Highlights from the May 2025 Stanford Law & Policy Lab Report[1]
on
"Increasing Accessibility to Trusted Climate Performance Data"
by
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Overview

Without fanfare, U.S. companies, financiers, and entrepreneurs are continuing to make substantial investments in reducing emissions of carbon, methane, and other greenhouse gases (GHGs) and, in a growing trend, in direct removals of carbon dioxide from the atmosphere. Within the last month, for example, the X Prize Carbon Removal competition doled out $100 million in the largest global incentive competition award in history.

While many clean energy investments will continue to scale, a single market failure—the lack of investor-grade performance metrics—threatens to hold back investments in three of the most promising opportunity areas for GHG emissions reductions and removals: methane emissions reductions; hybrid (or engineered) CDR solutions; and forest carbon interventions.

The Stanford report released today describes how poor performance accounting standards are the soft underbelly that is afflicting each of these sectors. In all three cases, there is no general agreement on protocols that should be used to measure and confirm GHG reductions and removals, nor is there a system for transparently sharing performance results that will trigger additional investment.

This lack of GHG performance accounting can and must be fixed. The Stanford report reviews how leaders in other fields have come together to identify and incentivize the use of modern data management tools to pool together shared, trusted performance information that data users of all types can rely upon. The report provides recommendations for how key stakeholders in each of the three sectors highlighted in the report can—with the assistance of expert convenors and university consortia—leverage and expand nascent standard-setting and data collection and sharing initiatives to generate accessible, trusted GHG performance data, triggering increased

[1] **About the Report.** The Stanford report has been prepared by a Stanford Law and Policy Lab class—"Bridging the Climate Data & Decision-making Divide"—led by Stanford Professor of the Practice, David J. Hayes. The Policy Lab class culminated in a March 2025 conference and workshop that was sponsored by Stanford Law School's Environmental and Natural Resources Law and Policy and CODE-X programs, the Stanford Doerr School of Sustainability's Accelerator and Woods Institute for the Environment, and the Data Foundation.

investment in activities that will reduce methane emissions, scale CDR solutions, and increase carbon uptake in forests (and other nature-based solutions).

The report also highlights GHG performance data gains that can be made in the urban context, building on foundational work undertaken by Crosswalk Labs and the Data Foundation.

Background

The Need for Investor-Grade GHG Performance Information

Investor-grade climate performance information that is based on the type of assurances and standards that are broadly required by accountants, financial markets, institutional investors, and regulators in other contexts are needed for:

- Investors to identify and prioritize effective greenhouse gas mitigation activities.
- Companies to make more accurate carbon disclosures, measure progress against climate goals, and participate in market-based opportunities.
- Policy-makers and government officials at all levels to evaluate mitigation investment returns and to track and confirm that promising carbon reduction strategies are actually generating measurable, positive atmospheric impacts.

Generating and publicly sharing investor-grade GHG performance information will generate broad economic and societal benefits including:

- Confirming claimed atmospheric impacts from investments in GHG emissions reductions and removals.
- Triggering innovations and increasing investments in scalable, top-performing mitigation opportunities.
- Bolstering the credibility and effectiveness of voluntary and compliance carbon markets and carbon accounting constructs.
- Reliably identifying lower carbon-intensity product information that can generate market premiums and trade preferences.

Carbon Disclosures Are Not Producing Investor-Grade GHG Performance Information

Skeptics may question the need for better climate performance information, given that tens of thousands of companies all around the world already are gathering carbon emissions data for carbon disclosure reports. However:

- While carbon disclosure reporting serves an important function helping companies understand entity-wide emissions and climate risks, it often relies on generalized models, emissions factors, and “spend-based” carbon estimates that can vary significantly in their accuracy and applicability across different GHG contexts and scales.
- Carbon disclosure reporting also typically does not require companies to provide separate performance tracking or accounting information for activity-level investments in emissions reduction or removal projects. The activity-level investments that are not covered by reporting requirements are of greatest interest to companies and investors.

