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Geochemical perspectives on measuring, reporting and verifying carbon dioxide removal from the atmosphere.

ELLA HOLME, REBECCA TYNE, KEVIN SUTHERLAND, RHYS JOHN SAVAGE, MARYA MATLIN-WAINER, SOPHIE GILL, JING HE, JENNIFER YIN AND ADAM WARD

Isometric

Presenting Author: ella.holme@isometric.com

Carbon dioxide removal (CDR), alongside decarbonization, is a critical component of efforts to mitigate anthropogenic climate change and can be achieved through several pathways. Each of these CDR pathways are evaluated using separate monitoring, reporting, and verification (MRV) frameworks, which are each associated with their own degrees and types of uncertainty. One particularly consequential form of uncertainty across pathways is the timescale of removal and how this relates to ex-ante (before climate impact) vs. ex-post (after climate impact) credit issuance.

We consider four options for the definition of when a removal occurs: 1) when the project action that will lead to CDR is taken; 2) when the irreversible action has measurably occurred; 3) when the atmosphere feels the effect of the removal; and 4) when carbon is durably stored in its final storage reservoir (e.g. the ocean, subsurface storage). We apply these options to four pathways – enhanced weathering (EW), ocean alkalinity enhancement (OAE), biomass with carbon removal and storage (BiCRS), and direct air capture (DAC). We examine the processes governing removal timescales in each of these pathways and their associated uncertainties as they relate to crediting. These pathways are examined because of the considerable differences in their removal timescales– for example, the time elapsed between options (2) and (4) may be minimal for a DAC project, but may equate to decades in an EW project. Furthermore, while the strictest definition of ex-post is important to understand for long-term climate impacts, adopting it in crediting timescales can present an obstacle to scaling CDR and mitigating climate change in the next century. This highlights the importance of striving for consistency on cross-pathway crediting timelines while taking operational feasibility into account.