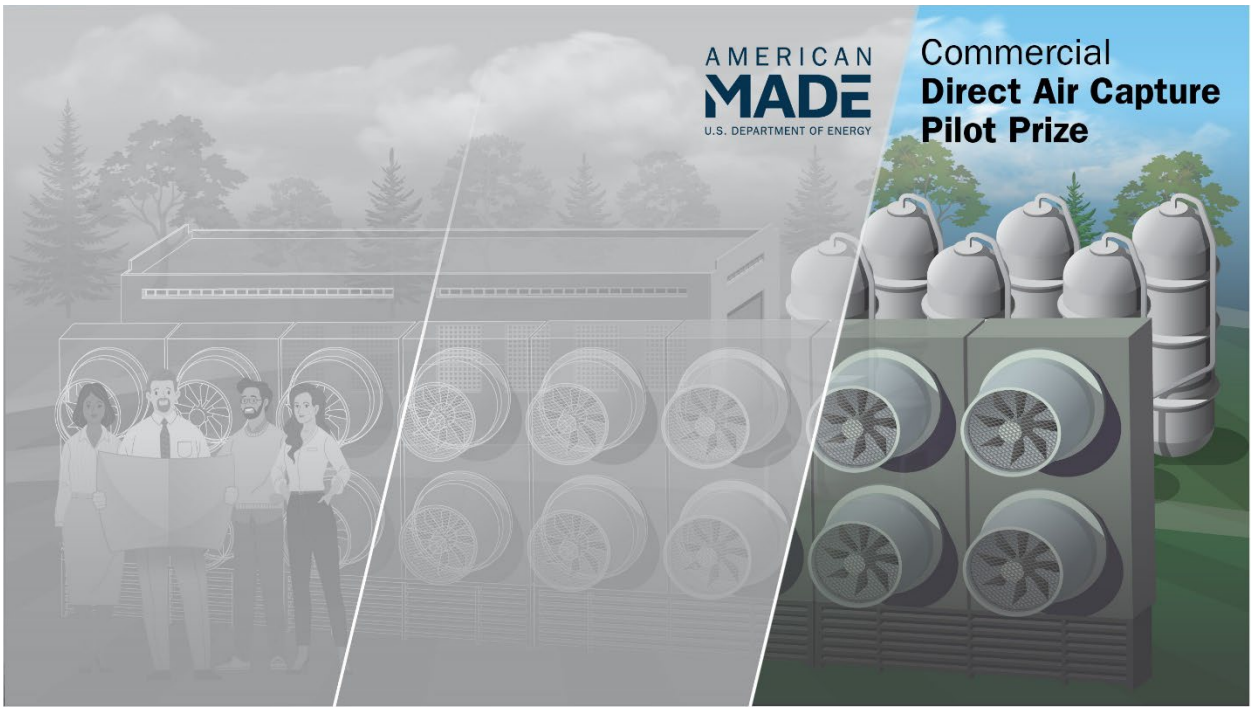

Commercial Direct Air Capture Pilot Prize

Modification 1

10/31/24

Modification 1 includes the following (highlighted in yellow in the document):

- Clarification Phase 1 Bench-Scale Operating Data requirements, section 1.5.5.

Preface

The American-Made Commercial Direct Air Capture (DAC) Pilot Prize will provide performance-based cash awards to technology developers that design, build, commission, and operate DAC pilots capable of capturing at least 500 tonnes of atmospheric carbon dioxide (CO_2) per year. This four-phase prize competition will support the development of multiple first-of-a-kind DAC pilots and enable these technologies to be deployed in the commercial space.

The U.S. Department of Energy's American-Made Commercial Direct Air Capture Pilot Prize will be governed by 15 U.S.C. § 3719 and this Official Rules document. This is not a procurement under the Federal Acquisitions Regulations and will not result in a grant or cooperative agreement under 2 CFR 200. The Prize Administrator reserves the right to modify this Official Rules document if necessary and will publicly post any such notifications as well as notify registered prize participants.

To learn more and sign up, go to: https://www.herox.com/DAC-Pilot.

Table of Contents

Overview

The U.S. Department of Energy Office of Fossil Energy and Carbon Management is launching the American-Made Commercial Direct Air Capture Pilot Prize. This prize will support the construction of multiple first-of-a-kind direct air capture pilot systems that operate at a minimum scale of 500 tCO_2 capture per year. The four phases of the prize will foster the development of these direct air capture pilots from the design stage through the construction and operation of the systems. As they progress through the four phases of this prize, competitors may receive up to $12 million of the $52.5 million prize purse.

0.1 Summary

Carbon dioxide removal (CDR) at the gigaton scale is necessary to achieve net-zero global CO_2 emissions, according to nearly every scenario assessed in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.[1,2] To meet the demand for CDR solutions, the third target of the U.S. Department of Energy (DOE) Energy Earthshot Initiative is the "Carbon Negative Shot," an all-hands-on-deck call for innovation in CDR pathways that will capture CO_2 from the atmosphere and store it at gigaton scales for less than $100/net metric ton of carbon dioxide-equivalent (tCO_2e) by 2032.[3] Meeting this challenge is essential for the U.S. to achieve the goal of net-zero emissions by 2050 and to remove legacy emissions in the years thereafter.

DOE's Office of Fossil Energy and Carbon Management (FECM) prioritizes research, development, demonstration, and deployment of CDR. FECM works to de-risk technologies, improve transparency around costs and performance, and leverage technical expertise to evaluate potentially transformative CDR pathways. To realize these goals, FECM is issuing a portfolio of prizes to advance direct air capture (DAC) technologies, in collaboration with the National Renewable Energy Laboratory (NREL) and the National Energy Technology Laboratory (NETL). These prizes will stimulate rapid maturation and commercialization of DAC technologies while incorporating environmental justice, community benefits, stakeholder engagement, equity, and workforce development.

The American-Made Commercial Direct Air Capture Pilot Prize ("Commercial DAC Pilot Prize") will provide capital to support DAC pilots that have exceeded the technology readiness levels (TRLs) eligible for Pre-Commercial DAC Prizes but are not sufficiently demonstrated or commercially de-risked enough to be deployed in the Regional DAC Hubs program.[4] This prize will strengthen the commercial CDR technology industry by providing an intermediate support mechanism within the DAC technology development pipeline. Teams will be eligible to receive up to $12 million after they successfully design, construct, and operate a pilot DAC system for a minimum of 2,000 hours. Prize winners will also have successfully demonstrated that their DAC technology is commercially viable and has the potential to contribute to or participate in the Regional DAC Hubs program.

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[1] Intergovernmental Panel on Climate Change (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg1/.

[2] IPCC Special Report on *Global Warming of 1.5 °C* models 90 scenarios that include CDR from the combination of bioenergy with carbon capture and sequestration (BECCS) and direct air carbon capture and sequestration (DACCS). These integrated assessment models (IAM) show a range of 3.5 to 16 gigatons of CO_2 per year ($GtCO_2/yr$) needed to be removed in 2050 for these two technologies. https://www.ipcc.ch/sr15/.

[3] **Carbon Dioxide Equivalent** (CO_2e) represents the quantity of CO_2 emissions with the same global warming potential as one metric ton of another greenhouse gas (e.g., CO_2, CO, CH_4, N_2O, etc.).

[4] See Appendix 8 for description of Technology Readiness Levels (TRLs).

0.2 Direct Air Capture Prizes

Direct air capture (DAC) facilities use carbon capture equipment to capture CO_2 directly from the ambient air.[5] DAC is an integral part of the CDR portfolio that the United States will deploy to meet the Biden-Harris Administration's decarbonization goals of 50-52% net reduction in greenhouse gas (GHG) emissions by 2030 (compared to 2005 emissions) and a net-zero GHG emission economy by 2050.

The Bipartisan Infrastructure Law, signed by President Biden in 2021, authorized and appropriated $115 million to DOE for DAC prize competitions. This includes up to $15 million for a Pre-Commercial DAC Prize (Section 41005(a)) and up to $100 million for a Commercial DAC Prize (Section 41005(b)). The American-Made Pre-Commercial and Commercial DAC Prizes are a suite of prizes that work together to advance DAC technologies. The DAC Pre-Commercial Technology Prize and the DAC Pre-Commercial EPIC Prize were launched in March 2023.[6,7]

DOE's "Carbon Negative Shot Pilots" Notice of Intent (DE-FOA-0003081) announced the intention to establish and administer two prizes under the Commercial DAC Prize: (1) the CDR Purchase Pilot Prize and (2) the Commercial DAC Pilot Prize.[8] These Commercial DAC Prizes are intended to build upon the success of the Pre-Commercial DAC Prizes and DOE's CDR research and development portfolio to support the entire spectrum of technologies across technology readiness levels (TRLs) in the developing DAC industry. The CDR Purchase Pilot Prize was launched in September 2023.[9] The CDR Purchase Pilot Prize will augment and shape a domestic market for high-quality CDR and evaluate the potential role of the U.S. government as a participant in this market. The CDR Purchase Pilot Prize provides demand-side support across the full portfolio of CDR technologies, including DAC, biomass carbon removal and storage (BiCRS), enhanced carbon mineralization, and other planned or managed carbon removal activities, including natural and artificial.

To complement the CDR Purchase Pilot Prize, this official rules document establishes the Commercial DAC Pilot Prize. This prize will support technologies that have progressed beyond the innovation stage and need assistance to reach the deployment stage. The projects that progress through the four phases of this prize will advance and accelerate the commercial deployment of DAC. Together, the two Commercial DAC Prizes will accelerate the design, financing, construction, and operation of DAC facilities (among the other CDR technologies supported in the Purchase Pilot Prize) to help achieve the Biden-Harris Administration's aggressive net-zero emissions target.[10] These prizes will encourage DAC developers to invest in America's workforce and scale diverse, equitable, inclusive, and accessible businesses.

0.3 Commercial Direct Air Capture Pilot Prize

This Commercial DAC Pilot Prize is issued by the U.S. Department of Energy's (DOE's) Office of Fossil Energy and Carbon Management (FECM), in collaboration with the National Renewable Energy Laboratory (NREL) and the National Energy Technology Laboratory (NETL). This prize will demonstrate the commercial viability of DOE's portfolio of DAC RD&D investments and will enable FECM and the National Laboratories to strengthen the pipeline of DAC technology development by fostering projects from the pre-commercial stage and readying them for full commercial deployment in DAC Hubs. These efforts will help maximize

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[5] The term "direct air capture facility" does not include any facility which captures carbon dioxide that is deliberately released from naturally occurring subsurface springs or using natural photosynthesis.
[6] Direct Air Capture Pre-Commercial Technology Prize | Department of Energy.
[7] Direct Air Capture Pre-Commercial EPIC Prize | Department of Energy.
[8] Notice of Intent to Issue Funding Opportunity: Carbon Negative Shot Pilots | U.S. Department of Energy.
[9] DAC Commercial CDR Purchase Pilot Prize | HeroX.
[10] FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies | The White House.

the benefits of the clean energy transition as the nation works to curb the climate crisis, empower workers, and advance environmental justice.

DOE is aware of and is working to address environmental, climate, and energy justice concerns regarding how DAC projects may impact communities, including local environmental quality and economic benefits. To ensure DAC is designed, developed, and commercialized responsibly and equitably, this prize competition will include several requirements designed to establish an inclusive and diverse landscape of entrepreneurs, develop businesses for technologies that optimize environmental co-benefits, and create good, high-wage jobs across the country. Successful competitors will consider and appropriately manage land, water, and energy resources, make workforce investments, and deliver other social benefits as part of their projects. Consistent with the Biden-Harris Administration's commitment to Justice40 through the BIL, successful competitors will develop and implement community benefit plans (CBPs) that effectively distribute economic, environmental, and other benefits to disadvantaged communities.[11]

0.4 Phases of the Commercial DAC Pilot Prize

The Commercial DAC Pilot Prize offers up to $52,500,000 in prizes:

Contest	Winners	Prizes	Total	Duration
Phase 1: Pilot Concept and Pre-FEED	5 teams	$500,000	$2,500,000	6 Months
Phase 2: Front-End Engineering Design	5 teams	$4,000,000	$20,000,000	12 Months
Phase 3: Permit and Detailed Design	4 teams	$1,000,000	$4,000,000	12 Months
Phase 4: Construct and Operate	4 teams	Up to $6,500,000	$26,000,000	30 Months

The Commercial DAC Pilot Prize is structured to award winning teams with cash prizes as they successfully achieve design, development, and deployment milestones over the course of four phases: Phase One - Concept, Phase Two - Engineer, Phase Three - Permit, and Phase Four - Operate. Winning teams will be eligible to receive up to $12 million after they successfully design, construct, and operate a pilot DAC system for a minimum of 2,000 hours, and submit plans for their DAC system at the next planned testing scale.[12]

Phase 1 – Concept

The Phase 1 submission package will include: a concept paper outlining the technology; completed state-point data tables for the proposed DAC technology; environmental questionnaire; data from any lab/bench scale testing; and a pre-Front End Engineering Design (pre-FEED) study[13] for the proposed first-of-a-kind DAC pilot system at a minimum scale of 500 tCO_2 capture/year. Up to five (5) winning

[11] The Justice40 Initiative, established by Executive Order 14008 Tackling the Climate Crisis at Home and Abroad, sets a goal that 40% of the overall benefits of certain federal investments flow to disadvantaged communities. DOE recognizes disadvantaged communities as defined and identified by the White House Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST). DOE's Justice40 Implementation Guide: Final DOE Justice40 General Guidance 072522.pdf (energy.gov).

[12] The term *Pilot*, in the context of this prize, refers to technologies that will be tested for the first time at a scale >100 tons CO_2 capture/year.

[13] Class 4 estimate with expected cost accuracy ±30% and project definition maturity of at least 5%. Pre-FEED Study requirements can be found in Appendix 9.

teams will receive **$500,000** each. Teams that submit an entry for a Phase 1 prize will be eligible to compete in Phase 2, irrespective of whether they are awarded a Phase 1 prize.

Phase 2 – Engineer

Phase 2 is open to all Phase 1 competitors and to teams that did not submit a Phase 1 submission package. Competitors will deliver a complete FEED study[14] for the first-of-a-kind DAC pilot system. Competitors will also submit: a community benefits plan (CBP); life cycle assessment (LCA); environmental, health and safety (EH&S) risk assessment; environmental questionnaire, environmental information volume; updated risk analysis; host site commitment letter; and plans necessary to execute the required Phase 3 activities, including DAC pilot system detailed design, National Environmental Policy Act (NEPA) compliance, and permitting. At the end of Phase 2, up to five (5) teams will receive **$4,000,000** each and up to four (4) of those prize-winning teams will be eligible to compete as Semifinalists in Phase 3.

Phase 3 – Permit

Semifinalists will complete the detailed design[15] for the first-of-a-kind DAC pilot system and obtain all required approvals, including NEPA compliance, to initiate construction. Competitors will submit: the detailed design package; all required permit approvals; participation in the NEPA compliance process; an updated risk analysis; plans necessary to execute the required Phase 4 activities, including DAC pilot system procurement, construction, commissioning, operation, and monitoring, measurement, reporting, and verification (MMRV); and a report detailing CBP implementation activities. Long-lead procurement activities may also be initiated in Phase 3 following NEPA compliance with prior DOE approval. Up to four (4) winning teams will receive **$1,000,000** each and will be eligible to compete as Finalists in Phase 4.

Phase 4 – Operate

Finalists will construct a first-of-a-kind DAC pilot system, commission the system's operation, and operate the pilot system for at least 2,000 hours with MMRV. Competitors will deliver updated state-point data tables based on pilot test data, a technology maturation plan, and a pre-FEED study for their DAC system at the next planned testing scale (minimum capacity of 5,000 tCO_2/year). Portions of the prize will be administered when significant milestones are reached. At the end of Phase 4, up to four (4) winning teams will receive up to **$6,500,000** each.

0.5 Key Dates

- **Phase 1 – Concept**
  Phase 2 Opens: August 9, 2024
  Phase 1 Submission Deadline: 5 p.m. ET on February 7, 2025
  Winner Announcement: June 6, 2025 (anticipated)
- **Phase 2 – Engineer**
  Phase 2 Opens: June 6, 2025 (anticipated)
  Phase 2 Submission Deadline: June 6, 2026 (anticipated)
  Winner Announcement: September 9, 2026 (anticipated)
- **Phase 3 – Permit**
  Phase 3 Opens: September 9, 2026 (anticipated)

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[14] Class 3 estimate with expected cost accuracy ±15% and project definition maturity of at least 40%. FEED Study requirements can be found in Appendix 10.

[15] Competitors shall complete 90% of the engineering such that the main contractors and all the sub-contractors can provide construct details (shop fabrication drawings) of all sub-systems and construction bids that will result in 5% capital cost estimate. Detailed Design guidance can be found in Appendix 14.

Phase 3 Submission Deadline: September 9, 2027 (anticipated)
Winner Announcement: December 5, 2027 (anticipated)

- **Phase 4 – Operate**
  Phase 4 Opens: December 5, 2027 (anticipated)
  Phase 4 Submission Deadline: May 8, 2030 (anticipated)
  Winner Announcements: June 2030 (anticipated)

0.6 Submission Requirements

Only submissions relevant to the goals of this program are eligible to compete. The Prize Administrator must conclude that all the following statements are true when applied to your submission:

- The proposed DAC technology approach and associated pilot are first-of-a-kind.[16]
- The proposed DAC technology chemically or physically separates CO_2 from ambient air, without the use of photosynthesis, using a mechanical air contactor.
- The proposed DAC pilot does not involve point-source carbon capture.
- The teams have performed integrated testing on this DAC technology at a scale not less than 1 tCO_2/yr, but not greater than 100 tCO_2/yr and have operated for at least 500 hours.
- The proposed DAC pilot will operate at a scale greater than 500 tCO_2/yr.
- The proposed DAC (and CO_2 conversion, if applicable) technology has achieved a Technology Readiness Level (TRL) of at least 4 (see Appendix 8 for complete TRL 4 description).[17]
- The proposed solution demonstrates the ability to scale a DAC technology to help achieve DOE's Carbon Negative Shot (a pathway-neutral "Energy Earthshot") that aims to develop <$100/net tCO_2e removal across the CDR portfolio by 2032, with costs including MMRV.[18]
- All activities that are described in and support the submission package are performed in the United States and have the potential to benefit the U.S. market.
- The proposed solution is not dependent on new, pending, or proposed federal, state, or local government legislation, resolutions, or appropriations.
- The proposed solution does not involve the lobbying of any federal, state, or local government office.
- The proposed solution is based on fundamental technical principles and is consistent with a basic understanding of the U.S. market economy.
- The proposed DAC pilot system must not present extreme schedule risk, budget risk, technical risk, societal impact risk, and/or environmental risk. Environmental risk includes, but is not limited to, adverse impacts to air, soil, water, or a positive cradle-to-grave greenhouse gas footprint (carbon dioxide equivalent, CO_2e).
- The submission content sufficiently confirms the competitor's intent to commercialize early-stage technology and establish a viable U.S.-based business in the near future.

0.7 Eligibility and Competitors

Commercial DAC Pilot Prize Eligibility

[16] DAC and storage technologies are engineered systems that remove carbon dioxide directly from the atmosphere by capturing CO_2 from ambient air for secure geologic storage or conversion to long-lived products that result in negative emissions.
[17] Component and/or system validation in laboratory environment.
[18] Carbon-Negative-Shot-Infographic.pdf (energy.gov).

- The competition is open only to private entities (for-profits and nonprofits); non-federal government entities such as states, counties, Tribes, and municipalities; and academic institutions.
- Private entities must be incorporated in and maintain a primary place of business in the United States. If an entity seeking to compete does not have majority domestic ownership and control, FECM may consider issuing a waiver of that eligibility requirement where (1) the entity otherwise meets the eligibility requirements; (2) the entity is incorporated in and maintains a primary place of business in the United States; and (3) the entity submits a compelling justification. FECM may require additional information before making a determination on the waiver request. See Appendix 11 for more information on the waiver process.
- Academic institutions must be based in the United States.
- Individuals competing as part of an incorporated private entity may participate if they are legally allowed to work in the United States.
- DOE employees, employees of sponsoring organizations, members of their immediate families (e.g., spouses, children, siblings, or parents), and persons living in the same household as such persons, whether or not related, are not eligible to participate in the prize.
- Individuals who worked at DOE (federal employees or support service contractors) within six months prior to the submission deadline of any contest are not eligible to participate in any prize contests in this program.
- Federal entities and federal employees are not eligible to participate in any portion of the prize.
- DOE national laboratory employees cannot compete in the prize.
- Entities and individuals publicly banned from doing business with the U.S. government such as entities and individuals debarred, suspended, or otherwise excluded from or ineligible for participating in Federal programs are not eligible to compete.
- Entities identified by the U.S. Department of Homeland Security (DHS) Binding Operational Directives (BOD) as an entity publicly banned from doing business with the United States government are not eligible to compete. See https://cyber.dhs.gov/directives/.
- Entities and individuals identified as a restricted party on one or more screening lists of U.S. Departments of Commerce, State, and the Treasury are not eligible to compete. See Consolidated Screening List: https://www.trade.gov/consolidated-screening-list.
- This prize competition is expected to positively impact U.S. economic competitiveness. Participation in a foreign government talent recruitment program[19] could conflict with this objective by resulting in unauthorized transfer of scientific and technical information to foreign government entities. Therefore, individuals participating in foreign government talent recruitment programs of foreign countries of risk are not eligible to compete. Further, teams that include individuals participating in foreign government talent recruitment programs of foreign countries of risk[20] are not eligible to compete.

[19] Foreign government talent recruitment program is defined as an effort directly or indirectly organized, managed, or funded by a foreign government to recruit science and technology professionals or students (regardless of citizenship or national origin, and whether having a full-time or part-time position). Some foreign government-sponsored talent recruitment programs operate with the intent to import or otherwise acquire from abroad, sometimes through illicit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government. Many, but not all, programs aim to incentivize the targeted individual to physically relocate to the foreign state for the above purpose. Some programs allow for or encourage continued employment at U.S. research facilities or receipt of Federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to U.S. entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

[20] Currently, the list of countries of risk includes Russia, Iran, North Korea, and China.

- DOE may conduct a review, using Government resources, of the competitor and project personnel for foreign interference. The result of the risk review may result in the submission being deemed ineligible in the prize competition. This risk review, and potential determination of ineligibility, can occur at any time during the prize competition. The results of a risk review are not appealable.
- As part of your submission to this prize program, you will be required to sign the following statement:

  I am providing this submission package as part of my participation in this prize. I understand that I am providing this submission to the Federal Government. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the Official Rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the Federal Government may result in civil and/or criminal penalties under 18 U.S.C. § 1001 and § 287.

Phase 2 Eligibility

- Phase 2 is open to all teams that meet the above criteria, regardless of whether they tendered a Phase 1 submission package or won a Phase 1 prize.

Phase 3 Eligibility

- Only winners of Phase 2 that are selected as Semifinalists are eligible to compete in Phase 3.

Phase 4 Eligibility

- Only winners of Phase 3 that are selected as Finalists are eligible to compete in Phase 4.

The above criteria are minimum eligibility criteria for competitors for the Commercial DAC Pilot Prize. Selection criteria for subsequent phases and award selection are described in detail in the Prize Rules below.

0.8 Additional Requirements

Please read and comply with additional requirements in Appendix 1.

COMPETITORS WHO DO NOT COMPLY WITH THESE REQUIREMENTS MAY BE DISQUALIFIED.

1 Phase One - Concept

1.1 Goal

The *Concept Phase* is the first phase of this four-phase prize program and offers up to $2,500,000 in total cash prizes.

Any team meeting the eligibility requirements may compete in the Concept Phase.

1.2 Prizes

Up to 5 winners will receive $500,000 each and will have the opportunity to compete in Phase 2. Teams that are not selected as winners in Phase 1 may also choose to compete in Phase 2.

1.3 How To Enter

Go to HeroX and follow the instructions for registering and submitting all required materials before the phase deadline. Competitors also have the ability to form teams or find partners through the HeroX platform. Refer to the timeline on HeroX for relevant dates and deadlines.

1.4 Concept Phase Process

Phase 1 (Concept) consists of the following steps:

1. **Submission** – Competitors will submit a 15 page concept paper that outlines a proposal for a DAC pilot system. Submission packages also include a completed pre-FEED study. Competitors must complete their submission packages and submit online before the Phase closes.
2. **Assessment** – The Prize Administrator screens submissions for eligibility and completion and assigns subject-matter expert reviewers to independently score the content of each submission.
3. **Announcement** – After the winners are publicly announced, the Prize Administrator notifies them and requests the necessary information to distribute cash prizes. After winning Phase 1, competitors develop their pilots in accordance with their plan to compete in Phase 2.

1.5 What to Submit

A complete submission package for Phase 1 – Concept should include the following items:

- Cover Page (Public)
- Concept Paper
    1) Technology proposal
    2) Team, network, and resources
    3) Business model, cost estimate, and regulatory requirements
    4) Project objectives and approach
    5) Preliminary LCA
- Complete Pre-FEED Study
- Pre-FEED Study Summary (Public)
- Bench-scale Operating Data
- State-Point Data Tables
- Environmental Questionnaire
- Other Letters of Commitment or Support (optional).

1.5.1 Cover Page (will be made public)

List basic information about your submission, including:

- Project title and team name
- Company, organization, or institution name
- Short description of proposed DAC technology, anticipated capture capacity, and pilot location
- Key project members (names, contacts, and links to their professional online profiles)
- Other relevant partners (if any)
- Your city, state, and nine-digit ZIP code.

The cover page will be made public and should not include any confidential, proprietary, or privileged information.

1.5.2 Concept Paper

The concept paper should address each of the following five topics. Competitors can decide where to focus your answers; the content bullets are suggestions to guide your responses. The individual responses for each section do not have a word limit; however, **the aggregate response to these five topics must not exceed 15 pages (12-point font; double-spaced; 1" margins),** not including captions, figures/graphs, or references. You may also include **up to 5 supporting images, figures, or graphs**. The reviewers will score the submission based on the content you provide.

