U.S. DEPARTMENT OF ENERGY

Carbon Management Collegiate Competition

January–May 2023

Preface

The U.S. Department of Energy's Carbon Management Collegiate Competition 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 and notify registered prize participants.

Date	Modification

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1 | Executive Summary

In support of the Biden administration's decarbonization goals, the U.S. Department of Energy (DOE) Office of Fossil Energy and Carbon Management is launching the American-Made Carbon Management Collegiate Competition. This competition aims to engage teams of undergraduate and graduate students to propose a regional carbon network to transport at least 1 million metric tons of carbon dioxide (CO_2) per year. These proposals must include a defined transport network business model optimized across five parameters. In addition, proposals must demonstrate consideration of regional stakeholders, anticipated future demand, and cost variability.

The competition aims to inspire students to consider career opportunities in carbon management, learn industry-relevant skills, engage with industry professionals in community and energy transition roles, and gain hands-on experience to lead the next generation of carbon management development. As competitors, students:

- Gain experience with innovative carbon dioxide removal and carbon management.
- Develop real-world concepts that can shape the future of carbon management.
- Collaborate with multifunctional teams across majors and disciplines.
- Compete to earn a portion of the $25,000 cash pool, along with national recognition.

The Carbon Management Collegiate Competition invites teams of at least three students enrolled in accredited U.S.-based collegiate institutions or U.S. citizens at non-U.S.-based collegiate institutions. In this case, "collegiate institution" refers to any school of post-secondary or higher education, including but not limited to community colleges, technical colleges, and traditional 4-year and graduate-level universities. Faculty participation is welcomed and optional, but the faculty participant does not count toward the three-student requirement. See Section 1.3 for more eligibility information. There is no cost to register or participate.

Teams must represent more than one major. The competition targets majors or specializations in anthropology and sociology; business and management; computer and data sciences; engineering; environmental science and geosciences; geography; geographic information systems (GIS); planning; law; and public policy and economics. Each team is highly encouraged to have representation across two or more disciplines.

1.1 Prizes

The Carbon Management Collegiate Competition offers a total prize pool of $25,000 in cash. There will be three winners, with first place receiving $12,000; second place receiving $8,000; and third place receiving $5,000.

Cash prizes are paid to the team captain upon receipt of proof of school enrollment, Internal Revenue Service (IRS) Form W-9, and Automated Clearing House (ACH) banking information.

In addition, the winning teams will be invited to present their winning proposal at DOE's Carbon Management Annual Project Review Meeting. All three winning teams and their respective collegiate institutions will be publicly recognized.

1.2 Key Dates

- **Competition Opens:** January 2, 2023
- **Midway Check-In Submission (Required):** 5 p.m. EST on February 28, 2023

- **Final Submission Closes:** 5 p.m. EST on April 17, 2023
- **Winner Announcement:** May 22, 2023 (anticipated)
- **Presentation at DOE Annual Project Review Meeting:** August 2023, Pittsburgh, PA.

1.3 Eligibility and Competitors

The Carbon Management Collegiate Competition invites teams consisting of at least three students that meet the following criteria:

- All participating students must be enrolled in an accredited collegiate institution. Students must be enrolled in at least one class and be pursuing a degree throughout the duration of the competition.
    - For the purposes of this competition, "collegiate institution" refers to a school of post-secondary or higher education, including but not limited to community colleges, colleges, and universities. Collegiate students of any level are eligible to compete. Teams with students from multiple universities are allowed, and multiple teams from the same university are allowed. Individual students may be members of only one team.
- The team captain and HeroX account holder for the team submission must be a U.S. citizen.
    - Teams may represent U.S.-based or non-U.S.-based accredited collegiate institutions, provided the team captain is a U.S. citizen.
    - For teams representing non-U.S.-based accredited collegiate institutions, the team captain and all team members must be U.S. citizens.
- Members of the expert reviewer panels, competition administrator staff, and DOE and national laboratory employees are ineligible to compete.
- Teams are encouraged to have at least one faculty advisor; however, an advisor is not required for participation. The faculty advisor is not an official team member and does not count toward the minimum requirement of three participating students per team.
- By uploading a submission package, a team self-certifies that they comply with the eligibility requirements. If the competition administrator becomes aware that a team or individual is not eligible, that team may be disqualified from the competition.

