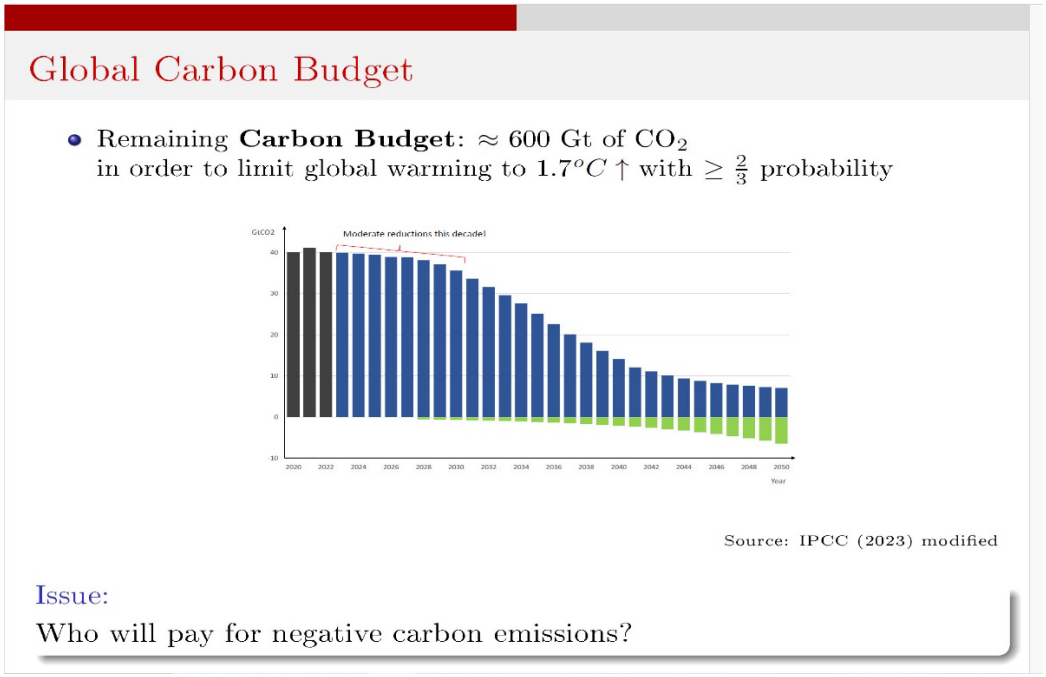
Accounting for Carbon Credits
by Stefan Reichelstein

Will the world economies be able to decarbonize fast enough to keep the increase in global temperature within the targets set by the Paris climate agreement? One possible pathway that would enable such a timely transition is shown in the figure below, which modifies an illustration originally produced by the Intergovernmental Panel on Climate Change. According to this figure, the world's economies would reach a net zero position by the year 2050, as carbon removals - the green bars – balance out the remaining emissions represented by the blue bars. Further, the cumulative total net emissions along the way, represented by the area under the curve, would not exceed what climate scientists have identified as our carbon budget: roughly 600 gigatons of CO_2 if we want to preserve at least a two-thirds chance of keeping global warming below 1.7°C.



Since it is already proving a challenge for the international community to reduce emissions, it seems even more challenging to organize the removal of CO_2 from the atmosphere. This is basically the task of "cleaning up a commons" in terms of greenhouse gas emissions. Who will make this happen and who will have an incentive to pay for these removals? This is where I believe corporate carbon accounting can play a useful role.

We have all heard about corporate net-zero pledges, where companies say they will be carbon neutral by the year 2050, and some issue a forecast for their own firm-level pathway to a net-zero position in accordance with the above figure. Companies also increasingly report emission metrics for their overall corporate carbon footprint (CCF) and individual product carbon footprints (PCFs).

Further to the point of net-zero positions, some consumer product firms, particularly in Europe, have already begun to advertise individual consumer products as carbon-neutral. The public's general reaction understandably appears to have been somewhat skeptical, with some environmental groups decrying these advertisements as "greenwashing". It is understood that, given current production methods, net zero products require companies to rely on carbon offsets, which may (but not necessarily do) include CO_2 removals from the atmosphere.

