

PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT

Research Performance Progress Report (quarterly)

(for the period October 1 – December 31, 2022)

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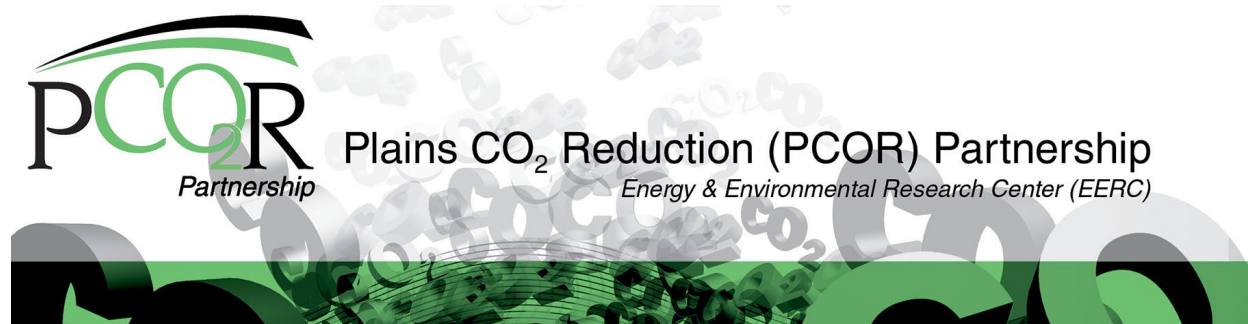
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PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT

Quarterly Progress Report October 1 – December 31, 2022

EXECUTIVE SUMMARY

The Plains CO₂ 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 240 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 and the University of Alaska Fairbanks.

Federal appropriation for FY2022 funding directed DOE to make available not less than \$20 million for the Regional Carbon Sequestration Partnership (RSCP) program. In compliance with this, a letter proposal was submitted to the DOE project manager on April 26, 2022, requesting \$5 million in FY2022 funding from DOE. The letter proposal also included value-added scope totaling \$4 million, should additional funding from DOE be available beyond the \$5 million FY2022 funding. On December 12, 2022, DOE published FOA No. DE-FOA-0002799, which states, “A difference between the ongoing work [of the Regional Initiatives, including the PCOR Partnership] and the work sought under this FOA is that Applicants under this FOA must focus their efforts within one or more specific, more narrowly-defined geographic area(s) rather than over a broad region of the U.S.” At the time of this quarterly report, the status of the letter proposal submitted April 26, 2022, is unknown.

Presentations on the PCOR Partnership were given to eight prospective partners. Five new members were welcomed to the PCOR Partnership, bringing the membership to 242 as of December 31, 2022: Air Products and Chemicals, Inc.; Paragon Geophysical Services, Inc.; GLJ; RITE; and Enbridge.

A revised project management plan (PMP) was submitted to DOE on December 15, 2022, and included changes to the due dates of two deliverables:

- D9 – Report – Infrastructure, Scale-Up, and Techno-Economic Assessments due date moved to March 31, 2023.
- D15 – PCOR Partnership Atlas – due date moved to March 31, 2024.