1.4 Diversity, Equity, and Inclusion

It is the policy of the Biden administration that:

"The federal government should pursue a comprehensive approach to advancing equity for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality. Affirmatively advancing equity, civil rights, racial justice, and equal opportunity is the responsibility of the whole of our government. Because advancing equity requires a systematic approach to embedding fairness in decision-making processes, executive departments and agencies must recognize and work to redress inequities in their policies and programs that serve as barriers to equal opportunity. By advancing equity across the federal government, we can create opportunities for the improvement of communities that have been historically underserved, which benefits everyone."

As part of this whole-of-government approach, this competition seeks to encourage the participation of disadvantaged communities and underrepresented groups. Teams are highly encouraged to include individuals from groups historically underrepresented in science, technology, engineering, and mathematics (STEM) on their project teams. Teams are also highly encouraged to consider project

concepts aligned with *Executive Order 14008: Tackling the Climate Crisis at Home and Abroad*[1] and the Justice40 Initiative.[2] Under the Justice40 Initiative, implementation efforts of carbon management projects will support the goal that 40% of the overall benefits flow to disadvantaged communities.

Further, minority-serving institutions, minority business enterprises, minority-owned businesses, woman-owned businesses, veteran-owned businesses, or entities located in an underserved community that meet the eligibility requirements are encouraged to participate in this competition. The Judging Committee may consider the inclusion of these types of entities as part of the selection decision.

2 | Background

The Carbon Management Collegiate Competition is part of the American-Made Challenges program, funded by DOE and administered by the National Renewable Energy Laboratory (NREL) to incentivize innovation and fast-track the clean energy revolution. The American-Made Challenges program includes prizes, training, teaming, and mentoring to accelerate solutions by lowering the barriers faced by innovators. These prizes fast-track product development timelines from years to months, speed innovator progress thanks to rapid prize timelines and goals, and create partnerships that connect entrepreneurs to increased opportunities.

2.1 Prize Background

Greenhouse gas emissions are a key contributor to climate change. The Biden administration has identified a decarbonization goal to achieve a carbon-pollution-free electricity sector by 2035 and economywide net-zero greenhouse gas emissions by 2050. Meeting these goals requires strategic planning and accelerated development of a nationwide carbon transport infrastructure to support carbon capture, utilization, and storage (CCUS) and carbon dioxide removal (CDR) projects.[3]

Today, there are approximately 5,000 miles of carbon dioxide pipelines across the United States, with significant scale-up of transport capacity demand projected to align with these decarbonization goals. Recent studies have evaluated scenarios for over 13,000 miles of new CO_2 transport trunk pipelines and over 52,000 miles of spur pipelines to service the conversion and permanent geologic storage of 1 billion metric tons of CO_2 per year by 2050.[4] This finding is also supported in the 2021 National Academies of Sciences, Engineering, and Medicine report *Accelerating Decarbonization of the U.S. Energy System*, which conducted a review of U.S. decarbonization studies.[5]

In order to be eligible for the competition, proposals must consider CO_2 transported from at least one anthropogenic source to one or more CO_2 conversion locations and/or one or more permanent geologic storage locations. The CO_2 must be derived only from anthropogenic sources, which could include point-source CO_2 locations and CO_2 removal sources. Point-source CO_2 locations can include power generation, iron and steel manufacturing, cement manufacturing, and chemical manufacturing. CO_2 removal sources

[1] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/

[2] The Justice40 initiative, established by Executive Order 14008, set a goal that 40% of the overall benefits of certain federal investments flow to disadvantaged communities. The interim guidance defines benefits as direct and indirect investments (program outcomes) that positively impact disadvantaged communities and provides examples starting on page 4—see memorandum on "Interim Implementation Guidance for the Justice40 Initiative" (July 20, 2021).

[3] https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf

[4] https://netzeroamerica.princeton.edu/the-report

[5] https://nap.nationalacademies.org/catalog/25932/accelerating-decarbonization-of-the-us-energy-system

can include direct air capture and biomass carbon removal and storage. Geologic storage locations can include geologic CO_2 saline storage, geologic CO_2 basalt storage, or CO_2 geologic storage in depleted oil and gas reservoirs. CO_2 conversion can include locations that convert CO_2 into carbon-based chemicals and/or materials. Proposals with CO_2 conversion must not result in the release of CO_2 back into the atmosphere from the manufactured product.

