CARBON DIOXIDE REMOVAL MISSION

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1ST EDITION

Carbon Dioxide Removal Mission Action Plan 2022-26

Contents

Summary in Brief

- The MI CDR mission aims **to enable CDR technologies to achieve a net reduction of 100 million tonnes (0.1 gigatonnes) of CO2 per year by 2030.** Climate models, such as those reported by the Intergovernmental Panel on Climate Change, indicate several gigatons of CO2 removal annually will be needed by 2050.

- In order to achieve this goal, the Mission has identified innovation priorities (Section 2.2) to inform its activities. Ultimately, the Mission aims to facilitate three short-term outcomes:

    - **Outcome 1: Enhanced understanding of local and global CDR potential**
    - **Outcome 2: Advancement of R&D for CDR technologies**
    - **Outcome 3: Global demonstrations and pilot-scale tests**

- The Mission will launch successive research and innovation (R&I) projects aimed at achieving these desired short-term outcomes. Potential projects are described in section 2.3. These projects will require collaboration between Mission members, innovators, investors, researchers, and/or other key players.

- In 2022, the Mission will launch two flagship projects (or "sprints") and initiate a series of LCA/TEA case studies to advance a harmonized approach and methodologies.

    - Through its first sprint, the CDR Launchpad, the Mission will lead a global push for CDR pilot-scale tests and demonstration projects (Outcome 3).
    - The Mission's second sprint, CDR Opportunities Mapping, will identify and consolidate geospatial data on CDR resource availability (Outcome 1).
    - The Landscape Analysis (LCA) / Techno-economic Analysis (TEA) case studies will advance a set of harmonized methodologies and practices in developing and conducting LCAs and TEAs as science-based decision-making tools (Outcome 1).

- A detailed overview of these initial projects is presented in section 2.4 of this Action Plan.

- Future projects will be launched by Mission members, guided by the Mission's Theory of Change (section 2.1), and responding to the Innovation Priorities identified in section 2.2.

1. Introduction

1.1 About the CDR Mission

Carbon removal is an essential tool in the suite of climate actions. The world simply cannot meet global climate goals without carbon removal. Alongside dramatic emissions cuts, the global community will need solutions to remove billions of tons of CO2 from the atmosphere every year to limit the impact of climate change (IPCC 2022 - SPM).

The Carbon Dioxide Removal (CDR) Mission, under Mission Innovation (MI), aims to enable CDR technologies to achieve a net reduction of 100 million tonnes (0.1 gigatons) of CO2 per year by 2030. This objective is an important milestone on the road to realizing the global ambition of net zero emissions by mid-century.

To achieve the 2030 mission objective and advance toward net zero, the emerging CDR ecosystem will need to concurrently deploy and scale mature technologies, while advancing research, development, and demonstration of earlier-stage technologies and pathways. Progress will also require an enhanced understanding of the global potential of CDR technologies, with attention to opportunities and challenges at the local and regional scales.

The Mission currently prioritizes three key engineered and hybrid CDR approaches[1]: direct air capture (DAC) with storage; biomass with carbon removal and storage (BiCRS); and enhanced mineralization (EM). These three approaches form the technical tracks along which the Mission is organized. The Mission is not currently focused on ocean-based or entirely nature-based CDR concepts such as afforestation, improved forest management, or wetland restoration.

The CDR Mission is co-led by the United States, Canada, and the Kingdom of Saudi Arabia. Core members include Australia, Japan, and Norway. Supporting members include the European Commission, the United Kingdom, and India.

1.2 About the CDR Mission Action Plan

In the first half of 2022, Mission members developed the CDR Mission Innovation Roadmap, which provides an overview of the status of CDR approaches, highlights key innovation needs, and presents research efforts undertaken by Mission members to date. The

[1] Hybrid approaches use technology to supplement natural CO_2 removal processes. Biomass with Carbon Removal and Storage (BiCRS) and enhanced mineralization are examples of hybrid approaches.

Roadmap draws on a review of recent literature, a survey of CDR Mission members, and input from mission stakeholders and subject matter experts.