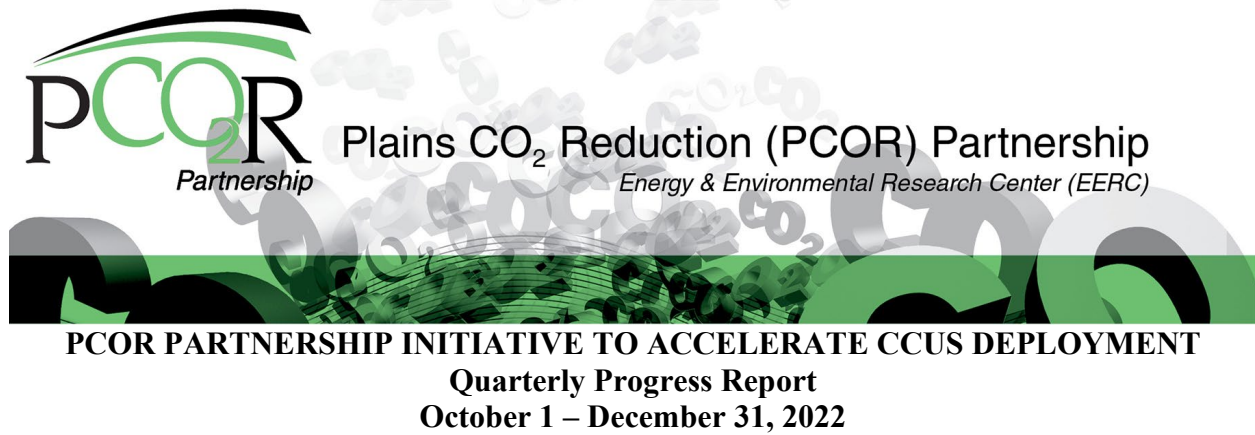
The EERC Program Manager gave several presentations this quarter: the Interstate Oil and Gas Compact Commission (IOGCC) 2022 Annual Meeting (October 16–18, 2022, in Baltimore, MD), the Alaska Resource Development Council Annual Conference (November 16–17, 2022, in Anchorage, AK.), and presented “Commercial CCUS Deployment” on a panel at CO₂ Conference Week (December 7, 2022, in Midland, TX).

Activities continued related to the field effort at the Red Trail Energy CCS (carbon capture and storage) site. The SASSA (scalable, automated, sparse seismic array) method is currently being used to record baseline seismic data from a surface orbital vibrator. SASSA data harvesting is ongoing. Eight DOE NETL seismometers with recording boxes have been made available for this effort. The NETL seismometers will be used for monitoring potential induced seismic activity and will complement the SASSA monitoring of the CO₂ plume. They were deployed at locations with SASSA sensors in October 2022. Finally, the EERC team installed the Instrumental Software Technologies, Inc. (ISTI) 6C seismic station for recording waveform data to complement SASSA processing effort. The station was installed in November and began recording data immediately. The EERC has installed open-source SWARM software that will allow for viewing the 6C station data in real time.

The 16th Greenhouse Gas Technologies Conference products below were finalized and submitted:

- PCOR Partnership: Breaking Down the Barriers in CCUS (oral presentation, delivered October 25, 2022, Session 6G – Regulatory Experiences USA)
- Risk-Based Area of Review Estimation in Overpressured Reservoirs to Support Injection Well Storage Facility Permit Requirements for CO₂ Storage Projects (oral presentation, delivered October 27, 2022, Session 11F – Risk Management for CO₂ Storage)
- Stacked Carbon Dioxide Storage: Technical and Geomechanical Considerations (oral presentation, delivered October 26, 2022, Session 8B – Site Characterization)
- Demonstration of Novel Monitoring Techniques for a North Dakota Carbon Capture and Storage Project, delivered October 26, 2022 (E-Poster Session Station C – Demonstration Projects CCS; content includes activities under a complementary project)

Numerous white papers continue to be under development by the EERC team as well as the subrecipient teams at UW and UAF. Four white papers were submitted this quarter, with topics on pore space, capillary entry pressure, local grid refinement, and Winter Storm Uri and electric grid stability.



INTRODUCTION

The Plains CO₂ 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 240 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, CO₂ 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 data sets 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 data sets 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 membership 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 regular progress update meetings with the Federal Project Manager (FPM).
- Discussed moving the end dates for two deliverables. Verbal approval from the FPM was received, and the EERC updated and submitted a revised PMP on December 15 based on the new due dates:
 - D9 – Report – Infrastructure, Scale-Up, and Techno-Economic Assessments due December 31, 2022, will be moved to March 31, 2023.
 - D15 – PCOR Partnership Atlas – due March 31, 2023, will be moved to March 31, 2024.
- Held progress meetings with subrecipients UAF and UW.
- Held discussions with prospective members on a weekly basis. The PCOR Partnership has 242 members at the time of this reporting. Welcomed new members Air Products and Chemicals, Inc.; Paragon Geophysical Services, Inc.; GLJ; RITE; and Enbridge.
- Continued planning discussions for the 2023 Annual Membership Meeting.
- Began planning and discussions for the TAB meeting to be held in the spring of 2023.