Several modes of transporting CO_2 have been identified—namely pipeline, ship, barge, truck, rail, or a combination thereof—and each scenario will have different associated regional challenges, costs, and benefits.[6,7] A critical component of nationwide CO_2 transport deployment will be to optimize routing and transport pathways by considering operational safety, life cycle carbon accounting, climate change impacts, environmental justice, and sustainable economic and business models at regional and national levels.

In order to advance innovation in regional carbon transport networks, this competition seeks to mobilize a diverse range of backgrounds and perspectives—including participants from underserved communities and underrepresented minorities in STEM fields—to support DOE's mission for an equitable path to net zero. This includes, but is not limited to, participants associated with minority-serving institutions, historically Black colleges and universities, and tribal colleges and universities. The Judging Committee may consider the inclusion of these individuals and institutions as part of the selection decision. Additionally, proposals will identify community impacts and respective engagement strategies, while emphasizing the consideration of disadvantaged, minority, indigenous, and tribal communities within the proposed regional carbon transport networks.

DOE has a history of supporting workforce development through competitions focused on project-based learning (e.g., Solar Decathlon, Collegiate Wind Competition, EcoCAR Mobility Challenge, Cleantech University Prize). Student competitors in the Carbon Management Collegiate Competition gain experience solving relevant industry challenges that prepare them for careers in carbon management and related energy fields while benefiting from training, collaboration, and mentorship. This competition supports DOE's ongoing work advancing carbon management technologies to achieve our nation's decarbonization goals and promote continued innovation through federally supported research, development, and demonstration of these technologies.

2.2 Program Goal Requirements

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

- The proposed solution is related to the carbon management industry.
- The majority of 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.
- Teams include students from more than one major.
- The proposed solution represents an innovation that will move the industry beyond its current state.
- 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.

[6] https://dualchallenge.npc.org/files/CCUS-Chap_6-030521.pdf
[7] https://betterenergy.org/blog/gpi-carbon-and-hydrogen-hubs-atlas/

2.3 Find Help: American-Made Network

The American-Made Network cultivates resources and builds connections that enhance, accelerate, and amplify competitors' efforts. The objective is to link participants with the people, resources, financing, perspectives, and industry expertise necessary for long-term success.

Power Connectors: Power Connectors are external organizations who play a substantial role in the competition and receive funds to expand and amplify DOE and NREL's efforts. They are deeply involved with prize program execution, recruitment, and support. These organizations are contracted to perform a variety of tasks for specific prizes that advance program successes—extending the reach and improving the diversity and inclusivity of the network overall. Power Connectors are anticipated to support student innovators with the resources they may need related to environmental justice, social impacts, and engagement considerations for this competition.

Updates on Power Connector information sessions, mentorship contacts, and office hours will be periodically posted on the HeroX platform, and competitors are encouraged to leverage these opportunities.

2.4 Additional Requirements

Please read and comply with additional requirements in Appendix 1.

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

3 | Submission Requirements and Review Process

3.1 Goal

The Carbon Management Collegiate Competition is designed to inspire students to consider new career opportunities, learn carbon management industry-relevant skills, engage with industry professionals working on community and energy transition considerations, and gain hands-on experience to lead the next generation of carbon management development.

3.2 Prizes

Prizes for the Carbon Management Collegiate Competition are as follows:

- First Place: $12,000 cash prize
- Second Place: $8,000 cash prize
- Third Place: $5,000 cash prize.

In addition, the winning teams will be invited to present their winning proposal at DOE's Carbon Management Annual Project Review Meeting.

3.3 How To Enter

Go to HeroX and follow the instructions to register and submit all required materials before the listed deadlines. Competitors also have the ability to form teams or find partners through the HeroX platform.

The site URL is: https://www.herox.com/carboncomp

Note: To be considered for the final submission, participants **must** complete the midway check-in.

3.4 Important Dates

- **Competition Opens:** January 2, 2023
- **Midway Check-In Submission (Required):** 5 p.m. EST on February 28, 2023
    - See Section 3.6
- **Final Submission Closes:** 5 p.m. EST on April 17, 2023
- **Winner Announcement:** May 22, 2023 (anticipated).

3.5 Narrative Content: The Five Parameters

The final submission report will detail a business plan for a proposed carbon transportation network. This report will include a narrative description of the five parameters, an Excel spreadsheet outlining life cycle analysis (LCA) calculations, and a map of the network in GIS or Google Maps format.

