GLOBAL CARBON MARKETS

Solving the Emissions Crisis Before Time Runs Out

Citi GPS: Global Perspectives & Solutions

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Citi Global Insights

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Solving the Emissions Crisis Before Time Runs Out

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The focus on emissions and climate change is likely to reach new heights this November with the advent of the UN Climate Change Conference (COP26) in Glasgow. But while we might all be aware of the big picture, the rise of "net zero," and the many climate acronyms popping up daily, do we really know where we are now, what the current plans in place — if delivered upon — would achieve, and what the plan to get to net zero actually is?

For most people the answer is a resounding, "No." Sadly, ignorance is not bliss in this situation; the reality is we still have a mountain to climb and we are lacking much of the equipment needed to scale it.

While the COP21 in Paris six years ago is recognized by most as a resounding success, progress to the agreed upon conference goals, at least from individual nations, has failed to live up to promise — both in terms of actions to date and future intentions. If we add up all of the current NDCs (national determined contributions — essentially each country's individual plan to stay within a 1.5 degree Celsius world — the aggregate effect in 2030 would be for emissions of around 55 gigatonnes (Gt) of carbon dioxide equivalent (CO_2e). This represents an emissions reduction of just 1% versus 2019 and a 9% increase since 2010 if the conditional elements of NDCs are included. However, the International Panel on Climate Change (IPCC) tells us that in order to meet their 1.5 degree Celsius scenario, emissions by 2030 would need to fall by 45% versus 2010 levels. So current efforts are not even reducing emissions, let alone heading towards net zero. Looking at it in a different way, the Paris scenario would all but use up the entire "carbon budget" (the amount we can emit before temperatures rise above 1.5 degrees Celsius) by 2030, meaning that even to stand a 50% chance of staying below 1.5 degrees Celsius, our emissions would then have to magically drop to zero — which is clearly a fantasy.

What is going on? If we all know about climate change, and 191 countries have signed up to the Paris Agreement to limit temperature increases to 1.5 degrees Celsius, how is it possible that emissions in 2030, even with each country's "efforts," will barely change? The simple answer is, "growth." While emissions have fallen and continue to fall in many developed markets, emissions from developing markets continue to grow significantly. This is for a variety of reasons. Economic development brings greater levels of wealth and demand for autos, white goods, holidays etc. In addition, the pace of growth, in countries where resources are limited, often means going for the fastest and cheapest upfront forms of energy, which are often carbon intensive — even if low-carbon alternatives might be cheaper in the long run.

Does this mean our current situation is all the fault of emerging markets? Not really. Emissions per capita are significantly higher in developed markets, and moreover, the vast majority of the carbon budget has been used up historically by developed nations, in particular the EU and the U.S. Therefore, while current emissions and future growth might be all down to emerging markets, it is very much the fault of developed markets that we are where we are. So, do developed nations have the moral right to tell emerging markets they cannot be afforded the same leeway in economic development which developed markets had historically? And by doing that, can they effectively consign large swaths of the population to slower economic development, and at the extremes, consign millions to poverty for many years longer than might otherwise be the case?

Simply put, to stand any chance of staying within a 1.5-degree Celsius temperature increase, we need to do much, much more to reduce emissions. Moreover, we cannot realistically expect emerging markets to fund their own decarbonization programs, and slow their economic growth and the prospects of their (voting) populaces themselves. The global burden must fall at least in part on developed nations. This would be a tough sell at the best of times, let alone in a massively indebted post-COVID-19 world. Convincing developed market voters they need to subsidize emerging markets — enabling them to compete better with developed markets in the future, with all of the implications for employment and economic growth it entails — will be difficult.

We need to find a mechanism whereby global efforts to decarbonize are funded efficiently and equitably. This is where COP26 can help, and in particular “Article 6,” which looks at ways in which countries can work together — either bilaterally, regionally, or indeed globally — to reduce overall emissions.

The world is a mess when it comes to carbon regimes — there are currently 64 carbon pricing systems globally, with another 30+ in development. Thirty of the existing systems are carbon markets, with the remaining 34 carbon tax regimes. Not only is there no agreement on a mechanism, but the prices within these regimes vary from the meaningless $0.10/tonne to an eye-watering $142.40/tonne — against a price widely seen as necessary now for Paris-alignment of $40-$80/tonne. This fragmented approach is clearly inefficient, and evidence tells us that so far, it is proving ineffective at a global level. Accordingly, to achieve real progress, we must find some way of integrating these individual regimes into one globally-fungible system. There are essentially four ways we could achieve this, using one, or a combination, of the methods mentioned below:

The first option is essentially via command and control directives, where governments/regulators simply mandate the amount of emissions that are allowed when and from which industries, with non-compliance penalized severely. While potentially effective, this is unlikely to be efficient, and almost certainly would not provide the lowest cost solution. This leads us to the three other, market-based solutions (which, it should be pointed out, are not mutually exclusive):

- The first of these is a carbon tax on emissions, which could either be applied as a flat rate globally, or with differing rates for emerging and developed markets, potentially with differing ratcheting up speeds, to eventually bring the world into alignment.

- The second option involves cap and trade systems, whereby allowances for emissions are granted and/or auctioned up to a (reducing) limit, with parties showing faster than prescribed progress allowed to sell their excess allowances to other slower moving parties — while still reaching the same cap.

- The third option involves baseline and credit systems, whereby parties earn credits for reducing emissions, which could be sold to others in deficit, potentially within one of the two preceding mechanisms.

Each of these is fraught with complexities, both technical, and perhaps more importantly, political. Discussion of the pros and cons of each of these methods, the pitfalls and stumbling blocks, as well as how they might be implemented, forms the basis of this report.

There are essentially two key problems common to all of the four methods — who pays for decarbonization, and assuming we successfully raise the money, how, and most importantly where, does the money get spent/distributed?

Bottom line, as already noted above, there will need to be some transfer of value from developed markets to emerging markets. Putting a price on carbon has the potential to drive the adoption of CBAMs (Carbon Border Adjustment Mechanisms), essentially taxing carbon-intensive imports that are not subject to an equivalent carbon regime in line with that of the importing country/bloc. Countries that either do not take action, or do not do so at the "required" rate, could potentially see themselves become international pariahs, in both political and economic/trade terms. As the Citi Global Insights Sustainable Finance team points out in a recent report, cross-border carbon has the potential to become one the biggest factors in global trade over the coming years and decades. The problem, is that a large proportion of carbon-intensive manufacturing is carried out in emerging markets, and hence CBAMs could actually cause money to flow in the opposite direction to that which we are trying to achieve — even if they might encourage other countries to decarbonize faster (to avoid taxes being applied to their exports).

The second issue of how to allocate revenues is also a thorny one. Should revenue raised from, for example, carbon taxes remain in the country where it is raised, helping the less fortunate to cover the inevitably higher cost of goods that will result? Undoubtedly some should, but the reality is that for many emerging markets, a carbon tax could represent a crippling sum — in some cases as much as 20% of GDP. The impact of this on growth could be so dramatic as to make it unfeasible, and hence the need for capital flows from developed markets. One novel idea, which we propose in this report, is the creation of a climate development bank along the lines of existing development finance institutions. The bank would be funded collectively by nations and could take some/all of the receipts from global regimes and reallocate them around the world into lower carbon development. While not without issues, this would at least provide a coordinated and specialized approach, and would also present an enormous opportunity to harness the trillions of dollars of private capital that wants to invest sustainably, by adopting a blended finance approach.

In summary, if we really are serious about tackling climate change and avoiding the resulting economic, social, and environmental decimation, we need to do much, much more, and we need to start working with each other to achieve our shared goals. There are no easy solutions, either economically or politically. However, we should not see these solutions as a cost. If approached correctly, the significant economic multiplier effects — even before we start to consider the environment and social multiplier effects — are compelling on their own. However, politics being politics, reaching a universal agreement in Glasgow will be tough, and hence it may be that the most likely outcome is the formation of so-called climate clubs — for example the U.S. and EU acting in concert and applying CBAMs to third-party countries that are not willing to pick up the baton (or move fast enough) to ultimately encourage a similar level of ambition.

Whatever the outcome of COP26 in Glasgow, a mountain lies before us that absolutely must be climbed — by all of us, collectively. If we are successful, the view at the top looking forward would be spectacular, and who knows, could even usher in an era of greater global cooperation. If we fail to climb it by choice though, rising temperatures and sea levels might push us up that slope unwillingly, by which time it would be too late to turn back the clock. Either way, we are going up that slope, and we might as well do it on our terms now, in the cheapest way possible, and have the option to return down the mountain again when it is safe — rather than being stuck up that mountain, remembering what the world used to be like.

Getting to Net Zero

WE ARE RUNNING OUT OF TIME

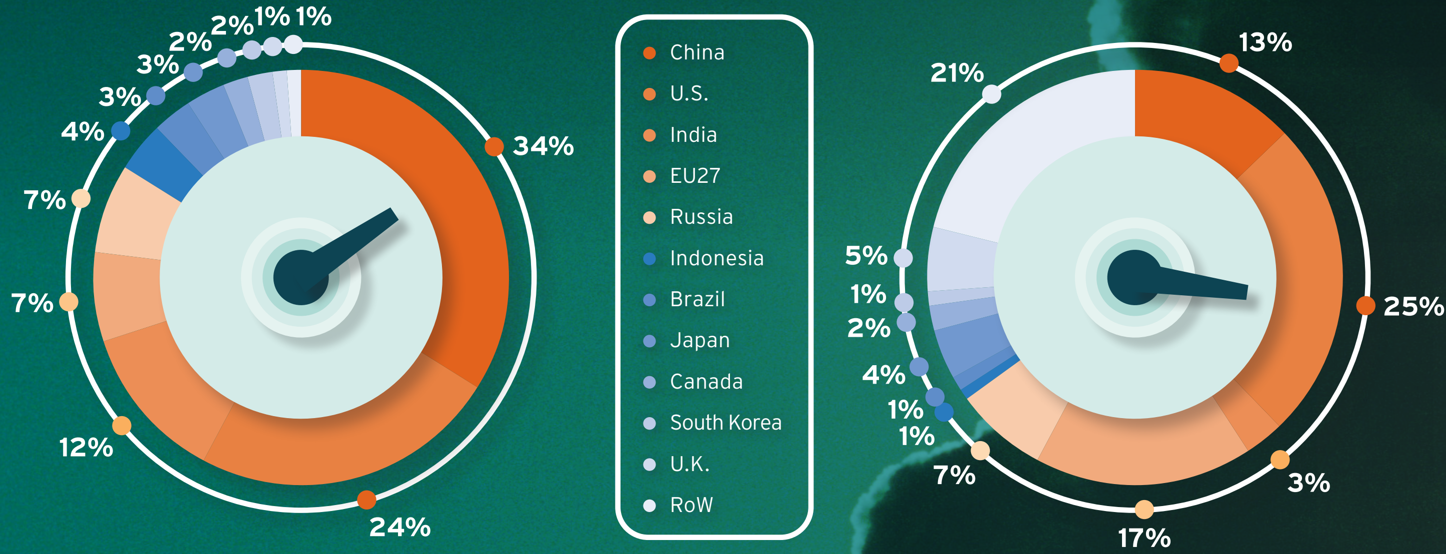
Human-induced greenhouse gases (GHGs) have already caused one degree of global warming. In 2018, cumulative CO_2 emissions exceeded 1.6 trillion tonnes, with the U.S. and EU27 responsible for the greatest shares. If we look at annual emissions, China is responsible for around 24% of total annual emissions, followed by the U.S. at 12%. Importantly, at current emission rates, we have just **14 years** before global temperatures rise beyond 1.5°C. This means the time is now to (1) limit greenhouse gas emissions, (2) reach at least net zero CO_2 emissions by 2050, and (3) look to go net negative in the second half of the century.

Annual GHG Emissions (2018)

Source: Climate Watch Data

Cumulative Emissions CO_2 (2018)

Source: Our World in Data based on the Global Carbon Project

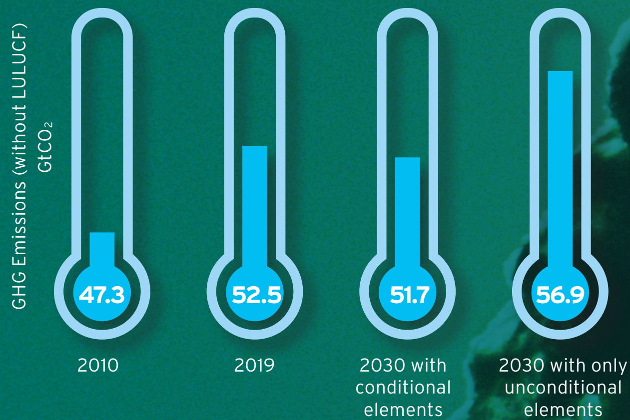


ANNOUNCED NATIONAL DETERMINED COMMITMENTS (NDCS) ARE NOT ENOUGH TO LIMIT TEMPERATURE INCREASE TO 1.5°C OR EVEN TO 2°C

According to the IPCC, by 2030, we need to reduce our GHG emissions by 45% from 2010 levels and reach net zero by 2050. Assuming just the unconditional parts of the announced NDCs are met, projections in 2030 would be 16% higher than 2010 levels. In the context of the carbon budget consistent with a 50% likelihood of limiting global warming to just 1.5°C, cumulative CO_2 emissions in 2020-30, based on the latest NDCs, would use up almost 89% of the remaining carbon budget, leaving just 55 $GtCO_2$ to be used post-2030.

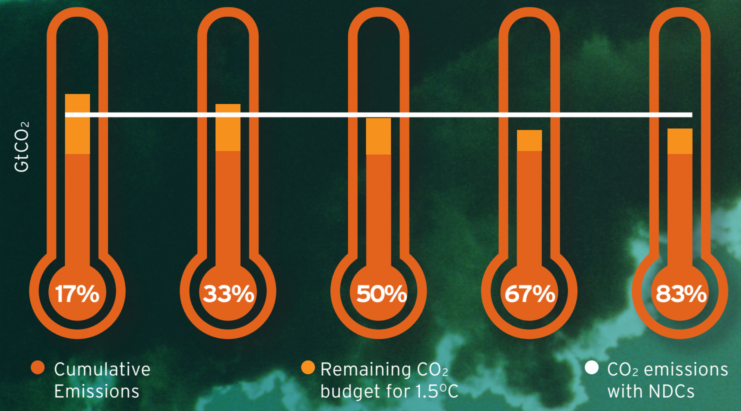
GHG Emissions in 2010, 2019, and 2030 Based on Most Optimistic NDC Outcomes

Source: UNFCCC



Carbon Budget Usage Based on Likelihood of Limiting Warming to 1.5°C

Source: IPCC



MARKET-BASED MECHANISMS TO REDUCE EMISSIONS

A global solution is required to get to a net zero world, which is especially difficult given most market-based mechanisms require global agreement to be effective. Agreeing a solution between two or more nations – a "climate club" – could be the solution. Whichever mechanism is used, a new "Climate Action Development Bank" would be needed to drive global investments and help de-risk projects, particularly in emerging markets.

Tradeable Emissions System:
Countries meet their climate pledges using "internationally transferred mitigation outcomes" to achieve their NDCs

✓ PROS
- Helps countries achieve their NDCs
- Generate revenue for emerging markets

X CONS
- Voluntary
- NDCs not enough to limit temp increase
- Emissions reduction not guaranteed
- Need international agreement

Global Market Mechanism:
International carbon market that trades emission credits between countries

✓ PROS
- Help countries achieve their NDCs
- Build on exiting infrastructure from CDM
- Engages private sector

X CONS
- Voluntary
- Global emissions reduction not guaranteed
- Need international agreement

Linking up Emission Trading Systems (ETS):
Bringing multiple existing ETS systems in different jurisdictions under one compatible system

✓ PROS
- Systems already in place in many jurisdictions
- Difficult to get agreement amongst nations

X CONS
- Reaching net zero is not guaranteed unless all countries join
- Difficult to get agreement amongst all nations

Global Carbon Tax:
Direct tax on global carbon emissions

✓ PROS
- Most effective way to reduce emissions at scale
- Revenue generation could be up to $2.9 trillion for countries we analyzed

X CONS
- Could be a large initial hit on emerging markets
- No cap on emissions makes it difficult to forecast emission reductions
- Difficult to reach agreement amongst all nations

Climate Change Club:
Voluntary 'club' set up between two or more nations with a CBAM for non-members

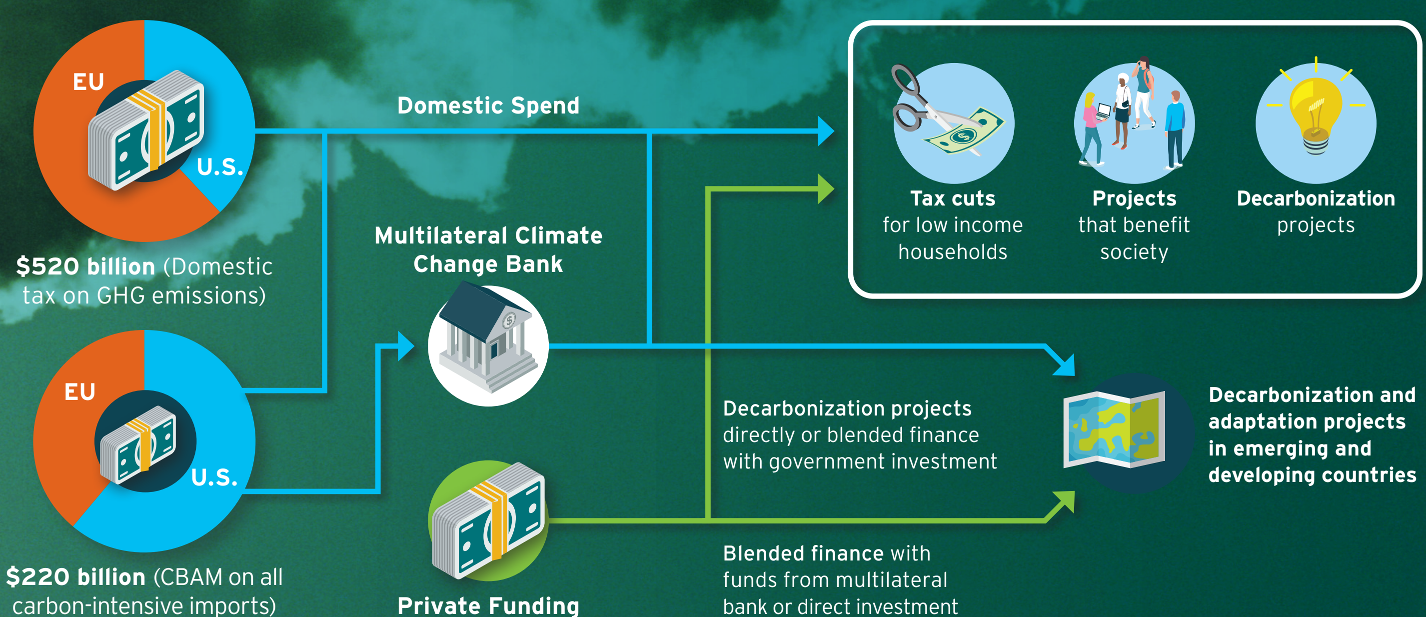
✓ PROS
- Easier to reach agreement between a number of nations
- Generates revenue for decarbonization projects in member countries and developing countries
- Could encourage non-members to join or reduce emissions

X CONS
- Non-member countries could feel like they are penalized unfairly with CBAM
- Difficult to set up a CBAM

HOW A CLIMATE CHANGE CLUB COULD WORK

Revenue from the Climate Change Club would be generated from (1) a domestic tax on GHG emissions and (2) a carbon border adjustment mechanism (CBAM) on carbon-intensive imports from countries which are not members of the club. Using a hypothetical club between, the U.S. and the EU, we estimate $520 billion could be generated through a domestic tax and up to $220 billion from a CBAM if placed on all imports.

Climate Club between the U.S. and the EU

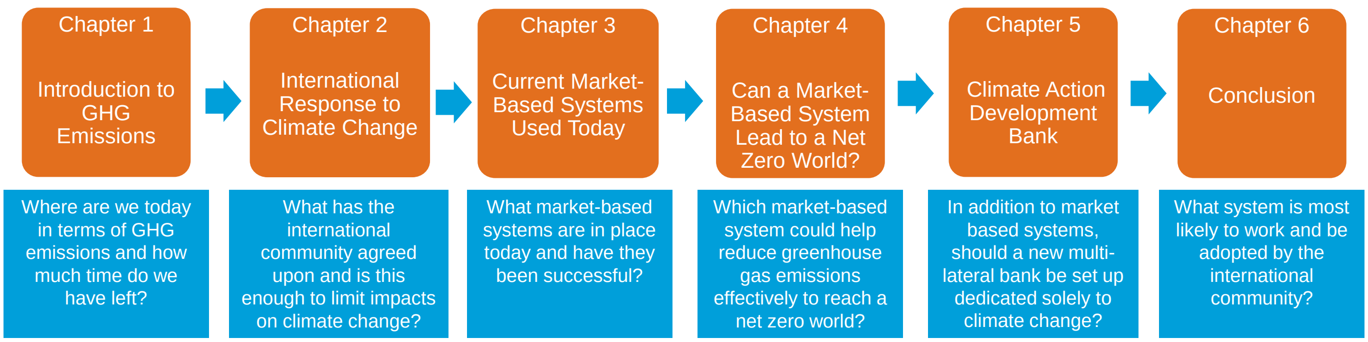


Contents

Report Outline

We have divided the report into five chapters as shown in the diagram below. Chapters 1 and 2 provide a detailed account of greenhouse gas emissions and the response of the international community today. Chapter 3 provides an assessment of the current market-based systems in different countries, while Chapter 4 provides a detailed analysis on different mechanisms that can be used to reduce global emissions. These include Article 6.2 and 6.4, which will be discussed during COP26 together with other mechanisms such as linking ETSs, setting up a global carbon tax, and forming a climate club amongst a few nations. We also discuss the importance of setting up a multilateral bank solely dedicated to climate change; this should happen whether a global mechanism is put into place or not. We end with a discussion around the mechanism we believe the world is heading towards.

Figure 1. Global Carbon Market Report Outline



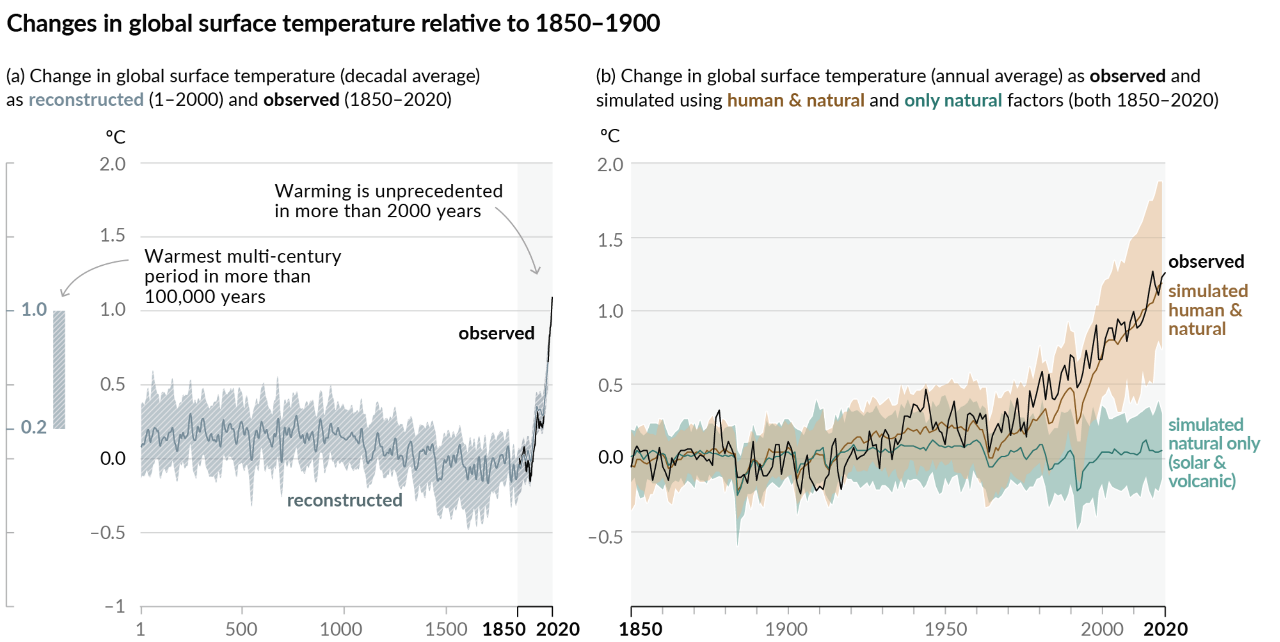
Source: Citi Global Insights

Introduction to GHG Emissions

According to the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report (AR6), "It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe." This report, released in August 2021, is the most comprehensive scientific review to date on climate systems and climate change and presents a stark warning — we have already caused 1°C of warming, and we will exceed 1.5°C and then 2°C this century unless significant reductions to greenhouse gas (GHG) emissions are made in the coming decades. UN Secretary General António Guterres called the report a "code red for humanity." Climate change is already affecting every region on Earth, and it is difficult to overstate the magnitude of this global challenge and the importance of taking action.

The planet's climate is rapidly changing as a result of an increasing concentration of GHGs caused by human activities such as combustion of fossil fuels and deforestation, as well natural processes. There are in fact a large array of GHGs but carbon dioxide (CO_2) accounts for 76% of the total. Other important gases driven by human activities include methane, nitrous oxides, and fluorinated gases. These GHGs have warmed the climate at a rate that is unprecedented in more than 2,000 years.[1] For a deep dive into the science and impacts of climate change, see the Citi GPS report *Energy Darwinism III: The Electrifying Path to Net Zero Carbon*.

Figure 2. Changes in Global Surface Temperature Relative to 1850-1900

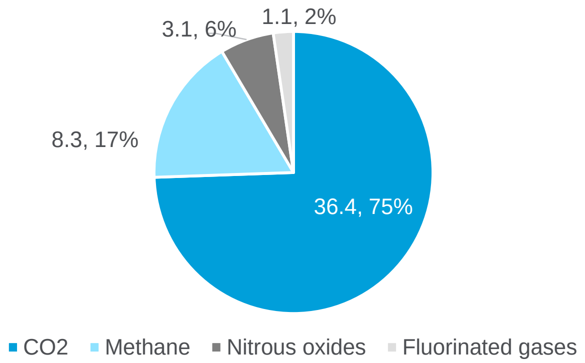


Source: IPCC. 2021: Summary for Policymakers. In: Climate Change 2021: the Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[1] IPCC, *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 2021.

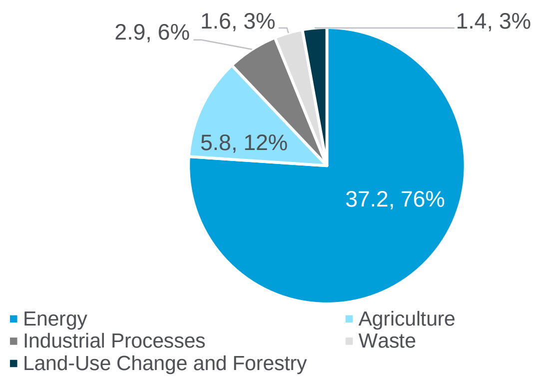
The activities that are generating greenhouse gases are primarily the burning of hydrocarbons (i.e., oil and gas) for energy, agricultural activity in which we change the use of land and create emissions through livestock farming, and industrial processes which include the production of steel and concrete. In 2018, 48.9 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) of greenhouse gases was released globally, with the energy sector responsible for 37.2 Gt (76% of total GHGs) followed by agriculture with 5.82 Gt (12%).

Figure 3. GHG Emissions Split by Gas ($GtCO_2e$)



Source: Climate Watch Data

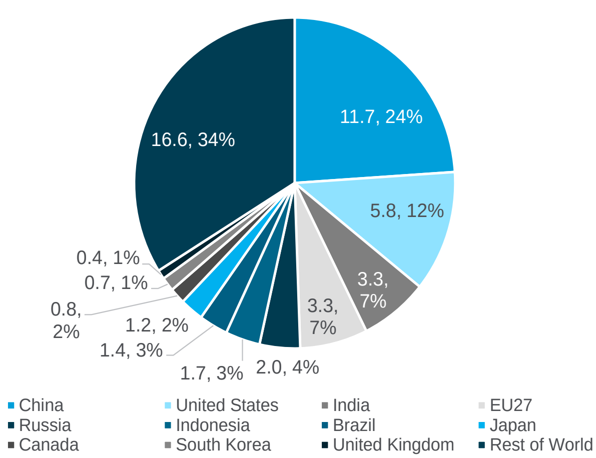
Figure 4. GHG Emissions Split by Sector ($GtCO_2e$)



Source: Climate Watch Data

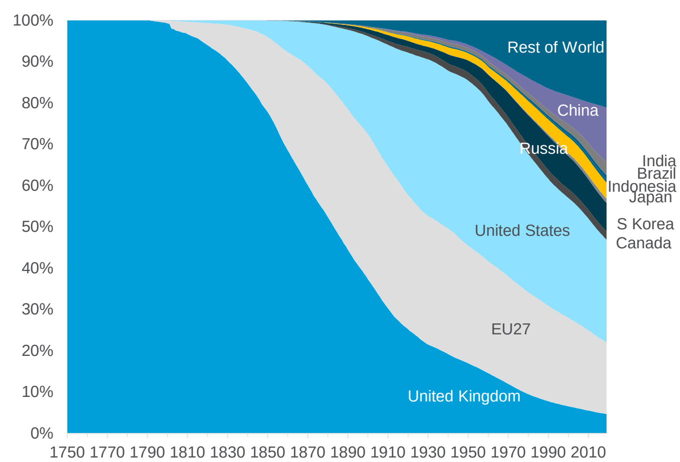
We consider GHG emissions by country/region through a few different lenses. A snapshot of 2018 (Figure 5) shows that China dominates the landscape, generating 24% of GHG emissions followed by the U.S. with 12%. However, the real issue is how much GHG, CO_2 especially, is already in the atmosphere and therefore it is important to consider cumulative emissions to date, shown in Figure 6.

Figure 5. Annual GHG Emissions in 2018 ($GtCO_2e$)



Source: Climate Watch Data

Figure 6. Cumulative CO_2 Emissions from 1750

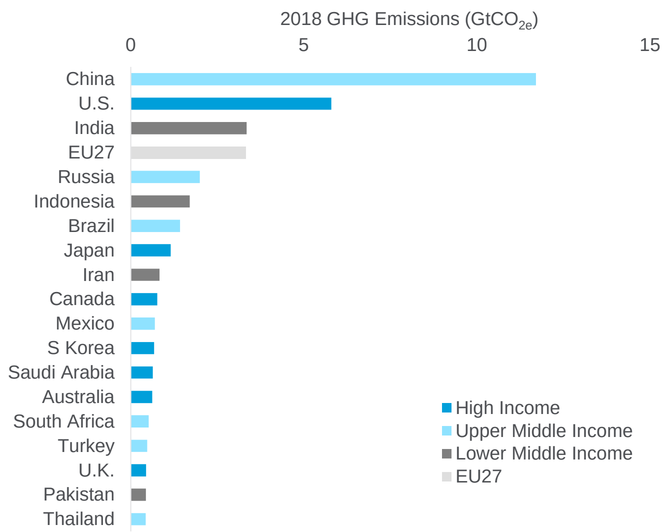


Source: Our World in Data

Unsurprisingly, the cumulative data shows a different picture. In 2018, cumulative CO_2 emissions exceeded 1.6 trillion tonnes, with the U.S. and the EU27 responsible for the largest shares of 25.7% and 18%, respectively, compared with China's share of 13.3%. Considering GHG emissions per capita also provides a different lens on assessing national emissions. Figure 7 and Figure 8 below show the top 20 emitting countries by total annual emissions compared to emissions per capita which reveals a different set of rankings.

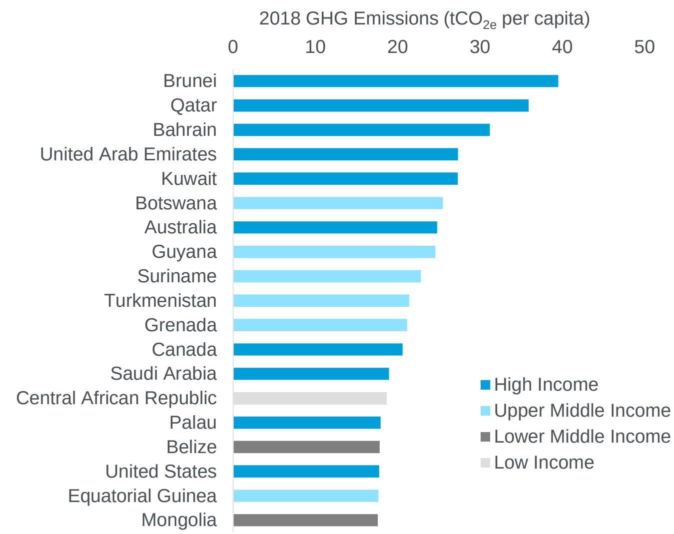
The world's largest per capita emitters such as Brunei, Qatar, and Bahrain tend to be large oil/gas producers. If we consider the GHG emissions per capita for the major emitters, there is a wide range from 2.5 tCO_2e per capita in India, to 24.8 tCO_2e per capita in Australia.

Figure 7. Annual GHG Emissions of the Top Emitters



Source: Climate Watch Data

Figure 8. Per Capita Annual GHG Emissions



Source: Climate Watch Data

The latest IPCC assessment report considers the projected impacts of five new emissions scenarios ranging from the doubling of GHG emissions from current levels by 2050 and 2100, to net zero around 2050 and net negative emissions. The results show that with every additional increment (i.e., 0.5°C) in global warming, the change in regional mean temperature and precipitation gets larger, and changes in extreme weather events get greater in frequency and intensity.[2] Under all scenarios, the global surface temperature will continue to increase until at least mid-century and reach 1.5°C or 1.6°C in the next two decades. The report also presents the most comprehensive regional assessments to date, revealing that no region is safe from the impacts of climate change.

Figure 9. Global Surface Temperature Change Relative to 1850-1900

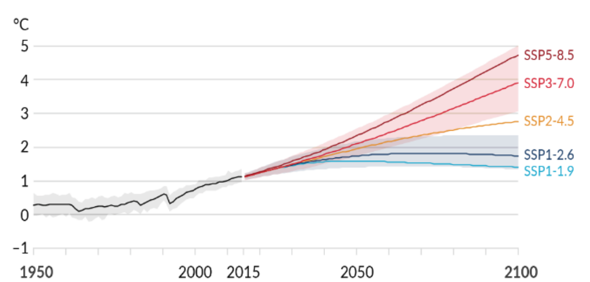
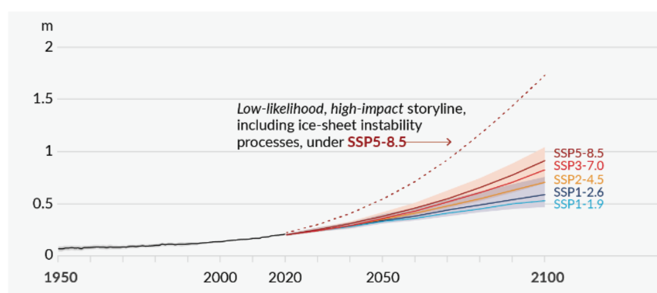


Figure 10. Global Mean Sea Level Change Relative to 1900



Source: IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[2] Ibid.

Figure 11. Scenarios Assessed in the Latest IPCC Assessment Report

Scenario	Description	Near term, 2021-2040	Mid-term, 2041-2060	Long term, 2081-2100
SSP1-1.9	Very low GHG emissions (Net zero CO_2 emissions around 2050)	1.5°C	1.6°C	1.4°C
SSP1-2.6	Low GHG emissions (Net zero CO_2 emissions after 2050)	1.5°C	1.7°C	1.8°C
SSP2-4.5	Intermediate GHG emissions (In line with upper end of aggregate NDC emission levels by 2030)	1.5°C	2.0°C	2.7°C
SSP3-7.0	High GHG emissions (CO_2 emissions roughly double from current levels by 2100)	1.5°C	2.1°C	3.6°C
SSSP5-8.5	Very high GHG emissions (CO_2 emissions roughly double from current levels by 2050)	1.6°C	2.4°C	4.4°C

Source: IPCC ARC 6

It is clear we cannot continue business as usual, but how long do we have to change our ways? The carbon budget is the total amount of carbon emissions that can be emitted for a given temperature rise limit. The IPCC AR6 report updated the estimates for a 1.5°C and 2°C long-term limit. For a 50% chance of meeting a 1.5°C warming, CO_2 emissions from 2020 must not increase by more than 500 $GtCO_2$. For a 67% chance, CO_2 emissions must not increase by more than 400 $GtCO_2$. A 50% chance for a 1.5°C warming equates to about 14 years at current emission rates. But this does not mean lowering emissions is tomorrow's problem and we have time to continue as we are. The only way to even stand a chance of staying within the budget is to start changing our energy use and emissions level now. We need to limit *cumulative* CO_2 emissions, reaching at least net zero CO_2 emissions by 2050, and then actually look to go net negative in the second half of the century.

