From: Stephanie Arcusa <sarcusa@asu.edu>
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To: Supervisory-Body <Supervisory-Body@unfccc.int>
Subject: Call for input 2022 - activities involving removals under the Article 6.4 Mechanism of the Paris Agreement

Thank you for the opportunity to comment on defining and accounting for carbon removal in Article 6.4 on behalf of the Center for Negative Carbon Emissions. For context, the Center for Negative Carbon Emissions is a research center at Arizona State University focusing on advancing carbon removal science, technology, and policy to manage climate change.

We would like to highlight several points:

1. The accounting of carbon removal requires a different approach than previously used to account for emission reduction or avoidance. Carbon removal has the distinct advantage of being directly measurable. One can measure the amount of carbon being removed and the amount of carbon added to a reservoir. This measurability makes carbon removal verifiable. An auditor can independently measure the carbon content of the reservoir and check it against the values reported by the storage operator. This means that accounting rules should move away from using hypothetical "business as usual" baselines - there is no excuse for not directly measuring the baseline, i.e., the carbon content of the reservoir before activities, directly since this is the strength of carbon removal.

The issue with a hypothetical baseline is that it relies on counterfactual scenarios. Because the counterfactual does not happen, it cannot be verified, although it can be shown to be plausible, using external information. While conservative approaches can be taken, baselines are easily manipulated.

This observation means that none of the methodologies offered in decision 3/CMA.3, annex, paragraph 36 are sufficient to harness the level of verifiability offered by carbon removal activities. Instead, we would suggest that accounting rules should make the most of this feature to ensure the highest level of verifiability. This means that accounting rules - for all types of removal - must be able to (1) delineate the boundaries of the reservoir, (2) quantify the carbon added to a reservoir, (3) quantify the carbon content of the reservoir, (4) estimate the measurement error in a way that is commensurate across all types of removal.

2. All types of removal must be put on equal footing through the accounting rules. This is critical because many different types of removal will be necessary to meet global needs. Furthermore, if carbon removal is to be sold interchangeably and to neutralize an emission, all carbon removal must meet the same criteria. Therefore, no single type of removal should be preferred over others, and all removal must be held to the same standard.

What would equal accounting rules need to look like? First and foremost, all removals used to neutralize an emission must be permanent. What does permanence mean? Arguably not 40 years and not even 100 years. CO_2 captured from the environment and released (even 100 years later) has little benefit for climate mitigation since CO_2 once re-emitted will resume causing damage for hundreds of thousands of years. This scientific fact has been known for decades. CO_2 that is temporarily sequestered has a benefit for the generations of humans and other species that live during the sequestration period because it minimizes the overshoot (i.e., the exceedance of the limits set in the commitments of the Paris Agreement). This is true if one takes the optimistic view that global atmospheric concentrations will peak and come down within the span of temporary

sequestration, which implies active measures to remove carbon from the environment. Unless active removal of carbon is maintained, the release of carbon from temporary storage will create a cycle of degradation of the climate and the human environment. Temporary storage without the obligation of re-sequestering losses from storage represents willful neglect of the interest of future generations to lower the cost of a habitable climate for our generation.

CO2 that is captured from the environment and sequestered durably mitigates climate change and allows for the world to transition to net negative emissions. This condition will be necessary if the Paris Agreement is to be upheld. However, this all depends on the definition of permanence. An arbitrary selection of a timeframe, or applications of discounting, ignores the well-being of future generations. The requirement to consider intergenerational equity is explicitly stated in the Paris Agreement and it should be a consideration in the accounting rules that will directly impact future generations.

This observation means that a definition of permanence as defined in Article 6.4 Appendix 1. paragraph 4 (c) as [40][50][60][100] is inadequate. The option of using tonne year accounting as indicated by Article 6.4 Appendix 1. paragraph 4 (c) (i) also discounts the well-being of future generations and should not be considered. Commitment periods end the responsibility of the buyer and the storage operator after a set time, effectively deciding that a partial cleanup of carbon waste is acceptable. Discounting short-term storage on timescales of tens of thousands of years very quickly demonstrates the futility of temporary storage to tackle the carbon problem. The perpetual renewal of expiring credits has not been successful in the past when it was used in the Clean Development Mechanism because buyers did not want to repurchase.