- Began discussions and initial planning of the 2023 Regulatory Roundup to be held in South Dakota in the summer of 2023.
- Presented at the Interstate Oil and Gas Compact Commission (IOGCC) 2022 Annual Meeting on October 16–18, 2022, in Baltimore, Maryland.
- The PCOR Partnership PM presented on the PCOR Partnership and CCUS deployment in the PCOR Partnership region at the Alaska Resource Development Council Annual Conference in Anchorage, Alaska, November 16–17, 2022.
- Presented “Commercial CCUS Deployment” on a panel at CO₂ Conference Week in Midland, Texas, on December 7, 2022.

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

- Begin planning the next PCOR Partnership Invitational with UAF and UW.
- Continue tracking progress on project deliverables (D) and milestones (M) (see Tables 1 and 2).

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.

Table 1. Project Deliverables

Deliverable 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	12/31/2022		Topical report submitted to DOE PM	A revised PMP moving the due date to 3/31/23 was submitted to DOE on 12/15/22.
D10 – Report – NRAP Testing and Validation	3/31/2023	12/17/2021 (Part 1)	Topical report submitted to DOE PM	To be provided in two parts.
D11 – Report – Basement Faulting and Stress State, Induced Seismicity	9/30/2023		Topical report submitted to DOE PM	
D12 – Report – Regional Socioeconomic Assessments	9/30/2023		Topical report submitted to DOE PM	
D13 – Report – Updated Regional Business Case Assessment	12/31/2023		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 3/31/2023	6/30/2021	Atlas submitted to DOE PM	A revised PMP moving the due date to 3/31/24 was submitted to DOE on 12/15/22.
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 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		Reported in subsequent quarterly report	
M10 – GHGT-17 Abstract Submitted	1/31/2024		Reported in subsequent quarterly report	
M11 – Annual Meeting Scheduled	3/31/2024		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.

Progress on Task 2.0 is as follows:

- Continued internal reviews on the white paper on approaches to geomechanical evaluations.
- Continued collaboration for the field effort at the Red Trail Energy (RTE) carbon capture and storage (CCS) site. Activities included the following:
 - The EERC team rented an electronic vib (E-vib) for both active and static sourcing operations.
 - A 3000-m seismic reflection line was collected along a W–E transect through the injection area for monitoring plume extents.
 - The cement platform for the E-vib and shed is in place at the injection pad site for continuous on-demand operations. Electrical work will be complete by the end of December 2022. Mechatronics will travel to the site from the Netherlands to lead installation efforts and electrical hookup in early January 2023.
 - Continued processing E-vib data from East–West 2D line, including quality control of Stryde records from the 2D line recorded in Quarter 4 of 2022.