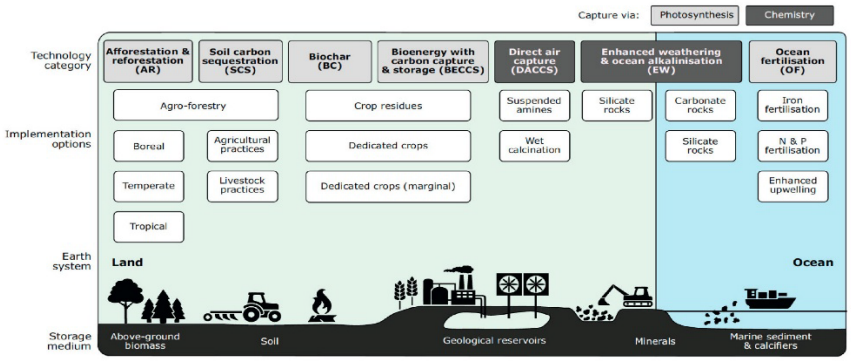
Do consumers, the public, or investors trust companies' claims that a particular consumer product is indeed "carbon neutral", that is, it has a zero PCF? My view is that there would be a lot more trust if companies adopted a more structured framework of generally accepted accounting principles for carbon emissions, like what businesses all over the world have practiced in the domain of financial accounting.

When companies procure carbon credits, they typically turn to the voluntary carbon markets. These markets have sprung up in recent years, growing rapidly in terms of trading volume. McKinsey estimated that in 2023 the median price was $4 per ton of CO_2. Considering how CO_2 is priced in various compliance markets around the world, that is a remarkably low figure, immediately raising a host of questions. Is there simply a lot of "low-hanging fruit" in terms of effective but inexpensive carbon offsets, or does the median price of $4 per ton of CO_2 reflect questionable credit trades that do not really represent emission reductions? At the same time, some high-end credits have been trading above $500 per ton of CO_2. This is puzzling and raises the question of what is going on in these markets, and how we can properly distinguish between high- and low-quality credits?

Conceptually, it is important to distinguish between CO_2 avoidance and CO_2 removal offsets. With avoidance offsets, the logic is that one party interferes and pays for an activity so that another party does not emit one ton of CO_2. One classic example is a forest that is not burned down because of the intervention of the party buying the offset. The installation of renewable energy facilities provides another example of generating avoidance offsets. The investor in the renewable energy facility then claims carbon credits because consumers avoid kilowatt hours of grid electricity based partly on fossil fuel combustion. Typically, avoidance offsets are based on counterfactuals and frequently result in double accounting. In contrast, removal offsets are far more direct. They generally involve a company, or a party acting on its behalf, directly removing tons of CO_2 from the atmosphere, thereby avoiding the counterfactual line of reasoning.

The chart below provides an overview of some currently available carbon dioxide removal (CDR) technologies. The top row lists alternative technologies, including afforestation and reforestation. It also lists bioenergy with carbon capture and storage (BECCS), where biomass is combusted to generate electricity, while the released CO_2 is captured and subsequently sequestered underground. These technologies, shown in the grey boxes, are all nature-based solutions where the CO_2 capture is done through photosynthesis. In contrast, the black boxes represent technologies relying on chemical engineering such as direct air capture (DAC), which relies on a filtration process.

Carbon Dioxide Removal Technologies: Overview



Source: Minx et al. (2018)

CDR Quality Criteria: Additionality and Permanence

- Accounting for CDRs not yet standardized:
  - Recognize only permanent and irreversible removals?
  - Discretion in applying current CDRs to individual PCF measures?

The bottom of the chart depicts different possibilities of storing CO_2. It can be stored above ground, in a forest, in surface soil, or even in oceans. At an additional cost, CO_2 and carbon-heavy matter can also be sequestered in much deeper geological layers.