The narrative proposal must consider the following five parameters:

1. Economics and Business Model Proposals must align with net-zero decarbonization goals and be capable of transporting at least 1 million metric tons of CO_2 per year at technically feasible, standard operating pressures and temperatures of CO_2 or appropriate CO_2-carrier material for transport. The proposed regional carbon transport networks must be located within the United States.
2. Operational Safety Considerations Proposals must include a range of operational safety considerations to ensure a safe and reliable CO_2 transport network that supports the deployment of CCUS and CDR.
3. Life Cycle Analysis The LCA framework can help support decision-making as part of the energy transition. Proposals must include a series of LCA calculations and determinations to support their plans.
4. Climate Change Projected Impacts Proposals must consider climate change projected impacts and resiliency considerations.
5. Environmental Justice, Social Impacts, and Engagement Teams must identify potential impacts (benefits/harms) of their proposal. Proposals must include a strategy to engage with communities within the regional carbon transport network to ensure the proposal centers disadvantaged communities and/or tribes and indigenous communities. Teams are encouraged to demonstrate collaboration with college and university staff and experts who are already working on these community engagement efforts.

3.6 Midway Check-In Submission: What To Submit

To be eligible for the final submission, teams are required complete a midway check-in. The check-in provides an opportunity for teams to receive feedback and identify areas for refinement prior to the final submission deadline. The questions included in the midway check-in are also in the final submission. Therefore, teams can use their midway check-in to build toward the final narrative.

For your midway check-in, please provide a narrative draft answering one question from each of the five parameters. These answers are not graded, and your responses for each question may change in the final submission. Teams are required to submit their narrative draft by 5 p.m. EST on February 28, 2023, via the HeroX platform.

The template for completing the midway check-in is provided on HeroX in the Resources section. The questions included in this narrative draft are below:

Midway Check-In Narrative

Parameter 1: Economics and Business Model

Overview: Proposals must align with net-zero decarbonization goals and be capable of transporting at least 1 million metric tons of CO_2 per year at technically feasible, standard operating pressures and temperatures of CO_2 or appropriate CO_2-carrier material for transport. The proposed regional carbon transport networks must be located within the United States.

- Introduce your proposed carbon transport network.
    - For the identified mode(s) of transport in the proposed transport network, define the volume, boundaries, pressure and temperature conditions, and, if needed, intermodal storage facilities.
    - Calculate the unit cost of CO_2 transport mode(s) proposed and identify the location and volume of anthropogenic CO_2 sources—point-source capture or carbon dioxide removal sources—and sinks, including secure geologic storage locations and/or CO_2 conversion locations to carbon-based products.

Parameter 2: Operational Safety Considerations

Overview: Proposals must include a range of operational safety considerations to ensure a safe and reliable CO_2 transport network that supports the deployment of CCUS and CDR.

- What safety considerations do you propose within this network?
    - Summarize CO_2 handling and safety considerations for any CO_2 transportation mode (ship, barge, train, rail, or pipeline) utilized in your transport network.

Parameter 3: Life Cycle Analysis

Overview: The LCA framework can help support decision-making as part of the energy transition. Proposals must include a series of LCA calculations and determinations to support their plans.

- Analyze and summarize potential life cycle environmental impacts for the different CO_2 transportation modes and scenarios from point of capture to disposition using the principles of LCA.
    - This analysis is strictly focused on carbon dioxide transport and does not include emissions accounting at capture, utilization, or storage.
    - The functional unit for the LCA should be the transport of 1 metric ton of CO_2 over a defined distance in the transportation network.
    - All calculations should be documented in a spreadsheet model. The Resources section of HeroX contains a summary of the life cycle data that should be used to support these calculations.
    - It is not expected that the teams will have a complete LCA model at this point in the project. The narrative should be used to describe the approaches and challenges in applying LCA to this project, along with any key considerations for investigation in the final submission.

Parameter 4: Climate Change Projected Impacts

Overview: Proposals must consider climate change projected impacts and resiliency considerations.

1. Identify what projected climate change impacts are most relevant to each component of your transportation network through research and case studies.
    - Assess the vulnerabilities of each component or mode of transport in your proposed network.
    - Climate change projected impacts under consideration for this parameter include risks from wildfire, geohazards, ground subsidence, earthquakes, sea level rise, hurricanes, floods, droughts, and extreme heat.
    - The Climate Mapping for Resilience and Adaptation (CMRA) tool can be a useful tool for this assessment, as well as additional references located in the Resources tab on HeroX.