In June 2022, the CDR Mission held a workshop with members and stakeholders to discuss innovation priorities for DAC, BiCRS, and EM and to identify potential actions that the Mission could take to address those priorities. A separate workshop, held in July 2022, focused on opportunities to advance common approaches to LCAs and TEAs.

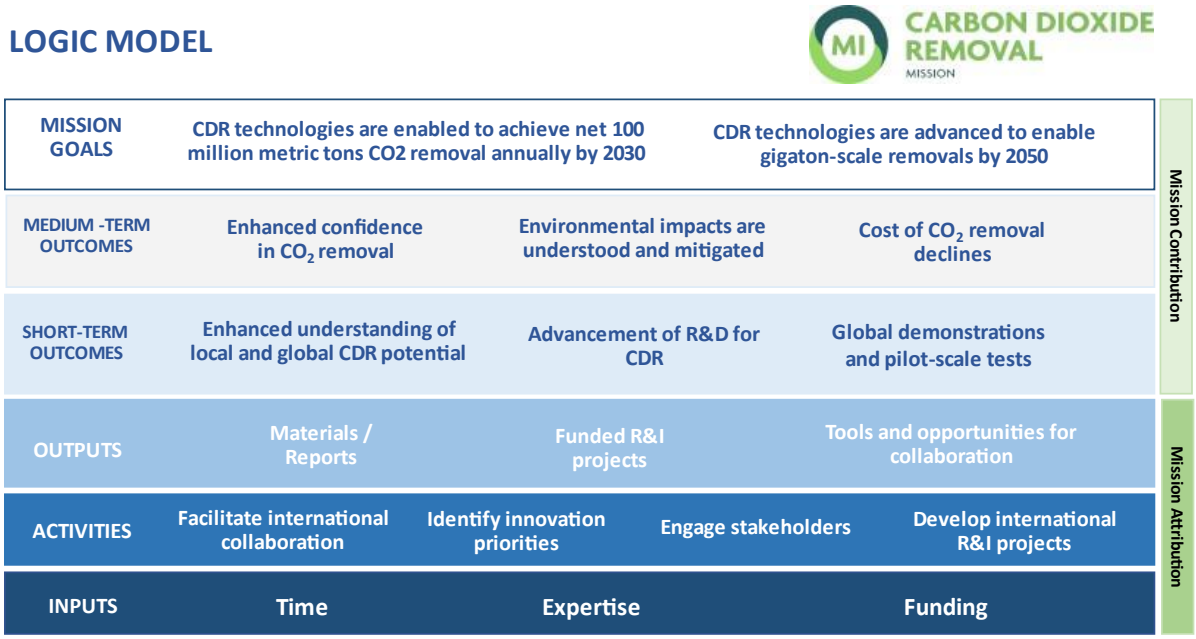
Building on the analysis in the CDR Mission Innovation Roadmap and the feedback received during workshops, this Action Plan:

- Sets out a vision for how to drive progress toward the Mission's objectives (section 2.1);
- Lays out innovation priorities for DAC, BiCRS, enhanced mineralization, and LCAs/TEAs (section 2.2);
- Lists potential actions that can advance CDR pathways and the next generation of CDR technologies (section 2.3); and
- Outlines the initial projects that CDR Mission members and their partners will deliver, beginning in September 2022 (section 2.4).

The Action Plan is intended to serve as an evergreen document and will be updated to reflect new projects delivered through the Mission and/or new innovation priorities in the CDR space.

2. Activities

2.1 Theory of Change



The CDR Mission logic model outlines the intended outcomes of Mission efforts and describes how Mission resources will be used to facilitate these outcomes. It is a partial representation of a highly complex system, and the achievement of desired outcomes and goals are beyond the complete control of the Mission alone.

While the Mission targets a 2030, and secondarily, a 2050 goal, the Mission itself is shorter in duration, continuing for five years from its official launch in 2021. The Mission alone cannot achieve the goals it has set out: it can only contribute to the scale of change desired for the whole CDR ecosystem. It is a significant player, but outcomes in the short- and medium-term will be the work of many dedicated actors including innovators, investors, researchers, local and national governments, informed and engaged citizens, and more. Mission goals will necessarily be supported by enabling policies and ongoing political will.

