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April 26, 2024

Mr. Reice Haase
Deputy Director
North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Dear Mr. Haase:

Subject: Quarterly Progress Report for the Period of January 1 – March 31, 2024, "PCOR Partnership Initiative to Accelerate CCUS Deployment"; Contract Nos. FY20-XCI-226 and G-050-096

Attached please find the Energy & Environmental Research Center (EERC) quarterly progress report for the subject project. If you have any questions, please contact me by phone at (701) 777-5236 or by email at kconnors@undeerc.org.

Sincerely,

DocuSigned by:
Kevin Connors
1D14EF7CF3CD456...

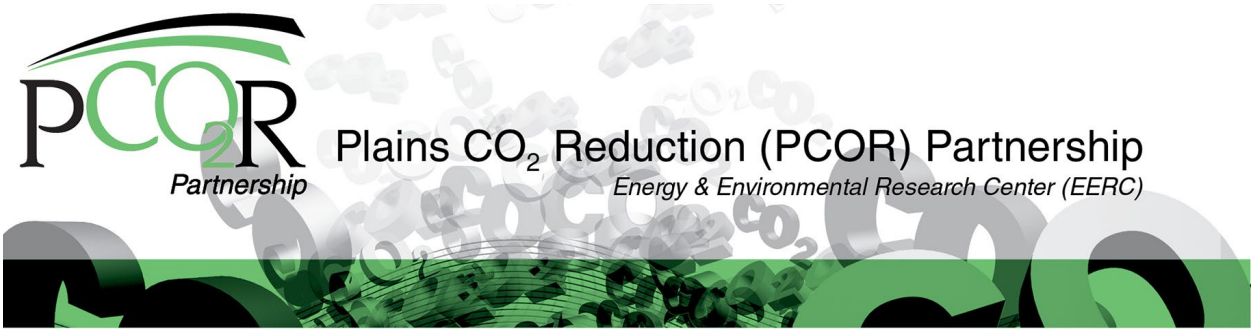
Kevin C. Connors
Assistant Director for Regulatory Compliance and Energy Policy
PCOR Partnership Program Manager

KCC/rlo

Attachment

c/att: Michael Holmes, Lignite Energy Council
Brent Brannan, North Dakota Industrial Commission (NDIC) Department of Mineral Resources, Oil and Gas Division
Erin Stieg, NDIC

c: Jamie Mitzel, EERC



PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT

Quarterly Technical Progress Report

(for the period January 1 – March 31, 2024)

Prepared for:

Reice Haase

North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Contract Nos. FY20-XCI-226 and G-050-96

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April 26, 2024

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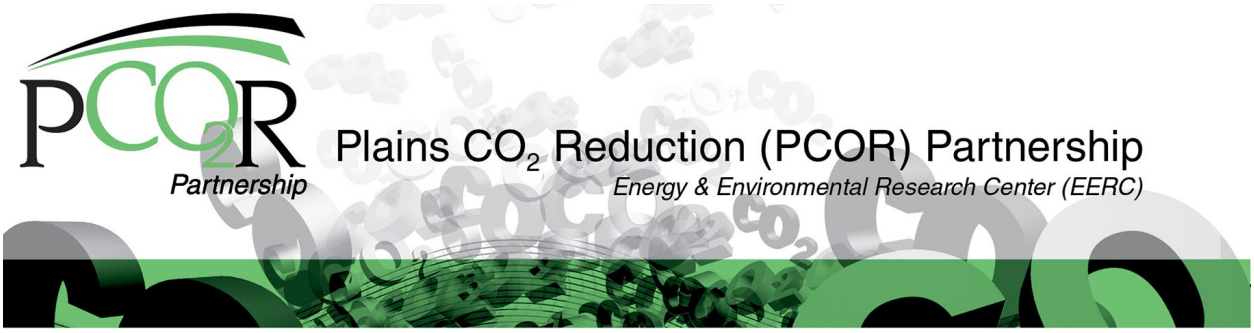
TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES



PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT
Quarterly Progress Report
January 1 – March 31, 2024