It is also worth highlighting the importance of reducing methane (CH_4), which is now at higher concentrations than at any time in at least 800,000 years. Methane is also more potent than CO_2. The global warming potential (GWP_{20}) measures the relative warming impact of one unit mass of GHG relative to CO_2 — methane has a GWP_{20} of 84-86 which means one tonne of methane has 84-86 times the warming impact of one tonne of CO_2 over a 20 year time horizon.[3] Methane is not in most countries' NDCs (nationally determined contributions) but the U.S. and EU have recently announced a joint pledge to cut global methane emissions by at least 30% by 2030, based on 2020 levels. The pledge will open for signatories at COP26, but eight additional countries have already expressed their support as of mid-September 2021.[4]

Climate change is an existential risk that threatens the entire world, and we cannot solve it without the international community coming together. The world is currently heading for a global temperature rise of more than 3°C this century. There is still time to change that trajectory, but the window of opportunity is closing. The decisions and actions taken this decade will determine the climate and possibly the prosperity of future generations.[5] The Paris Agreement was a huge achievement for the international community but it is now time to turn those commitments into real action.

[3] "The Challenge," United Nations Economic Commission for Europe, accessed October 25, 2021.

[4] "Joint US-EU Press Release on the Global Methane Pledge," The White House, September 18, 2021.

[5] United Nations Environment Programme, *Emissions Gap Report 2020*, December 09, 2020.

Chapter 2: International Response to Climate Change

The international response to climate change began in 1992 with the adoption of the UN Framework Convention on Climate Change. This Framework Convention set out basic legal frameworks and principles for international cooperation on climate change with the aim of "stabilizing" greenhouse gas emissions to avoid "dangerous anthropogenic interference" with the climate system.[6] However, it did not contain any specific national or international targets to reduce greenhouse gas (GHG) emissions.

In 1997, the Kyoto Protocol was adopted; however, owing to a complex ratification process, it only entered into force in February 2005. This was the first legally-binding climate treaty. As part of this agreement, developed countries and economies in transition committed to limit and reduce their greenhouse gas emissions in accordance with individual targets. There were two commitment periods that formed part of this Protocol. During the first commitment period (2008-12), 37 industrialized countries and economies in transition plus the European Community committed to reduce GHG emissions to an average of 5% against 1990 levels. The Kyoto Protocol was then extended to 2020 through the Doha Agreement — known as the second commitment — which strengthened the pledges of these countries and set a goal of reducing GHG emissions by 18% compared to 1990 levels.

One important element of the Kyoto Protocol was the establishment of flexible market-based mechanisms including:

1. An international emissions trading scheme.

2. The Clean Development Mechanism (CDM), allowing developed countries to purchase emission credits for investing in emissions savings in developing countries.

3. The Joint Implementation (JI) mechanism, which is similar to the CDM, but may only be hosted by developed countries and transition economies (Annex 1 countries to the Kyoto Protocol).[7]

A large number of countries refused to ratify the Kyoto Protocol (mainly the U.S. and Australia) as they argued that developing countries also needed to reduce their emissions.

In 2015, countries came together once again and adopted the Paris Agreement. The agreement includes the goal of limiting the average global temperature increase to well below 2°C above pre-industrial levels, and pursuing efforts to limit it to 1.5°C. Under this agreement, developed countries committed to mobilize $100 billion per year by 2020 for climate action in developing nations.

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[6] "Summary, 2-15 December 2019," International Institute for Sustainable Development, December 2019.

[7] Annex 1 countries include the industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States,

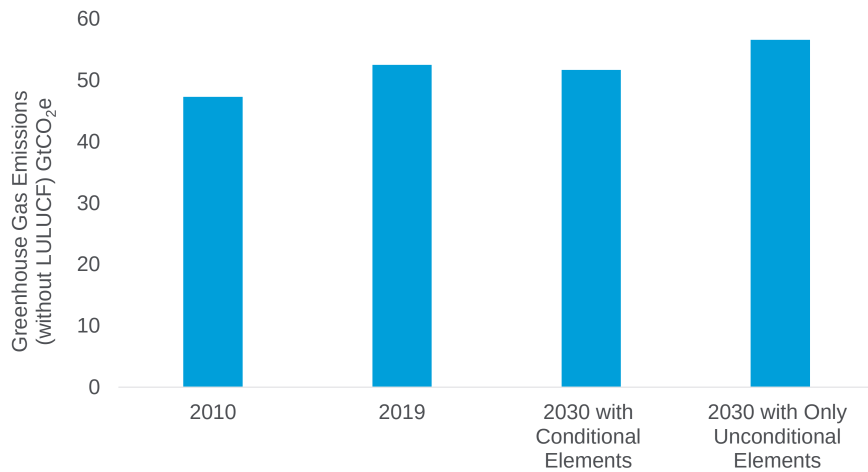
All countries (including developing and emerging nations) also committed to communicate their National Determined Contributions (NDCs) at five-year intervals, which should include more ambitious reductions in greenhouse emissions reductions with every new communication. NDCs are national climate action plans, highlighting climate-related initiatives, targets and policies, and measures that governments aim to implement in response to climate change.[8] In total 164 NDCs have been submitted representing 191 parties. The NDCs are not easily comparable as countries use different parameters to communicate their targets. For example, most advanced economies use absolute emission reduction figures while developing and emerging countries use parameters such as the reduction in carbon intensity per unit of GDP. Business-as-usual scenarios also differ — some countries aim to reduce their emissions below 1990 levels, while others choose a different date. Many also include land use, land-use change, and forestry (LULUCF) as a means to reduce their greenhouse gas emissions over time.

According to Climate Action Tracker, 87 countries have updated their NDCs ahead of the November COP26 meeting in Glasgow with some NDCs putting more-ambitious targets in place than their original commitments. In its most recent analysis report, the UN Framework Convention on Climate Change (UNFCCC) states that under the latest NDCs, total global GHG emissions levels (without LULUCF) are estimated to be around 55.1 $GtCO_2e$ in 2030 (ranging from 51.7 to 58.4 $GtCO_2e$).[9]

Taking into account the full implementation of all the latest NDCs, could possibly mean that global emissions would peak by 2030 if the lower bound of 51.7 $GtCO_2e$ is met. This would mean a 1.4% reduction in GHG emissions versus 2019 levels (see Figure 12) but a 9% increase from 2010 levels. This scenario takes into account conditional elements of the NDCs, including access to finance, technological transfer, technical capacity, capacity building support, absorption of forests, and market based mechanisms. If the assumption is that only the unconditional parts of the countries NDCs are met, then projections in 2030 would be 16% higher than 2010 levels. This could change if new NDCs are submitted ahead of COP26.

[8] "NDC Spotlight," United Nations Framework Convention on Climate Change, accessed October 25, 2021.
[9] United Nations Framework Convention of Climate Change, *Nationally Determined Contributions Under the Paris Agreement, Synthesis Report by the Secretariat*, September 17, 2021

Figure 12. Comparison of GHG Emissions in 2010, 2019, and Projected 2030 Based on Most Optimistic Outcome of NDCs



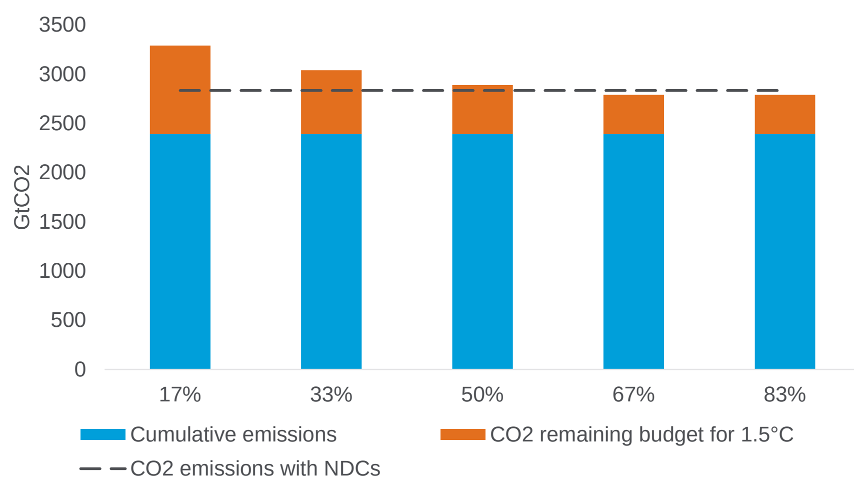
Source: UNFCCC

Note: The figure for 2030 with conditional elements represents the most optimistic scenario for GHG projections based on submitted NDCs at the time of writing the report. The figure for 2030 with only unconditional elements represents the average of the lowest and highest numbers projected in this scenario.

However according to the IPCC in their SR1.5 scenario, global emissions by 2030 should reduce by 45% from 2010 levels to ensure we do not increase global temperatures above 1.5°C, reaching net zero by 2050. For a 2°C temperature increase, global emissions by 2030 should decrease by 25% from 2010. Current NDCs are not in compatible with this scenario.

In the context of the carbon budget consistent with a 50% likelihood of limiting warming to a 1.5°C increase, cumulative CO_2 emissions between 2020 and 2030, based on the latest NDCs, would most likely use up 89% of the remaining carbon budget, leaving just 55 $GtCO_2$ to be used post-2030. To put this into context, in 2018 alone we emitted a total of 36.4 $GtCO_2$.

Figure 13. Carbon Budget Left After Taking Into Consideration Submitted NDCs

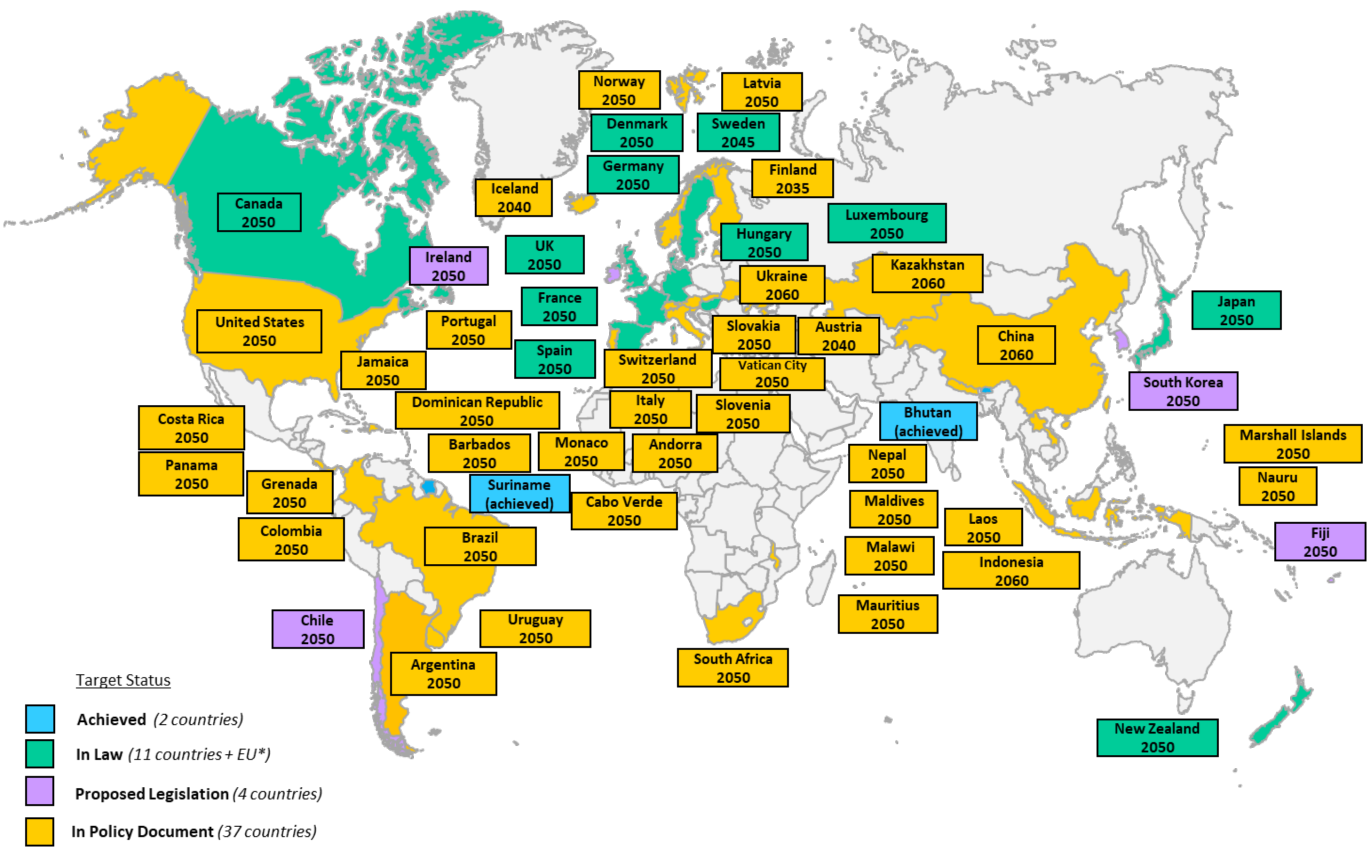


Source: Citi Global Insights

It is obvious there needs to a significant increase in country commitments to reduce emissions if we are to have any chance of limiting the temperature increase to 1.5°C or even to 2°C. We are expecting more countries to submit their NDCs before COP26, so this analysis could change; however, it is difficult to see how new commitments before COP26 could reach a reduction of 45% from 2010 levels, as stated by the IPCC.

Even so, there is some good news, as many countries are committing to net zero targets. Most recently China stated they would reach a net zero target in 2060. However, there is a lack of data available as to how many of these net-zero targets could be reached. Time is also against us — the later we leave it to reduce emissions and reach net zero, the harder it will be to have any chance of limiting temperature increase.

Figure 14. Country Net Zero Commitments (Achieved, In Law, In Policy Document & Proposed Legislation)



*Note: European Union member countries not marked fall within the EU's 2050 law

Source: Citi Global Insights

The Paris Agreement and the commitment of many countries to produce NDCs is a first step in getting commitments to reduce emissions by 2030. However, it is not quite clear whether the process of submitting NDCs regularly is going to get us to a net zero world. Although the NDCs are part of a legally-binding framework and are a first step in getting countries to form some sort of agreement on GHG emissions, they do not have any specific obligations regarding country emission reduction targets, nor is there any provision for non-compliance. It is really up to each individual country to decide how to reduce their emissions over time and to what extent.

We believe the best way to effectively achieve net zero targets is for countries to cooperate with one another and put an appropriate price on carbon. Article 6 in the Paris Agreement attempts to form some global cooperation in a voluntary way; however, as it currently stands there is yet to be an agreement reached and it remains the only part of the Paris Agreement that has not yet been resolved. This, amongst things such as finance, will be one of the main discussion points in COP26.

So What Is Article 6?

Article 6 sets out the rules for how parties can engage in voluntary international cooperation in order to raise a higher ambition and reduce emissions. It contains three separate mechanisms for "voluntary cooperation" toward meeting each country's goals. Two of these mechanisms are market-based while the third is based on non-market approaches.

- Article 6.2 states that parties engaging on a voluntary basis in cooperative approaches could make use of internationally transferred mitigation outcomes (ITMOs) towards their NDCs. This mechanism would allow a country that has beaten its Paris Agreement climate pledge to sell any over-achievement to another country that has fallen short of their goals. This article also mentions the importance of avoiding double counting — meaning countries who sell their ITMOs cannot count them as part of their obligation.

- Article 6.4 calls for a new international carbon market, supervised by a UN body, for the trading of emission reductions created anywhere by the public or private sector. This new proposed market is being called the Sustainable Development Mechanism (SDM), and would replace the Clean Development Mechanism (CDM) which operated under the Paris Agreement's precursor, the Kyoto Protocol. A share of the proceeds would be used to cover administrative expenses as well as to assist developing countries who are extremely vulnerable to climate change. This article revolves more around projects, while Article 6.2 is more about trading between countries.

- Article 6.8 promotes non-market cooperation between countries to assist with their NDCs, such as through technology transfer or capacity building.

Article 6 has not yet been agreed upon by all countries. There are a number of sticking points such as the use of old credits in the CDM system, double counting, and transparency, among others.

However, Article 6 has been specified in the Paris Agreement as being voluntary so it is not quite clear whether it would succeed in reducing emissions globally. Although many countries stated in their NDndcCs they will make use of market-based systems to meet their commitments, there is a lack of detail as to what type of mechanism would be used and how this would be implemented.

In Chapter 4 we discuss different mechanisms that could be used to reduce emissions and reach a net zero world. We discuss not only the implications of Articles 6.2 and 6.4, but also other available mechanisms such as linking existing emissions trading schemes (ETSs), setting up a global carbon tax, and forming a climate club. However before we look at this analysis, it is first important to understand what mechanisms are currently being used in different economies.

Chapter 3: Current Systems

As we note in the previous chapter, the current national determined contributions (NDCs) submitted by countries are not enough to limit the global temperature increase to 2°C let alone a 1.5°C increase. To have any chance of reaching net zero and to limit this temperature increase, we need to price carbon high enough to encourage polluters to change their ways, and provide incentives for consumers to switch to green products and services. There are a number of ways to do this: countries could set up a direct carbon tax; implement an emissions trading system; or use carbon credits, also known as carbon offsets (see box below).

Three Market-Based Systems Used to Set Up Carbon Pricing

- A direct carbon tax implemented on CO_2 emissions or directly on fossil fuels
- Cap-and-trade systems, commonly referred to as emissions trading systems, are mechanisms that place a cap on the total quantity of CO_2 that can be emitted by a participating entity. A government or a central authority allocates or sells a limited number of permits allowing entities to discharge specific quantities of CO_2 emissions. Firms are required to hold permits equal to their allowed CO_2 emissions and are taxed if they produce CO_2 emissions higher than their permits allow. Companies that reduce their emissions can either sell, or "trade" unused permits to other companies. The EU Emissions Trading System (EU ETS), launched in 2005 is an example of a cap-and-trade system. On a country level, a system can be designed, for example, where the cap on each country is equal to the commitments in its NDC. If the country achieves far more than this cap, it can sell its extra "allowances" to countries that have not met the commitments in their NDC. This is essentially what Article 6.2 in the Paris Agreement is all about.
- Baseline-and-credit systems utilize carbon credits or carbon offsets but do not place a fixed limit on the reduction of emissions per se. The reductions can be done on a voluntary basis or as part of a cap-and-trade system in some instances. This market is highly fragmented with international credit mechanisms such as the Clean Development Mechanism, regional crediting mechanisms such California's Compliance Offset Program, and independent crediting mechanisms also known as the voluntary offset market.

Carbon pricing systems have become a cornerstone of Energy Transition policies in many jurisdictions and have the potential to become some of the largest financialized commodity markets, affecting many other areas of investments. The proposal for a regulated carbon emissions market traces back to an essay from John Dales published in 1968.[10] The rationale is that negative externalities such as pollution, which are not reflected in the market price of goods and services offered, should be internalized. Therefore, beyond a predefined threshold, producers should compensate other stakeholders for implicitly sharing the social cost of their environmental impact.

Over the past two decades, greenhouse gas (GHG) emission pricing programs have become increasingly popular among policymakers. Authorities continue to develop international, national, and regional carbon emissions systems not just to limit GHG emissions and provide an economic incentive to switch to greener energy sources and more sustainable business models, but also to raise fiscal revenues for income redistribution. The World Bank estimates initiatives around the world generated $53 billion in fiscal revenues in 2020. Recently, due to spiraling power prices in Europe, the Italian and Spanish governments laid out a plan to allocate €900 million from existing European allowances auctions to subsidize energy bills for low-income households.

[10] J.H. Dales, *Pollution, Property & Prices: An Essay in Policy-Making and Economics* (Toronto: Toronto University Press, 1968).

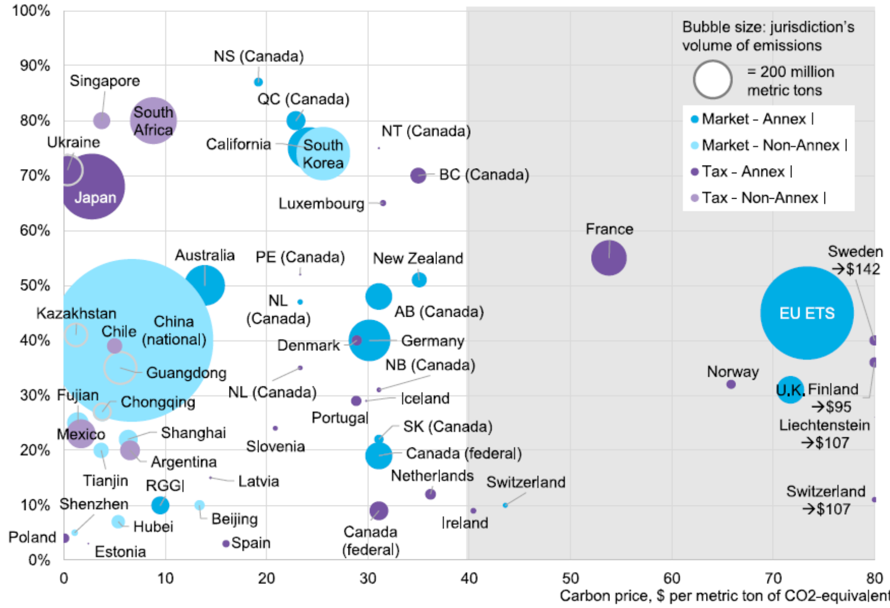
However, today there is not a unique global carbon price given the heavy fragmentation of environmental policies, agreements, and protocols globally that would underpin a global carbon market. As of late 2021, there were 64 carbon pricing systems in effect in the world, covering a quarter of global emissions, with another 30 or more in development. Of the systems currently in place, 30 are carbon markets and 34 are carbon tax regimes at various jurisdiction levels.

Many G-20 countries have some sort of carbon price system. The European Union, for example, has the oldest ETS system in place and China has just introduced an ETS that covers its power sector, while the U.S. has a patchwork of climate policies at the federal and state level, including two of the major ETSs accessible to investors: the California Cap-and-Trade Program and the Regional Greenhouse Gas Initiative (RGGI). However, there are some glaring exceptions within the G20 — Brazil, Indonesia, Russia, Saudi Arabia, and Turkey do not have any emissions covered by a carbon pricing system. Meanwhile, India has only approximately 8% of its emissions covered by a carbon price. Indonesia is developing an ETS with voluntary trials started in March 2021, Sakhalin in Russia is set to begin emissions trading in 2022, and several others are scheduled to be implemented over the next decade. Early efforts to create a single market under the UN's Kyoto Protocol, reached in 1997, have not led to a global market. Yet, successful GHG programs worldwide serve as examples that should encourage the global community to act together.

All in all, carbon pricing systems today cover about one quarter of global emissions, with 4.5% covered by carbon taxes, and 21% covered by carbon markets. However, as shown in Figure 15, carbon prices range from as low as $0.10/tonne to $142.40/tonne. Only a few systems, covering just 4% of global emissions, have prices in the $40-$80/tonne range, which many see as the price needed to reach a 2°C target.[11] Some of the highest prices are those at ~$100/tonne and above in Finland, Liechtenstein, Sweden, and Switzerland, but their emissions are not large. A good number of carbon pricing systems have prices in the $20-$40/tonne range now, notably California and Canada, as well as a host of European countries. Carbon tax systems tend to have rising price levels over time, with 2030 levels expected to see higher price levels, notably in France and Canada. Canada's federal carbon price increases C$15/tonne per year to C$170/tonne by 2030. Meanwhile, major ETS prices could reach meaningful levels by 2030, including the EU ETS, which could reach $100/tonne and California's Cap-and-Trade Program, which could reach $60/tonne or higher. A more detailed analysis of carbon systems is found in Appendix 1.

[11] See data from the World Bank and the International Energy Agency.

Figure 15. Carbon Pricing Systems by Price and Percent Share of Emissions Covered



Source: Citi Research

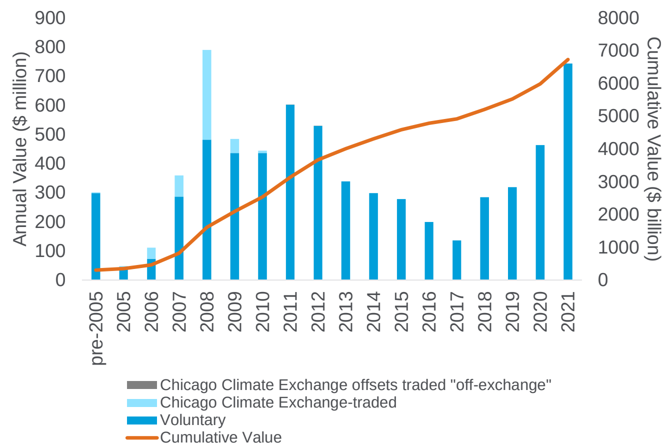
Baseline or Credit Systems (Carbon Credits/Offsets)

In addition to direct carbon pricing or ETS systems, there is also the possibility of countries, companies, or even individuals using carbon credits to reduce their emissions. Also known as carbon offsets, these mechanisms are used to compensate for emissions by funding an equivalent carbon dioxide saving elsewhere.

There are two main markets for offsets. The first is the compliance market, which usually forms part of an emissions trading scheme. The other is the voluntary market, which functions outside of the compliance market and enables entities to purchase offsets on a voluntary basis. Many companies and organizations offer carbon credits/offsets for the voluntary market. These organizations offer hundreds of carbon offset projects in different parts of the world. The majority of voluntary offsets are third-party verified; however, the protocols around which offsets are verified varies amongst the different programs. Each organization has different projects listed on their website — relating to, as examples, energy efficiency, biogas digesters, efficient stoves, and forestry — and each project has a different price per tonne of CO_2. The variation of pricing between carbon offsets provided by different organizations can vary immensely for reasons that are far from transparent.

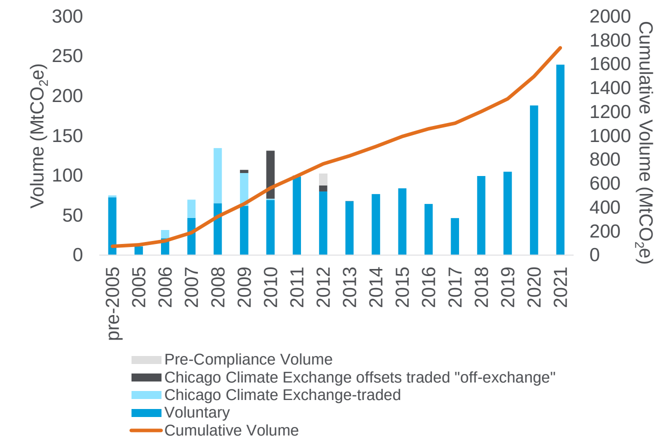
Voluntary markets are expected to increase substantially over the coming years. In fact, we are already seeing an increase in the use of offsets in 2021. According to Ecosystem Marketplace, as of August 2021 traded volumes of voluntary carbon offsets have reached the highest value since 2005 — estimated at 240 $MtCO_2e$. If we look at the traded value of this market in the same time period, it has nearly reached the peak of 2005 — a total of $748 million.

Figure 16. Market Size by Traded Value of Voluntary Carbon Offsets



Source: Ecosystem Marketplace, 2021 Washington, DC: Forest Trends Association. https://ecosystemmarketplace.com/

Figure 17. Market Size by Traded Volumes of Voluntary Carbon Offsets



Source: Ecosystem Marketplace, 2021 Washington, DC: Forest Trends Association. https://ecosystemmarketplace.com/

There are a number of issues surrounding offsets — first and foremost is the lack of a global standard. There is also a lack of consistency between firms that offer offsets with different prices per tonne of CO_2 for similar projects and often a lack of transparency as to why these prices differ so much. Other criticisms include the aspects of additionality, permanence, enforceability, and double counting. A taskforce on scaling offsets has been set up to bring all parts of the offset value chain together and provide recommendations to address some of the main issues surrounding this market. If done well, carbon offsets can help reduce emissions and increase investment in developing and emerging countries. Appendix 1 provides a detailed assessment on carbon offsets together with a more detailed analysis of the current systems in use in different countries.

Conclusion

There are many mechanisms being used to price carbon in different countries — direct carbon taxes, ETS systems, or even baseline and credit systems — but they are all really disjointed. Carbon price levels and the share of emissions covered through ETS systems and direct carbon taxes vary widely across all global carbon pricing systems. Only a few, covering just 4% of global emissions, have CO_2 prices in the $40-$80 per tonne range — the level seen by many as the price needed to reach a 2°C target. Many of these systems are fragmented — some covering just a few sectors — while others are more extensive. [12] This fragmented approach is clearly inefficient, and the evidence tells us that at the moment it is also proving to be ineffective at reducing global emissions. Carbon prices are expected to increase over time in some jurisdictions; however, it is unclear whether these will be sufficient enough to reduce emissions at a global level. At the moment, as we have seen from Chapter 1, global greenhouse gas emissions continue to increase.

To achieve real progress at a global level we must find some way of either integrating these systems into some sort of global system or building a new global mechanism that could be effective at reducing emissions on a global scale. We discuss this in the next chapter.

[12] See data from the World Bank and the International Energy Agency.

Chapter 4: Can Market-Based Mechanisms Lead to a Net Zero World?

As we have seen from the previous chapters, the current national determined contributions (NDCs) that countries have submitted to date are not enough to limit temperature increase to 2°C, let alone 1.5°C. Many countries have taken the initiative to set up mechanisms that could help reduce emissions; however, they are fragmented. Only 4% of global emissions currently have a carbon price in the region of $40-$80 per tonne of CO_2, a price which many believe is essential in 2021 to put us on the road to limit temperature increase to 2°C. This carbon price should increase further to $50-$100 per tonne of CO_2 in 2030.[13] Unfortunately, the pricing mechanisms introduced in many countries are not currently making a difference to global carbon emissions.

Climate change is a global problem and will require a global solution. It is imperative that countries work together to reduce their emissions and reach net zero effectively. The International Emissions Trading Association (IETA) and the University of Maryland noted that Article 6, if implemented well, has the potential to reduce the total cost of implementing NDCs by more than half (~$250 billion per year in 2030), or alternatively facilitate the removal of ~5 gigatonnes of carbon dioxide ($GtCO_2$) per year in 2030, at no additional cost.[14]

As we saw in Chapter 2, countries have been negotiating on climate change since 1992, but have not yet found a collective way to reach the deep emissions cuts needed over the next 20 to 30 years. It is important that we do so.

What type of mechanism can help us reach a net zero world? In this chapter we analyze four different mechanisms: (1) Article 6.2 and 6.4, (2) linking emissions trading schemes (ETSs), (3) setting up a global tax, and (4) setting up a climate club amongst a few nations (see Figure 18). All the mechanisms we analyze have the potential to reduce emissions over time, but what we want is a mechanism that allows us to reach net zero effectively. We do not have the luxury of spending another 20 years to negotiate a deal that is a win-win for all. Tackling climate change requires a drastic change in the way we operate, in the way we supply and use energy, and in the way we use our available land. If we do this, we should also be able to create new jobs and a new green economy.

To get to a global solution, there are issues we need to solve, such as establishing effective carbon pricing and revenue distribution systems, as well as ensuring that developing markets get appropriate funding to reduce their emissions. And as we will see from our analysis, these are not easy to solve. Given the urgency of the problem and the difficulty of negotiating a global agreement, we think agreeing on a solution amongst two or more nations (possibly the big emitters) would be easier, and could ultimately lead to a global solution. An agreed solution is essentially a "climate club" and this is the direction we think the world is moving towards. This is not to say other mechanisms would not work — these mechanisms are not mutually exclusive and could operate in tangent with one another.

[13] Carbon Pricing Leadership Coalition, *Report of the High Level Commission on Carbon Prices,* May 29, 2017.
[14] International Emissions Trading Association, *The Economic Potential of Article 6 of the Paris Agreement and Implementation Challenges*, September 2019.

We also believe a multilateral bank dedicated solely to climate change should be set up to drive global investments and help de-risk projects, especially in emerging and developing economies.

This chapter is divided into five sections providing a detailed analysis of the mechanisms in question together with a discussion at the end.

Figure 18. Market-Based Mechanisms in Our Analysis

Mechanism	Description
Section 1: Article 6.2 & 6.4 Tradeable emissions system at a country level as proposed in Article 6.2	Countries meet their climate pledges by allowing parties to use internationally transferred mitigation outcomes (ITMOs) to achieve their NDCs. This essentially means a country that has achieved its climate pledge can sell its overachievement to a country falling short of its own goals.
Global market mechanism under Article 6.4 that is subject to centralized governance by a UN body	Creation of a new international carbon market for the trading of credits from emissions reductions generated from projects anywhere in the world. Often referred to as the "Sustainable Development Mechanism," this would replace the Clean Development Mechanism which operated under the Kyoto Protocol.
Section 2: Linking existing ETS systems to form one global system	Existing ETS systems could be reformed or replaced to form one, harmonized ETS system across multiple jurisdictions. This could see all covered jurisdictions "racing to the top" to cover the most extensive set of sectors. Alternatively, jurisdictions could agree on a smaller set of sectors as a core ETS, with individual jurisdiction-level ETSs for additional sectors. Countries/jurisdictions currently without an ETS could join this global ETS over time.
Section 3: Setting up a global carbon tax	A global carbon tax would be set up across all nations — either be in the form of an equal rate across all nations, or emerging markets would initially have a lower carbon price. Revenues could either stay in the country where the tax is collected or be distributed according to some fairness/equity parameter.
Section 4: Setting up a voluntary climate club	Establish a "climate club" by setting up a voluntary club between a few nations. Members of the club would agree on an equal, market-based mechanism on carbon. The benefits of the membership could include shared technological innovations, a competitive level playing field amongst different sectors, and preferential trade agreement. A Carbon Border Adjustment Mechanism (CBAM) would be placed on imports from non-members of the club.

Source: Citi Global Insights

Section 1: Article 6.2 and 6.4

As we have described in Chapter 2, Article 6 is the only part of the Paris Agreement that has not yet been agreed upon. It is a one-page document that tries to set out the rules for how parties can engage in voluntary international cooperation and contains three separate mechanisms for "voluntary cooperation" toward meeting a country's goals. Two of these mechanisms are market-based, while the third is based on non-market approaches. In this section, we analyze the two market-based systems — Article 6.2 and 6.4 — and discuss whether such systems could be effective at reducing global emissions.

Article 6.2: Tradeable Emission System on a Country Level

The aim of Article 6.2 is to help countries meet their climate pledges by allowing parties to use internationally transferred mitigation outcomes (ITMOs) to achieve their national determined contributions (NDCs). This essentially means a country that has achieved its climate pledge can sell its overachievement to a country that has fallen short of its own goals. Article 6.2 also sets out three requirements that ITMO transfers have to meet — "Parties shall […] promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting." This means that country-to-country trading should lead to real emission reductions and benefits for the environment, and that emission cuts must only count toward one country's climate targets. It is worth highlighting here the difference between NDCs and net zero — Article 6.2 is designed to help parties achieve their NDCs but as we show in Chapter 2, current NDCs do not come close to reaching the emission reductions needed to achieve net zero.

As it stands, the mechanism of Article 6.2 is relatively loose with few rules or restrictions set at the international level.[15] This includes a lack of definition for what counts as an ITMO, which could include emission cuts as well as other types of targets such as installed renewable power capacity. Deciding on the key metric to use for ITMOs is a challenging issue, with some parties advocating for the use of carbon dioxide equivalent (CO_2e) while others argue that parties should be able to choose what metric they use to sell and buy ITMOs. According to the Asian Development Bank, some parties object to the use of the CO_2e metric as a matter of principle and ask the question, "Do the Article 6 rules need to be inclusive, or do the NDCs themselves have to adapt to the accounting rules of Article 6?"[16] Given that participation in Article 6 is completely voluntary, one could make the case that the rules should be inclusive, while alternatively, the use of one consistent metric can help with accounting, transparency, and comparability.

Article 6.2 also does not specify the types of instruments that can be used to generate ITMOs. These could include the linking of emissions trading systems as well as the use of the Article 6.4 mechanism if the emission reductions generated would be considered ITMOs. Both of these mechanisms are described in more detail later in the chapter. This essentially means the parties involved in the bilateral trade are able to make up their own rules, and there is limited governance at the international level (this differs from Article 6.4 which pursues a more centralized approach).

[15] Simon Evans and Josh Gabbatiss, "In-Depth Q&A: How 'Article 6' Carbon Markets Could 'Make or Break' the Paris Agreement," CarbonBrief, November 29, 2019.
[16] Asian Development Bank, *Decoding Article 6 of the Paris Agreement Version II*, December 2020.

One area for which there will be some international guidance is on the accounting of ITMO transfers, including the avoidance of double counting. Accounting for the transfer of ITMOs is a key challenge for Article 6.2, especially as it has to contend with the diversity of individual country NDCs, which have different base years and could have single year or multi-year targets. In addition, some NDCs have targets based on emission intensity (i.e., emissions per unit of GDP) instead of absolute emissions. The heterogeneity makes accounting for international transfers more complex as the application of "corresponding adjustments," which are required to ensure emission reductions are only counted towards the NDCs for one country, is not consistent.