<table>
<tr><th colspan="2">Concept Paper
Maximum of 15 pages and 5 supporting images or figures (PDF)</th></tr>
<tr><th colspan="2">Section 1: Technology Proposal</th></tr>
<tr><th>Suggested Content Competitor Provides</th><th>A score of 1–5 will be given, according to how the provided content aligns with each statement:</th></tr>
<tr><td>

Describe key parameters of the anchoring DAC (and CO_2 conversion, if applicable) technology. The description of the technology should include the following: (1) overall process flow diagrams; (2) mass and energy balances; (3) resource requirements (i.e., materials, energy, land, water, etc.); (4) discussion of the absorption/desorption chemistry and operating cycle for solvent and sorbent systems (as applicable); and (5) description of relevant membrane chemistry, including transport mechanism (as applicable).
Summarize any relevant bench-scale or pre-commercial data that demonstrate the viability of your DAC (and CO_2 conversion, if applicable) technology.
Describe the current efficiency of the DAC (and CO_2 conversion, if applicable) technology (provide data) and plans to improve the efficiency, including relevant

</td><td>

The proposed DAC (and CO_2 conversion, if applicable) pilot has the potential to operate for at least 2,000 hours and to capture (and convert, if applicable) at least 500 tCO_2/yr during the prize competition.
The technical description of the proposed DAC (and CO_2 conversion, if applicable) technology is sufficiently detailed and addresses each of the key parameters.
The proposed technology is technically sound and consistent with scientific principles.
The bench-scale and/or pre-commercial operating data provided to the NETL EDX platform are summarized and demonstrate the ability of the DAC pilot to operate at the required scale during the prize competition.
The proposed DAC (and CO_2 conversion, if applicable) technology does not have inherent resource requirements (energy,

</td></tr>
</table>

technical milestones or performance benchmarks. • Provide the current technology readiness level (TRL) and discuss plans for scale-up (see Appendix 8). Scientific, engineering, and technical information and data should be provided to evince the readiness of the proposed DAC (and CO_2 conversion, if applicable) technology. • Describe the potential of your DAC pilot to scale commercially beyond the prize. • Explain how your DAC pilot builds on previous technologies and pushes the CDR field forward. • Identify risks and discuss mitigation strategies. • Demonstrate the near-term feasibility of the DAC pilot to move through the four phases of this Commercial DAC Pilot Prize and to deliver an operating pilot within the timeframe of the prize.	land, water, etc.) that would prevent the technology from scaling beyond the prize competition. • Winning a prize in the Concept Phase will significantly increase the team's chances of creating a viable business out of their DAC technology. • The initial risk analysis effectively identifies major risks and thoroughly discusses mitigation strategies. • The proposed DAC pilot is unique, innovative, and, if successful, would advance the field of carbon removal.
Section 2: Team, Network, and Resources	
Suggested Content Competitor Provides • Introduce your team, explain how the team came together, and highlight the knowledge, diversity, experience, and skills that make the team uniquely capable of achieving success. • Describe your team's commitment and readiness to meet your goals (technical, financial, labor capacities) and whether your team requires additional talent and resources to guarantee timely delivery of a DAC pilot, if awarded a Phase 1 prize. • Describe your strategy to develop a Community Benefits Plan (CBP) that supports meaningful community and labor engagement, invests in quality jobs and the American workforce, advances diversity, equity, inclusion, and accessibility (DEIA), and supports the goal that 40% of the overall benefits of climate and clean energy investments flow to disadvantaged communities.	**A score of 1–5 will be given, according to how the provided content aligns with each statement:** • The team has the requisite commitment, skills, and experience to successfully deliver a DAC pilot system within the timeframe of the prize. • The team has access to the necessary physical and financial resources to successfully deliver the proposed DAC pilot system. • The team appropriately identifies any resource deficits and plans to resolve these insufficiencies during the prize competition. • The team describes their strategy to develop a comprehensive CBP. • The proposed CBP activities include plans to establish strategies and partnerships to advance implementation of CBP goals as project progresses toward operation.

Section 3: Business Model, Cost Estimate, and Regulatory Requirements

Suggested Content Competitor Provides	A score of 1–5 will be given, according to how the provided content aligns with each statement:
• Describe your business model, cost model, and estimated price points in $/tCO$_2$e captured and net removed. • Discuss any technology licensing or other agreements, as well as compliance with carbon registries. • Detail costs required to execute all prize activities, including system design, procurement, construction, commissioning, operation for at least 2,000 hours, decommissioning, MMRV, CBP implementation, data analysis, and prize reporting. Discuss plans to reduce prize execution costs. • Discuss all regulatory and permitting requirements, responsible regulatory and permitting authorities, current status, and remaining issues. • Clearly identify all local, state, federal permits and environmental reviews necessary, including CO_2 transport and storage (if applicable), to initiate construction. Describe plans to acquire necessary permits. • Describe potential future improvements, cost reductions, and an overall pathway to achieve DOE's Carbon Negative Shot, which is an "Energy Earthshot" that aims to develop <$100/tCO$_2$e removal by 2032, with costs including ongoing MMRV, across the CDR portfolio.	• A business model that will support deployment at scale is discussed and is reasonable. • A quantitative description of key cost drivers and price points is provided and is reasonably inclusive. • The team provides a complete and accurate cost estimate for all prize execution activities through Phase 4, including any cost reduction plans. • The team proactively identifies potential financial, regulatory, or resource bottlenecks that could delay construction of the DAC pilot system and proposes appropriate contingencies and safeguards to address these issues. • Discussion of regulatory and compliance requirements is provided with coverage of all permits necessary to initiate construction of the DAC pilot and the team's corresponding permitting plans. • The team's long-term plan beyond this prize contest is logical and well-reasoned.

Section 4: Project Objectives and Approach

Suggested Content Competitor Provides	A score of 1–5 will be given, according to how the provided content aligns with each statement:
• Describe the overall objective(s) of the work. Explain why participation in this prize competition (i.e., piloting at this scale) is necessary to the advancement of the proposed DAC technology. • Describe the team's approach to execute the required activities of Phases 2, 3, and 4, including roles and responsibilities.	• The team's objectives are clearly stated and evince the necessity of pilot testing to the advancement of the DAC technology. • The proposed approach is innovative and built on reasonable assumptions, valid technical foundations, and lessons learned from other notable efforts in this industry.

• Plans to complete a FEED study before Phase 2, if selected as a Phase 1 winner. • Define performance metrics and corresponding targets for the proposed pilot system, including CO_2 capture working capacity, pressure drop, operating cycle duration and planned number of cycles, CO_2 volumetric productivity, planned operating hours and capacity factor, total CO_2 captured during pilot operation, anticipated CO_2 product purity, and any other relevant metrics for the technology.	• The plan is adequately detailed and supports the ability of the team to complete the activities required to be awarded in all phases of this prize competition. • Performance metrics and corresponding targets are present, appropriately defined, and realistic for the proposed technology.
Section 5: Preliminary Life Cycle Assessment (LCA)	
Suggested Content Competitor Provides • Provide a preliminary LCA based on the requirements listed in Appendix 4: Life Cycle Assessment (LCA) Guidance, including a high-level CO_2 balance covering major inputs to the DAC process, planned sources of energy and their corresponding emissions, intended disposition of the captured CO_2, co-products/by-products, potential co-benefits and non-GHG environmental impacts of the process, and how technical advances to the underlying DAC technology might impact LCA results.	**A score of 1–5 will be given, according to how the provided content aligns with each statement:** • The provided emissions estimate is robust and contains coverage of all relevant contributors, including materials, energy, transportation, equipment, land-use change, waste disposal, other utilities, etc. • The applicant has provided quantitative data as part of the preliminary LCA where possible and qualitative discussion where not possible. • The proposed DAC process is likely to durably achieve negative emissions when considering emissions impacts across the technology's material and energy supply chain and is unlikely to result in significant non-GHG environmental harm. • The preliminary LCA identifies sources of uncertainty and details a plan to overcome them.

1.5.3 Pre-FEED Study

The pre-FEED study shall be prepared and submitted in accordance with pre-FEED study guidance in Appendix 9. This submission will not be scored but will be used for internal fact-checking of the Pre-FEED Study Summary.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: • The pre-FEED Study for the proposed DAC pilot has been prepared and submitted in accordance with pre-FEED Study guidance in Appendix 9.

1.5.4 Pre-FEED Study Summary (will be made public)

Submit a summary of a pre-FEED study that demonstrates the technical and economic feasibility of the proposed first-of-a-kind DAC pilot system at a minimum scale of 500 tCO_2 capture/yr. **The maximum length of the pre-FEED study summary is 8 pages, not including captions or figures (12-point font; double-spaced; 1" margins).** The pre-FEED study summary may include **up to 6 supporting images, figures, or graphs**. The pre-FEED summary will be made public and should not include any confidential, proprietary, or privileged information.

Reviewer Recommendation	
Suggested Content Competitor Provides • Design basis, proposed site, and scale • Block flow diagram • Material and energy balance • Process descriptions • Process controls (where available) • Key equipment list • Hazard and operability (HAZOP) review.	**A score of 1–5 will be given, according to how the provided content aligns with each statement:** • The pre-FEED study summary includes all suggested content in Appendix 9. • The pre-FEED study summary demonstrates the technical and economic feasibility of the proposed DAC pilot system.

1.5.5 Bench-Scale Operating Data

Submit integrated, bench-scale system operating data to NETL's Energy Data eXchange (EDX) Platform confirming performance and attainment of a TRL of at least 4. In total, the data must represent at least 500 hours of not-necessarily-continuous, integrated, bench-scale system operation at relevant environmental conditions insofar as possible. Submitted data for the bench-scale system should encompass: (1) site characteristics and ambient conditions (e.g., pressure, temperature, relative humidity), fuel feedstock characteristics (if applicable), and site environmental requirements; (2) process mass and energy balance, CO_2 working capacity, and state-point operating data (e.g., flowrates, compositions, pressures, temperatures) for all significant test unit streams; (3) calculation of DAC efficiency (with uncertainty clearly labeled) of overall process (i.e., (CO_2 captured from the air - CO_2 directly emitted by the system)/ CO_2 captured from the air), total electrical and thermal energy requirements, and absorber/desorber performance as a function of conditions tested (e.g., space velocity, temperature, feed composition) for each process cycle; (4) technology related emissions as available (e.g., material losses, degradation products, wastes, byproducts, etc.) and (5) data generated during dynamic operations as available, such as trip-conditions, quick start-up and shutdown, and varying air input flowrates beyond design parameters. See Appendix 6 for additional information on NETL's EDX Platform.

Reviewer Recommendation
A single score on a scale of 1–5 is provided, taking the following statements into consideration: • The submitted bench-scale operating data represent at least 500 of not-necessarily-continuous hours of integrated, bench-scale operation of the proposed technology using ambient air. • The techniques used to record the bench-scale operating data are standard and legitimate.

- The bench-scale operating data submitted to NETL's EDX platform are accurately summarized in the concept paper.

1.5.6 State-Point Data Tables

Submit tables based on the measured and projected system testing of the DAC technology. At the time that the Phase 1 package is submitted, competitors are required to provide the best-to-date measured performance data for their solvent, sorbent, or membrane material and projected performance data at the next testing scale. See Appendix 3 for guidance.

Reviewer Recommendation

A score of 1–5 will be given, according to how the provided content aligns with each statement:

- The state-point data tables are completed based on the measured and projected system testing of the DAC technology.
- The data in the state-point data tables are realistic and consistent with the rest of the application.

1.5.7 Environmental Questionnaire

Teams must submit an environmental questionnaire (NETL Form 451.1-1/3) for the DAC pilot host site and any other location in which work will be performed in Phase 4, and CO_2 disposition site (if applicable). See Appendix 13 for National Environmental Policy Act Compliance guidance.

Reviewer Recommendation

A single score of Complete or Incomplete is provided, taking the following statements into consideration:

- The environmental questionnaire for the proposed pilot host site is complete.

1.5.8 Optional Letters of Support

Competitors may choose to submit additional one-page letters from relevant entities to endorse the viability of the proposed DAC pilot. This could include letters from partners or others believed to be critical to the success of the proposal, including any project financiers or investors, community groups, labor groups, or project development partners. Any letters of commitment or support must be on letterhead, uploaded as a single file, and readable by Adobe PDF.

1.6 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible. Then the Prize Administrator, in consultation with DOE, assigns subject-matter-expert reviewers who independently score the content of each submission. They will review the competitor's submission package according to the criteria above.

Submission	Weight
Concept Paper	60%
Pre-FEED Study Summary	20%

Bench-Scale Operating Data	10%
State-Point Data Tables	10%
Pre-FEED Study	Complete / Incomplete
Environmental Questionnaire	Complete / Incomplete

A submission lacking any of these requirements may be disqualified from the prize competition. Additionally, discrepancies across the components of the submission package (e.g., misrepresentation of pre-FEED study information in pre-FEED study summary) may result in disqualification.

1.6.1 Reviewer Panel Scoring

The scoring of submissions will proceed as follows:

- Reviewers will score each statement 1–5 or Complete/Incomplete, depending on the degree to which the reviewer agrees that the submission reflects the statements for consideration.
- Each statement score will be weighted and added together to generate a section score.
- Each section score will be weighted, then the scores will be added together to generate a total score for the submission.
- The total scores from each reviewer will be averaged to produce a final score for the competing team/organization. This score will inform the judge's decisions on prize awards.

See Appendix 15.1 for Phase 1 Reviewer Scoring Rubrics.

1.6.2 Interviews

DOE may decide to interview any competitor. The interviews would serve to help clarify questions the reviewers may have before selecting the winners. Interviews are not an indication of a competitor's likelihood to win.

1.6.3 Final Determination

DOE will designate a federal employee as the judge before the final determination of the winners. Final determination of the winners by the judge will take into account the reviewers' feedback and scores, application of program policy factors, and the interview findings (if applicable).

1.7 Additional Terms and Conditions

See Appendix 1 for additional requirements.

COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX 1 MAY BE DISQUALIFIED.

2 Phase Two - Engineer

2.1 Goal

The *Engineer Phase* is the second phase of this four-phase prize program and offers $20,000,000 in total cash prizes.

Any team meeting the eligibility requirements may compete in the Engineer Phase.

2.2 Prizes

Up to 5 teams will receive up to $4,000,000 each for completing the requirements of Phase 2. Up to 4 Phase 2 winners will also be selected to compete as Semifinalists in Phase 3.

2.3 How To Enter

Go to HeroX and follow the instructions for submitting all required materials before the phase deadline. Refer to the timeline on HeroX for relevant dates and deadlines.

2.4 Engineer Phase Process

Phase 2 (Engineer) consists of the following steps:

- **Submission** – Competitors will complete a FEED study (Class 3 estimate with expected cost accuracy of ±15% and project definition maturity of 40%) for the DAC pilot.
- **Assessment** – The Prize Administrator screens submissions for eligibility and completion and assigns subject-matter expert reviewers to independently score the content of each submission. The reviewer criteria assess the ability of the competitor to implement the study as a successful pilot project based on the provided information. FEED documents and other submission materials will be evaluated on merit of plant design, technology, siting/permitting, and other eligibility criteria.
- **Announcement** – After the winners are publicly announced, the Prize Administrator notifies them and requests the necessary information to distribute cash prizes. After winning Phase 2, competitors develop their solutions in accordance with their plan to compete in Phase 3.

2.5 What to Submit

A complete submission package for Phase 2 – Engineer should include the following items:

- Cover Page (Public)
- Summary of FEED Study (Public)
- Phase 3 Plans
- Complete FEED Study
- Bench-Scale Operating Data
- State-Point Data Tables
- LCA (Public)
- CBP (Public)
- Environmental Questionnaire
- Environmental Information Volume
- EH&S Risk Assessment (Public)
- Host Site Commitment Letter.

2.5.1 Cover Page (will be made public)

List basic information about your submission, including:

- Project title and team name
- Company, organization, or institution name
- Short description of proposed DAC technology and location of pilot DAC system
- Key project members (names, contacts, and links to their professional online profiles)
- Other relevant partners (if any)
- Your city, state, and nine-digit ZIP code.

The cover page will be made public and should not include any confidential, proprietary, or privileged information.

2.5.2 Summary of FEED Study (will be made public)

The **summary must not exceed 12 pages (12-point font; double-spaced; 1" margins),** not including captions, figures/graphs, or references. You may also include **up to 10 supporting images, figures, or graphs**. The reviewers will score the submission based on the content you provide. The FEED study summary will be made public and should not include any confidential, proprietary, or privileged information.

Summary of FEED Study	
Maximum of 10 pages and 5 supporting images or figures (PDF) A full FEED study shall be submitted in addition to this summary (for requirements: See Appendix 10).	
Suggested Content Competitor Provides ● The FEED study summary in accordance with Appendix 10. ● Summarize your most recent bench-scale operating data that demonstrates the viability of your DAC (and CO_2 conversion, if applicable) technology. ● Outline a climate resilience strategy for the DAC pilot system that accounts for climate impacts and extreme weather patterns such as high winds (tornadoes and hurricanes), heat and freezing temperatures, drought, wildfire, and floods. Strategy should include an analysis of possible risks that these impacts present and how the proposed DAC pilot system could be affected.	**A score of 1–5 will be given, according to how the provided content aligns with each statement:** ● The FEED study summary demonstrates the technical and economic feasibility of the proposed DAC pilot system. ● The information provided in the summary of the DAC pilot system FEED, including mass and energy balances, estimates of heating and cooling duties and electric power requirements covering the DAC system and required balance-of-plant through CO_2 disposition, and cost of CO_2 removal, is adequate and complete. ● The FEED study integrates detailed design activities with CBP requirements and activities as appropriate for the project. ● The team's most recent bench-scale operating data provided to the NETL EDX platform are summarized and demonstrate the ability of the DAC pilot to operate at the required scale during the prize competition. ● A climate resilience strategy that accounts for a range of climate impacts to the DAC pilot is outlined.

2.5.3 Phase 3 Plans

The **Phase 3 plans must not exceed 5 pages (12-point font; double-spaced; 1" margins), including** captions, figures/graphs, or references.

Plans and Proposed Milestones	
Suggested Content Competitor Provides • Submit a workplan for timely detailed design, NEPA compliance, permitting, and procurement for the DAC pilot system. • Propose relevant milestones that will demonstrate the implementation of the CBP. • Clearly identify all local, state, federal permits and environmental reviews necessary, including CO_2 transport and storage (if applicable), to initiate construction. • List necessary permits that have been attained and where permits have not been attained, provide a plan and timeline for permits to be secured.	**A score of 1–5 will be given, according to how the provided content aligns with each statement:** • There are no major financial, regulatory, permitting, or resource hurdles that will prevent or delay the construction of the DAC pilot system. • The provided workplan is high-quality and achievable on the proposed schedule. • Relevant verifiable milestones from the CBP are included in workplan. • The provided procurement plan is feasible and verifiable. • The team has identified all the permits necessary to initiate construction of the DAC pilot. • The team provides a list of the permits they have acquired and a plan to attain necessary permits that have not yet been acquired.

2.5.4 Complete FEED Study

Submit the complete FEED study (i.e., Class 3 estimate with expected cost accuracy of ±15% and project definition maturity of 40%) for the DAC pilot system with a minimum capacity of 500 tCO_2/year. Follow FEED study guidance in Appendix 10. This submission will not be scored, but it will be used for internal fact-checking of the FEED Study Summary.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: • The FEED Study for the proposed DAC pilot has been prepared and submitted in accordance with FEED study guidance in Appendix 10.

2.5.5 Bench-Scale Operating Data

Submit up-to-date integrated, bench-scale system operating data to NETL's Energy Data eXchange (EDX) Platform confirming performance and attainment of a TRL of at least 4. The data must represent at least 500 hours of integrated, bench-scale system operation at relevant environmental conditions. A summary of the data produced must be included in the FEED Study Summary. See Appendix 6 for additional information on NETL's EDX Platform.

Reviewer Recommendation

A single score on a scale of 1–5 is provided, taking the following statements into consideration:

- The submitted bench-scale operating data represent at least 500 non-continuous hours of integrated, bench-scale operation of the proposed technology using ambient air.
- The techniques used to record the bench-scale operating data are standard and legitimate.
- The bench-scale operating data submitted to NETL's EDX platform are accurately summarized in the summary of the FEED Study.

2.5.6 State-Point Data Tables

Submit tables based on the measured and projected system testing of the DAC technology. At the time that the Phase 2 package is submitted, competitors are required to provide the best-to-date measured performance data for their solvent, sorbent, or membrane material and projected performance data at the next testing scale. See Appendix 3 for guidance.

Reviewer Recommendation

A score of 1–5 will be given, according to how the provided content aligns with each statement:

- The state-point data tables are completed based on the measured and projected system testing of the DAC technology.
- The data in the state-point data tables are realistic and consistent with the rest of the application.

2.5.7 Life Cycle Assessment (will be made public)

Provide the results of a GHG emissions-focused LCA for a reference DAC plant that captures at least 100,000 tCO_2/year from air and is assumed to have access to geologic storage and/or sufficient utilization capacity. The LCA must be prepared according to the guidelines in Appendix 4 and demonstrate robust accounting of full life cycle emissions of the reference facility. The LCA will be made public and should not include any confidential, proprietary, or privileged information.

Reviewer Recommendation

A score of 1–5 will be given, according to how the provided content aligns with each statement:

- The competitor provides a rigorous and comprehensive GHG emissions-focused LCA of their DAC pilot system with assumptions and results clearly stated.
- Full discussion of the low-carbon energy procurement is provided, inclusive of use of any behind-the-meter (BTM) energy resources, siting in grid regions with low carbon generation, renewable energy certificates (RECs), power purchase agreements (PPAs), and 24/7 carbon pollution-free electricity (CFE) strategies.
- The LCA is prepared in the format provided in Appendix 4 and demonstrates robust accounting of full life cycle emissions.

2.5.8 Community Benefits Plan (will be made public)

Submit a CBP that demonstrates the following goals: 1) support meaningful community and labor engagement; 2) invest in quality jobs and the American workforce; 3) advance diversity, equity, inclusion,

and accessibility (DEIA); and 4) contribute to President's goal that 40% of the climate and clean energy investments flow to disadvantaged communities (the Justice40 Initiative). Follow D&D Community Benefits Plan guidance in Appendix 7. The CBP will be made public and should not include any confidential, proprietary, or privileged information.

Reviewer Recommendation
A score of 1–5 will be given, according to how the provided content aligns with each statement: ● When implemented, the CBP will advance each of the four goals listed above. ● The CBP specifically and convincingly demonstrates how the proposed DAC pilot will provide societal benefits and mitigate/minimize negative impacts to workers and communities. ● The CBP includes plans for analysis, workforce, and/or engagement efforts that address community, labor, and workforce desires and/or concerns which go beyond regulatory compliance and technical, business, environmental, labor, and other project requirements. ● The CBP is integrated into the project management schedule and other key documents and provides mechanisms, supported by measurable actions, to impact project direction in a timely manner. ● The CBP is consistent with the requirements and guidance of Appendix 7.

2.5.9 Environmental Questionnaire

Teams must submit an environmental questionnaire (NETL Form 451.1-1/3) for the DAC pilot host site and any other location in which work will be performed in Phase 4, and CO_2 disposition site (if applicable). See Appendix 13 for National Environmental Policy Act Compliance guidance.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: ● The environmental questionnaire for the proposed pilot host site is complete.

2.5.10 Environmental Information Volume

Teams must submit an Environmental Information Volume (EIV) for the DAC pilot system host site, site(s) of other work being performed in Phase 4. and CO_2 disposition site (if applicable) to support DOE's National Environmental Policy Act (NEPA) compliance process. See Appendix 13 for NEPA compliance guidance.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: ● The EIV for the proposed DAC pilot host site is complete.

2.5.11 Environmental Health and Safety Risk Assessment (will be made public)

Submit an EH&S risk assessment of the pilot DAC system in accordance with the format provided in Appendix 5. The EH&S risk assessment should include a discussion of direct environmental impacts from the expected pilot facility, including air and water emissions, water consumption, solid waste streams, noise, and potential environmental impacts of the technology, including toxicological effects and hazards of emissions and waste streams. Follow the EH&S risk assessment guidance in Appendix 5. The EH&S risk assessment will be made public and should not include any confidential, proprietary, or privileged information.

Reviewer Recommendation
A score of 1–5 will be given, according to how the provided content aligns with each statement: • The EH&S Risk Assessment is complete, addresses each of the topics listed above, and is submitted in accordance with the format provided in Appendix 5. • There are no environmental risks that jeopardize the delivery of the pilot on the prize timeline.

2.5.12 Host Site Commitment Letter

Submit a commitment letter that demonstrates approval for the use of the host site for the purpose of developing the proposed DAC pilot system.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: • An approval letter for use of the host site for the purpose of developing the proposed DAC pilot system has been submitted.

2.6 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible. Then the Prize Administrator, in consultation with DOE, assigns subject-matter-expert reviewers who independently score the content of each submission. The reviewers will be composed of federal and nonfederal subject-matter experts with expertise in areas relevant to the competition.

Submission	Weight
Summary of FEED Study	40%
Phase 3 Plans	10%
Bench-Scale Operating Data	10%
State-Point Data Tables	10%
Life Cycle Assessment	10%
Community Benefits Plan	10%
EH&S Risk Assessment	10%

Complete FEED Study	Complete / Incomplete
Environmental Questionnaire	Complete / Incomplete
Environmental Information Volume	Complete / Incomplete
Host Site Commitment Letter	Complete / Incomplete

A submission lacking any of these requirements may be disqualified from the prize competition. Additionally, discrepancies across the components of the submission package (e.g., misrepresentation of FEED study information in FEED study summary) may result in disqualification.

2.6.1 Reviewer Panel Scoring

The scoring of submissions will proceed as follows:

- Reviewers will score each statement 1–5 or Complete/Incomplete, depending on the degree to which the reviewer agrees that the submission reflects the statements for consideration.
- Each statement score will be weighted and added together to generate a section score.
- Each section score will be weighted, then the scores will be added together to generate a total score for the submission.
- The total scores from each reviewer will be averaged to produce a final score for the competing team/organization. This score will inform the judge's decisions on prize awards.

See Appendix 15.2 for Phase 2 Reviewer Scoring Rubrics.

2.6.2 Interviews

DOE may decide to interview any competitor. The interviews would serve to help clarify questions the reviewers may have before selecting the winners. Interviews are not an indication of a competitor's likelihood to win.

2.6.3 Final Determination

DOE will designate a federal employee as the judge before the final determination of the winners. Final determination of the winners by the judge will consider the reviewers' feedback and scores, application of program policy factors, and the interview findings (if applicable).

2.7 Additional Terms and Conditions

See Appendix 1 for additional requirements.

COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX 1 MAY BE DISQUALIFIED.

3 Phase Three - Permit

3.1 Goal

The *Permit Phase* is the third phase of this four-phase prize program and offers up to $4,000,000 in total cash prizes.

Only winners of Phase 2 – Engineer may compete in the Permit Phase.

3.2 Prizes

Up to 4 winners can receive up to $1,000,000 each. Up to 4 Phase 3 winners will be selected to compete as Finalists in Phase 4.

3.3 How To Enter

Go to HeroX and follow the instructions for submitting all required materials before the phase deadline. Refer to the timeline on HeroX for relevant dates and deadlines.

3.4 Permit Phase Process

Phase 3 (Permit) consists of the following steps:

- **Submission** - Semifinalists that were awarded in Phase 2 will complete the detailed design[21] (Class 1 estimate with expected cost accuracy of ±5% and project definition maturity of 90%) for the first-of-a-kind DAC pilot system and obtain all required approvals, including NEPA compliance, to initiate construction.
- **Assessment** – The Prize Administrator screens submissions for eligibility and completion and assigns subject-matter expert reviewers to independently score the content of each submission. Detailed design documents and other submission materials will be evaluated on the merit of plant design, technology, siting/permitting, and other eligibility criteria.
- **Announcement** – After the winners are publicly announced, the Prize Administrator notifies them and requests the necessary information to distribute cash prizes. After winning Phase 3, competitors develop their solutions in accordance with their plan to compete in Phase 4.

3.5 What To Submit

A complete submission package for Phase 3 - Permit should include the following items:

- Cover Page (Public)
- Summary of Detailed Design (Public)
- Phase 4 Plans
    1) Plans and Proposed Milestones
    2) Pre-Operational Milestone Verification Strategy
    3) Operational Verification Strategy (MMRV Plan)
- Complete Detailed Design
- Participation in NEPA Compliance Process

[21] Competitors shall complete 90% of the engineering such that the main contractors and all the sub-contractors can provide construct details (shop fabrication drawings) of all sub-systems and construction bids that will result in +/-5% capital cost estimate. Detailed design guidance can be found in Appendix 14.

- Permit Approvals
- Community Benefits Plan Outcomes and Objectives Report.

3.5.1 Cover Page (will be made public)

List basic information about your submission, including:

- Project title and team name
- Company, organization, or institution name
- Short description of proposed DAC technology and location of pilot DAC system
- Key project members (names, contacts, and links to their professional online profiles)
- Other relevant partners (if any)
- Your city, state, and nine-digit ZIP code.

The cover page will be made public and should not include any confidential, proprietary, or privileged information.

3.5.2 Summary of Detailed Design (will be made public)

The **response must not exceed 10 pages (12-point font; double-spaced; 1" margins),** not including captions, figures/graphs, or references. You may also include **up to 5 supporting images, figures, or graphs**. The reviewers will score the submission based on the content you provide. The Detailed Design summary will be made public and should not include any confidential, proprietary, or privileged information.