The focus of this Action Plan and Logic Model is on activities the Mission can undertake in the next four years (to 2026) to best facilitate three key short-term outcomes that provide the best chances of enabling the Mission goal.

Short-term Outcome #1: Enhanced understanding of local and global CDR potential

The mass deployment of CDR technologies and approaches will require an advanced understanding of the complex social, economic, and environmental challenges and opportunities associated with each approach as well as access to the best available data.

All CDR technologies require some combination of land, energy, water, materials, and other resources, many of which are finite, each of which has competing uses, and could change or be tailored to the context and needs of each region. The availability of resources for CDR, their competing uses and the potential co-benefits, as well as the limitations and trade-offs at any location must be better understood to enable siting decisions, allow for the identification and mitigation of potential negative impacts, and enhance public confidence.

There are currently zero globally accepted approaches, boundaries, or baselines for measuring, reporting, and verifying CO2 removals attributable to CDR processes. Transparent LCAs and TEAs will allow for more accurate assessment of all CDR technologies, while accurate and precise measurement, reporting, and verification (MRV) technologies and methodologies will ensure the long-term removal of CO2 from the atmosphere. MRV will also enable deploying jurisdictions to take advantage of current voluntary and compliance carbon pricing systems.

An enhanced understanding of CDR technologies can also lead to greater global confidence, and thereby greater investments that will help these technologies to mature and commercialize.

Short-term Outcome #2: Advancement of Research and Development (R&D) for CDR

While the technologies supported through this Mission are at different levels of readiness, with some BiCRS technologies (e.g. Bioenergy with Carbon Capture and Storage, BECCS) deployed at commercial-scale, and DAC deployments at pilot-scale, all technical tracks will need R&D to accelerate the development of novel technologies in order to reach gigatonne scale removal.

R&D across technical tracks will enable reduced resource (including energy) intensity, improved technical performance, and increased ability to develop and scale up promising systems. CDR technologies are at an early stage, and it is through R&D that applicability and viability can be demonstrated. R&D also allows for innovation, discovery, and identifying new solutions, and is a critical component of any innovation ecosystem.

Key R&D opportunities for DAC systems include the scale-up of lower-cost materials that can capture CO2 faster, at a greater capacity, with longer lifetimes, and with lower energy use.

Key R&D opportunities for BiCRS include conversion processes that accommodate heterogeneous biomass feedstocks, optimization of biomass feedstocks to maximize

carbon removal, measuring upstream emissions such as those associated with land use change and crop management, and supply chain logistics for biomass resources, facilities, markets, and storage.

Key R&D opportunities for enhanced mineralization include resource mapping, kinetics of carbonation in rocks, energy and land use, monitoring and verification of CO2 uptake, marketable products for carbonates, and system logistics for in-situ and ex-situ pathways.

The list of innovation priorities (section 2.2) details the key R&D needs across technical tracks.

Short-term Outcome #3: Global demonstrations and pilot-scale tests

Demonstrations and pilot-scale tests are critical to accelerating the scale-up of CDR. Demonstrations of technologies in the technology readiness level (TRL) 5-7 range have the potential to deliver near-term improvements in cost and performance and result in more CO2 removed in the short term.

Demonstrations drive learning-by-doing improvements and help to commercialize new technologies by enabling technical, organizational, and market learning, so that projects can be developed faster and more effectively.

Demonstrations can also inform regulatory and policy development, and advance cooperation with local communities, ensuring that CDR technologies are developed and deployed in a socially and environmentally acceptable way.

By providing confidence and clarity to investors and other stakeholders, Mission support for demonstrations can crowd in additional private sector funding to amplify the impact of government resources.

2.2 Innovation Priorities

To advance the short-term outcomes outlined in the previous section, actions must be tailored to the needs and challenges of each of the Mission's three technical areas (DAC, BiCRS, and enhanced mineralization). The Logic Model above describes how Mission inputs and activities will facilitate the desired outcomes; the innovation priorities identified here will be used to guide the development of specific R&I projects under the Mission.