- The EERC team is currently planning to acquire near-surface refraction with the Betsy Seisgun and a N-S 2D line sourced with the E-vib across the injection site for imaging the CO₂ plume.
- Eight DOE NETL seismometers with recording boxes have been made available for the RTE effort. The NETL seismometers will be used for monitoring potential induced seismic activity. The technical seismometer characteristics will allow the PCOR Partnership to complement the SASSA monitoring of the CO₂ plume.
 - Seismometer stations were installed and deployed at locations with SASSA sensors in October 2022.
 - Continue planning for conversion of three of the stations to continuous real-time monitoring.
- SASSA is currently recording seismic baseline and monitoring data from multiple surface orbital vibrators (SOVs).
 - The geophysics team started software development for data analysis and processing of SASSA seismic data acquired from April through September 2022.
 - The EERC team procured a 6C seismic station for recording waveform data to complement SASSA processing effort.
 - In addition to the SASSA deployment effort in early June 2022, the team collected drone imagery to support ongoing field efforts related to locating feasible equipment deployment locations for the NETL seismometers and preliminary planning for potential artificial reflector installation.
 - The EERC team has performed geomechanical studies to understand the extent of surface deformation related to pressure change from injection operations. This surface deformation study will inform the deployment of artificial reflectors for higher-resolution measurements with InSAR.
 - The geophysics team started software development for data analysis and processing of SASSA seismic data April–September 2022.
 - The EERC completed the latest SASSA harvesting in October 2022 and again in December 2022. The EERC partially completed December SASSA harvest because of weather conditions causing access issues with some of the SASSA array locations.
- Weekly meetings began with contractor SkyGeo to review InSAR (interferometric synthetic aperture radar) data for historical analysis and modeling to inform decision making for artificial reflector installation.
 - SkyGeo has completed fabrication of the artificial reflector (AR) package for review by the EERC. SkyGeo will move forward with fabricating the rest of the ARs.
 - SkyGeo has completed fabrication of the ARs and is preparing to ship 20 units to the EERC for deployment at the RTE site.
- The EERC team installed the Instrumental Software Technologies, Inc. (ISTI) 6C seismic station for recording waveform data to complement the SASSA processing effort. The seismic station includes a three-component (3C) rotational and a 3C translational sensor. The 3C rotational sensor is sensitive enough to detect our RTE seismic sources (SOVs and E-vib) as well as natural events (earthquakes).

- The location for the 6C station was determined, and the station was installed in early November.
 - Early data collected at the site show the 6C (3C translational sensor and 3C rotational) station is working as expected. The translational and rotational sensors detected the 6.4 magnitude earthquake 12 km from Ferndale, California, that occurred in December 2022.
 - The 6C station is in service and is currently recording ambient noise at the site. The EERC has installed open-source SWARM software that will allow for viewing the 6C station data in real time.
- UW continued work on draft documents to advance the technical foundation in the PCOR Partnership region, including the following topics under Task 2.0:
 - UW submitted a deliverable to the EERC on September 30, 2022: formation outlines for Minnelusa, Hulett, and Lakota Formations and associated seals. These reports included updated CO₂ storage estimates for formations in the Powder River Basin.
 - UW continues to work on a deliverable entitled “Formation Outlines for Storage Reservoirs and Seals in the Rock Springs Uplift.” UW is using the workflow used for estimating storage capacity in the Powder River Basin for storage reservoirs at the Rock Springs Uplift. The existing drafts of formation outlines for the Rock Springs Uplift will be updated with new storage estimates.
 - UW has incorporated comments from the EERC and continues to refine deliverable “Stacked Storage Potential in the Powder River Basin and the Rock Springs Uplift.” This report was submitted to the EERC by October 31, 2022.
 - Formation Outlines for Minnelusa, Hulett, and Lakota Formations and Associated Seals – Drafts were submitted a second time to the EERC on October 26, 2022, for review. EERC reviewed and provided comments to UW. Revisions are ongoing.
 - Formation Outlines for Storage Reservoirs and Seals in the Rock Springs Uplift – UW continues to work to incorporate feedback from the EERC into formation outlines for the Rock Springs uplift.
 - Basement Faulting and Stress State, Induced Seismicity – UW is currently working on a project analyzing paleostress and fractures in the eastern Bighorn Mountains and western Black Hills, which flank the Powder River Basin. UW is also building a database of existing fracture and fault data for all Wyoming basins. This work will eventually contribute to Deliverable D11.
 - UW presented a poster entitled “Paleostress and Fracture Analysis of the Eastern Bighorn Mountains and Western Black Hills, Powder River Basin” at the Geological Society of America annual meeting in Denver, Colorado, on October 12, 2022.

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

- Undertake additional RTE field activities: meet weekly with contractor SkyGeo to review InSAR data for historical analysis and modeling to inform decision making for artificial reflector installation.