Summary of Detailed Design	
Maximum of 10 pages and 5 supporting images or figures (PDF) A full detailed design package shall be submitted in addition to summary (for requirements: see Appendix 14).	
Suggested Content Competitor Provides • A detailed design summary in accordance with Appendix 14. • Business objectives and the summary of the proposed project with the roles and scope of work for the different parties involved in the project clearly delineated. • A total plant cost (TPC) estimate, construction bids that will result in ±5% capital cost estimate, and operating cost estimates, including the cost in $/net tonne CO_2e removed and cost of the CO_2 conversion product (if applicable). • Social and environmental factors, including, but not limited, to emergency planning, stormwater runoff plans, spill containment, and water discharge.	**A score of 1–5 will be given, according to how the provided content aligns with each statement:** • The information provided in the summary of the DAC pilot system detailed design, including final mass and energy balances, heating and cooling duties and electric power requirements covering the DAC system and required balance-of-plant through CO_2 disposition, and cost of CO_2 removal, is adequate and complete. • The team has provided justification for all major design decisions. • The values referenced in the detailed design summary agree across sections of the entire detailed design report. • Energy sources and the impact of the energy sources on the net capture rate have been provided.

• Process flow diagrams; detailed heat and material balances; plot plan and elevation drawings; and DAC process model scaled-up to the proposed capture capacity. • Site characteristics and ambient conditions, fuel feedstock characteristics (if applicable), and site environmental requirements. • Energy sources used should be clearly defined, and the impact of the energy sources on the net air capture rate should be clearly provided. • Summarize any DAC (and CO_2 conversion, if applicable) technology improvements made between Phase 2 submission and the Phase 3 deadline.	• The team integrates detailed design activities with CBP requirements and activities, as appropriate for the project. • Social and environmental risks are discussed and plans for their mitigation are thorough. • The team has shown the ability to improve their DAC (and CO_2 conversion, if applicable) technology by demonstrating advances between Phases 2 and 3 of this prize competition.

3.5.3 Phase 4 Plans

The **Phase 4 plans must not exceed 15 pages (12-point font; double-spaced; 1" margins), including** captions, figures/graphs, or references.

Plans and Proposed Milestones	
Suggested Content Competitor Provides • Submit a workplan for timely procurement, construction, commissioning, and operation of the DAC pilot system. • Provide indicators that will demonstrate that the construction of the DAC pilot system has progressed beyond the mid-point (50%). • Describe how the team will fulfill all procurement needs before the 50% construction verification is conducted. • Provide indicators that will demonstrate the completion of construction and commissioning of the DAC pilot system. • Propose relevant milestones that will demonstrate the implementation of the CBP (specifically reference the Community Benefits Outcomes and Objectives table).	**A score of 1–5 will be given, according to how the provided content aligns with each statement:** • There are no major financial, regulatory, permitting, or resource hurdles that will prevent or delay the construction of the DAC pilot system. • The DAC pilot system is likely to hit major construction milestones, be constructed, commissioned, and begin operation on schedule, within the established timeframes of this prize. • The provided workplan is high-quality and achievable on the proposed schedule. • The provided indicators are well-defined, easily measurable, and represent accurate identifiers of progress toward completing construction and/or commissioning. • Relevant milestones from the CBP are included in workplan. • The provided procurement plan is feasible and verifiable.
Pre-Operational Milestone Verification Strategy	

Suggested Content Competitor Provides	A score of 1–5 will be given, according to how the provided content aligns with each statement:
• Provide a plan that describes how an independent reviewer will verify that the milestones for 50% construction completion, 100% construction completion, implementation of the CBP, and commissioning of the DAC pilot system have been achieved. • Describe submission packages that will be submitted during Phase 4 to certify that construction has been completed and that the system has been commissioned.	• The team has provided a sufficient and comprehensive milestone verification plan. • The milestone verification strategy will allow for reviewers to objectively determine that milestones have been achieved. • The proposed submission packages for system construction completion and system commissioning are satisfactory.
Operational Verification Strategy (MMRV Plan)	
Suggested Content Competitor Provides	**A score of 1–5 will be given, according to how the provided content aligns with each statement:**

• The competitor shall submit a plan that describes how the following will be independently verified:
  • Identification of DAC system boundaries.
  • Quantification of emissions from the DAC process on a cradle-to-grave basis (including operational and embodied emissions), with uncertainty clearly labeled.
  • Quantification of system leakage.
  • Description of quantification methods for detecting captured CO_2 (e.g., gravimetric, volumetric, barometric, gas analyzer, etc.) in real time; preferably two or more methods are employed.
  • Description of sensor calibration procedures.
  • Estimate of total uncertainty in the reported captured CO_2 quantities.
  • Description of downstream storage and/or conversion of the CO_2 generated from the DAC process (if applicable).
  • Calculation of DAC efficiency (with uncertainty clearly labeled) of overall process (i.e., (CO_2 captured from the
	• The operational verification strategy describes, in detail, how the operational data will be independently monitored, measured, reported, and verified.
	• The provided plan will allow competitors and any independent MMRV partners to accurately perform the work required to compete for operational Phase 4 prizes.
	• The operational verification strategy describes how DOE will verify the independence of all reported operational data.
	• The proposed MMRV plan is comprehensive and sufficiently detailed.

air - CO_2 emitted)/ CO_2 captured from the air).	

3.5.4 Complete Detailed Design

Submit the complete detailed design (i.e., Class 1 estimate with expected cost accuracy of ±5% and project definition maturity of 90%) for the DAC pilot system with a minimum capacity of 500 tCO_2/year. Follow the detailed design guidance in Appendix 14. This submission will not be scored, but it will be used for internal fact-checking of the Detailed Design Summary.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: ● The Complete Detailed Design for the proposed DAC pilot has been prepared and submitted in accordance with the FEED Study guidance in Appendix 14. ● There are no inconsistencies in reported values in different sections of the report.

3.5.5 Participation in the NEPA Compliance Process

Competitors must receive a determination regarding environmental effects from DOE at the conclusion of the NEPA process for the DAC pilot system. Based on review of the environmental questionnaire and environmental information volume (submitted in Phases 1 and 2, respectively), and the sensitivity of the proposed host site, DOE may need to complete a NEPA Environmental Assessment (EA) or Environmental Impact Statement (EIS), and prepare a NEPA determination (i.e., Finding of No Significant Impact (FONSI) or Record of Decision (ROD)) by the end of Phase 3. See Appendix 13 for NEPA compliance guidance.

Long-lead procurement activities may also be initiated in Phase 3, with prior DOE approval, following NEPA compliance.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: ● DOE has received a NEPA determination for the competitor's DAC pilot system.

3.5.6 Permit Approvals

Competitors must secure all permits necessary to commence construction, including air and building permits, CO_2 pipeline permits and right-of-way access (if applicable), and UIC Class VI Permit to Construct for the selected CO_2 storage site (if applicable).

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration:

- Teams have secured all permits necessary to commence construction of their DAC pilot system. Any permits not required by the submission of Phase 3 are in process and have an expected delivery date that would not delay the Phase 4 schedule.

3.5.7 Community Benefits Outcomes and Objectives Report

Competitors must update the "Summary Table: Community Benefits Outcomes and Objectives" in Section E of Appendix 7.

Reviewer Recommendation

A score of 1–5 will be given, according to how the provided content aligns with each statement:

- Teams have completed the Summary Table to reflect the commitments and relevant time-based milestones completed up to this point in the prize timeline.
- The Community Benefits Outcomes and Objectives Report milestones are laid out in quantifiable terms with SMART milestones.

3.6 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible. Then the Prize Administrator, in consultation with DOE, assigns subject-matter-expert reviewers who independently score the content of each submission. The reviewers will be composed of federal and nonfederal subject-matter experts with expertise in areas relevant to the competition.

Submission	Weight
Summary of Detailed Design	40%
Phase 4 Plans	40%
Community Benefits Outcomes and Objectives Report	20%
Complete Detailed Design	Complete / Incomplete
NEPA Compliance Determination	Complete / Incomplete
Permit Approvals	Complete / Incomplete

A submission lacking any of these requirements may be disqualified from the prize competition. Additionally, discrepancies across the components of the submission package (e.g., misrepresentation of detailed design study information in the detailed design study summary) may result in disqualification.

3.6.1 Reviewer Panel Scoring

The scoring of submissions will proceed as follows:

- Reviewers will score each statement 1–5 or Complete/Incomplete, depending on the degree to which the reviewer agrees that the submission reflects the statements for consideration.
- Each statement score will be weighted and added together to generate a section score.

- Each section score will be weighted, then the scores will be added together to generate a total score for the submission.
- The total scores from each reviewer will be averaged to produce a final score for the competing team/organization. This score will inform the judge's decisions on prize awards.

See Appendix 15.3 for Phase 3 Reviewer Scoring Rubrics.

3.6.2 Interviews

DOE may decide to interview any competitor. The interviews would serve to help clarify questions the reviewers may have before selecting the winners. Interviews are not an indication of a competitor's likelihood to win.

3.6.3 Final Determination

DOE will designate a federal employee as the judge before the final determination of the winners. Final determination of the winners by the judge will consider the reviewers' feedback and scores, application of program policy factors, and the interview findings (if applicable).

3.7 Additional Terms and Conditions

See Appendix 1 for additional requirements.

COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX 1 MAY BE DISQUALIFIED.

4 Phase Four - Operate

4.1 Goal

The Operate Phase is the fourth phase of this four-phase prize program and offers up to $26,000,000 in total cash prizes.

Only winners of Phase 3 – Permit may compete in the Operate Phase.

4.2 Prizes

Up to 4 winners can receive up to $6,500,000 each.

Portions of the prize will be delivered at the completion of significant milestones, detailed below:

Milestone	Prize	Duration
50% Construction Complete	$4,000,000	9 months
System Construction and Commissioning Complete	$1,000,000	9 months
Operational Awards	up to $1,000,000	12 months
Pre-FEED Study and Technology Maturation Plan	$500,000	

4.3 How To Enter

Go to HeroX and follow the instructions for submitting all required materials before the phase deadline. Refer to the timeline on HeroX for relevant dates and deadlines.

4.4 Operate Phase Process

Phase 4 (Operate) consists of the following steps:

- Submission

  Construction – Competitors will initiate and complete construction of their commercial DAC system. Prizes will be awarded when teams reach previously determined (in Phase 3) milestones that represent 50% of the construction is complete.

  Commissioning – Teams will submit independent verification that construction of the DAC pilot has been completed and that the pilot has been commissioned with technical documentation from a third-party demonstrating adequate operational capacity. Teams will also complete the Community Benefits Outcomes and Objectives Summary Table to reflect the completion of all proposed commitments and relevant time-based milestones.

  Operation – Teams will submit independently verified performance data from the first year of the DAC pilot system operation.

  Plans Beyond Pilot – Competitors will deliver a pre-FEED study for their DAC system at the next planned testing scale (minimum capacity of 5,000 tCO_2/yr) and a technology maturation plan.

- **Assessment** – The Prize Administrator screens submissions for eligibility and completion and assigns subject-matter expert reviewers to independently score the content of each submission. The reviewer criteria assess the following competitor activities:

  50% Construction – In addition to the review of verification packages, an onsite inspection will be conducted to determine that the 50% construction completion milestones are achieved.
  Commissioning – In addition to the review of verification packages, a second inspection may occur to confirm that competitors have successfully commissioned the DAC pilot system, achieved operations at the design capacity, and implemented their CBP.

  Operation – Prizes will be awarded to teams that operate their DAC pilot system for no less than 2,000 hours. Teams can earn a maximum of $1,000,000 in operational awards in Phase 4. The magnitude of the prize will depend on the performance of the DAC system; prizes will be proportional to quantity of captured CO_2 and dependent upon the final disposition of the captured CO_2 (see table below). Operation prizes will be awarded 1 year after commissioning.

Disposition of CO_2	Prize / tCO_2	500 tCO_2 Award*
Capture Only	$50	$25,000
Capture + Utilization	$130	$65,000
Capture + Geologic Storage	$180	$90,000

  Plans Beyond Pilot – Final prizes will be awarded upon delivery of a pre-FEED study for a DAC system at the next planned testing scale and a technology maturation plan for the DAC system.

- **Announcement** – After the winners are publicly announced, the Prize Administrator notifies them and requests the necessary information to distribute cash prizes.

4.5 What To Submit

Submissions will occur on an ongoing basis for Phase 4 – Operate and will include the following items:

- 50% Construction Completion Summary
- Construction and Commissioning Completion Summary
- Operational and MMRV Data
- Pre-FEED Study and Technology Maturation Plan.

4.5.1 50% Construction Completion Summary

Competitors will certify the milestones submitted in the Phase 3 submission package have been completed according to the Pre-Operational Milestone Verification Strategy that was submitted in Phase 3.

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* For reference.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: • The proposed milestones have been achieved. • The completeness of the milestones has been independently verified. • Procurement has been completed.

4.5.2 Construction and Commissioning Completion Summary

Competitors will verify that construction is completed as proposed in the plans submitted in Phase 3. Competitors will demonstrate that the constructed DAC pilot system has been commissioned according to the indicators proposed in Phase 3. Teams will provide technical documentation from a third-party demonstrating adequate operational capacity.

DOE will only consider the commissioning of the DAC system successful if the proposed CBP has been implemented. Competitors must update the "Summary Table: Community Benefits Outcomes and Objectives" in Section E of Appendix 7. Teams will also provide an outline of any ongoing or future activities that will advance CBP implementation beyond the scope and timeline of the Commercial DAC Pilot Prize.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: • The construction of the DAC system has been completed. • The system is fully commissioned and ready for pilot testing. • The submission qualifies for this part of the Phase 4 prize. • Teams have implemented the CBP and completed the Community Benefits Outcomes and Objectives Summary Table to reflect the commitments and relevant time-based milestones completed up to this point in the prize timeline.

4.5.3 Operational and MMRV Data

Awards will be made based on the independently verified quantity of CO_2 captured by the pilot DAC system in its first year of operation. Awards will also depend on the end-use of captured CO_2, if applicable. Provide complete independently verified documentation and carbon accounting information supporting the claimed CO_2 captured in the DAC pilot system. Teams shall also submit updated State-Point Data Table (Appendix 3) and LCA (Appendix 4) for the first year of operation.

Submit an independent technical measurement and validation of claimed CO_2 capture and removal. To the extent possible, documentation should support third-party validation and direct measurement of the project's claimed CO_2 capture and use or sequestration, if applicable.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: • The claims of the competitor have been satisfactorily verified by an independent third-party. • The State-Point Data Table(s) and LCA for the first year of operation have been prepared and submitted in accordance with Appendices 3 and 4, respectively. **Awards based on Operational and MMRV Data will be variable, depending upon total volume of CO_2 captured and the final disposition of the captured CO_2.**

4.5.4 Pre-FEED Study and Technology Maturation Plan

Competitors will deliver a pre-FEED study for their DAC system at the next planned testing scale (minimum capacity of 5,000 tCO_2/yr) and a technology maturation plan. Recipients must prepare a Technology Maturation Plan that describes the current technology readiness level (TRL) of the DAC technology and describes any known post-project research and development necessary to further mature the technology.

The pre-FEED study for the next planned testing scale shall be prepared and submitted in accordance with pre-FEED study guidance in Appendix 9. The Technology Maturation Plan should be prepared according to the template provided in Appendix 12.

Reviewer Recommendation
A single score of Complete or Incomplete is provided, taking the following statements into consideration: • The Pre-FEED Study Summary provides all necessary information and is prepared in accordance with Appendix 9. • The Technology Maturation Plan provides all necessary information and is prepared in accordance with template provided in Appendix 12.

4.6 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible.

Then the Prize Administrator, in consultation with DOE, assigns subject-matter-expert reviewers who independently score the content of each submission. The reviewers will be composed of federal and nonfederal subject-matter experts with expertise in areas relevant to the competition. They will review the competitor's submission package according to the criteria above.

Review	Scoring
50% Construction Completion	Complete / Incomplete
Construction Completion	Complete / Incomplete
System Commissioning and CBP Implementation	Complete / Incomplete

Operational Data	Variable
Updated State-Point Data Table	Complete/Incomplete
Updated LCA	Complete/Incomplete
Pre-FEED Study and Technology Maturation Plan	Complete / Incomplete

A submission lacking any of these requirements may be disqualified from the prize competition.

4.6.1 Site Visits and Interviews

DOE may decide to perform site-visits to verify the completion of project milestones.

DOE may decide to interview any competitor. The interviews would serve to help clarify questions the reviewers may have before selecting the winners.

4.6.2 Final Determination

DOE will designate a federal employee as the judge before the final determination of the winners. Final determination of the winners by the judge will take into account the reviewers' feedback and scores, application of program policy factors, and the interview findings (if applicable).

4.7 Additional Terms and Conditions

See Appendix 1 for additional requirements.

COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX 1 MAY BE DISQUALIFIED.

Appendix 1: Additional Terms and Conditions

A.1 Universal Contest Requirements

Your submission for the Commercial DAC Pilot Prize is subject to the following terms and conditions:

- You must post the final content of your submission or upload the submission form online by 5 p.m. ET on November 22, 2024, before the prize's Phase 1 submission period closes. Late submissions or any other form of submission may be rejected.
- All submissions that you wish to protect from public disclosure must be marked according to the instructions in Section 10 of Appendix 1 (Section A.10). Unmarked or improperly marked submissions will be deemed to have been provided with unlimited rights and may be used in any manner and for any purpose whatsoever.
- You must include all the required elements in your submission. The Prize Administrator may disqualify your submission after an initial screening if you fail to provide all required submission elements. Competitors may be given an opportunity to rectify submission errors due to technical challenges.
- Your submission must be in English and in a format readable by Adobe PDF. Scanned hand-written submissions will be disqualified.
- Submissions will be disqualified if they contain any matter that, in the sole discretion of the U.S. Department of Energy or the National Renewable Energy Laboratory (NREL), is indecent, obscene, defamatory, libelous, and/or lacking in professionalism, or demonstrates a lack of respect for people or life on this planet.
- If you click "Accept" on the HeroX platform and proceed to register for any of the prizes described in this document, these rules will form a valid and binding agreement between you and DOE and are in addition to the existing HeroX Terms of Use for all purposes relating to these contests. You should print and keep a copy of these rules. These provisions only apply to the prize described here and no other prize on the HeroX platform or anywhere else.
- The Prize Administrator, when feasible, may give competitors an opportunity to fix nonsubstantive mistakes or errors in their submission packages.
- As part of your submission to this prize, you will be required to sign the following statement:

> I am providing this submission package as part of my participation in this prize. I understand that I am providing this submission to the Federal Government. I certify under penalty of perjury that the named competitor meets the eligibility requirements for this prize competition and complies with all other rules contained in the Official Rules document. I further represent that the information contained in the submission is true and contains no misrepresentations. I understand false statements or misrepresentations to the Federal Government may result in civil and/or criminal penalties under 18 U.S.C. § 1001.

A.2 Verification for Payments

The Prize Administrator will verify the identity and role of all competitors before distributing any prizes. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The Prize Administrator will notify winning competitors using provided email contact information for the individual or entity that was responsible for the submission. Each competitor will be required to sign and return to the Prize Administrator, within 30 days of the date on the notice, a completed NREL Request for ACH Banking Information form and a completed W9 form (https://www.irs.gov/pub/irs-pdf/fw9.pdf). In the sole

discretion of the Prize Administrator, a winning competitor will be disqualified from the competition and receive no prize funds if: (i) the person/entity does not respond to notifications; (ii) the person/entity fails to sign and return the required documentation within the required time period; (iii) the notification is returned as undeliverable; (iv) the submission or person/entity is disqualified for any other reason.

In the event of a dispute as to any registration, the authorized account holder of the email address used to register will be deemed to be the competitor. The "authorized account holder" is the natural person or legal entity assigned an email address by an internet access provider, online service provider, or other organization responsible for assigning email addresses for the domain associated with the submitted address. All competitors may be required to show proof of being the authorized account holder.

A.3 Teams and Single-Entity Awards

The Prize Administrator will award a single dollar amount to the designated primary submitter, whether it consists of a single or multiple entities. The primary submitter is solely responsible for allocating any prize funds among its member competitors or teammates as they deem appropriate. The Prize Administrator will not arbitrate, intervene, advise on, or resolve any matters or disputes between team members or competitors.

A.4 Submission Rights

By making a submission and consenting to the rules of the contest, a competitor is granting to DOE, the Prize Administrator, and any other third parties supporting DOE in the contest, a license to display publicly and use the parts of the submission that are designated as “public” for government purposes. This license includes posting or linking to the public portions of the submission on the Prize Administrator or HeroX applications, including the contest website, DOE websites, and partner websites, and the inclusion of the submission in any other media worldwide. The submission may be viewed by DOE, the Prize Administrator, and judges and reviewers for purposes of the contests, including but not limited to screening and evaluation purposes. The Prize Administrator and any third parties acting on their behalf will also have the right to publicize competitors’ names and, as applicable, the names of competitors’ team members and organization, who participated in the submission on the contest website indefinitely.

By entering, the competitor represents and warrants that:

1. The competitor’s entire submission is an original work by the competitor and the competitor has not included third-party content (such as writing, text, graphics, artwork, logos, photographs, likenesses of any third party, musical recordings, clips of videos, television programs or motion pictures) in or in connection with the submission, unless (i) otherwise requested by the Prize Administrator and/or disclosed by the competitor in the submission, and (ii) the competitor has either obtained the rights to use such third-party content or the content of the submission is considered to be in the public domain without any limitations on use.
2. Unless otherwise disclosed in the submission, the use thereof by the Prize Administrator, or the exercise by the Prize Administrator of any of the rights granted by the competitor under these rules, does not and will not infringe or violate any rights of any third party or entity, including, without limitation, patent, copyright, trademark, trade secret, defamation, privacy, publicity, false light, misappropriation, intentional or negligent infliction of emotional distress, confidentiality, or any contractual or other rights.
3. All persons who were engaged by the competitor to work on the submission or who appear in the submission in any manner have:

a. Given the competitor their express written consent to submit the submission for exhibition and other exploitation in any manner and in any and all media, whether now existing or hereafter discovered, throughout the world;
b. Provided written permission to include their name, image, or pictures in or with the submission (or, if a minor who is not competitor's child, competitor must have the permission of the minor's parent or legal guardian) and the competitor may be asked by the Prize Administrator to provide permission in writing; and
c. Not been and are not currently under any union or guild agreement that results in any ongoing obligations resulting from the use, exhibition, or other exploitation of the submission.

A.5 Copyright

Each competitor represents and warrants that the competitor is the sole author and copyright owner of the submission; that the submission is an original work of the competitor or that the competitor has acquired sufficient rights to use and to authorize others, including DOE, to use the submission, as specified throughout the rules; that the submission does not infringe upon any copyright or any other third-party rights of which the competitor is aware; and that the submission is free of malware.

A.6 Contest Subject to Applicable Law

All contests are subject to all applicable federal laws and regulations. Participation constitutes each participant's full and unconditional agreement to these Official Rules and administrative decisions, which are final and binding in all matters related to the contest. This notice is not an obligation of funds; the final award is contingent upon the availability of appropriations.

A.7 Resolution of Disputes

DOE is solely responsible for administrative decisions, which are final and binding in all matters related to the contest.

Neither DOE nor the Prize Administrator will arbitrate, intervene, advise on, or resolve any matters between team members or among competitors.

A.8 Publicity

The winners of these prizes (collectively, "winners") will be featured on DOE's and NREL's websites.

Except where prohibited, participation in the contest constitutes each winner's consent to DOE's and its agents' use of each winner's name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media worldwide, without further permission, payment, or consideration.

A.9 Liability

Upon registration, all participants agree to assume any and all risks of injury or loss in connection with or in any way arising from participation in this contest. Upon registration, except in the case of willful misconduct, all participants agree to and, thereby, do waive and release any and all claims or causes of action against the federal government and its officers, employees, and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential, and whether foreseeable or not) arising from their participation in the contest, whether the claim or cause of action arises under contract or tort.

In accordance with the delegation of authority to run this contest delegated to the judge responsible for this prize, the judge has determined that no liability insurance naming DOE as an insured will be required of competitors to compete in this competition, per 15 U.S.C. § 3719(i)(2). Competitors should assess the risks associated with their proposed activities and adequately insure themselves against possible losses.

A.10 Records Retention and Freedom of Information Act

All materials submitted to DOE as part of a submission become DOE records and are subject to the Freedom of Information Act. The following applies only to portions of the submission not designated as public information in the instructions for submission. If a submission includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the Government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the application. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, DOE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source.

Submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose.

The submission must be marked as follows and must identify the specific pages containing trade secrets or confidential, proprietary, or privileged information: "Notice of Restriction on Disclosure and Use of Data: Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. [End of Notice]"

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure." In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets.

Competitors will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26. Competitors may then have the opportunity to review materials and work with a Freedom of Information Act representative prior to the release of materials. DOE does intend to keep all submission materials private except for those materials designated as "will be made public."

A.11 Privacy

If you choose to provide HeroX with personal information by registering or completing the submission package through the contest website, you understand that such information will be transmitted to DOE and may be kept in a system of records. Such information will be used only to respond to you in matters regarding your submission and/or the contest unless you choose to receive updates or notifications about other contests or programs from DOE on an opt-in basis. DOE and NREL are not collecting any information for commercial marketing.

A.12 General Conditions

DOE reserves the right to cancel, suspend, and/or modify the prize, or any part of it, at any time. If any fraud, technical failures, or any other factors beyond DOE's reasonable control impairs the integrity or proper functioning of the prize, as determined by DOE in its sole discretion, DOE may cancel the prize. Any performance toward prize goals is conducted entirely at the risk of the competitor and DOE shall not compensate any competitors for any activities performed in furtherance of this prize.

Although DOE may indicate that it will select up to several winners for each prize, DOE reserves the right to only select competitors that are likely to achieve the goals of the program. If, in DOE's determination, no competitors are likely to achieve the goals of the program, DOE will select no competitors to be winners and will award no prize money.

A.13 Program Policy Factors

While the scores of the expert reviewers will be carefully considered, it is the role of the prize judge to maximize the impact of the prize funds. Some factors outside the control of competitors and beyond the independent expert reviewers' scope of review may need to be considered to accomplish this goal. The following is a list of such factors. In addition to the reviewers' scores, the below program policy factors may be considered in determining winners:

- Geographic diversity and potential economic impact of projects.
- Whether the use of additional DOE funds and provided resources are non-duplicative and compatible with the stated goals of this program and DOE's mission generally.
- The degree to which the submission exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other competitors.
- The degree to which the submission presents schedule risk, budget risk, technical risk, societal impact risk, and/or environmental risk. Environmental risk includes, but is not limited to, adverse impacts to air, soil, water, or a positive cradle-to-grave greenhouse gas footprint (carbon dioxide equivalent, CO_2e).
- The degree to which the submission is likely to lead to increased employment and manufacturing in the United States or provide other economic benefits to U.S. taxpayers.
- The degree to which the submission will accelerate transformational technological, financial, or workforce advances in areas that industry by itself is not likely to undertake because of technical or financial uncertainty.
- The degree to which the submission supports complementary DOE-funded efforts or projects, which, when taken together, will best achieve the goals and objectives of DOE.
- The degree to which the submission expands DOE's funding to new competitors and recipients who have not been supported by DOE in the past.
- The degree to which the submission exhibits team member diversity and the inclusion of underrepresented groups, with participants including but not limited to graduates and students of Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), and other minority-serving institutions (MSIs) or members operating within Qualified Opportunity Zones or other underserved communities.
- The degree to which the submission enables new and expanding market segments.
- Whether the project promotes increased coordination with nongovernmental entities toward enabling a just and equitable clean energy economy in their region and/or community.