Table 1 summarizes the top innovation priorities for the Mission's technical tracks, based on member and stakeholder feedback during and following a workshop in June 2022.[2] Life cycle analyses (LCAs), techno-economic analyses (TEAs), and measurement, reporting, and verification (MRV) were consistently identified as top priorities for all three technology

[2] Table 1 is not an exhaustive list of all innovation gaps and challenges related to CDR technologies. (For a deeper analysis on innovation gaps and challenges, refer to the CDR Mission's Innovation Roadmap). Rather, Table 1 reflects the top priorities for each technical area based on recent feedback. These priorities may be subject to change, as the CDR space is rapidly evolving.

areas. These innovation priorities were identified in the Mission's Innovation Roadmap and distilled in collaboration with Mission members and stakeholders.

Leads for each of the Mission's technical tracks will feed into the actions the Mission takes, by providing technical expertise and advice, and ensuring the innovation priorities for these technical tracks are being addressed.

Table 1. List of Innovation Priorities

Technical Track	Top Innovation Priorities
Direct Air Capture and Storage	Energy use: • Reducing energy requirements and/or integrating low-cost, low-carbon heat and electricity with minimal trade-offs for resource consumption and competing uses for the energy.
	Material performance: • Developing materials that can capture CO2 at a greater capacity, with longer lifetimes.
	CO2 capture and desorption kinetics: • Faster kinetics; reduced diffusion resistances; optimization of the effect of temperature and humidity on CO2 capture rates
	Environmental impacts and siting: • Plant siting that takes into consideration the effects on the local resources and communities.
Biomass with Carbon Removal and Storage	Biomass feedstocks: • Understanding sustainability and minimizing ecological risks, including competition for the resources. • Optimizing biomass for life-cycle carbon removal, including marine biomass. • Technologies for combustion and conversation of biomass feedstocks.
	System logistics: • Mapping possible network configurations considering biomass resources, transport, land use, water consumption, product markets, geological storage, etc. • LCA of complete systems and sustainability issues, including all stages from biomass production to end use, and additional environmental factors beyond amount of CO2 removed.
	Utilization: • Development of higher value, long-lived products (e.g. construction materials), as well as technologies adapted to "cascading principles" for the use of biomass. • Quantification of sequestration performance; use of biomass in process industry.
Enhanced Mineralization	Mineralization kinetics: • Characterizing mineralization rates and kinetics across different mineral types, reaction fronts and environmental conditions.
	Energy use, land use, and environmental impacts: • Understanding the benefits and risks associated with introducing particulate matter to environments.

Cross-Cutting	Life cycle analyses (LCAs) and Techno-economic analysis (TEAs): • Development of consistent cradle-to-grave system boundaries, and harmonization of variables (e.g., land, process, temporal) • Enabling access to high-quality data.
	Monitoring, reporting, and verification (MRV): • Developing methods to measure, report, and verify carbon removals, including remote sensing techniques to measure carbon cycle impacts (beyond existing MRV approaches for CO2 storage).

Member countries are encouraged to keep these priorities in mind when designing collaborative projects to advance CDR innovation.

2.3 Potential Actions

Through engagement with members and stakeholders, a suite of actions and mechanisms have been proposed to advance CDR pathways and the next generation of CDR technologies. These actions were informed by the innovation priorities previously described and would directly contribute to advancing the Mission's objectives.

Note that the Mission may not necessarily implement all actions listed below, nor precisely as described here; moreover, additional actions may be added to this list. This list is intended to inspire future, collaborative action on CDR innovation. For a list of initial projects that the Mission intends to implement, see section 2.4.

Potential Actions to Advance Outcome 1: Enhanced Understanding of Local and Global CDR Potential

Data Collection, Analysis, and Access: Improving the quality and access to data will support CDR LCAs, RD&D projects, and technology deployment. There are a wide range of data-related gaps and priorities to advance global CDR potential including:

- Mapping of geospatial data, including resource availability, DAC siting (e.g. proximity to currently available or potential new low-carbon energy sources), CO2 storage capacity (e.g. in sedimentary basins, saline aquifers, basalt formations, mafic and ultramafic rock), transportation networks, disposal sites in a common framework.
- Additional data collection and analysis, including the assessment of the environmental impacts of the various technological streams, as well as a better understanding of the opportunities for co-benefit with local communities.
- Accurate and verified methods for data collection and science-based decision-making, combined with global data access.