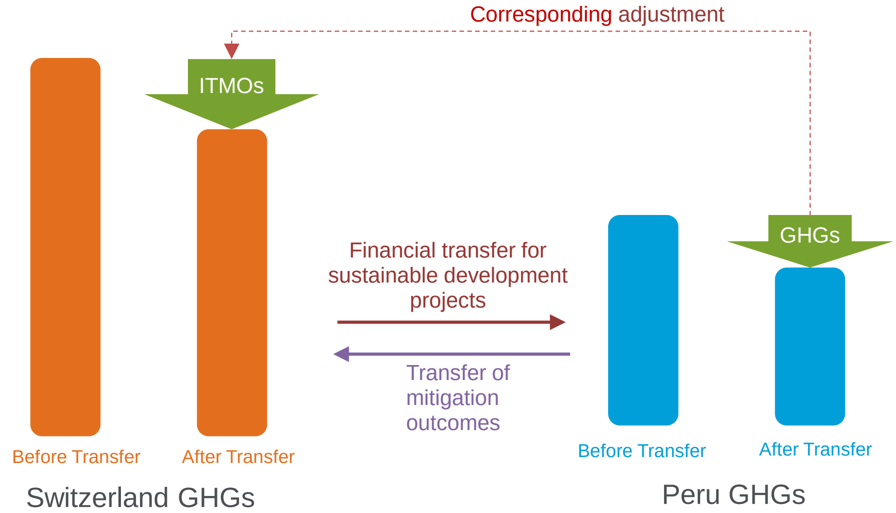
A key unresolved issue for Article 6 is whether Article 6.2 should support the Adaptation Fund, which helps vulnerable countries adapt to the impacts of climate change. Mandatory share of proceeds (SOPs) will apply for Article 6.4, and therefore some parties argue it should also apply to Article 6.2 to maintain parity, and generate revenue for the Adaptation Fund. Share of proceeds for Article 6.2 was originally left out of the Paris Agreement, but has been put back on the table following pressure by negotiating parties. It remains a contentious issue, and will be a key area of discussion in the upcoming COP26 negotiations.

Article 6.2 is designed to help parties reach their NDCs, and it seems the international rules governing Article 6.2 will remain relatively light in terms of rules and restrictions. This may not be a good thing, as there is a real danger countries will just make up their own rules.[17] At the same time, flexibility may not be a bad thing. Mehling, Metcalf, and Stavins (2018) make the case that clear and consistent guidance for the accounting of emission transfers is important for the success of Article 6.2, but too much guidance — especially if it includes restrictive quality or ambitious requirements — could dampen incentives for cooperation.[18] Another aspect of country-to-country trading that we think could also benefit from some international guidance/rules is the pricing of ITMOs to help facilitate a level playing field.

Despite the rulebook not yet being finalized, we are already seeing countries come together and implement Article 6.2. Switzerland, for example, has signed partnership agreements with Peru and Ghana, and initial agreements with Senegal and Thailand on the transfer of mitigation outcomes. Switzerland will fund sustainable development projects in these countries and use the transfer of ITMOs to meet its NDC targets. For sellers, ITMOs represent a way of generating revenues to support sustainable development and mobilize decarbonization beyond their NDC target. This shows that even without international agreement on the rulebook, countries can come together and operationalize bilateral market collaboration under Article 6.2. However, in order to help ensure the requirements of Article 6.2 are met, we think there should be clarification at the international level on the nature and scope of ITMOs as well as guidance on the accounting and pricing of ITMOs.

[17] Simon Evans and Josh Gabbatiss, "In-Depth Q&A: How 'Article 6' Carbon Markets Could 'Make or Break' the Paris Agreement," CarbonBrief, November 29, 2019.
[18] Michael A. Mehling, Gilbert E. Metcalf, and Robert N. Stavins, "Linking Climate Policies to Advance Global Mitigation," *Science* 359, no. 6379 (2018): 997-998.

Figure 19. Example of Bilateral Trade of ITMOs Under Article 6.2



Source: Citi Global Insights

Article 6.4: Replacement of CDM with SDM

The second market mechanism (6.4) of Article 6 calls for a new international carbon market, supervised by a UN body, for the trading of emissions reductions created anywhere by the public or private sector. This new proposed market — the Sustainable Development Mechanism (SDM) — would replace the Clean Development Mechanism (CDM) which operated under the Paris Agreement's precursor, the Kyoto Protocol.

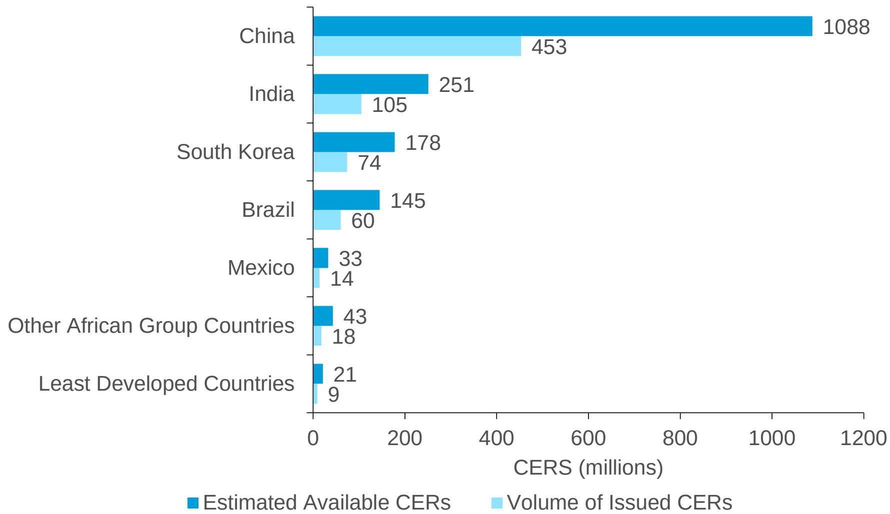
The CDM along with the Joint Implementation (JI) were two mechanisms set up under the Kyoto Protocol and used in the international compliance market. CDM projects may only be hosted by developing countries (referred to as non-Annex 1 countries to the Kyoto Protocol), while JI may only be hosted by developed and transition economies (Annex 1 countries).[19] The CDM is the larger of the two systems and was set up with the aim of helping developed countries achieve their climate commitment while at the same time help developing economies achieve sustainable development.

The CDM mechanism is complex. If a developed country wants to acquire credits from a CDM project, it must first obtain the consent of the developing country hosting the project. The developed country must prove the project chosen would not have happened anyway (i.e., prove additionality) and then it must calculate the baseline, estimating the future emissions in absence of that particular project. Next, the project must be approved by the CDM Executive Board and validated by a third party. The CDM then issues Certified Emission Reductions (known as CERs) to the project participants by taking into consideration the difference between the baseline and actual emissions. Once a carbon offset project has been verified, it can be used as a carbon credit and can also be linked with an official ETS system.

[19] Annex 1 countries include the industrialized countries that were members of the OECD in 1992, plus countries with economies in transition (including the Russian Federation, the Baltic States, and several Central and Eastern European States).

There are currently over 8,000 projects registered under the CDM, with China and India accounting for almost 70% of projects.[20] By 2019, CDM projects had issued CER units equivalent to ~2 $GtCO_2e$.[21] The second commitment period of the Kyoto Protocol came to close at the end of 2020, but the CDM Executive Board decided to temporarily extend the CDM operations beyond 2020 so that CDM projects can continue to operate as negotiations continue on the implementation rules for Article 6.[22]

Figure 20. Number of CERs Issued and Potentially Available for Issuance



Source: OECD/IEA 2019 (data as of December 2018) CERs stands for Certified Emissions Reductions

The CDM has been heavily criticized, and widely regarded as a failure.[23] Key criticisms include:

1. Many argue that **CDM credits have been issued for projects that would probably have happened anyway**. A study from the European Commission found it is likely the majority of projects registered under the CDM are not providing real, measureable, and additional emission reductions.[24]

[20] "CDM Projects by Host Region," Centre on Energy, Climate and Sustainable Development, UNEP DTU Partnership, last updated October 01, 2021.
[21] Luca Lo Re and Jane Ellis, "Operationalising the Article 6.4 mechanism: Options and Implications of CDM Activity Transition and New Activity Registration," *OECD/IEA Climate Change Expert Group Papers*, no. 2021/02, May 2021.
[22] "CDM Executive Board Decides to Temporarily Extend CDM Operations Beyond 2020," UPM, January 13, 2021.
[23] Simon Evans and Josh Gabbatiss, "In-Depth Q&A: How 'Article 6' Carbon Markets Could 'Make or Break' the Paris Agreement," CarbonBrief, November 29, 2019.
[24] Martin Cames et al., *How Additional Is the Clean Development Mechanism: Analysis of the Application of Current Tools and Proposed Alternatives*, The Oeko-Institut, March 2016.

2. In some cases, **the mechanism acted as an incentive for companies to increase their production of pollutants so that they could generate credits**. At the beginning of the CDM, project developers were found to be increasing production of harmful industrial gases like fluoroform (HFC-23) to increase the number of credits available.[25]

3. The **distribution of projects was unequal among host countries**, in particular African countries. Some argue this undermined global support for the CDM and was one of the reasons why the CDM failed.[26]

4. **There was an oversupply of credits and quality was low.** Around a billion tonnes of Kyoto-era credits are available now, and potentially even more are able to still be generated or registered.[27] The low price of CERs has brought into question the ability of the CDM to finance projects. Studies have found the revenues generated from the CDM have actually been insufficient in financing the registered projects.[28] Price data from the World Bank show CERs in 2019 were valued at \$0.15–\$0.24/tCO_2e.[29]

The Article 6 rulebook has been a significant hurdle at previous COP negotiations post COP21 in Paris. There is agreement on the need for common rules around accounting, reporting, and review, but defining those rules is the sticky challenge. Two key outstanding issues where there remains divergence amongst parties relate to Article 6.4 — the use of CDM credits, and accounting and avoidance of double counting.

1. **The use of CDM credits:** Should CDM units generated before 2020 be eligible for use to meet NDC targets under the Paris Agreement? Some parties that invested heavily in projects under the Kyoto Protocol (i.e., Brazil and India) make the case for allowing these credits to remain valid, while the EU and many other countries at COP25 were firmly against the carry-over of Kyoto-era units, arguing it would undermine already insufficient ambitions by allowing the use of old emission-reduction credits to meet new targets, as well as erode confidence in carbon markets. An OECD/IEA (Organisation of Economic Co-operation and Development/International Energy Agency) study assessing the transition of CDM activities and CERs, reports that a full transition of CERs could lead to low credit prices and less incentive for private sector investment in Article 6.4 activities. It could also potentially put the development of new mitigation actions, as well as the environmental gains which Article 6.4 is meant to achieve, at risk.[30]

[25] Carbon Market Watch, *The Clean Development Mechanism: Local Impacts of a Global System*, October 29, 2018.
[26] Yves Steinebach and Julian Limberg, "Implementing Market Mechanisms in the Paris Era: The Importance of Bureaucratic Capacity Building for International Climate Policy," *Journal of European Public Policy* (2021).
[27] Simon Evans and Josh Gabbatiss, "In-Depth Q&A: How 'Article 6' Carbon Markets Could 'Make or Break' the Paris Agreement," CarbonBrief, November 29, 2019.
[28] Carsten Warnecke, Thomas Day, and Noemie Klein, *Analysing the Status Quo of CDM Projects: Status and Prospects*, NewClimate Institute/Ecofys, May 2015.
[29] World Bank, *State and Trends of Carbon Pricing 2020*, 2020.
[30] Luca Lo Re and Manasvini Vaidyula, "Markets Negotiations Under the Paris Agreement: A Technical Analysis of Two Unresolved Issues," *OECD/IEA Climate Change Expert Group Papers*, no. 2019/03, June 2019.

The study explored options for a partial transition, which limits the carry-over of CERs based on the credits geography and vintage (i.e., the year they were created); for example, allowing the carry-over of units from Least Developed Countries. Other suggestions include putting pre-2020 units into a reserve to avoid flooding the market, and only using them when there are shortages in supply.

2. **Accounting and avoidance of double counting/claiming of units:** Under the Kyoto Protocol, developing economies did not have emission reduction targets and there was a certain Annex 1 versus non-Annex 1 dichotomy at play. But under the Paris Agreement, all parties have mitigation goals and targets. This raises the issue of double counting and the claiming of units generated by Article 6.4. The rules for addressing them are still to be determined. Some parties are calling for "corresponding adjustments," referring to the need for the country hosting a project to make adjustments to its emissions inventory when the "emissions reductions" are transferred and claimed by another country. Other parties argue this corresponding adjustment is not required as long as the reductions are counted by one country.

Another difference between the CDM and SDM worth highlighting is that the CDM has been viewed by many as an offsetting mechanism, which has resulted in the shifting of CO_2 emissions rather than the reduction of them.[31] The Article 6.4 mechanism aims to deliver an "Overall Mitigation in Global Emissions" (often referred to as OMGE), which means the SDM must contribute to an overall or net reduction in emissions. How an OMGE will be implemented is an unresolved issue, but the approach raised at COP25 and identified by various studies as the most reliable way to deliver an OMGE is the application of a cancellation percentage to units generated under the Article 6.4 mechanism.[32] The percentage of emission reduction credits to be cancelled is yet to be decided.

Another unresolved issue relates to share of proceeds (SOP) — all parties agree on the importance of adaptation finance but are divided on how Article 6 should contribute. Mandatory SOPs will apply for Article 6.4 but again, similar to OMGE, the percentage of emission reductions credits that should be set aside as SOPs for adaptation is undecided.

It is still not clear how the outstanding issues of the Article 6 and the Article 6.4 rulebook more broadly will be resolved, but what is clear is that the SDM should not be a carbon copy of the CDM. The world has moved on since the Kyoto Protocol established the CDM. We now have the Paris Agreement where all parties have mitigation goals and targets, and all parties can host SDM projects. The CDM may be widely regarded as a failure, but the SDM can and should build from the learnings of the CDM. The SDM will not be a pure offsetting tool, but a mechanism that contributes to further emissions reductions. This means clear rules need to be in place to prevent double counting, to implement an OMGE, and to address the use of aged carbon credits. It is highly unlikely that Article 6 will allow a full transition of CERs, but we may see the allowance of some CERs with certain restrictions.

[31] Carbon Market Watch, *Building Blocks for Robust Sustainable Development Mechanism*, May 04, 2017.
[32] Harry Fearnehough et al., *Analysis of Options for Determining OMGE, SOP and Transition Within Article 6: Implications of Policy Decisions for International Crediting Under the Paris Agreement*, Climate Analytics, NewClimate Institute, Oeko-Institut, 2021.

In addition, the SDM can utilize and adapt the existing CDM infrastructure, capacity, and institutional processes as well as leverage working groups and expertise. Studies have found the CDM created a consistent and robust administrative system for emissions reductions accounting, and there is value in the infrastructure used to govern projects including the cycle of registration and verification.[33] The SDM is an opportunity for the international community to get it right this time round, and build a more credible, effective, and balanced international carbon market that delivers on the Paris Agreement. However, as it stands, this mechanism would be used to help countries reach their NDCs and it is unclear whether they would be successful in helping to reach a net zero world effectively, as all countries would eventually need to reduce their absolute emissions.

Conclusion

It is debatable whether Article 6.2 and Article 6.4 can reach the deep emissions cuts needed to reach net zero. The problem lies in the fact that both these mechanisms have been described as being voluntary. There is no denying these mechanisms can actually help countries reach their NDCs more effectively, and as we noted earlier, they can reduce the total cost of implementing nationally determined contributions (NDCs) by more than half (~$250 billion per year in 2030). However, as we also stated previously, the NDCs are currently not compatible with a 1.5°C or even a 2°C world. What we need is a mechanism that reduces overall emissions globally, which means all countries need to reduce their absolute emissions.

However, what these mechanisms can definitely achieve is raising revenue for emerging and developing economies, which is really needed. For example, the share of proceeds in Article 6.4, as stated above, could be used to assist developing countries, which are particularly vulnerable to adverse effects of climate change, to meet the costs of adaptation.

There are a number of issues that need to be resolved at COP26, such as share of proceeds under Article 6.2 and 6.4, or whether to include old CDM credits in Article 6.4. These aren't difficult to solve and if clear guidance and rules are given, could potentially help develop a global solution. But time is working against us, and there is an urgent need for more to be done.

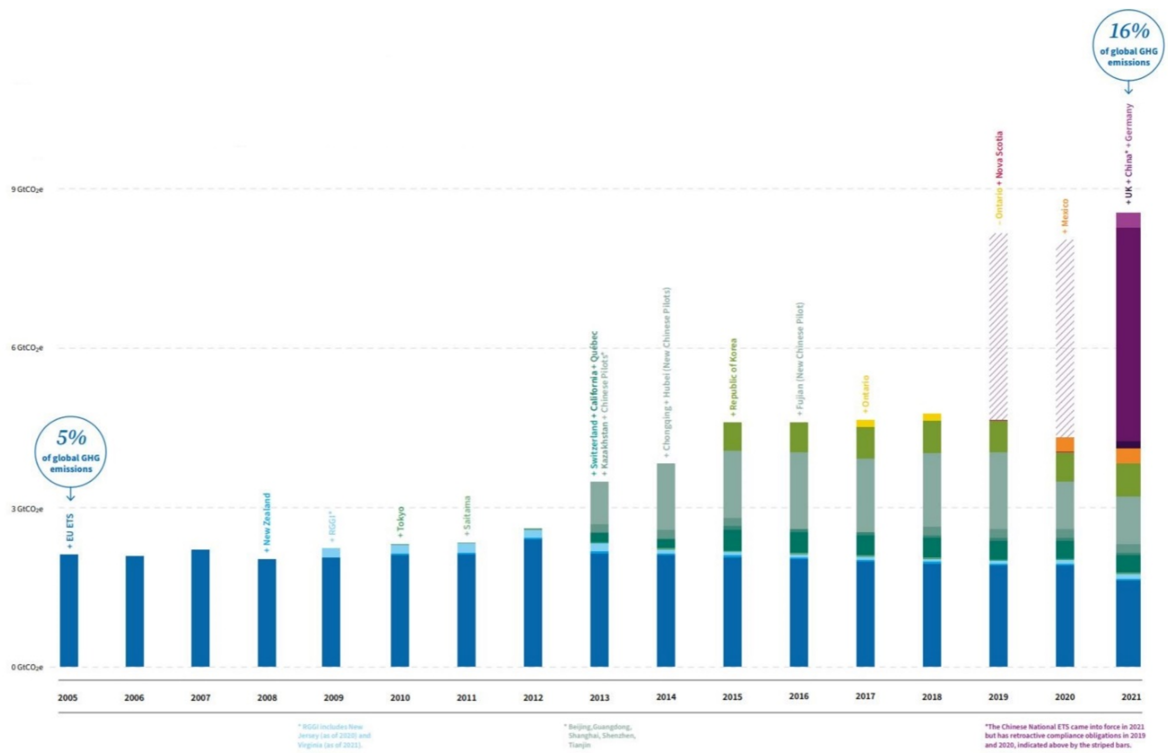
In the next section we analyze whether linking current systems such as ETSs could work in reducing emissions globally. This is not to say that Articles 6.2 and 6.4 should not be put in place — they absolutely should as there are a mountain of benefits that could be achieved from such mechanisms.

[33] Antonio Mele, Elena Paglialunga, and Giorgia Sforna, "Climate Cooperation from Kyoto to Paris: What Can Be Learnt from the CDM Experience?" *Socio-Economic Planning Sciences* 75 (2021); Carbon Market Watch, *Building Blocks for Robust Sustainable Development Mechanism*, May 04, 2017.

Section 2: Linking up Existing ETS Systems

Emissions trading schemes (ETSs) have expanded significantly since 2005. The volume of global emissions covered by ETSs has risen over time, starting with (1) the EU ETS in 2005, (2) major subsequent additions in emissions coverage from the Regional Greenhouse Gas Initiative (RGGI) in 2009, (3) California and Quebec ETS system in 2013, (4) South Korea in 2015, (5) Mexico in 2020, and (6) China in 2021. According to the World Bank there are currently 29 ETS systems on a national, sub-national, and regional basis.

Figure 21. ETS Coverage of Emissions, 2005-21



Source: ICAP

The major ETSs have emissions caps that decline over time, typically in line with jurisdiction-wide climate goals. Entities in economic sectors covered by the ETS need to surrender compliance instruments to cover their GHG emissions. Emissions allowances are the main compliance instrument available, supplied by the jurisdiction typically by regular auctions, although other compliance instruments may also be eligible, such as certain offsets, usually up to a low limit as a percentage of compliance obligations. Jurisdictions often provide free allocations of allowances to certain sectors like power and industrials, which help to protect against "carbon leakage," while still providing the marginal incentive to mitigate emissions.

Sector-wise, the major ETSs tend to cover the power and industrial sectors. The RGGI scheme is a notable, covering only power. Other exceptions include (1) California-Quebec, which covers transportation fuel suppliers; (2) the EU ETS, which covers aviation; (3) South Korea, which covers domestic aviation and the waste sector; and (4) New Zealand, which covers all sectors including uniquely forestry and agriculture. Several ETSs are considering adding further sector coverage (see the EU ETS discussion in the next chapter).

China is on track to establish the world's largest carbon market — a key building block in the country's 2030 peak emissions commitment. Over time, this should raise production costs in the world's biggest manufacturing hub, transforming carbon-intensive industries including aluminum and steel, where China dominates global supply, as well as influencing global consumption patterns. However, the initial set-up of China's national ETS has resulted in limited liquidity and low carbon prices. From the start of China's national ETS operations on July 16, prices have fallen 12% and daily trading volume has averaged less than 20,000 tonnes. Taking the closing price from October 2021 of RMB42/tCO_2 ($6.55/t), much lower than €62/tCO_2 ($72/t) in the EU ETS. Limited liquidity and low prices were a result of more than ample free allowances and fossil-fueled power generation being the only participating sector. The authority currently grants free allowances based on a set of loose carbon-intensity benchmarks rather than absolute emissions — without an auction — and an emissions cap to help boost liquidity. Beijing plans to include construction materials and non-ferrous metal sectors to the national ETS in 2022, followed by steel, petrochemical, and aviation in later years. Currently, only entities with actual emissions allowances are eligible to trade in the national ETS, with participation from institutional investors likely to be included at a later stage.

How Successful Have ETSs Been?

Jurisdictions with ETSs have seen emissions comfortably below emissions caps until recently. This is due in part to: (1) higher emissions caps in the early days of the schemes, where the focus was on building familiarity with such systems and to avoid an unsustainable economic burden on domestic industry; and (2) the exogenous impact on domestic industrial production, and therefore carbon emissions levels from the Great Financial Crisis in 2007, the Sovereign Debt Crisis in Europe in 2011 and the global pandemic in 2020. Further, the earliest emissions reductions were the result of decarbonization of the power sector, helped by complementary policies to retire coal-fired power plants and install renewable capacity. It also helped that natural gas prices became much cheaper in the 2010s as a result of the U.S. shale boom, displacing coal. These emissions targets have been comfortably met, and surplus markets led to low prices.

According to data from the UN Framework Convention on Climate Change (UNFCCC), total emissions from countries in the European Economic Area (EEA) dropped to 3.8 Gt in 2019, down 1.1 Gt from the 2005 when the EU ETS came into operation. In particular, emissions from the industrial sectors covered by the EU ETS, which represent roughly 40% of the total, dropped by 0.4 Gt to 1.3 Gt in 2019. Some of these emissions reductions were obtained due to cheap abatement options in the early years of the decarbonization policies and due to the impact of the Great Financial Crisis and the European Sovereign Debt Crisis on industrial activity. However, a 2020 study by the Proceedings of the National Academy of Sciences of the United States of America estimated the EU ETS reduced emissions by more than 1 Gt between 2008 and 2016 compared to a scenario without carbon pricing. Furthermore, EU ETS auction volumes raised an estimated cumulative €70 billion, which was partly used to finance Energy Transition projects.

As a result of earlier surplus markets and more ambitious climate goals, significant policy reforms were put through over the past few years to tighten up major ETSs through price or quantity stability mechanisms that tighten the market further when emissions targets are achieved early. Unsurprisingly, these reforms have finally led to robust appreciation in carbon allowance prices in the EU and California — towards the $60-$70/tonne and $25-$30/tonne range, respectively, and other schemes are likely to follow over time.

The price appreciation is also based on forward-looking fundamentals for these ETSs. The next phases of the more mature ETS programs come at a time when national goals are moving toward net zero by mid-century, meaning that ETS emissions targets for 2030 are much more stringent (with emissions reductions on the order of -55% in the EU and -40% in California), with expectations for 2030-50 to be even more stringent. Thus, ETS carbon allowance prices are moving higher to reflect the high marginal abatement costs expected to be needed to achieve deep decarbonization in these jurisdictions, notably technologies such as green and blue hydrogen, and carbon capture and storage (CCS) for cement, chemicals, steel, and other industrials, as well as for power.

Is it Possible to Link ETS Systems and How Could it be Done?

Bringing multiple jurisdictions under compatible systems, let alone across the globe, is a complex undertaking. There are many differences between systems, but key ones include: emissions targets and the pace of reduction of emissions caps; desired carbon price levels and rising paths over time; economic sectors covered (e.g., power, industry, transportation, agriculture); and market stability mechanisms to manage extremes of over/undersupply of allowances in ETSs.

In terms of broad approaches to harmonization, a jurisdiction could: (1) discard a current system and implement a new one in line with other jurisdictions; (2) create/reform a current system to be linkage-ready with other systems, and link them over time (for example, with California and Quebec, with Washington looking to join them, or the use of model rules in RGGI that can be enacted by member states at the jurisdiction level); (3) adopt border adjustments to harmonize price levels between imported and exported products based on some methodology to allocate emissions to these products; and/or (4) adopt a supranational backstop that would be in effect only if it is more stringent and/or has a higher price than the jurisdiction's system (such as Canada's federal backstop relative to the systems at the state/province/territory level). The third item pertains to the later discussion on carbon border adjustment mechanisms (CBAMs) which seek to address "carbon leakage" and maintaining a level playing field for domestic industries to remain competitive internationally.

The scope of each emissions trading system, the sectors covered, the different setups of the price mitigating mechanisms, and the judicial entities responsible for the emissions trading system are legislative hurdles that make it extremely challenging to link two, let alone all, currently established ETSs. Linking different ETSs continues to be limited to neighboring systems that have consolidated political and economic relationships (e.g., in Europe, where a provisional link was established between the EU and Swiss ETSs in September 2020) or among subnational jurisdictions in North America (i.e., where Virginia joined the RGGI in 2021 and Pennsylvania is considering joining).

An exception is California and Quebec, which successfully linked their systems despite being in separate countries and on different coasts of the North American continent. Chances of broader linkages are thin given different legislative frameworks, pricing provisions, which may distort the price signal in one system or the other, judicial control, and market liquidity. For instance, even the chances of a linkage between the EU ETS and the U.K. ETS are set to dim as the regulatory underpinnings of the carbon emissions trading systems start to diverge given different decarbonization targets reshaping each market and the different setup of the respective mitigating mechanisms — the Market Stability Reserves (MSR) for the EU ETS, and the Auction Reserve Price (ARP) and the Cost Containment Mechanism (CCM) for the U.K. ETS.

With sufficient political will, jurisdictions with ETSs could attempt to undertake the challenge and agree on and implement a shared core ETS in terms of covered economic sectors. Some jurisdictions could see this as an opportunity to expand beyond the sectors covered by their current ETSs. It could even be an opportunity for all major ETSs to effectively cover the whole economy, as New Zealand practically does. Alternatively, a smaller set of sectors could be chosen as a core global ETS, with other sectors separated out into their own jurisdiction-level ETS (such as Germany currently, which participates in the EU ETS, but has also started its own ETS covering heating and transportation fuels).

Meanwhile, a range of systems — with price floors/tiers/ceilings or allowance injection/withdrawal rules-based mechanisms based on price or quantity thresholds — would need to be harmonized. Particularly sensitive items would be the treatment of existing allowances held by compliance entities and investors; jurisdictions may want these to carry over in some way into a new system, so as to not penalize participants of existing systems, as well as maintain market stability and emissions reductions to date. Further, existing administrative systems would need to be harmonized too, which is also a major undertaking. Adding additional jurisdictions to existing ETSs is a more straightforward affair, and even without a single global ETS made by joining existing ETSs, this could well be a trend in any case in terms of regional ETSs slowing gaining members to form several blocs (refer to Section 4: Setting Up a Climate Club).

Conclusion

The number of emissions trading systems has increased over the years, the latest being in China, where such a system was set up just this year. However, it is not clear whether ETS systems have reduced global emissions as reductions are dependent on a number of issues including pricing, allowances, and the sectors covered. The greatest evidence at the moment of emissions cuts is the ETS system in the EU, which has been operating since 2005. Evidence shows it may have been successful in reducing emissions — in fact, it has been estimated that total net emissions from EEA countries dropped by 1.1 Gt to 3.8 Gt in 2019. However, carbon prices in the ETSs need to reach a level that will provide an incentive for change. We are only now seeing an increase in the price of the EU ETS system, which has reached €60-€70/tonnes and many believe could reach €100/tonne in 2030, if not earlier. However, prices in other ETS systems are still rather low — $6.55/tonne in China and $25-$30/tonne in California.

Linking current ETS systems into one global system can help harmonize the systems currently in operation, however it is challenging. Setting up a global ETS system or linking all existing ETS systems — if done well and if carbon prices are adequate — could help the world reach net zero. However, not all countries have an ETS in place, and therefore for such systems would need to be introduced in these countries to an effective global system. For example, the U.S. only has regional systems in place. If national systems aren't adopted, it could also be the case that regional ETS systems could form several blocs each using carbon border adjustment mechanisms to avoid carbon leakage in their territories, encouraging countries outside the system to reduce emissions or set up their own ETS system — this is similar to the climate club change scenario we explore in Section 4: Setting Up a Climate Club.

Section 3: Setting Up a Global Carbon Tax

In 2019, over 3,600 economists — including four former chairs of the Federal Reserve and 27 Nobel Laureate economists — issued the largest public statement of economists in history supporting carbon taxes as the most cost-effective way to reduce carbon emissions at scale and at the speed needed to avoid the impacts of climate change. They stated: "By correcting a well-known market failure, a carbon tax will send a powerful price signal that harnesses the invisible hand of the marketplace to steer economic actors towards a low-carbon future."[34]

Fundamentally, a carbon tax is a broad-based tax on the carbon content of fossil fuels, which essentially puts a price on carbon emissions to encourage consumers and businesses to produce less of it and to encourage less carbon-intensive alternative solutions. However, implementing a global carbon tax is difficult, as it requires an agreement by all nations.

Because the stock of CO_2 accumulates over time, there are many who believe developed markets should bear the responsibility for climate change given they are responsible for emitting the majority of greenhouse gas emissions in the atmosphere over time. Emerging and developing economies argue they should be given time to develop, and that a global carbon tax would disproportionately penalize them.

However, we have reached a point where all countries need to reduce their emissions if we want to avoid the dangerous impacts of climate change. A global carbon tax can help us do this more effectively.

In order to understand how a global carbon tax would work we run two different scenarios for the ten largest emitters plus the U.K. as shown below.

- **Scenario 1** assumes a tax rate of $100 starts in 2030 and is equal across developed and developing countries. It increases over time as described in more detail below.

- **Scenario 2** assumes the tax rate starts in 2030, with developed nations taxed at $100 per tonne of CO_2e and emerging and developing countries initially at $50 per tonne of CO_2e, but rising over to the same level as developed markets. The problem with a different tax rate is that developed markets could feel they were placed at a competitive disadvantage until the emerging markets tax rate reaches parity. This could potentially lead to carbon leakage, where businesses in developed markets move to emerging markets to avoid the higher tax rate. To avoid this, the time period where tax rates are different should be the shortest possible to avoid developed markets setting up carbon border adjustment mechanisms to protect their market.

We base our analysis on all greenhouse gas (GHG) emissions, rather than just on CO_2 emissions, as many individual country national determined contributions (NDCs), are primarily focused on the reduction of all greenhouse gas emissions and not just CO_2. We also recognize that to reach a net zero world, we need to reduce all GHG emissions. However, taxing all GHGs instead of just energy-related emissions is more challenging as their source is not limited to fossil fuel use and some of these gases are difficult to measure.

[34] "Economists' Statement on Carbon Dividends," *The Wall Street Journal*, January 16, 2019.

A carbon tax would be placed at a country level with each individual country deciding the best way to implement such a tax domestically. Options include setting up regulatory requirements for each sector, mandates for the use of certain fuels, creating ETS systems, improvements in fuel efficiency for road transport, and just adding a simple carbon tax. Each government would decide the best way for such a tax to be introduced in their economy and could involve a combination of the options noted above. International shipping and international aviation are not included in a country's NDC, so these sectors would also be linked to these carbon prices; however, they will be managed by the International Maritime Organization (IMO) and International Civil Aviation Organization (ICAO), which currently regulate these sectors. Appendix 2 provides for a more detailed analysis of why we chose a $100 initial tax rate in 2030.

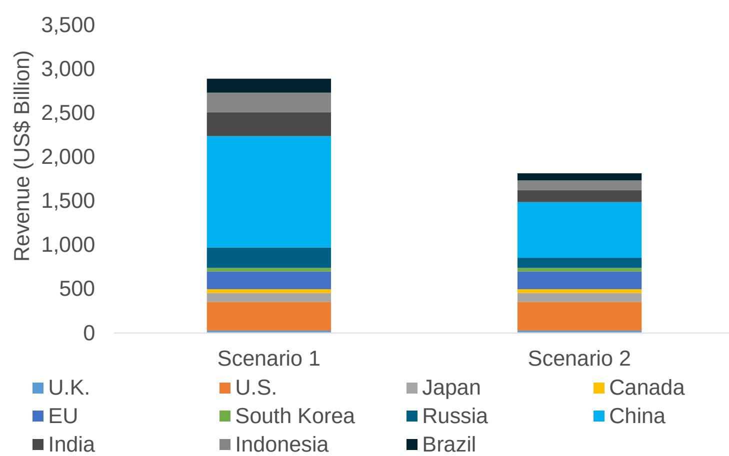
In this section we discuss:

1. How revenue is generated from such a carbon tax in all the countries we analyze.
2. How these revenues could be distributed across emerging and developed markets and what these revenues should be used for.
3. The potential impact carbon prices could have on greenhouse gas emissions reduction and how these prices could impact the global economy.

Revenue Generated from a Carbon Tax

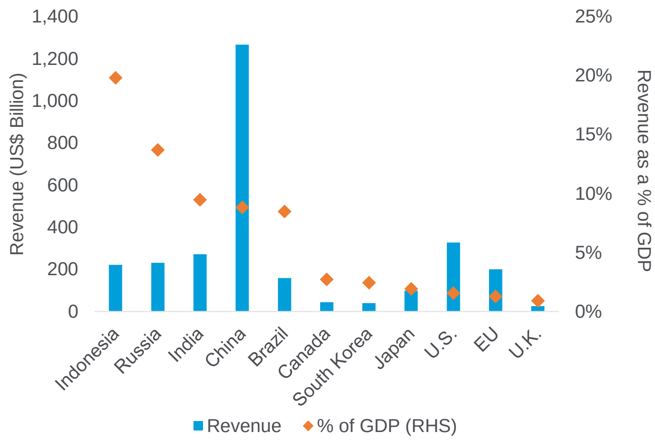
Using the carbon tax rate and future greenhouse gas emissions (refer to Appendix 2 for more detail), we calculate the revenue generated from using a global carbon tax across our two scenarios for the countries we studied. Our results show that a tax on all GHG emissions would generate total revenue (in today's real prices) of $2.9 trillion and $1.8 trillion in 2030 for Scenario 1 and 2, respectively. In Scenario 1, the revenue generated from a carbon tax as a percent of GDP (in 2019) is much higher for emerging markets than for developed markets, reaching nearly 14% for Russia, approximately 9% for China, India and Brazil, and a staggering 20% for Indonesia. This decreases in Scenario 2 as shown in Figure 22, given that the tax is reduced from $100 to $50 for emerging markets in 2030.

Figure 22. Revenue Generated from Tax on All Greenhouse Gas Emissions in 2030



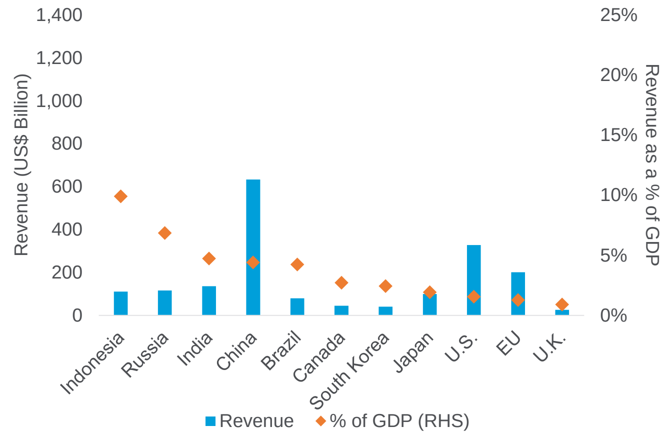
Source: Citi Global Insights

Figure 23. Revenue Generated for Each Country and Revenue as a Percent of GDP for Scenario 1



Source: Citi Global Insights

Figure 24. Revenue Generated for Each Country and Revenue as a Percent of GDP for Scenario 2



Source: Citi Global Insights

The revenue raised under both scenarios could significantly help reach net zero targets more effectively. In the report *Net Zero by 2050, A Road Map for the Global Energy Sector*, the International Energy Agency (IEA) claims that total annual energy investment would need to surge to $5 trillion in 2030 if we want to have any chance of reaching net zero. This is more than triple what we spend today. This number is not a surprise, given to reach net zero we need to change our transport modes as well as the way we produce and use energy, manufacture our goods, and produce our food. We also need investment in new alternative fuels. Raising $2.9 trillion from a carbon tax can help raise a proportion of the investment needed. However, as we discuss in the next section, some of this revenue also needs to be recycled back to communities to cushion the impact that such a tax could have on their income.

Revenue Distribution from a Carbon Tax

There are two aspects that need to be considered when dealing with revenue distribution from a global carbon tax. The first one relates to revenue distribution amongst the countries themselves and the second is what a country should do with this revenue.