In addition to corporate reporting, a growing number of carbon registries and third-party verification entities have emerged to collect and review carbon data—largely to support voluntary carbon market transactions. Unfortunately, however, the lack of standards and transparency in how these entities collect and analyze climate performance information has eroded trust in performance claims.[2] And while technological advances in the earth observation and artificial intelligence fields have been opening new and better ways to collect relevant data—as illustrated by breakthrough work undertaken by Planet Labs, CTrees, Climate Trace, and other pioneering companies and organizations—limited access or agreement regarding how underlying data are collected and analyzed, and inconsistencies among and the lack of transparency across competing data platforms continues to undermine GHG performance claims.

Improved GHG Performance Information Is Particularly Needed For Three Important Use Cases—Methane Reductions; Forest Carbon Interventions; and Carbon Dioxide Removals.

As a general matter, adequate investor-grade GHG information is available for emissions that are caused by the combustion of fossil fuels. So long as the quantity and type of fossil fuel that is being combusted in a stationary or mobile source is known, a straight-forward calculation of resulting emissions can be undertaken. As a result, strong, science-based GHG performance information is generally available for carbon dioxide emissions generated from power plants, major industrial activities that burn fossil fuels, and cars and trucks that use petroleum-based fuels.

Unfortunately, this approach is not applicable for three of the most significant opportunity areas for increased GHG emissions reductions and removals: methane emissions reductions; hybrid (or engineered) carbon dioxide removals (CDR); and forest carbon interventions.

Emissions from major sources of **methane**— oil and gas operations, landfills, and livestock-related activities—are highly variable, traditionally difficult to measure and monitor and, as a result, are poor candidates for generalized emissions assumptions. Many of the most promising **hybrid CDR** applications involve "open system" applications that implicate hard-to-quantify carbon absorption in rock, biochar and other materials over large and complex geographic areas. And while reforestation activities and other types of **forest carbon interventions** clearly can generate additional carbon capture and storage, there is no agreement regarding the best protocols for measuring, verifying, and publicly sharing information on activity-level forest carbon gains.

Modern Data Management Tools Can and Should Be Applied to These Important GHG Reduction and Removal Opportunity Areas

The deployment of modern data management tools has transformed how key performance information is developed and shared across many sectors, making activity-level performance

[2] Also, as discussed in the Stanford report, policy questions of additionality, permanence, and leakage have been centrally important when scrutinizing voluntary carbon market transactions—typically overshadowing more fundamental underlying questions from an accounting perspective about the numeric integrity of GHG emissions reductions or removals claims—even though accurately calculating the atmospheric impact of a mitigation activity will always be of central importance to companies, investors, and other interested parties in both market and non-market contexts..

information accessible to a broad array of investors, practitioners, researchers, public officials, and interested citizens.

Core modern data management tools typically include: (1) reliance on scientifically-sound, consensus-based measurement and monitoring methods (i.e., protocols); (2) coding and use of common definitions and other machine-readable tools so that data from multiple sources is "interoperable" —that is, easily accessed, aggregated and analyzed; and (3) the utilization of open-source data platforms that increase transparency and democratize access to high-quality data, building public trust.

The time is ripe to apply these modern data management tools to the three major GHG opportunity areas highlighted in the Stanford report. A major new wave of emissions-relevant data will be generated in the coming months and years due to technological advancements in detecting and measuring greenhouse gas emissions and removals; the ever-higher economic stakes in making smart, effective investments in emissions reduction and removal activity; and continued frustration with poor quality, non-replicable performance claims made in the key opportunity areas of methane emissions reductions, hybrid CDR removals, and forest carbon interventions.

Tailoring the Application of Modern Data Management Tools to Generate Investor-Grade GHG Performance Information in Three High-Priority Use Cases

Rather than pushing for a grandiose, across-the-board climate performance data solution, the Stanford report advances targeted recommendations that are tailored to methane emissions reductions, hybrid CDR removals, and forest carbon interventions—all of which are well-positioned to deploy sector-specific communities of interest and modern data management approaches to generate publicly available, investor-grade GHG performance information.

The Key Recommendations section below outlines the Stanford report's sector-specific recommendations for tackling this goal for each of the three key use cases.

Learning from the Urban GHG Context: Sharing Key Climate Performance Data through User Friendly Data Dissemination

The Stanford report also covers a fourth instructive use case that involves getting accurate, hyper-local carbon dioxide emissions data into the hands of local decision-makers for effective climate action. Although reliable carbon dioxide data sets are generally available (as explained above), the urban context presents a critical challenge for climate performance data, as the interplay of carbon dioxide emissions from buildings, transportation, and industrial activities in cities creates uniquely complex measurement difficulties.