As a vehicle for international collaboration, the CDR Mission is uniquely placed to bolster collaborative data collection and sharing amongst member countries.

Potential Actions to Advance Outcome 2: Advancement of Research and Development (R&D) for CDR

Joint R&D funding call: Joint funding calls offer an opportunity to minimize duplication across participating countries and facilitate knowledge sharing. There are different models for joint R&D funding that the CDR Mission could borrow from. Of note, the Accelerating CCS Technologies (ACT) call is an existing mechanism for international cooperation on CCUS technologies. Through the ACT call, a consortium of R&D funding organizations come together to fund proponents from their countries. Funding recipients are required to partner with researchers from other countries. The CDR Mission could work with the coordinator of the ACT Call to design a joint R&D funding call, targeted toward one or multiple CDR innovation priorities. Important considerations for joint funding calls include designing them around Mission goals, integrating collaboration into the funding call (with researchers or other countries), and ensuring that resources are in place to facilitate application processing and evaluation.

Global CDR Community Testing Sites: During stakeholder engagements, access to permitted testing sites was identified as a barrier as well as an opportunity for the CDR Mission. CDR Mission members could enable access to testing and research space for researchers from around the world while increasing knowledge sharing and accelerating knowledge entering the public domain. There are international models to learn from, such as the International Test Centre Network, which was founded by the US DOE National Carbon Capture Centre and TCM to share public information among CCUS testing facilities around the world. There are unique challenges such initiatives could present, such as protection of intellectual property and security.

Potential Actions to Advance Outcome 3: Global demonstrations and pilot-scale tests

Pilot-scale/demo projects: Under the CDR Mission, targeted funding could be deployed by member countries to incentivize development and demonstration of pilot-scale or larger CDR projects (1000+ tonnes of CO_2 per year). Projects could be funded domestically, with expectations that participating countries and stakeholders would exchange lessons learned. The Mission could consider a flagship project that sets a target number of projects or funding amount to which each country could commit. Considerations include defining the parameters around acceptable pilot-scale/demo projects (e.g. TRL, size, timeframe for their development, scalability), building partnerships with the private sector to develop projects, replicability across member countries, as well as considering how the projects will contribute to advancing research.

Lighthouse regions/CDR Hubs: Geographically proximate countries could collaborate on a network of CDR demonstration projects to test, validate, and share learnings on innovations. For example, countries with similar biomass resources could combine their knowledge and leverage resources to showcase BiCRS innovation. Or, countries could

establish waste-to-energy (WtE) networks in densely populated areas. Based on the learnings from a flagship project, a similar model could be applied to other regions around the world. In order to qualify as a flagship project under the Mission, a lighthouse region or CDR hub initiative would need to demonstrate additionality.

Collaboration with complementary carbon management organizations: Throughout stakeholder consultations, enabling policies were discussed as an important foundation for CDR technology scale-up. While the CDR Mission is focused on technological innovation (i.e. RD&D), the Mission could nevertheless share technical learnings with demand-pull initiatives (such as the First Movers Coalition and Frontier Fund), and CO_2 transport and storage organizations to advance CDR policy, governance, and deployment. Potential partners in this regard could include: the Clean Energy Ministerial (CEM) CCUS Initiative, the Carbon Sequestration Leadership Forum (CSLF), and the CDR Forum. The Mission could also support efforts to link companies with climate goals to projects supplying early CDR credits.