Tackling the first issue — how revenue from a global carbon tax should be distributed amongst the countries themselves — we believe there are two options available:

1. **Distribute the revenue raised from each country back to the country where the money is raised.** The problem here is that emerging economies would initially have a huge hit from such a tax, e.g., Indonesia where revenue from the tax is estimated at 20% of GDP for Scenario 1. Although we see the tax as an essential tool for governments to raise revenue to reinvest in a green economy and to avoid having a stranded economy based on fossil fuel assets, additional support would be required. Many emerging markets do not have other adequate means to finance their decarbonization efforts and to build necessary infrastructure, since there are binding limits to their fiscal capacity. Developed markets would need to provide some additional funds to emerging economies in some other way.

As part of the Paris Agreement, developed countries agreed to scale up their support and mobilize $100 billion per year for climate action, both for mitigation and adaptation projects. Under this scenario, these funds should continue. It could also be the case that different developed countries allocate part of their revenue of the tax to do this if they want to.

2. **Distribute the revenue based on some fairness parameter that takes into account that the majority of stock of CO_2 in the atmosphere has been put there by developed countries.** This could be based on income level and population, share of global cumulative emissions etc. The problem with this scenario is it is a hard sell for politicians in developed countries to tell their citizens that the taxes they are paying or part of the taxes they are paying will be sent to emerging and developing economies.

Next, what should countries do with the revenue generated from these taxes? According to Beiser-McGrath and Bernauer (2019), the main reason for the gap between existing carbon prices and those that are actually needed for a deep cut in emissions is political feasibility.[35] Most politicians are aware that citizens appear to have very little appetite for tax increases. An example of this is the movement called “Gilet Jaunes” where ordinary people got together and protested against the proposed fuel tax increase in France. They argued that this tax would have had a profound impact on their livelihoods.

Even though a carbon tax would allow countries to raise revenues for green projects and for infrastructure investment, we argue that some of this revenue should actually return to citizens or at least to low income households in something called revenue recycling. Carbon prices would have an impact on real incomes via higher consumer prices, and since energy tends to comprise a large proportion expenditures for lower income families, these taxes could have a huge impact on low income households.[36] Carattini, Carvalho, and Fankhauser (2017) state that providing low income households with a higher amount of tax revenue through, for example, a generous income tax rebate or though lump sum transfers, would be the best way to support low income households that are negatively affected by a carbon tax.[37] They refer to this as “social cushioning.”

Low income households are not the only group that could be negatively affected. In some cases there could also be a profound impact on businesses, especially those that have prices controlled by the government and are unable to raise them as they see fit, e.g., taxi drivers or even some utility sectors. A recent example can be seen in the U.K. where small utility firms are facing a crisis due to an increase in natural gas prices. Because they operate in a regulated industry, they cannot pass on cost increase from natural gas prices to consumers as they can only raise prices in accordance with what is allowed by the regulator. This is important as it protects households from immediate price hikes.

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[35] Liam F. Beiser-McGrath and Thomas Bernauer, “Could Revenue Recycling Make Effective Carbon Taxation Politically Feasible?” Science Advances 5, no. 9 (September 2019).

[36] Alex Bowen, *Carbon Pricing: How Best to Use the Revenue?* Grantham Research Institute on Climate Change and the Environment and Global Green Growth Institute, 2015.

[37] Stefano Carattini, Maria Carvalho, and Sam Fankhauser, *How to Make Carbon Taxes More Acceptable*, Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science, December 2017.

A carbon tax could have a similar impact on these companies. However if plenty of time is given before a tax is introduced, companies would have time to prepare and to invest in low carbon technology. Governments could also earmark some of this revenue to subsidize low carbon solutions, such as electric taxis, to help cushion some of the burden.

Carbon taxes with some sort of revenue recycling might also be more acceptable to citizens and therefore to politicians. A study by Jagers and Hammar (2009) showed that Swedish citizens were more likely to accept a carbon tax on passenger car fuel if it was combined with an income tax cut.[38] Part of the revenue from carbon taxes could be returned in one form or another to citizens and businesses that are disproportionately hit by the tax; however, specific mechanisms to do this should be made transparent.

Revenue could also be spent on projects that benefit society, including green projects, parks, and education, and could be welcomed by citizens, especially when governments earmark specific funds for such projects. Alternatively, revenue could be spent on infrastructure and new technologies needed to support a deep reduction in emissions, along with investing in green jobs and re-training citizens for these new jobs.

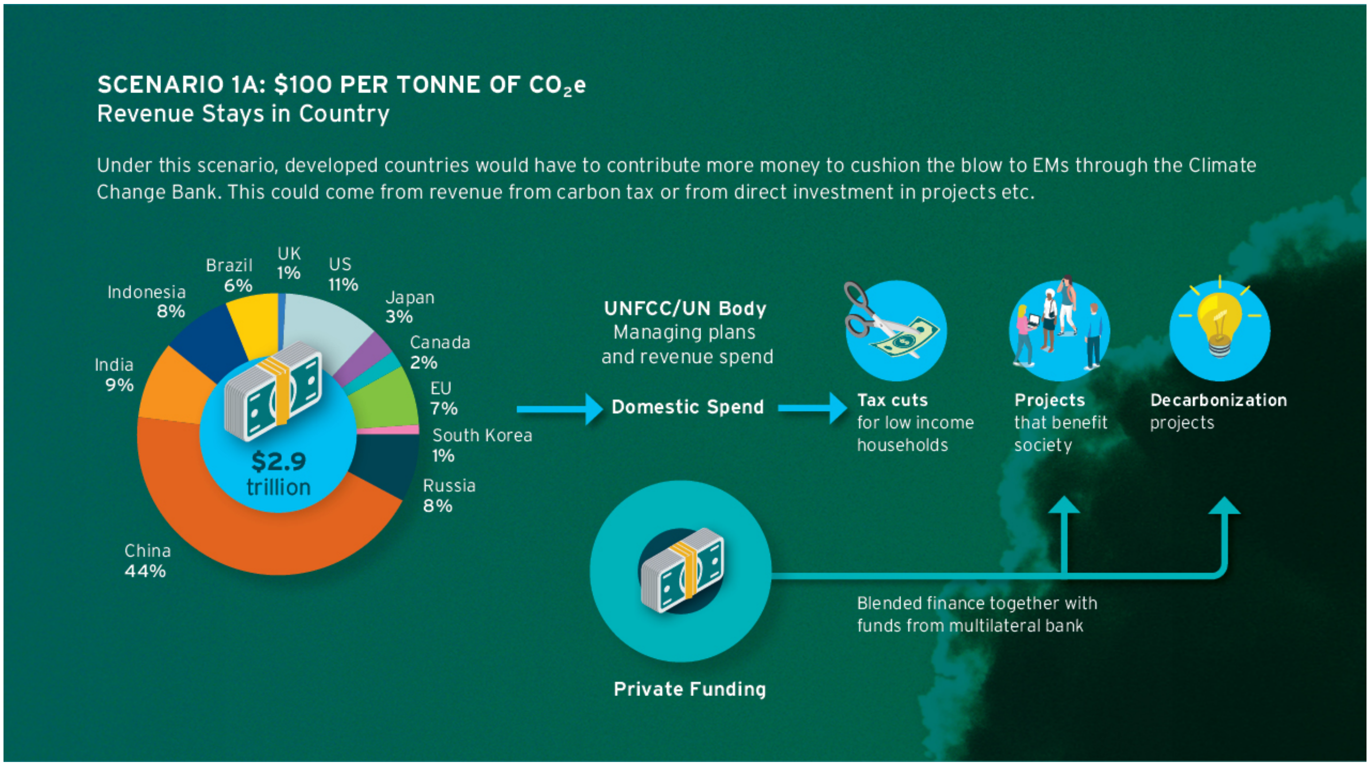
There is also an argument that revenue should be used to reduce public debt relative to GDP. Public debt in many developed countries rose sharply after the financial crisis and has risen even more as a result of COVID-19 spending. Although governments may welcome the revenue generated from the taxation of greenhouse gas emissions, there needs to be a strategy to ensure the revenue from these taxes is not allocated or perceived to be allocated to the government's coffers even though a reduction in public debt would benefit society. The way this revenue is split would depend on the country in question as each country has different needs. But for all countries, proposals on how these funds would be used should be made so there is transparency on how the revenue is used.

Comparison of Revenue Flows

Error! Reference source not found. shows the expected revenue distribution based on our scenarios. Scenario 1 and 2 have been split further to show how revenue could either be distributed in the country where the money is generated or via some fairness mechanism as described above. Scenario 1a and 2a requires additional financial flows directed to emerging and developing economies to cushion the initial blow a carbon tax could have on an emerging markets economy. Private funding would also be important here, and can be sought either directly for investment in projects, or through some blended finance mechanism either with government funds or through a multilateral bank. Blended finance is a structural approach that allows organizations with different objectives to invest alongside each other while achieving their own objectives, e.g., financial return, social or a combination or both.[39] Blended finance can address many of the investment barriers faced by private investors, including high perceived or real risk and poor returns for the risk relative to comparable investments. This mechanism is particularly useful for developing and emerging markets where the perceived or real risk is considered to be high.

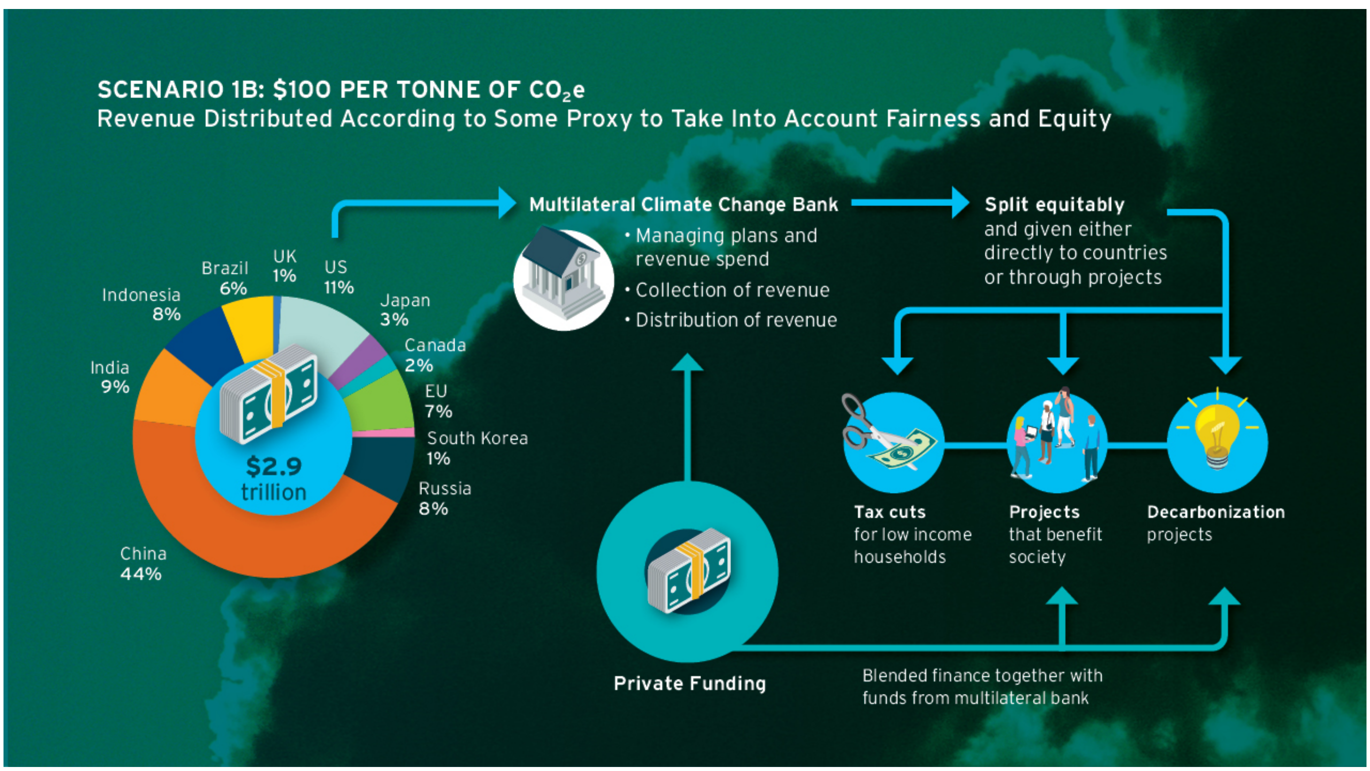
[38] Sverker C. Jagers and Henrik Hammar, "Environmental Taxation for Good and for Bad: The Efficiency and Legitimacy of Sweden's Carbon Tax," *Environmental Politics* 18, no. 2 (2009): 218-237.
[39] Convergence finance.

Figure 25. Market-Based Carbon Mechanism: Scenario 1A



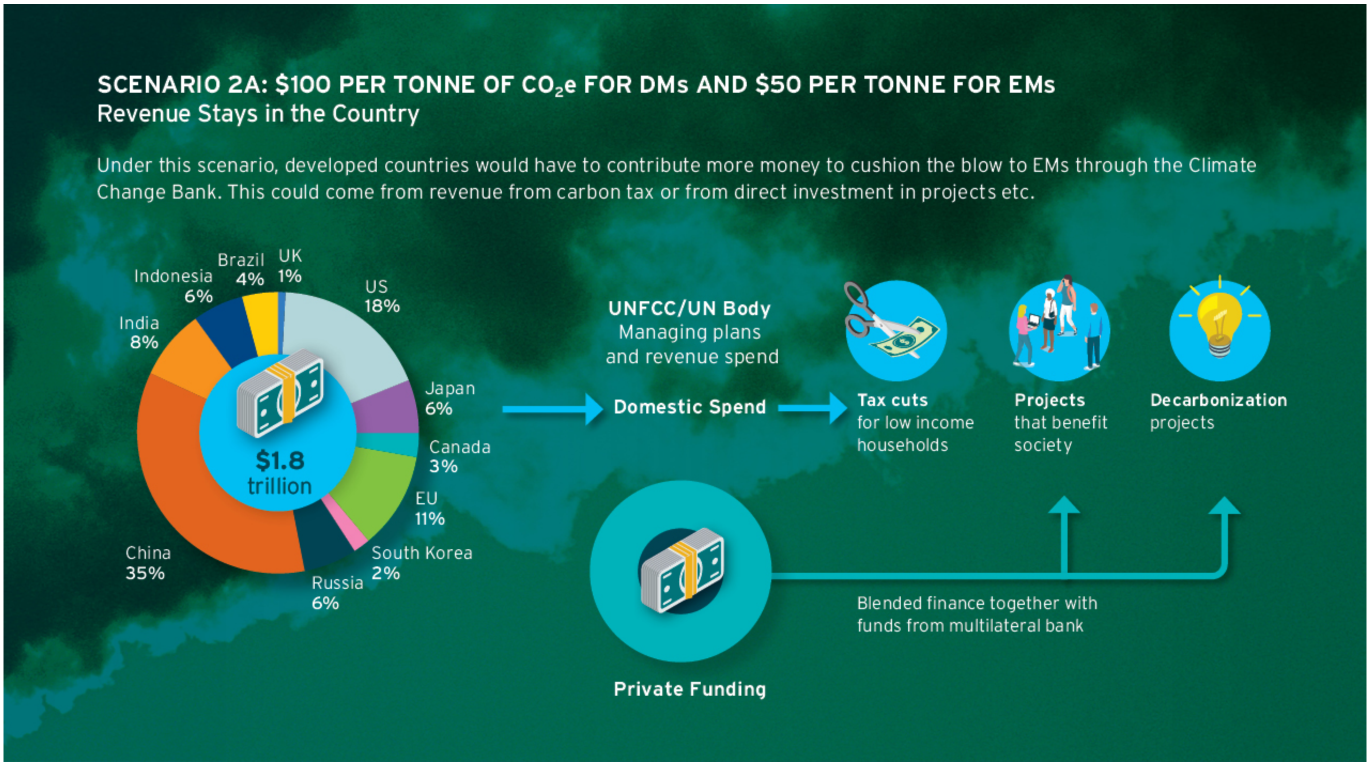
Source: Citi Global Insights

Figure 26. Market-Based Carbon Mechanism: Scenario 1B



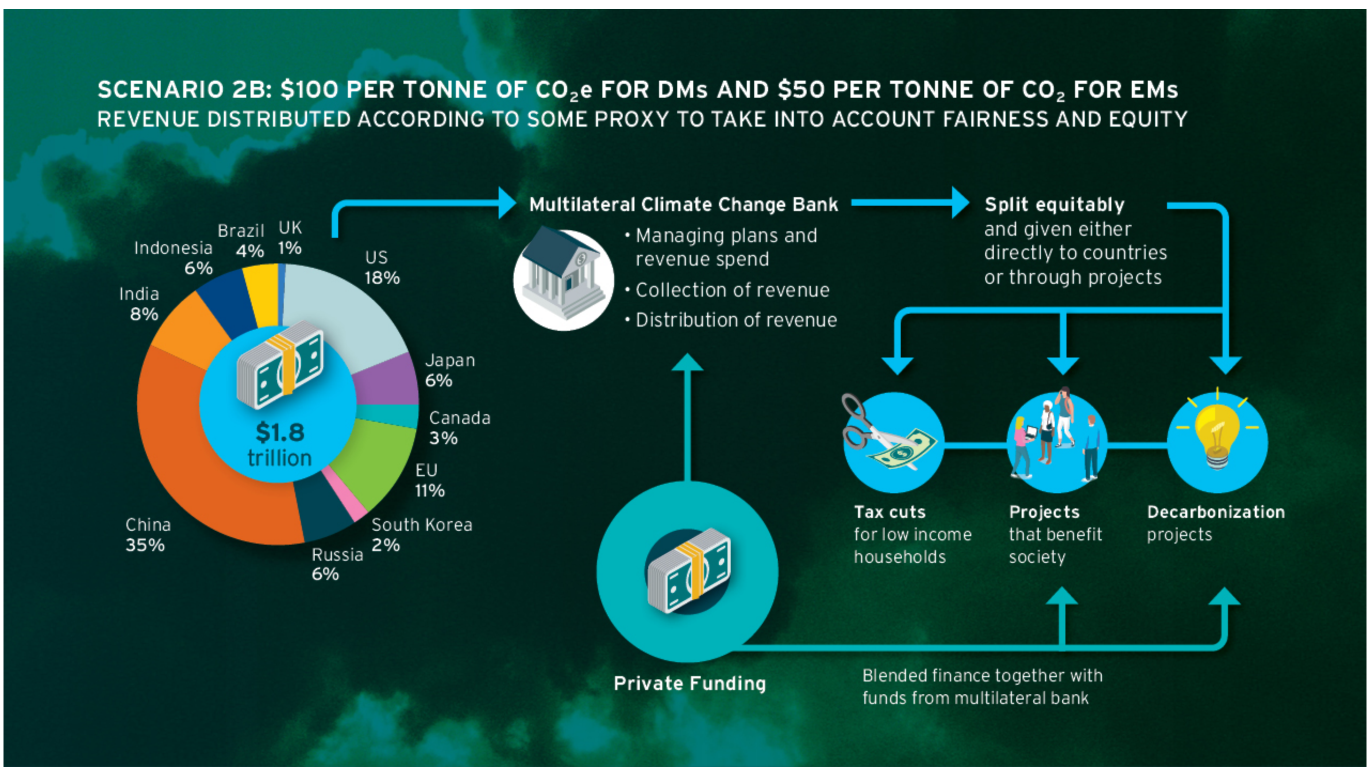
Source: Citi Global Insights

Figure 27. Market-Based Carbon Mechanism: Scenario 2A



Source: Citi Global Insights

Figure 28. Market-Based Carbon Mechanism: Scenario 2B



Source: Citi Global Insights

What Impact Would a Carbon Tax Have on Greenhouse Gas Emissions?

The above scenario analysis shows how much revenue can be generated from a global carbon tax, but will the tax have an impact on greenhouse gas emissions? Carbon taxes should be priced high enough to encourage people to switch to cheaper and greener products and services, and they should also encourage many sectors to invest in alternative green solutions. Many published estimates for the emissions reductions achieved by current carbon taxes and emissions trading systems calculate the reduction from a business-as-usual scenario with no carbon taxes. The scenarios used in these models are only estimates as to what would have happened without a tax. For example, Murray and Rivers (2015) conclude that a carbon tax in British Columbia reduced emissions of between 5% and 15% below a reference level (without a carbon tax).[40] However, direct carbon taxes that have been implemented around the world are priced rather low (with the exception of Sweden) and therefore it is difficult to find a long-term analysis of how carbon prices at a rate of say $100 would decrease emissions year-over-year.

Others have modeled the impact of a carbon tax based on technological changes, energy prices, consumer behavior, and how they believe consumer behavior will change. However, there is a level of uncertainty in many of these models, especially when calculating a long-term analysis.

The year-over-year reduction of emissions from the introduction of a tax depends on a number of factors including: (1) how such a tax is introduced in the countries (e.g., whether it is a simple carbon tax, an ETS system, tax on fuels, etc.); (2) the rate of technological change; (3) changes in energy mix; (4) price elasticity of products; and (5) the rate of change of consumer demand for carbon intensive products, etc.

The effect of carbon taxes on emission reductions will differ between countries and regions, depending on the make-up of the economy (such as the prominence of carbon intensive sectors), the availability of alternative technologies, and labor costs. Looking at particular sectors, power generation seems to be one of the easiest sectors to decarbonize as renewables are readily available and in some countries are actually cheaper than fossil fuels. However, renewables still have a problem with intermittency and therefore investment continues to be needed in energy storage, which will increase its cost, as well as carbon capture, utilization, and storage (CCUS). Once power generation is decarbonized, green electricity can help reduce emissions in a number of different sectors.

Other sectors, such as steel and cement, are more difficult to decarbonize. In the Citi GPS report *Hard to Abate Sectors and Emissions*, we calculated the CO_2 abatement costs for a number of different alternative fuels as shown in Figure 29. These range from $60 per tonne of CO_2 for a steel plant to $100 per tonne of CO_2 for a cement plant. Sectors such as aviation and shipping might need a higher carbon price to encourage change. If carbon tax rates increase over time and reach higher levels, this would encourage other sectors to reduce their emissions in the future. Many of these sectors will start investing in new alternative options once it is economical feasible to do so and when there is a competitive playing field within the sector. A global tax on emissions can create some sort of certainty while at the same time create a competitive playing field across the board, especially if a tax is equitable between emerging and developed economies.

[40] Brian C. Murray and Nicholas Rivers, "British Columbia's Revenue=-Neutral carbon Tax: Review of the Latest 'Grand Experiment' in Environmental Policy," Energy Policy (2015).

Figure 29. Decarbonization Solutions for Transport and Industrials

Transport

Sector	Solutions	Measures	Carbon Abatement ($ per t/CO_2)
Aviation	Demand side solutions	• Aircraft technology improvements. • Operational improvements	
	Supply side solutions	• Sustainable Aviation Fuel-Hydroprocessed Esters & Fatty Acids (SAF-HEFA)	258 – 430
Shipping	Demand side solutions	• Improving fleet management and optimizing voyage plans • Improving energy efficiency by improving shipping design and hull & propulsion efficiency	
	Supply side solutions	• Ammonia (green & blue)	150 – 350
Road Freight	Demand side solutions	• Improving aerodynamics and engine efficiency, reducing rolling resistance through better tyre design • Improving fleet management and operations, as well as potential mode shifts to shipping or rail if suitable	
	Supply side solutions	• Biofuels • Fuel cells • Electric Trucks	

Industry

Sector	Solutions	Measures	Carbon Abatement ($ per t/CO_2)
Cement	Demand side solutions	• Designing buildings more efficiently, reusing concrete, substituting concrete with timber • Energy efficiency improvements	
	Supply side solutions	• Hydrogen • Bioenergy • CCUS	55 – 156
Steel	Demand side solutions	• Recycling, circularity of materials • Energy efficiency	
	Supply side solutions	• Hydrogen • CCUS • Bioenergy (charcoal)	60 – 120 18 – 100

Note: Numbers are on million tons of CO_2e.
Source: Citi Global Insights

While it is difficult to calculate with any certainty how a carbon tax would affect greenhouse gas emissions over time, if done well it should help achieve net zero targets in many countries. The uncertainty surrounding the achievement of emissions targets is one of the theoretical weaknesses of a carbon tax, however there may be rule-based mechanisms which will allow periodic upward adjustments. But doing this on a global scale would be challenging.

Potential Impacts on the Economy

Enacting carbon taxes would likely have macroeconomic consequences and a key question is whether a global carbon tax will impact economic growth. To estimate the impact, Citi Economics utilized a global macroeconomic model.[41]

The model assumed a carbon tax of $27 per tonne with the proceeds used to lower income taxes, thereby preserving consumers' purchasing power and addressing the regressivity of the carbon tax. The model simulations indicated that global growth would not suffer under this scenario. In the near-term, global growth under the carbon tax is actually slightly stronger — by 0.1 percentage points — than under the baseline scenario. At 0.3 percentage points, the positive growth effect would be stronger in Asia, particularly in China, where consumers benefit more from lower income taxes. There would be a small negative effect on U.S. growth of about 0.1 percentage points due to high economic sensitivity to carbon taxation.

Our $27 per ton carbon tax assumption was modeled off of what was initially introduced in Sweden as an example of implementing a carbon tax without sacrificing growth. As it is evident from the discussion in other parts of the paper, a much higher carbon tax — in the region of $100 per tonne of CO_2 — would be required to meet climate goals. While our analysis did not cover this scenario, given the mechanisms in the model, we conjecture that even a carbon tax at that level could have a neutral or even beneficial impact on global growth, if it were structured in the same way, i.e., if its proceeds were used to reduce income taxes. Of course, there likely would be heterogeneous effects on different economies, depending on their level of carbon emissions and income taxes, as well as the size of the economy.

Even though the revenues from the carbon tax are not used to close fiscal deficits or reduce debt, the policy would likely reduce debt-to-GDP ratios globally, since the policy is revenue-neutral but does raise growth. The policy would likely reduce the debt-to-GDP ratio in the U.S. as well, despite the slight negative impact on growth, mainly due to an energy-driven increase in inflation.

Empirical studies, although scarce due to limited use of carbon taxes over longer periods of time, seem to paint a similar picture. Metcalf (2019) analyzes the data on the carbon tax in the Canadian province of British Columbia.[42] The regressions suggest that carbon taxation in British Columbia (where the revenues are returned to businesses and households using tax rate reductions, grants, and tax breaks) is associated with stronger output growth. While estimates are imprecise, the author concludes that at the very least, enacting a carbon tax in British Columbia did not have an adverse effect on GDP.

[41] See Citi Research, "Greener Future Post-COVID-19? Green Policies & Global Stimulus," September 04, 2020.
[42] Gilbert E. Metcalf, "On the Economics of a Carbon Tax for the United States," *Brookings Papers on Economic Activity* (Spring 2019): 405-484.

As discussed earlier in the chapter, the revenues from a carbon tax could be spent in ways other than reducing income taxes, such as for green investment or reducing debt. Given that fiscal multipliers are generally higher for investment than for tax changes, if carbon tax proceeds were at least partially used for financing green investment, the impact on growth would likely be positive in itself. However, this approach could have other consequences such as an increase in inequality due to the regressive nature of carbon taxation. For example, the U.S. Congressional Budget Office (CBO) estimates that in the U.S., "the burden [of a carbon tax] on households in the lowest income quintile […] would be roughly twice as large as that imposed on households in the highest income quintile."[43] If tax proceeds were to be used to reduce countries' debt burdens, this would likely have a negative effect on growth due to a low fiscal multiplier.

A global carbon tax would also affect labor markets. As the composition of the economy changes with the adoption of less-polluting technologies, many workers will shift jobs and industries to fulfill labor demand from emerging green industries. The transition to net zero is likely to result in a net gain of jobs.[44] Empirical evidence tends to support these conclusions. Yamazaki (2017) studies the carbon tax in British Columbia and finds that it generated a small but statistically significant net increase in employment, with a fall in employment in the most carbon-intensive industries and an increase in clean service industries.[45] Martin, de Preux, and Wagner (2014) find that a carbon tax in the U.K. was associated with a small increase in employment, though this was not statistically significant.[46]

Enacting a global carbon tax would tend to be inflationary. However, there are several nuances involved in this assessment. First, the most notable impact would be seen when the tax is first enacted. This would translate into a one-off increase in prices and would not be inflationary in the medium term. The impact on inflation would then depend on the pace at which the tax were to increase each year. It also has to be noted that a carbon tax would have a much stronger price impact on some goods and services than others — in particular the ones with a higher carbon intensity of production such as electricity and gas prices or airfares. While this would, naturally, show up in inflation measures and would mean that the price of the overall consumption basket would be rising faster, it would also change the relative prices of goods and services in the economy by making the ones with a higher carbon intensity of production relatively more expensive. But this is exactly the point — the higher relative price of carbon-intensive goods and services would make them less attractive to consumers who would shift demand away, incentivizing producers to reduce the carbon intensity of production.

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[43] U.S. Congressional Budget Office, *Distributional Effects of Reducing Carbon Dioxide Emissions with a Carbon Tax: Working Paper 2021-11*, September 13, 2021.
[44] Citi GPS, *Technology at Work v6.0: The Coming of the Post-Production Society*, June 2021.
[45] Akio Yamazaki, "Jobs and Climate Policy Evidence from British Columbia's *Revenue-Neutral* Carbon Tax," *Journal of Environmental Economics and Management* 83 (May 2017): 197-216.
[46] Ralf Martin, Laure B. de Preaux, and Ulrich J. Wagner, "The Impact of a Carbon Tax on Manufacturing: Evidence from Microdata," *Journal of Public Economics* 117 (2014):1-24.

Conclusion

A global tax, if done well, could have a huge impact on the reduction of global emissions. It can: (1) provide incentives for companies and countries to reduce their emissions; (2) provide a clear strategy for companies to invest in new technologies; and (3) generate large amounts revenue that can be used for different purposes, including investing in new green solutions, investing in a new green economy or even returning some of the tax back to low income households to cushion their increase in costs due to the carbon tax (revenue recycling). It can also create a competitive playing field across all sectors and is easier to administer when compared to other market-based systems such as ETS systems.

However, a global carbon tax is very difficult to achieve politically and could have a large initial impact on some emerging economies. Issues such as pricing, revenue distribution, revenue spend, monitoring, and transparency are difficult to agree on amongst all nations. This is why many claim that a global carbon tax would be extremely difficult to achieve. It would take an enormous effort by country leaders to agree on this in the short time we have left to ensure we limit temperature increase to 1.5°C. However, if the aim is to reduce global greenhouse gas emissions, then it should be something to consider.

Section 4: Setting Up a Climate Club

The term “climate club” was first set out by William Nordhaus in his paper called “Climate Clubs: Overcoming Free-Riding in International Climate Policy.” Nordhaus argues that a voluntary club could be set up between some nations. He defines a club as a voluntary group that derives mutual benefits from sharing the costs of producing a shared good or service. The gains of such a club are so great, that members pay their dues and adhere to the club rules to get the benefits of membership. Non-members would be excluded from the club and penalized at a relatively low cost to members.

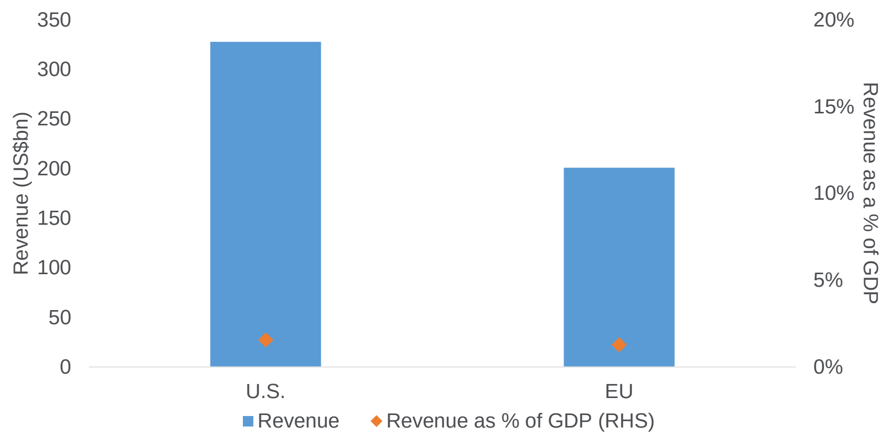
To understand how a climate club would work we have developed a scenario where such a club was set up between the U.S. and the EU. Both have set a net zero target to be reached in 2050. The U.S. and the EU have also just announced a commitment to reduce methane emissions by 30% over the next decade and are currently lobbying other large emitters to join the effort. So it is not inconceivable that they will take one step further and form a climate club.[47]

To form the club, the two nations would need to agree on an equal carbon tax and the benefits of the membership could include shared technological innovations, a competitive level playing field amongst different sectors, and preferential trade agreement. Non-participating countries could either be taxed on the carbon content of their imports or a uniform tariff on all imports could be imposed. In our scenario, we assume the former — that a carbon-based adjustment mechanism (CBAM) will be used and it will be based on the carbon emissions of imports for non-participating countries similar to the one that the European Union is planning to impose in their region. A border adjustment tax shifts the base of carbon tax from carbon-intensive products produced in the U.S. and the EU to all products consumed in these regions. This will eliminate any competitive pressures that may encourage a company to shift its production overseas. This tax would be equal to the carbon tax established in these two regions or the difference between the carbon tax in the member countries and non-member countries. It could also be the case that a carbon credit is also given to any goods produced in these regions subject to the carbon tax but exported to countries outside the climate club; however, we do not calculate this. A more detailed analysis of CBAMs is found in Appendix 3.

Revenue from the climate club would be generated from two different mechanisms (1) a domestic tax on greenhouse gas emissions set at the initial price of $100 per tonne of CO_2e in 2030 and (2) a carbon border adjustment tax on carbon-intensive imports on countries that are not members of the club. The revenue generated from a domestic tax would be the same as that shown in Scenario 1 at $100 per tonne of CO_2.

[47] Derek Brower and Mehreen Kahn, “U.S. and EU Plan Agreement to Curb Methane Pollution,” *Financial Times*, September 15, 2021.

Figure 30. Revenue Generated in the U.S. and EU from a Domestic Tax on Greenhouse Gas Emissions in 2030 (Not Including CBAM Revenue)



Source: Citi Global Insights

Revenue Generated from a CBAM

To calculate the revenue generated from a CBAM, we need to look at a range of imports and the carbon intensity of these imports. To do this we use trade-weighted emissions for the U.S. and the EU. Unfortunately, complete datasets for a number of countries are only available for 2015, and only available for embodied CO_2 and not embodied GHG emissions. However, just by looking at the current data we can get a sense of where the imported emissions to the EU and U.S. come from, what sort of revenue might be generated from these taxes, and which countries might likely benefit from joining this club. For more information on trade-weighted emissions and data referring to the U.S. and the EU, refer to Appendix 4.

We look at two scenarios for revenue generated from CBAMs:

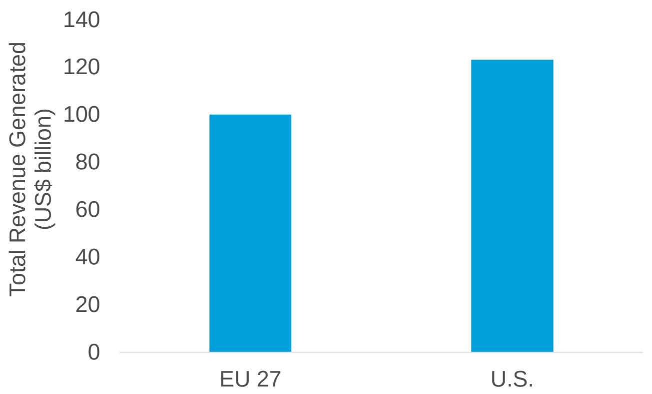
1. Revenue generated assuming that all imported CO_2 emissions are taxed at $100 per tonne of CO_2, as shown in Figure 31, and

2. Revenue generated from a CBAM if only two sectors are included — chemicals & non-metallic mineral products and basic metals & fabricated metals, as shown in Figure 32.

The reason for the second scenario is that CBAMs are notoriously difficult to administer given that emission intensity data needs to be collected from all imports. Focusing on a few sectors at first could be less of an administrative burden. The EU is proposing doing something similar as it is only focusing its CBAM on five sectors — fertilizers, chemicals, aluminum, iron & steel, and electricity.

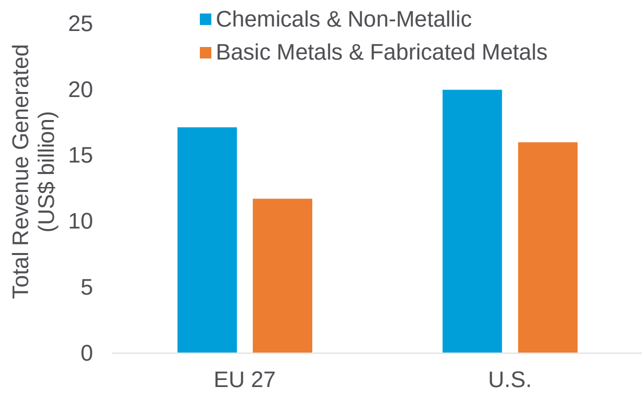
If all imports are included, our analysis shows the total revenue generated from a CBAM could be as much as $100 billion in the EU and over $120 billion in the U.S. If we look at sector-specific data, the revenue generated from just imports of chemicals and non-metallic mineral products could reach $17 billion and $19 billion in the EU and U.S., respectively; and $11 billion and $16 billion for basic metal and fabricated metals in the EU and U.S., respectively, in 2030 alone.