Parameter 5: Environmental Justice, Social Impacts, and Engagement

Overview: Teams must identify potential impacts (benefits/harms) of their proposal. Proposals must include a strategy to engage with communities within the regional carbon transport network to ensure the proposal centers disadvantaged communities and/or tribes and indigenous communities. Teams are encouraged to demonstrate collaboration with college and university staff and experts who are already working on these community engagement efforts.

- Summarize what is known about potential environmental and health impacts (both positive and negative) of the carbon transport modes employed (pipeline, rail, truck, barge, shipping) in your network.
    - For your region, assess where impacts from your carbon transport network would be located and how they might interact with historical and ongoing community concerns and priorities.
    - Analyze how benefits might be directed toward disadvantaged communities. What measures could be taken to mitigate harms? If there are potential benefits, what policies or actions would be needed to guarantee them?

3.6.1 Midway Check-In Feedback

All competing teams who complete the midway check-in will receive the following feedback:

A written document describing areas that are on track or nonresponsive according to the evaluation criteria. Nonresponsive areas will require further refinement for the final submission. The feedback document is anticipated to be no longer than one page in length and will address each of the five parameters requested in the midway check-in narrative.

3.7 Final Submission: What To Submit

A complete submission package includes the following items:

- Cover page and narrative
- Excel spreadsheet with LCA calculations
- Maps in GIS or Google Maps format
- Summary submission slide.

The following sections provide more guidance on what information to include and how reviewers evaluate and score your submission. Reviewers will evaluate your submission by assigning a single score for each parameter, based on the rubric below.

Outstanding	**6**	A response that strongly demonstrates a comprehensive understanding of the carbon transport parameters, fully addresses all aspects of the criteria, and convincingly demonstrates the applicant's ability to **meet and significantly exceed** the intent of the Carbon Management Collegiate Competition parameter.
Great	**5**	A response that clearly demonstrates an understanding of the carbon transport parameters, addresses all aspects of the criteria, and demonstrates the applicant's ability to **meet and exceed** the intent of the Carbon Management Collegiate Competition parameter.
Satisfactory	**4**	A response that demonstrates an understanding of the carbon transport parameters, addresses all aspects of the criteria, and demonstrates a likelihood that the applicant will **meet** the intent of the Carbon Management Collegiate Competition parameter.
Poor	**3**	A response that demonstrates a preliminary understanding to address the carbon transport parameters, addresses several but not all aspects of the criteria, and demonstrates a likelihood that the applicant will **meet** the intent of the Carbon Management Collegiate Competition parameter.
Unsatisfactory	2	A response that fails to demonstrate an understanding and fails to address the carbon transport parameters, does not address all aspects of the criteria, and **fails to demonstrate the applicant's ability to meet** the intent of the Carbon Management Collegiate Competition parameter.
Incomplete	1	A response that fails to demonstrate an understanding and fails to address the carbon transport parameters, does not address all aspects of the criteria, and **is missing significant and critical components required** in the Carbon Management Collegiate Competition parameter.

3.7.2 Cover Page Content

List basic information about your submission, including:

- Project title
- Team name
- Short description
- Key project members (names, contacts, and links to their professional online profiles)
- Other partners (if any)
- Your city, state, and ZIP code/postal code.

3.7.3 Narrative

You should address each of the five parameters and the associated content below. The individual parameter responses do not have a word limit; however, **the aggregate response to these five parameters must not exceed 3,000 words,** not including captions, figures/graphs, or references. A word count must be included at the end of your submission. You should also include **up to five supporting maps in GIS or Google Maps format**. The reviewers will score the questions based on the content you have provided.

Narrative

Maximum 3,000 words and 5 supporting maps (PDF)

Parameter 1: Economics and Business Model (20%)