Over the past year, the Data Foundation's Climate Data Collaborative has partnered with Crosswalk Labs to launch an open data tool, open.crosswalk.io, that brings census level CO_2 data to communities across the United States. The tool allows any user to zoom in or out to facility, community, or regional level emissions and transforms complex emissions modeling into accessible, decision-ready information for non-technical users. It exemplifies the type of open-source tool that can take available emissions datasets and make them more readily available and actionable for public officials and other interested user groups.

As presented at conferences and workshops in Washington DC, Stanford, CA, and most recently at the World Meteorological Organization in Geneva, Crosswalk's approach utilizes a unique measurement, reporting, and verification methodology that is designed to present a digital twin of emissions in every neighborhood of the United States. Crosswalk builds its digital twin using publicly available data and a uniform methodology, modernizing emissions modeling by incorporating web-scraping and data-fusion methods.

Key Recommendations

Cross-Cutting Recommendation to Learn From Other Sectors

Workshop Data Management Learning from Other Sectors. An important recommendation relevant to all of the use cases highlighted in the Stanford Report is for data management organizations like the Data Foundation to sponsor workshops that introduce interoperability and open-source data learnings from the accounting, medical, and other sectors to priority GHG applications. Such workshops could open the door to a work plan or research roadmap that focuses on the development of definitions, standards, and data commons for the important GHG use cases highlighted in the Stanford Report.

Recommendations for Oil & Gas Methane Emissions.

Forge Cross-Sector Oil & Gas Methane Collaborations Among Industry, NGOs & Academic Leaders. Given the extraordinary level of national and international attention on methane leakage in the oil and gas industry and the related technological advances in leak detection, a number of key actors have an interest in agreeing on protocols for collecting and pooling oil and gas methane emissions data. This group includes major oil and gas companies that have invested heavily in leak detection technology and in repairing leaks; philanthropy-supported research and advocacy non-profits like CarbonMapper and the Environmental Defense Fund; international organizations like the Global Methane Hub and the International Methane Emissions Observatory (IMEO); and other leading NGOs such as the World Resources Institute and the Natural Resources Defense Council.

Explore How U.S.-Based Methane Oil & Gas MRV Advances Could Help Accelerate IMEO Standard-Setting. Given the global importance of reducing oil and gas-related methane emissions and the international commitments that have been made in the sector, IMEO could be a promising forum for advancing common methane measurement and monitoring protocols and data sharing mechanisms. A US-based oil and gas methane data collaborative potentially could help jump-start an effective IMEO process by engaging domestic oil and gas methane emissions stakeholders in preliminary standard-setting and data-sharing discussions. Participants in the initiative could involve experts from industry, government (including subnationals), NGOs, academics, and data management companies, along the lines originally envisioned by the National Institute of Standards and Technology.

A key to success would be recruiting respected, neutral convenors that have experience in deploying modern data management tools to construct open source, shared databases by developing consensus-based data collection protocols and negotiating common definitions, APIs,

and other interoperability standards to facilitate formation of a trusted data commons. Technical assistance could be provided by methane experts at universities and organizations with deep methane detection expertise like the Global Methane Hub, EDF, CarbonMapper, the University of Texas-Austin, Stanford University, and others.

Recommendations for Landfill Methane Emissions.

The landfill sector appears to be an excellent candidate for an initiative that would seek consensus around specific measurement and monitoring and data sharing protocols and tools that should be adopted by landfill operators. The effort could build upon the significant progress that the ICVCM already has made in this area.

Leadership by U.S. State and Local Leaders. Because many landfills in the U.S. are owned by municipalities with input and some regulatory oversight by local, state, and federal authorities, there is an existing community of interest around landfills that could be encouraged to participate in a pilot project to establish a data commons for landfill methane data. State and local authorities, working through organizations like Climate Mayors and the U.S. Climate Alliance (composed of state governors) that have a direct stake in quantifying and reducing methane emissions from publicly-owned and/or regulated landfills could work with data management conveners and methane detection experts to develop consensus-based protocols and information-sharing tools to develop landfill best-in-class methane standards and quantification information. As with other major methane sources, technological advances in methane detection and broad-based stakeholder interest in reducing methane emissions can help advance a trusted landfill methane data collection and sharing effort.