Figure 31. Total Revenue Generated in the U.S. and EU from a CBAM for All Imports



Source: Citi Global Insights

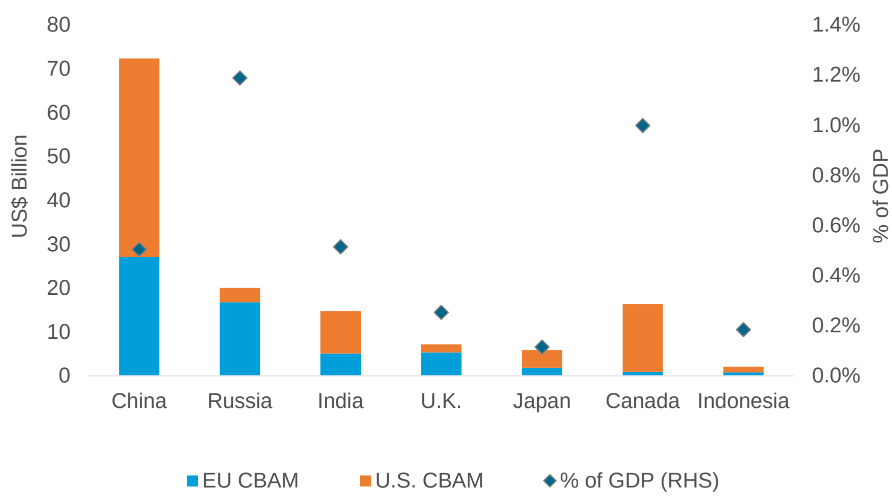
Figure 32. Revenue Generated in the US and EU if a CBAM Was Initially Set on Two Sectors — Chemicals and Non-Metallic Mineral Products and Basic Metals and Fabricated Metals



Source: Citi Global Insights

Figure 33 below shows the countries in our analysis that would be exposed to a carbon border adjustment tax and the tax that would need to be paid by these countries on their imports to the EU and the U.S. The most tax would be paid by China — estimated at $70 billion in 2030 for all its imports ($45 billion to the U.S. and over $25 billion to the EU). This is approximately 0.5% of China's GDP in 2019. The other countries are estimated to pay less; however, for Russia and Canada the amount of tax estimated from a CBAM in the U.S. and EU is more than 1% of GDP in 2019. Russia is really impacted by an EU CBAM while Canada is affected by a U.S. CBAM.

Figure 33. Carbon Border Adjustment Taxes Paid by a Number of Countries in the EU and U.S. for All Imports



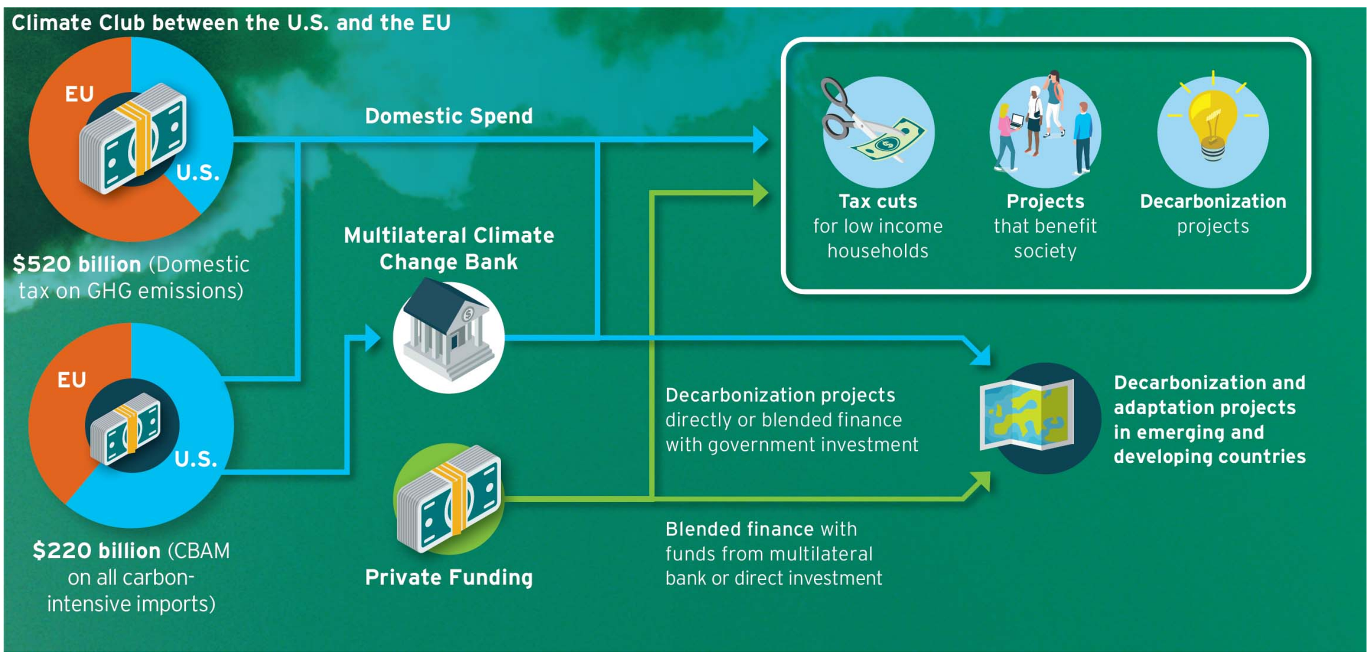
Source: Citi Global Insights

Revenue Flows from Climate Club

Revenue generation from the climate club comes from two sources — domestic tax and a CBAM. Similar to the global tax scenario we discussed above, revenues from a domestic tax should be used to cut taxes for low income households, for investment in projects that generate benefits for society, or for investment in decarbonization projects.

The EU is the only region that has a proposal to introduce the use of CBAMs on some of the products it imports. The revenue from this mechanism has been earmarked to help cover the cost of the €750 billion EU recovery fund. The EU recovery plan called NextGenerationEU aims to help repair the damage and recovery of EU member states due to COVID-19 and to make EU economies "more sustainable, resilient, and better prepared for the challenges and opportunities of the green and digital transitions."[48] In essence, revenue from the CBAM is going to EU member states. However, we propose that some or all of the revenue raised through CBAMs in our climate club scenario is allocated towards developing countries to help them decarbonize. This could be in the form of blended finance, or through technology transfers, or direct investments in decarbonization projects as shown in Figure 34.

Figure 34. Climate Club Scenario



Source: Citi Global Insights

Conclusion

A voluntary climate club can help reduce emissions in countries that are members of the club, and encourage non-members to either join the club or reduce their domestic carbon emissions to reduce the carbon tax paid on imports. It could also raise significant revenue for the member countries to invest in decarbonization projects. Reaching an agreement between two nations is also easier than reaching an agreement amongst all nations.

[48] "Recovery Plan for Europe," European Commission, accessed October 25, 2021.

Chapter 5: Climate Action Development Bank

In addition to the market-based systems we discussed in the previous chapter, we believe it is also essential that adequate financing is provided to emerging and developing markets to help them reduce their emissions. Access to appropriate climate financing remains a substantial barrier for many developing countries.

For the past five or more years, several multilateral development banks (MDBs) have constructed programs to facilitate cleaner paths to emerging market economic development. Preparations for COP26 incorporate innovative ideas such as buttressing lending programs guarantees or striving for a collective framework to facilitate the marshalling of global capital toward cleaner development programs. The time has come to propose the creation of a new global development bank whose sole purpose is to facilitate accelerated solutions and adaptation to the distinctive climate change challenges for emerging market countries.

Whether and how a global carbon pricing mechanism will come about does not change the fact that vast sums of clean energy investments are necessary to drive the Energy Transition, particularly in developing countries. Forming a Climate Action Development Bank to unite this investment effort, which has so far been scattershot, should be an option in driving substantially more dedicated "Energy Transition" investments.

Hurdles in driving more Energy Transition investments include not only the willingness or dedication to the transition but also the access to funding. First, to some emerging market countries, an investment that could yield more immediate economic return, such as a polluting factory without carbon abatement equipment, could be more attractive than a more expensive factory that produces less pollution. In addition, mandating emerging market countries to implement carbon pricing would not be easy — especially as carbon is viewed as a cost that would adversely impact their competitiveness, and when improving living standards is often more important — unless there could be a global minimum carbon price level that does not disadvantage any single country.

Similarly, to some advanced economies, following through with the $100-billion funding pledge from the Paris Agreement and having an effective mechanism to channel this funding have yet to come to fruition. Indeed, the COP26 official website stresses this: "Developing countries in particular need support. Developed countries must deliver on their promise to raise at least $100 billion every year in climate finance to support developing countries... Ahead of COP26, we must work to unleash the trillions in private finance that are needed to power us towards net zero by the middle of the century."[49] We subscribe to this, but believe it would be a far more efficient if capital were to be allocated with the assistance of an institution fully dedicated to achieving climate change objectives.

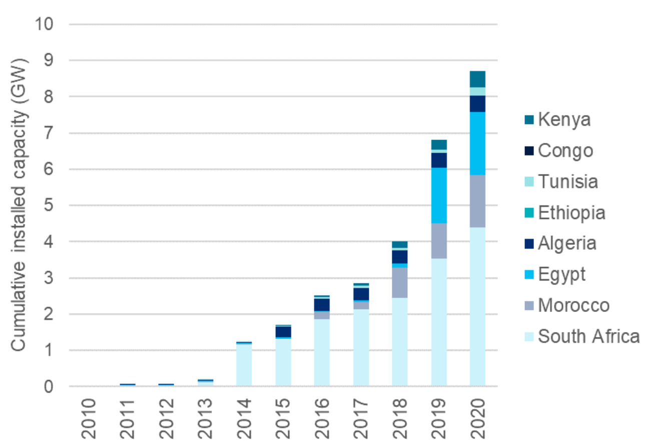
Second, access to climate financing remains a substantial barrier. Unlike some developed markets that have strong renewable energy policies, institutional capacity, resource assessment, local expertise, and grid connections, many developing nations and even some developed nations are still forming their policies.

[49] "Finance," COP26 Goals, UN Climate Change Conference UK 2021, accessed October 23, 2021.

Crucially, various types of risks make clean energy investments in many developing countries, viewed on their own, less attractive. These risks are political, social, technical, and financial. Political risks include the direction of renewable energy policy, market access, permitting processes, and general uncertainty (e.g., stability of a government and its policies). Social risks include whether the public wants to have renewable energy. Even if people do support renewables, they may have a NIMBY (Not-In-My-Backyard) issue about the location of renewable projects. Technical risks include the experience, expertise, and adequacy of infrastructure in accommodating renewable energy, as well as data availability and resource assessment in helping project developers and financial partners evaluate projects. Financial risks include counterparty risk in making sure off-takers of the energy generated can pay; local funding conditions; macroeconomic risks, including inflation and interest rates; as well as foreign exchange risks in relation to bringing in foreign capital or importing equipment and fuels.

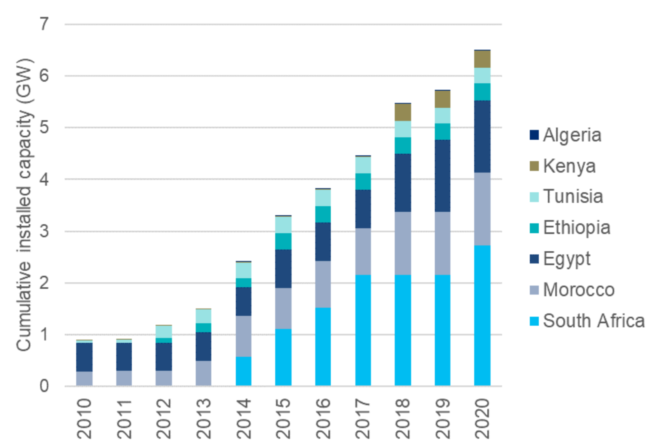
Thus, as much as the African Development Bank (AfDB), for example, has touted the continent it represents as the next "renewable powerhouse," while investments in clean energy could certainly ramp up much more, higher costs of capital have and will continue to slow clean energy development, among other impediments, including currency risks.[50] To illustrate, the AfDB cited Africa's "unlimited potential" for clean energy, with solar at ~10-TW, hydro at ~350-GW, wind at ~110-GW, and geothermal ~15-GW. The International Renewable Energy Agency (IRENA) suggested that renewable energy capacity in Africa could rise to ~310-GW by 2030, which seems to be a tall order. Total solar capacity in the top three countries of Africa in terms of installed solar capacity — South Africa, Egypt, and Morocco – is only ~7.6-GW as of 2020. These three countries also account for the majority of the continent's onshore wind capacity, but they only had less than 6-GW by 2020.

Figure 35. Cumulative Installed Solar Capacity in African Countries (2010-20)



Source: Citi Research, BNEF

Figure 36. Cumulative Installed Onshore Wind Capacity in African Countries (2010-20)



Source: Citi Research

50 "Why Africa Is the Next Renewables Powerhouse," African Development Bank Group, December 07, 2018.

Indeed, one of the four key areas that COP26 seeks to address is mobilization and access to finance. At the Climate and Development Ministerial, convened by the U.K. COP26 Presidency in March 2021, "participants recognized the urgent need to streamline access to climate finance, with greater individual and collective action required both before and following COP2…The Taskforce on Access to Climate Finance was announced in response to calls for coherent and effective support for developing countries' efforts to decarbonize their economies, adapt to climate change and establish green growth pathways."[51] Citi's GPS reports *Financing a Greener Future* (2015) and *Financing a Greener Planet* (2021) have also explored public-private partnerships and funding issues.

Specifically, many developing market countries need to address their policy gaps, which hinder the adoption of more renewable energy supply, through the use of policy de-risking instruments. However, some countries may need more direct financial incentives to lower the costs of renewable energy because other electricity generation sources are more economically competitive or can be more directly implemented. For example, coal-fired generation is often cheap in a coal producing country, so support for renewable energy could help make renewables more competitive versus coal. Some countries may need financial de-risking instruments to lower the cost of capital, because sovereign and foreign exchange risks are high, or because of tight local financing markets.

Therefore, the public sector, with help from the international community in offering funding, expertise, and capacity building, could help de-risk projects in ways that could sharply lower the cost of capital and expand the size of private financing into renewable projects. Designing and applying appropriate instruments to de-risk projects involves multiple factors. These include: (1) identifying and quantifying risks that contribute to entry barriers and higher costs of capital versus similar projects in markets with best practices; (2) formulating effective policy instruments to break down key barriers and reduce risks, so that renewable energy projects become economically competitive enough versus conventional energy projects; and (3) evaluating the effectiveness of these policy instruments in lowering the cost of capital, boosting private investments, reducing consumer expenditure, and cutting emissions.

1. **For policy de-risking instruments**, the core costs include the design, implementation, impact evaluations of instruments, and the duration of these cost items. There are costs associated with funding permanent regulatory bodies and monitoring functions, but the streamlining of existing processes and enhancing the new process could save money.

2. **For financial de-risking instruments**, costs include the capital deployed or held in reserve for loan guarantees plus public equity co-investment. At times, there is no cost to the public because green banks or development banks make the loan but expect only a small profit. But these policy banks could incur capital losses due to defaults. Thus, risk evaluation is key to avoiding defaults as much as possible. Policy banks may leverage their paid-in capital and high credit ratings to raise private capital to lend to project developers. Some estimates suggest institutions like the World Bank could leverage 3.5 times their paid-in capital.

[51] "Finance," COP26 Goals, UN Climate Change Conference UK 2021, 2021.

3. **Evaluations of policy effectiveness** involve (1) assessing how much more private capital has been raised versus the amount of public capital put in; (2) how much consumers have saved and the affordability for consumers; and (3) how much emissions can be cut, which can be associated with lowering the health and environmental costs.

In fact, the latest study from University College of London's (UCL's) Institute for Sustainable Resources highlights difficulties for developing countries in obtaining funding, with higher costs of capital, as a reflection of the financing access problem, hindering the pace of emission reduction and Energy Transition development.

The Climate Action Development Bank as an MDB Dedicated to Driving the Energy Transition

With the existential challenge of climate change, we propose the formation of a **Climate Action Development Bank**, which would address the above-mentioned challenges and drive global investments, help de-risk projects, particularly those in emerging economies through public sector involvement, and accelerate capacity building. It would have a dedicated focus on the Energy Transition and a pool of global resources dedicated to this mission. Nonetheless, even if a new Climate Action Development Bank or institution comes into being, existing development banks will continue to have important roles to play, both through joint investments with the new climate transition development bank and by investing independently in accordance with their visions and missions. With that in mind, does the world even need a new development bank solely focused on climate change? We think so. In what follows, we explain (1) why a development bank model could be instrumental in tackling various obstacles that we identified in the previous section in order to drive Energy Transition investments; and (2) why a new bank dedicated to the Energy Transition, with the explicit mandate to draw on the annual funding pledges from advanced economies to help emerging market economies, could be more effective than current multi-purpose development banks that have to juggle different needs, priorities and missions.

(1) Why a Development Bank Could Help Drive Energy Transition Investments

The access to green finance could be partly resolved by having proactive public sector involvement, through de-risking, improving access to finance and capacity building. Existing MDBs could fit this bill, but a dedicated Climate Change Development Bank could be more effective in facilitating Energy Transition investments, especially in many developing countries.

The principal goal of MDBs is to provide financing assistance with the aims of achieving sustainable development goals and promoting human and social capital development. In the process, MDBs provide knowledge, technology, and expertise to local communities that carry out development projects. MDBs, both at the global and regional levels, commonly share the mandates of fostering economic and social development and supporting regional cooperation and integration.

MDBs are well-placed to address market failures that occur due to externalities, information asymmetries, and coordination problems, leading to an inefficient allocation of goods and services by market forces.

(a) Information asymmetries can be particularly acute with new and less-known technologies. An investment process in climate-friendly technologies, which are at present relatively less established, could therefore be riskier or less-known by investors. This could drive up the cost of financing or significantly reduce the amount of available capital. MDBs can be useful in these situations as they would be able to provide the capital for the required investments more readily.

(b) There should be positive informational externalities involved in the process of Energy Transition. These stem from the fact that when new knowledge is acquired, it can potentially have multiple practical use cases and can be used a stepping stone for yet new discoveries. This is very difficult to fund using private markets, because funding research where discoveries are not protected using patents do not make financial sense, whereas patents limit access to a particular technology. MDBs can fund research whose findings benefit the Energy Transition and can be widely disseminated, therefore speeding up the global climate effort.

(c) A global issue, such as the Energy Transition to mitigate climate change, which requires a global approach with many different countries and governments involved, can easily lead to coordination problems. MDBs provide a platform for coordination between governments that is subject to rules and therefore facilitate a structured and orderly approach to tackling pertinent issues. This helps boost efficiency of the process.

MDBs are built as collaborative partners that can provide scaled-up and low-cost services by pooling resources from key stakeholder countries and avoiding waste and duplication. Governments around the world have come to realize the rising global challenges in social, economic, and environmental realms, which would be almost impossible to solve by individual countries alone. By pooling resources and sharing the responsibility, MDBs are set up as cooperatives to provide international “public goods” and reduce cross-border externalities.

The business model of MDBs allows them to mobilize resources for development from international capital markets. MDBs source their “paid-in” capital from their member governments at negotiated ratios and then against their capital base. MDBs borrow resources from international capital markets through public bond issuance, private placements, and syndicated loans. These borrowings are raised on market terms and hence need to be lent on market terms as well. This is called the “hard loan window.” They fund their daily operating costs from proceeds earned on non-concessional loans to borrower countries. MDBs also have “soft loan windows,” which are usually separate funds that are supported by donors, which provide grant resources that are highly concessional. The capital resources for development mainly come from either borrowing directly on their own account and then relending to the borrowing countries, or guaranteeing the repayment of funds that the market is going to provide directly to borrowing countries.

Apart from direct lending operations, the financial structure and financing capabilities of MDBs let them leverage their capital finance, such as equity investment and guarantees. This is more common in the private sector operations of MDBs.

MDBs have unique mechanisms for allocating financing to make their investments more effective in achieving their missions. They also focus specifically on development projects, which usually find it hard to attract private finance due to their high risks. The multilateral shareholder structure allows donor governments and countries of operations to discuss and agree on the criteria for providing multilateral finance before the funds are provided. This is because usually the lending countries are also stakeholders of the MDBs.

Capacity building is a key function of MDBs. In an institution that is owned by governments and serves a wide range of members in the region or across the region, stakeholders would naturally have the resources to learn from each other and have extensive cross-country experience in development policy and reform. Borrowers, also potentially the shareholders of the MDBs, will tend to find the conditionality and monitoring imposed by MDBs more "acceptable" than if they are being imposed purely from a financial institution.

(b) Why the Formation of a New Development Bank Could Help Focus Investments

Existing MDBs recognize the need to coordinate, as they have done joint investments and joint studies, including the annual *Joint Report on Multilateral Development Banks' Climate Finance* report. The report specifically mentions multiple times the need to "harmonize" their approaches, methodologies, and other aspects of climate change finance. If done so effectively, perhaps the existing model of involving many development banks, but with substantially more resources devoted to the Energy Transition, could work.

But the need to harmonize across institutions also underscores the fact that existing MDBs, even with the many good work that they have done, were formed with different purposes, visions, and missions in mind, and have different practices. Within most existing development banks, there are many sectors involved, ranging from energy and infrastructure, to technology, finance, and education. However, depending on the history and sometimes the geographic locations and levels (global versus regional versus country), banks do have different specializations, in particular at the regional level. For example, the more recently established (compared to the long history of MDBs since 1940s) Asian Infrastructure Investment Bank (AIIB) primarily focuses on investment projects in infrastructure. The European Bank of Reconstruction and Development (EBRD) has a mission to promote market-oriented economies in Central and Eastern Europe.

However, if climate change is a generational and even existential issue for the world, then forming a new, dedicated Climate Change development bank could help focus resources and capacity in an institution that has the vision and mission of pushing the Energy Transition. If achieving Energy Transition is as ambitious as the reconstruction efforts post-World War II, then an equally ambitious effort must take place. The World Bank's own history states that "Founded in 1944, the International Bank for Reconstruction and Development soon [became] the World Bank… Originally, its loans helped rebuild countries devastated by World War II." The current climate efforts should be in similar vein, but instead of rebuilding after an already-inflicted devastation of war, they ought to avoid future devastation, one that would be larger in scale than that caused by WWII as well as irreparable. Thus, if the world's energy infrastructure that powers the economic growth and community development globally has to transform in scale and expeditiously, then it stands to reason that a similarly purposed organization should lead the massive Energy Transition financing needed.

In addition, this new bank could also have a brand new mandate to draw on supposed annual funding pledges from advanced economies and invest in emerging market economies to facilitate the Energy Transition. If advanced economies are serious about tackling climate change besides their net-zero promises, then they should follow through with the previously pledged funding to help emerging market economies in their Energy Transitions. However, simply forming a fund to give out investments would be rather one-dimensional, when driving resources to this generational challenge and capacity building are equally important. Yet, the power structure within each of the existing development banks could make the governance and decision-making process difficult, aside from the different visions, missions and processes they each have. For example, an organization formed within the World Bank might draw the dissatisfaction that a certain set of countries could have an outsized amount of power, which implicitly was the reason why the Asian Infrastructure Investment Bank (AIIB) was formed. A new climate action development bank would have a clean slate, a focused vision to combat climate change, as well as a dedicated mission to help drive investments and capacity building in the Energy Transition. Governance would be primarily determined by the size of a member country's paid-in capital, without interference from an existing development bank structure.

Importantly, having a dedicated Climate Action Development Bank would allow it to build technical expertise and know-how that would complement the funding and therefore have the potential to enhance the return on investments and drive better outcomes. Many existing national and multinational developments have consulting arms that help implement complex projects, share technical assistance, and train other practitioners in the field. This helps investment projects succeed, improves efficiency, and increases the probability that the loans are eventually repaid.

Establishing a Climate Action Development bank has potential pitfalls, too.[52] Development banks have in the past been criticized for being too bureaucratic, not appropriately measuring the impact of their work and the fulfilment of their mission statements, for crowding out private enterprises, not aligning performance indicators with their missions and goals, and for being costly to run. When establishing the Climate Action Development Bank, member countries should learn from past experience of other development banks in order to set up a structure that mitigates some of the potential downsides.

In particular, there are several best practices that have been proposed in the literature that should be followed by any development bank, and would therefore be applicable to the Climate Action Development Bank.[53] These best practices include enhancing accountability for program effectiveness, implementing rigorous monitoring of projects, complementing funding with technical assistance, ensuring private sector funds are encouraged not crowded out, and ensuring preferential funding for projects with large positive externalities.

[52] Aldo Musacchio et al., *The Role and Impact of Development Banks: A Review of Their Founding, Focus, and Influence*, Brandeis International Business School, March 2017.
[53] Ibid.

(c) How Would the Climate Action Development Bank Work with Other National and Multinational Development Banks?

While a development bank that focuses primarily on climate action would be beneficial for the aforementioned reasons, it is indisputable that the bank would need to work hand-in-hand with other development banks — both national and multinational. There are at least two reasons for that. First, Energy Transition could have an impact in areas that are under the purview of either existing national (e.g., industrial policy) or multinational development banks (e.g., alleviating poverty). As such, a degree of coordination would be necessary in some of the efforts in order for all the parties to be able to work towards fulfilling their missions and goals. Second, some existing development banks already have facilities in place that encourage climate action.

The World Bank has projects such as its Global Program on Sustainability that promotes using high quality-data and analysis on natural capital, ecosystem services, and sustainability to better inform decisions made by governments, the private sector and financial institutions.[54] It has launched a Climate Support Facility — a new fund that manages funding provided under a Green Recovery Initiative aimed at helping countries build a low-carbon, climate-resilient recovery from COVID-19. It also issues the World Bank Green Bonds, which raise funds from fixed income investors to support World Bank lending for eligible projects that seek to mitigate climate change or help affected people adapt to it.[55]

The Inter-American Development Bank aims to develop green finance markets and leverage private investments, and "offers bespoke capital market and financing solutions such as thematic bonds, institutional capability building, and dedicated public-private dialogues among financial sector agents and key actors of the real economy."[56]

The African Development Bank has a green bond program that "facilitates the achievement of the Bank's corporate priority of green growth through the financing of eligible climate change projects."[57]

The Asian Development Bank also has a green bond program that "enables ADB to support its developing member countries seeking to mitigate greenhouse gas (GHG) emissions and adapt to the consequences of climate change, whilst delivering environmentally sustainable growth to help reduce poverty and improve the quality of life of their people."[58]

The European Bank for Reconstruction and Development offers Green Economy Financing Facilities (GEFFs) to develop local financing markets for sustainable energy and resource efficiency projects. The Green Cities program identifies, prioritizes and connects environmental challenges with sustainable infrastructure and policies. The Finance and Technology Transfer Centre for Climate Change (FINTECC) fosters the uptake of advanced climate technologies in select economies.

[54] "Sustainable Finance," The World Bank, August 05, 2021.
[55] "IBRD Funding Program," The World Bank, accessed October 23, 2021.
[56] "Green Finance," Inter-American Development Bank, accessed October 23, 2021.
[57] "Background," African Development Bank Group, accessed October 23, 2021.
[58] "ADB Green and Blue Bonds," Asian Development Bank, accessed October 23, 2021.

The Bank's Sustainable Infrastructure Group delivers its sustainable infrastructure agenda through investments and policy reform across the EBRD regions.[59]

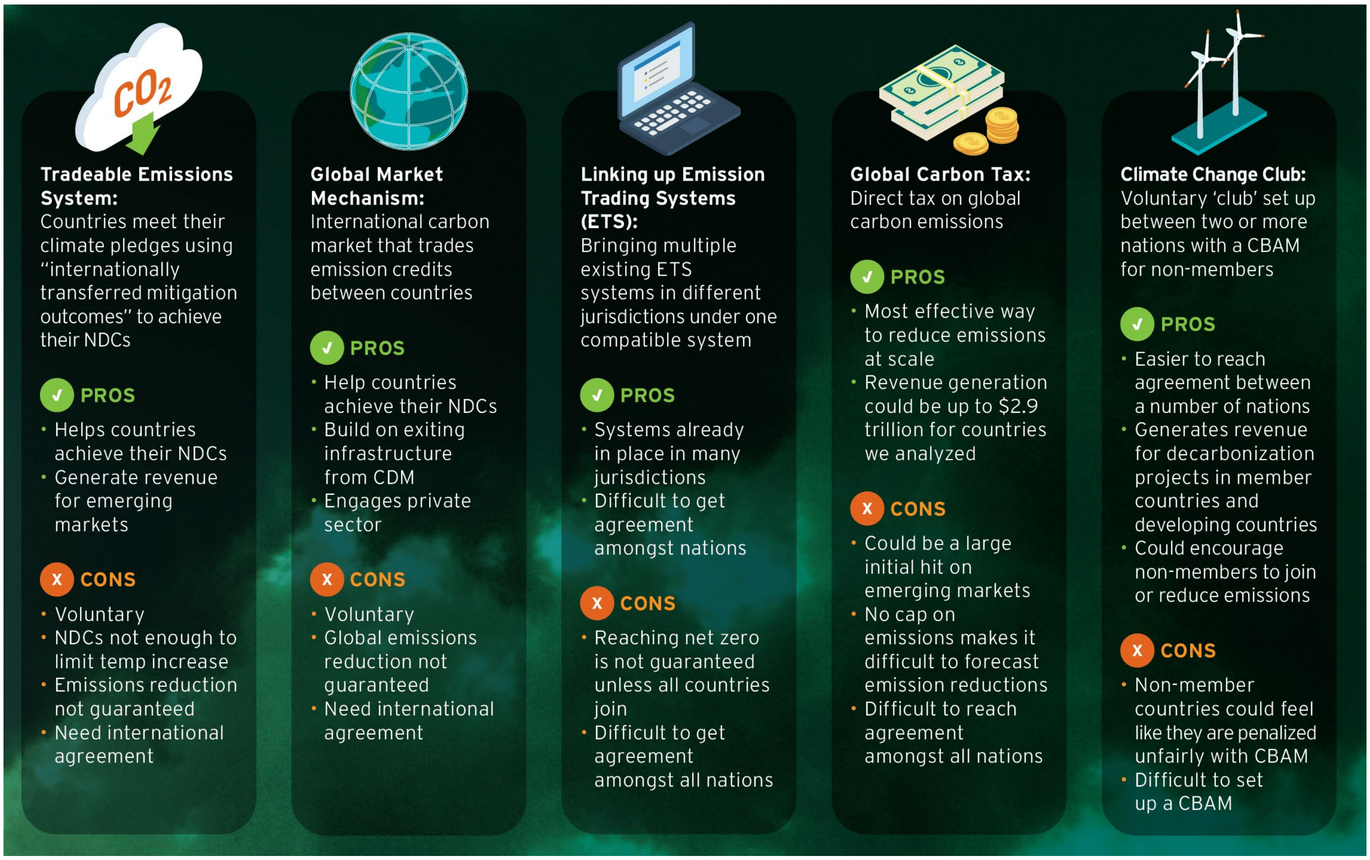
It will be vital that the Climate Action Development Bank complements and consolidates the existing efforts to facilitate green investment, Energy Transition, and climate action. Combating climate change has become a critical and urgent endeavor. Let's devote the same kind of determination in facilitating this work. A Climate Action Development Bank could be the solution.

[59] "EBRD Green," European Bank for Reconstruction and Development, accessed October 23, 2021.

Conclusion

In this report, we provided an analysis of a number of different mechanisms that could be used to get countries to collaborate with one another. These mechanisms are not mutually exclusive, and can be applied in tangent with one another. However, ultimately what we really want is a mechanism that can help the world reach net zero emissions. As we see from Figure 37, each of the mechanisms has advantages and disadvantages and there is not one that would be acceptable to all. We have also seen from Chapter 3 that current systems in place are not effective at reducing emissions on the global scale. If we are serious about reducing emissions, then we need to find a global solution that works.

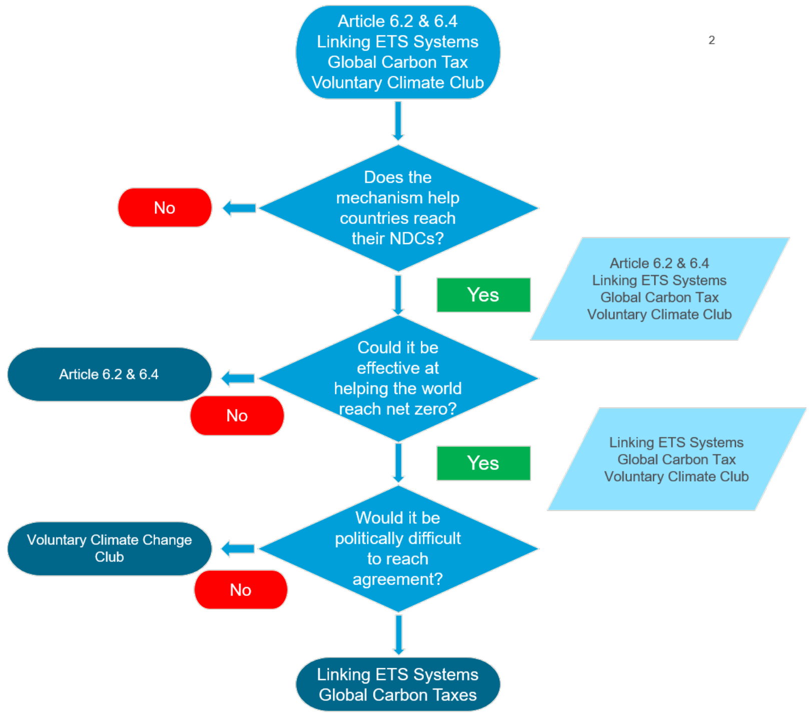
Figure 37. Advantages and Disadvantages of Mechanisms we Analyzed



Source: Citi Research

Below is a flow chart we have created comparing each of these scenarios based on three parameters: (1) Does the mechanism help countries reach their NDCs? (2) Could it be effective at helping the world reach net zero? (3) Would it be politically difficult to reach an agreement?

Figure 38. Flow Chart Comparing Different Scenarios



Source: Citi Global Insights

All of the mechanisms that we analyzed can help countries reach their NDCs; however, as we have explained in Chapter 2, we need to go beyond countries' pledges as they do not go far enough to ensure that we limit temperature increase to a 1.5°C world. The second question we looked at is whether any of the mechanisms could be effective at helping the world reach net zero. In our opinion, Article 6.2 and Article 6.4 do not achieve this — even though they will help countries reduce their emissions effectively, they are voluntary and therefore it is difficult to say how many countries would make use of these systems. However, these mechanisms could be really useful in increasing investment in decarbonization projects in developing and emerging nations and in starting some collaboration between countries.

Next we asked whether such mechanisms would be politically feasible. This is where a global ETS system and a global carbon tax fail. Both require getting an agreement between all nations. Linking current ETS systems is difficult as deciding upon a design for all jurisdictions would be challenging given the different legislative frameworks, pricing provisions, judicial control, and market liquidity.

Setting up a global tax amongst all nations would have similar challenges, despite its lower complexity versus an ETS. Deciding on the right price for a carbon tax for developed and emerging markets, choosing a metric to use for revenue distribution, and deciding who will monitor the system would be extremely difficult to get global agreement on. It has taken more than 20 years for all countries to agree on just the goal of limiting average temperature increase to well below 2°C above pre-industrial levels. It has also taken more than 20 years for all countries to agree on putting together targets to reduce emissions over time. Time is running out; therefore, we don't have the luxury of waiting another 20 years to agree on a global carbon price/mechanism.

The only mechanism we believe could be easier to negotiate and more political feasible is the voluntary climate change club. We believe that ultimately the world will go down this pathway in one form or another. We are already seeing the EU set up carbon border adjustment mechanisms on some imports from countries outside the EU jurisdiction. Rebates on carbon border adjustment tax paid on imports to the EU to countries that have similar carbon prices are already in place. It is likely other countries will introduce a similar system if domestic carbon taxes/policies are stepped up and if they want to avoid carbon leakage. Going a step further and setting up a climate club between different jurisdictions makes sense and includes other benefits such as technological transfers, a competitive level playing field amongst different sectors, and a preferential trade agreement. In our opinion this would also encourage other countries to join. We are already seeing this happen with the pledge between the U.S. and the EU around methane reductions, with eight more countries asking to join this “club.” The ten biggest emitters in the world are responsible for over two-thirds of global emissions, so forming some sort of club between these nations would go a long way to reducing global emissions. If this works, we believe it could be the beginning of a global solution to reduce emissions effectively and reach net zero.

We also emphasize that whatever mechanism the world decides to choose (and hopefully it chooses one), it does not change the fact that trillions of dollars needs to be invested to reach a net zero world. Developing and emerging markets need support to achieve this; therefore, developed markets must continue to help finance this change. This is why we believe a multilateral bank dedicated to climate change should be set up. Not only can this bank manage the revenue generated from a number of the solutions we discuss, but can also drive global investments, help-de-risk projects particularly in emerging economies, and accelerate capacity building that is needed to reduce global emissions.

This could be the start we needed. But there is one more caveat we need to solve — who is going to finance net negative emissions? The International Panel on Climate Change (IPCC) stated that to limit the temperature increase of the planet we not only need to reach net zero by 2050, but then move to net negative emissions in the second half of the century. This dilemma is a problem for another day and another report.

Let us first get the mechanism needed to get to net zero before time runs out.

Appendix 1: Current Practices

Carbon pricing systems have become a cornerstone of Energy Transition policies in many jurisdictions and have the potential to become some of the largest financialized commodity markets, affecting many other areas of investments. The proposal for a regulated carbon emissions market traces back to an essay from John Dales published in 1968.[60] The rationale is that negative externalities such as pollution, which are not reflected in the market price of goods and services offered, should be internalized. Therefore, beyond a predefined threshold, producers should compensate other stakeholders for implicitly sharing the social cost of their environmental impact.

