action 100+ use indicators of companies' climate policy advocacy to evaluate 160+ of the most carbon intensive companies[22]. Climate Action 100+ is supported by 570 investors with US$54 trillion in assets. Companies are expected to have a Paris Agreement aligned climate lobbying position and to align and disclose all direct lobbying with this position. Companies should have Paris Agreement aligned expectations for their trade associations, disclose their memberships and have a process to ensure trade associations align with these expectations.

[19] World Bank (May 2021). 2021 State and Trends of Carbon Pricing

[20] Transition Pathway Initiative (April 2021). TPI State of Transition Report 2021

[21] Investor Agenda 2021 https://theinvestoragenda.org/wp-content/uploads/2021/09/2021-Global-Investor-Statement-to-Governments-on-the-Climate-Crisis.pdf

[22] Climate Action 100+ (March 2021). www.climateaction100.org/wp-content/uploads/2021/03/CA100-Disclosure-Indicators-assessment-methodology-March-2021.pdf

While these policy lobbying indicators do not explicitly mention carbon pricing/markets (or any specific type of policy), the many expert institutions which point out how essential carbon pricing is, we believe makes it implicit that investors expect companies to lobby in favour of well-designed carbon tax and/or carbon cap and trade policies.

2.5 Conclusion

With almost 80% of carbon emissions not covered by a carbon ETS or tax, and for those emissions that are regulated by a carbon price, the average carbon price globally is just US$10/tonne[23]. This suggests that with national net zero commitments now covering over 80% of world GDP[24], and carbon pricing promising to become a key part of achieving that goal, it reveals that carbon market coverage and prices have significantly more room to spread and rise. In fact, a carbon price between US$50-100/tonne by 2030 is viewed as necessary to meet the Paris climate agreement[25]. The Bank of England has also warned companies to be ready for US$150/tonne carbon price[26], while some companies[27] are using an internal carbon price of US$200+/tonne.

[23] World Bank (May 2021). 2021 State and Trends of Carbon Pricing
[24] UK Net Zero Strategy: Build Bank Greener (October 2021)
[25] World Bank (May 2017). Report of the High-Level Commission on carbon prices
[26] Bank of England (May 2021). Climate change – plotting our course to Net Zero – speech by Sarah Breeden
[27] CDP (April 2021). Putting a price on carbon

IMPORTANT INFORMATION – EMEA, APAC & LATAM

This marketing communication is intended for professional clients only.

DWS is the brand name of DWS Group GmbH & Co. KGaA and its subsidiaries under which they do business. The DWS legal entities offering products or services are specified in the relevant documentation. DWS, through DWS Group GmbH & Co. KGaA, its affiliated companies and its officers and employees (collectively "DWS") are communicating this document in good faith and on the following basis.

This document is for information/discussion purposes only and does not constitute an offer, recommendation or solicitation to conclude a transaction and should not be treated as investment advice.

This document is intended to be a marketing communication, not a financial analysis. Accordingly, it may not comply with legal obligations requiring the impartiality of financial analysis or prohibiting trading prior to the publication of a financial analysis.

This document contains forward looking statements. Forward looking statements include, but are not limited to assumptions, estimates, projections, opinions, models and hypothetical performance analysis. No representation or warranty is made by DWS as to the reasonableness or completeness of such forward looking statements. Past performance is no guarantee of future results.

The information contained in this document is obtained from sources believed to be reliable. DWS does not guarantee the accuracy, completeness or fairness of such information. All third party data is copyrighted by and proprietary to the provider. DWS has no obligation to update, modify or amend this document or to otherwise notify the recipient in the event that any matter stated herein, or any opinion, projection, forecast or estimate set forth herein, changes or subsequently becomes inaccurate.

Investments are subject to various risks. Detailed information on risks is contained in the relevant offering documents.

No liability for any error or omission is accepted by DWS. Opinions and estimates may be changed without notice and involve a number of assumptions which may not prove valid.

DWS does not give taxation or legal advice.

This document may not be reproduced or circulated without DWS's written authority.

This document is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction, including the United States, where such distribution, publication, availability or use would be contrary to law or regulation or which would subject DWS to any registration or licensing requirement within such jurisdiction not currently met within such jurisdiction. Persons into whose possession this document may come are required to inform themselves of, and to observe, such restrictions.