Recommendations for Livestock/Agricultural Methane Emissions.

Sponsor Research Symposiums and Technical Workshops on Livestock/Agricultural Methane Emissions. With many research institutions in the U.S. and around the world focused on techniques to reduce livestock and other agricultural-related methane emissions, it is important that the research and policy communities stay up to date on developments in the area, and share information on protocols and research results.

Organize Collaborations Among Leading Companies, NGOs, Researchers, and Data Management Experts. Because limited attention to date has been given to protocol development and data sharing for livestock-related methane emissions, now is arguably the best time for methane detection and data management experts–including experts that have had data management experience in multiple sectors—to work with researchers and technical experts in academia; dairy and meat processing companies; and NGOs to develop data gathering and sharing conventions that facilitate common approaches for measuring, monitoring, and authoritatively confirming methane reductions from feed additive, genetic advances, and other livestock methane mitigation efforts.

Recommendations for Hybrid CDR Solutions.

The relatively small (but growing) U.S. CDR community has a unique opportunity to demonstrate how modern data management tools can be used to create open source datasets that

will provide reliable, trusted confirmatory information for the most promising types of hybrid CDR solutions.

Leadership by CDR Buyers and Adjacent Industry Players. CDR buyers and their agents (including registries in their employ) are making substantial expenditures in scientific reviews and other due diligence to ensure that CDR projects will generate quantifiable, durable removals. Currently, the primary focus is on one-off projects in which CDR buyers are investing, with much less attention being given to mapping and pooling MRV information for similar types of CDR projects.

As noted in the Stanford Report, however, Frontier and other industry leaders are aware of the need to broaden data sharing and collaboration, and new organizations like Beyond-Alliance.org are providing potential new vehicles for lifting up and broadening out open source performance data for key types of CDR projects. Also, the National Institute for Standards and Technology (NIST) has initiated a Carbon Dioxide Removal Consortium. An independent non-profit or university should be encouraged to continue and expand NIST's efforts to build consensus around protocol and data sharing standards for hybrid CDR projects.

Because significant investment dollars are already being spent in generating quantifiable, durable removals, CDR buyers, early-stage CDR company investors, rock companies, agricultural producers, waste management companies, and other adjacent industry players that stand to profit from future CDR investments are well-positioned to establish data management expectations for this young industry.

Forge Company & University Collaborations. A special initiative also could be developed to address the special challenges of measuring and monitoring the potential off-site environmental ramifications of "open system" CDR solutions like biochar or enhanced rock weathering (ERW) applications. The science community agrees that for these types of applications, it will be necessary to study off-site impacts and construct sophisticated predictive ecosystem models that account for such potential impacts.

Individual CDR companies are not well-positioned to undertake this type of landscape-scale modeling, nor may they be good candidates to undertake the representative on-site sampling required to support such a modeling exercise. Indeed, to the extent that periodic confirmatory sampling must be undertaken for model integrity, the modelers should choose those locations, rather than being subject to the randomness of CDR company-owned (or otherwise readily-available) lands.

This situation suggests that for open system CDR, pooled investments may be needed to develop, calibrate, and refine models that analyze transport and potential environmental impacts of biochar, ERW, and other open system solutions. This could present an opening for universities and other researchers to partner with CDR companies and potential suppliers of CDR materials to create MRV tools that will benefit multiple companies and locations. In addition, industries that will potentially benefit from CDR expansion—such as rock companies and biomass suppliers—potentially could be enlisted to provide financial support and (rock or biomass) materials for such an exercise. The ERW Data Quarry concept that Climate Cascade has begun to construct from commercial data sets may provide another key piece to the open system puzzle.

Recommendations for Forest Carbon Interventions.

The forest data work that major U.S. forestry NGOs have begun provides a strong basis for a collaborative effort that a expert intermediary like the the Data Foundation's Climate Data Collaborative could launch with NGOs, states, private forest owners and commercial entities to develop an open source forest carbon data sharing platform that would integrate diverse data sources across multiple scales—from project-level to regional and datasets — with the overarching goal of providing a comprehensive, scientifically-grounded basis of forest carbon data that enhances the credibility of nature-based solutions and accelerates their adoption at scale.