- Continue work on 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 CO₂ 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:

- Subtask 3.1 – Data Sharing
 - The EERC continues to identify and catalog data sets that will be generated through the PCOR Partnership and available for upload to the EDX for M12 – BP2 EDX Submitted.
 - The EERC submitted a white paper entitled “Impacts of Local Grid Refinement, Capillary Pressure, and Relative Permeability on Early Injection Well Behavior During Simulation of Large-Domain Dedicated Carbon Dioxide Storage” on November 16, 2022.
- Subtask 3.2 – NRAP Validation
 - Continued additional testing of the NRAP-Open-IAM. The project team is comparing the results from NRAP-Open-IAM against the results for an identical storage complex and overburden stratigraphy in the Analytical Solution for Leakage in Multilayered Aquifers (ASLMA) FORTRAN-based semianalytical model. The additional NRAP-Open-IAM testing will be submitted as D10 Part 2 (D10 Part 1 was submitted on December 17, 2021).
- Subtask 3.3 – Machine Learning
 - Continued to explore the use of ML-based predictive modeling techniques to use geophysical well logs to classify aquifers located throughout the PCOR Partnership region into three groups based on their estimated total dissolved solids (TDS) concentrations: i) confidently less than 10,000 mg/L TDS, ii) confidently greater than 10,000 mg/L TDS, or iii) uncertain classification – not i) or ii). Collaborating with UW on this effort.
 - Analyzing the results of numerical reservoir simulations to quantify the impacts to injectivity at Storage Site A when a second Storage Site B is located 10–25 miles away; both sites are injecting 0.5–4 MtCO₂/year, and different injection constraints are applied to the simulations.
 - The EERC continues to track the historical work (Phase 1) and the ongoing work (Phase 2) conducted under the SMART Initiative and look for ways to incorporate these learnings into the PCOR Partnership region.
- UW continued work on draft documents to advance the PCOR Partnership knowledge in topics under Task 3.0, including the following:

- Classification of TDS Based on Well Log Interpretation – An initial set of wells from the Powder River Basin that have water quality data and well logs were identified. Preliminary analysis of these wells has been completed in order to better understand the relationship between TDS and well log data. UW completed digitization for the initial set of wells. The EERC is currently analyzing compiled data. Preliminary results using well log measurements to predict aquifer TDS concentrations were unsuccessful (large classification errors), and the application of machine learning to this problem was temporarily abandoned.

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

- Continue to explore the use of ML-based predictive modeling techniques to use geophysical well logs to classify aquifers located throughout the PCOR Partnership region.
- Prepare and submit D10 – NRAP Testing and Validation report – Part 2.

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 CO₂ 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:

- Continuing development of D9 for CCUS project development and infrastructure buildout. Team is evaluating source/sink relationships and infrastructure development using SimCCS tool in order to identify future project development scenarios. Team has been investigating/compiling latest economics around capture and infrastructure development for use in the techno-economic analysis of development scenarios for reporting.
- The 16th GHGT-16 products below were finalized and submitted:
 - PCOR Partnership: Breaking Down the Barriers in CCUS (oral presentation, delivered October 25, 2022, Session 6G – Regulatory Experiences USA)
 - Risk-Based Area of Review Estimation in Overpressured Reservoirs to Support Injection Well Storage Facility Permit Requirements for CO₂ Storage Projects (oral presentation, delivered October 27, 2022, Session 11F – Risk Management for CO₂ Storage)
 - Stacked Carbon Dioxide Storage: Technical and Geomechanical Considerations (oral presentation, delivered October 26, 2022, Session 8B – Site Characterization)

