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Carbon Markets in a Net-Zero World - A Policy Brief

Regina Betz and Paula Castro

Carbon markets are an increasingly common policy instrument to incentivize greenhouse gas (GHG) emission reductions from industrial installations and other sources in a cost-effective way. Over 50 different carbon markets function around the world, and several more are planned (World Bank 2021). Many more countries have noted their intention to use international carbon markets to help them meet their mitigation targets under the 2015 Paris Agreement.

Article 4 of the Paris Agreement states that 'a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century' is necessary to achieve its long-term temperature goal. Consequently, an increasing number of countries is adopting GHG neutrality targets: According to the Net-Zero Tracker, as of October 2021, two countries have already achieved net-zero, 61 have adopted net-zero targets in existing or proposed legislation, or in policy documents, and 79 countries are discussing the adoption of such targets.

So far, carbon markets have been conceived as tools to incentivize emission reductions, for example through energy efficiency measures or by switching from fossil fuels to cleaner energy sources. To achieve a net-zero world, however, emission reductions will have to be complemented with activities that capture CO_2 from the atmosphere (so-called carbon capture and storage or CCS) and that generate negative emissions (negative emission technologies or NETs). These options will be necessary to offset emissions from sectors in which full carbon neutrality is difficult to achieve, such as agriculture, aviation, or certain industrial processes. Different carbon market designs could be used to support and promote CO_2 capture activities.

Types of carbon markets

Broadly, there are two types of carbon markets. Emissions trading systems (ETSs) set a limit on the allowed level of GHG emissions (the so-called *cap*) for a specified group of entities (e.g., companies, installations, or countries). The regulator issues emission *allowances* up to the level of the cap and distributes them among the participating

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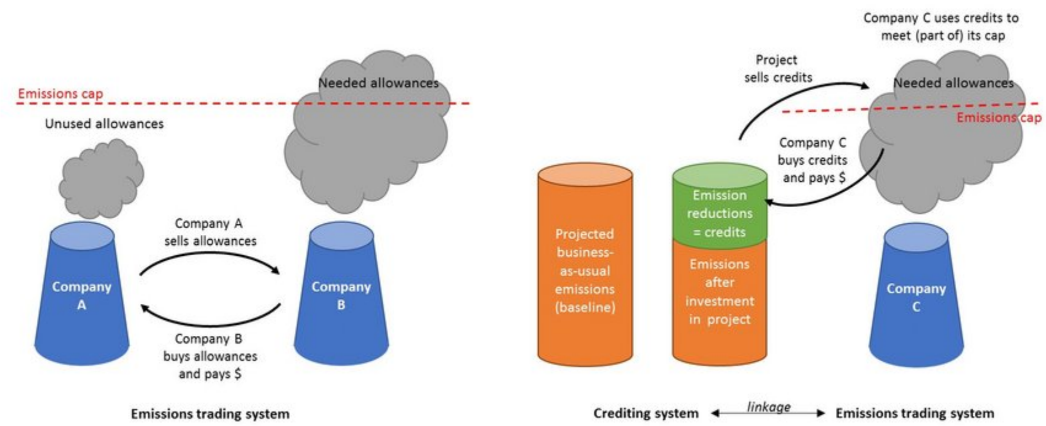
entities through free allocation or via auctions. At the end of each compliance period (usually a year), the participating entities must submit one allowance for each tonne of carbon dioxide equivalent (CO_2e) emitted during the period. To comply, participants can either implement mitigation measures to reduce their emissions or buy allowances in the market.

Baseline-and-credit systems (also known as crediting or offsetting systems) function without a cap on emissions. Rather, activities that reduce emissions are compared to a reference scenario (the *baseline*) that reflects the situation that would have happened in the absence of the carbon market. The difference between the baseline emissions and the emissions of the reduction project determines how many emission reduction *credits* can be issued. Once independently verified, the credits can be sold in the market, for example to be used for compliance with an international GHG emissions target or a national cap and trade scheme. Figure 1 shows these two types of carbon markets and how they can be interlinked.

Figure 1. Emissions trading and crediting systems



Source: Own graphic.

Types of carbon removal activities

Reaching net-zero emissions will require a combination of conventional emission reduction measures and measures that remove CO_2 from the atmosphere, which may involve natural sinks, artificial storage, or a combination of both.