Over the past two decades, greenhouse gas (GHG) emission pricing programs have become increasingly popular among policymakers. Authorities continue to develop international, national, and regional carbon emissions systems not just to limit GHG emissions and provide an economic incentive to switch to greener energy sources and more sustainable business models, but also to raise fiscal revenues for income redistribution. The World Bank estimates that initiatives around the world generated $53 billion in fiscal revenues in 2020. Recently, due to spiraling power prices in Europe, the Italian and the Spanish governments laid out a plan to allocate €900 million from existing European allowances auctions to subsidize energy bills for low-income households.

However, a unique global carbon price does not exist today given the heavy fragmentation of environmental policies, agreements, and protocols that underpin a global carbon market. Currently, more than 60 carbon pricing initiatives have been adopted worldwide, up from 20 only five years ago. Several others are scheduled to be implemented over the next decade. Early efforts to create a single market under the UN's Kyoto Protocol, reached in 1997, have not led to a global market. However, successful GHG programs worldwide serve as examples that should encourage the global community to act together.

Four general ways to impose or encourage an Energy Transition involve carbon pricing, either implicitly or explicitly, and can often be implemented in some combination. These include: (1) command and control systems and (2) carbon tax regimes. There are also market-based tradeable systems: (1) cap-and-trade of emission allowances and (2) baseline-and-credit systems.

1. **Command and control directives**, or some clean energy standards/levels, are established by authorities prescribing limits on the quantity of emissions and setting strict compliance methods to force adherence at the sector, plant, or emission source level. These orders effectively stipulate the level of green energy and resources implemented, and the pace of retirement of polluting plants. However, unless the economics of going green are more favorable than continuing to emit, they provide no incentive for going *beyond* the predefined limit. Command-and-control is *theoretically* not the most "economically efficient," since it involves picking winners and losers that may or may not be the most cost-efficient or benefit-inducing ways to cut emissions, and makes assumptions on technological progress. For example, imposing a certain amount of energy storage might assume that technology has progressed to a more advanced level (or not), when in fact other means to facilitate the Energy Transition, also under some imposed targets, could be more economical (or not).

[60] J.H. Dales, *Pollution, Property & Prices: An Essay in Policy-Making and Economics* (Toronto: Toronto University Press, 1968).

Meanwhile, some implied carbon prices are involved that firms would use as an abstract way to plan their own investments. They could also have politically-motivated loopholes. Nonetheless, command and control approaches on paper could reduce the uncertainty in achieving climate goals, when cost-benefit analyses that underpin programs with explicit carbon pricing do involve difficult-to-assess assumptions. Those assumptions include the level of economic gain and the scale of environmental damage. Instead, advocates of clean energy standards point to the fact that climate impacts could be catastrophic and that using explicit carbon prices to fine-tune and optimize costs and benefits to societies could be too slow and ineffective relative to command and control approaches.

2. Under a **carbon tax regime**, regulators set prices or (typically, rising) price paths that emitters must pay for each ton of GHG emissions produced. A carbon tax ensures certainty in GHG emission prices, sparing companies from fluctuating regulatory costs, when uncertainty can be a headwind to longer-term investments or decision-making. A carbon tax also typically does not involve complicated intermediaries that could distort the system, such as when prices of carbon allowances in a trading system fluctuate wildly, even when fundamentals do not justify those price moves. The system is simpler and can reduce rent-seeking behavior by speculators. However, a carbon tax regime would probably set too high or too low a price on carbon, since there is no emissions cap to meet. If emission cuts fail to reach some implicit targets, then the carbon tax is probably too low and vice versa. Regulators might then adjust the program over time, which would introduce a different set of uncertainty, now on the regulatory side. However, carbon tax regimes can incorporate rule-based price adjustments if emissions targets are not met (discussed more later).

In a market-based tradeable system, the supply and demand balance of specific carbon emission permits largely determines the cost of emitting. These systems theoretically have the advantage of setting a predefined target for carbon emissions reduction and track progress made. Thus, if emission cuts reach some explicit targets quicker than expected, then emission permit prices should fall, since the cost of cutting emissions might be less expensive than previously thought. Similarly, these systems promote energy efficiency and reward companies that can reduce their environmental footprint faster. However, price volatility, among other factors, is a problem, particularly in affecting longer-term investment.

The involvement of speculators and financial intermediaries can be both economically efficient and inefficient. Speculators are needed to improve liquidity generally and help balance out buying and selling pressure from actual corporates. Some corporates, who may have invested in emission abatement processes, might choose to sell their excess carbon allowances in the longer term, while other corporates might have more immediate needs to buy. Carbon allowances might also have mark-to-market accounting implications. Speculators and financial intermediaries could enter the market to balance out these forces. However, a poorly designed emissions program could introduce rent-seeking behavior. Therefore, regulators seek to control price volatility in the design of their specific program, via buffers or minimum and maximum price thresholds. Thus, while a pure emissions market would have no set price, additional price thresholds or other market stability measures can help to keep prices within a (typically, rising) price corridor that policymakers might prefer. The EU Emissions Trading System (EU ETS) and California Cap-and-Trade Program, for example, have many safeguards as a result.

Overall, there are two different kinds of market-based tradeable systems, which at times could be complementary.

- **Cap-and-trade systems** commonly referred to as emissions trading systems (ETS), where the regulators set an upper limit on carbon emissions and distribute carbon emissions permits either freely, based on specific industry benchmarks, or they are monetized via auctions. These *carbon allowances* must be surrendered by emitters at a specific future date. Both physical emitters and financial institutions can exchange and bank (hold for use in future compliance periods) these allowances. On top of the "physical" market is a market for financial futures or derivatives that allows other market participants to trade. The EU ETS, California Cap-and-Trade Program, the South Korean ETS, the New Zealand ETS, and the recently launched Chinese ETS are examples of cap-and-trade systems.

- Under **baseline-and-credit systems** there is no fixed limit on any specific type of GHG emissions. Emitters that reduce their emissions, even on a voluntary basis, or compensate for them with sustainable projects (including forestry), receive *carbon credits.* These can be monetized either by exchanging them for carbon allowances to use within the regulation they are subjected to or by selling them to other emitters in deficit. This is why carbon credits are sometimes also known as *carbon offsets*.

  The carbon credit market is heavily fragmented.

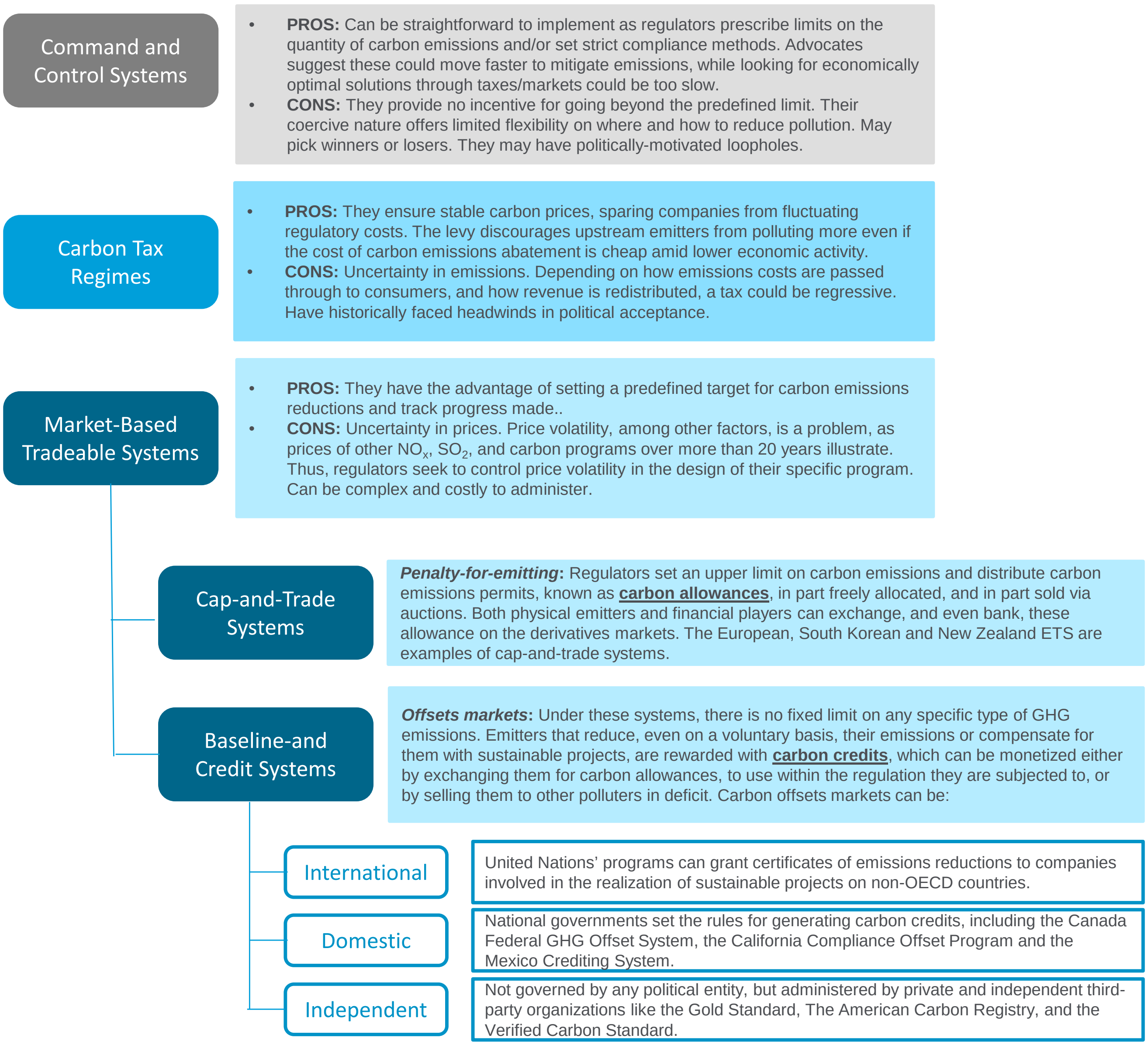
  - There have been *international crediting mechanisms*, such as the Clean Development Mechanism (CDM) and Joint Implementation (JI) developed under the Kyoto Protocol, which have granted certified emissions reductions (CERs) and emissions reduction units (ERUs) to companies involved in the realization of sustainable projects, with CERs in particular for projects in emerging markets.

  - There are *regional and national crediting mechanisms,* such as Australia's Emissions Reduction Fund and California's Compliance Offset Program.

  - Lastly, there is a plethora of *independent crediting mechanisms* not governed by any national regulation or international treaties, but administered by private and independent third-party organizations, like the Gold Standard, the American Carbon Registry (ACR) and the Verified Carbon Standard (VCS).

  Monitoring the effectiveness of these mechanisms in reducing or absorbing emissions is generally difficult. For example, it is challenging to monitor numerous forestry projects, which tend to be in remote locations. That is in part why carbon credits tend to see restricted use in carbon allowance trading programs, and why carbon credits tend to cost a small fraction of actual carbon allowance prices. In theory, if carbon credits are completely verifiable, trustworthy, and have a same effectiveness in reducing emissions, and if fundamentals correspond, their price could converge with the price of carbon emission allowances. Here, specificities in the value of a carbon credit tied to a specific project type (e.g., forestry) could see its price driven by the marginal abatement cost of that type of project, while the carbon allowance for a specific compliance program that covers power and industry, etc., would be driven by these other marginal abatement costs. Separately, the value of carbon credits can differ based on other factors, such as those related to legal and regulatory risks, e.g., invalidation risk based on project inspections specific to crediting programs. This is discussed later in this appendix.

Figure 39. A Framework for Carbon Pricing Systems



Source: Citi Research

Carbon Pricing Systems in Practice

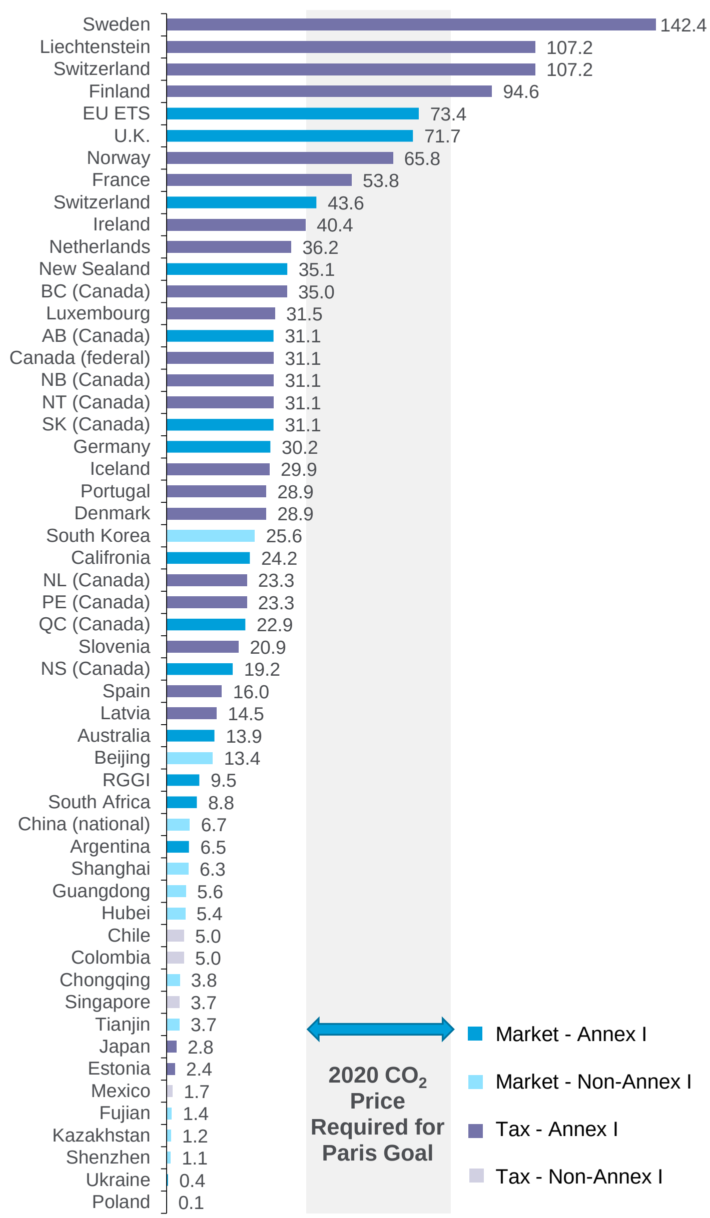
Carbon pricing systems are on the rise around the world, with an increasing number of jurisdictions planning and implementing them. The systems are expanding their coverage of economic sectors and due to policy design and corresponding ETS fundamentals, as well as the likely direction of policy reforms, price levels are moving higher over time.

As of late 2021, there were 64 carbon pricing systems in effect in the world — covering a quarter of global emissions — with another 30 or more in development. Of these, there are 30 carbon markets, and 34 carbon tax regimes already, at various jurisdictional levels — whole countries, individual states/provinces/territories, and regional groupings of these. Almost 50 countries have at least one nationwide system, and 35 have sub-national jurisdictions.

When it comes to the largest economies in the world, many now have a carbon pricing system of some kind. Looking at the G-20 countries many already have carbon pricing systems in place, notably the European countries; China, Japan, South Korea, India, and Australia in the Asia Pacific region; the U.S., Canada, and Mexico in North America; and South Africa and Argentina.

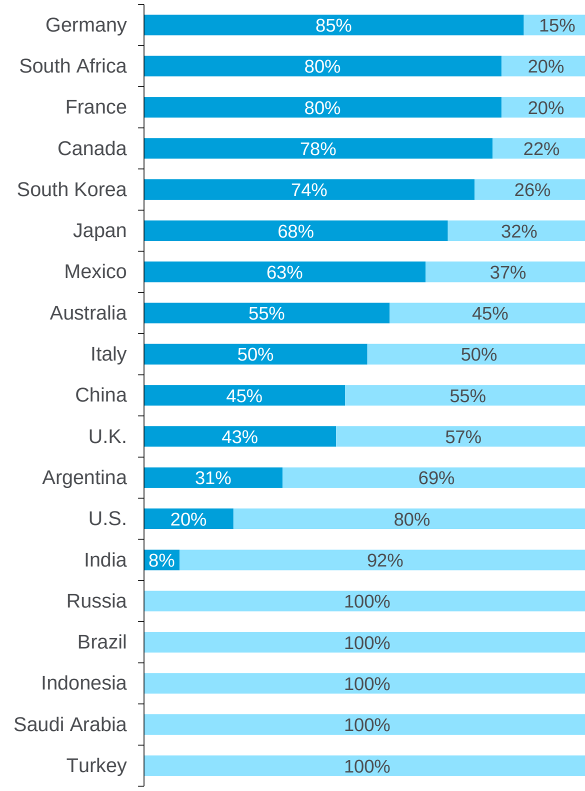
However, there are glaring exceptions in the G-20 at the moment — Brazil, Indonesia, Russia, Saudi Arabia, and Turkey do not have any emissions covered by a carbon pricing system. Meanwhile, India has only ~8% of its emissions covered. Even the U.S. has only ~20% of its emissions covered by an outright carbon pricing system. On the positive side, Indonesia is developing an ETS with voluntary trials started in March 2021. Sakhalin, Russia, is set to begin emissions trading in 2022, which, if successful, could see ETS pilots implemented elsewhere in Russia, too.

Figure 40. Carbon Prices by Jurisdiction, from Highest to Lowest



Source: BNEF, ICAP, World Bank, Citi Research

Figure 41. G-20 Share of Emissions Covered by Carbon Price



Source: BNEF, ICAP, World Bank, Citi Research

The U.S. is itself a complicated patchwork of climate policies at both the federal and state level, and includes two of the major ETSs accessible to investors: the California (and Quebec) Cap-and-Trade Program, and the Regional Greenhouse Gas Initiative (RGGI), which covers 11 East Coast states as of 2021. California, as a standalone economy is one of the largest in the world, and its ETS covers about 80% of statewide emissions, with carbon price levels ~$25/tonne as of late 2021 and expected to move toward the $60/tonne range in the coming years. RGGI carbon allowances cover only the power sector, with carbon price levels in the high-single digits, though these have also been moving higher in 2021.

California and other states either have or are developing Low-Carbon Fuel Standard (LCFS) systems that stipulate a carbon intensity (CI) benchmark each year. Fuels with CIs below the benchmark earn credits and CIs above the benchmark are subject to compliance obligations to surrender credits; California's LCFS credits are around $180/tonne and could move to $200/tonne or higher.

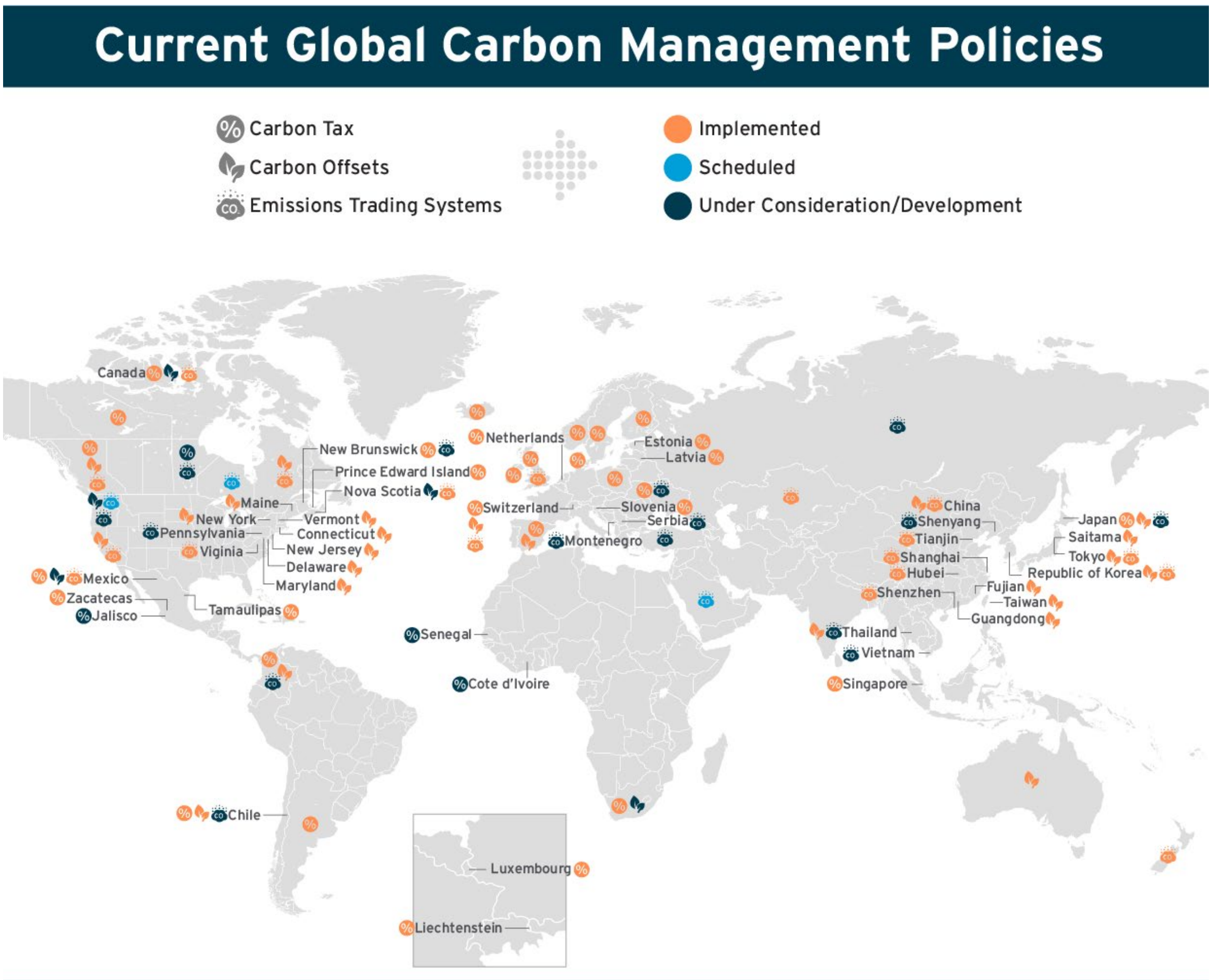
The U.S. has a federal-level 45Q tax credit for eligible carbon capture and storage (CCS) projects worth $50/tonne by 2026 (rising by the rate of inflation beyond 2026), with proposed legislation potentially lifting that credit level. Further, federal carbon tax bills have been proposed, with more than 10 bills introduced in the last few years, several with bipartisan support.[61] The state of Washington is looking to start its cap-and-invest scheme as well as an LCFS by 2023, with the emissions trading linkage-ready with California and Quebec. Oregon and New Mexico are also considering their own ETSs.

[61] See Resources for the Future's Carbon Pricing Bill Tracker website.

And Pennsylvania is looking to join RGGI, which would be a big proportional increase in the size of the East Coast ETS, but could be at risk of being scuttled by the Republican-controlled state legislature. North Carolina is considering joining RGGI too. New York City is considering an ETS for its buildings sector. Thirteen East Coast states are also part of the Transportation & Climate Initiative (TCI), with a subset of members looking to establish the Transportation & Climate Initiative Program (TCI-P), an ETS covering transportation fuels—which make up a third of the region's CO_2 emissions. Operations could begin as soon as 2023, with the system design looking similar to RGGI.

Over 30 additional carbon pricing systems are under discussion or in development worldwide. Other than the plans in the U.S., Russia, and Indonesia mentioned earlier, other proposals include the EU ETS potentially adding buildings and road transportation in 2026; ETSs under consideration in Brazil, Chile, Japan, Kenya, Pakistan, Thailand, Turkey, Ukraine, and Vietnam; as well as a potential carbon taxes in Austria and Morocco.

Figure 42. Current Carbon Management Policies



Source: Citi Research

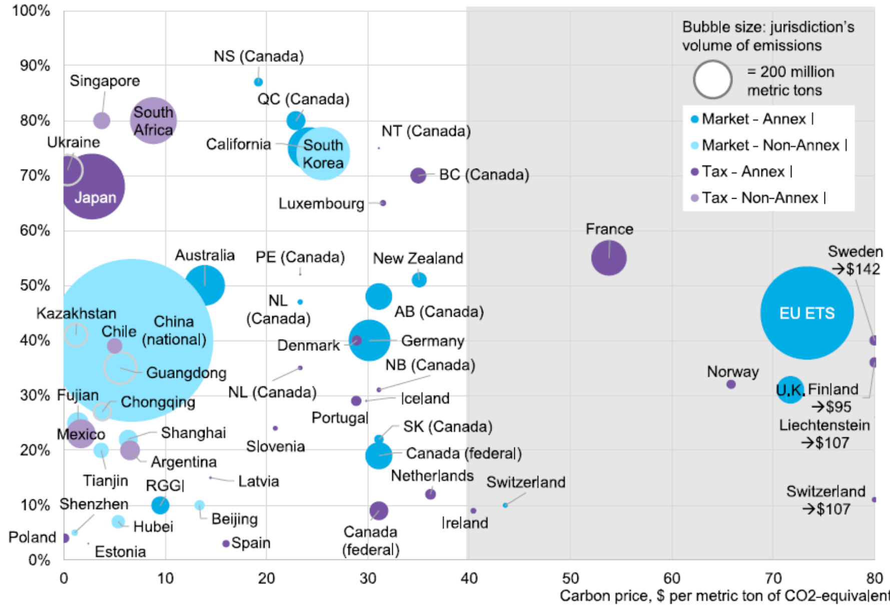
Carbon Price Levels

Carbon price levels and the share of emissions covered remain wildly divergent across carbon pricing systems worldwide. Only a few, covering just 4% of global emissions, have prices in the $40-$80/tonne range — the 2020 level the World Bank sees as needed to be on track for 2°C targets (with the 2030 price range at $50-$100/tonne). However, many systems are moving in the right direction. In a 2018 report, the International Panel on Climate Change (IPCC) estimated a price of at least $135/tonne (and potentially much higher) is needed by 2030 to achieve a 1.5°C target. In 2021, carbon pricing systems cover a quarter of global emissions, with 4.5% covered by carbon taxes, and 21% covered by carbon markets. This is up from ~15% in 2020, with the year-on-year change mainly due to the start-up of China's national ETS, with some help from Germany's new ETS which covers fuel emissions not covered by the EU ETS. Within the global picture, carbon taxes tend to have higher price levels, but overall cover a smaller share of emissions globally.

Notable within the $40-$80/tonne range are the EU ETS and the recently separated U.K. ETS, as well as carbon taxes in France and Norway. Some of the highest prices —~$100/tonne and above — are in Finland, Liechtenstein, Sweden, and Switzerland, but their emissions are not large, and the California LCFS is in the $180-$200/tonne range while the U.S. 45Q tax credit is heading to $50/t by 2026. A good number of carbon pricing systems have prices in the $20-$40/tonne range now, notably California and Canada as well as a host of European countries.

Carbon tax systems tend to have rising price levels over time. Price levels in 2030 are expected to be higher, notably in France and Canada. Canada's federal carbon price increases C$15/tonne per year and is expected to hit C$170/tonne by 2030. Meanwhile, prices in major ETSs could reach meaningful levels, including the EU ETS, which could reach $100/tonne by 2030, and California's Cap-and-Trade Program, which could reach $60/tonne or higher also by 2030. By design, falling emissions caps in ETSs can help price discovery of marginal abatement costs to achieve emissions targets, which are likely based on the cost of green hydrogen and/or CCS for power and industry. These could be in the $100/tonne range by 2030, given some technological improvement over time.

Figure 43. Carbon Pricing Systems by Price and Percent Share of Emissions Covered



Source: BNEF, Citi Research

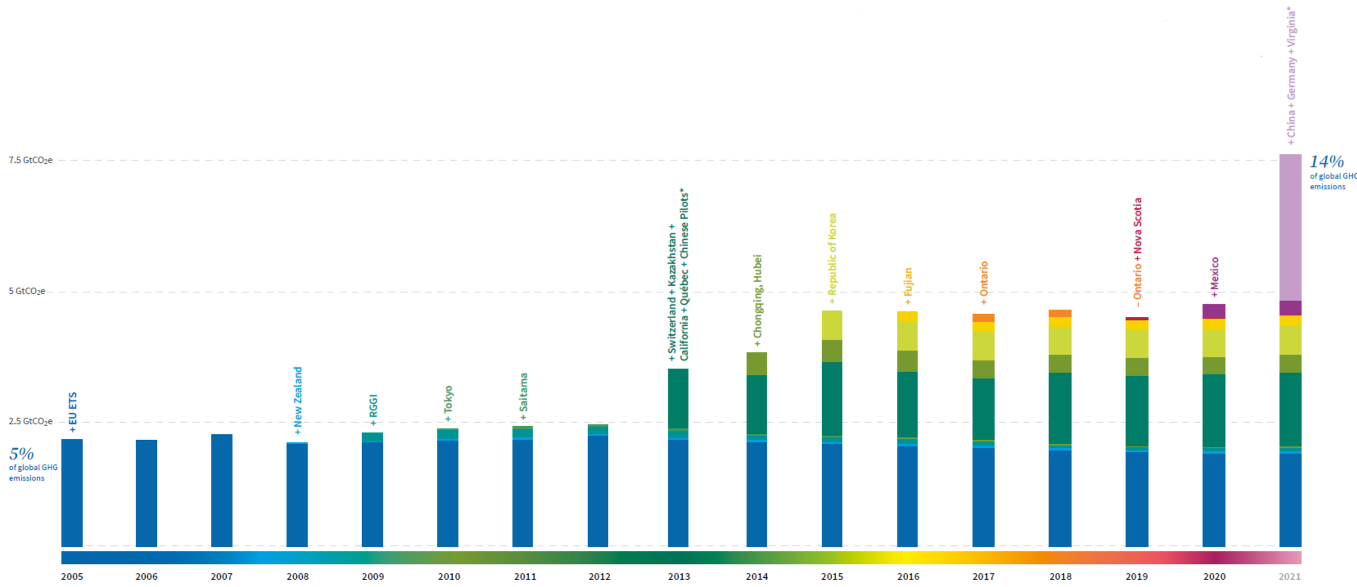
Carbon taxes are likely to continue to face critical political considerations regarding use of revenues, particularly to make sure they are progressive, or at least not regressive, in their overall impact. Carbon tax systems have tended to see revenues on balance go toward two main uses: (1) green spending, such as climate mitigation projects, infrastructure, and R&D, such as in France and Switzerland, and (2) “dividends” back to citizens to make the overall carbon tax regime more progressive, such as in Sweden and the province of British Columbia in Canada.

U.S. federal carbon tax proposals see a range of approaches with different balances across the two main spending cases, with earmarks toward uses such as dividends/rebates, tax credits, payroll tax cuts, social security benefits, fossil fuel worker assistance, and rural energy assistance, as well as environmental restoration, coastal flooding infrastructure, clean energy R&D, and highway trust funds. This sensitivity to the progressiveness of any carbon tax regime is not surprising given the higher proportion of household spending and lower price elasticity of demand of lower income households, with political pushback in recent years seen in places with carbon taxes, such as in France, Australia, and the U.S. state of Washington. Meanwhile, some carbon tax regimes also provide flexibility in compliance with carbon taxes, such as the use of offsets from GHG emissions-reducing projects, in particular Canada, Mexico, and South Africa.

ETS Systems

Carbon markets — ETSs — have expanded significantly since 2005. The volume of global emissions covered by ETSs has risen over time, starting with the EU ETS in 2005, with major subsequent additions in emissions coverage from RGGI from 2009, California and Quebec in 2013, South Korea in 2015, Mexico in 2020, and China in 2021.

Figure 44. ETS Coverage of Emissions 2005-21



Source: ICAP

Sector-wise, the major ETSs tend to all cover the power and industrial sectors (though RGGI, uniquely, covers only power). More unusually, the California-Quebec ETS covers transportation fuel suppliers; the EU ETS covers aviation too; South Korea's ETS covers domestic aviation and the waste sector; and New Zealand's ETS covers all sectors including forestry and agriculture. Several ETSs are considering adding additional sector coverage over time. Eligibility of climate capture and storage (CCS) is important for industrial and power decarbonization going forward. The EU ETS added eligibility for CCS in its Phase 3 (2013-20), while South Korea considers CCS under a domestic offset credit framework. California's Cap-and-Trade Program still does not recognize CCS. In practice, this means if a cement facility installs CCS, it would still have compliance obligations equal to its GHG emissions pre-CCS. Adding CCS eligibility in California it likely to be straightforward, given that its low-carbon fuel standard (LCFS) program recognizes CCS under the LCFS CCS Protocol. This means California carbon allowance prices could provide an additional price signal to stimulate CCS investment to reduce emissions.

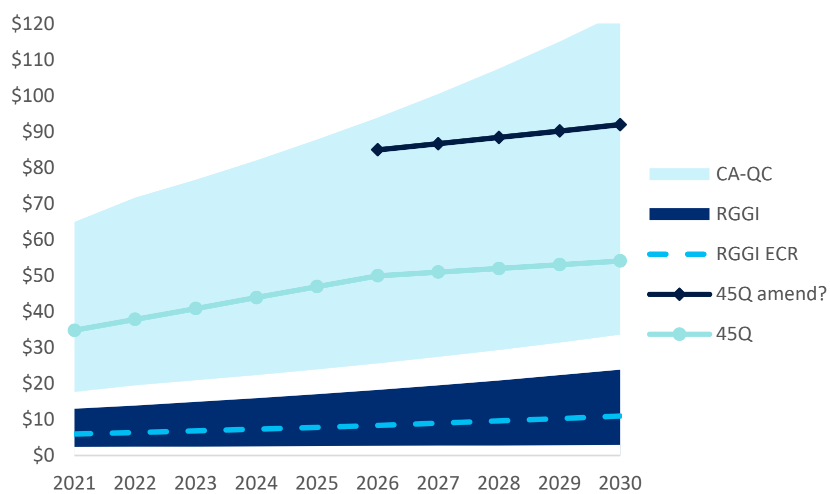
Early on, the major ETSs tended to face oversupplied markets, which were tightened up significantly following policy reforms later. Initially, policymakers may want market participants to build up familiarity with the ETS, and avoid economic pressure on emitters during the learning process. Further, for the EU ETS in particular, an oversupply of international carbon credits also swamped the market. With learnings from the EU experience, other ETSs may go through a shorter lifecycle to get to tighter, more stringent markets. Ongoing policy reviews for California-Quebec and RGGI in the next few years are likely to tighten the programs and thus raise allowance prices in these systems. China's ETS started with lenient caps and generous free allocations for emitters, which held down carbon prices to the single digits. But after an initial learning period, policies will likely be tightened, leading to higher prices and accelerating decarbonization to support ambitious climate goals.

In practice, carbon pricing systems exhibit significant flexibility, with few pure price or quantity-based systems based on earlier schemes. This means policymakers are able to target both the price and the quantity of emissions over time through hybrid carbon pricing systems. While carbon taxes have a fixed price but unknown quantity impacts, policymakers can include rule-based provisions for upward adjustments to price levels if emissions reductions fall short of annual targets.

Cap-and-trade systems have a falling, hard emissions cap meant to ensure a declining emissions path toward a target, but policymakers have also incorporated price floors, tiers, and ceilings. For instance, California uses an auction price floor, as well as a price ceiling and two price tiers, which if breached, trigger additional allowance supply from reserves. RGGI has a similar price ceiling (its “Cost Containment Reserve”) and a price floor, but also an “Emissions Containment Reserve” which provides an additional soft price floor above the lowest price floor, which if prices fall through, allowances are removed from the market. These are examples of price threshold-based triggers. It is important to note, however, that if these ETS prices end up trading mostly at the price floor or price ceiling, then it effectively becomes a carbon tax again, albeit a more expensive carbon tax given relatively higher ETS administrative costs.

There are also quantity threshold triggers, most notably the market stability reserve (MSR) mechanism in the EU ETS (see box below), but also the banking adjustment mechanism in RGGI, and treatment of unsold allowances at auctions in the California-Quebec ETS. Beyond these rule-based mechanisms, overall program design can be reformed over time, with ETSs having regular policy reviews to address system design; these tend to have a strong interest in keeping emissions reductions on track as well as keeping prices from being too low, or too high.

Figure 45. U.S. Carbon Price Ranges: California Cap-and-Trade, RGGI, 45Q Tax Credit ($/t)



Source: CARB, RGGI, US Congress, Citi Research *Not shown is California LCFS credit price at $200/t in 2015

Further compliance flexibility comes with the limited use of offsets, though these are likely to remain very limited. Policymakers may be wary of offsets, given the experience of the EU ETS, which eventually phased out the eligibility of UN Clean Development Mechanism certified emission reductions (UN CDM CERs) and Joint Implementation emission reduction units (JI ERUs). Meanwhile, the California’s ETS had an 8% usage limit for covered entities to use offsets to meet compliance obligations from 2013 to 2020, which has been reduced to 4% in 2021-25 and 6% in 2026-20.

Price volatility and speculation remain concerns, and should continue to be monitored. In the EU ETS, cost control measures can be trigged if undue speculation is suspected. In California, holding limits are used to ensure individual entities cannot manipulate prices. Nevertheless, speculative trading in ETSs remains important for providing liquidity to markets. In addition, the proportion of investor interest in primary and secondary markets remains low, though rising, and bears watching, given rising interest in carbon markets as part of the uptick in ESG considerations for the investment community.

The EU ETS in focus

The EU Emissions Trading System (ETS) was the world's first established carbon emissions market and the largest in emission volume, until the launch of the Chinese ETS this year. The EU ETS is a transnational cap-and-trade scheme. It is currently operational across 30 countries — all the 27 EU member states and three other European Economic Area countries (Norway, Iceland and Liechtenstein). Following the departure of the United Kingdom from the EU, the British government developed its own national ETS. Overall, the EU ETS accounts for roughly 75% of global carbon emissions market turnover and roughly 85% of its market value.