Points To Address	Goal and Scoring Considerations
1. <u>Identify the proposed region.</u> a. In your region, assess and compare unit costs ($) per metric ton of CO_2 transport through various transport modes—pipeline, rail, ship, barge, and truck. This sensitivity analysis does not include the cost of carbon capture, utilization, or storage and is strictly transport cost analysis following point of capture to point of disposition. 2. <u>Introduce your proposed carbon transport network.</u> a. For the identified mode(s) of transport in the proposed network, define the volume, boundaries, pressure and temperature conditions, and, if needed, intermodal storage facilities. b. Calculate the unit cost of CO_2 transport mode(s) proposed and identify the location and volume of anthropogenic CO_2 sources—point-source capture or carbon dioxide removal sources—and sinks, including secure geologic storage locations and/or CO_2 conversion locations to carbon-based products. 3. <u>Outline a business and economics model for the transport costs of this network.</u> a. The business and economics model should strictly focus on compression and transport costs and should not include costs for capture, utilization, or geologic storage. b. Considerations for the business and economics model should include existing U.S. federal, state, or regional incentives placed on reducing carbon, and the applicant should address which incentives are relevant or employed. Some examples of incentives include California's Low	Proposals must align with net-zero decarbonization goals and be capable of transporting at least 1 million metric tons of CO_2 per year at technically feasible, standard operating pressures and temperatures of CO_2 or appropriate CO_2-carrier material for transport. The proposed regional carbon transport networks must be located within the United States. **A single score on a scale of 1–6 is provided, taking the following statements into consideration:** • The submission provides a clear description of a regional CO_2 transport network located within the United States with specific volumes, sources, and sinks identified. • The proposed regional CO_2 transport network is appropriate for a CO_2 transport case and aligned with U.S. net-zero decarbonization efforts. • The proposed regional CO_2 transport network meets the minimum volume requirements described by the collegiate competition topic. • The team provides sources to data and clearly articulates accurate conclusions from available data. • The team has used appropriate methodology and calculations to determine economic feasibility ($/metric ton CO_2). • The proposal demonstrates an understanding of potential risks and sensitivities with the CO_2 transport network's business and economics model. • The submission has considered the utility of the regional CO_2 transport network for near-term and long-term time frames. • CO_2 is derived from anthropogenic sources. • Proposals with CO_2 conversion do not result in the release of CO_2 back into the atmosphere from the manufactured product.

Carbon Fuel Standard (LCFS) and the U.S. IRS section 45Q tax credit. 4. <u>Understand risks and sensitivity analyses associated with your business and economics model.</u> a. Determine if your business model is driven by production (sources) or consumption (sinks), and if the regional network can handle future demand of sources and sinks that may not exist today and/or interconnection with other networks/hubs. b. Identify if there are any material supply chain constraints or challenges with the proposed transport network in the near term. c. Demonstrate clear understanding of challenges associated with land access, road access, and other access and right-of-way considerations. d. Propose a timeline of project development with consideration toward local and regional regulations, permitting, and other factors or policies that may impact feasibility of development.	
Parameter 2: Operational Safety Considerations (20%)	
<u>Points To Address</u> 1. <u>What safety considerations do you propose within this network?</u> a. Summarize CO_2 handling and safety considerations for any CO_2 transportation mode (ship, barge, train, rail, or pipeline) utilized in your transport network. 2. <u>What are the operational and emergency response plans for this proposal?</u> a. Provide dispersion modeling scenarios for the relevant CO_2 transportation mode(s) in your proposed transport network.	**Goal and Scoring Considerations** Proposals must include a range of operational safety considerations to ensure a safe and reliable CO_2 transport network that supports the deployment of CCUS and CDR. **A single score on a scale of 1–6 is provided, taking the following statements into consideration:** • The submission provides relevant sources to safety data and provides a clear description of operational safety considerations in the design of a proposed regional CO_2 transport network located within the United States. • The team clearly articulates accurate conclusions from available data, including in analysis of transporting alternative and/or novel CO_2 byproducts.