This project could focus on key themes that recur throughout the Stanford Report, including development of:

Establishing A Data Integration Framework: Developing agreed-upon protocols for data quality, transparency, governance, and interoperability, to authenticate data providers and facilitate machine-actionable knowledge sharing across key forest carbon datasets from multiple inputs including MRV inputs from reforestation and improved forestry practices practices; applied research; private and government-sponsored monitoring systems, etc. Significant efforts should be made in parallel to develop data inputs and a data integration framework for non-carbon ecosystem services benefits that accrue from forestry investments.

Public-Private Partnerships: Creating a collaborative model that balances privacy concerns, proprietary information, and varying data ownership models while systematically highlighting where private sector innovation is most needed.

Decision Support & Implementation: Developing visualization capabilities and analytical tools that transform integrated data into actionable insights for landowners, project developers, researchers, and policymakers to accelerate adoption of nature-based solutions.

Comprehensive Analysis of Working Forests Issues and Opportunities. Collaborate with working forest owners and operators and develop a verified database that combines interoperable carbon stock data from working forests with post-harvest carbon storage and losses, based on verified life-cycle analyses. The initiative would highlight data and methodology gaps where private sector innovation is most needed, creating targeted opportunities for advancements in measurement, reporting, and verification technologies and capabilities.

Drawing inspiration from successful models like the Internet of Water and the Data for the Common Good framework, such a collaborative would seek to bridge critical data gaps, reduce redundancy, and enhance data accessibility. Successful piloting of forest carbon data integration could provide insights and frameworks to expand this model to other key nature-based climate solutions.

Identify and Evaluate Promising Performance Metrics for Non-Carbon Forestry Co-Benefits.

As referenced above and described more fully in a 2024 Stanford Law & Policy Lab report, efforts should be taken to identify and calibrate the potential non-carbon benefits and

consequences of forest carbon and other nature-based interventions. Significant academic and project-based research and experimentation is underway in this area. It would be useful to engage a respected, independent technical and policy organization to sponsor public reviews of promising measurement and valuation approaches for typical forestry co-benefits and, ideally, to recommend additional investments and test piloting of the most promising calibration and valuation approaches.

Recommendations for Urban Performance Information.

Looking ahead over the next five years, the priority in the urban context should be bridging the science-policy gap to empower a community of local decision makers to use the best available scientific evidence to inform climate action. As a starting point, efforts could include establishing an ecosystem with three distinct sets of players to improve climate performance data in the urban context. This model could include:

A Consortium that serves as an independent body that convenes agencies, commercial service providers, NGOs, and researchers to co-develop standards and best practices in urban emissions measurement and modeling. This consortium should accelerate the translation of state-of-the-art science into decision-ready information while providing baseline R&D that enables private sector innovation, potentially creating a "race to the top" where organizations compete to exceed established standards through continuous improvement and innovation. The consortium would serve as a trusted platform/group to help evaluate emissions data using transparent methods and observational validation approaches.

Organizations focused on understanding stakeholder needs, like the Data Foundation/Climate Data Collaborative, should prioritize ensuring the best urban greenhouse gas (GHG) information makes its way to cities and local decision-makers. These organizations serve as crucial intermediaries between technical data providers and end users, translating complex emissions data into actionable insights. By conducting regular needs assessments and maintaining open communication channels with diverse urban stakeholders, they can identify information gaps and usage barriers. Stakeholder needs for climate action should then inform future R&D priorities for the consortium, creating a feedback loop that ensures scientific advances remain relevant to real-world implementation challenges.

Service Providers that create data visualization tools, aggregation platforms, and value-added services could leverage the consortium's scientific foundations while receiving credibility through third-party validation. By implementing the consensus standards in innovative commercial applications, these companies can deliver solutions that directly address stakeholder needs identified by organizations like the Data Foundation/Climate Data Collaborative.

This three-player model would facilitate building trust in burgeoning data tools, connecting decision-makers with training and support, building partnerships, and connecting trusted datasets to improve climate mitigation decisions at local levels.