Cross-cutting Actions

International Guidelines and Common Approaches: Increasing research and development for CDR approaches as well as advancing transparency and common approaches for conducting LCAs and TEAs are core components of the CDR Mission's mandate. When consulting with stakeholders, LCAs and TEAs were consistently identified as priorities for each technical track, as was the development of methods and technologies to measure, report and verify (MRV) effective and permanent CO2 removal. LCAs and TEAs are science-based decision-making tools that will have a significant impact on the potential for deployment and scale-up of CDR technologies. The Mission has an opportunity to bring together global experts on LCA and TEA modeling to develop and validate LCA and TEA methodologies. This work would provide policymakers and insurers certainty or improved insights on CDR approaches so that policy, regulatory, and financial frameworks are in place to facilitate investment. LCA Case Studies have been identified as a possible flagship project in section 2.4. In identifying case studies, it will be important to select projects that contribute to global knowledge sharing, apply to different regions, and address the most urgent data gaps. The Mission may also explore partnership opportunities to help disseminate findings.

Joint prize competition: Prize competitions are designed to incentivize solutions to a specific problem, with challenge winners earning a "prize," which can vary from a prize purse, access to testing facilities, access to mentoring/business support, or some combination of the above. Prize competitions can raise the profile of participating innovators, lending credibility to winning ideas and generating additional private sector interest. Not only are prizes an innovative way to target an ambitious goal, but they may help to crowd in private sector investment greater than the initial prize value. Important considerations when developing a prize competition include the need for a clear strategy for measuring results and judging applicants, as well as the need for clear objectives, supporting expertise, and a sufficiently sized prize to motivate innovators to participate.

Collaboration with other MI Initiatives: Recognizing that there are potential areas of overlap between the CDR Mission and other MI Missions, members could explore opportunities for joint projects and/or knowledge sharing. For example:

- Integrated Biorefineries Mission – collaborating on BiCRS projects (e.g. biomass with carbon capture and conversion into long-lived products) and/or sharing lessons learned around life cycle analyses related to the use of biomass.
- Green Powered Future Mission – identifying opportunities for low-carbon and cost-efficient energy supplies to support various CDR applications.
- Hydrogen Mission – advancing opportunities to use H2 as a feedstock for conversion of CO2 to products.
- Net-Zero Industries Mission – sharing lessons learned around CO2 transport and storage, and developing high-integrity, value-adding offset pathways for hard-to-abate sectors.

Moreover, the CDR Mission could partner with the Materials for Energy (M4E) Innovation Community to accelerate the discovery of materials, their efficiency, and the ability to scale up materials manufacturing. Material supply and performance is identified in the CDR Mission Innovation Roadmap as an innovation gap for DAC technologies and was underscored through stakeholder consultations as a priority. M4E is working to make solutions more affordable using materials acceleration platforms (MAPs), which are autonomous or self-driving laboratories that enable accelerated materials discovery.

2.4 Initial Projects

CDR Mission members are dedicated to taking action that will contribute to achieving the Mission's ambitious goal. These initial projects will build upon the prospective activities outlined in the previous section while also making tangible contributions to reaching the Mission's objectives. Throughout these projects, the specific innovation priorities and needs of the Mission's three priority technological areas will be considered.

In 2022, the Mission will launch two "sprints" (flagship projects) and initiate a series of Life Cycle Analysis (LCA) case studies to advance globally shared methods, definitions, and boundaries.

- Through its first sprint, the CDR Launchpad, the Mission will enable significant progress against outcome 3: Demos and pilot-scale tests are launched globally.
- The Mission's second sprint, CDR Resource / Opportunities Mapping, will advance outcome 1: Enhanced understanding of local and global CDR potential, by identifying and consolidating geospatial data on CDR resource availability.
- The LCA/TEA case studies will similarly advance outcome 1, working toward a set of harmonized methodologies and practices in developing and conducting LCEA and TEA as science-based decision-making tools.

Sprint 1: CDR Launchpad

Activity Area: Joint pilot-scale/demonstration projects

Scope and Objectives

The CDR Launchpad will create a coalition of countries working collectively to:

1. Drive down the cost of a portfolio of CDR technologies to less than $100/metric ton.
2. Enable CDR to scale to at least a gigaton/year globally within two decades of initiative launch.
3. Ensure CDR solutions advance in a way that protects the environment and communities in which it is deployed and does not distract or delay from efforts to reduce emissions directly.