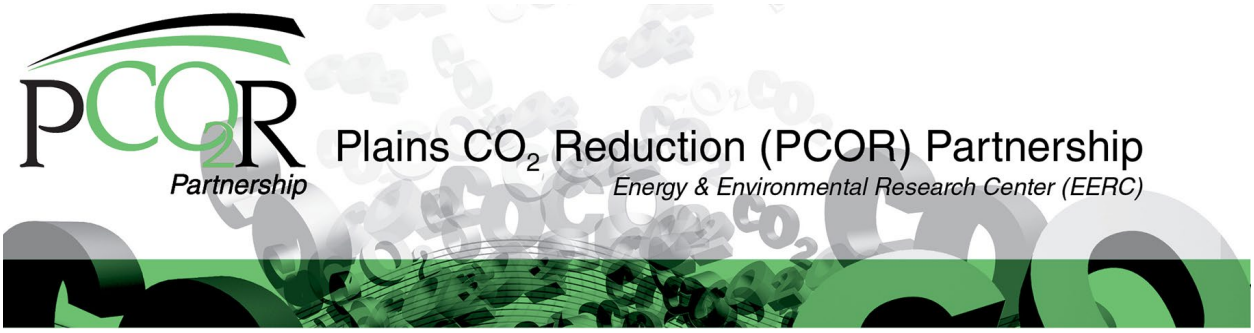
EXECUTIVE SUMMARY

The Plains CO_2 Reduction (PCOR) Partnership, funded by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL), the North Dakota Industrial Commission Oil and Gas Research Program and Lignite Research Program, and more than 250 public and private partners, is accelerating the deployment of carbon capture, utilization, and storage (CCUS) technology. The PCOR Partnership is focused on a region comprising ten U.S. states and four Canadian provinces in the upper Great Plains and northwestern regions of North America. It is led by the University of North Dakota Energy & Environmental Research Center (EERC), with support from the University of Wyoming (UW) and the University of Alaska Fairbanks (UAF).

The EERC welcomed one new member, Heidelberg Materials, to the PCOR Partnership this quarter, bringing the membership to 262. The PCOR Partnership held introductory meetings for eDrilling on January 16, 2024, Zero Carbon Partners on January 19, 2024, and BNSF Railway on February 2, 2024.

Work was executed, finalized, and submitted for two deliverables (D): a revised D11 – Report – Basement Faulting and Stress State, Induced Seismicity and D15 – PCOR Partnership Atlas. D15 was updated for Budget Period (BP)2. Two milestones (M) were achieved: M10 – GHGT-17 Abstract Submitted and M11 – Annual Meeting Scheduled.

The PCOR Partnership sent its fifth newsletter to project partners on February 1, 2024. The focus this quarter was a recap of a special joint information-sharing meeting between Alaska and North Dakota legislators held in December 2023 and a focus on several partners who are key players in the legislative arena.



PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT
Quarterly Progress Report
January 1 – March 31, 2024

INTRODUCTION

The Plains CO_2 Reduction (PCOR) Partnership, funded by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL), the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program and Lignite Research Program, and more than 250 public and private partners, is accelerating the deployment of carbon capture, utilization, and storage (CCUS) technology. The PCOR Partnership is focused on a region comprising ten U.S. states and four Canadian provinces in the upper Great Plains and northwestern regions of North America. It is led by the University of North Dakota Energy & Environmental Research Center (EERC), with support from the University of Wyoming (UW) and the University of Alaska Fairbanks (UAF).

The goal of the PCOR Partnership is to identify and address regional capture, transport, and storage challenges facing commercial deployment of CCUS in an expanded region, compared to past Regional Carbon Sequestration Partnership project phases. To achieve this goal, the PCOR Partnership will meet the following objectives:

1. Address key technical challenges by advancing critical knowledge and capabilities.

2. Facilitate data collection, sharing, analysis, and collaboration.

3. Evaluate regional infrastructure challenges/needs and promote infrastructure development.

4. Promote regional technology transfer.

The project goal and objectives will be accomplished through five tasks over two budget periods (BPs), corresponding to a 5-year period of performance. The EERC and project partners will collaborate to identify and address technical challenges facing deployment of CCUS in multiple categories, including stacked storage opportunities, CO_2 storage performance and monitoring, and risk assessment. The EERC will work with PCOR Partnership members and regional stakeholders to promote the development of infrastructure and large projects within the PCOR Partnership region. This development will then provide best practices throughout the United States for wide-scale deployment of CCUS technologies. Existing datasets and technologies will be analyzed and evaluated to highlight current challenges limiting commercial

adoption of CCUS as well as to identify potential solutions. The project team will support DOE's National Risk Assessment Partnership (NRAP) and machine learning (ML) initiatives by drawing on datasets and experience available through the team. Assessments of infrastructure, site readiness, techno-economics, and socioeconomics will provide an overview of the CCUS landscape within the defined PCOR Partnership region. Potential business case scenarios will be evaluated, accounting for current economic incentives to identify opportunities in CCUS project development. Technology transfer activities will inform and educate CCUS stakeholders of project learnings through annual meetings, regulatory roundup meetings, technical advisory board (TAB) meetings, webinars, reports, and conference presentations/papers. These activities will facilitate knowledge sharing and support DOE program goals.

ACCOMPLISHMENTS

Task 1.0 – Project Management and Planning

The objective of Task 1.0 is to manage and direct the project in accordance with a project management plan (PMP) to meet all technical, schedule, and budget objectives and requirements. Activities will be coordinated in order to effectively accomplish the work. The project manager (PM) will ensure that project plans, results, and decisions are appropriately documented and project reporting and briefing requirements are satisfied.

Significant accomplishments for Task 1.0 during the reporting period include the following:

- Held progress meetings with subrecipients UAF and UW.
- Held regular progress update meetings with the federal PM.
- Held discussions with prospective members on a regular basis. The PCOR Partnership currently has 262 members. The EERC welcomed one new member, Heidelberg Materials, to the PCOR Partnership this quarter. The PCOR Partnership held introductory meetings for eDrilling on January 16, 2024, Zero Carbon Partners on January 19, 2024, and BNSF Railway on February 2, 2024.
- Prepared and submitted PCOR Greenhouse Gas Control Technologies (GHGT)-17 and Clearwater Energy Conference abstracts on January 15, 2024 (see updates in Tasks 2, 3, and 5). The submission of the GHGT-17 abstract satisfies Milestone (M)10.
- M11 – Annual Meeting Scheduled was achieved on March 26, 2024. The PCOR Partnership annual meeting will be held in Bismarck, North Dakota, August 27–28, 2024. Information has been sent to all PCOR partners (Figure 1).
- In conjunction with the PCOR Annual Meeting, the PCOR Partnership will also host this year's TAB meeting. A full schedule of events (in CDT) is listed below:

Figure 1. PCOR Annual Meeting "Save the Dates!" flyer sent to PCOR partners on March 26, 2024.

Monday, August 26, 2024
- TAB Meeting, 3:00–5:00 p.m., Lignite Energy Council Headquarters

- Networking Social, 6:00–8:00 p.m., Heritage Center Northern Lights Atrium

Tuesday, August 27, 2024
- Annual Meeting, 8:00 a.m. – 5:00 p.m., Bismarck State College (BSC) National Energy Center of Excellence (NECE) Bavendick Stateroom

- Networking Social and Dinner, 6:00–10:00 p.m., Huckleberry House

Wednesday, August 28, 2024
- Field trip to active carbon, transport, and storage site, 9:00 a.m. – 3:00 p.m.

Thursday, August 29, 2024
- Regulatory Roundup (for regulators; invite only as space is limited), 8:00 a.m. – 5:00 p.m., BSC NECE Epic Conference Room 335

- Networking Social, 6:00–8:00 p.m., location TBD

The PCOR Partnership will be hosting the Regulatory Roundup the same week as the Annual Meeting to provide our regulators with the option to attend the annual meeting, field trip, and/or networking events.

Next steps to accomplish the goals under Task 1.0 include the following:

- Continue tracking progress on project deliverables and milestones (Tables 1 and 2).

