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Technical monitoring considerations for advancing CCS Projects under the California Low Carbon Fuel Standard and other global regulatory regimes

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Abstract

Carbon capture and geological storage (CCS) is a proven technology for climate change mitigation which must be significantly up-scaled over the next 30 years. According to the International Energy Agency, a total of 94 gigatones of CO_2 must be sequestered via CCS by 2050 to limit global warming to 2°C (IEA, 2016, 2017). The recent IPCC Special report on 1.5C strongly recommends an even more ambitious target of 1.5C which will require even larger volumes sequestered. To encourage CCS project development in the United States and globally towards these emissions reduction targets, new tax incentives (Section 45Q of the US tax code) and regulations for gaining CO_2 credits (the California Low Carbon Fuel Standard (LCFS) CCS Protocol) have been recently established. Given the magnitude of upscaling needed, it is widely anticipated that more such incentives will be enabled globally and will likely build on and evolve from established protocols.

At present, the backbone of current global policies and regulations designed to stimulate CCS require monitoring plans to demonstrate that CO_2 remains underground apart from atmosphere. Monitoring must be implemented during the entire project including the post-injection phase which can last from 15-100 years (CARB, 2019; EPA, 2010, 2011). Environmental safety is also prioritized, along with methods for quantifying any loss to atmosphere should it occur. For example, the LCFS states: *"... Project Operators must monitor the surface, near-surface, and deep subsurface for CO2 leakage that (1) may endanger public health or the environment or (2) require reversals of the storage credits due to a failure to achieve and maintain permanence*." Thus, demonstration of "permanent storage" and environmental integrity is required under these schemes to gain financial benefits.

While deep-focused monitoring for conformance plays an important role in all monitoring protocols including the LCFS, it can be argued that shallow-focused monitoring most directly addresses the aspects of environmental safety and identification of leakage. For example, source attribution of shallow gases is a critical step in determining if CO_2 emissions represent actual loss of permanence or some other environmental factor (Dixon and Romanak, 2015). Surface flux methods can then be used to quantify the loss that occurs. Thus we focus only on the portion of the LCFS protocol that is addressed using shallow environmental monitoring techniques, specifically those attribution methods

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discussed in Dixon and Romanak, 2015. We then determine monitoring protocols and techniques that are sufficiently accurate, economical, easy to deploy over long time periods, and easy to communicate to non-technical stakeholders which will most efficiently satisfy LCFS regulations. Such aspects are critical for ensuring that projects 1) can be approved and permitted to proceed with environmental integrity and 2) to ensure that projects are not hampered during the operating phase by unnecessary burdens which could interrupt projects and jeopardize efforts to achieve climate objectives using CCS technology.

Focusing on the California LCFS, the "Permanence certification" requires two sub-certifications: a "sequestration site certification" and a "CCS project certification". A sequestration site certification requires the normal monitoring components of site characterization, risk assessment, design, monitoring, operational and closure plans and the CCS project certification focuses on well construction and remediation of legacy wells.

From a technical standpoint, one of the most challenging requirements under the LCFS is developing the baseline testing plan. CCS Project Operators must submit a baseline testing plan with the application for Sequestration Site Certification that can "detect, validate, and quantify potential CO_2 leakage" over the entire project lifetime including the 100 year PISC. The plan must include *actual data* acquired pre-project that demonstrates "*Natural background variability at daily, seasonal, or long duration trends (e.g., climate change, sea level rise, urbanization, or other landscape evolution) must be considered, and may require advanced approaches to separate CO2 leakage signals from natural changes.*"

"The CCS Project Operator must also demonstrate that seasonal and diurnal variations in CO2 levels have been captured and describe the variability in the data for future reference and to compare to operational and post-operational monitoring." So these regulations require that baseline be sufficient for predicting how baselines might change from climate change, sea level rise, urbanization, or other landscape evolution over at least 100 years into the future. Technically this is a very difficult challenge, and the need for pre-project data collection that is relevant over long time periods and encompasses the unknowns of long duration trends could be a significant challenge that hinders a project.

We will discuss the technical ramifications of this and other requirements set out by the LCFS CCS Protocol and discuss the ways in which common and low-cost near surface monitoring techniques can best be used to satisfy the requirements.

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