The effort will initially focus on pilot-scale testing and demonstration of technologies with greatest potential for cost reductions from deployment-led innovation, such as: direct air capture (DAC), enhanced mineralization, and biomass with carbon removal and storage (BiCRS). In time, this effort could expand to and/or coordinate with efforts to improve the scale and robustness of nature-based carbon removal activities.

In signing on to the CDR Launchpad, members commit to:

1. Fund or support at least one, 1,000+ metric ton CO2/year CDR project by 2025. This can include commitments and projects already underway that have the potential to meet the target.
2. Share data and information from the projects, with the aim to improve data bases for LCA, TEA and regulatory requirements
3. Contribute to a Launchpad goal of providing at least $100 million collectively by 2025 to support CDR pilots and demonstrations globally. This can include current funding and private sector/organization funding.
4. Provide in-kind support (with financial support as appropriate) to both:
5. Advance robust measurement, reporting, and verification (MRV) efforts for CDR projects by supporting a new “CDR MRV working group” within the MI CDR sub-mission; and
6. Increase demand for CDR solutions by both:
    a. Supporting efforts to link companies with climate goals (such as those in the First Movers Coalition) to projects supplying early CDR credits (such as these pilots and demonstrations).
    b. Providing the science and data (such as CDR mapping and LCA case studies) to inform policy efforts and share best practices.

Implementation Plan

The sprint will be announced in late 2022, where preliminary participants will signal their commitment to the project goals. After this announcement, the Launchpad members will take the following actions:

- Monitor progress to ensure demos meet the 2025 target.
- Collect, disseminate, and share learnings from the projects amongst members (and via the CDR Mission website and/or other external communication platforms).
- The project lead (US-DOE) will recruit additional participants, with the support of the members of the CDR Mission and the CDR Launchpad.
- The MRV Working Group will form promptly after launch of the project and develop a workplan to identify key priorities and actions.
- Launchpad members will voluntarily sign on to stakeholder engagement and report to the Mission on the results of these activities.
- Funding levels will be reported by 2025 and will be announced.

Participants

This project will be led by the United States Department of Energy, with participation from Mission members including Canada, Saudi Arabia, Norway, Japan, and the United Kingdom. Following launch at the Global Clean Action Forum in Pittsburgh in September 2022, the project proponents will seek to recruit additional countries, such that the CDR Launchpad has twelve signatory countries by the end of 2022. Private sector companies, coalitions, and non-MI countries can also make the pledge and sign-on to this project.

Sprint 2: CDR Opportunities Mapping

Activity area: Data Collection, Analysis, and Access

Scope and Objectives

To facilitate an enhanced understanding of local and global CDR potential, the Mission will launch a CDR resource mapping initiative that focuses on identifying and consolidating CDR-specific geospatial data. Based on member priorities, the initial phase of the project will focus on mapping sustainable biomass feedstocks for BiCRS, and mafic/ultramafic rock availability for enhanced mineralization. Future phases may investigate mapping regional co-benefits, CO2 transport and storage, disposal sites, DAC siting, etc.

The project aims to increase the availability of harmonized or transparent data for evidence-informed decision making; enhance assessment of CDR potential; engage global researchers, and; facilitate knowledge dissemination through a publicly accessible mapping platform.
The project will address four key challenges:

1. Data Gaps – In order to effectively quantify global CDR potential, additional geospatial data is required. For example, an understanding of the global potential of CO2 removal

via enhanced mineralization, sources of mafic and ultramafic rocks (along with other minerals) must be identified and quantified.

2. Data Harmonization (or Transparency) – Existing data is often difficult to compare or integrate, due to discrepancies in methodology. While data harmonization may be difficult to achieve at a global scale, data transparency can enable the integration of data from diverse sources.
3. Data Consolidation – Existing data is not consolidated. Therefore, a central repository or hub would advance efforts to analyze and synthesize data and provide a more accurate estimate of global potential.
4. Cross-border collaboration – To accelerate understanding of global CDR potential, international collaboration is needed to ensure shared data, and transparency of methodologies.