A.14 Return of Funds

As a condition of receiving a prize, competitors agree that if the award was made based on fraudulent or inaccurate information provided by the competitor to DOE, DOE has the right to demand that any prize funds or the value of other non-cash prizes be returned to the government.

ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE PRIZE.

Appendix 2: Definitions

Prize Administrator – DOE has partnered with NREL to administer the Commercial DAC Prize. NREL, as the administrator, helps competitors locate and leverage the vast array of national laboratory resources. NREL also connects elements of the network with the competitors, as described below. Ultimate decision-making authority regarding contest matters rests with the Office of Fossil Energy and Carbon Management.

Carbon Dioxide Removal (CDR) - The capture of CO_2 that is already in the atmosphere or upper hydrosphere and involves the subsequent secure storage of the captured CO_2 in geological, biobased, and ocean reservoirs, or in the form of long-lived products. CDR is different from point-source carbon capture, which directly captures CO_2 from fossil fuel or industrial facilities before it is released into the atmosphere.

Carbon Dioxide Equivalent (CO_2e) - The impact of a given greenhouse gas (GHG) (e.g., CO_2, CO, CH_4, N_2O, etc.) by converting its mass to the equivalent mass of CO_2 that would have the same global warming effect. The mass of a GHG is converted to the mass of CO_2e based on the GHG molecule's potential to affect global warming, or its global warming potential (GWP). The GWP takes into account both the radiative forcing effect of the GHG and the gas' lifetime in the atmosphere, and is dependent on the time horizon, which is most commonly 20 years (GWP-20) or 100 years (GWP-100). These values are different because the GWP is time-integrated, and the GWP of CO_2 is always 1, regardless of the time horizon.

Direct Air Capture (DAC) facility - Any facility which uses carbon capture equipment to capture carbon dioxide directly from the ambient air. Direct air capture facilities do not include any facility which captures carbon dioxide that is deliberately released from naturally occurring subsurface springs or using natural photosynthesis.

Appendix 3: State-Point Data Tables

Instructions for Completing Data Tables: The tables that follow in this attachment shall be populated with data developed by the prize competitor. Competitors shall complete the appropriate combinations of Table 1 (required for all prize competitors) and Tables 2–8 that relate to their proposed process concept. *Merit scoring will correspond to the completeness of the data table and supporting information.*

To assist teams, elective templates are provided below. Teams are not required to use this template of data tables, but if teams should elect to use their own format, they must make sure to include all the substantive information included in the data tables below.

At the time that the Phase 1 package is submitted, competitors are required to provide the best-to-date measured performance data for their solvent, sorbent, or membrane material and projected performance data at the next testing scale.

For the Phase 1 package, measured data should be derived from performance during integrated testing of the proposed DAC technology at a scale of at least 1 tCO_2/yr but not greater than 100 tCO_2/yr, and projected performance data should be based on projected results at the proposed pilot scale of at least 500 tCO_2/yr. For the Phase 4 package, measured data will be derived from performance during integrated pilot testing of the proposed DAC technology at a scale of at least 500 tCO_2/yr, and projected performance data will be based on projected results at the next testing scale of at least 5,000 tCO_2/yr.

Key data or estimates provided in the table(s) shall be supported with short narratives in bullet form within the concept paper. These bullets shall describe the sources for the individual data provided. This may be measurements made directly by the competitor, and competitors shall identify the apparatus and methodology used in the measurement(s). Due to page limitations, citations may be utilized to describe the sources for the individual data provided by the competitor or others, or by example calculations for noncritical data. Other acceptable sources of data are the open literature (with a citation and description), or estimated or extrapolated data (with a description of the method/model used for the estimate, or the procedure used for extrapolation). Arguments supported by theory/mechanisms shall be provided for projected performance for new, advanced solvent, sorbent, or membrane materials.

State-of-the-Art DAC Reference Cases

For the purposes of this prize, any comparisons to state-of-the-art DAC technologies should be based on at least one of the following reference documents. These reference cases should be utilized to justify all claims of cost and performance improvement that would lead to breakthrough technology development. Overall DAC systems proposed should be compared with one of the cases in these reports to illustrate how the technology achieves a breakthrough improvement. Individual DAC system components proposed should be incorporated into one of the cases in these reports in order to illustrate the potential breakthrough improvements in terms of cost and performance.

Erans, M., Sanz-Pérez, E.S., Hanak, D.P., Clulow, Z., Reiner, D.M., and Mutch, G.A. 2022. “Direct air capture: process technology, techno-economic and socio-political challenges.” *Energy & Environmental Science*. https://pubs.rsc.org/en/content/articlelanding/2022/ee/d1ee03523a.

Mission Innovation. 2022. “Carbon Dioxide Removal Technology Roadmap: Innovation Gaps and Landscape Analysis.” http://mission-innovation.net/wp-content/uploads/2022/09/Attachment-1-CDR-Mission-Roadmap-Sept-22.pdf.

Sievert, K., Schmidt, T.S., and Steffen, B. 2024. “Considering technology characteristics to project future costs of direct air capture.” *Joule*. https://www.cell.com/joule/fulltext/S2542-4351(24)00060-6.

B.C. Centre for Innovation and Clean Energy. 2024. “Catalyzing Carbon Dioxide Removal at Scale.” https://cice.ca/knowledge-hub/catalyzing-carbon-dioxide-removal-at-scale-report/.

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Solvent-Based DAC:

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Table 1. Data Table for Overall System

	Units	Measured Performance	Projected Performance
Technology and Technology Readiness Level (TRL)			
Gross Annual Scale	Gross t CO_2/yr		
Total System Energy Requirements	GJ/t CO_2 removed from atmosphere		
Total Thermal Energy Requirement (including any electricity used to generate heat)	GJ/t CO_2 removed from atmosphere		
Required Maximum Temperature of Thermal Energy	°C		
Total Electrical Energy Requirement (excluding any electricity used to generate heat)	GJ/t CO_2 removed from atmosphere		
Volumetric Productivity	mol CO_2/m^3 capture media/ time; kg CO_2/ha/yr; other as appropriate		
CO_2 Capture Percentage from Feed Air	%		
Pressure Drop	Pa		
Emissions Related to Energy Source	t CO_2e/yr		
CO_2 Conversion Method (if applicable)			
CO_2 Storage Method (if applicable)			
Distance to CO_2 Storage and/or Conversion Option (if applicable)	Mile		
Total Land Requirements (excluding energy supply)	Acre		
Total Water Requirements or Production	Gallons per minute (gpm)		

Table 2. State-Point Data for Solvent-Based Systems

	Units	Measured Performance	Projected Performance
Type of Solvent	Name		
Pure Solvent/Agent			
Molecular Weight	g/mol		
Standard Boiling Point	°C		
Standard Freezing Point	°C		
Vapor Pressure @ 15°C	bar		
Working Solution			
Concentration	kg/kg		
Specific Gravity (15°C/15°C)			
Specific Heat Capacity @ STP	kJ/kg·K		
Viscosity @ STP	cP		
Surface Tension @ STP	dyne/cm		
CO_2 Mass Transfer Rate [K_L]	m/s		
CO_2 Reaction Rate			
Thermal Conductivity	W/(m·K)		
Adsorption			
Pressure	bar		
Temperature	°C		
Equilibrium CO_2 Loading During Adsorption	mol CO_2/kg		
Heat of Absorption	kJ/mol CO_2		
Solution Viscosity	cP		
Desorption			
Pressure	bar		
Temperature	°C		
Equilibrium CO_2 Loading During Desorption	mol CO_2/kg		
Heat of Desorption	kJ/mol CO_2		
Testing Data			
Cumulative Total of Captured CO_2	kg CO_2		
Location			
The following information should be provided for the longest steady-state duration test performed.			
Scale	t CO_2/year		
Consecutive Duration of Long-Term Test	hr		
CO_2 Concentration in the Feed Stream	mol %		

Carbon Capture Efficiency From Feed Air	%	
Solvent Make-Up Rate	%/yr	
Reboiler Duty	kJ/kg CO_2	
CO_2 Product Purity	mol % dry	
CO_2 Product Oxygen Concentration	mol % (or ppm)	
Environmental Conditions (temperature, humidity, elevation/partial pressure, air flow rates, etc.)		

Definitions for Table 2:

- STP – Standard temperature and pressure (25°C, 1 atm).
- Pure Solvent – Agent(s), working alone or as a component of a working solution, responsible for enhanced CO_2 absorption. For example: the amine monoethanolamine (MEA) in an aqueous solution.
- Working Solution – The solute-free (i.e., CO_2-free) liquid solution used as the working solvent in the absorption/desorption process. For example: the liquid mixture of MEA and water.
- Absorption – The conditions of interest for absorption are those that prevail at maximum solvent loading, which typically occurs at the bottom of the absorption column. Measured data are preferable to estimated data.
- Desorption – The conditions of interest for desorption are those that prevail at minimum solvent loading, which typically occurs at the bottom of the desorption column. Operating pressure and temperature for the desorber/stripper are process-dependent. Measured data are preferable to estimated data.
- Pressure – The pressure of CO_2 in equilibrium with the solution. If the vapor phase is pure CO_2, this is the total pressure, and if it is a mixture of gases, this is the partial pressure of CO_2.
- Concentration – Mass fraction of pure solvent in working solution.
- Loading – The basis for CO_2 loading is moles of pure solvent.
- Mass Transfer Rate – Overall liquid phase mass transfer coefficient.
- CO_2 Reaction Rate – A characterization of the CO_2 absorption trend with respect to time, as complete in the range of time as possible.
- Details on Solvent Reclamation or Refreshing – Include information about reclamation rates or solvent replacement/refreshing during the long-term test.
- CO_2 Product Purity – Average purity of the CO_2 product from the capture system during the long-term testing.
- CO_2 Product Oxygen Concentration – Oxygen content of the CO_2 produced during the long-term testing.

Table 3. State-Point Data for Sorbent-Based Systems

	Units	Measured Performance	Projected Performance
Sorbent			
Sorbent, Substrate, and Contactor Material (as applicable)	Name		
True Density @ STP	kg/m^3		
Bulk Density	kg/m^3		
Average Particle Diameter	mm		
Particle Void Fraction	m^3/m^3		
Packing Density	m^2/m^3		
Solid Heat Capacity @ STP	kJ/kg·K		
Crush Strength	kgf		
Attrition Index			
Thermal Conductivity	W/(m·K)		
Adsorption			
Pressure	bar		
Temperature (may be a range)	°C		
Equilibrium CO_2 Loading During Adsorption	mol CO_2/kg		
Equilibrium H_2O Loading	mol H_2O/kg		
Heat of CO_2 Adsorption	kJ/mol CO_2		
Heat of H_2O Adsorption (if applicable)	kJ/mol H_2O		
CO_2 Adsorption Kinetics	mol CO_2/time		
Desorption			
Pressure	bar		
Temperature	°C		
Equilibrium CO_2 Loading During Desorption	mol CO_2/kg		
Heat of CO_2 Desorption	kJ/mol CO_2		
Heat of H_2O Desorption (if applicable)	kJ/mol H_2O		
CO_2 Desorption Kinetics	mol CO_2/time		
Testing Data			
Cumulative Total of Captured CO_2	kg CO_2		
Location			
The following information should be provided for the longest steady-state duration test performed.			
Scale	t CO_2/yr		
Consecutive Duration of Long-Term Test	hr		
CO_2 Concentration in Feed Stream	%		
Carbon Capture Efficiency From Feed Air	%		

Cycle Time	hr	
Sorbent Make-Up Rate	%/yr	
Details on Sorbent Reactivation or Refreshing		
Heat Duty	kJ/kg CO_2	
CO_2 Product Purity	mol % dry	
CO_2 Product Oxygen Concentration	mol % (or ppm)	
Environmental Conditions (temperature, humidity, elevation/partial pressure, air flow rates, etc.)		

Definitions for Table 3:

- Attrition Index – For circulating sorbents, the attrition index includes the percentage and size of the fines generated.
- STP – Standard temperature and pressure (25°C, 1 atm).
- Sorbent – Adsorbate-free (i.e., CO_2-free) and dry material as used in adsorption/desorption cycle.
- Adsorption – The conditions of interest for adsorption are those that prevail at maximum sorbent loading. Measured data are preferable to estimated data.
- Desorption – The conditions of interest for desorption are those that prevail at minimum sorbent loading. Operating pressure and temperature for the desorber/stripper are process-dependent. Measured data are preferable to estimated data.
- Pressure – The pressure of CO_2 in equilibrium with the sorbent. If the vapor phase is pure CO_2, this is the total pressure, and if it is a mixture of gases, this is the partial pressure of CO_2.
- Packing Density – Ratio of the active sorbent area to the bulk sorbent volume.
- Loading – The basis for CO_2 loading is mass of dry sorbent.
- Kinetics – A characterization of the CO_2 adsorption/desorption trend with respect to time, as complete in the range of time as possible.
- Cycle Time – Time for entire absorption and regeneration cycle utilized during long-term testing.
- Details on Sorbent Reactivation or Refreshing – Include information about reactivation process and rates or sorbent replacement during the long-term test.
- CO_2 Product Purity – Average purity of the CO_2 product from the capture system during the long-term testing.
- CO_2 Product Oxygen Concentration – Oxygen content of the CO_2 produced during the long-term testing.

Table 4. State-Point Data for Membrane-Based Systems

	Units	Measured Performance	Projected Performance
Materials Properties			
Material of Fabrication for Selective Layer	Name		
Material of Fabrication for Support Layer	Name		
Nominal Thickness of Selective Layer	mm		
Membrane Geometry			
Max Trans-Membrane Pressure	bar		
Time Tested Without Sig. Degradation	hr		
Membrane Performance			
Temperature	°C		
Pressure Standardized Flux for Permeate (CO_2)	GPU or equivalent		
CO_2/H_2O Selectivity			
CO_2/N_2 Selectivity			
Type of Measurement (ideal or mixed gas)			
Proposed Module Design			
Flow Arrangement			
Packing Density	m^2/m^3		
Shell-Side Fluid			
Testing Data			
Cumulative Total of Captured CO_2	kg CO_2		
Location			
The following information should be provided for the longest steady-state duration test performed.			
Scale	t CO_2/yr		
CO_2 Concentration in Feed Stream	%		
Consecutive Duration of Long-Term Test	hr		
Average CO_2 Capture Efficiency From Feed Air	%		
Starting CO_2 Capture Efficiency From Feed Air	%		
Ending CO_2 Capture Efficiency From Feed Air	%		
Membrane Performance Degradation	%/yr		
CO_2 Product Purity	mol % dry		
CO_2 Product Oxygen Concentration	mol % (or ppm)		
Membrane Feed Pressure*	psia		

Permeate Pressure*	psia	
Environmental Conditions (temperature, humidity, elevation/partial pressure, air flowrates, etc.)		

Definitions for Table 4:

- Membrane Geometry – Flat discs or sheets, hollow fibers, tubes, etc.
- Pressure Standardized Flux – For materials that display a linear dependence of flux on partial pressure differential, this is equivalent to the membrane's permeance.
- GPU – Gas permeation unit, which is equivalent to 10^{-6} $cm^3/(cm^2 \cdot s \cdot cmHg)$ at 1 atm and 0 °C. For nonlinear materials, the dimensional units reported shall be based on flux measured in $cm^3/(cm^2 \cdot s)$ (at 1 atm and 0 °C) with pressures measured in cm Hg. Note: 1 GPU = 3.3464×10^{-6} $kgmol/(m^2 \cdot s \cdot kPa)$ [SI units].
- Type of Measurement – Either mixed or pure gas measurements.
- Flow Arrangement – Typical gas-separation module designs include spiral-wound sheets, hollow-fiber bundles, shell and tube, and plate and frame, which result in either co-current, counter-current, or cross-flow arrangements, or some complex combination of these.
- Packing Density – Ratio of the active surface area of the membrane to the volume of the module.
- Shell-Side Fluid – Either the permeate or retentate stream.
- Details on Membrane Reactivation or Replacement – Include information about reactivation process and rates or membrane replacement during the long-term test.
- Starting CO_2 Capture Efficiency – Capture efficiency achieved in the first hour of long-term testing.
- Ending CO_2 Capture Efficiency – Capture efficiency achieved in the last hour of long-term testing.
- CO_2 Product Purity – Average purity of the CO_2 product from the capture system during the long-term testing.
- CO_2 Product Oxygen Concentration – Oxygen content of the CO_2 produced during the long-term testing.
- Membrane Feed Pressure – Pressure of gas fed to the membrane for separation during the long-term test. *Repeat this parameter for each stage of membrane used during the long-term test.
- Permeate Pressure – Pressure of the corresponding permeate of the membrane that accounts for the trans-membrane pressure drop and any vacuum used. *Repeat this parameter for each stage of membrane used during the long-term test.

Table 5. Electrochemical State Point Data Table

	Units	Measured Performance	Projected Performance
Reaction Thermodynamics			
Balanced Chemical Equations			
$\Delta H°_{rxn}$ (calculated from standard enthalpies of formation; at STP)	kJ/mol		
$\Delta G°_{rxn}$ (calculated from standard free energies of formation; at STP)	kJ/mol		
Cell Operating Conditions			
Nominal Cell Potential	V		
Nominal Current Density	mA/cm^2		
Nominal Power Density	mW/cm^2		
Nominal Operating Temperature	°C		
ΔT Across Cell	°C		
Operating Pressure	atm		
Cell/System Performance			
Fuel/Steam Utilization	%		
Air Utilization	%		
Degradation Rate	%/1000 hr		
Electrolyte	Name		
Electrolyte Concentration	mol/L		
Electrolyte Loss Rate	%/1000 hr		
Electricity Production (Fuel Cell)	kW		
Product Production (Electrolysis)	kg/h		
Electrical Efficiency (Fuel Cell)	%		
Faradaic Efficiency (Electrolysis)	%		
Membrane and Catalyst Properties			
Membrane Material(s)	Name		
Membrane Cost	$/m^2$		
Presence of PFAS in Supply Chain	Yes/no		
Anode Catalyst	Name		
Anode Catalyst Loading	g/cm^2		
Anode Catalyst Cost	$/g		
Cathode Catalyst	Name		

Cathode Catalyst Loading	g/cm^2		
Cathode Catalyst Cost	$/g		
The following information should be provided for the longest steady-state duration test performed.			
Scale	t CO_2/yr		
CO_2 Concentration in Feed Stream	%		
Consecutive Duration of Long-Term Test	hr		
Average CO_2 Capture Efficiency From Feed Air	%		
Starting CO_2 Capture Efficiency From Feed Air	%		
Ending CO_2 Capture Efficiency From Feed Air	%		
CO_2 Product Purity	mol % dry		
CO_2 Product Oxygen Concentration	mol % (or ppm)		
Environmental Conditions (temperature, humidity, elevation/partial pressure, air flowrates, etc.)			

Table 6. Synthesis of Value-Added Organic Products or Hydrogen Co-Production

	Units	Measured Performance	Projected Performance
Synthesis Pathway Steps[1]			
Balanced Chemical Equations			
Source of External Intermediate 1 (e.g., natural gas, oil, renewable energy, etc.)			
Source of External Intermediate n (add rows as needed)			
Reaction Thermodynamics[2,3]			
Type of Reaction[4]			
ΔH^{o}_{rxn} (calculated from standard enthalpies of formation; at STP)	kJ/mol		
ΔG^{o}_{rxn} (calculated from standard free energies of formation; at STP)	kJ/mol		
Conditions			
Catalyst[5]	Name		
Pressure	bar		
CO_2 Partial Pressure	bar		
Temperature	^{o}C		
Performance			
Nominal Residence Time[6]	s		
Selectivity to Desired Product[7]	%		
Product Composition[8]			
Desired Product	mol%		
Desirable Co-Products	mol%		
(Add rows as needed)	mol%		
Unwanted Byproducts	mol%		
(Add rows as needed)	mol%		
Grand Total	**mol%**	–	100%
Conventional Commercial Product Properties[9]			
U.S. Market Size	t/yr		
Global Market Size	t/yr		
Market Price	$/t		

Notes for Table 6:

[1] Balanced equations for each step in the synthesis pathway. Intermediates provided from external sources (e.g., ethane, methane, hydrogen, etc.) should be shown in **BOLD** type. Intermediates generated as part of the synthesis pathway should be in standard type.
[2] *STP* – Standard Temperature and Pressure (25°C, 1 atm).
[3] If Standard Enthalpies and Gibbs Free Energies of Formation cannot be found for some chemical species in the proposed chemical reaction(s), they should be estimated; however, *the method used must be clearly referenced or described*.
[4] Identify the type of reaction; for example, thermochemical, electrochemical, photochemical, etc.
[5] Identify the catalyst composition.
[6] Reactor residence times are difficult to quantify, especially early in any laboratory-scale development effort. Definitions vary based on whether the reaction is being carried out in a batch or continuous reactor and whether a homogeneous, heterogeneous, or no catalyst is being used. For the calculation of Nominal Residence Time, the competitor should use the following equations:
For experimental systems involving batch reactors:

{Nominal Residence Time} = {Length of Time Reactor is Operated}

For continuous reactors operated at steady state, employing a solid catalyst:

{Nominal Residence Time} = {Mass of Catalyst in Reactor} / {Total Mass Flowrate into Reactor}

For continuous reactors operated at steady state, employing a homogenous or no catalyst:

{Nominal Residence Time} = {Volume of Reactor} / {Total Volume Flowrate into Reactor}

[7] Selectivity to Desired Product is the fraction of the carbon in the Desired Product (see definition below) to the total amount of available carbon reacted, expressed as mole-percent.
[8] Competitors should define the primary product of interest. Normally, this is either the highest value or largest volume compound or material produced. Desirable co-products are any other reaction products of sufficient value that they would be profitable for the producer to recover, purify, transport, and market. Whether to maximize or minimize production of these co-products is an economic decision. Unwanted byproducts are produced from undesired side reactions, which may result from system upsets or may be an unavoidable consequence of the current state of technology development.
[9] Commercial Product Properties are the properties of the current commercial product that the proposed technology plans to produce or compete against.

Table 7. Production of Inorganic Materials (e.g., solid carbon products, minerals)

	Units	Measured Performance	Projected Performance
Reaction Thermodynamics[1,2]			
Reaction Type[3]			
Balanced Chemical Equations			
$\Delta H°_{rxn}$ (calculated from standard enthalpies of formation; at STP)	kJ/mol		
$\Delta G°_{rxn}$ (calculated from standard free energies of formation; at STP)	kJ/mol		
Reaction Conditions			
Catalyst[4]	Name		
Pressure	bar		
CO_2 Partial Pressure	bar		
Temperature	°C		
Nominal Residence Time[5]	s		
Once-Through Performance[6]			
CO_2 Conversion[7]	%		
Selectivity to Desired Product[8]	%		
Yield of Desired Product[9]	%		
Product Composition			
Desired Product[10]	name		
Main Product Impurities[11]	name		
Purity of Finished Product[12]	%		
Product Production[13]	kg/hr		
Co-Products[14]	name		
Co-Product Production[15]	kg/hr		
Product Properties[16]			
Density	kg/m^3		
Particle Size	micron		
Surface Area	m^2/g		
Conventional Commercial Product Properties[17]			

Density	kg/m^3		
Particle Size	Micron		
Surface Area	m^2/g		
U.S. Market Size	t/yr		
Global Market Size	t/yr		
Average Market Price	$/t		

Notes for Table 7:

[1] STP – Standard Temperature and Pressure (25°C, 1 atm).
[2] If Standard Enthalpies and Gibbs Free Energies of Formation cannot be found for some chemical species in the proposed chemical reaction(s), they should be estimated; however, the method used must be clearly referenced or described.
[3] Identify the type of reaction; for example, thermochemical, electrochemical, photochemical, etc.
[4] Identify the catalyst composition.
[5] For the calculation of Nominal Residence Time, the competitor should use the following equations:
For experimental systems involving batch reactors:

{Nominal Residence Time} = {Length of Time Reactor is Operated}

For continuous reactors operated at steady state, employing a solid catalyst:

{Nominal Residence Time} = {Mass of Catalyst in Reactor} / {Total Mass Flowrate into Reactor}

For continuous reactors operated at steady state, employing a homogenous or no catalyst:

{Nominal Residence Time} = {Volume of Reactor} / {Total Volume Flowrate into Reactor}

[6] Once-Through Performance should be reported for the reaction(s) based on moles of CO_2 in the feed.
[7] CO_2 Conversion is the quotient of the CO_2 reacted to the initial CO_2 in the feed, expressed as mole-percent.

CO_2 Conversion =100 x (moles CO_2 reacted) / (moles CO_2 in feed)

[8] Selectivity to Desired Product (as defined below) is the quotient of the moles of carbon from CO_2 in the Desired Product to the moles of CO_2 reacted, expressed as mole-percent.
Selectivity to Desired Product =100 x (moles of carbon from CO_2 in Desired Product) / (mols CO_2 reacted).
[9] Yield of Desired Product = (CO_2 Conversion) × (Selectivity to Desired Product) / 100.
[10] Identify the desired product, for example, graphene, carbon nanotubes, carbon black, etc. finished, commercial carbon products are defined by the performance specifications required for their specific uses. As used here, the term 'Desired Product' refers to the morphology of the carbon: nanotubes, graphene or graphitic sheets or flakes, etc., and does not include impurities left in the finished product.
[11] Identify the main product impurities (for example, byproducts, contaminants, etc.) that are not separated from the finished product.
[12] Purity of Desired Product = (mass of the desired product) / (Total mass of the finished product), where the 'Total mass of the product' is the mass of the desired product plus the mass of the product impurities or contaminants.
[13] Product Production is the mass flowrate of the desired product produced during the proposed testing.
[14] List the main co-product, if applicable.
[15] Co-Product Production is the mass flowrate of the co-product produced during the proposed testing.
[16] Product Properties are the properties of the desired product produced during testing.
[17] Commercial Product Properties are the properties of the commercial product that the finished product of the proposed technology plans to produce or compete against.

Table 8. Production of Inorganic Materials: Concrete and Cement

	Units	Measured Performance	Projected Performance
Reaction Thermodynamics[1,2]			
Balanced Chemical Equations			
$\Delta H°_{rxn}$ (calculated from standard enthalpies of formation; at STP)	kJ/mol		
$\Delta G°_{rxn}$ (calculated from standard free energies of formation; at STP)	kJ/mol		
Reaction Conditions			
Pressure	bar		
CO_2 Partial Pressure	bar		
Temperature	°C		
Nominal Residence Time[3]	s		
Alkaline Reactant Source[4]	Name		
Process Route[5]	Direct/ indirect		
Once-Through Performance[6]			
CO_2 Conversion[7]	%		
CO_2 Uptake Potential[8]	g CO_2/g material		
CO_2 Uptake Actual[9]	g CO_2/g material		
Product Properties[10]			
Desired Product	Name		
Compressive Strength[11]	MPa		
Density	kg/m^3		
Product Production	kg/hr		
Conventional Commercial Product Properties[12]			
Commercial Product	Name		
Compressive Strength[13]	MPa		
Density	kg/m^3		
U.S. Market Size	t/yr		
Global Market Size	t/yr		
Average Market Price	$/t		

Notes for Table 8:

[1] STP – Standard Temperature and Pressure (25°C, 1 atm).
[2] If Standard Enthalpies and Gibbs Free Energies of Formation cannot be found for some chemical species in the proposed chemical reaction(s), they should be estimated; however, the method used must be clearly referenced or described.
[3] For the calculation of Nominal Residence Time, the competitor should use the following equations:
For experimental systems involving batch reactors:

{Nominal Residence Time} = {Length of Time Reactor is Operated}

For continuous reactors operated at steady state, employing a solid catalyst:

{Nominal Residence Time} = {Mass of Catalyst in Reactor} / {Total Mass Flowrate into Reactor}

For continuous reactors operated at steady state, employing a homogenous or no catalyst:

{Nominal Residence Time} = {Volume of Reactor} / {Total Volume Flowrate into Reactor}

[4] Identify the Alkaline Reactant Source; for example, fly ash, slags, mine tailings, etc.
[5] Process Route: Identify the process as direct (carbonation of the feed occurs as a single step without extraction or dissolution of the mineral ions) or indirect (extraction or dissolution of mineral ions from the feed occurs in a separate step before carbonation).
[6] Once-Through Performance should be reported for the reaction(s) based on moles of CO_2 in the feed.
[7] CO_2 Conversion is the quotient of the CO_2 reacted to the initial CO_2 in the feed, expressed as mole-percent.