For institutional / professional investors in Taiwan:

This document is distributed to professional investors only and not others. Investing involves risk. The value of an investment and the income from it will fluctuate and investors may not get back the principal invested. Past performance is not indicative of future performance. This is a marketing communication. It is for informational purposes only. This document does not constitute investment advice or a recommendation to buy, sell or hold any security and shall not be deemed an offer to sell or a solicitation of an offer to buy any security. The views and opinions expressed herein, which are subject to change without notice, are those of the issuer or its affiliated companies at the time of publication. Certain data used are derived from various sources believed to be reliable, but the accuracy or completeness of the data is not guaranteed and no liability is assumed for any direct or consequential losses arising from their use. The duplication, publication, extraction or transmission of the contents, irrespective of the form, is not permitted.

Issued in the UK by DWS Investments UK Limited which is authorised and regulated in the UK by the Financial Conduct Authority.

In Hong Kong, this document is issued by DWS Investments Hong Kong Limited. The content of this document has not been reviewed by the Securities and Futures Commission.

In Singapore, this document is issued by DWS Investments Singapore Limited. The content of this document has not been reviewed by the Monetary Authority of Singapore.

In Australia, this document is issued by DWS Investments Australia Limited (ABN: 52 074 599 401) (AFSL 499640). The content of this document has not been reviewed by the Australian Securities and Investments Commission.

IMPORTANT INFORMATION – NORTH AMERICA

The brand DWS represents DWS Group GmbH & Co. KGaA and any of its subsidiaries, such as DWS Distributors, Inc., which offers investment products, or DWS Investment Management Americas Inc. and RREEF America L.L.C., which offer advisory services.

This document has been prepared without consideration of the investment needs, objectives or financial circumstances of any investor. Before making an investment decision, investors need to consider, with or without the assistance of an investment adviser, whether the investments and strategies described or provided by DWS, are appropriate, in light of their particular investment needs, objectives and financial circumstances. Furthermore, this document is for information/discussion purposes only and does not and is not intended to constitute an offer, recommendation or solicitation to conclude a transaction or the basis for any contract to purchase or sell any security, or other instrument, or for DWS to enter into or arrange any type of transaction as a consequence of any information contained herein and should not be treated as giving investment advice. DWS, including its subsidiaries and affiliates, does not provide legal, tax or accounting advice. This communication was prepared solely in connection with the promotion or marketing, to the extent permitted by applicable law, of the transaction or matter addressed herein, and was not intended or written to be used, and cannot be relied upon, by any taxpayer for the purposes of avoiding any U.S. federal tax penalties. The recipient of this communication should seek advice from an independent tax advisor regarding any tax matters addressed herein based on its particular circumstances. Investments with DWS are not guaranteed, unless specified. Although information in this document has been obtained from sources believed to be reliable, we do not guarantee its accuracy, completeness or fairness, and it should not be relied upon as such. All opinions and estimates herein, including forecast returns, reflect our judgment on the date of this report, are subject to change without notice and involve a number of assumptions which may not prove valid.

Investments are subject to various risks, including market fluctuations, regulatory change, counterparty risk, possible delays in repayment and loss of income and principal invested. The value of investments can fall as well as rise and you may not recover the amount originally invested at any point in time. Furthermore,

For Institutional investors and Professional investors February 2022 – In EMEA for Professional Clients (MiFID Directive 2014/65/EU Annex II) only; no distribution to private/retail customers. In Switzerland for Qualified Investors (art. 10 Para. 3 of the Swiss Federal Collective Investment Schemes Act (CISA)). In APAC for institutional investors only. Australia and New Zealand: For Wholesale Investors only. In the Americas for Institutional Client and Registered Rep use only; not for public viewing or distribution. Forecasts are based on assumptions, estimates, views and hypothetical models or analyses, which might prove inaccurate or incorrect

substantial fluctuations of the value of the investment are possible even over short periods of time. Further, investment in international markets can be affected by a host of factors, including political or social conditions, diplomatic relations, limitations or removal of funds or assets or imposition of (or change in) exchange control or tax regulations in such markets. Additionally, investments denominated in an alternative currency will be subject to currency risk, changes in exchange rates which may have an adverse effect on the value, price or income of the investment. This document does not identify all the risks (direct and indirect) or other considerations which might be material to you when entering into a transaction. The terms of an investment may be exclusively subject to the detailed provisions, including risk considerations, contained in the Offering Documents. When making an investment decision, you should rely on the final documentation relating to the investment and not the summary contained in this document.