Table 1. Project Deliverables

Deliverable (D) No. and Title	Planned Completion Date	Actual Completion Date	Verification Method	Comments
D1 – PMP	30 days after contract definitization	2/21/2020	PMP file submitted to DOE PM	
D2 – Report – Storage Optimization	4/30/2021	4/30/2021	Topical report submitted to DOE PM	Moved from 12/31/2020.
D3.A – Report – Stacked Storage Opportunity Assessment	8/31/2021	8/31/2021 (E.S.) 11/12/2021 (full report)	Topical report submitted to DOE PM	Moved from 6/30/2021.
D3.B – Report – Stacked Storage Scenario Geomechanical Modeling	3/31/2022	3/31/2022	Topical report submitted to DOE PM	Created a second D3 report.
D4 – Report – Regional Business Case Assessment	12/31/2021	12/17/2021	Topical report submitted to DOE PM	Moved from 3/31/2021.
D5 – Report – Subsurface and Legacy Well Integrity	12/31/2021	12/30/2021	Topical report submitted to DOE PM	
D6 – Report – MVA Strategies	6/30/2022	6/30/2022	Topical report submitted to DOE PM	
D7 – Report – Evaluation of Risk Management	9/30/2022	9/30/2022	Topical report submitted to DOE PM	
D8 – Report – Regional Permitting Guidance	9/30/2022	9/30/2022	Topical report submitted to DOE PM	Two reports submitted for D8.
D9 – Report – Infrastructure, Scale-Up, and Techno-Economic Assessments	3/31/2023	3/31/2023	Topical report submitted to DOE PM	
D10 – Report – NRAP Testing and Validation	3/31/2023	12/17/2021 (Part 1) 3/31/2023 (Part 2)	Topical report submitted to DOE PM	Provided in two parts.
D11 – Report – Basement Faulting and Stress State, Induced Seismicity	12/1/2023	11/27/2023 (original) 2/7/2024 (revised)	Topical report submitted to DOE PM	A revised D11 was resubmitted on 2/7/24 to account for updated figures and tables.
D12 – Report – Regional Socioeconomic Assessments	12/1/2023	11/27/2023	Topical report submitted to DOE PM	A request to move the due date to 12/1/23 was made; a revised PMP was submitted to DOE on 9/29/23.
D13 – Report – Updated Regional Business Case Assessment	12/31/2023	12/22/2023	Topical report submitted to DOE PM	
D14 – Report – Risk-Based Area of Review	1/31/2021	1/29/2021	Topical report submitted to DOE PM	Moved from 12/31/2020.
D15 – PCOR Partnership Atlas	6/30/2021 and 3/31/2024	6/30/2021 (BP1) 3/28/2024 (BP2 update)	Atlas submitted to DOE PM	
D16 – Enabling Sustainable Monitoring for CCUS	6/30/2024		Topical report submitted to DOE PM	
D17 – PCOR Partnership Initiative Road Map	5/31/2024		Topical report submitted to DOE PM	

Table 2. Milestone Status Report

Milestone (M) No. and Title	Planned Completion Date	Actual Completion Date	Verification Method	Comments
M1 – Regulatory Roundup Scheduled	2/29/2020	3/31/2020	Reported in subsequent quarterly report	
M2 – Initial Techno-Economic Framework Established	4/30/2020	4/28/2020	Reported in subsequent quarterly report	
M3 –Annual Meeting Scheduled	3/31/2021	3/29/2021	Reported in subsequent quarterly report	
M4 – Regulatory Roundup Scheduled	3/31/2021	3/29/2021	Reported in subsequent quarterly report	
M5 – Data Share with National Lab for NRAP Assessment	6/30/2021	6/30/2021	Reported in subsequent quarterly report	Files added to EDX.[1]
M6 – GHGT-16[2] Abstract Submitted	1/31/2022	1/14/2022	Reported in subsequent quarterly report	
M7 – BP1 EDX Submitted	3/31/2022	3/31/2022	Reported in subsequent quarterly report	
M8 – Draft Journal Article Completed	11/30/2022	9/30/2022	Reported in subsequent quarterly report	
M9 – Regulatory Roundup Scheduled	3/31/2023	3/31/2023	Reported in subsequent quarterly report	
M10 – GHGT-17 Abstract Submitted	1/31/2024	1/15/2024	Reported in subsequent quarterly report	
M11 – Annual Meeting Scheduled	3/31/2024	3/26/2024	Reported in subsequent quarterly report	
M12 – BP2 EDX Submitted	6/30/2024		Reported in subsequent quarterly report	

[1] Energy Data eXchange.
[2] 16th International Conference on Greenhouse Gas Control Technologies.