EU regulators have revised the legislative framework of the EU ETS several times, added a plethora of details, derogations, and caveats, and included more drastic market mechanisms. The regulatory underpinning is set to be revised further in order to align the EU ETS directive with the new, stricter decarbonization targets proposed by the EU Commission under the Fit-for-55 package. Since its inception in 2005, there have been four trading phases, with the latest one inaugurated in 2021.

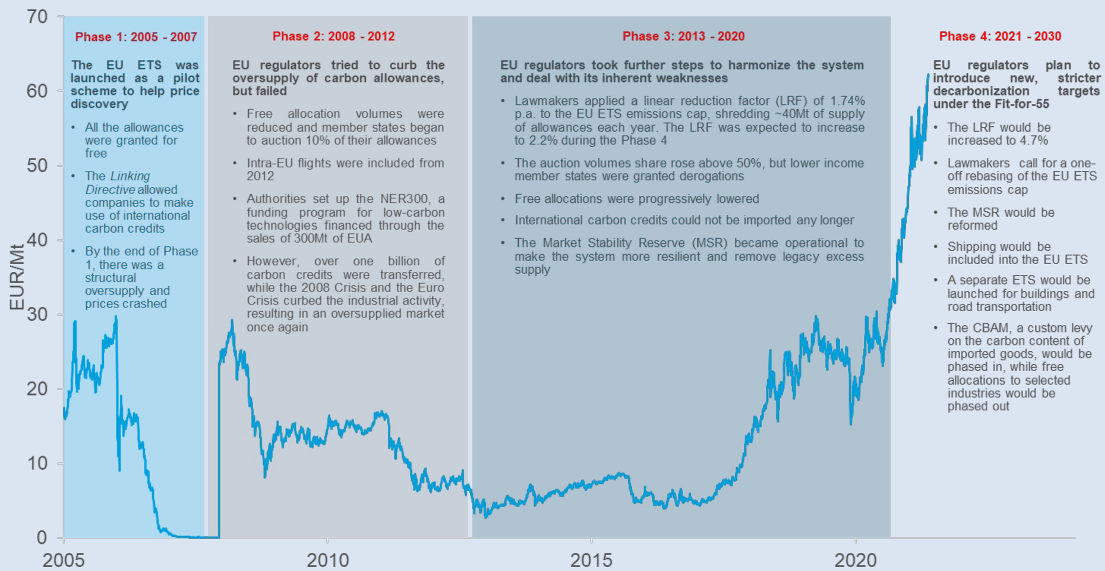
As with all emissions trading programs, the EU ETS is a commodity market with a monopolistic supplier — the regulator, in this case the European Commission. The EU ETS has a specific internal mechanism that dynamically rebalances supply and demand fundamentals through the Market Stability Reserve (MSR). The system sets an EU ETS Cap, which limits the total volume of carbon emissions from utilities, industrial emitters, and aircraft operators. These sectors are responsible for roughly 40% of the total amount of European GHG emissions. The EU ETS Cap defines the two primary sources of carbon emissions allowances (EUAs): auction volumes and free allocation volumes, although other elements and calculations concur to the formation of the final supply. By the end of April each year, covered entities must surrender a number of allowances equivalent to their actual emissions levels generated throughout the previous year. Therefore, the demand for allowances is represented by the verified emissions output of the covered entities.

One drawback of the EU ETS was the structural surplus of allowances accumulated in its early phases. Indeed, carbon emission permits do no expire. To address this issue and make the EU ETS more resilient to imbalances, EU regulators developed the MSR, which dynamically adjusts severe surpluses or deficits. The EU ETS allows covered companies to bank their unused allowances each year and surrender them in a future compliance year. During its early phases, the EU ETS accumulated a hefty surplus of allowances, threatening the stability of the system for years to come, in that carbon emission permit prices might be too low to induce emission cuts. The MSR seeks to impose a proper stability mechanism.

The MSR lowers the annual auction volumes by 24% of the total number of allowances in circulation (TNAC) if the TNAC is above 833MT, while it increases the annual auction volumes by 100MT if the TNAC falls below 400MT. The TNAC formula is

$$TNAC = Supply$$

A Brief History of the European Emissions Trading System (EU ETS)



Source: The ICE, Citi Research

Meanwhile, outside of carbon taxes and ETSs, there are many other environmental policies with regulations or codes, subsidies, and tax credits; the impact of these on GHG emissions when paired with a carbon tax, or the impact of these on carbon prices when paired with an ETS, can lead to further divergence of pathways across economic sectors and geographies. In the transportation sector, various policies outside of carbon pricing systems can include regulations on fuel economy (such as CAFÉ, or corporate average fuel economy, standards in the U.S.) or renewable fuel standards. In the power sector, these include policies such as clean energy standards (as has been proposed by the Biden Administration) or the renewable portfolio standard in California. In other sectors, subsidies and tax credits are seen for renewables, biofuels, CCS, and electric vehicles. Buildings and appliances can face efficiency standards. The fossil fuel sector has enjoyed various kinds of subsidies that could be eliminated. For all of these policies without an explicit carbon price, an *implicit* carbon price per ton can be estimated based on the cost of the policy and the corresponding GHG emissions reductions. This implicit carbon price can range widely and can be very high (see World Bank State of Carbon Pricing reports for 2019, 2020, and 2021).

Conclusion

Overall, carbon pricing systems, without a concerted effort for global harmonization, could remain a patchwork of systems that interact with one another. This may lead to higher overall costs and inefficiencies, though emissions reductions in different economic sectors may also require tailored carbon prices/markets to achieve their own net zero targets at their own pace. As noted, there are already several countries and jurisdictions with both carbon taxes and ETSs. In Canada, there are differences across provinces/territories due to a system based on a federal backstop; sub-national jurisdiction administrations may implement their own carbon pricing systems, but if these feature carbon prices below the federal benchmark, then the federal backstop comes into effect. Broadly, if different economic sectors or geographic regions have their own planned path to net zero, then their marginal costs of abatement over time are almost certainly going to differ. On the flip side, using a single carbon price across multiple sectors/geographies would mean that sub-sectors or sub-geographies necessarily have a different schedule to reach net zero, given different marginal abatement costs today and over time.

Carbon Offsets/ Carbon Credits

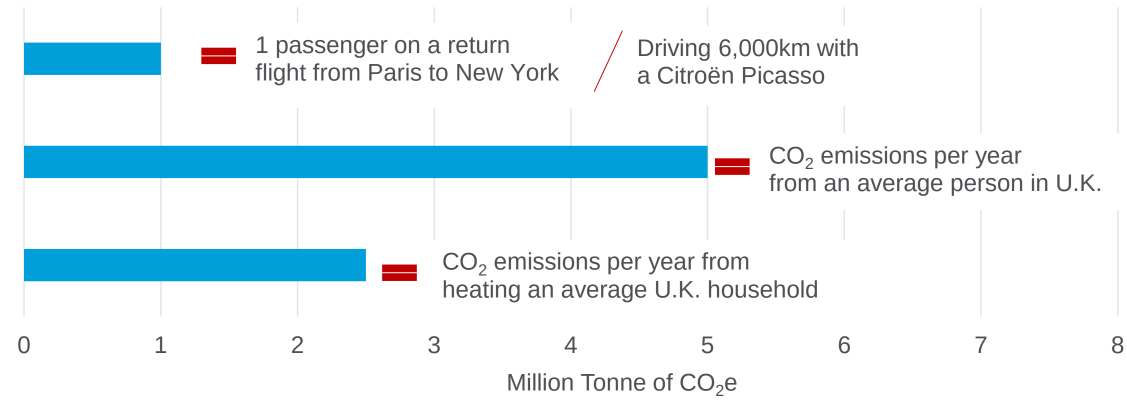
A carbon offset is used to compensate for emissions by funding an equivalent carbon dioxide saving elsewhere. It is essentially an accounting mechanism — a way of balancing the scales on pollution or in this case on greenhouse gas emissions. In the past, offset schemes have been particular successful in solving things like air pollution. The difference is that to reduce local air pollution, the offsets need to be in the vicinity of the pollution. Given greenhouse gas emissions is a global problem, it does not matter where emissions reductions take place.

The concept of carbon offsetting began in the late 1980s with the first demonstrations of carbon offsets mostly voluntary and done on a small scale. Offsets really started to take off after the Kyoto Protocol in 1997. The Kyoto Protocol was one of the most complex multilateral environmental agreements ever negotiated. At its core was a bargain between developed countries and developing nations. A flexible compliance mechanism was agreed upon, involving carbon offsets generated by either Annex 1 countries under Joint Implementation or offsets generated in the developing world under the Clean Development Mechanism (CDM). [62] The CDM became the largest offset market ever created.[63]

Offsets are measured in tonnes of carbon-dioxide equivalent (CO_2e). One tonne of carbon offsets represents the reduction of one tonne of carbon dioxide or its equivalent in other greenhouse gas emissions. To put it into perspective, one tonne of CO_2 is equivalent to one return trip from Paris to New York or driving 6,000 km with a Citroën Picasso. The average person in the U.K. emits approximately 5 tonnes of CO_2 per year while the average U.K. household emits 2.5 tonnes of CO_2 per year just from heating their home. It was estimated that by the end of 2019 over 36.8 billion tonnes of carbon dioxide was pumped into the atmosphere from industrial activities and the burning of fossil fuels. Total carbon emissions from all human activities, including agriculture and land use, totalled 43.1 billion tonnes.

[62] Annex 1 countries include the industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States.
[63] Michael Wara and David G. Victor, "A Realistic Policy on International Carbon Offsets," Program on Energy and Sustainable Development Working Paper, No. 74 (April 2008).

Figure 46. Equivalence of Tonnes of CO_2e



Source: Citi Global Insights, OECD

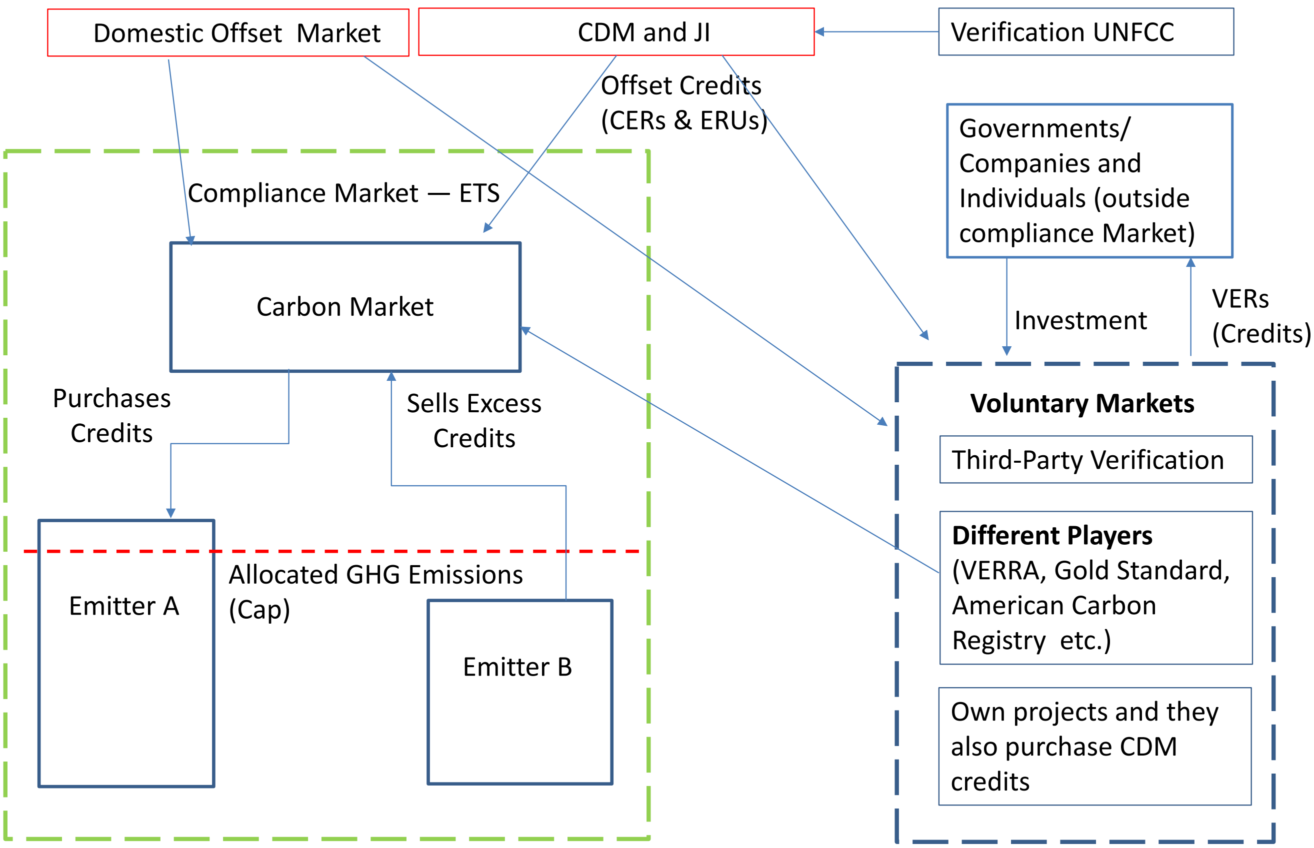
Main Markets for Offsets

So how do offsets actually work? Currently there are two main markets for offsets: (1) the compliance market, which is created and regulated by mandatory national, regional, or international policies/regulation as discussed in the section above, and (2) voluntary market which enable companies and individuals to purchase offsets on a voluntary basis.

Compliance markets usually use cap-and-trade systems and some of these systems allow companies to offset a proportion of their CO_2 emissions. Some systems allow the use of Kyoto carbon credits (CDM and JI) while others allow the use of domestic credits for offsets.

The voluntary market functions outside of the compliance market and gained traction in 2005, when it was recognized there was a demand for these instruments beyond just regulated companies and countries. There are many companies and organizations that offer carbon credits/offsets for the voluntary market. These organizations offer hundreds of carbon offsets projects in many different parts of the world, The majority of voluntary offsets are third-party verified; however, the protocols around which offsets are verified vary amongst the different programs. Each organization has different projects listed on their website — relating to, as examples, energy efficiency, biogas digesters, efficient stoves, and forestry — and each project has a different price per tonne of CO_2. The variation of pricing between carbon offsets provided by different organizations can vary immensely for reasons that are far from transparent.

Figure 47. Global Offset Market



Source: Citi Research

Voluntary Market

Voluntary markets are expected to increase substantially over the coming years. Over 3,000 companies have joined the Race to Zero coalition and these companies join 120 countries who have also committed to reaching net zero by 2050.[64] Meeting these targets will require complete decarbonization, which is difficult for some countries and some sectors. For example, technology to decarbonize road freight, aviation, shipping, and some industrial sectors is still far away from being economical.

The demand for carbon offsets is also set to increase with CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation). CORSIA was adopted in 2016 by the International Civil Aviation Organization (ICAO) with the aim to address any annual increase in total CO_2 emissions from the international civil aviation above 2020 levels and contribute to the industry's commitment to carbon neutral growth from 2020. It was the first time a single industrial sector agreed to a global market-based mechanism to tackle climate change. The scheme started operation in January 2021, with the voluntary phase expected to last until 2023.

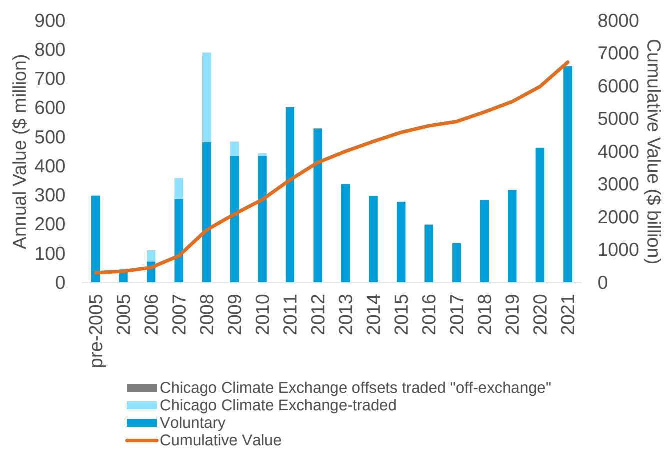
Seventy-eight countries, representing three-quarters of international flights, have volunteered to take part in the initial phase. The first formal phase of CORSIA is expected to start from 2027 to the end of 2035 and will be mandatory for all ICAO members, except those with less than 0.5% of international aviation. Airlines under the scheme would be required to buy offsets to cover any growth above the 2019

[64] https://unfccc.int/climate-action/race-to-zero-campaign

baseline level. Before the onset of the COVID-19 pandemic, the International Air Transport Association (IATA) forecasted CORSIA would have to offset around 2.5 billion tonnes of CO_2 (~1.6 to 3.7 $GtCO_2e$) between 2021 and 2035, which is an average of 165 million tonnes of CO_2 per year.[65] This is the equivalent to the annual CO_2 emissions from the Netherlands. The IATA also estimates the CORSIA scheme could generate over $40 billion in climate finance between 2021 and 2035. Some experts claim the total market for carbon credits could be worth upward of $50 billion in 2030.[66]

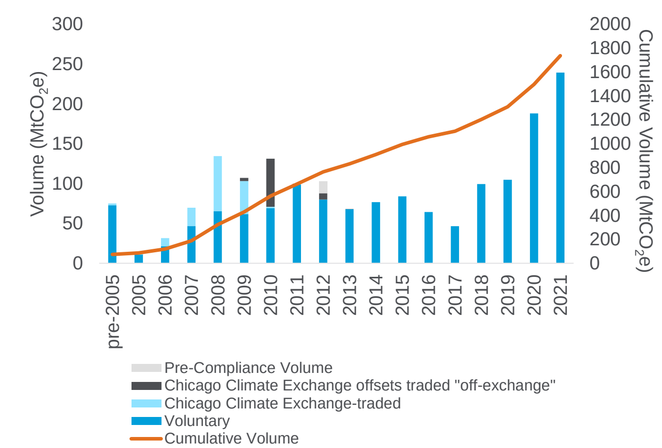
We are already seeing an increase in offsets in 2021; however. the number is still rather small compared to what many are suggesting the market could reach over time. According to Ecosystem Market Place as of August 31, 2021 traded volumes of voluntary carbon offsets have reached the highest value since 2005 — estimated at 240 $MTCO_2e$. The traded value of this market, as of August 2021, had nearly reached the peak of 2005 — a total of $748 million.

Figure 48. Market Size by Traded Value of Voluntary Carbon Offsets



Source: Ecosystem Marketplace, 2021 Washington, DC: Forest Trends Association. https://ecosystemmarketplace.com/

Figure 49. Market Size by Traded Volumes of Voluntary Carbon Offsets



Source: Ecosystem Marketplace, 2021 Washington, DC: Forest Trends Association. https://ecosystemmarketplace.com/

Looking at sector data, we see that the majority of the offsets measured in value and volume in 2021 were allocated to the forestry sector, followed by renewable projects. According to Ecosystem Market Place there seems to be a real interest in forest and land-use project types including Reducing Emissions and from Deforestation and Forest Degradation "plus" Conservation (REDD+) credits.[67] REDD+ is a United Nations backed framework that aims to reduce carbon emissions by stopping the destruction of forests. The program helps countries evaluate the carbon and important ecosystem services that forests provide, and create financial incentives to reduce deforestation. It basically means that entities — countries, the private sector, or multilateral funds — can pay countries not to cut down their forests. This can take the form of direct payments or can be exchanged as carbon credits. There is a lot of debate whether to include REDD+ projects as part of offset schemes and there is a lot of criticism of REDD+ projects, including

[65] Carsten Warnecke et al., "Robust Eligibility Criteria Essential for New Global Scheme to Offset Aviation Emissions", *Nature Climate Change*, 218-221 (2019).
[66] McKinsey Sustainability, "A Blueprint for Scaling Voluntary Carbon Markets to Meet the Climate Challenge, (2021); Taskforce on Scaling Voluntary Carbon Markets, January 2021
[67] Ecosystem Marketplace, 2021 Washington, DC: Forest Trends Association. https://ecosystemmarketplace.com/.

the effect some projects had on local communities and the problem of permanence and additionality. We discuss the issue of permanence and additionality later on in the chapter.

What Are the Benefits and Criticisms of Offsets?

There are many people who believe that offsets can really make a difference to climate change, while others who are adversely critical of them. Undoubtedly, carbon offsets provide regulated firms access to cheaper sources of CO_2 emission reductions while at the same time reducing their compliance costs. Offsets can help reduce CO_2 emissions from hard-to-abate sectors such as aviation and road freight, where current low carbon technology is not yet commercially available or economically feasible. They can steer capital into sustainable infrastructure, better forestry management, renewable energy sources and other projects which might not have occurred without such mechanisms. They can also have additional social benefits such as improving economic development or health and promoting the transition to renewable sources.[68] For example, projects approved by the Gold Standard must meet at least two of the UN Sustainable Development Goals (UN SDGs) in addition to addressing climate change. They also allow unregulated firms to publicize various projects they have supported and become carbon neutral. Offsets also encourage a company to know what it currently emits, as they need to have this information before they start buying offsets. Crucially and most importantly, offsets can be applied quickly.

There is criticism, however, around the way offsets operate. Many argue that offsets are the “get out of jail free” card for corporates that could potentially discourage companies from solving their emissions problem, and discourage the investment needed to reduce their greenhouse gas emissions over time. Other criticisms focus on the quality of offsets and argue it is important that offsets provide additionality, permanence, and are easily enforceable. We discuss some of terms below.

- **Additionality:** For offsets to compensate for emissions they must be additional — i.e., they must represent action above and beyond what would have happened in the absence of an offset project. Many offset protocols include various tests for additionality including whether the project is the first of its kind or significant departure from common practice. Proving additionality is extremely difficult and many argue that determining a business-as-usual scenario is near to impossible to prove.

- **Permanence:** For carbon offsets to compensate for a regulated firms’ emissions, they must be permanent. It is no good investing in planting trees or in forest management if at a later time these trees are either cut down for conversion to cropland or else destroyed from natural fires. To counter this, many standard bodies withhold a certain percentage of each project’s offsets in a buffer pool, which acts as an insurance mechanism. They also contractually require minimum project lengths to ensure sequestration continues over time. However, even a project length of 100 years does not equate to permanent sequestration. In other words, trees might be a risky bet for permanent carbon storage, as they demand indefinite monitoring and protection.

- **Enforceability:** An offset needs to be enforceable, meaning the emissions reduction it has created is supported by legal instruments that define their creation, provide for transparency, and ensure exclusive ownership. Enforceability also relies upon the capability of government and judicial

[68] Benjamin C. Pierce (2018), Carbon offsets- An overview for scientific societies

institutions to enforce contracts and this capability differs between different countries. Weak contract enforceability in many developing countries is unfortunately an accepted reality. This is also important with regards to permanence — how a contract is enforced for a long-term period to render sequestration offsets permanence matters.[69]

- **Double Counting:** When an offset is purchased, the underlying emission reduction should not be sold again or allocated to someone else. This seems simple enough but in practice it is proving to be difficult. For example, during the COP25 meeting many countries agreed on the use of international offsets; however, they fell short of agreeing on a trading scheme. Countries such as Brazil wanted more leeway in counting rainforest preservation against their own targets while also still selling offsets to other countries.[70]

[69] Jack B. Smith, "California Compliance Offsets- Problematic Protocols and Buyer Behavior", Harvard Kennedy School, Mossaver-Rahmani Center for Business and Government, 2019.

[70] Umair Ifran, "Can You Really Negate Your Carbon Emissions? Carbon Offsets Explained," Vox, February 27, 2020.

- **Unintended Consequences:** Offsets have also been criticized for having unintended consequences that could inadvertently increase CO_2 emissions and in some cases also have negative impacts on local communities. For example the CDM has been criticized over its offsets used for destroying the gas flouroform (HFC-23) — a potent greenhouse gas — during the 2009-13 period. The average price of CDM offsets was nearly $20 during this period, about 70 times the cost of destroying the HFC-23 gas. Many Indian and Chinese manufacturers recognized the revenue potential and therefore increased their production of the gas while at the same time cashing in on offsets. By 2013, 362 million offsets had been issued to Chinese HFC-23 projects — and some report that much of this revenue drained into government's coffers.[71]

Figure 50. Summary of Benefits and Criticism of Offsets

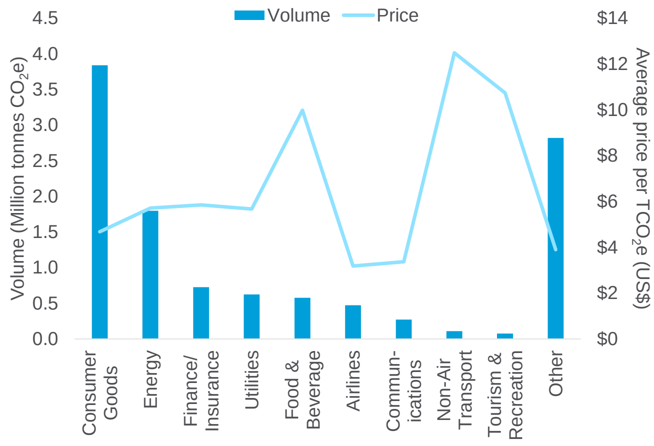
Benefits	Criticisms
Access to cheaper sources of CO_2 emissions reductions for regulated firms (most Cap-and-Trade systems allow a percent of offsets to be used).	Carbon offsets could potentially discourage companies from solving the problem.
Steer capital into sustainable infrastructure, renewable energy, and forestry projects which might not have occurred without this investment.	They could discourage companies from investing in low carbon solutions.
Projects can also have additional social benefits.	Good quality offsets must be additional, permanent, enforceable, and not have unintended consequences. Many argue these are hard to measure and to prove.
Encourage companies to calculate what they emit as they need this information before they decide to offset.	There is no global standard for offsets and many providers operate differently from each other.
Help compensate for GHG emissions from hard-to-abate sectors.	
They can be quickly applied.	

Source: Citi Global Insights

Many organizations have worked hard to improve the way they operate and to become more transparent in the way they work. However, there isn't a global standard for offsets and many firms operate differently. Firms that offer offsets have different prices per tonne of CO_2 for similar projects and there is a lack of transparency as to why these prices differ so much.

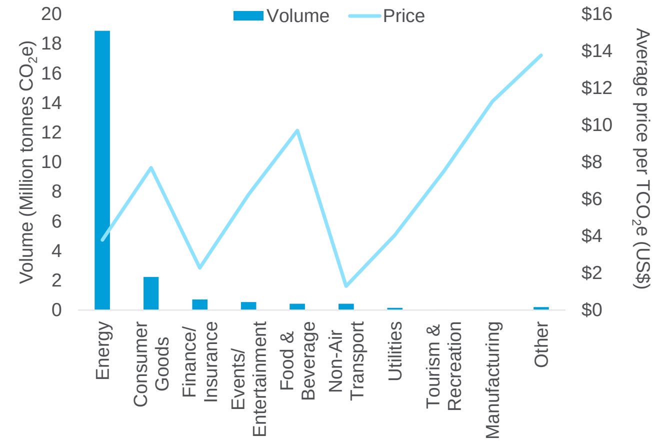
[71] Jack B. Smith, "California Compliance Offsets- Problematic Protocols and Buyer Behavior", Harvard Kennedy School, Mossaver-Rahmani Center for Business and Government, 2019.

Figure 51. Volumes and Prices by Buyer Sector, 2020



Source: Ecosystem Marketplace, 2021 Washington, DC: Forest Trends Association. https://ecosystemmarketplace.com/

Figure 52. Volumes and Prices by Buyer Sector, 2021 through August



Source: Ecosystem Marketplace, 2021 Washington, DC: Forest Trends Association. https://ecosystemmarketplace.com/

The Taskforce on Scaling Voluntary Markets was set up to bring all parts of the value chain of offsets to work together and provide recommendations to address some of the "pressing pain-points" facing voluntary carbon markets.[72] They have recently set up an independent governance body to ensure the integrity of voluntary markets. They aim to publish a Core Carbon Principles for voluntary markets, including a set of threshold standards to set a global benchmark for carbon credit quality. However, it is not quite clear what this group will be producing and how they aim to change or regulate the voluntary offset market.

The number of offsets is expected to increase over the years and the price per tonne of CO_2e for each offset should also increase. Current prices are too low, and there is the risk that many firms will choose to use offsets rather than reduce their absolute emissions. However if offsets are done well, they could be a real tipping point for climate change (at least in the short term), as they can be quickly applied.

[72] Taskforce on Scaling Voluntary Carbon Market website.

Appendix 2: Calculating Carbon Price and Future GHG Emissions for the Global Carbon Tax Scenario

In order to calculate the revenue generated from a global carbon tax in Chapter 4 of this report, we needed to decide on the right carbon price to use and calculate future greenhouse gas emissions of the countries we analyzed. Below is a description of the methodology that we used.

Setting Up the Right Carbon Price

To find the optimal price for carbon, economists have focused on a metric called the social cost of carbon (SCC). It represents the marginal social damage from emitting one metric tonne of carbon dioxide-equivalent at a certain point in time. It is usually calculated using climate-economy integrated assessment models (IAMs).[73] However there is a degree of uncertainty in calculating the SCC, with different studies coming up with different pricing regimes. This is due to the methodology used, the parameters taken into consideration, approach to weighing impacts in different regions, the discount price that is used, and the study time period among others.

Kaufman et al. (2020) uses a different methodology which he calls a "near-term to net zero" (NT2NZ), which is combined with a broader policy strategy to achieve an emissions pathway consistent with the net-zero target in the near term. [74] There are four steps to this analysis (1) select a net-zero CO_2 emissions date; (2) select an emissions pathway to the net-zero target; (3) estimate CO_2 prices consistent with the emissions pathway in the near term; and (4) periodically update steps 1, 2, and 3. For a net zero target in 2050, the author claims the U.S. would require a carbon price of between $34/tonne and $64/tonne in 2025, and $77/tonne and $124/tonne in 2030 should be used.

Other studies as shown in the table below have come up with different carbon prices. For example, the High Level Commission on Carbon Prices stated a carbon tax consistent with achieving the Paris temperature target should be at least $40-$80/tonne of CO_2 by 2020 and $50-$100/tonne by 2030.

Figure 53. Suggested CO_2 Carbon Prices in Various Studies

Source	Carbon Price	Goal
High Level Commission on Carbon Price	$40-$80/tonne of CO_2 by 2020 and $50-$100/tonne of CO_2 by 2030	To achieve the Paris temperature target
IMF	$75/tonne of CO_2 by 2030	To keep temperature increase to 2°C
IEA	CO_2 prices for electricity, industry and energy production would need to reach $130 and $250 for advanced economies and $90 and $200 for a selection of EMs in 2030 and 2050 respectively.	To reach the IEA's net zero scenario

Source: Citi Global Insights

As shown in Figure 53, there is not consensus as to what the right carbon price is. Given the literature above, we run two different scenarios based on different prices for the 10 largest emitters (the U.S., EU, Japan, Canada, Russia, South Korea, China, India, Brazil, and Indonesia. plus the U.K.).

[73] R. Daniel Bressler, "The Mortality Cost of Carbon," *Nat Commun* 12, 4467 (2021).
[74] Noah Kaufman et al., "A Near-Term to Net Zero Alternative to the Social Cost of Carbon for Setting Carbon Prices," *Nat. Clim. Chang,* 10, 1010–1014 (2020).

- **Scenario 1** assumes a tax rate of $100 starts in 2030 and is equal across developed and developing countries. It increases over time as described in more detail below.

- **Scenario 2** assumes the tax rate starts in 2030, with developed nations taxed at $100 per tonne of CO_2e, and emerging and developing countries initially at $50 per tonne of CO_2e, but rising over to the same level as developed markets. The problem with a different tax rate is that developed markets could feel they were placed at a competitive disadvantage until the emerging markets tax rate reaches parity. This could potentially lead to carbon leakage, where businesses in developed markets move to emerging markets to avoid the higher tax rate. To avoid this, the time period where tax rates are different should be the shortest possible to avoid developed markets setting up carbon border adjustment mechanisms to protect their market.

We base our analysis on all greenhouse gas (GHG) emissions, rather than just on CO2 emissions, as many individual country national determined contributions (NDCs), are primarily focused on the reduction of all greenhouse gas emissions and not just CO2. We also recognize that to reach a net zero world, we need to reduce all GHG emissions. However, taxing all GHGs instead of just energy-related emissions is more challenging as their source is not limited to fossil fuel use and some of these gases are difficult to measure.

A carbon tax would be placed at a country level with each individual country deciding the best way to implement such a tax domestically. Options include setting up regulatory requirements for each sector, and mandates for the use of certain fuels; creating ETS systems,; making improvements in fuel efficiency for road transport; and just adding a simple carbon tax. Each government would decide the best way for such a tax to be introduced in their economy and could involve a combination of the options noted above. International shipping and international aviation are not included in a country's NDC, so these sectors would also be linked to these carbon prices; however, they will be managed by the International Maritime Organization (IMO) and International Civil Aviation Organization (ICAO), which currently regulate these sectors.

The tax in each of these scenarios would increase over the years, either in a stepwise fashion, after being constant for the first 5 to 10 years. A second option would be for the carbon tax to increase slowly every year. Although it is important the tax rate takes into consideration inputs like inflation, income increases, and the price of fossil fuels over time, it is also important that a long term plan is given for tax rate increases so that countries and businesses can be prepared and be able to plan for these changes. This will give market participants more confidence to invest to invest in new technologies and alternative fuels.

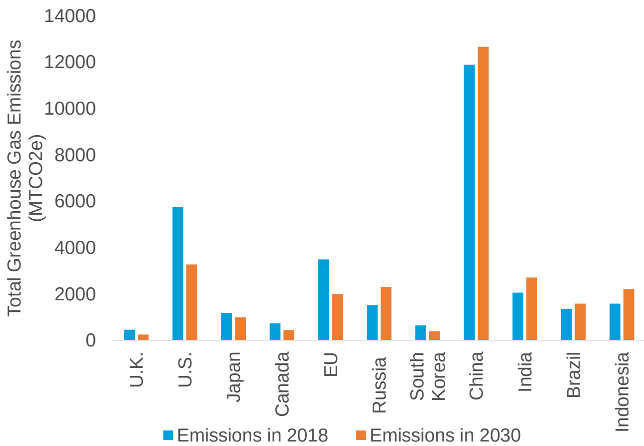
Projecting Future GHG Emissions

To calculate the revenue generated from a carbon tax, we first need to estimate a country's future emissions. Projecting this is extremely uncertain as a country can follow a number of different pathways to reduce its emissions over time. For 2030, we assume that every country in our analysis reaches their national determined contribution. Calculating what this means is also uncertain given that many developing markets such as China and Indonesia do not give an absolute number for GHG emissions in 2030, instead basing their projections on parameters such as lowering the carbon intensity per unit of GDP. There is also uncertainty in calculating GHG sinks or in the case of some countries, GHG emissions from land use change (LULUCF).

Many countries include LULUCF in their NDCs — for example China's key target for the LULUCF sector as presented in its NDC is an increase of the national forest stock volume by 4.5 billion cubic meters in 2030, compared to the 2005 level. What this actually means in terms of greenhouse gas emissions reductions over time is very difficult to calculate with any certainty.

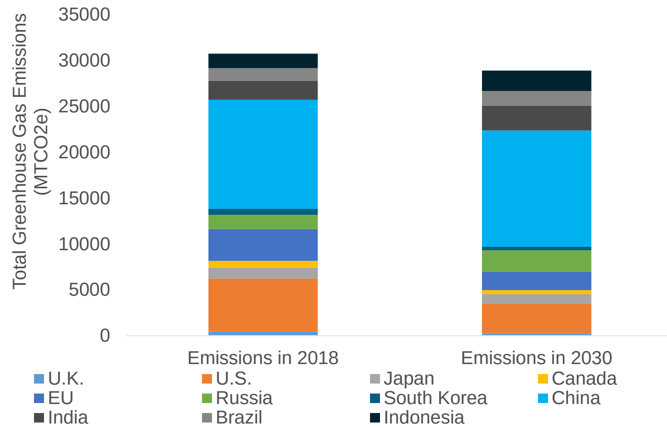
Below are two graphs which compares greenhouse gas emissions in 2018 for the countries we have studied with our projected greenhouse gas emissions if countries were to reach their INDC in 2030. As you can see the reductions in total greenhouse gas emissions are not very significant for the countries we analyzed given that many emerging markets greenhouse gas emissions are still expected to increase in 2030. However, emissions in developed market decrease substantially in this period and it is thought that in some emerging markets emissions would peak after 2030 and reduce over time.

Figure 54. Greenhouse Gas Emissions, 2018 vs. 2030 by Country



Source: Citi Global Insights

Figure 55. Total Greenhouse Gas Emissions, 2018 vs. 2030, by Country



Source: Citi Global Insights

Appendix 3: Carbon Border Adjustment Mechanisms

Approximating a Global Carbon Price through the Back Door

Increased ambitions for emission reductions raise concerns about the potential for “carbon leakage.” In carbon leakage, businesses transfer production to countries with lower emission constraints based on costs related to climate change. This can potentially lead to an increase in global emissions. To counter this a carbon adjustment mechanism could be introduced.

Instituting a Carbon Border Adjustment Mechanism (CBAM) or direct global carbon tax through Regional Free Trade Agreement (RFTA) frameworks — equivalent to our climate club scenario — could incentivize the following long-term outcomes:

- Minimize carbon leakage and counter production shifts by implementing an iterative CBAM tariff on all countries within climate club frameworks, thereby limiting defection and instituting General Agreement on Tariffs and Trade (GATT) Article XX with the objective of minimizing impact to (GATT) commitments consistent with the World Trade Organization (WTO), the Kyoto Protocol, and the Paris Climate Agreement.