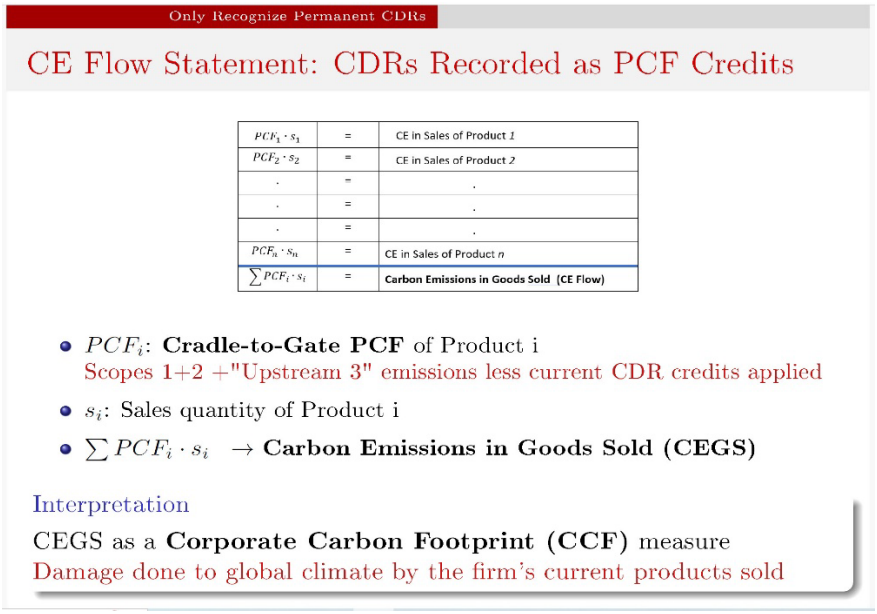
Analysts frequently refer to two criteria when discussing the quality of different CDRs. One is *additionality*, which is typically not an issue for removal technologies but is very much an issue for avoidance offsets. The other is the issue of durability and *permanence*. Can it be guaranteed that the CO_2 is removed from the atmosphere for a long period of time, ideally even permanently?

The criteria for assessing carbon removal credits bring up questions of how companies should account for these credits if they acquire them at considerable cost. Should companies only be allowed to recognize on their books permanent and irreversible CDRs? If so, should companies have discretion in applying these high-quality carbon credits to individual PCF measures? The buyers of these credits would probably have a strong preference to do so because select sales products could then credibly be advertised as “carbon neutral”. But to some observers such practice may seem to be an attempt at greenwashing select products.

The next slide illustrates one accounting method for including CDR credits in a company’s current CCF metric. Under this method, the CCF is calculated as the aggregate carbon footprint of products (and services) sold in the current period. Analogous to Costs of Goods Sold in an income statement, Carbon Emissions in Goods Sold (CEGS) represents the total CO_2 tonnage embodied in the products delivered to a company’s customers in the current period. As such, it is a measure of the damage (loss) the company has inflicted upon the global climate.

Companies in different industries have implemented carbon accounting systems that calculate the carbon intensity of their sales products (kg of CO_2 per unit of the product) on a cradle-to-gate basis. Accordingly, these PCF metrics reflect a share of a company’s direct (Scope1) emissions as well as shares of the indirect (Scope 2 and upstream Scope 3) emissions that have been accumulated by a company’s supplier network. For the

accounting method illustrated on the next slide, companies would then be in a position to offset their cradle-to-gate PCFs through CDR credits. In this context, the most “liberal” accounting rule would give companies discretion in assigning the CDR credits to products, assuming there is no causal link between the production and removal activity. Alternatively, the applicable accounting rules could specify that current CDRs be netted against current direct emissions, and the resulting net direct emissions be assigned (allocated) to products in the same manner that applies to direct emissions. Clearly, such a more conservative treatment may have direct implications for companies’ willingness to acquire costly CDR credits.



Shown below is a balance sheet corresponding to the above flow statement. The left-hand side records the emissions embodied in operating assets. The right-hand side records the accumulated emissions embodied in production inputs the business has acquired from its suppliers (its Scope 2 and 3 emissions). In addition, the right-hand side tracks accumulated direct emissions less accumulated direct removals, the latter shown in parentheses, as these are viewed as negative emissions. As the business runs through an operational cycle and debits the work-in-process and finished goods accounts with emissions incurred, these emission counts are offset by any CDRs that the company has acquired in the current period. Finally, the CE flow measure is reconciled with the balance sheet via the Equity account, which represents the firm’s legacy emissions as it records the accumulated past CE Flow figures.