CO_2 Conversion =100 x (moles CO_2 reacted) / (moles CO_2 in feed)

[8] CO_2 Uptake Potential is the mass of CO_2 that can theoretically be reacted per mass of the unreacted material that produces the final product after carbonation.
[9] CO_2 Uptake Actual is the actual mass of CO_2 reacted per mass of the unreacted material that produces the final product after carbonation.
[10] Product Properties are the properties of the desired product produced during testing.
[11] Compressive strength following 28 days of aging.
[12] Commercial Product Properties are the properties of the current commercial product that the proposed technology plans to produce or compete against.

Appendix 4: Life Cycle Assessment (LCA) Guidance

Life cycle assessment (LCA) is a framework for holistically evaluating the environmental impacts of products and processes throughout their entire life cycles, from extraction of raw materials through their end-of-life. LCA translates inputs from and outputs to the environment (to and from air, water, and land) into a variety of environmental indicators that characterize the product or process's effects on metrics ranging from climate change to human health. LCA requirements for this prize are shown in the table below.

Phase 1 (Concept) Submission	Phase 2 (Engineer) Submission	Phase 4 (Operate) Submission
Preliminary LCA	Reference Plant LCA	Operating LCA

Competitors are required to submit a preliminary LCA in Phase 1, a reference plant LCA in Phase 2, and an operating LCA in Phase 4. These materials should be submitted in written form with corresponding figures but may be based on external modeling performed in spreadsheet software, LCA software, or comparable tool.

The different LCAs for each phase have varying expectations, as detailed below. Submitted analysis will be used by DOE to assess the potential for the proposed DAC technology to durably contribute to negative emissions or emissions reduction, depending on whether the CO_2 captured by the DAC facilities at scale will ultimately be stored, utilized in a long-lived product, or utilized in a short-lived product.

Competitors are encouraged to review the LCA reference materials listed at the end of this appendix for further guidance on conducting high-quality LCAs. It is critical that qualified personnel with professional experience in performing this type of work conduct the LCAs. This activity shall not be viewed as a training exercise.

Phase 1: Preliminary LCA

The preliminary LCA is intended to provide an overview of emissions considerations for the proposed DAC technology. If quantitative data are not available, the competitor should provide qualitative discussion. Competitors should also highlight any major uncertainties, along with their plan to address these uncertainties in the next phase of the prize.

The following items should be analyzed and discussed as applicable in the preliminary LCA:

- High-level CO_2 balance of the proposed process, considering emissions from major inputs such as materials, energy, transportation, equipment, land-use change, waste disposal, and other utilities
- Planned sources of energy (electricity and heat) with corresponding emissions analysis and discussion of low-carbon energy procurement strategy
- Intended disposition at scale of the captured CO_2 via storage or utilization
- Co-products/byproducts produced by the process
- Potential co-benefits such as reduction in criteria air pollutants (CAPs)
- Potential non-GHG environmental impacts from the process and mitigation strategies
- Extent to which technical advances will help reduce overall process emissions.

Phase 2: Reference Plant LCA

In Phase 2, competitors must provide a GHG emissions-focused LCA for a reference DAC plant using their proposed technology and assuming gross capture of 100,000 tonnes per year as well as ample access to storage or utilization. The LCA must be as consistent as possible with all other aspects of the competitor's submission.

The reference plant LCA will be made public with several other parts of the Phase 2 submission to increase transparency and provide the public with valuable reference materials. Competitors should therefore redact or otherwise conceal any input data they would prefer to remain confidential, although this kind of data (e.g., sorbent composition) should be accessible to reviewers in separate, non-public aspects of the submission to allow for a complete evaluation of the LCA.

The required elements of the reference plant LCA include the following.

1. Block flow diagram (BFD) identifying all major process steps, inputs, and outputs with a visual representation of the system boundary used for the LCA
2. Thorough description of all process steps, inputs, and outputs
3. Discussion of GHG emissions contributions from all inputs listed below with particular emphasis on the energy procurement strategy
4. Calculation and disclosure of GHG emissions per gross tonne of CO_2 captured using IPCC AR6 global warming potentials across requested GWP and electricity scenarios with a visualized breakdown by input
5. Discussion of CO_2 utilization or storage approach and allocation of post-decommissioning GHG emissions if applicable
6. Discussion of uncertainty and key model sensitivities
7. Plan for GHG emissions reduction over time and at larger scales.

The following inputs should receive specific coverage in the LCA as applicable using the most up-to-date and geographically representative LCA data possible:

- Materials/feedstocks (including sorbent/solvent replenishment)
- Transportation of materials/feedstocks
- CO_2 purification, transportation, and storage
- Energy
- Non-energy utility needs, including water, nitrogen, compressed air, etc.
- Waste management
- Capital equipment, including equipment replacement over project lifetime
- Direct and indirect land-use change
- Any other major emissions drivers unique to the competitor's circumstances.

All sources (e.g., ecoinvent, USLCI) and estimation assumptions for emissions factors should be disclosed to a reasonable extent.

Emissions from one-time and upfront inputs, such as capital equipment and facility construction, may be distributed across the expected lifetime of the project for the purposes of this exercise. Inputs that contribute negligible emissions may be excluded with justification.

The functional unit of the LCA must be mass of CO_2 captured from the atmosphere with a reference flow of one gross tonne of CO_2 captured from the atmosphere. Competitors must calculate and disclose a climate change midpoint indicator of kilograms of CO_2 equivalent per gross tonne of CO_2 captured from the atmosphere. This indicator should model emissions using a cradle-to-grave system boundary to the extent possible, which includes raw material sourcing, project operation, end-of-life decommissioning, and subsequent storage monitoring.

It is permitted for competitors to propose and model processes intending to utilize the CO_2 captured via DAC via direct use, separate conversion, or conversion integrated as part of the DAC process (known as reactive carbon capture). In such cases, calculation of the climate change midpoint indicator described above is still required, although further analysis calculating the emissions reductions generated by the system relative to a conventional reference case is required.

Competitors should use average global warming potential (GWP) values from the Sixth Assessment Report (AR6) published by the Intergovernmental Panel on Climate Change (IPCC). Results using GWP-100 factors must be reported by default, and results using GWP-20 factors must also be provided as a scenario. See the table below for common GWP factors to use and refer to EPA's IPCC GWP tracker on Data.gov for a full list. The prize administrator and reviewers reserve the right to apply alternative and updated GWP values during the review period.

GHG	AR6 GWP-100 (Default)	AR6 GWP-20 (Scenario)
CO_2	1.0	1.0
Fossil CH_4	29.8	82.5
Non-Fossil CH_4	27.0	79.7
N_2O	273.0	273.0
SF_6	25,200	18,300
CFC-11	6,226.0	8,321.0

Processes intending to use any amount of grid-based electricity must model results using at least the following scenarios:

- Regional grid mix in project location using EPA eGRID territory and emissions data
- Current average U.S. grid mix as specified in EPA eGRID
- 100% renewables mix (using current emissions factors for renewable sources)
- 100% unabated coal.

For processes using thermal energy from natural gas, biomass-powered heat, waste heat, or some other heat source, competitors must describe the source, availability, and corresponding process, sustainability, and scalability implications. Transportation energy sources (e.g., diesel) can be modeled with other energy sources or separately as transportation-specific contributors, and competitors are free to model and provide the impacts of different transportation energy scenarios (e.g., electrified trucking) as long as a baseline assumption of representative conditions is provided.

Competitors must fully describe their energy procurement strategy in addition to the intended use of any attributes, certificates, or similar instruments, including renewable energy certificates (RECs), power purchase agreements (PPAs), and renewable natural gas (RNG) certificates. Any use of behind-the-meter (BTM) power, book-and-claim systems, and 24/7 carbon-free energy (CFE) through temporal and geographic matching must be clearly disclosed.

Some DAC processes produce valuable co-products/byproducts. Conventional LCA impact allocation rules may be used to allocate overall process emissions between the primary capture activity and co-products/byproducts. In some cases, co-products/byproducts may have lower emissions than their conventional counterparts after allocation. Corresponding emissions reductions, if present, may be quantified and reported as part of the LCA but must be separated from the emissions quantification for the primary capture activity. The prize administrator and reviewers reserve the right to apply alternative impact allocation methods during the review period, and competitors are encouraged to apply such procedures conservatively.

Phase 4: Operating LCA

In Phase 4, competitors must adapt their LCA provided in Phase 2 with actual operational data from the constructed facility's first year of operation inclusive of any realized storage or utilization approaches. This update must be as representative as possible of real conditions of the facility, including factors such as observed degradation rates, energy sources, equipment mass, input transportation distances, etc. Emissions factors from LCA databases, literature, etc. should still be used unless there are more precise values available from suppliers. Except for use of operating data in place of a reference plant, all other requirements outlined for the Phase 2 LCA apply to the Phase 4 LCA.

While the true plant conditions must be used for the baseline assessment, scenario modeling of different energy sources, storage options, etc. is permitted.

Reference LCA Materials

Competitors may refer to the below resources for general guidance on conducting LCAs.

- NETL Carbon Dioxide Utilization Life Cycle Analysis Guidance
- NETL CO2U LCA Guidance Toolkit
- FECM Best Practices for Life Cycle Assessment (LCA) of Direct Air Capture with Storage (DACS)
- ISO 14040 and ISO 14044
- ILCD Handbook General Guide for Life Cycle Assessment
- Global CO_2 Initiative Techno-Economic Assessment & Life Cycle Assessment Guidelines for CO_2 Utilization
- AssessCCUS LCA Resources.

Appendix 5: EH&S Risk Assessment Guidance

Phase 2 (Engineer) submissions must include an environmental, health, and safety (EH&S) risk assessment.

The purpose of the EH&S activity is to assess the environmental safety of any future process based on the materials and process being proposed under this DOE prize. For example, EH&S is a major concern for solvents in use today, and exposure to nanoparticles is also coming under increasing scrutiny by the U.S. Environmental Protection Agency (EPA), National Institute for Occupational Safety and Health (NIOSH), and others. The EH&S risk assessments shall be conducted by qualified and experienced organizations and professionals (e.g., environmental scientists, industrial hygienists, safety engineers).

Required elements for the EH&S Assessment are:

1. All potential ancillary or incidental air and water emissions and solid wastes produced from the proposed technology shall be identified and their magnitude estimated. In addition to solvents or sorbents used, researchers shall consider possible byproducts of side reactions that might also occur in the system, accumulated waste products, and the fate of contaminants from the feed gas stream. Environmental degradation products shall be addressed. Bioaccumulation, soil mobility, and degradability shall be considered. Conditions at the point of discharge shall be examined.
2. If possible, a concise but complete and comprehensible description of the various toxicological effects of the substances identified in (1) above shall be provided. A thorough literature search shall be conducted to examine potential human health effects and ecotoxicity. Where information is lacking for a particular material, it shall be compared to similar substances or classes of substances.
3. Properties related to volatility, flammability, explosivity, other chemical reactivity, and corrosivity shall also be collected from existing databases or if necessary, through direct measurement in cases where the substance is not in common use.
4. The compliance and regulatory implications of the proposed technology shall be addressed with reference to applicable U.S. EH&S laws and associated standards, including, but not limited to, the Comprehensive Environmental Response and Liability Act of 1980 (CERCLA), Toxic Substances Control Act (TSCA), Clean Water Act (CWA), Clean Air Act (CAA), Superfund Amendments and Reauthorization Act (SARA) Title III, and the Occupational Safety and Health Act (OSHA).
5. An engineering analysis shall be conducted for any potentially hazardous materials identified to look for ways their use can be eliminated or minimized. Less-hazardous materials should be substituted where possible. For any new materials being proposed, synthetic options shall be examined that may lead to similar, less-hazardous compounds with the required functionality. Possible engineering controls and other mitigation strategies shall be described as appropriate.
6. Precautions for safe handling and conditions for safe storage shall be identified, including any incompatibilities with other materials that may be used in the process. Waste treatment and off-site disposal options shall be examined. Accidental release measures shall also be discussed.

Appendix 6: Energy Data eXchange (EDX) Requirements

DOE is required to improve access to federally funded research results, proper archiving of digital data, and expanded discovery and reuse of research datasets per DOE and executive orders. The Energy Data eXchange (EDX) is a data laboratory developed and maintained by NETL to find, connect, curate, use, and reuse data to advance fossil energy and environmental research and development (R&D).

EDX uses federation and web services to elevate visibility for publicly approved assets in the system, including connections with DOE's Office of Scientific and Technical Information (OSTI) systems, Data.gov, and Re3Data. This ensures compliance with federal requirements, while raising visibility for researcher's published data products to promote discoverability and reuse.

EDX supports a wide variety of file types and formats, including: (1) data, (2) metadata, (3) software/tools, and (4) articles (provided that there is an accompanying Government use license). A partial list of file formats accepted by EDX is provided below; however, EDX is designed for flexibility and accepts all types of file formats.

- Common data product submission formats: ASC, AmiraMesh, AVI, CAD, CSV, DAT, DBF, DOC, DSV, DWG, GIF, HDF, HTML, JPEG2000, JPG, MOV, MPEG4, MSH/CAS/DAT, NetCDF, PDF, PNG, PostScript, PPT, RTF, Surface, TAB, TIFF, TIFF Stacks, TXT, XLS, XML, ,Xradio, ZIP, and others.
- Geographic formats: APR, DBF, DEM, DLG, DRG, DXF, E00, ECW, GDB, GeoPDF, GeoTIFF, GML, GPX, GRID, IMG, KML, KMZ, MDB, MrSID, SHP, and others.

Information provided to EDX will be made publicly available. Additional information on EDX is available at https://edx.netl.doe.gov/about.

When data products are submitted to EDX, the data product will need to be registered with a digital object identifier (DOI) through OSTI to ensure more visibility in other search repositories (i.e., osti.gov, data.gov, Google Scholar, etc.). The OSTI DOI can be established through an application programming interface (API) by completing just a few additional fields.

Appendix 7: D&D Community Benefits Plan

Competitor should insert here:

Project title and team name

Company, organization, or institution name

City, state, and nine-digit ZIP code

Instructions for Use of this Template:

The purpose of this document is to summarize the **specific** objectives the team is committing to in its Community Benefits Plan (CBP).

Important information about using this template:

- **The instructional textboxes within each section can be removed when submitting the application. The information below the instructional textboxes is intended to provide examples of commitments that may be relevant to each section, proposed project, or program. Not all information provided may apply.**

- **All information included in this CBP Template must be consistent with other parts of the application.** The CBP should accurately define the work that is planned and the progress that will be expected throughout the project to be achieved.

- **Wherever possible, the objectives laid out in the CBP should be in quantifiable terms with SMART milestones: S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imely – and include timelines. The Community Benefits Plan may include multiple milestones and should have at least one SMART end of project goal.

- The information provided in the Community Benefits Objectives and Outcomes (CBOO) summary table in the final section should be consistent with the commitments made throughout the CBP Template and broader submission package.

- By submitting this form, the competitor acknowledges and agrees that the information provided may be distributed or made publicly available, without any restrictions or obligations to maintain confidentiality, as required by applicable laws, rules, and regulations. If the competitor wishes to protect proprietary or trade secret information submitted with this CBP Template, every line and paragraph containing such information must be clearly marked as "CONFIDENTIAL" and designated with double brackets or highlighting to indicate the confidential information.

A. Definitions

Throughout this document, certain terms are used regularly. Please refer to the definitions below for these commonly used terms and apply them throughout.

Underrepresented

"Underrepresented" refers to populations sharing a particular characteristic, as well as geographic communities, that are shown to have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life, as exemplified by communities that have been denied fair, just, and impartial treatment, which may include Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; persons otherwise adversely affected by persistent poverty or inequality; women; and veterans.

Justice40 Initiative and disadvantaged communities

Established by Executive Order 14008 on *Tackling the Climate Crisis at Home and Abroad*, the Justice40 Initiative sets a goal that 40% of the overall benefits of certain federal investments in climate, clean energy, and other areas flow to "disadvantaged communities" that are marginalized by underinvestment and overburdened by pollution. Pursuant to M-21-28 and M-23-09, issued by the White House Office of Management and Budget, White House Council on Environmental Quality, and White House Office of Domestic Climate Policy, DOE recognizes disadvantaged communities as the census tracts that are identified as disadvantaged by the White House Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST), as well as all Federally Recognized Tribes. For information about whether a particular DOE program is covered under the Justice40 Initiative, please see DOE's Justice40 Initiative webpage.

Community Benefits Agreement

Community Benefits Agreements are legally binding, enforceable agreements between a developer and affected community groups detailing the benefits provided to the community in return for support or non-opposition to a development project. They are an emerging tool for communities to win protections, investments, and benefits related to energy and infrastructure projects.

Captive Audience Meetings

Captive audience meetings refer to the practice among employers of meeting with employees during union organizing campaigns to express the employer's view of the possible negative effects that unionizing may have on the general workforce. Some employers have structured such meetings as mandatory and held them on company property during working hours.

Minority-Serving Institution

Minority-Serving Institution is defined in 7 CFR § 3430.302.

Project Labor Agreement

A project labor agreement is a pre-hire collective bargaining agreement consistent with section 8(f) of the National Labor Relations Act (29 U.S.C. 158(f)).

Collective Bargaining Agreement

A collective bargaining agreement is an agreement that is consistent with the National Labor Relations Act (29 U.S.C. 151 et seq.).

B. General Project Information

Instructions: This section asks for the competitor to provide general information on the project, including a high-level description of the CBP and how it integrates with the project, including critical information on the construction components, identification of potential risks, and the locations and communities affected. The competitor should also provide a description of all parties involved, including community representatives and project personnel overseeing the CBP, their qualifications, and time allocated for the activities proposed.

1. High-level description of the CBP and project

Please provide a 2-3 sentence description here. Competitors should also describe community support and/or opposition for the project, if applicable.

2. Construction Information

For the planned project location identified in the Phase One submission, **please address each of the following:**

a. Any known construction risks that could cause delays to the schedule, such as availability of skilled workers, permitting delays, materials or supply delays, etc.:
b. Potential public health and safety risks and hazards associated with construction:
c. Potential worker health and safety risk and hazards associated with construction:
d. Known possibilities of labor disruption:
e. Plans for coordination among various employers (i.e., prime contractors and subcontractors):
f. Plans for resolution mechanism to avoid potential labor delays (including issues that may arise among contractors and subcontractors as well as employees):
g. The general contractor or Engineering, Procurement, and Construction (EPC) contractor, if known:
h. The primary business of the general contractor or EPC contractor:

3. Locations and Communities Affected

For the planned project location identified in the Phase One submission, **please identify each known location served or impacted by the project, including:**

a. The location(s) of construction activity or facility
b. Communities geographically near the Applicant's proposed project:
c. Communities that are part of the proposed project's supply or waste life cycle (e.g., where raw materials are being sourced and where waste is planned to be sent):
d. Communities impacted that are disadvantaged communities:

Instructions for Sections B through E:

Sections B through E below should summarize the specific objectives the competitor is committing to, broken into specific commitments and tasks.

Wherever possible and relevant, each commitment or task should be stated in quantifiable or measurable terms, and SMART (**S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imely) milestones with timelines should be identified. The CBP may include multiple milestones but should have at least one SMART milestone per budget period, as well as one SMART end of project goal.

As permitted by prevailing law, milestones will be incorporated into the CBOO.

C. Community and Labor Engagement

Instructions: This section should describe the specific stakeholders and organizations already engaged by the project. Examples include—but are not limited to—local governments (town, county, etc.), Tribal governments, labor unions, economic development agencies, land grants and university extensions, community colleges and workforce training organizations, local non-profits, school boards, and community-based organizations that support or work with disadvantaged communities.

The section should specifically describe how any agreements with stakeholders or other entities engage disadvantaged communities and/or underrepresented groups.

Although Tribal governments are included in this section on community and labor stakeholders, American Indian and Alaska Native Tribal Nations have rights as sovereign governments recognized under the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. Applicants should identify specific Tribes potentially impacted by future development early and engage with potentially impacted Tribes to share information on the project and understand concerns, including those related to their reserved rights, sacred sites, resources, as well as explore opportunities to provide benefits to Tribes through community benefit or other wealth-building agreements or opportunities. This engagement is not a substitute for government-to-government consultation.

If the project has received support from any of these entities, describe the nature of the support (e.g., verbal, written, financial, etc.) and commitments that the project has made to the organization that provided the support. In Phase Four, competitors will be required to report on these activities.

1. **Community and Labor Stakeholders Engaged to Date**

[Example]

Name of Organization or Community of Interest Already Engaged:

Type of Engagement (e.g., Meeting, Community-Engaged Project Development, Research & Design, Reporting, Project Decision-Making, Community Input, Reporting Back, Technical Assistance, Other):

- Was a third-party facilitator used?

Date of Engagement:

Outcome of Engagement (e.g., Memorandums of Understanding, Letters of Support, concerns or opposition, ongoing discussion, survey data or other qualitative/quantitative data, formal documentation for how the outcomes of engagement will be implemented throughout the life cycle of a project, other):

2. Community and Labor Stakeholders To Be Engaged.

Instructions: This section should list stakeholders that the project plans to engage. Examples include—but are not limited to—local governments (town, county, etc.), Tribal governments, labor unions, economic development agencies, land grants and university extensions, community colleges and workforce training organizations, local non-profits, school boards, and community-based organizations that support or work with disadvantaged communities.

In Phase Four, competitors will be required to report on these activities.

[Example]

Name of Organization or Community of Interest Engaged:

Type of Engagement (e.g., Meeting, Community-Engaged Project Development, Research & Design, Reporting, Project Decision-Making, Community Input, Reporting Back, Technical Assistance, Other):

- Was a third-party facilitator used?

Frequency of Engagement:

Outcome of Engagement (e.g., Memorandums of Understanding, Letters of Support, concerns or opposition, ongoing discussion, survey data or other qualitative/quantitative data, formal documentation for how the outcomes of engagement will be implemented throughout the life cycle of a project, other):

3. Workforce and Community Agreements

Instructions: This section should identify whether the competitor is committing to negotiate workforce and/or community agreements and what type of agreements the competitor is committing to negotiate. The competitor should note that a Workforce Continuity Plan may be required and should refer to the CBP webpage to see frequently asked questions and answers. If the competitor has no entries for this section, continue to Section 4 below.

A non-exhaustive list of relevant optional examples of workforce and community agreements are listed below. The Applicant should modify, add, or delete to reflect the specific agreements committed to. If negotiating multiple agreements, provide this detail for each agreement.

For each agreement:

- The summary should describe the intended parties to the agreement and the intended scope of the agreement in concrete and specific terms.
- List key tasks and sub-tasks involved in finalizing the agreement (milestones), with associated budget periods.
- Explain, where relevant, any benefits for residents of disadvantaged communities, or underrepresented groups.

[Example]

Agreement A: Good Neighbor Agreement or Community Benefits Agreement

Agreement Summary:

Examples of intended scope (benefits vary per community, examples below)

The community benefits to be delivered, including those for disadvantaged communities (as discussed in the Justice40 section that follows)

i. Access to jobs and business opportunities for residents of disadvantaged communities and/or underrepresented workers
ii. Investments in training for local residents, residents of disadvantaged communities, and/or underrepresented workers
iii. Commitments to make investments in subsidies for caregiving (e.g., childcare subsidies) and/or in transportation services for workers to access to the worksite
iv. Access to local educational programs, electricity discounts, critical services, and associated grants
v. Commitments to make investments in a community-controlled fund to address community development and other needs identified by the community.
vi. Community steering committee/community governance structure
vii. Environmental, wealth-building, local energy, and other benefits identified by the community (this section can reference information provided in Section E below)
viii. Remedies for non-compliance

ix. Other: [Describe].

Phase to be completed:

Milestones with timelines:

[Example]

Agreement B: Collective Bargaining Agreement (pertains to non-construction work)

Agreement Summary:

Examples of intended scope include:

i. Access to jobs for local residents, residents of disadvantaged communities, and/ or underrepresented workers
ii. Training and career progression, including for local residents or underrepresented workers
iii. Wages, hours, and working conditions
iv. Guarantees against strikes, lockouts, and similar job disruptions
v. Effective, prompt, and mutually binding procedures for resolving labor disputes arising during the term of the agreement
vi. Mechanisms for labor-management cooperation on matters of mutual interest and concern, including productivity, quality of work, safety, and health
vii. Utilization of registered apprentices
viii. Other: [Describe].

Phase to be completed:

Milestones with timelines:

[Example]

Agreement C: Community Workforce Agreement

Agreement Summary:

Example of intended scope include:

i. Access to jobs and business opportunities for local residents, disadvantaged communities, and/or underrepresented workers
ii. Investments in training for local residents, residents of disadvantaged communities, and/or underrepresented workers (e.g., support of registered apprenticeship and pre-apprenticeship programs, contributions to training institutions to assist in the provision of workforce training)
iii. Commitments to make investments in subsidies for caregiving (e.g., childcare subsidies) and/or in transportation services for workers to access the worksite

iv. Commitments to make investments in a community-controlled fund for community development
v. Commitments to pay upper quartile wages and benefits for the industry
vi. Broad recruitment activities, particularly with strategies to reach disadvantaged communities or workers from underrepresented groups
vii. Other: [Describe].

[Example]

Agreement D: Project Labor Agreement or Community Workforce Agreement (pertains to construction work)

Agreement Summary:

Examples of intended scope include:

i. Access to jobs for local or underrepresented workers or residents of disadvantaged communities
ii. Investments in training for local or underrepresented workers and/or residents of disadvantaged communities
iii. Commitments to pay wages and benefits above required prevailing rates for construction
iv. Guarantees against strikes, lockouts, and similar job disruptions
v. Effective, prompt, and mutually binding procedures for resolving labor disputes arising during the term of the agreement
vi. Provide mechanisms for labor-management cooperation on matters of mutual interest and concern, including productivity, quality of work, safety, and health
vii. Utilization of registered apprentices and pre-apprenticeship programs
viii. Other: [Describe].

Phase to be completed:

Milestones with timelines:

[Example]

Agreement E: Other Type of Agreement

Agreement Summary:

Examples of Intended Scope:

i. Access to wealth-building opportunities, jobs and other benefits
ii. Tribal ownership
iii. Commitment to Tribal hire
iv. Commitment to Tribal revenue-sharing
v. Energy and electricity benefits
vi. Commitment to use Tribal monitors

vii. Other.

Phase to be completed:

Milestones with timelines:

4. Other Community and Labor Engagement Goals, Commitments, and Milestones

Instructions: This section should describe any additional key goals and milestones.

If the competitor is not, at this stage, committing to negotiate any workforce or community agreements, this section should describe the overall goal of community and labor engagement and key milestones, with timelines, that will be used to monitor progress toward successful community and labor engagement.

D. Investing in Quality Jobs

1. Worker Organizing and Collective Bargaining

Instructions: If the competitor plans to support worker organizing and collective bargaining beyond their legal obligations consistent with the National Labor Relations Act, those commitments should be listed below.

The competitor should add or delete commitments to reflect their specific plan.