This publication contains forward looking statements. Forward looking statements include, but are not limited to assumptions, estimates, projections, opinions, models and hypothetical performance analysis. The forward looking statements expressed constitute the author's judgment as of the date of this material. Forward looking statements involve significant elements of subjective judgments and analyses and changes thereto and/or consideration of different or additional factors could have a material impact on the results indicated. Therefore, actual results may vary, perhaps materially, from the results contained herein. No representation or warranty is made by DWS as to the reasonableness or completeness of such forward looking statements or to any other financial information contained herein. We assume no responsibility to advise the recipients of this document with regard to changes in our views.

No assurance can be given that any investment described herein would yield favorable investment results or that the investment objectives will be achieved. Any securities or financial instruments presented herein are not insured by the Federal Deposit Insurance Corporation ("FDIC") unless specifically noted, and are not guaranteed by or obligations of DWS or its affiliates. We or our affiliates or persons associated with us may act upon or use material in this report prior to publication. DB may engage in transactions in a manner inconsistent with the views discussed herein. Opinions expressed herein may differ from the opinions expressed by departments or other divisions or affiliates of DWS. This document may not be reproduced or circulated without our written authority. The manner of circulation and distribution of this document may be restricted by law or regulation in certain countries. This document is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction, including the United States, where such distribution, publication, availability or use would be contrary to law or regulation or which would subject DWS to any registration or licensing requirement within such jurisdiction not currently met within such jurisdiction. Persons into whose possession this document may come are required to inform themselves of, and to observe, such restrictions.

Past performance is no guarantee of future results; nothing contained herein shall constitute any representation or warranty as to future performance. Further information is available upon investor's request. All third party data (such as MSCI, S&P & Bloomberg) are copyrighted by and proprietary to the provider.

For Investors in Canada. No securities commission or similar authority in Canada has reviewed or in any way passed upon this document or the merits of the securities described herein and any representation to the contrary is an offence. This document is intended for discussion purposes only and does not create any legally binding obligations on the part of DWS Group. Without limitation, this document does not constitute an offer, an invitation to offer or a recommendation to enter into any transaction. When making an investment decision, you should rely solely on the final documentation relating to the transaction you are considering, and not the [document – may need to identify] contained herein. DWS Group is not acting as your financial adviser or in any other fiduciary capacity with respect to any transaction presented to you. Any transaction(s) or products(s) mentioned herein may not be appropriate for all investors and before entering into any transaction you should take steps to ensure that you fully understand such transaction(s) and have made an independent assessment of the appropriateness of the transaction(s) in the light of your own objectives and circumstances, including the possible risks and benefits of entering into such transaction. You should also consider seeking advice from your own advisers in making this assessment. If you decide to enter into a transaction with DWS Group you do so in reliance on your own judgment. The information contained in this document is based on material we believe to be reliable; however, we do not represent that it is accurate, current, complete, or error free. Assumptions, estimates and opinions contained in this document constitute our judgment as of the date of the document and are subject to change without notice. Any projections are based on a number of assumptions as to market conditions and there can be no guarantee that any projected results will be achieved. Past performance is not a guarantee of future results. The distribution of this document and availability of these products and services in certain jurisdictions may be restricted by law. You may not distribute this document, in whole or in part, without our express written permission.

For investors in Bermuda: This is not an offering of securities or interests in any product. Such securities may be offered or sold in Bermuda only in compliance with the provisions of the Investment Business Act of 2003 of Bermuda which regulates the sale of securities in Bermuda. Additionally, non-Bermudian persons (including companies) may not carry on or engage in any trade or business in Bermuda unless such persons are permitted to do so under applicable Bermuda legislation.

as of 2/1/22 087958_1 (02/2022)