3. How are operational safety considerations incorporated with or addressing local community concerns? a. Identify nearby communities, the resources required to execute emergency response, and whether they have these resources already or will require further resources.	• The team has used available literature and appropriate methodology and calculations to determine operational plans and dispersion modeling.
Parameter 3: Life Cycle Analysis (20%)	
Points To Address 1. Analyze and summarize potential life cycle environmental impacts for the different CO_2 transportation modes and scenarios from point of capture to disposition using the principles of LCA. a. This analysis is strictly focused on carbon dioxide transport and does not include emissions accounting at capture, utilization, or storage. b. The functional unit for the LCA should be the transport of 1 metric ton of CO_2 over a defined distance in the transportation network. All calculations should be documented in a spreadsheet model. The Resources section of HeroX contains a summary of the life cycle data that should be used to support these calculations. 2. For the evaluation of potential climate change impacts, utilize the most recent global warming potential factors from the Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC AR6 GWP 100) Table 7.15. a. These factors are duplicated in the Resources section of HeroX for reference. b. Include evaluations of other potential environmental impacts associated with the modeled emissions. c. For characterizing impacts other than global warming potential, use the U.S. Environmental Protection Agency's Tool for Reduction and Assessment of Chemicals and Other Environmental	**Goal and Scoring Considerations** The LCA framework can help support decision-making as part of the energy transition. Proposals must include a series of LCA calculations and determinations to support their plans. **A single score on a scale of 1–6 is provided, taking the following statements into consideration:** • The team provides sources to data and clearly articulates accurate conclusions from available data. • The team demonstrates an understanding of the challenges, opportunities, and trade-offs associated with the application of LCA to this system. The team has used available literature and appropriate methodology and calculations for thoroughly assessing potential life cycle environmental impacts across various CO_2 transportation modes. • The team has identified potential sources of uncertainty and variability in their analysis and proposed potential mitigation opportunities. • The team has evaluated the impacts of a changing energy mix on the robustness of their conclusions. • The submission has considered the utility of the regional CO_2 transport network for near-term and long-term time frames.

Impacts (TRACI)[8] to translate the emissions inventory associated with the proposed transportation mode(s) into potential environmental impacts. **d.** Discuss trade-offs between potential environmental impacts across the range of transportation scenarios evaluated and how they might impact other optimization parameters in this assessment. 3. Develop additional scenarios to evaluate the potential impacts of the base transportation options due to changes in the energy mix and electrification of transport in the future. a. The quantitative scope of these scenarios should focus specifically on changes in the types and amounts of greenhouse gas emissions and their impacts on climate change. b. In addition, provide a qualitative discussion of any shifts in other potential environmental and resource impacts due to a transitioning energy mix.	
Parameter 4: Climate Change Projected Impacts (20%)	
Points To Address 1. Identify what projected climate change impacts are most relevant to each component of your transportation network through research and case studies. a. Assess the vulnerabilities of each component or mode of transport in your proposed network. b. Climate change projected impacts under consideration for this parameter include risks from wildfire, geohazards, ground subsidence, earthquakes, sea level rise, hurricanes, floods, droughts, and extreme heat. c. The CMRA tool can be useful for this assessment, as well as additional references located in the Resources tab on HeroX.	**Goal and Scoring Considerations** Proposals must consider climate change projected impacts and resiliency considerations. **A single score on a scale of 1–6 is provided, taking the following statements into consideration:** • The team provides sources to data and clearly articulates accurate conclusions from available data. • The team has provided information through geospatial approaches. • The team demonstrates an understanding of the challenges and adaptation opportunities of climate change projected impacts across various CO_2 transportation modes. • The team has used available literature and appropriate methodology for assessing climate change projected impacts.

[8] https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci

2. Analyze longer-term considerations related to climate change projected impacts. a. Where might proposed built or added infrastructure exacerbate certain climate change impacts identified? b. What adaptation or other measures could be taken to address resiliency of these carbon transport modes in your region? c. Considering climate change impacts and the unique vulnerabilities of each component of your overall network, how does your transport network change, if at all?	• The submission has considered the utility of the regional CO_2 transport network for near-term and long-term time frames.

Parameter 5: Environmental Justice, Social Impacts, and Engagement (20%)

Points To Address	Goal and Scoring Considerations
1. For your region, assess the most significant historical and ongoing concerns related to environmental and health impacts. a. These concerns can include but are not limited to: i. Environment pollution including impacts to air, water, and soil. ii. Jobs, enterprise creation, and economic impacts. iii. Other health, safety, and quality of life impacts (e.g., noise, public safety, land-use changes). iv. Impacts to tribes and/or Alaska Native corporations. v. Any other relevant impacts identified through your research. b. Identify with as much spatial granularity as possible (e.g., census tract or block group level) where impacts are most concentrated and cumulative. 2. Summarize what is known about potential environmental and health impacts (both positive and negative) of the carbon transport modes employed (pipeline, rail, truck, barge, shipping) in your network. a. For your region, assess where impacts from your carbon transport network would be located and how they might interact	Teams must identify potential impacts (benefits/harms) of their proposal. Proposals must include a strategy to engage with communities within the regional carbon transport network to ensure the proposal centers disadvantaged communities and/or tribes and indigenous communities. Teams are encouraged to demonstrate collaboration with college and university staff and experts who are already working on these community engagement efforts. **A single score on a scale of 1–6 is provided, taking the following statements into consideration:** • The team provides sources to data and clearly articulates accurate conclusions from available data. • The team has used available literature and appropriate methodology for assessing environment justice benefits and harms. • The team demonstrates a thorough understanding of historical and ongoing environmental concerns and priorities for communities in their region. • The team has demonstrated a clear proposed engagement plan with local community groups and advocacy groups in the relevant region. • The team collaborated with college and university staff and experts who are already working on these community engagement efforts in formulating an engagement plan proposal.