Please describe the plan to support worker organizing and collective bargaining related to the following commitments:

[Examples]

Commitment C1.1: Commitment to negotiate a Project Labor Agreement (PLA) for construction activity (as summarized above in Section B)

Commitment C1.2: Pledge to remain neutral during any union organizing campaigns

Commitment C1.3: Intention or willingness to permit union recognition through card check (as opposed to requiring union elections)

Commitment C1.4: Intention to enter into binding arbitration to settle first contracts

Commitment C1.5: Pledge to allow union organizers access to appropriate onsite non-work spaces (e.g., lunchrooms)

Commitment C1.6: Pledge to refrain from holding captive audience meetings[23]

Commitment C1.7: Other commitments or pledges:

[23] "Captive audience" meetings refer to the practice among employers of meeting with employees during union organizing campaigns to express the employer's view of the possible negative effects that unionizing may have on the general workforce. Some employers have structured such meetings as mandatory and held them on company property during working hours.

2. Union support

Please list any unions supporting the project and any commitments made to unions that are not listed above in C1.

3. Job Quality and Workforce Continuity

Instructions: This section should stipulate commitments made regarding wages and benefits, education and training investments, and involvement of workers in health and safety committees. These commitments may also be covered by workforce agreements described in Section B.

The competitor should add or delete commitments, provide quantitative values where appropriate, and re-number appropriately to reflect their specific plan.

Prize winners will be required to report on job creation, wages, and benefits.

Please note that (a) pertains to ongoing operations and production jobs and (b) pertains to construction jobs.

Please describe the competitor's plan to ensure that jobs created by this project are good quality, to attract and retain a skilled workforce, including the following commitments to wages and benefits, education and training investments, and worker involvement in health and safety:

a. Ongoing Operations and Production Jobs

[Examples]

Commitment C3a.1: Competitor will provide above-average wages and benefits, benchmarked to industry and occupation reported by the Bureau of Labor Statistics (BLS):

The minimum starting wage for production workers is $_____ per hour compared to the [75th or 90th] percentile of $____per hour for the [_____] industry.

- The minimum value of the following benefits offered to hourly workers is:
  - Health insurance: $_____ per ___
  - Retirement contributions: $_____ per ___
  - PTO: ____hours per _____
  - Paid sick or family leave: _____ days per _____
  - Childcare or other caregiving financial assistance: $_____per worker or provision of on-/near-site care
  - Transportation assistance: $ _____per worker_
  - Education/tuition reimbursement or financial contribution: $_____
  - Other: $_____per worker___.

Commitment C3a.2: The competitor will provide workforce education and training through:

- Establishment of or contribution to labor-management training partnership(s)[24]
- [Insert minimum number of hours per worker] hours of paid on-the-job training

[24] For more information on labor-management partnership, see the Department of Labor's Know Your Rights Toolkit.

- Sponsoring registered apprenticeships: [insert goal number of apprentices]
- Covering costs and paid time for professional development and continuing education: [Enter certifications]
- Other:

Commitment C3a.3: The competitor will ensure hourly production workers are engaged in the design and implementation of workplace safety and health plans. Specifics include:

- [insert number of hourly workers] will participate in health and safety committee and will be paid [insert time and rate paid] for their time participating.
- Indicate which of the following, if any, the training provided will include:
    - Worksite safety analysis
    - Hazard prevention and control
    - Safety and health training
    - Anti-harassment and bystander intervention training
    - Other: [Describe].
- Indicate the frequency of these health and safety committee planning meetings will be held.
- Indicate plans for how these safety and health plans will be considered by the company's management (e.g., when they will be reviewed and by when a decision to incorporate the recommendations will be made).

b. Construction Jobs

[Examples]

Commitment C3b.1 The competitor commits to pay competitive wage and benefit rates benchmarked against local Davis-Bacon prevailing wages as follows:

- %____above posted prevailing wage per hour for base wages
- Health insurance: $_____ per ___
- Retirement contributions: $_____ per ___
- PTO: ____hrs per _____.

Commitment C3b.2 The competitor will provide workforce education and training through:

- Utilization of registered apprentices at [insert percentage] of total project labor hours.
- Utilization of pre-apprenticeship programs at [insert percentage] of total project labor hours.

Commitment C3b.3: The competitor will ensure highest standards of construction site health and safety, including site free of harassment and discrimination. Specifics include:

- [insert percent] of onsite workers that will have OSHA 30 certification
- [insert percent] of onsite workers that will have OSHA 10 certification
- [insert number of hours] that will be dedicated to a health and safety committee by construction workers and will be paid [insert time and rate paid] for their time participating.
- Indicate which of the following, if any, the training provided will include:
    - Worksite safety analysis
    - Worksite violence recognition and prevention plan
    - Hazard prevention and control

    - Safety and health training
    - Anti-harassment and bystander intervention training
    - Other: [Describe].
- Indicate the frequency of these health and safety committee planning meetings.
- Indicate plans for how these safety and health plans will be considered by the organization's management (e.g., when they will be reviewed and by when a decision to incorporate the recommendations will be made).

E. Diversity, Equity, Inclusion, and Accessibility

Instructions: This section should summarize the competitor's plan to incorporate diversity, equity, inclusion, and accessibility (DEIA) objectives into the project. A non-exhaustive list of possible commitments is provided below.

Each commitment may include a brief summary of the plan and should enumerate specific elements as sub-commitments below. The competitor should add or delete commitments to reflect their specific plan.

For prize winners, funding recipients will be required to report on partnerships described.

[Examples]

Commitment D1. The competitor commits to partnering or contracting with Minority-Serving Institutions, businesses majority owned or controlled by residents of disadvantaged communities, and/or underrepresented persons or groups of underrepresented persons.

Commitment D1.1: [Name of partnership]

Summary of scope of work: [insert here]

Contract amount: $_____

Overall value of partnership: $_____

Commitment D2. The competitor commits to implementing a plan to reduce barriers and improve access to jobs for local workers, residents of disadvantaged communities, and/or underrepresented workers.

Commitment D2.1: The competitor will partner with quality pre-apprenticeship or apprenticeship readiness programs[25] to foster improved access for local workers, underrepresented workers, and/or residents of disadvantaged communities to career-track training and employment.

Please indicate how, if applicable, partnering programs specifically work to improve access for underrepresented workers.

[25] Explore Apprenticeship.gov at https://www.apprenticeship.gov/employers/explore-pre-apprenticeship.

Name and description of readiness program(s): [insert here]

Partnerships and financial contributions to community-based organizations to provide support services to workers or people in relevant training (e.g., childcare supports, transportation vouchers, employability skills training, etc.): [Describe]

Commitment D2.2: The competitor will partner with training and placement programs [other than pre-apprenticeship programs] for underrepresented workers and residents of disadvantaged communities.

Name of training and placement programs: [insert here]

Establishing and executing an inclusive recruitment strategy (e.g., a strategy to support broad recruitment for the apprenticeship programs, outreach to community-based organizations that work with prospective workers/apprentices): [Describe]

Commitment D2.3: The competitor will provide ($_____) in supports/subsidies for workers to access affordable, reliable, and high-quality childcare, or other types of care.

Description of services: [insert here]

Commitment D2.4: The competitor will provide flexible work schedules.

Description of flexible work schedule program: [insert here]

Commitment D2.5: The competitor will provide ($_____) in transportation assistance to and from work and training sites.

Description of assistance provided, including any cost to employee, contractor, or trainee: [insert here]

Commitment D2.6: The competitor will provide emergency cash assistance for items such as tools, work clothing, etc.

Commitment D2.7: The competitor will recruit residents of disadvantaged communities and/or underrepresented workers. [insert description of recruiting efforts here]

Commitment D2.8: The competitor will recruit local workers. [insert description of recruiting efforts here]

F. Justice40 Initiative

Instructions: This section should reflect the Justice40 Initiative's overall benefits and plan for identifying and mitigating any anticipated negative impacts on disadvantaged communities that have been marginalized by underinvestment and overburdened by pollution. As outlined on DOE's Justice40 Initiative webpage, the overall benefits are grouped by policy priorities below, with space to add additional benefits that do not fit in categories provided.

Competitors must provide an overview of benefits to disadvantaged communities that the project can deliver, supported by measurable milestones. Applicants should use the White House Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST), a geospatial mapping tool used by federal agencies, as the primary tool to identify disadvantaged communities. Applicants are encouraged to use the information available through tools such as the Environmental Protection Agency's EJSCREEN to assist in assessing how the benefits of a project will reverse or mitigate the burdens of disadvantaged communities.

For each benefit, the competitor should indicate:

- Which disadvantaged community is to benefit
- How and when planned or anticipated benefits are expected to flow to communities
- SMART milestones to indicate progress toward benefit delivery
- Metrics to be used to track and report on benefits
- Community-based organizations involved in identifying, negotiating, or delivering benefits
- A discussion of anticipated negative and cumulative environmental impacts on disadvantaged communities.

The competitor should add or delete commitments (and re-number accordingly) to reflect their specific plan.

[Examples]

E.1. A decrease in energy burden (energy costs for low-income households)

Benefit E1.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):
- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Unanticipated barriers and strategies to address barriers:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.2. A decrease in environmental exposure and burdens

Benefit E2.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):

- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.3. An increase in access to low-cost capital

Benefit E3.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):
- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.4. An increase in quality job creation, the clean energy job pipeline, and job training for individuals

This section should clarify any quality jobs-related commitments that are specific to a disadvantaged community and are distinct from more general quality jobs commitments noted in Sections C or D above.

Benefit E4.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):
- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.5. Increases in clean energy enterprise creation and contracting (e.g., minority-owned or diverse business enterprises)

Benefit E5.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):
- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) or Tribes involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.6. Increases in energy democracy, including Tribal Nation or community ownership of project assets

Benefit E6.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):

- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.7. Increased parity in clean energy technology access and adoption

Benefit E7.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):
- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.8. An increase in energy resilience

Benefit E8.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):
    - When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.9. Other: Please identify additional, measurable benefits here.

Benefit E9.1: [Description of benefit]

- The disadvantaged community that will benefit:
- How benefit will be delivered (e.g., direct or indirect, who will deliver):
- When benefit will be delivered:
- Milestones toward benefit delivery:
- Metrics to track and report on benefits:
- Community-based organization(s) involved in identifying or negotiating benefit or developing plan for benefit delivery:

E.10. Anticipated or planned efforts to address or reduce potential negative environmental impacts

Instructions: This section should summarize anticipated or potential negative environmental, social, or economic impacts on local and disadvantaged communities, including communities geographically near the project or directly affected by project construction or operations, as well as known impacts upstream (in the supply chain, e.g., raw material extraction) or downstream (e.g., waste disposal). Consider direct impacts, indirect impacts, and cumulative impacts. This section may refer to the impacts identified in Appendix 13 of the Prize Rules Document: National Environmental Policy Act (NEPA) Compliance. The section should also summarize efforts to address or reduce discussed negative impacts.

Examples include:

1. Any increases in air pollution
2. Any increases in water use
3. Any increases in water pollution or other waste streams
4. Any increases to consumer energy prices.

For Phase 1 projects, this section should also summarize the Applicant's plan to monitor and mitigate negative impacts if the project proceeds to commercialization.

G. Summary Table: Community Benefits Outcomes and Objectives

Instructions: This section should be filled in to reflect the commitments and relevant time-based milestones covered throughout this document.

The competitor should add or delete rows and columns so the table summarizes commitments and timelines from sections above. Red text indicates examples and should be deleted or modified to reflect competitor's plan. The following items should not be included in the CBOO:

· Specific dates (only include general time frames (i.e., Demonstrate XYZ result by Month 3, not Demonstrate XYZ by June 8th, 2013).

· Subcontractors, vendors, or individuals by name.

Category and Commitment	Existing or Planned	Phase 2 Milestone	Phase 3 Milestone	Phase 4 Milestone
Community and Labor Engagement				
Community benefits agreement	☐ Yes ☐ Not at this time			
Collective bargaining agreement (operating jobs)	☐ Yes ☐ Not at this time			
Project Labor Agreement (construction jobs)	☐ Yes ☐ Not at this time			
[Other community and labor engagement commitments, e.g., # and type of engagements, etc.] *(The competitor should take note if there is a*				

requirement for Workforce Continuity Plan)				
Community feedback and data incorporated into the project	☐ Yes ☐ Not at this time (If "Not at this time", please provide an explanation in this cell).			
Investing in Quality Jobs	Total Number of Permanent Operations Jobs: [#] Number of Construction phase jobs: [#]			
Total Number of Permanent Operations Jobs:	[#]			
Number of Construction phase jobs:	[#]			
Minimum starting wage for permanent hourly jobs:	$__/hr			
Pay upper quintile wages for industry and occupation	☐ Yes ☐ No			
Fringe Benefits	☐ Employer-sponsored health insurance ☐ Contributions to retirement ☐ Transportation assistance ☐ Childcare assistance			
Training	☐ Contributions to labor-management training partnership ☐ Utilization of registered apprentices for at least 15% of construction jobs ☐ Paid training ☐ Tuition support or reimbursement			

Health and Safety Committee with Hourly Worker Representation	☐ Yes ☐ Not at this time			
Support for Worker Organizing/Collective Bargaining	☐ Pledge to make public any commitment made in the CBP to remain neutral during any union organizing campaigns ☐ Pledge to permit union recognition through card check ☐ Intention to enter into binding arbitration to settle first contracts ☐ Pledge to make public any commitment made in the CBP to allow union organizers access to appropriate onsite nonwork spaces (e.g., lunchrooms) ☐ Pledge to make public any commitment made in the CBP to refrain from holding captive audience meetings ☐ **[Applies to For-Profit-Entities]** Certify, consistent with 2 CFR 910.352 (*Cost Principles*) and 48 CFR 31.205-21 (*Labor Relations Costs*), that they will not claim as cost share or submit any such costs as allowable costs, the "costs of any activities undertaken to persuade employees, of any entity, to exercise or not exercise, or concerning the manner			

	of exercising, the right to organize and bargain collectively through representatives of the employees' own choosing." (48 CFR 31.205-21)			
Other Job Quality and Workforce				
Diversity, Equity, Inclusion, and Accessibility				
Local recruitment efforts	☐ Yes ☐ No			
Targeted recruitment efforts	☐ Yes ☐ No			
Partnering or contracting with Minority-Serving Institutions or businesses majority owned or controlled by underrepresented persons or groups of underrepresented persons	☐ Yes ☐ No			
Partner with quality pre-apprenticeship or apprenticeship readiness program[26]	☐ Yes ☐ No	*Partnerships with community-based organizations and ed/training providers for workforce needs planned.*		
Other DEIA				

[26] Explore Apprenticeship.gov at https://www.apprenticeship.gov/employers/explore-pre-apprenticeshiphttps://www.apprenticeship.gov/employers/explore-pre-apprenticeship.

Justice40 Initiative (disadvantaged communities)				
Identifies benefits/impacts	☐ Yes (If yes, list communities here) ☐ No			
Reduction in energy costs	☐ Yes ☐ No			
A decrease in environmental exposure and burdens	☐ Yes ☐ No			
An increase in access to low-cost capital	☐ Yes ☐ No			
An increase in quality job creation, the clean energy job pipeline, and job training for individuals	☐ Yes ☐ No			
Increases in clean energy enterprise creation and contracting	☐ Yes ☐ No			
Increases in energy democracy, including Tribal Nation ownership or community ownership of project assets	☐ Yes ☐ No			
Increased parity in clean energy technology access and adoption	☐ Yes ☐ No			
An increase in energy and climate resilience	☐ Yes ☐ No			
Other Justice40				

[END OF DEMONSTRATION AND DEPLOYMENT TEMPLATE]

Appendix 8: Description of Technology Readiness Levels (TRLs)

The following is a description of the DOE technology readiness levels.

Relative Level of Technology Development	TRL	TRL Definition	Description
System Operations	9	Actual system operated over the full range of expected mission conditions.	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	8	Actual system completed and qualified through testing and demonstration.	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing.
	7	Full-scale, similar (prototypical) system demonstrated in relevant environment.	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing a full-scale prototype in the field with a range of simulants in cold commissioning (1). Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.
Technology Demonstration	6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment.	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering-scale prototypical system with a range of simulants. Supporting information includes results from the engineering-scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.

Relative Level of Technology Development	TRL	TRL Definition	Description
Technology Development	5	Laboratory scale, similar system validation in relevant environment.	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory-scale system in a simulated environment with a range of simulants (1) and actual waste (2). Supporting information includes results from the laboratory-scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.
Technology Development	4	Component and/or system validation in laboratory environment.	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small-scale tests on actual waste. Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRLs 4–6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on-hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.
Research to Prove Feasibility	3	Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants. Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3, the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
	2	Technology concept and/or application formulated.	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The

Relative Level of Technology Development	TRL	TRL Definition	Description
Basic Technology Research			step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.
	1	Basic principles observed and reported.	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting information includes published research or other references that identify the principles that underlie the technology.

[1] Simulants should match relevant chemical and physical properties.
[2] Testing with as wide a range of actual waste as practicable and consistent with waste availability, safety, ALARA, cost, and project risk is highly desirable.

Source: U.S. Department of Energy. 2011. "Technology Readiness Assessment Guide." Office of Management.

Appendix 9: Pre-FEED Study Guidance

Phase 1 (Concept) submissions must include a pre-FEED study for the first-of-a-kind DAC pilot system (500 tCO_2/yr minimum capacity). The DAC pilot system pre-FEED study shall result in equipment sizing fully substantiated with kinetic, heat transfer, and mass transfer data, as well as justification for choice of materials of construction.

The pre-FEED study (i.e., Class 4 estimate with expected cost accuracy of −30% to +50% and project definition maturity of 1% to 15%) shall cover both the DAC pilot system (500 tCO_2/yr minimum capacity) and required balance-of-plant (BOP). BOP includes, but is not limited to, utilities such as compression, cooling water, water treatment, waste treatment, and any onsite sources of energy, electricity, and/or steam that are necessary to power the DAC system. The BOP also includes, as applicable, CO_2 transport and storage and/or CO_2 conversion and may include integration of an external energy source (e.g., grid electricity, solar, wind, geothermal, etc.). If the DAC pilot system is designed to purchase renewable electricity or to generate it on site, then the plant must include a method of energy storage or back-up power purchase or generation to supply electricity when renewable electricity is not available. Otherwise, the DAC pilot system design and cost should be reflective of the expected capacity factor of the power generating source. The energy sources used should be clearly defined, and the impact of the energy sources on the net DAC efficiency should be clearly provided.

If available, high-level schematics, technical specifications, and equipment supplier and vendor information for all technologies, systems, and connective infrastructure should be included in the application. Competitors should describe the mass and energy balance of any major supply chain elements or unit operations, relevant system capacities, and projected availabilities. If available, equipment descriptions should include consideration of how equipment would be used dynamically within the system. The team should describe how the system design will address relevant needs for energy buffering, storage of or buffering for any intermediary, input, or waste products. Needs for and plans to balance variable supply and demand signals as well as resiliency aspects necessary to handle maintenance outages and external system shocks should also be described as applicable.

Competitors are expected to develop detailed cost estimates that meet industry standards for the size and complexity of the proposed DAC pilot system. DOE expects that DAC pilots will employ industry standard cost estimating methodologies and tools. Cost estimates should correspond to the DAC pilot design maturity and reflect appropriate uncertainties. While DOE is not requiring its use, competitors are encouraged to review DOE's Cost Estimating Guide.[27] The table below is included in that guide and highlights examples of industry standard cost estimating approaches and use cases.

[27] DOE G 413.3-21A *Cost Estimating Guide*: https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-21A.

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

The cost estimate shall include preparation of a total plant cost (TPC) estimate inclusive of process equipment, supporting facilities, equipment installation, EPC services, and contingencies. Competitors should also estimate operating costs in addition to capital costs to estimate the total gross cost in $/t$CO_2$ captured, the total net cost in $/t$CO_2$e captured after considering LCA results, and the total cost of producing the CO_2 conversion product (if applicable). The pre-FEED shall include, as applicable: preliminary process flow diagrams; heat and material balances prepared based on a DAC process model scaled for the DAC pilot system (minimum 500 tCO_2/yr); preliminary utility flow diagrams; preliminary piping and instrumentation diagrams; rough plot plan; draft layout drawings; draft engineered process and utility equipment lists; draft single-line diagrams for electrical; vendor quotations; draft project execution plans; draft resourcing and workforce plans; and an initial hazard and operability study (HAZOP) review.

Appendix 10: FEED Study Guidance

Phase 2 (Engineer) submissions must include a FEED study for the first-of-a-kind DAC pilot system. The DAC pilot system FEED study (i.e., Class 3 estimate with expected cost accuracy −20% to +30% and project definition maturity of 10% to 40%) shall cover both the DAC pilot system (500 tCO_2/yr minimum capacity) and required balance-of-plant (BOP). BOP includes, but is not limited to, utilities such as compression, cooling water, water treatment, waste treatment, and any onsite sources of energy, electricity, and/or steam that are necessary to power the DAC system. The BOP also includes, as applicable, CO_2 transport and storage and/or CO_2 conversion and may include integration of an external energy source (e.g., grid electricity, solar, wind, geothermal, etc.). The DAC pilot system FEED study should include but not be limited to:

1. Project Scope and Design. This includes business objectives and the summary of the proposed project. The roles and scope of work for the different parties involved in the project should be clearly delineated.

2. Project Design Basis. This includes, but is not limited to, site characteristics and ambient conditions, fuel feedstock characteristics (if applicable), and site environmental requirements. The operating ranges considered during the FEED study should be provided. The design basis shall clearly identify all local, state, federal permits, and environmental reviews necessary to initiate construction. All approvals required to initiate construction shall be identified. Energy sources and their impact on the net DAC efficiency should be provided. If, after completing the FEED, it is decided that a different plant configuration should be considered, and that the reported design is not viable, this information should be communicated clearly up front. If major design changes are required, this should be reflected in the project timeline, and a path forward should be clearly outlined.

3. Engineering Design Package. Design of the DAC pilot system shall result in equipment sizing fully substantiated with kinetic, heat transfer, and mass transfer data, as well as justification for choice of materials of construction. The cost estimate shall include preparation of a total plant cost (TPC) estimate and capital and operating cost estimates, including the total gross cost in \$/tCO_2 removed, the total net cost in \$/tCO_2e removed after considering LCA results (assuming durable CO_2 storage), and cost of the CO_2 conversion product (if applicable). The FEED shall include, at a minimum: process flow diagrams; heat and material balances; plot plan; DAC process model scaled to the proposed capture capacity (minimum 500 tCO_2/yr); piping and instrumentation diagrams; complete process and utility equipment lists with all major equipment with all major equipment (e.g., for a solvent-based system: direct contact cooler, absorber, solvent heat exchangers, stripper, CO_2 compressors, etc.) specifications and sizing; single-line diagrams for electrical; electrical equipment and motor schedules; control logic diagrams; vendor quotations and equipment drawings; detailed project execution plans; resourcing and workforce plans; a hazard and operability study (HAZOP) review; and a constructability review. The FEED shall incorporate all engineering disciplines necessary to perform the final design and construction, which include but are not limited to: process and equipment, civil, architectural, structural, mechanical, piping, electrical, and control systems engineering. A list of all referenced work should be provided.

It is understood that the content to be included in a FEED study package is tailored by the type of project and the needs of the owner. Often Engineering, Procurement, and Construction (EPC) firms will have an in-house standard in the absence or lack of owner definition. The goal of the FEED study is for the owner and EPC firm to collaboratively refine the project's scope, design, and cost estimate as much as possible to reduce risk and uncertainty prior to executing the project. Often, items 1–3 in the list below are provided by the owner to the EPC firm.

The following is a more detailed list of content to be included in the FEED study developed by the end of Phase 2. Recipients are encouraged to include additional materials outside this list that result from the uniqueness of their respective project or the needs of the owner. Recipients are also encouraged to integrate detailed design activities with CBP requirements and activities as appropriate for the project into an overall integrated project schedule. All sections of the report should be cross-checked to ensure that the values agree between sections of the report(s). Missing appendices, section headings, and mislabeled figures should be avoided. Image quality should be checked; figures with unreadable text should not be included.

1) Project Background
    a) Discusses project need or business objective
    b) Includes major aims and conclusions of each of the subsequent chapters.
2) Project Scope
    a) Provides a summary of the proposed project, the project objective, and how it will meet the objective
    b) Delineates the roles and scope of work for the different parties involved in the project
    c) Provides the system boundaries, or battery limits, of the proposed project.
3) Project Design Basis
    a) Site Characteristics:
        i) Location, topography, available land, transportation access, available utilities, access to water, access to carbon dioxide piping or storage sites
        ii) Social characterization, including regional analysis of communities and disadvantaged communities, and whether those communities rely on limited resources (e.g., water) that could be impacted by the project. This information should be consistent with the CBP.
    b) Site Ambient Conditions:
        i) Elevation, prevailing wind, relative humidity, seismic data
        ii) Atmospheric pressure, temperature averages and extremes, air composition averages and extremes.
    c) Fuel Feedstock: compositional analyses of any fuel used depicting the expected compositional range
    d) Environmental Requirements – as dictated by the authority(s) having jurisdiction (the state's Department of Environmental Protection [DEP] and EPA, etc.):
        i) Air emission permitting limitations and required control technologies
        ii) Water discharge permitting limitations and required control technologies
        iii) Waste disposal (e.g., spent sorbents or solvents) permitting limitations, and required control technologies
        iv) Safety considerations – local fire department, community engagement.
    e) Site-Specific Design Considerations: flood plain, soil conditions, rainfall/snowfall criteria, building/enclosure permitting, noise regulations, local community requirements for the proposed site
    f) Modularization Design Requirements.
4) Basic Contracting and Purchasing Strategy
    a) Strategy for tracking cost and schedule performance, such as cost performance indicators from an earned value management system
    b) Details about staffing/operation of the DAC plant and the BOP.
5) Engineering Design Packages
    a) Process Engineering:
        i) Process area descriptions

ii) Finalized block flow diagrams (BFDs), process flow diagrams (PFDs), and piping & instrumentation diagrams (P&IDs).
    (1) Minimum Stream Requirements:
        (a) Gas effluent from the absorber
        (b) CO_2 product from the regenerator
        (c) CO_2 product after compression (with detailed impurities).
iii) Process simulation output and heat and material balances (H&MB)
iv) Direct air capture technology-specific design details. This includes capture fraction; pressure drop across the contactor; working capacity or solvent loading; adsorption, desorption, and cycle times; selectivity; vacuum pressure; regeneration energy; steam requirement; system auxiliary load; sorbent or solvent initial fill and make up rates
v) Equipment and instrumentation lists and vendor datasheets. Process equipment specifications should include sizing and key parameters used for equipment costing (e.g., height, diameter, heat duty, delta temperature, power, and materials of construction)
vi) HAZOP/Process Hazard Analysis (PHA) documentation
vii) Cause and Effect diagrams
viii) Overpressure Relief/Flare Study.

b) Civil and Structural Engineering:
    i) Soil load analysis
    ii) Soils resistivity assessment
    iii) Storm water runoff plan
    iv) Geologic assessment
    v) Spill containment assessment
    vi) Determination of type of foundation for various loads associated with process and balance of plant equipment.
c) Structural Engineering:
    i) Foundation design drawings (e.g., concrete sonotubes & slabs, helical pillars)
    ii) Structural and Architectural drawings (e.g., process equipment/piping structural supports, access gangways/ladders, building enclosures, etc.)
    iii) Structural steel support and its foundation
    iv) Material take-offs.
d) Mechanical Engineering:
    i) General site plan view(s)
    ii) 3D model and/or equipment elevation sections & plan drawings
    iii) Piping/tracing/insulation line list and material specification
    iv) Piping isometrics
    v) Piping layout/routing drawings.
e) Electrical Engineering:
    i) Electrical load lists
    ii) One-line diagram(s)
    iii) Electrical equipment (e.g., substation, motor control centers, switchgear) specifications
    iv) Cable/cable tray routing drawings and specifications
    v) Lighting drawings.
f) Instrumentation & Controls Engineering (System Integration)
    i) Control system architecture specification
    ii) Instrument/equipment lists, and specifications
    iii) Loop drawings
    iv) Communications infrastructure (e.g., remote SCADA ability, telephone, internet) specifications.

g) Fire Protection Engineering:
    i) Fire protection system (e.g., sprinkler, foam, and water cannons) design specifications and drawings.
h) Facilities Engineering:
    i) Building/Security Infrastructure Plans:
        (1) Front office/administration
        (2) Control room(s)
        (3) Maintenance/shop area.
    ii) HVAC.
i) Project Security:
    i) Site physical security
    ii) Cybersecurity and associated information protection systems.
j) Transportation & Logistics Study
k) Constructability:
    i) Construction access
    ii) Lay-down areas
    iii) Sequencing of construction work.
l) Project Cost Estimate – Must specify year dollar basis and nominal vs. real:
    i) Individual component capital cost, including quantity (weight, lengths, numbers, etc.), unit rate, process equipment cost, material cost, labor cost (including unit labor rate for individual line items), and man-hours required to complete individual line-item tasks. Details regarding what is included in the capital cost estimate (labor, materials, equipment, contingency, engineering fees, delivery, etc.) need to be provided.
    ii) Breakdown of variable operating costs, including quantity (weight, volume, etc.), per unit rate. The variable operation and maintenance (O&M) cost includes but is not limited to consumable consumption rates and unit costs, catalyst cost, specialty chemicals, waste generation rates and disposal costs, and power and fuel costs. Justifications for the unit costs should be provided where appropriate (e.g., power purchase agreements and waste classified as hazardous/nonhazardous).
    iii) Detailed accounting of fixed O&M costs should be provided. This includes labor rates and personnel requirements for operating labor, maintenance assumptions including labor and material required for annual maintenance, and administrative labor such as office support staff and supervisors.
m) Owner's Costs:
    i) Cost of capture ($/gross tCO_2 removed)
    ii) Cost of the CO_2 conversion product (if applicable)
    iii) Overall cost of removal considering LCA results ($/net tCO_2e removed)
    iv) Quantitative risk analysis and associated funding contingency requirements.
    Financial factors must be detailed. The methodology used to calculate the cost of CO_2 capture and removal must be clearly outlined. Requested details include:
        (1) Interest rate, project life, debt–equity arrangement (not considering use of prize money to pay or repay project costs), taxes, insurance, contingency and other cost escalation
        (2) Owner's cost calculation details
        (3) Annualization calculation details (capital costs should not simply be divided by the project lifetime and annual capture costs without considering interest, which should be set at a reasonably high rate for early-stage, risky DAC projects of at least 15%)
        (4) Calculated costs should take into account expected capacity and utilization factors and operational mode.