Instead, we would suggest that the standard for permanence be set against the damages we are trying to prevent. Preventing damages from temperature requires storage on timescales of multiple centuries to millennia to match the absorption of CO2 into the biosphere and its transfer into the oceans. However, climate change is not only about temperature. Damages from ocean acidification are expected to be significant. Preventing those will require storage over tens to hundreds of thousands of years to match the timescales of calcium carbonate reaction and the silicate rock cycle. We believe the damages from ocean acidification will be significant enough to warrant setting a standard for permanence closer to tens of thousands of years.

Carbon removal that can reach these timescales does exist including geological storage, mineralization, and alkalinization. Therefore, the argument that we cannot achieve truly permanent removals is untrue. Nor, is it true that we must reduce the standard of what permanence means. If Article 6.4 wishes to include all removal types, all must be on equal footing. Removal activities that cannot meet this standard can still be included in the following way: temporary removals must re-sequester lost carbon in perpetuity. The responsibility to continue the removal in perpetuity must be placed on the storage operator, not the buyer nor the public. The storage operator can price the obligation to re-sequester released carbon into their cost of removal. They can also price in a transfer of responsibility to the next willing party through time. This would ensure that future generations are not discounted and would set all removal activities on an equal footing.

Second, this would mean that all removals must be measured and monitored through time so that any carbon loss from storage can be identified and remediated by more removal. This makes direct measurements even more necessary. All removal activities must be monitored continuously. One could also imagine that if scientific consensus is reached that a certain reservoir is functionally stable, the reservoir's monitoring can decrease in frequency.

3. Lastly, the Article 6.4 section 1, sub-section 1.1, paragraph 6 asks for the accounting of net results which is problematic because this would rely on Life Cycle Assessments. LCAs are very useful when understanding where the emissions come from in a process or comparing the efficiency across different processes of the same type of system. Despite their wide and increasing application in carbon accounting, LCAs are not useful for carbon removal accounting purposes. Three decades of research have amassed a large body of literature on the issues with LCA, some of which are particularly pertinent to carbon removal and many remain unresolved. The type of LCA will depend on the system being assessed which is problematic when carbon removal accounting spans activities as incomparable as forest growth and direct air capture and injection in geologic formations. Furthermore, they require knowledge of elements that are known only approximately or rely on generic datasets. Drawing boundaries for LCAs is a subjective activity yet a highly important part of the process. This makes LCAs easy to manipulate and frequently inaccurate for accounting. LCAs also rely on large amounts of data that are frequently unknown or modeled, making the attribution of emissions a challenge. LCAs must make a value-judgment decision on the question of durability, which has major consequences as discussed in section 2. Moreover, because LCAs for carbon accounting wish to encapsulate other greenhouse gases (e.g., methane, nitrous oxide), it requires the reliance on Global Warming Potential, another unverifiable and modeled approach that makes a value judgment on time horizons. Even with calls to switch from attributional to consequential accounting that purports to measure the change in emissions due to some action) some of these problems persist. For example, consequential accounting cannot produce definitive quantitative estimates of actual outcomes, a clear issue if carbon accounting is verifiable. The complexity, expense, and time necessary to perform an LCA make it a poor candidate as the tool to account for carbon removal.

Instead, we suggest that the rules require that a certificate of sequestration be demanded when the carbon comes out of the ground. The carbon should not be let percolate its way through the supply chains, which makes it virtually impossible to account for it, and instead, people should be held accountable at the point of extraction. If the carbon is cleared the moment it comes out of the ground, LCA is unnecessary to figure out who is responsible for what. All carbon captured downstream from the air, surface ocean, and anthropogenic point sources would qualify for generating new certificates of sequestration. A power plant could generate maybe 90% of the certificates, that it will need to purchase tomorrow's fuel, by capturing CO2 from the plant. The rest, the fuel producer will have to purchase from other people. This situation removes the need to measure net removals for accounting, simplifying the entire system. Of course, the storage operator would need to know how well their system is working and an LCA may be necessary for that. A mechanism must also be designed to handle the transition as the carbon removal industry ramps up. However, the liability to match all extracted carbon with a removal should begin as soon as possible, ideally today. With such a policy change in place, fossil fuel extractors would purchase certificates of sequestration and special futures that commit right now to the removal of the extracted carbon at a prescribed future date. If one can prove removal capability one should be allowed to sell a number of futures (in lieu of certificates) that come due in a staggered phased-in timeframe. This would make it possible for society to start demanding carbon neutrality now and build carbon removal capacity with a proven future market.

Thank you for your consideration. The choices made through these rules will have significant, long-term consequences. We cannot stress this enough: these rules will either support the world's success in stopping climate change, or they will spell our failure. We could scrape by with sub-par rules but do we want to take this gamble?

Respectfully,
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