Only Recognize Permanent CDRs

CE Balance Sheet

CE in Assets		CE in Liabilities and Equity	
Buildings	EB_{BLD}	EB_{ETI}	Emissions Transferred In
Machinery & Equipment	EB_{MAC}	EB_{DE}	Direct Emissions
Raw Materials	EB_{MAT}	(EB_{DR})	Direct Removals
Work-in Process	EB_{WIP}	EB_{EQ}	Equity
Finished Goods	EB_{FG}		

- All entries represent stock variables → Cumulative emissions [1]
- Direct Removals (DR) as a contra-liability (with a negative sign)
- Balance in Equity (EQ) account shows the firm's Legacy Emissions
- Losses represented in $CEGS$ absorbed in Equity
  → $\Delta\ Equity = -CE\ Flow = -CEGS$

[1] S. Reichelstein, *Corporate Carbon Accounting: Balance Sheets and Flow Statements*", Review of Accounting Studies, Summer 2024

One way to make the impact of CDRs on the CE Flow measure more transparent is to show current removals as a separate line item. Accordingly, the individual cradle-to-gate PCFs are based on assigned shares of the firm's current gross Scope1, 2 and upstream Scope 3 emissions. Current direct removals are then subtracted from the aggregate CEGS metric to obtain an alternative periodic CE Flow metric. This is shown on the following slide. We note that the two resulting CE Flow measures will coincide for a service business that has neither beginning nor ending inventories of work-in-process or finished goods. Nonetheless, the format showing current CDRs as a separate line item will give analysts additional information on whether a reduction in the CCF metric (CE flow measure) is mainly due to an effective reduction in the company's gross emissions or due to an increase in the acquisition of CDR credits.