- Demonstration of Novel Monitoring Techniques for a North Dakota Carbon Capture and Storage Project, delivered October 26, 2022 (E-Poster Session Station C – Demonstration Projects CCS; content includes activities under a complementary project)
- Copies of the PCOR Partnership Atlas, 6th Edition (D15) continued to be shipped to the PCOR Partnership, including new members.
- Final internal reviews of the white paper on CO₂ stream impurities continued.
- Internal reviews continued of the white paper of the PCOR Partnership hydrogen CCUS road map.
- A white paper written and prepared by Jackson Walker LLP, on behalf of the PCOR Partnership, was submitted on November 15, 2022. The title of the paper is “Texas Response to Winter Storm Uri.”
- Stress Engineering Services, Inc., is working as a subcontractor to provide PCOR Partnership membership with a basic guideline on considerations for selecting corrosion-resistant alloys material for use in CO₂ storage and utilization applications. A white paper associated with the guidelines was delivered to the EERC this quarter and is under review.
- Stress Engineering has developed a guideline document for the use of carbon steel (CS) pipelines with CO₂ streams containing H₂S and for repurposing CS pipelines previously used in H₂S service for CO₂ streams without H₂S. The guidelines document has been received and is under review.
- UW continued work on draft documents to advance the PCOR Partnership knowledge in topics under Task 4.0, including the following:
 - Infrastructure, Scale-Up, and Techno-Economic Assessments – UW has begun this work and is planning to develop supply curves of CCUS and a map that will include potential coal power plants with CO₂ capture facilities, CO₂ pipelines, and CO₂ storage fields. The supply curves and the map will provide information about whether there is a need to expand existing pipelines, where and how to expand them, and where and how to develop new pipelines.
 - Hydrogen Production with CCS Opportunities – UW completed a draft and submitted to the EERC on November 15.
 - Social License for Wyoming’s Energy Future – This deliverable will be based on the results of a PCOR Partnership-sponsored survey and Q-study that will assess Wyoming residents’ opinions about energy topics, including CCS/CCUS. The survey format has been finalized by UW’s School of Energy Resources (SER), with input from the EERC. The survey is currently being distributed to Wyoming residents by the Wyoming Survey and Analysis Center (WySAC). Work has also started on the Q-study. We have acquired access to the software and are composing interview questions and scheduling interviews, which will be conducted with people who work

on energy-related issues in Wyoming. The results of both the survey and the Q-study will be analyzed and summarized in this deliverable. Final survey results were received from WySAC at the end of October. UW is underway with conducting interviews with stakeholders in the energy industry, discussing the results of the surveys to gain insight on the impact of public knowledge of the energy sector. UW is developing a 2-page summary of these results which will be released before the final report is due March 2023.

- UAF is currently waiting on approvals of foreign national students to get them involved with a deliverable to the EERC entitled “Efficacy of Corrosion Inhibitors at Various CO₂ Concentrations and Implications for CO₂ EOR Development on the North Slope.”
- UAF completed a first draft of the CO₂ corrosion inhibitor literature review and included preliminary CO₂ corrosion inhibitor testing proof of concept. The EERC will provide feedback on the report and preliminary CO₂ corrosion testing.
- The Alaska CCUS State Workgroup met December 13 to discuss the Gaffney Cline CCUS cost model they developed for the National Petroleum Council’s 2019 Roadmap to CCUS.

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

- Continue to ship the PCOR Partnership Atlas (D15) to new PCOR Partnership members.
- Complete and submit D9 – Infrastructure, Scale-Up, and Techno-Economic Assessments report by March 31, 2023.
- Continue development of secondary education content and beta-testing material.
- Complete white papers on the well testing for CO₂ storage sites and provide to DOE and PCOR Partnership members.