Task 2.0 – Technical Challenges

In Task 2.0, the project team will support regional deployment of CCUS programs by focusing on key technical challenges in the PCOR Partnership region related to stacked storage opportunities; storage performance; monitoring, verification, and accounting (MVA) technology; and subsurface integrity. The EERC will collaborate with PCOR Partnership members to identify knowledge gaps and address regional challenges through targeted webinars, workshops, reports, and papers.

Progress on Task 2.0 is as follows:

- Submitted GHGT-17 abstract entitled *Quantifying the Potential Atmospheric Leakage Risks Associated with the Geologic Storage of CO_2 in Saline Aquifers for Use in Voluntary Carbon Market Buffer Account Determination*.

- Submitted a revised D11 – Basement Faulting and Stress State, Induced Seismicity report to DOE on February 7, 2024. The revised deliverable included updates and refinements to referenced tables and figures from original submission (November 27, 2023).

- Attended the American Association of Petroleum Geologists (AAPG) CCUS conference in Houston on March 11–13, 2024.
  - Presented abstract: Regional Subsurface Stress Assessment for CO_2 Storage in Candidate Basal Reservoirs Within the Plains CO_2 Reduction Partnership Region
  - Other submitted abstracts to AAPG CCUS conference included:
    - Toward More Efficient and Cost-Effective CO_2 Monitoring Using a Sparse Surface Seismic Array: Example from an Industrial Site in North Dakota.
    - The PCOR Partnership Initiative: Building Momentum for Commercial CCUS Deployment.

- Continued collaboration for the field effort at the Red Trail Energy carbon capture and storage (CCS) site. Activities included the following:
  - Data harvesting continued from the Instrumentation Software Technologies, Inc. 6C seismic station to complement the scalable, automated, sparse seismic array (SASSA) processing effort.
  - Stryde nodes and auxiliary equipment were returned, and the last month of SASSA recording with those nodes was January 2024.
  - ZLand nodes were deployed and continued to record data into Quarter (Q)1 with expected pickup and final data harvest in Q2.
  - The EERC team progressed toward compiling D16 – Enabling Sustainable Monitoring for CCUS report.
  - The eVibe was transported back to the EERC in Grand Forks, North Dakota, for decommissioning and was shipped back to the Netherlands.

Next steps to accomplish the goals under Task 2.0 in the coming quarter include the following:

- Finalize white papers.

Task 3.0 – Data Collection, Sharing, and Analysis

In Task 3.0, the project team will collaborate with other DOE Fossil Energy Carbon Management (FECM)-funded researchers to improve understanding of CO_2 injection and storage impacts. The project team will work with national laboratories to facilitate data sharing, support the development and validation of NRAP tools with site-specific data, and participate in development of ML-based tools/methods in a commercial setting.

Progress on Task 3.0 is as follows:

- Submitted GHGT-17 abstract entitled *Reservoir Simulations and Accuracy Measures for CO_2 Pressure Buildup Plumes for the Broom Creek Formation in Central North Dakota*.

- Subtask 3.1 – Data Sharing
  - The EERC identified and cataloged datasets generated through the PCOR Partnership that will be available for upload to the Energy Data eXchange (EDX) for M12 – Budget Period 2 EDX Submitted.
    - EDX links have been created and folders were set up.
    - The EERC is preparing a milestone report to summarize the geologic modeling and simulation datasets and formats (e.g., a fine-scaled and upscaled standard reference geomodel). The geomodels and reservoir simulations were developed for a body of work estimating the accuracy of the predicted 5-year CO_2 and pressure buildup plumes for a hypothetical storage project injecting CO_2 into the Broom Creek Formation near central North Dakota.
    - Once the report is finalized, geologic models and reservoir simulations will be uploaded.

- Subtask 3.3 – Machine Learning
  - The EERC continues to track ongoing work conducted under the SMART (Science-Informed Machine Learning for Accelerating Real-Time Decisions in Subsurface Applications) Initiative and look for ways to incorporate these learnings into the PCOR Partnership region.

Next steps to accomplish the goals under Task 3.0 in the coming quarter include the following:

- Upload datasets to EDX to satisfy M12 and inform DOE PM once complete.

