# Response to
# Call for input 2022 - Activities involving removals

Thank you for the opportunity to respond to the process of defining carbon removals[1] - how they should be counted, monitored, and reported. Also, thank you for your work in addressing climate change - I personally appreciate the time and energy each of you expend in solving the largest challenge of this century.

Summary of my response:

> Please update *Annex 5* to include the possibility that Ocean Alkalinity, and perhaps other approaches in the future, will be best verified through modeling, indirect measurement, or other approaches as determined by the best scientific consensus at the time.

Detail:

The document A6.4-SB002-AA-A05, titled *Draft Recommendation* (Annex 5) lays out two primary storage mechanisms for carbon dioxide that has been removed from the atmosphere: land-based (primarily for reforestation and afforestation), and geological formations (see paragraphs 3 and 4 on page 5 of Annex 5, Appendix I and Appendix II and many other locations).

*Annex 6* specifically includes Ocean Alkalinity (paragraph 24 (b) (iii) on page 8.

Ocean Alkalinity uses the ocean itself (not the seabed below the ocean) as the reservoir for storing excess carbon dioxide. Ocean Alkalinity converts carbon dioxide into carbonate and bicarbonate ions; these remain in seawater for tens of thousands of years (Middleburg, et. al.[2]). This approach clearly achieves the durability, additionality, and leakage characteristics desired for carbon dioxide removals.

Also, a small increase in the percentage of carbon dioxide converted and stored in the ocean can have a large impact on atmospheric carbon dioxide.

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[1] As publicized on https://unfccc.int/process-and-meetings/the-paris-agreement/article-64-mechanism/calls-for-input/sb002-removals-activities, accessed on 2 October 2022.

[2] Middelburg, J. J., Soetaert, K., & Hagens, M. (2020). Ocean alkalinity, buffering and biogeochemical processes. Reviews of Geophysics, 58, e2019RG000681. https://doi.org/10.1029/2019RG000681

However, on page 5 of *Annex 5,* the first requirement for a removal is that

> Mechanism methodologies shall require that all removal activities monitor the achieved carbon stocks through their quantification using field measurements, or field measurements in combination with remote-sensing data where applicable.

In the case of Ocean Alkalinity, this may not currently be possible because of the variability of the baseline and the lack of precision of measurements now available. Removing a gigatonne of carbon dioxide from the atmosphere would result in only a very small percentage change in ocean chemistry, one that might not be measurable now. Just because it can not be measured at this time does not mean that the carbon dioxide has not been removed and safely sequestered for tens of thousands of years.

This is noted in the same Middleburg paper, starting on line 369,

> We note that for all cases the alkalinity-induced CO2 deficit spreads over a very large area within one year and the changes in pCO2 are in the sub µatm range. This makes direct monitoring and verification of OAE extremely challenging and will likely need to rely on modeling and indirect experimental verification.

The technique of Ocean Alkalinity has huge potential. The process of measurement, reporting, and verification (MRV) for Ocean Alkalinity is in its formative stages, and significant resources are being expended to address current issues.

Please update *Annex 5* to include the possibility that Ocean Alkalinity, and perhaps other approaches in the future, will be best verified through modeling, indirect measurement, or other approaches as determined by the best scientific consensus at the time.

Thank you very much for your consideration.

For your information, my background in CDR/GGR is as follows:

- I am responsible for commercialization efforts for Planetary Technologies. Planetary is an ocean-based CDR company past the lab scale and moving into field trials now. We have sold carbon credits to Shopify. They have agreed with us on the MRV for those credits. We work with many other groups and scientists in the field, including NOAA, NOC, EDF, TNC, and others. We partner with Dalhousie University, University of Miami, Plymouth Marine Labs, and others on the science and practice of MRV. We participate regularly in conferences and workshops , so we are very familiar with the state of the art regarding MRV.

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