with historical and ongoing community concerns and priorities. b. Analyze how benefits might be directed toward disadvantaged communities. What measures could be taken to mitigate harms? If there are potential benefits, what policies or actions would be needed to guarantee them? 3. Develop an engagement plan. a. Propose a strategy that could be used in future engagement with communities identified in the point above, including identifying relevant community-based organizations or other advocacy organizations and steps that could be taken to validate your research. b. Please note that direct engagement with communities for this collegiate competition is not expected or anticipated. c. Identify any gaps in literature, experimental, and/or field validation related to these impacts for future work.	

3.7.4 Submission Summary Slide (Will Be Made Public)

Make a public-facing, one-slide submission summary that introduces your team and school(s) represented. There is no template, so competitors are free to present the information in any format. Any text must be readable in a standard printed page and a conference room projection and should be in at least 14-point font.

3.8 How We Determine and Award Winners

The Prize Administrator screens all completed submissions and ensures that the teams are eligible. Then a subset of reviewers will determine if the submissions comply with the criteria in Section 2.2: Program Goal Requirements. In consultation with DOE, the Prize Administrator 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 and representatives with expertise in areas relevant to the competition. They will review the competitor's submission package according to the criteria above.

3.8.1 Reviewer Panel Scoring

The scoring of submissions will proceed as follows:

- Teams participating in the final submission will be checked to ensure that they completed the midway check-in. If the midway check-in deadline is not met, the final submission will not be considered.
- Experts will review each submission individually and assess the response from the competitor to each statement in the five criteria described in the tables in Section 3.7.3.

- Reviewers will score each section 1–6, depending on the degree to which the reviewer agrees that the submission reflects the statements for consideration.
- Each section score 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.

3.8.2 Interviews

DOE may decide to interview a subset of competitors. The interviews would be held prior to the announcement of the winners and would serve to help clarify questions the reviewers may have. Participating in interviews is not required, and interviews are not an indication of a competitor's likelihood to win.

3.8.3 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).

3.8.4 Announcement

Approximately 60 days after the contest closes, the Prize Administrator will notify the winners and request the necessary information to distribute the prizes. The Prize Administrator will then publicly announce the winners.

3.9 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 Requirements

Your submission for the Carbon Management Collegiate Competition is subject to the following terms and conditions:

- You must post the final content of your submission by the deadlines established by the Prize Administrator/U.S. Department of Energy (DOE). 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 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 Microsoft Word or Adobe PDF. Scanned handwritten submissions will be disqualified.
- Submissions will be disqualified if they contain any matter that, in the sole discretion of DOE 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 (1) the person/entity does not respond to notifications, (2) the person/entity fails to sign and return the required documentation within the required time period, (3) the notification is returned as undeliverable, or (4) 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.
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; 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; the submission does not infringe upon any copyright or any other third-party rights of which the competitor is aware; and 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 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 impair 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:

- It may be desirable to select for award a project or group of projects that represent a diversity of technical approaches and methods under this competition or the overall program.
- It may be desirable that different kinds and sizes of organizations be selected for award in order to provide a balanced programmatic effort and a variety of technical perspectives under this competition or the overall program. For example, it may be desirable to select a project or group of projects that exhibit team member diversity, with participants including but not limited to those from disadvantaged communities.
- It may be desirable to select for award a project or group of projects with a broad or specific geographic distribution and potential economic impact under this competition or the overall program.
- 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 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 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 National Environmental Policy Act Compliance

This prize is subject to the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321, et seq.). NEPA 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 at http://nepa.energy.gov/.

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, all participants in the Carbon Management Collegiate Competition will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their participation in the prize competition. If applicable, participants may be asked to provide DOE with information on fabrication and testing of their device such that DOE can conduct a meaningful evaluation of the potential environmental impacts.

A.15 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.