Natural CO_2 sinks are a well-known, relatively inexpensive option. Forests can be expanded and restored to sequester carbon in wood and soils and to generate credits for offsetting markets. There are risks that may make the storage only short-lived, however. Forest fires can release the carbon stored over decades, or reforestation in one area can lead to more deforestation somewhere else, a phenomenon called *leakage*.

Other natural options include improving soil carbon content in agricultural systems, for example by increasing the use of cover crops, or by adding compost or biochar to soils. However, it is difficult to assess the long-term effects of any given practice on the carbon content of soils, because of the variability and complexity of natural systems. If agricultural practices are changed, the stored carbon may be released again. In addition, very large-scale changes to agricultural systems would be needed to make a sizable impact. Such technologies have therefore so far not been covered by existing carbon markets.

Artificial options include carbon capture and storage (CCS), which collects CO_2 from

Australian ETS.

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Artificial options include carbon capture and storage (CCS), which collects CO_2 from large sources such as power plants and industrial facilities and stores it in facilities underground. A newer technology, called direct air-capturing with carbon capture and storage (DACCS), allows carbon to be captured directly from the air before storage, which means that it can be employed wherever the carbon can be stored best, rather than at its source. However, this technology is still very costly and energy intensive.

New technologies for storing carbon safely are also being developed. Among them, one option entails making CO_2 react with specific minerals so that it is bound permanently in rock formations. Carbon capture and utilization (CCU), on the other hand, involves using the captured CO_2 in the production of long-lived materials such as cement. CO_2 can also be used for producing carbonated drinks, or synthetic fuels such as methane. These products, however, do not store carbon permanently, as they re-release the captured CO_2 to the atmosphere when used.

A promising technology to achieve negative emissions, called bioenergy with carbon capture and storage (BECCS), involves burning biomass for energy generation, and then capturing and storing the CO_2 from this process. This can take place in power plants or energy-intensive industries such as cement or paper production. Because biomass sequesters CO_2 during growth, and this CO_2 is captured and stored, BECCS has the potential to generate negative emissions. The limitations of this technology are the availability of sustainable-sourced biomass, avoiding leakage, the required infrastructure to transport and locations to permanently store CO_2.

Setting the right incentives for net-zero

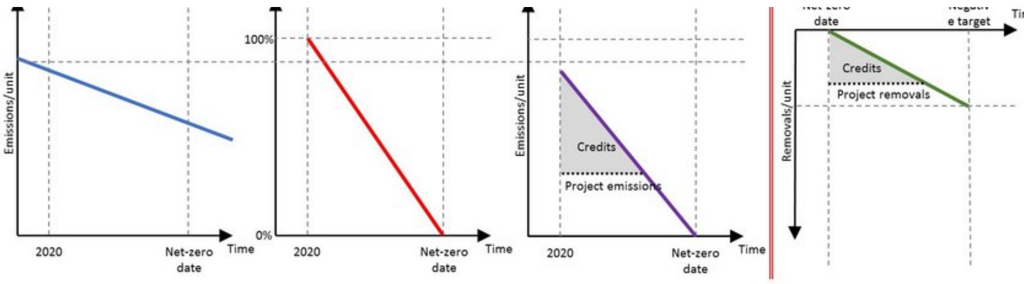
While carbon markets can help to create the necessary incentives for industry to start investing in carbon removal and negative emissions technologies, a net-zero world sets new challenges for the design of these markets.

What, for example, is an appropriate approach to baseline setting if the goal is to have zero emissions? Can any reductions be credited at all in such a situation?

A relatively straightforward approach as net-zero targets become a reality would be to define a downward-sloping emissions path from today's emissions level to zero emissions at an appropriate 'net-zero date' for each country hosting a baseline-and-credit mechanism. Such net-zero dates could be differentiated according to countries' level of responsibility and capability to address emissions, so that more developed countries must meet a net-zero baseline earlier. The emissions path towards net-zero would become an ambition coefficient to be multiplied with the expected business-as-usual emissions path of the technology or industry being credited (Michaelowa et al. 2021). This approach is depicted in Figure 2 below.