Only Recognize Permanent CDRs

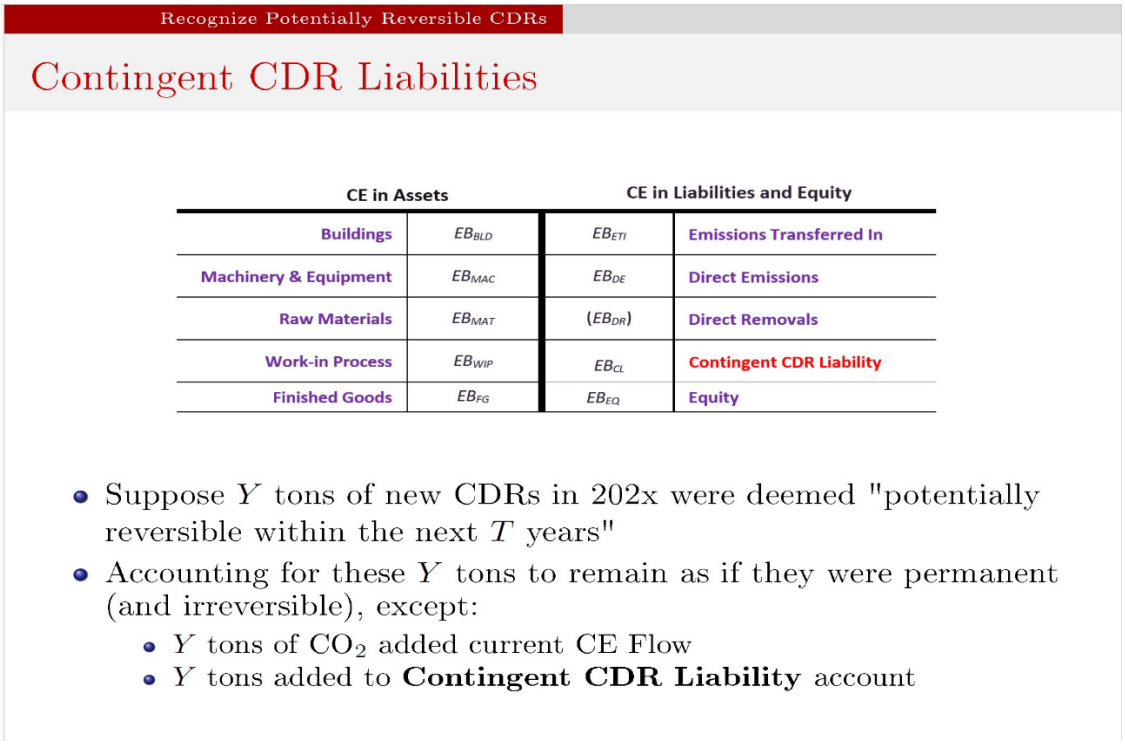
CDRs Recorded as Lump-sum Credits

$PCF_1^+ \cdot s_1$	=	CE in Sales of Product *1*
$PCF_2^+ \cdot s_2$	=	CE in Sales of Product *2*
.	=	.
.	=	.
.	=	.
$PCF_n^+ \cdot s_n$	=	CE in Sales of Product *n*
$\sum PCF_i^+ \cdot s_i$	=	**Carbon Emissions in Goods Sold (CEGS)**
X	=	Current CDRs
$\sum PCF_i^+ \cdot s_i - X$	=	**CE Flow**

- PCF_i^+: Product i's PCF based on cradle-to-gate gross emissions only
- Gains/Losses in $CE\ Flow$ are added to $Equity$:
  → $\Delta Equity = -CE\ Flow = X - \sum_i PCF_i^+ \cdot s_i$

Let me now turn to the more fundamental question as to what constitutes a valid CDR credit. Specifically, should corporate carbon accounting only recognize as valid removals those tons of CO_2 that have been captured and permanently sequestered, provided there is virtual certainty that these tons of CO_2 will not re-enter the atmosphere within the next T years (where T could be 100, 500 or 1000)? Such a high benchmark of "permanent irreversibility" has been postulated by some parties involved in this debate. Importantly, this criterion would exclude some of the less expensive removal technologies, in particular afforestation. There is simply no guarantee that the CO_2 stored in trees is permanently removed from the atmosphere. Does that mean the carbon accounting and reporting standards should preclude recognition of these removals?

An accounting system that distinguishes between stock and flow variables by relying on a balance sheet and flow measures gives us additional flexibility in accounting for different types of removals. This flexibility is reflected in the line-item Contingent CDR Liability on the balance sheet shown on the following chart.



The idea of a contingent liability is, of course, quite common in financial accounting. In the context of potentially reversible removals, the addition to the account Contingent CDR Liability corresponds to those tons of CO_2 that have been removed in the current accounting period, but the reversibility of which remains in question. For credits to equal debits, the tons in question do not reduce the current CE Flow measure. In that sense, the accounting is conservative in order to reflect the potential reversibility of these removals.

Analysts and outside stakeholders will be able to rely on the reported figures if there is a commitment to audit and report on these removals in subsequent years. Specifically, if the forest we reforested did not burn down, and therefore the carbon continues to be stored, the accounting for this cohort of tons removed remains unchanged until we reach the promised time "T" in the above image. On the other hand, if there is even a partial reversal within the next T years (e.g., a portion of the forest burned down), then, just as in financial

accounting, we make the corresponding adjustments to the accounts Direct Removals and Contingent CDR Liability on the balance sheet.

In closing, negative carbon emissions in the form of CDRs will become an increasingly important tool for companies to make good on their net-zero pledges and thereby to limit the most severe effects of climate change. Corporate carbon accounting systems that generate temporally consistent and independently verified emissions data can lead to more transparency and accountability in this space.

I have focused specifically on two accounting issues in connection with carbon credits. The first is whether we should restrict attention only to carbon dioxide removals that are virtually certain to be irreversible for a long period of time. A practical alternative would be to broaden recognition to those removals that could possibly be reversed within the next 100 years, provided an accounting and verification process is in place that tracks the status of these removals over time. The second question concerns discretion in assigning CDR credits to different sales products. Giving companies discretion to do so creates potentially powerful incentives to acquire costly credits in the first place because companies are keen to advertise select consumer products as being low-carbon or even carbon-free.

This article is accompanied by a session from the Accountability in a Sustainable World Conference.

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