- Maintain regional and national direct and indirect carbon tax systems, while gradually increasing climate club-determined carbon prices over time to accommodate developing counterparts by minimizing domestic GDP impact losses by aligning the CBAM with national and regional prices.

- Accelerate alternative energy innovation by incentivizing carbon efficient means of production through CBAM export rebates, while maintaining short-term carbon allowance programs to enhance subsidies and dedicated financing solutions, such as a Climate Action Development Bank.

Leveraging CBAM & RFTA Policy Momentum…

The utilization of RFTA’s or climate clubs as a practical CBAM mechanism is common to academic debates amongst policy experts. Unilateral leverage is not only an effective policy tool for larger export markets seeking to limit carbon leakage, but it also will likely induce border carbon adjustment (BCA) cooperation thereby fostering a more “comprehensive global regime.”[75].

Non-UNFCCC (United Nations Framework Convention on Climate Change) state actors will likely be incentivized to choose to cooperate by legislating or implementing the necessary domestic climate policy regulations rather than forgo participating in sizeable export markets. Because RFTAs represent the largest exports markets in the world (e.g., the European Union and the U.S.-Mexico-Canada Agreement), the logic of impasse scenarios is that such policies would induce non-cooperation amongst RFTA members and non-UNFCCC state participants. This is unlikely given the prospects of such export market losses coupled with limited alternative markets.

[75] Madison Condon and Ada Ignaciuk, *Border Carbon Adjustment and International Trade: A Literature Review*, OECD Trade and Environment Working Papers 2013/06, 2013.

In September 2021, the European Commission recommended that beneficial trade tariffs be linked to commitments set forth in the Paris Agreement. In doing so, the European Commission proposed to utilize the sizeable export market of the European Union as a unilateral tool to force carbon-intensive industries to transition or lose the benefits enjoyed under the EU regional free trade agreements.

This potential legislation, if passed, would effectively reverse the long-standing Generalized Scheme of Preferences (GSP), which allow for lower import duties on foreign exports. In addition, the EU will propose adding the Paris Agreement to the current list of international agreements, including the United Nations Framework on Climate Change, Kyoto Protocol, and Convention on Biological Diversity.[76] The likelihood that countries forgo the benefit from the EU export market and thus certain free trade agreements, is improbable given the expected revenue losses due to non-compliance.

The EU CBAM proposals have received critical political attention in both the United States and Russia. Though publicly supportive of a carbon border adjustment tax, the White House withheld support of a $3.5 trillion proposal that would include a CBAM tax to fund the Infrastructure and Reconciliation Bills in Congress in July 2021.[77] Later iterations and amendments to this package include a national carbon tax, which is seen as a compromise to earlier attempts to institute a CBAM but has also been part of the debate within the Democratic Party on how to finance U.S. infrastructure plans.

Despite the political obstacles, a global carbon tax is gaining considerable traction from within the United States, the European Union, Canada and Japan. According to the World Bank, these countries represent nearly 60% of global trade. Together with the recent rise in the volume of RFTAs (see Figure 56), the prospect that CBAMs will inevitably become a mainstay within regional trade frameworks is conceivable and increasingly likely. The question is when.

A key success factor is size, which confers market power. Therefore, having more regions jointly implement a CBAM is important, but it might mean reducing the number of goods that fall within a CBAM system, since not all countries would agree to the same set of goods. In other words, there would be a tradeoff between scale and the number of goods covered. As much as the EU tries to use a CBAM to entice other regions to adopt climate-friendly regulations, some exporters might simply give up the European market if the compliance burden is too costly for them. It might be too costly because of the necessary investments needed to cut emissions and the possible need to maintain parallel operations, where one set of operations would meet the EU's CBAM emission standards and another set would cater to all other regions without CBAM.

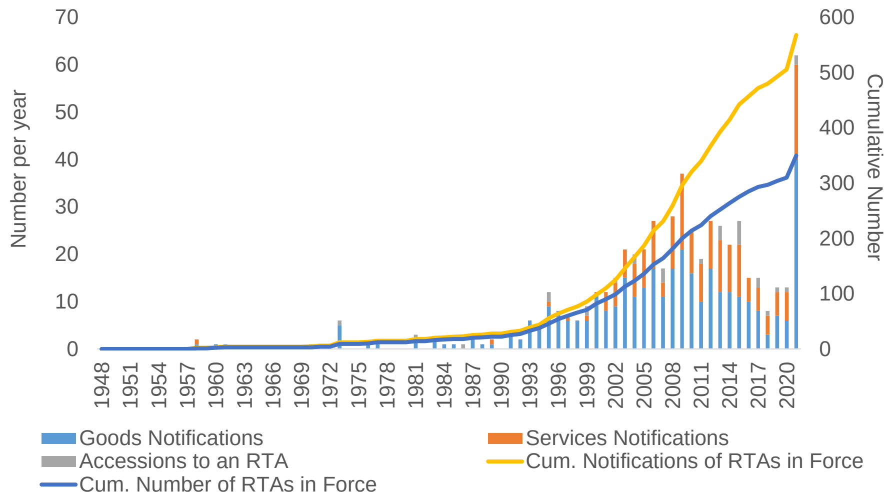
The number of goods within a CBAM might start out small, thus incentivizing more jurisdictions to join, but also to help accelerate the development and cost decline of either emission abatement technology or alternative non-emitting processes. The number of countries joining a CBAM and abatement technology adoption go hand-in-hand — the larger the number of countries joining the CBAM, the more combined market power they have, which then would economically compel more exporters to adopt emission abatement technology.

[76] EU links tariff preferences to Paris climate agreement

[77] White House withholds support of Democratic carbon border tax

The more that firms adopt abatement technology, the more likely that costs would decline, through economies of scale and learning by doing. The hope is this cost decline would lead to further technology diffusion, so that more industries could adopt emission abatement technology, to the extent that such technology can be applied in different industries.

Figure 56. Regional Free Trade Agreements, 1948-2021



Source: World Trade Organization, Citi Research

What Steps Are Necessary to Create a Functional RFTA Carbon Border Adjustment Mechanism?

The formulation of a regional RFTA carbon price benchmark (a climate club) that is consistent with the proportional GDP and import/export considerations is necessary for most countries to meet the agreed upon emission reduction targets that align to the national determined contributions (NDC's) set forth the in Paris Agreement. The key differentiation when determining the balance between the national carbon price tax or emissions trading scheme (ETS) versus the prevailing tariff from a climate club is the relative geographic consideration of emission targets (i.e., national, regional, or global). A multilateral carbon tariff within a climate club structure would more immediately achieve the practical implementation of emission targets given the sheer size of their export markets. It would thereby make a global comprehensive agreement, at least within the near-term, unnecessary and even counterproductive to the emission reduction objective.

The legal and regulatory framework surrounding an RFTA or climate club must account for at least four actions: First, it is imperative that a climate club CBAM is designed in a manner that separates the CO_2 emission generation with respect to carbon tariffs and the specific application to the sector carbon-intensive production verticals. This would minimize potential conflicts with the WTO and GATT.[78] Second, the WTO's Trade and Environment Committee needs to enact a new article that formalizes the general environmental provisions of the WTO principles, specifically citing the Montreal Pledge (2014) and Basel Convention (1992).

[78] Katrin Jordan-Korte and Stormy Mildner, "Climate Protection and Border Tax Adjustment: Economic Rationale and Political Pitfalls of Current U.S. Cap-and-Trade Proposals," 2008.

Third, it needs to include the necessary climate agreements, including the United Nations Framework Convention on Climate change (UNFCCC), the Kyoto Protocol, and Paris Agreement. Whether a state is party to these agreements will be irrelevant if the non-annexed nations are smaller exporters with respect to the climate club. Lastly, the general argument that border taxes are prohibited is historically inaccurate as governments continue and have deployed them since the early 1800's.

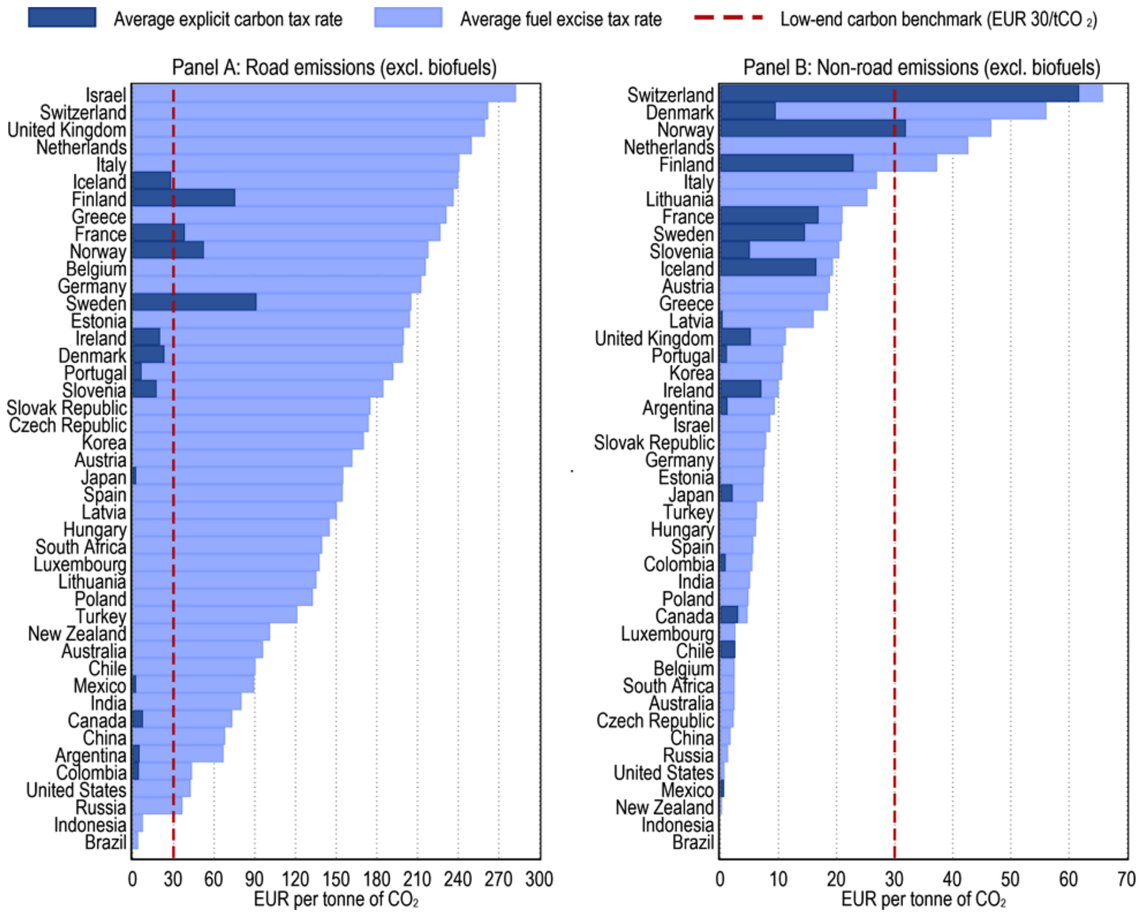
A mutually accepted regional transitional CBAM roadmap that gradually aligns country ETSs and carbon allowances consistent with that of the free trade/climate club carbon tax benchmark is critical. These CBAM's must account for the practical transition of carbon-intensive sectors and reduction pathways specific to the agreements by creating an CBAM revenue collection and allocation program that targets multi-national corporations (MNCs) and domestic energy companies that are incentivized to restructure their carbon intensive export industries over the long-term. Within the RFTA framework, specific earmarks and debt financing through a Use of Proceeds (UOP) model complements the regional financing provided by a Climate Action Development Bank (See Chapter 4).

Global Carbon Tax Step-Function Plan (Developed Countries)

In Figure 57, the variation between the average explicit and current national excise taxes on fossil fuels for OECD countries vary widely. As previously outlined, this is a result of inconsistent approaches to ETS market dynamics and standard setting across greenhouse gas (GHG) emission channels derived from legislated, and often compromised, carbon pricing policies and laws. As long as the current pricing dynamic is uneven with respect to OECD benchmark prices, the likelihood of achieving the 2030 target emission reduction levels is low. Therefore, rather than create a global institutional carbon tax, utilizing the current RFTA agreements and institutions as conduits for a climate club CBAM, is far more practical and timely. This does not mean that pursuing or striving for a globally accepted carbon tax should be abandoned. Rather, institutions, such as the WTO, World Bank, and our proposed Climate Action Development Bank, can induce supplemental financing and provide the necessary policy and scientific support to guide RFTA structures so as to limit the potential economic losses across carbon intensive emission sectors, both nationally and regionally.

Further, preventing the inadvertent derailment of a climate club implementation would assure that the CBAM tariff price over the next decade gradually merges with the domestic carbon prices set in each country. The step function would lead to improved reductions in carbon intensity without inducing endogenous shocks that might prompt unforeseen social and political counterproductive challenges. The requirement that countries adopt another country's domestic carbon prices with differentiating endowments is not reasonable nor practical in the short-term. Therefore, given that the proportionate GHG emissions as a percentage of GDP per capita is higher for OECD countries, developed nations within a climate club framework must absorb the proportional upfront tariff impact in the near-term, while subsequently lowering their burden over the longer term as emerging countries acclimate to the new regional Energy Transition structure, while CBAM and domestic carbon prices converge. This would lead to nominal carbon emission reductions in emerging market countries in the short-run, with greater, relative outsized emission reductions over the longer term.

Figure 57. Effective Road vs. Non-Road Emissions Fossil Fuel Carbon Rates by Country



Source: OECD

Global Carbon Tax Step-Function Plan (Developing Countries)

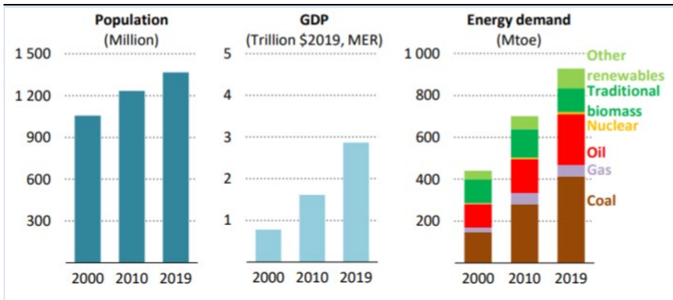
The disproportionate advantages gained by regional and domestic developed economies that can more readily deploy alternative energy solutions must be addressed, either in a regional or global framework. As discussed in previous sections, the WTO must play an integral role in determining the optimal climate club CBAM levels to ensure that carbon leakage is minimized.

The historical antecedents in developed countries, from both a tariff and emissions perspective, as a percentage of GDP per capita are critical when devising a globalizing structure of a climate club CBAM. This, of course, could exacerbate competing national interests when determining emission reduction targets for developing nations, even within varying pricing structures such as an ETS price, cap-and-trade permits, or even a global carbon price. The initial upfront cost by developed nations should be accepted, as the advantages of creating a regional framework to advance technological transfer of alternative energy methods through the export of such industries to developing nations, which suffer from importing downstream fuel and energy inflation costs, is mutually advantageous.

Case Study: Thermal Coal Transition in India

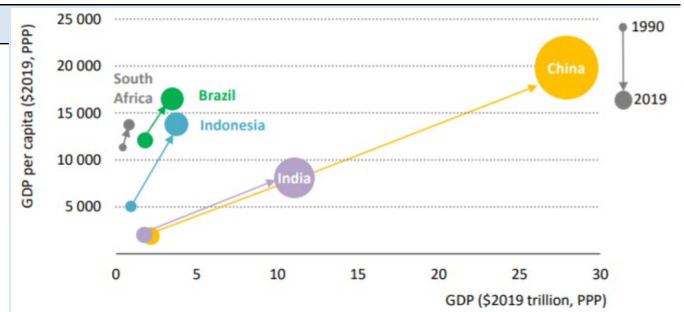
A sizeable portion of India's low income population relies on thermal coal. Therefore, it is imperative that a CBAM proactively support or subsidize practical substitutes for coal, thereby preventing unknown social consequences stemming from disproportionate higher energy prices. Inflation is already a major sticking point in India and any adverse actions that accelerate this outcome is political suicide. Alternative energy is relatively more expensive for developing nations; if the industrial base is dependent on access to cheaper forms of energy, how will they compete globally with their developed market peers?

Figure 58. India: Population, GDP & Energy Demand



Source: IEA World Energy Outlook 2021

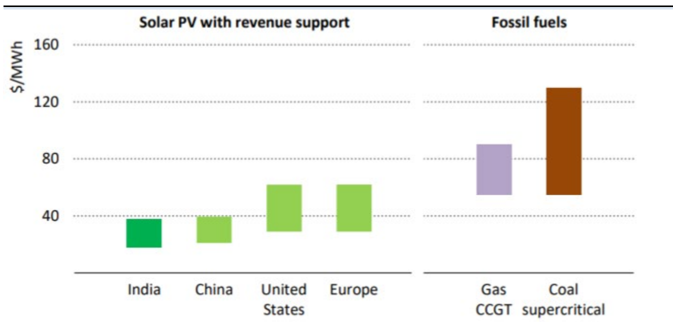
Figure 59. Relative Emerging Market Peer GDP per Capita



Source: IEA World Energy Outlook 2021. Note: Bubble Size indicates GDP

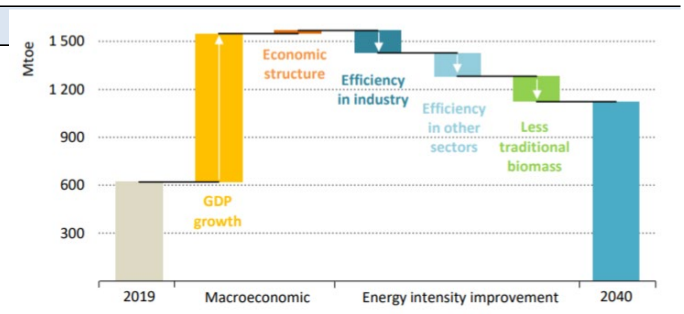
The combination of more multilateral supranational funding, a thoughtfully-aligned Energy Transition policy, and financing (sustainability-linked bonds and transition bonds) with strict use of proceeds covenants and targets is a far more practical and achievable plan. If strictly adhered to, this would lower the long-term cost of alternative forms of energy (Figure 60) without putting unnecessary burden on low-income emerging market populations that utilize less energy per capita than developed counterparts in developed and emerging market countries. Therefore, proper incentives are necessary if governments are to cooperate and align their respective national interests.

Figure 60. Utility-Scale Solar PV LCOE vs. Fossil Fuels



Source: IEA World Energy Outlook 2021

Figure 61. Total Final Energy Consumption



Source: IEA World Energy Outlook 2021

Appendix 4: Imported Emissions

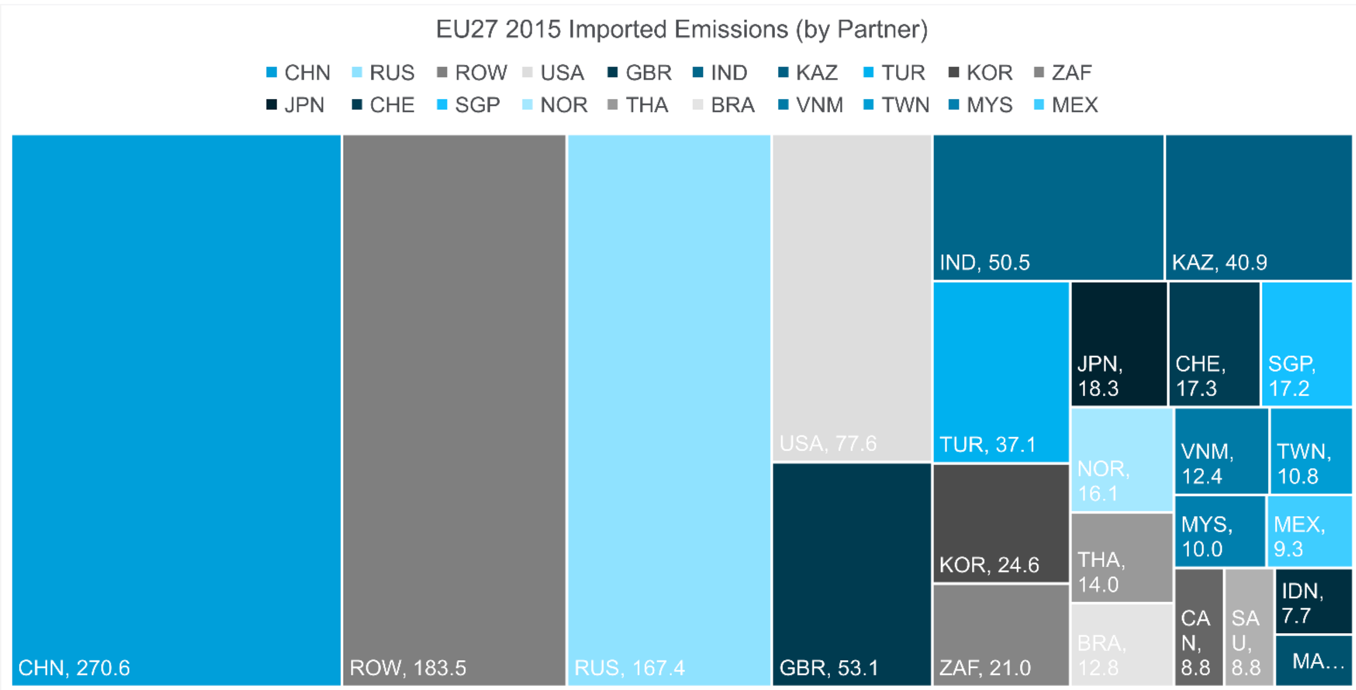
CO_2 emissions are typically measured on the basis of production — sometimes referred to as territorial emissions. These are used when countries report their emissions and set targets to reduce their emissions domestically and internationally. However, statisticians also used something called consumption-based emissions which are basically the emissions that are embedded in goods that are imported into various countries (embodied imported emissions).

To calculate the CBAM revenue that could be generated from our climate club scenario we need to look at the embodied imported emissions from the EU and the U.S. Unfortunately, the data is only available for 2015, but even so it could provide an indication on what could be generated if a carbon border adjustment tax is placed in our climate club scenario.

EU27's Embodied Imported Emissions

In 2015, the EU imported approximately 1,096 million tonnes of CO_2 emissions. [79] Twenty-five percent of these emissions were imported from China, 15% from Russia, 7% from the U.S., and 5% from the U.K.

Figure 62. EU's Imported Emissions by Partner (2015, MT of CO_2e)

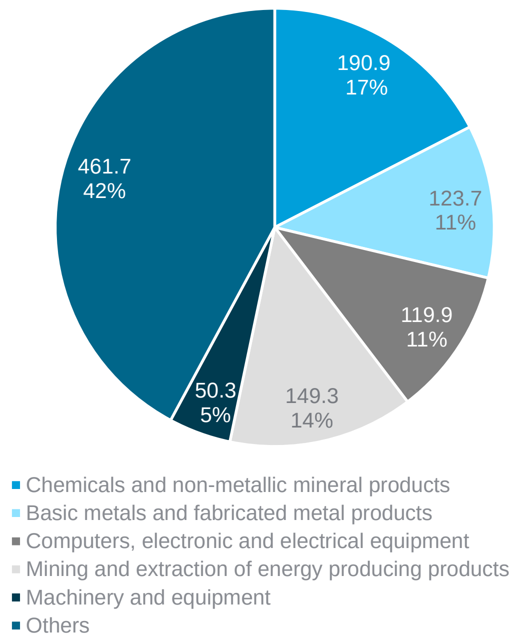


Source: OECD, Citi Global Insights

Digging deeper into the data, 17% of imported embodied emissions come from chemicals and non-metallic mineral products; 11% from basic materials and fabricated metal products; 11% from computers, electronic and electrical equipment; 14% from mining and extraction of energy producing products; and 5% from machinery and equipment.

[79] For this analysis we have removed the U.K. from the EU trade-weighted emissions and have reported the U.K. separately.

Figure 63. EU-27 Imported Emissions by Industry (2015)

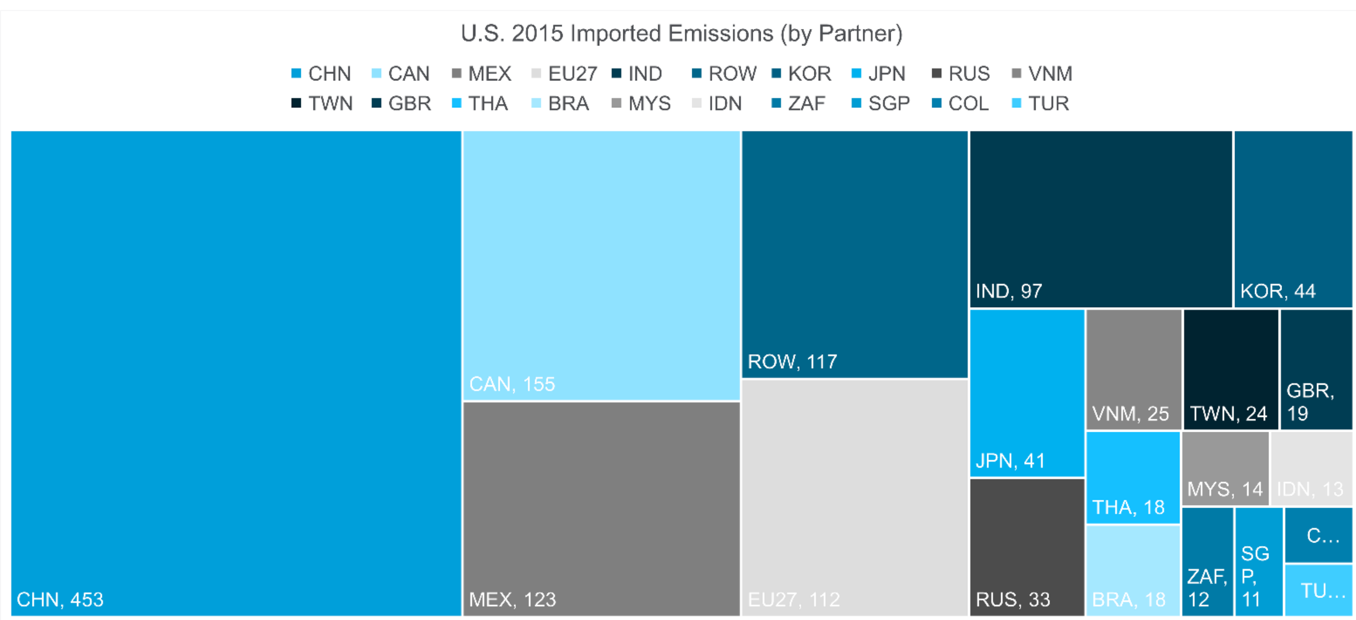


Source: OECD, Citi Global Insights

U.S. Embodied Imported Emissions

If we look at the U.S., total CO_2 emissions embodied in its imports in 2015 are estimated at 1,340 million tonnes of CO_2; 34% of these emissions were imported from China, 12% from Canada, 9% from Mexico, 8% from EU27, and 7% from India.

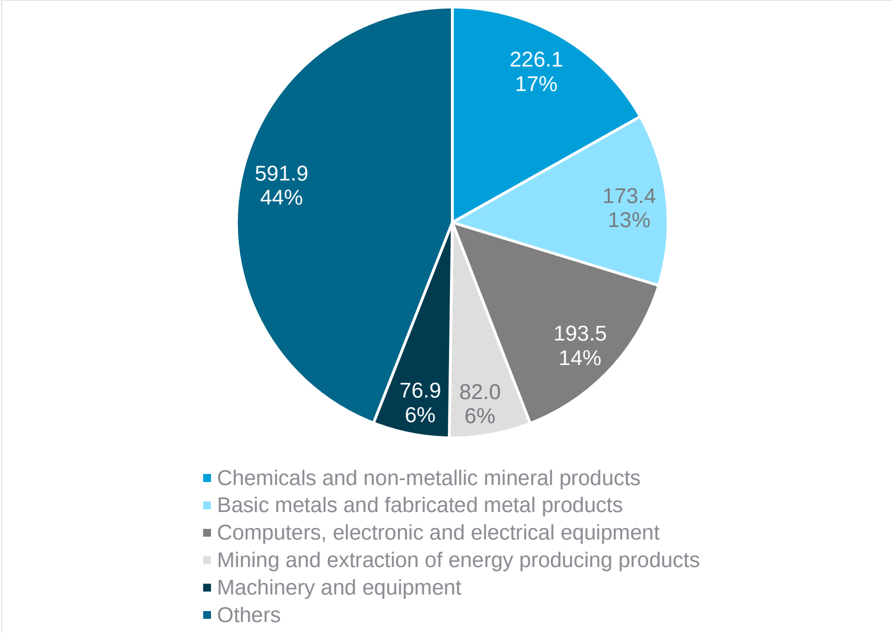
Figure 64. U.S. Imported Emissions by Partners (2015, MT of CO_2e)



Source: OECD, Citi Global Insights

If we look at the split by sector we can see that the 17% of embodied imported emissions comes from chemicals and non-mineral products; 13% from basic materials; 14% from computers, electronic and electrical equipment; and 6% from mining and extraction of energy producing products; with another 6% from and machinery and equipment.

Figure 65. U.S. Imported CO_2 Emissions by Sector



Source: OECD, Citi Global Insights

Appendix 5: Market-Based Mechanism

Below is a detailed table of the pro, cons and issues of the mechanisms that we analyzed in our report.

Figure 66. Summary of Pros and Cons of Market-Based Mechanisms

Instrument	Description	Pros	Cons	Issues
Article 6.2 and 6.4				
Tradeable emissions system at a country level as proposed in Article 6.2	Countries meet their climate pledges by allowing parties to use "internationally transferred mitigation outcomes" (ITMOs) to achieve their nationally determined contributions (NDCs). This essentially means that a country that has achieved its climate pledge can sell its overachievement to a country that has fallen short of its own goals.	Could help countries achieve their NDCs more effectively. Revenue is generated for EMs to support sustainable development projects.	Article 6.2 is voluntary. NDCs are not enough to limit temperature increase to 1.5°C or 2°C. Emission reductions are not guaranteed. Need international agreement for it to be effective.	Lack of definition for ITMOs. Limited guidance and rules for .bilateral trading. Risk of double counting. No agreed metric for ITMOs. No global agreed price for ITMOs.
Global market mechanism under Article 6.4 that is subject to centralized governance by UN body	Creation of a new international carbon market for the trading of credits from emissions reductions generated from projects anywhere in the world. Often referred to as the "Sustainable Development Mechanism" (SDM), and would replace the Clean Development Mechanism (CDM) which operated under the Kyoto Protocol.	Could help countries achieve their NDCs more effectively. Could build on infrastructure, processes, and expertise from CDM. Aims to engage the private sector.	Article 6.4 is voluntary. Emissions reductions are not guaranteed. Need international agreement on rules to become operational.	The carryover of CDM credits is an issue for some countries. There is a risk of double counting/claiming of emissions reductions. Percent of emission reduction credits to be set aside as share of proceeds (SOPs) is a debate.
Linking Existing Systems				
Linking up emissions trading schemes (ETSs) to form one global ETS	Existing ETS systems could be reformed or replaced to form one, harmonized ETS system across multiple jurisdictions. This could see all covered jurisdictions "racing to the top" to cover the most extensive set of sectors. Alternatively, jurisdictions could agree on a smaller set of sectors as a core ETS, with individual jurisdiction-level ETSs for additional sectors. Countries/jurisdictions currently without an ETS could join this global ETS over time.	New system could set a clear emissions trajectory in line with climate goals and moving toward net zero. Prices should move high enough to achieve emissions goals over time, while also providing flexibility in compliance across economic sectors, geographies, and over time. Carbon prices within an ETS may be politically more palatable than a carbon tax. Could promote a competitive playing field and raise revenue for decarbonization projects.	ETSs can be complex to create and administer. Carbon prices with an ETS, while they can trade up to the levels needed to achieve climate goals, can also be volatile given short-term factors that drive emissions within a given year, notably macroeconomic activity and weather conditions. Volatile prices over time make it more challenging for longer-term private sector investment. However, a very liquid ETS could also see financial hedging help to manage price volatility to support investment. Joining multiple ETSs that are not explicitly linkage-ready is likely to be challenging politically, legally, and administratively.	ETSs are carefully designed policy tools with many design choices possible. This means that existing major ETSs differ from each other along multiple axes. Deciding upon a design for all jurisdictions could be politically challenging depending on divergent climate goals, emissions targets, and carbon intensity or domestic industries. Transitioning from existing ETSs to a new cross-jurisdictional system can be very challenging, including treatment of existing compliance obligations and compliance instruments and how these might be grandfathered into a new system, while maintaining stability in terms of emissions, economic activity, and the financial positions of covered entities.
Setting up a Global Carbon Tax Amongst All Nations				
Setting up a global carbon tax	A global carbon tax would be set up across all nations. This could either be in the form of an equal rate across all nations, or a split rate where EMs would initially have a lower carbon price. Revenues could either stay in the country where the tax is collected or be distributed according to some fairness/equity parameter.	Effective at reducing greenhouse gas emissions across the globe if carbon is priced appropriately. Could help countries reach their NDCs and net zero targets. Could promote a competitive playing field. Would generate revenue that could be used for decarbonization projects.	Could have an initial impact on EMs depending on tax rate used and depending on revenue distribution. Would require international agreement, which would be extremely difficult to obtain. Would be politically and legally challenging to set up a global carbon tax.	Even though setting up a global carbon tax is not as complex as setting up a global ETS system, it r would require an agreement by all countries. This would be challenging as not only would carbon prices need to be determined (including agreeing on the price, whether DMs and EMs should have the same carbon price, how these carbon prices would increase over time, and whether all sectors would be covered) but also how revenue generated from this tax should be redistributed.

Source: Citi Global Insights

Figure 67. Summary of Pros and Cons of Market-Based Mechanisms

Instrument	Description	Pros	Cons	Issues
Setting up a Voluntary Climate Club				
Voluntary Climate Club	Setting up a voluntary club between a few nations. Members of the club would agree on an equal market-based mechanism on carbon- Benefits of the membership could include shared technological innovations, a competitive level playing field amongst different sectors, preferential trade agreement etc. A CBAM would be placed on imports from non-members of the club.	Reduces GHG emissions in members of the club, and could create an incentive for non-members to either join the club or reduce their emissions to avoid paying the carbon border adjustment tax. Creates a level competitive playing field amongst members of the club. Is easier to negotiate amongst a number of nations. Generates revenue for decarbonisation projects amongst member states and raises revenues for developing countries if CBAM money is allocated to projects in these nations.	Setting up CBAM systems requires a lot of administration. Could have an impact on developing countries that have less means to reduce their emissions.	Bilateral agreements between a number of nations could take a while to negotiate. However they are easier to do than negotiating a deal amongst all nations.

Source: Citi Global Insights

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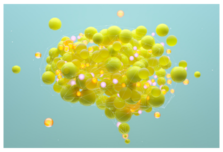

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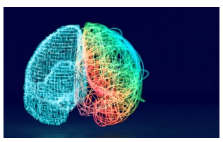

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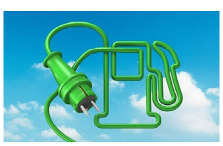

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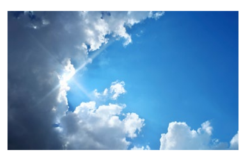

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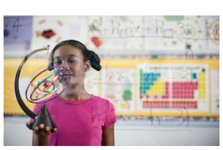

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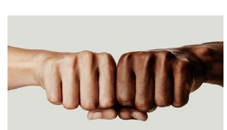

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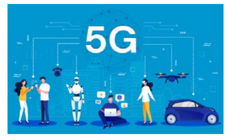

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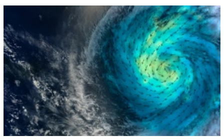

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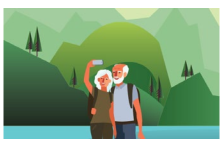

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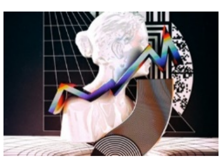

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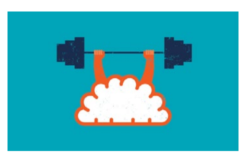

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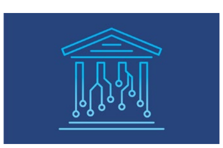

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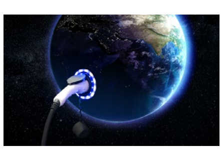

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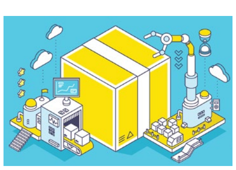

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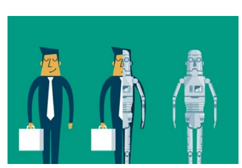

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Key Insights regarding the future of the Global Carbon Market

GLOBAL REACH

There are currently only 64 carbon pricing schemes in place around the world and the carbon price associated with them varies greatly and it not transparent. / Climate change is a global problem and requires a global solution — setting up a global carbon tax and developing a climate change club could be part of the solution.

INFRASTRUCTURE

Developing markets need more direct financial incentives to lower the costs of renewable energy because other electricity generation sources are more economically competitive or can be more directly implement. / A Climate Action Development Bank could deliver a sustainable infrastructure agenda to developing markets and facilitate green investment, Energy Transition, and climate action.

SUSTAINABILITY

Human-induced greenhouse gas emissions are still increasing. At current emissions rates, we have just 14 years before global temperatures rise beyond 1.5°C. / Our actions in the next decade will determine the fate of the planet. Efforts need to be decided on now to avoid hitting a point of no return.