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:

- Efforts continued to populate both the public website (undeerc.org/pcor) and the Partners-Only website (undeerc.org/pcorpartners) with new and updated information.
- Internal meetings were held to discuss outreach strategy and preparation of an outreach plan.
- A “partner engagement” internal brainstorming session was held on October 19, 2022, to discuss opportunities to solicit partner input on CCUS activities, encourage networking amongst PCOR Partnership stakeholders, and provide enhanced value to the PCOR Partnership.
- An invitation-only webinar was presented entitled “Risk-Based Area of Review (AOR) Delineation for CO₂ Storage Projects” on October 11, 2022, to an audience of 32 regulatory representatives.
- A PCOR Partnership webinar was scheduled for November 16, 2022, featuring the former North Dakota Tax Commissioner discussing recent changes to the Internal Revenue Code, Section 45Q. Registration information was sent to the partners and regional regulatory contacts. A presentation entitled “Using 45Q Tax Credits to Enhance CCUS” was given to over 80 people in attendance.
- EERC representatives attended the Midwest Regional Carbon Initiative (MRCI) 2022 Partners and Stakeholders Meeting on September 27–28, 2022, in Columbus, Ohio.
- The white paper entitled “Incorporating Capillary Entry Pressure Measurements into Evaluations of Storage Permanence for Permitting Class VI Injection Wells” was submitted to DOE and NDIC on December 14, 2022.
- A white paper entitled “Pore Space: Technical and Legal Considerations for CO₂ Storage in North Dakota” was submitted to DOE on October 21, 2022.
- Continued development of several white papers, focusing on the following topics: capillary pressure, step rate testing, and other lessons learned through the PCOR Partnership efforts.
- Discussions began with the Groundwater Protection Council (GWPC) regarding a new PCOR Partnership collaboration between the EERC, the GWPC, and the North Dakota Department of Mineral Resources (NDDMR) to provide technology transfer that will support the development of a state regulatory database for CO₂ storage to track permitting and regulatory reporting. The GWPC is working with NDDMR to develop a permitting and reporting module for NDDMR’s current NorthStar database. The EERC will be supporting this effort through the PCOR Partnership to provide technology transfer. All states will have access to and the ability to use the database module when complete.

- A member of the UAF team was asked by the Alaska Department of Natural Resources (DNR) to serve as the host and lead facilitator for the newly constituted CCUS Alaska State Workgroup. The CCUS state workgroup purpose is to accelerate commercial carbon capture, use, and sequestration in Alaska.
 - The first CCUS regulatory framework workgroup meeting was held August 10, 2022, with approximately 50 participants.
 - A series of four meetings were held in August to inform DNR regarding the state of Alaska’s proposed regulatory framework. The Alaska DNR is taking the lead on these topics which include state property rights and leasing, amalgamation of property rights, long-term liability, fiscal terms, and Class VI primacy. During the full-day symposium on August 30, participants discussed and documented their preferences. The result will be a white paper authored by DNR and shared with the Governor’s office. Carbon legislation, to be proposed by the Governor and authored by the Department of Law, is expected to be one of four legislative priorities in the January 2023 session.
- UAF and EERC personnel continue to work on a techno-economic assessment for CCS in and around the Alaska Cook Inlet coupled with electricity generation of different capacities. This techno-economic assessment will inform a UAF deliverable entitled “A Road Map for Deploying Commercial CCUS in Alaska.”
- The PCOR Partnership PM met with the Alaska Department of Natural Resources and the Alaska Oil and Gas Conservation Commission in Anchorage, Alaska, November 15–17, 2022, to discuss the development of statutory and regulatory frameworks for CCUS.
- UW and the EERC continue to collaborate on efforts to draft several white papers focused on permitting CCUS on federal land and lessons learned from site characterization and permitting first mover CCS projects in Wyoming.
 - Regional Permitting Guidance D8 – The EERC provided additional feedback, and UW is completing another round of edits to be completed by the end of December 2022.
 - Federal Land Challenges for CCS – The EERC provided additional feedback on this draft, and UW is making edits in response. An updated draft will be completed in January 2022.

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

- Continue updating the PCOR Partnership public and partner websites.
- Complete white paper on the stabilized plume evaluations.

CHANGES/PROBLEMS

No changes or problems at this time.

SPECIAL REPORTING REQUIREMENTS

None.