Task 4.0 – Regional Infrastructure

The objective of Task 4.0 is to evaluate the regional needs, challenges, and potential economic impacts related to the development of safe and environmentally sound CO_2 transportation infrastructure to accelerate commercial CCUS project deployment. This evaluation will be accomplished by assessing existing infrastructure, scale-up challenges and needs, and techno-economic and socioeconomic impacts in the PCOR Partnership region and will be communicated through outreach activities.

Progress on Task 4.0 is as follows:

- Completed D15 PCOR Partnership Atlas on March 29, 2024.

- The EERC advised for Stress Engineering Services, Inc.'s white paper "Repurposing Pipelines for CCS and CCUS" to be presented at the GHGT-17 conference. The EERC is awaiting confirmation of acceptance from GHGT prior to publishing the white paper at the conference in Calgary in October 2024. An announcement is expected to be made in May 2024.

- UW continued work on draft documents to advance the PCOR Partnership knowledge in topics under Task 4.0, including the following:
  - Updated Wyoming Pipeline Initiative Summary – This deliverable will include an assessment of steps for operators seeking to develop pipelines within the Wyoming Pipeline Corridor to obtain the necessary permits and regulatory review. Work on this deliverable has begun, and UW has partnered with the Enhanced Oil Recovery Institute on this task. The expected timeline for completion is by Q2, 2024.

- UW delivered the final draft report of its deliverable regarding interstate pore space entitled "Regulatory Considerations for Carbon Dioxide Storage and Area of Review Migration on Interstate Pore Space Related to Wyoming Carbon Storage Permitting and Unitization" to the EERC on March 11, 2024. This final draft included input from the Wyoming Department of Environmental Quality and Wyoming Oil and Gas Conservation Commission.

- UAF continued work to advance the PCOR Partnership knowledge in topics under Task 4.0, including the following:
  - Laboratory experiments on CO_2-induced corrosion. A report with the data collected in the experiments will be delivered to the EERC.

Next steps to accomplish the goals under Task 4.0 in the coming quarter include the following:

- Continue to track progress of white papers, UWY and UAF products.

Task 5.0 – Technology Transfer

Task 5.0 will inform and educate stakeholders about CCUS technologies. Nontechnical challenges to CCUS deployment in the PCOR Partnership region will be identified and assessed, with an emphasis on regulatory issues and solutions. Business case scenarios for CCUS projects will be identified, reviewed, and developed. Outcomes of this task will be transferred to stakeholders through meetings, presentations, and webinars. Developed materials will be shared with DOE to support its broader FECM program goals.

Progress on Task 5.0 is as follows:

- Submitted GHGT-17 abstract entitled PCOR Partnership: a Catalyst for Commercial CCUS Deployment.

- Development of new fact sheets continued, covering these topics:
  - The importance of regulatory frameworks and Class VI primacy
  - Pore space ownership and CCS projects

- Work progressed toward the next PCOR Pioneer newsletter to be submitted for Q2, 2024.

- Continued development of D17 – PCOR Road Map, due May 31, 2024.

- UAF finalized review on a topical report for the Cook Inlet Region entitled Low Carbon Emissions and Economic Analysis: Biomass-Coal versus Natural Gas Generation. The EERC finalized and submitted it to DOE and NDIC on February 29, 2024.

- UW submitted a deliverable by Dr. Soheil Saraji, entitled "Monitoring Verification and Accounting for CCUS Using Blockchain," to the EERC for review on February 12, 2024.

Next steps to accomplish the goals under Task 5.0 in the coming quarter include the following:

- Continue progress on fact sheets, covering these topics:
  - The importance of regulatory frameworks and Class VI primacy
  - Pore space ownership and CCS projects

- Continue reviews and development of white papers focusing on lessons learned through PCOR Partnership efforts with topics on North Dakota reporting requirements and pipeline specifications through UW School of Energy Resources.

- Continue UW and the EERC collaborative activities.

- Progress work on D17 – PCOR Partnership Initiative Road Map, due May 31, 2024.

CHANGES/PROBLEMS

No changes or problems at this time.

SPECIAL REPORTING REQUIREMENTS

None.