Implementation Plan

As an initial phase, the project will address data challenges in two key areas:

1. Biomass feedstock (plants, woods, biogenic residues and municipal solid waste) availability for BiCRS. (Focus will be for selected regions or countries)
2. Mafic/ultramafic rock availability for enhanced mineralization.

For each of these areas, participating countries will:

1. Identify existing sources of data (in government, industry, academia, etc.).
2. Identify barriers to accessing and using data (e.g. jurisdictional issues, data held by private companies, discrepancies in methodology, lack of data transparency).
3. Identify and agree upon a shared platform for visual display of data.

Participants

The project will be led by Canada, Norway, Australia. Japan and the United States will support this initiative.

Initial Project: LCA Case Studies

Activity area: Data Collection, Analysis, and Access

Scope and Objectives

To make progress towards the Mission's immediate outcome of "enhanced understanding of local and global CDR potential," the Mission will undertake LCA case studies to enable the cross-country comparison of results and methodologies, and to make progress towards globally shared standards and a common approach.

LCAs and TEAs are key science-based decision-making tools for technology assessment, policy making, and funding program design, but there are important gaps in the

approach that need to be addressed in a systematic way. Transparent life cycle assessments (LCAs) and technoeconomic analyses (TEAs) will unlock greater insights into the environmental, social, and economic implications of CDR. These tools will have a significant impact on the potential of these technologies and how, where, and at what rate CDR solutions are going to be deployed at local, national, and international scale.

The objective of this work is to bring expertise from Mission member countries together to develop case studies that will enable comparison between LCA methodologies and address identified gaps systematically. The focus, within each study will be on the:

- Lack of consistent approach to system boundaries.
- Develop standards for assessing technology scenarios and cost reduction opportunities.
- Assessing data gaps and approaches to address lack of project and performance data for nascent technologies – data pas and data access and validation.
- Assessment of environmental impacts and benefits.
- Analysis of how each CDR technology performs in different environments, and system conditions.
- Analysis of future scenarios and opportunities for improvement of methodologies and assessment of deployment potential of CDR technologies.
- Assessment of non-technical factors such as policy, regulatory and socio-economic factors in the potential for the wide-scale deployment of CDR technologies.
- Support creation of a data sharing hub.

The project will build on the current and on-going work, as well as planned future work by member countries and will involve:

- Identification of engineered CDR scenarios for analysis, in the three areas of priority (DAC, BiCRS, EM) by different member countries.
    - For example, a case study can be conducted for the application of direct air capture (DAC) in different geographic areas and climate conditions that have a defined physical boundary as well as a system boundary with temporal considerations. Moreover, the most beneficial way to utilize or store the CO2 captured by direct air capture can be assessed.
- Comparative assessments of the methodologies and advancing common/harmonized approaches.
- Sharing best practices and lessons learned.
- Assessments of future scenarios. For example, an assessment of biomass supply chain for BECCS (bioenergy with carbon capture and storage), or an assessment of energy options for DAC.
- Determining the mechanism for adoption of common methodologies.

Implementation Plan

To develop this project, a workshop was held in July to identify project scopes and opportunities for case studies. When the project launches, it will start with the

identification of available data, as well as the available resources to guide and inform the studies. Functional Working Groups (WG) will be formed for each study and will be responsible for managing the planning and execution. These WG's will work collaboratively to define the specific LCA/TEA projects to be studied and identify the participants in given project.

In the long-term, the studies will support the formation of a global data hub, combined with the results from the CDR Mapping exercise. The data hub will make the results of case studies available and will serve future technology assessment. Additionally, the project participants will work towards identifying mechanisms to advance common approaches to LCA/TEA studies for CDR.

The Mission will seek commitments from participating countries which could include any form of contribution, both in-kind or funding, to support and advance the different projects under the LCEA/TEA workstream.

Participants

Member countries, namely Canada, Japan (co-leads), the United States, Saudi Arabia, Australia will support this work (with more to be confirmed at the end of October).To deliver the project, leads will collaborate with academic organizations, as well as federal and governmental research organizations (such as, research labs). Collaboration with industry, who have expertise and experience with LCAs, will also be an important component of the work.

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