FEED Study Checklist

Based on prior experience with FEED study reporting, the following checklist is provided to emphasize key pieces of information that should be contained in the FEED study (as a minimum). The items shown in the checklist are all included in the above explanation but are identified in this chart for emphasis.

Reporting Guidelines

Category	Topic	Description
Reporting	Report organization	This rules document gives an outline for important sections to be included in the FEED report, and this outline should be followed. The executive summary should include a summary of all pertinent information and major aims and conclusions of each of the subsequent chapters upfront.
	Quality control	There should be no inconsistencies in reported values in different sections of the report. Missing appendices, section headings, and mislabeled figures should be avoided. Image quality should be checked; figures with unreadable text should not be included.

General Guidelines

Category	Topic	Description	Location in Text/ Page #
General	Potential changes to design	If after completing the FEED it is decided that a different plant configuration should be considered, and that the reported design is not viable, this information should be communicated clearly up front. If major design changes are required, this should be reflected in the project timeline, and a path forward clearly outlined.	
	Definition of roles	The roles and scope of work for the different parties involved in the project should be clearly delineated.	
	Sources used	A list of sources should be provided.	

Performance Guidelines

Category	Topic	Description	Location in Text/ Page #
	DAC process configuration	1 - The overall process flow diagram with main input and output streams should be highlighted. 2 - Detailed P&ID should be included. 3 - An equipment list with all major equipment specifications and sizing should be provided.	
	DAC system details	The process design and operation should be clearly described. DAC system details allowing comparison with other technologies are requested. These details include, but are not limited to: 1 - Initial sorbent/solvent fill and sorbent/solvent make up rates 2 - Performance metrics: capture fraction; pressure drop across the contactor; working capacity or solvent loading; adsorption, desorption, and cycle times; selectivity; vacuum pressure; regeneration energy; steam requirement; system auxiliary load.	
	Compression system details	Compression technology details allowing comparison with other technologies are requested. These details include: 1 - Compressor type 2 - Number of stages 3 - Intercooling and/or aftercooling requirements 4 - Electricity or steam requirement details 5 - Output pressure, CO_2 purity, and justification for product CO_2 stream purity and pressure.	
Performance	Stream tables	Energy and mass balance details should be provided. At a minimum, this includes the flow rate, composition, temperature, pressure, density, and enthalpy for the following streams: 1 - Ambient air 2 - Process effluent and emissions streams 3 - Effluent from any air-conditioning steps 4 - CO_2 product stream from the contactor 5 - CO_2 product after compression (with detailed impurities).	
	Steam requirement	The source, quality, and quantity of steam required by the process must be specified for each application, including: 1 - Solvent/sorbent regeneration steam 2 - Compression system steam (if applicable) 3 - Other miscellaneous applications such as triethylene glycol (TEG) drying.	
	Auxiliary power	1 - Auxiliary power requirements for different sub-systems of the direct air capture system and balance of plant systems must be specified. A detailed electrical load list should be provided. 2 - The power source should also be specified	

Category	Topic	Description	Location in Text/ Page #
		(e.g., purchased from grid, dedicated renewable energy source, and auxiliary combined heat and power [CHP] with carbon capture). The impact of the power source on the net air capture rate should be detailed.	
	Justification of design	Justification for all major design decisions should be provided. This includes: 1 - Results from any case studies performed when deciding on the specific configuration 2 - DAC system (and any non-commercially available system at scale) modeling details, including model basis and validation, system modeling results, and justification for any design decisions that deviate from the modeled system 3 - Justification for product CO_2 stream purity and pressure.	

Cost Guidelines

Category	Topic	Description	Location in Text/ Page Numbers
Cost	Dollars	The year dollar must be provided and nominal vs. real dollars specified for clarity. The capital cost estimate should be consistent with AACE Class 3 accuracy ±15%.	
	Cost details	Detailed costs should be provided. This includes: 1 - Capital cost: preferably includes costs for individual pieces of equipment, but at a minimum provides totals for the DAC system, compression system, and BOP. Details regarding what is included in the capital cost estimate (labor, materials, equipment, contingency, engineering fees, delivery, etc.) need to be provided. 2 - O&M costs: a detailed accounting of O&M costs should be provided. This includes labor rates and personnel requirements, maintenance assumptions, insurance, property taxes, consumable consumption rates and unit costs, waste generation rates and disposal costs, and power and fuel costs. Justifications for the unit costs should be provided where appropriate (e.g., power purchase agreements and waste classification as hazardous/nonhazardous) 3 - Owner's costs 4 - Cost of capture ($/net tonne of CO_2e captured by DAC technology) 5 - Cost of the CO_2 conversion product (if applicable) 6 - Overall cost of removal ($/net tonne of CO_2e removed by integrated DAC system).	
	Costing methodology	Financial factors must be detailed. The methodology used to calculate the cost of CO_2 capture must be clearly outlined. See NETL's Quality Guidelines for Energy Systems Studies: Cost Estimation Methodology for NETL Assessments of Power Plant Performance, Department of Energy, Pittsburgh, Pa, 2021 for an example of the detail requested. Requested details include: 1 - Expenditure period, operating period, capital escalation during expenditure, assumed inflation rate, O&M escalation, O&M levelization factor, sales tax rates, debt-equity arrangement, interest rate on debt, return on equity, fixed charge factor, etc. 2 - Owner's cost calculation details 3 - Annualization calculation details.	

FEED Value Template

Based on prior experience with FEED study reporting, it is suggested that this template is adapted for the competitor's specific technology, completed, and submitted with the FEED study. This will facilitate review of the final design parameters. To assist teams, elective templates are provided below. Teams are not required to use this template, but if teams should elect to use their own format, they must make sure to include all the substantive information included in the template below. The values in this table should agree with the values throughout the report. All parameters relevant to the specific DAC technology should be reported. Additional relevant entries not included in this table should be added.

Parameter	Units	Value		Pages in Text Discussing Parameter
DAC Pilot Design Basis and Performance				
Ambient Air Design Basis Range Note: If air is comingled with any streams or pretreated upstream of the CO_2 removal step (e.g., with a desiccant), this information must be provided for all streams prior to the CO_2 removal step.	°F			
	psia			
	ppmv CO_2			
	mol% H_2O			
	mol% N_2			
	mol% O_2			
	Other notable constituents/ pollutants			
Auxiliary Load of DAC	MW			
Auxiliary Load of CO_2 Compression	MW			
Auxiliary Load of BOP equipment	MW			
Electrical Auxiliary Boiler Load (if applicable)	MW			
Heat Requirement (if applicable)	MW			
Heat Source	--			
Auxiliary Boiler Steam Generation	lb/hr			
	psia			
Steam for Sorbent/Solvent Regeneration	lb/hr			
	psia			
	Direct/indirect			
Capacity Factor of Power/Heat Source	%			
Utilization Factor of DAC	%			
Air Inlet to DAC Process	lb/hr			
Contactor CO_2 Capture Fraction	%			
Gross DAC CO_2 Capture Capacity	tonnes/yr.			
Gross Plant CO_2 Capture Capacity	tonnes/yr.			
Net CO_2 Capture Capacity	tonnes/yr.			
CO_2 Stream Leaving the DAC Contactor, or for Multistage Processes, CO_2 Stream Leaving Each Stage	lb/hr			
	mol% CO_2			
	mol% H_2O			
	mol% O_2			
	°F			
	psia			
	lb/mol			
CO_2 Product after Compression	lb/hr			
	°F			
	psia			
	mol% CO_2			

Parameter	Units	Value		Pages in Text Discussing Parameter
	ppm_v H_2O			
	ppm_v O_2			
Pressure Drop Across the Air Contactor	psi			
Air Superficial Velocity	ft/s			
Contactor Depth	ft			
Water Consumption of the DAC System	lb/hr			
Number of Contactor Modules				
Initial Solvent Fill	tonne			
Solvent Make-up Rate	tonne/yr.			
Solvent Loading	mol/mol			
Solvent Regeneration Energy	Btu/lb CO_2			
Sorbent Initial Fill	tonne			
Sorbent Life	years			
Sorbent Working Capacity	mol/kg			
Sorbent Bulk Density	lb/ft^3			
Sorbent Void Fraction				
Sorbent Selectivity	CO_2/N_2			
	CO_2/O_2			
	CO_2/H_2O			
Sorbent Vacuum Pressure	psia			
Specific Sorbent Regeneration Energy	Btu/mol CO_2			
Adsorption Time	s			
Desorption Time	s			
Cycle Time	s			
Costs				
Dollar Basis	Year			
	Real or nominal			
Capital Cost Accuracy	+/– %			
DAC Pilot System Capital Cost				
Equipment	$			
Material	$			
Direct and indirect labor for installation and construction	$			
Engineering Contracting	$			
Process Contingencies	$			
Project Contingencies	$			
CO_2 Compression System Capital Cost				
Equipment	$			
Material	$			
Direct and indirect labor for installation and construction	$			
Engineering Contracting	$			
Process Contingencies	$			
Project Contingencies	$			
BOP and Modifications Capital Cost				
Equipment	$			
Material	$			

Parameter	Units	Value		Pages in Text Discussing Parameter
Direct and indirect labor for installation and construction	$			
Engineering Contracting	$			
Process Contingencies	$			
Project Contingencies	$			
Solvent Costs				
Initial Fill	$			
Solvent Make-up	$/yr.			
Unit Price	$/tonne			
Sorbent Cost				
Initial Cost Per Module	$			
Initial Fill Cost (Sorbent)	$			
Replacement Cost	$/yr.			
Unit Cost	$/tonne			
Solvent or Sorbent Waste Disposal	$/tonne			
	$/yr.			
Natural Gas (if applicable)	$/MMBtu			
	$/yr.			
Electricity	$/MWh			
	$/yr.			
Other Consumables/Waste Disposal	$/yr.			
Maintenance Allowance	$/yr.			
Operating and Maintenance Labor Costs	$/yr.			
Property Taxes/Insurance	$/yr.			
Expenditure Period	years			
Operating Period	years			
Inflation	%			
Capital Escalation During Expenditure	%			
O&M Escalation	%			
O&M Levelization Factor	%			
Effective Sales Tax Rate (State and Federal)	%			
Debt-to-Equity Ratio				
Interest Rate on Debt	%			
Return on Equity	%			
Fixed Charge Factor				

Appendix 11: Waiver for Foreign Entity Participation

Waiver for Foreign Entity Participation

Many of the technology areas DOE funds fall in the category of critical and emerging technologies (CETs). CETs are a subset of advanced technologies that are potentially significant to U.S. national and economic security.[28] For projects selected under this prize, all recipients and subrecipients must be organized, chartered, or incorporated (or otherwise formed) under the laws of a state or territory of the United States; have majority domestic ownership and control; and have a physical location for business operations in the United States. To request a waiver of this requirement, an individual must submit an explicit waiver request in the Full Application.

Waiver Criteria

Foreign entities seeking to participate in this prize must demonstrate to the satisfaction of DOE that:

a) Its participation is in the best interest of U.S. industry and U.S. economic development;
b) The project team has appropriate measures in place to control sensitive information and protect against unauthorized transfer of scientific and technical information;
c) Adequate protocols exist between the U.S. subsidiary and its foreign parent organization to comply with export control laws and any obligations to protect proprietary information from the foreign parent organization;
d) The work is conducted within the U.S., and the entity acknowledges and demonstrates that it has the intent and ability to comply with the U.S. Manufacturing Plan; and
e) The foreign entity will satisfy other conditions that may be deemed necessary by DOE to protect U.S. government interests.

Content for Waiver Request

A Foreign Entity waiver request must include the following:

a) Information about the entity: name, point of contact, and proposed type of involvement with the Institute;
b) Country of incorporation, the extent of the ownership/level control by foreign entities, whether the entity is state owned or controlled, a summary of the ownership breakdown of the foreign entity and the percentage of ownership/control by foreign entities, foreign shareholders, foreign state or foreign individuals;
c) The rationale for proposing a foreign entity participate (must address criteria above);
d) A description of the project's anticipated contributions to the U.S. economy;
- How the project will benefit U.S. research, development, and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
- How the project will promote domestic American manufacturing of products and/or services;

e) A description of how the foreign entity's participation is essential to the project;
f) A description of the likelihood of Intellectual Property (IP) being created from the work and the treatment of any such IP; and
g) Countries where the work will be performed (Note: if any work is proposed to be conducted outside the U.S., the individual must also complete a separate request foreign work waiver).

DOE may also require:

- A risk assessment with respect to IP and data protection protocols that includes the export control risk based on the data protection protocols, the technology being developed, and the

[28] See Critical and Emerging Technologies List Update (whitehouse.gov).

foreign entity and country. These submissions could be prepared by the project lead, but the prime recipient must make a representation to DOE as to whether it believes the data protection protocols are adequate and make a representation of the risk assessment – high, medium, or low risk of data leakage to a foreign entity.
- Additional language be added to any agreement or subagreement to protect IP, mitigate risk, or other related purposes.

DOE may require additional information before considering the waiver request.

The individual does not have the right to appeal DOE's decision concerning a waiver request.

Waiver for Performance of Work in the United States (Foreign Work Waiver)

As set forth in Section 1.7, 100% of the work under this prize must be performed in the United States. To seek a waiver of the Performance of Work in the United States requirement, the individual must submit an explicit waiver request in its submission package. A separate waiver request must be submitted for each entity proposing performance of work outside of the United States.

Overall, a waiver request must demonstrate to the satisfaction of DOE that it would further the purposes of this prize and is otherwise in the economic interests of the United States to perform work outside of the United States. A request to waive the *Performance of Work in the United States* requirement must include the following:

- The rationale for performing the work outside the U.S. ("foreign work");
- A description of the work proposed to be performed outside the U.S.;
- An explanation as to how the foreign work is essential to the project;
- A description of the anticipated benefits to be realized by the proposed foreign work and the anticipated contributions to the U.S. economy;
- The associated benefits to be realized and the contribution to the project from the foreign work;
- How the foreign work will benefit U.S. research, development, and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
- How the foreign work will promote domestic American manufacturing of products and/or services;
- A description of the likelihood of Intellectual Property (IP) being created from the foreign work and the treatment of any such IP;
- The total estimated cost (DOE and recipient cost share) of the proposed foreign work;
- The countries in which the foreign work is proposed to be performed; and
- The name of the entity that would perform the foreign work.

DOE may require additional information before considering the waiver request.

The individual does not have the right to appeal DOE's decision concerning a waiver request.

Appendix 12: Technology Maturation Plan (TMP) Template

TECHNOLOGY MATURATION PLAN

for *{insert project title}*

{Date Prepared}

SUBMITTED BY

{Organization Name}

{Organization Address}

{City, State, Zip Code}

TEAM CAPTAIN

{Name}

{Phone Number}

{E-mail}

SUBMITTED TO

U.S. Department of Energy

This plan should be formatted to include the following sections, with each section to include the information described below:

A. TECHNOLOGY READINESS LEVEL

- Using the technology readiness levels (TRLs) in Appendix 8, specify the current TRL of the proposed technology. Note that, to be at a certain TRL, all of the descriptions must be met. The application must provide a clear technical write-up describing the state of the proposed technology and use TRL description-based activities to justify the TRL score assigned.
- Provide a one-paragraph description of the target commercial application(s).

B. PROPOSED WORK

- Relate the proposed project work to the maturation of the proposed technology.
- List known performance attributes and their performance requirements to the extent possible. Explain how the performance requirements were determined (i.e., from FOAs; program plans;

technology road maps; need to surpass the current state of the art). Be as specific as practical on any supporting technical/economic assessments.

- Define the TRL that is anticipated at the end of the project and describe how the project objectives will meet the TRL description if the project is successful.

C. POST-PROJECT PLANS

- Describe known post-project work needed to attain the next TRL. Explain why that work is not part of the proposed project, and why the project end point sets the best foundation practical for the next phase of work. To the extent practical, include market assessments and deployment strategies.

Appendix 13: National Environmental Policy Act (NEPA) Compliance

All federally funded projects are subject to review in accordance with the National Environmental Policy Act (NEPA; 42 U.S.C. 4321, *et seq.*), which requires federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please see DOE's NEPA website (https://www.energy.gov/nepa).

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, all participants in the DAC Pilot Prize will be required to assist in the timely and effective completion of the NEPA process. If applicable, participants may be asked to provide DOE with information on construction and operation of their pilot such that DOE can conduct a meaningful evaluation of the potential environmental impacts.

Competitors will be requested to submit to the NEPA process a wide array of information about the proposed DAC pilot, options under consideration for the proposed pilot, reasonable alternatives to the proposed pilot for achieving similar objectives, the affected environment (to include both the natural environment and the human environment), the socio-economic setting of the proposed pilot and affected area surrounding the site, trends regarding changes in the surrounding environment (natural, socio-economic, human) and the potential effects (both positive and negative) of the proposed pilot, its options, and its reasonable alternatives. Teams will also be expected to cooperate fully with those who prepare the NEPA documents and implement the NEPA process.

Information may be submitted in the form of an Environmental Information Volume (EIV) that provides all initial environmental data and details about the proposed actions to take place at the host site(s). **An EIV is due with the Phase 2 submission.**

Based on DOE's review of the environmental questionnaire (**submitted in Phases 1 and 2**) and EIV, and the sensitivity of the proposed work area, DOE may need to prepare an Environmental Assessment/Finding of No Significant Impact or Environmental Impact Statement/Record of Decision during Phase 3. The target CO_2 storage formation and confining zone(s) (if applicable) should not contain drinking waters as defined by the Safe Drinking Water Act.

Environmental questionnaire can be found at:
http://www.netl.doe.gov/File%20Library/Business/forms/451_1-1-3.pdf.

Environmental Information Volume can be found at:
https://netl.doe.gov/sites/default/files/2018-02/451_1-1-6_0.pdf.

Appendix 14: Detailed Design Guidance

Phase 3 (Permit) submissions must include a detailed design for the first-of-a-kind DAC pilot system (500 tCO_2/yr minimum capacity). Competitors shall complete 90% of the engineering such that the main contractors and all the sub-contractors can provide construct details (shop fabrication drawings) of all sub-systems and construction bids that will result in a ±5% capital cost estimate. Activities include, but are not limited to, those listed below:

- **Project Scope and Design** that includes business objectives and the summary of the proposed project. The roles and scope of work for the different parties involved in the project should be clearly delineated.

- **Project Design Basis,** including, but not limited to, site characteristics and ambient conditions, fuel feedstock characteristics (if applicable), and site environmental requirements. The operating ranges considered during detailed design should be provided. The design basis shall clearly identify all local, state, and federal permits and environmental reviews necessary to initiate construction. All approvals required to initiate construction shall be identified. Energy sources and their impact on the net air capture rate should be provided.

- **Engineering Design Package**. Detailed design of the integrated DAC system shall result in equipment sizing fully substantiated with kinetic, heat, and mass transfer data, as well as justification for choice of materials of construction. The cost estimate shall include preparation of a total project cost (TPC) estimate, construction bids that will result in ±5% capital cost estimate, and operating cost estimates, including the cost in $/net tonne CO_2e removed and cost of the CO_2 conversion product (if applicable). The detailed design shall include, at a minimum: process flow diagrams; detailed heat and material balances; plot plan and elevation drawings; DAC process model scaled-up to the proposed capture capacity; piping and instrumentation diagrams; instrument list; valve list; piping list, final layout drawings, and isometrics; mechanical design drawings; detailed three dimensional model; complete process and utility equipment lists with all major equipment specifications and sizing; single line diagrams for electrical; electrical equipment and motor schedules; control logic diagrams; construct details (shop fabrication drawings) of all sub-systems; vendor quotations and equipment drawings; detailed project execution plans; resourcing and work force plans; a full team process hazard analysis (PHA) review; storm water management plan; permitting plan; and a geotechnical report with foundation design recommendations. The detailed design shall incorporate all engineering disciplines necessary to perform the final design and construction, which include, but are not limited to: process and equipment, civil, architectural, structural, mechanical, piping, electrical, and instrumentation and control systems engineering. A list of all referenced work should be provided.

Engineering design shall cover both the DAC pilot system and balance-of-plant (BOP). BOP includes, but is not limited to, utilities such as compression, cooling water, water treatment, waste treatment, and the sources of energy, electricity, and/or steam that are necessary to power the DAC system. The BOP also includes CO_2 transport, CO_2 conversion (if applicable), and may include integration of an external energy source (e.g., grid electricity, solar, wind, and geothermal). If the DAC system is designed to purchase renewable electricity or to generate it on site, then the plant must include a method of energy storage or back-up power purchase or generation to supply electricity when renewable electricity is not available. Otherwise, the DAC plant design and cost should be reflective of the expected capacity factor of the power

generating source. The energy sources used should be clearly defined, and the impact of the energy sources on the net air capture rate should be clearly provided.

Any costs associated with CBP activities should also be included in the TPC estimate. Narratives accompanying cost estimates should include an explanation of the estimate class and/or maturity, a description of the methodology employed, and the uncertainty or accuracy range. While DOE is not requiring specific escalation assumptions be used for the application TPC, cost estimate narratives should explain what assumptions were used and why they were deemed appropriate. DOE may require use of standard cost estimating assumptions, including escalation assumptions in future phases.

Detailed Design Study – Requirements

It is understood that the content to be included in a detailed design package is tailored by the type of project and the needs of the owner. Often Engineering, Procurement, and Construction (EPC) firms will have an in-house standard in the absence or lack of owner definition. The goal of the detailed design is for the owner and EPC firm to collaboratively refine the project's scope, design, and cost estimate as much as possible to reduce risk and uncertainty prior to executing the project. Often, items 1–3 in the list below are provided by the owner to the EPC firm. **The following is a list of content to be included in the detailed design package developed by the end of Phase 3. Competitors are encouraged to include additional materials outside this list that resulted from the uniqueness of their respective project or the needs of the owner. Competitors are also encouraged to integrate detailed design activities with CBP requirements and activities as appropriate. ALL sections of the report should be cross-checked to ensure that the values agree between sections of the report(s). Missing appendices, section headings, and mislabeled figures should be avoided. Image quality should be checked; figures with unreadable text should not be included.**

- Project Background
    - Discusses project need or business objective
    - Includes major aims and conclusions of each of the subsequent chapters
- Project Scope
    - Provides a summary of the proposed project, the project objective, and how it will meet the objective
    - Delineates the roles and scope of work for the different parties involved in the project
    - Provides the system boundaries, or battery limits, of the proposed project
- Project Design Basis
- Site Characteristics
    - Location, topography, available land, transportation access, available utilities, access to water, access to carbon dioxide piping or storage sites
    - Social characterization, including regional analysis of communities and disadvantaged communities, and whether those communities rely on limited resources (e.g., water) that could be impacted by the project. This information should be consistent with the CBP.
    - Archaeology and culture studies
- Site Ambient Conditions
    - Elevation, prevailing wind, relative humidity, seismic data
    - Atmospheric pressure, temperature averages and extremes, air composition averages and extremes
- Fuel Feedstock: compositional analyses of any fuel used depicting the expected compositional range
- Environmental Requirements – as dictated by the authority(s) having jurisdiction (the state's Department of Environmental Protection [DEP] and the Environmental Protection Agency [EPA], etc.)