Once the net-zero date is reached, countries will likely adopt 'net-negative' targets that involve achieving a specific amount of GHG removal. In such a case, crediting baselines would become negative, that is, rather than measuring emissions intensity, they would measure '*removal intensity*'. Crediting would then only be available for negative emissions technologies such as DACCS and BECCS once the negative baseline has been surpassed (fourth graph in Figure 2).

Figure 2. Baselines towards net-zero emissions and under negative emission targets



Note: The projected technology-specific emissions intensity path would be calculated using existing methods. For power plants, it could rely on the grid emissions factor. For industrial facilities, it could be based on emissions benchmarks for the best available technology. In both bases, the expectation is that baseline emissions intensity decreases over time as the system becomes 'greener'.

Source: Own graphic, partly based on Michaelowa et al., 2021.

The main difficulty with this approach would be to agree on appropriate net-zero dates for each country or group of countries. The Paris Agreement envisages two international carbon market mechanisms. Under Article 6.2, countries can bilaterally establish cooperation mechanisms to trade so-called 'Internationally Transferred Mitigation Outcomes'. Internationally agreed rules are expected to be kept at a minimum. In such a context, buyer countries could get together to agree on the appropriate level of ambition coefficients that they would be willing to accept. Under Article 6.4, which is expected to set up a market mechanism similar to the Kyoto Protocol's Joint Implementation, the Sustainability Board overseeing the market could decide on appropriate ambition coefficients for all participating countries (Michaelowa et al. 2021). The advantage of such coefficients is that, once established, they cannot be manipulated easily. The difficulty relies in the interplay between political, technical, and environmental considerations to set them correctly in the first place. Transparency is crucial to make such decisions legitimate and credible.

An additional challenge under baseline-and-credit systems relates to addressing the risks of leakage and accidental re-release of stored CO_2. Options applied in existing offset markets include insurance and buffers, in which a portion of the credits is kept as a reserve to compensate future reversals (Honegger et al. 2021).

What changes to emissions trading systems are necessary in a net-zero world?

ETSs will only incentivize CCS and NETs once the allowance price is high enough to finance these technologies. Once this is achieved, ETSs give the covered industrial plants or fossil-fuel power plants an incentive to invest in CCS as it allows companies to buy fewer CO_2 allowances and even to sell them if they have received free allocation. However, this would only lead to negative emissions if it were linked to the burning of sustainable biomass, as in BECCS.

A critical challenge with CCS is that appropriate storage sites are frequently located away from the main emission sources, either because of geological requirements or because of local opposition to CO_2 storage. For this reason, it is likely that CO_2 will be transferred internationally, for example to former gas and oil deposits with the required infrastructure and technical knowledge for CO_2 storage. Such transportation bears the risk that some CO_2 will leak again to the atmosphere.

If capture, transport, and storage are covered by an ETS, allowances covering any leakage would need to be surrendered, as is currently done in the EU ETS with CCS and in the New Zealand ETS with leakage or reversal in afforestation and reforestation.

As NETs will require high carbon prices and free allowance allocation becomes impossible, carbon border adjustment mechanisms (CBAM) may be introduced to reduce impacts on industrial competition. CBAMs imply setting a levy on imports from countries that do not have a comparable carbon price. Carbon markets could be integrated into such mechanisms; for example, an exemption from paying the CBAM levy could be obtained by surrendering the corresponding removal or reduction credits.

Many open questions remain on using carbon markets under a net-zero target.

How can carbon markets be made compatible with NETs? Will there be separate markets for emission reduction and emissions removal units, or will markets be integrated (on this question, see La Hoz Theuer et al. 2021)? In CCS, which potentially involves different actors undertaking the capturing, transportation and storing: How will the removal units be divided between capturer, transportation, and storage provider?

How can options that help to store carbon temporarily – such as CCU and the use of harvested wood products in, for example, construction – be accounted for in carbon markets?

How can new risks such as land conflicts, food security, loss of biodiversity and co-benefits such as enhanced biodiversity be addressed and reflected adequately?

These and other questions will need to be answered by future research. Carbon market regulation will need to be flexible to adapt to these new technologies, but at the same time stringent enough to avoid risks to environmental integrity such as from leakage or reversals.

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