    - Air emission permitting limitations and required control technologies
    - Water discharge permitting limitations and required control technologies
    - Waste disposal (e.g., spent sorbents or solvents) permitting limitations and required control technologies
    - State- and federal-specific fish and wildlife permitting
    - Safety considerations – local fire department, community engagement
- Site-Specific Design Considerations: flood plain, soil conditions, rainfall/snowfall criteria, building/enclosure permitting, noise regulations, local community requirements for the proposed site
- Modularization Design Requirements
- Basic Contracting and Purchasing Strategy
    - Strategy for tracking cost and schedule performance, such as cost performance indicators from an earned value management system
    - Approved vendors list
    - Approved subcontractors list
    - Work breakdown structure
    - Procurement and inspection plan
- Quality Plan
- Engineering Design Packages
- Process Engineering
    - Process area descriptions
    - Finalized block flow diagrams (BFDs), process flow diagrams (PFDs), utility flow and distribution diagrams, and piping & instrumentation diagrams (P&IDs)
    - Detailed heat and material balances (H&MBs)
    - Effluent and emissions summary
    - Chemical summary
    - Process design calculations and process simulation report
    - DAC technology specific design details. This includes capture fraction; pressure drop across the contactor; working capacity or solvent loading; adsorption, desorption, and cycle times; selectivity; vacuum pressure; regeneration energy; steam requirement; system auxiliary load; sorbent or solvent initial fill and make up rates
    - Equipment and instrumentation lists and vendor datasheets. Process equipment specifications should include sizing and key parameters used for equipment costing (e.g., height, diameter, heat duty, delta temperature, power, and materials of construction)
    - Performance guarantees
    - Pre-commissioning, commissioning, operating, and maintenance procedures
    - Full team PHA documentation and process safety management documentation
    - Full pressure relief and flare study finalizing header/flare size
    - Finalized cause and effect diagrams
    - 3D piping drawings for inlet/outlet, valving, and piping
- Civil and Structural Engineering
    - Soil load analysis
    - Soils resistivity assessment
    - Storm water runoff plan
    - Geologic assessment
    - Spill containment assessment
    - Determination of type of foundation for various loads associated with process and balance of plant equipment
    - Construction quality civil layout, earthworks specifications, and grading drawings

    - Construction quality structural and architectural drawings (e.g., steel, building enclosures, and weather proofing)
    - Foundation design drawings (concrete sonotubes and slabs, helical pillars, etc.)
    - Process equipment/piping structural support steelwork specifications, layouts, and drawings
    - Buildings and weatherproofing specifications and drawings
    - Fireproofing requirements
    - Underground services and cable trench specifications, layouts, and drawings
    - Maintenance access drawings (e.g., gangways, ladders, platforms, handrails, and stairs)
    - Site fencing, paving, and road plan layout
    - Material take-offs
    - Reinforced concrete specifications, piling specification and layout, foundation and concrete structure details
    - All drawings shall be construction ready
- Mechanical Engineering
    - General site plan view(s)
- Detailed 3D model
    - Ensure necessary platforms and chain wheels for access to valves (both process and control) and instrumentation
    - Consider weatherproofing for personnel and equipment
    - Thermal and acoustical piping reviews
    - Piping/tracing/insulation line list and material specification
    - Piping isometrics
    - Piping layout/routing drawings for 1” diameter and larger pipes
- Electrical Engineering
    - Electrical load lists. Auxiliary power requirements for different sub-systems of the direct air capture system and balance of plant systems must be specified
    - Load flow analysis
    - Key one-line diagram, and one-line diagrams for emergency power
    - Cable/cable tray routing and underground duct bank layout drawings and specifications. Hanger design drawing and structural steel support drawing ready for construction
    - Lighting layout drawings
    - Grounding layout drawings
    - Electrical bulk material list and equipment list (substation, motor control centers, switchgear, transformers, power supplies, chargers, generators, control panels, packaged equipment, etc.), datasheets, drawings, front and interior layout, specification, sizing calculation, and maintenance and instruction manuals
    - Motor operated valve control schematic
    - Motor datasheets and schematic
    - Substation and switchgear building equipment layout drawings
    - Interconnection drawing between panels, and electrical installation details
    - Electrical wiring drawing
    - Heat tracing calculation and isometrics
- Instrumentation & Controls Engineering (System Integration)
    - Control system architecture specification
    - Instrument/equipment lists, valve lists, datasheets, and specifications
    - Control logic and loop diagrams
    - Instrument and control system schematics, hook up diagrams (electric, pneumatic, etc.), and location drawings

    - Communications infrastructure (e.g., remote SCADA ability, telephone, and internet) specifications
- Fire Protection Engineering
    - Fire protection system (e.g., sprinkler, foam, and water cannons) design specifications and drawings
    - P&ID for fire water ring main
    - Firefighting equipment list and layout, and extinguishing systems design
- Facilities Engineering
    - Building/Security Infrastructure Plans
    - Front office/administration
    - Control room(s)
    - Maintenance/shop area
    - HVAC
- Project Security
    - Site physical security
    - Cybersecurity and associated information protection systems
- Transportation & Logistics Study
    - Constructability
    - Construction access
    - Lay-down areas
    - Sequencing of construction work
- Project Cost Estimate (±5%) – Must specify year dollar basis and nominal vs. real
    - Individual component capital cost, including quantity (weight, lengths, numbers, etc.), unit rate, process equipment cost, material cost, labor cost including unit labor rate for individual line item, and man-hours required to complete individual line item tasks. The cost should be closest to $1,000. Details regarding what is included in the capital cost estimate (labor, materials, equipment, contingency, engineering fees, delivery, etc.) need to be provided.
    - Breakdown of variable operating costs, including quantity (weight, volume, etc.), per unit rate. The variable operation and maintenance (O&M) cost includes but is not limited to consumable consumption rates and unit costs, catalyst cost, specialty chemicals, waste generation rates and disposal costs, and power and fuel costs. Justifications for the unit costs should be provided where appropriate (e.g., power purchase agreements and waste classified as hazardous/nonhazardous)
    - Detailed accounting of fixed O&M costs should be provided. This includes labor rates and personnel requirements for operating labor, maintenance assumptions including labor and material required for annual maintenance, and administrative labor such as office support staff and supervisors.
- Owner's Costs
    - Cost of capture ($/net tCO_2e captured)
    - Cost of the CO_2 conversion product (if applicable)
    - Cost of removal ($/net tCO_2e removed)
    - Quantitative risk analysis and associated funding contingency requirements. Financial factors must be detailed. The methodology used to calculate the cost of CO_2 capture must be clearly outlined. Requested details include:
    - Interest rate, project life, debt-equity arrangement, taxes, insurance, contingency and other cost escalation
    - Owner's cost calculation details
    - Annualization calculation details

    - Calculated costs should take into account expected capacity and utilization factors and operational mode
- Integrated Project Schedule
    - Identification of the project critical path
    - A Level 4 schedule identifying associated milestones, including integration between engineering, procurement, construction, and startup and commissioning activities
    - Strategy for tracking schedule performance such as schedule performance indicators from an earned value management system.

Detailed Design Study Checklist

Based on prior experience with front-end engineering design (FEED) study reporting, the following checklist is provided to emphasize key pieces of information that should be contained in the detailed design reports (as a minimum). The items shown in the checklist are all included in the above explanation but are identified in this chart for emphasis.

Reporting Guidelines

Category	Topic	Description
Reporting	Report organization	This appendix gives an outline for important sections to be included in the detailed design report, and this outline should be followed. The executive summary should include a summary of all pertinent information and major aims and conclusions of each of the subsequent chapters upfront.
	Quality control	There should be no inconsistencies in reported values in different sections of the report. Missing appendices, section headings, and mislabeled figures should be avoided. Image quality should be checked; figures with unreadable text should not be included.

General Guidelines

Category	Topic	Description	Location in Text/ Page #
General	Project feasibility	An assessment of the feasibility of the project, as outlined in the detailed design, should be communicated clearly up front. If major design changes are required, this should be reflected in the project timeline with a path forward clearly outlined. Lessons learned should be highlighted.	
	Definition of roles	The roles and scope of work for the different parties involved in the project should be clearly delineated.	
	Sources used	A list of sources should be provided.	

Performance Guidelines

Category	Topic	Description	Location in Text/ Page #
Performance	Overall	1 - Comprehensive P&IDs for the facility should be provided. 2 - A 3D model with foundation, insulation, valves, and platforms for operator and maintenance access should be completed.	
	DAC process configuration	1 - The overall process flow diagram with main input and output streams should be highlighted. 2 - Detailed P&ID should be included. 3 - An equipment list with all major equipment specifications and sizing should be provided.	
	DAC system details	The process design and operation should be clearly described. DAC system details allowing comparison with other technologies are requested. These details include but are not limited to: 1 - Initial sorbent/solvent fill, and sorbent/solvent make up rates 2 - Performance metrics: capture fraction; pressure drop across the contactor; working capacity or solvent loading; adsorption, desorption, and cycle times; selectivity; vacuum pressure; regeneration energy; steam requirement; system auxiliary load.	
	Compression system details	Compression technology details allowing comparison with other technologies are requested. These details include: 1 - Compressor type 2 - Number of stages 3 - Intercooling and/or aftercooling requirements 4 - Electricity or steam requirement details 5 - Output pressure, CO_2 purity, and justification for product CO_2 stream purity and pressure.	
Performance	Stream tables	Energy and mass balance details should be provided. At a minimum this includes the flow rate, composition, temperature, pressure, density, and enthalpy for the following streams: 1 - Ambient air 2 - Process effluent and emissions streams 3 - Effluent from any air conditioning steps 4 - CO_2 product stream from the contactor 5 - CO_2 product after compression (with detailed impurities).	

	Steam requirement	The source, quality, and quantity of steam required by the process must be specified for each application, including: 1 - Solvent/sorbent regeneration steam 2 - Compression system steam (if applicable) 3 - Other miscellaneous applications such as triethylene glycol (TEG) drying.	
	Auxiliary power	1 - Auxiliary power requirements for different sub-systems of the DAC system and balance of plant systems must be specified. A detailed electrical load list should be provided. 2 - The power source should also be specified (e.g., purchased from grid, dedicated renewable energy source, and auxiliary combined heat and power [CHP] with carbon capture). The impact of the power source on the net air capture rate should be detailed.	
	Justification of design	Justification for all major design decisions should be provided. This includes: 1 - Results from any case studies performed when deciding on the specific configuration 2 - DAC system (and any non-commercially available system at scale) modeling details including model basis and validation, system modeling results, and justification for any design decisions that deviate from the modeled system 3 - Justification for product CO_2 stream purity and pressure.	

Cost Guidelines

Category	Topic	Description	Location in Text/ Page Numbers
Cost	Dollars	The year dollar must be provided and nominal vs. real dollars specified for clarity. The capital cost estimate should be consistent with AACE Class 1 accuracy ±5%.	
	Cost details	Detailed costs should be provided. This includes: 1 - Capital cost: preferably includes costs for individual pieces of equipment, but at a minimum provides totals for the DAC system, compression system, and BOP. Details regarding what is included in the capital cost estimate (labor, materials, equipment, contingency, engineering fees, delivery, etc.) need to be provided. 2 - O&M costs: a detailed accounting of O&M costs should be provided. This includes labor rates and personnel requirements, maintenance assumptions, insurance, property taxes, consumable consumption rates and unit costs, waste generation rates and disposal costs, and power and fuel costs. Justifications for the unit costs should be provided where appropriate (e.g., power purchase agreements and waste classification as hazardous/nonhazardous). 3 - Owner's costs. 4 - Cost of capture ($/net tonne of CO_2e captured by DAC technology). 5 - Cost of the CO_2 conversion product (if applicable). 6 - Overall cost of removal ($/net tonne of CO_2e removed by integrated DAC system).	
	Costing methodology	Financial factors must be detailed. The methodology used to calculate the cost of CO_2 capture must be clearly outlined. See NETL's Quality Guidelines for Energy Systems Studies: Cost Estimation Methodology for NETL Assessments of Power Plant Performance, Department of Energy, Pittsburgh, Pa, 2021 for an example of the detail requested. Requested details include: 1 - Expenditure period, operating period, capital escalation during expenditure, assumed inflation rate, O&M escalation, O&M levelization factor, sales tax rates, debt-equity arrangement, interest rate on debt, return on equity, fixed charge factor, etc. 2 - Owner's cost calculation details 3 - Annualization calculation details.	

Detailed Design Value Template

Based on prior experience with FEED study reporting, it is suggested that this template is adapted for the competitor's specific technology, completed, and submitted with the detailed design report. To assist teams, elective templates are provided below. Teams are not required to use this template, but if teams should elect to use their own format, they must make sure to include all the substantive information included in the template below. This facilitates review of the final design parameters. The values in this table should agree with the values throughout the report. All parameters relevant to the specific DAC system should be reported. Additional relevant entries, not included in this table, should be added. DOE G 413.3-21A *Cost Estimating Guide*: https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-21A.

Parameter	Units	Value	Location in Text/ Page Numbers
DAC System Design Basis and Performance			
Ambient Air Design Basis Range Note: If air is comingled with any streams or pretreated upstream of the CO_2 removal step (e.g., with a desiccant), this information must be provided for all streams prior to the CO_2 removal step.	°F		
	psia		
	ppmv CO_2		
	mol% H_2O		
	mol% N_2		
	mol% O_2		
	Other notable constituents/ pollutants		
Auxiliary Load of DAC	MW		
Auxiliary Load of CO_2 Compression	MW		
Auxiliary Load of BOP equipment	MW		
Electrical Auxiliary Boiler Load (if applicable)	MW		
Heat Requirement (if applicable)	MW		
Heat Source	--		
Auxiliary Boiler Steam Generation	lb/hr		
	psia		
Steam for Sorbent/Solvent Regeneration	lb/hr		
	psia		
	Direct/indirect		
Capacity Factor of Power/Heat Source	%		
Utilization Factor of DAC	%		

Air Inlet to DAC Process	lb/hr		
Contactor CO_2 Capture Fraction	%		
Gross DAC CO_2 Capture Capacity	tonnes/yr.		
Gross Plant CO_2 Capture Capacity	tonnes/yr.		
Net CO_2 Capture Capacity	tonnes/yr.		
CO_2 Stream Leaving the DAC Contactor, or for Multistage Processes, CO_2 Stream Leaving Each Stage	lb/hr		
	mol% CO_2		
	mol% H_2O		
	mol% O_2		
	°F		
	psia		
	lb/mol		
CO_2 Product After Compression	lb/hr		
	°F		
	psia		
	mol% CO_2		
	ppm_v H_2O		
	ppm_v O_2		
Pressure Drop Across the Air Contactor	psi		
Air Superficial Velocity	ft/s		
Contactor Depth	ft		
Water Consumption of the DAC System	lb/hr		
Number of Contactor Modules			
Initial Solvent Fill	tonne		
Solvent Make-up Rate	tonne/yr.		
Solvent Loading	mol/mol		
Solvent Regeneration Energy	Btu/lb CO_2		
Sorbent Initial Fill	tonne		
Sorbent Life	years		
Sorbent Working Capacity	mol/kg		
Sorbent Bulk Density	lb/ft^3		
Sorbent Void Fraction			
Sorbent Selectivity	CO_2/N_2		
	CO_2/O_2		
	CO_2/H_2O		

Sorbent Vacuum Pressure	psia		
Specific Sorbent Regeneration Energy	Btu/mol CO_2		
Adsorption Time	s		
Desorption Time	s		
Cycle Time	s		
Costs			
Dollar Basis	Year		
	Real or nominal		
Capital Cost Accuracy	±%		
DAC System Capital Cost			
Equipment	$		
Material	$		
Direct and indirect labor for installation and construction	$		
Engineering Contracting	$		
Process Contingencies	$		
Project Contingencies	$		
CO_2 Compression System Capital Cost			
Equipment	$		
Material	$		
Direct and indirect labor for installation and construction	$		
Engineering Contracting	$		
Process Contingencies	$		
Project Contingencies	$		
BOP and Modifications Capital Cost			
Equipment	$		
Material	$		
Direct and indirect labor for installation and construction	$		
Engineering Contracting	$		
Process Contingencies	$		
Project Contingencies	$		
Solvent Costs			
Initial Fill	$		
Solvent Make-up	$/yr		
Unit Price	$/tonne		
Sorbent Cost			
Initial Cost Per Module	$		
Initial Fill Cost (Sorbent)	$		
Replacement Cost	$/yr		

Unit Cost	$/tonne		
Solvent or Sorbent Waste Disposal	$/tonne		
	$/yr.		
Natural Gas (if applicable)	$/MMBtu		
	$/yr		
Electricity	$/MWh		
	$/yr		
Other Consumables/Waste Disposal	$/yr		
Maintenance Allowance	$/yr		
Operating and Maintenance Labor Costs	$/yr		
Property Taxes/Insurance	$/yr		
Expenditure Period	years		
Operating Period	years		
Inflation	%		
Capital Escalation During Expenditure	%		
O&M Escalation	%		
O&M Levelization Factor	%		
Effective Sales Tax Rate (State and Federal)	%		
Debt-to-Equity Ratio			
Interest Rate on Debt	%		
Return on Equity	%		
Fixed Charge Factor			

Appendix 15: Reviewer Scoring Rubrics

15.1 Phase 1 – Concept

Submission	Weight
Concept Paper	60%
Pre-FEED Study Summary	20%
Bench-Scale Operating Data	10%
State-Point Data Tables	10%
Pre-FEED Study	Complete / Incomplete
Environmental Questionnaire	Complete / Incomplete

Using the below scale in increments of 1, please rate the extent to which you agree with each of the following statements for the corresponding section of the application.	
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

Concept Paper

Technology Proposal		
Statement	Score	Weight
The proposed DAC (and CO_2 conversion, if applicable) pilot has the potential to operate for at least 2,000 hours and to capture (and convert, if applicable) at least 500 tCO_2/yr during the prize competition.		20%
The technical description of the proposed DAC (and CO_2 conversion, if applicable) technology is sufficiently detailed and addresses each of the key parameters.		15%
The proposed technology is technically sound and consistent with scientific principles.		15%
The bench-scale and/or pre-commercial operating data provided to the NETL EDX platform are summarized and demonstrate the ability of the DAC pilot to operate at the required scale during the prize competition.		5%
The proposed DAC (and CO_2 conversion, if applicable) technology does not have inherent resource requirements (energy, land, water, etc.) that would prevent the technology from scaling beyond the prize competition.		15%
Winning a prize in the Concept Phase will significantly increase the team's chances of creating a viable business out of their DAC technology.		10%
The initial risk analysis effectively identifies major risks and thoroughly discusses mitigation strategies.		10%

The proposed DAC technology is unique, innovative, and, if successful, would advance the field of carbon removal.		10%
Technology Proposal Weighted Average		**50%**

Team, Network, and Resources		
Statement	Score	Weight
The team has the requisite commitment, skills, and experience to successfully deliver a DAC pilot system within the timeframe of the prize.		30%
The team has access to the necessary physical and financial resources to successfully deliver the proposed DAC pilot system.		30%
The team describes their strategy to develop a comprehensive Community Benefits Plan.		20%
The proposed CBP activities include plans to establish strategies and partnerships to advance implementation of CBP goals as project progresses toward operation.		10%
The team appropriately identifies any resource deficits and plans to resolve these insufficiencies during the prize competition.		10%
Team, Network, and Resources Weighted Average		**10%**

Business Model, Cost Estimate, and Regulatory Requirements		
Statement	Score	Weight
A business model that will support deployment at scale is discussed and is reasonable.		10%
A quantitative description of key cost drivers and price points is provided and reasonably inclusive.		30%
The team provides a complete and accurate cost estimate for all prize execution activities through Phase 4, including any cost reduction plans.		20%
The team proactively identifies potential financial, regulatory, or resource bottlenecks that could delay construction of the DAC pilot system and proposes appropriate contingencies and safeguards to address these issues.		15%
Discussion of regulatory and compliance requirements is provided with coverage of all permits necessary to initiate construction of the DAC pilot and the team's corresponding permitting plans.		15%
The team's long-term plan beyond this prize contest is logical and well-reasoned.		10%
Business Model, Cost Estimate, and Regulatory Requirements Weighted Average		**15%**

Project Objectives and Approach		
Statement	Score	Weight
The team's objectives are clearly stated and evince the necessity of pilot testing to the advancement of the DAC technology.		20%
The proposed approach is innovative and built on reasonable assumptions, valid technical foundations, and lessons learned from other notable efforts in this industry.		20%

The plan is adequately detailed and supports the ability of the team to complete the activities required to be awarded in all phases of this prize competition.		40%
Performance metrics and corresponding targets are present, appropriately defined, and realistic for the proposed technology.		20%
Project Objectives and Approach Weighted Average		**10%**

Preliminary Life Cycle Assessment (LCA)		
Statement	Score	Weight
The provided emissions estimate is robust and contains coverage of all relevant contributors, including materials, energy, transportation, equipment, land-use change, waste disposal, other utilities, etc.		40%
The applicant has provided quantitative data as part of the preliminary LCA where possible and qualitative discussion where not possible.		20%
The proposed DAC process is likely to durably achieve negative emissions when considering emissions impacts across the technology's material and energy supply chain and is unlikely to result in significant non-GHG environmental harm.		30%
The preliminary LCA identifies sources of uncertainty and details a plan to overcome them.		10%
Preliminary Life Cycle Assessment Weighted Average		**15%**

Pre-FEED Study Summary

Statement	Score	Weight
The pre-FEED study summary includes all suggested content in Appendix 9.		25%
The pre-FEED study summary demonstrates the technical and economic feasibility of the proposed DAC pilot system.		75%

Bench-Scale Operating Data

Statement	Score	Weight
Submitted bench-scale operating data represents at least 500 of not-necessarily-continuous hours of integrated, bench-scale operation of the proposed technology using ambient air.		60%
The bench-scale operating data submitted to NETL's EDX platform are accurately summarized in the concept paper.		20%
Techniques used to record the bench-scale operating data are standard and legitimate.		20%

State-Point Data Tables

Statement	Score	Weight

The state-point data tables are completed based on the measured and projected system testing of the DAC technology.		50%
The data in the state-point data tables are realistic and consistent with the rest of the application.		50%

15.2 Phase 2 – Engineer

Submission	Weight
Summary of FEED Study	40%
Phase 3 Plans	10%
Bench-Scale Operating Data	10%
State-Point Data Tables	10%
Life Cycle Assessment	10%
Community Benefits Plan	10%
EH&S Risk Assessment	10%
Complete FEED Study	Complete / Incomplete
Environmental Information Volume	Complete / Incomplete
Host Site Commitment Letter	Complete / Incomplete

Using the below scale in increments of 1, please rate the extent to which you agree with each of the following statements for the corresponding section of the application.

Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

FEED Study Summary

Statement	Score	Weight
The information provided in the summary of the DAC pilot system FEED, including mass and energy balances, estimates of heating and cooling duties and electric power requirements covering the DAC system and required balance-of-plant through CO_2 disposition, and cost of CO_2 removal, is adequate and complete.		40%
The FEED study summary demonstrates the technical and economic feasibility of the proposed DAC pilot system.		25%
The FEED study integrates detailed design activities with CBP requirements and activities as appropriate for the project.		15%

The team's most recent bench-scale operating data provided to the NETL EDX platform are summarized and demonstrate the ability of the DAC pilot to operate at the required scale during the prize competition.		10%
A climate resilience strategy that accounts for a range of climate impacts to the DAC pilot is outlined.		10%

Phase 3 Plans

Statement	Score	Weight
There are no major financial, regulatory, permitting, or resource hurdles that will prevent or delay the construction of the DAC pilot system.		20%
The provided workplan is high-quality and achievable on the proposed schedule.		20%
Relevant verifiable milestones from the CBP are included in workplan.		20%
The provided procurement plan is feasible and verifiable.		10%
The team has identified all the permits necessary to initiate construction of the DAC pilot.		10%
The team provides a list of the permits they have acquired and a plan to attain necessary permits that have not yet been acquired.		20%

Bench-Scale Operating Data

Statement	Score	Weight
Submitted bench-scale operating data represents at least 500 non-continuous hours of integrated, bench-scale operation of the proposed technology using ambient air.		60%
The bench-scale operating data submitted to NETL's EDX platform are accurately summarized in the summary of the FEED Study.		20%
Techniques used to record the bench-scale operating data are standard and legitimate.		20%

State-Point Data Tables

Statement	Score	Weight
The state-point data tables are completed based on the measured and projected system testing of the DAC technology.		50%
The data in the state-point data tables are realistic and consistent with the rest of the application.		50%

Life Cycle Assessment

Statement	Score	Weight
The competitor provides a rigorous and comprehensive LCA of their DAC pilot system with assumptions and results clearly stated.		50%
Full discussion of the low-carbon energy procurement is provided, inclusive of use of any behind-the-meter (BTM) energy resources, siting in grid regions with low-carbon generation, renewable energy certificates (RECs), power purchase agreements (PPAs), and 24/7 carbon-free energy (CFE) strategies.		30%
The LCA is prepared in the format provided in Appendix 4 and demonstrates robust accounting of full life cycle environmental impacts.		20%

Community Benefits Plan

Statement	Score	Weight
When implemented, the CBP will advance each of the following goals: 1) support meaningful community and labor engagement; 2) invest in quality jobs and the American workforce; 3) advance diversity, equity, inclusion, and accessibility (DEIA); and 4) contribute to the President's goal that 40% of the overall benefits from certain federal investments flow to disadvantaged communities (the Justice40 Initiative).		50%
The CBP specifically and convincingly demonstrates how the proposed DAC pilot will provide societal benefits and mitigate/minimize negative impacts to workers and communities.		10%
The CBP includes plans for analysis, workforce, and/or engagement efforts that address community, labor, and workforce desires and/or concerns which go beyond regulatory compliance and technical, business, environmental, labor, and other project requirements.		10%
The CBP is integrated into the project management schedule and other key documents and provides mechanisms, supported by measurable actions, to impact project direction in a timely manner.		20%
The CBP is consistent with the requirements and guidance of Appendix 7.		10%

Environmental Health & Safety Risk Assessment

Statement	Score	Weight
The EH&S Risk Assessment is complete, addresses each of the topics listed above, and is submitted in accordance with the format provided in Appendix 5.		90%
There are no environmental risks that jeopardize the delivery of the pilot on the prize timeline.		10%

15.3 Phase 3 – Permit

Submission	Weight
Summary of Detailed Design	40%
Phase 4 Plans	40%
Community Benefits Outcomes and Objectives Report	20%
Complete Detailed Design	Complete / Incomplete
NEPA Compliance Determination	Complete / Incomplete
Permit Approvals	Complete / Incomplete

Using the below scale in increments of 1, please rate the extent to which you agree with each of the following statements for the corresponding section of the application.	
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

Summary of Detailed Design

Statement	Score	Weight
The information provided in the summary of the DAC pilot system detailed design, including final mass and energy balances, heating and cooling duties and electric power requirements covering the DAC system and required balance-of-plant through CO_2 disposition, and cost of CO_2 removal, is adequate and complete.		25%
The detailed design summary demonstrates the technical and economic feasibility of the proposed DAC pilot system.		25%
The team has provided justification for all major design decisions.		10%
The values referenced in the detailed design summary agree across sections of the entire detailed design report.		10%
Energy sources and the impact of the energy sources on the net capture rate have been provided.		10%
The team integrates detailed design activities with CBP requirements and activities as appropriate for the project.		10%

The team has shown the ability to improve their DAC (and CO_2 conversion, if applicable) technology by demonstrating advances between Phases 2 and 3 of this prize competition.		10%

Phase 4 Plans

Plans and Proposed Milestones		
Statement	Score	Weight
There are no major financial, regulatory, permitting, or resource hurdles that will prevent or delay the construction of the DAC pilot system.		20%
The DAC pilot system is likely to hit major construction milestones, be constructed, commissioned, and begin operation on schedule, within the established timeframes of this prize.		20%
The provided workplan is high-quality and achievable on the proposed schedule.		20%
The provided indicators are well-defined, easily measurable, and represent accurate identifiers of progress toward completing construction and/or commissioning.		20%
Relevant milestones from the CBP are included in workplan.		10%
The provided procurement plan is feasible and verifiable.		10%

Plans and Proposed Milestones		**40%**

Pre-Operational Milestone Verification Strategy		
Statement	Score	Weight
The team has provided a sufficient and comprehensive milestone verification plan.		45%
The milestone verification strategy will allow for reviewers to objectively determine that milestones have been achieved.		45%
The proposed submission packages for system construction completion and system commissioning are satisfactory.		10%

Pre-Operational Milestone Verification Strategy		**30%**

Operational Verification Strategy (MMRV Plan)		
Statement	Score	Weight
The operational verification strategy describes, in detail, how the operational data will be independently monitored, measured, reported, and verified.		30%
The provided plan will allow competitors and any independent MMRV partners to accurately perform the work required to compete for operational Phase 4 prizes.		30%
The operational verification strategy describes how DOE will verify the independence of all reported operational data.		20%
The proposed MMRV plan is comprehensive and sufficiently detailed.		20%

Operational Verification Strategy (MMRV Plan)		**30%**

Community Benefits Outcomes and Objectives Report

Statement	Score	Weight
Teams have completed the Summary Table to reflect the commitments and relevant time-based milestones completed up to this point in the prize timeline.		75%
The Community Benefits Outcomes and Objectives Report milestones are laid out in quantifiable terms with SMART milestones.		25%