BUDGETARY INFORMATION

ENERGY & ENVIRONMENTAL RESEARCH CENTER
PLAINS CO₂ REDUCTION PARTNERSHIP INITIATIVE TO ACCELERATE CARBON CAPTURE, UTILIZATION, AND STORAGE
DEPLOYMENT
DE-FE0031838

Project-to-Date Financial Report at December 31, 2022

(\$K)	Q4 Oct - Dec 2019	Q1 Jan - Mar 2020	Q2 Apr - Jun 2020	Q3 Jul - Sep 2020	Q4 Oct - Dec 2020	Q1 Jan - Mar 2021	Q2 Apr - Jun 2021	Q3 Jul - Sep 2021	Q4 Oct - Dec 2021	Q1 Jan - Mar 2022
Baseline Cost Plan										
Federal Share	63.8	81.4	213.9	239.7	296.8	376.4	1230.8	1402.3	814.6	1388.5
Nonfederal Share	0.0	6.5	49.7	40.6	83.0	81.9	179.0	82.8	488.5	495.0
Total Planned	63.8	87.9	263.6	280.3	379.8	458.3	1409.8	1485.1	1303.1	1883.5
Cumulative Federal	63.8	145.2	359.1	598.8	895.6	1272.0	2502.8	3905.1	4719.7	6108.2
Cumulative Nonfederal	0.0	6.5	56.2	96.8	179.8	261.7	440.7	523.5	1012.0	1507.0
Cumulative Baseline Costs	63.8	151.7	415.3	695.6	1075.4	1533.7	2943.5	4428.6	5731.7	7615.2
Actual Incurred Cost										
Federal Share	63.8	81.4	213.9	239.6	296.8	376.4	1230.8	1402.3	814.6	1388.5
Nonfederal Share	0.0	6.5	49.7	40.6	83.0	81.9	179.1	82.8	488.4	495.0
Total Incurred Costs	63.8	87.9	263.6	280.2	379.8	458.3	1409.9	1485.1	1303.1	1883.5
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Cumulative Nonfederal	0.0	6.5	56.2	96.7	179.8	261.6	440.7	523.5	1011.9	1506.9
Cumulative Incurred Costs	63.8	151.7	415.4	695.5	1075.3	1533.6	2943.5	4428.6	5731.7	7615.2
Variance										
Federal Share	0.0	(0.0)	(0.0)	0.1	0.0	(0.0)	(0.0)	0.0	(0.0)	0.0
Nonfederal Share	0.0	0.0	0.0	0.0	(0.0)	0.0	(0.1)	0.0	0.1	(0.0)
Total Variance	0.0	(0.0)	(0.0)	0.1	0.0	0.0	(0.1)	0.0	0.0	0.0
Cumulative Federal	0.0	(0.0)	(0.1)	0.0	0.0	0.0	(0.0)	0.0	(0.0)	(0.0)
Cumulative Nonfederal	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.1
Cumulative Variance	0.0	(0.0)	(0.1)	0.1	0.1	0.1	(0.0)	0.0	0.0	0.0

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(\$K)	Q2 Apr - Jun 2022	Q3 Jul - Sep 2022	Q4 Oct - Dec 2022	Q1 Jan - Mar 2023	Q2 Apr - Jun 2023	Q3 Jul - Sep 2023	Q4 Oct - Dec 2023	Q1 Jan - Mar 2024	Q2 Apr - Jun 2024	Q3 Jul - Sep 2024
Baseline Cost Plan										
Federal Share	889.2	889.2	889.2	889.2	889.2	889.2	889.2	889.2	889.1	889.1
Nonfederal Share	224.6	224.6	224.6	224.6	224.6	224.6	224.6	224.6	224.6	224.5
Total Planned	1113.8	1113.8	1113.8	1113.8	1113.8	1113.8	1113.8	1113.8	1113.7	1113.6
Cumulative Federal	6997.4	7886.6	8775.8	9665.0	10554.2	11443.4	12332.6	13221.8	14110.9	15000.0
Cumulative Nonfederal	1731.6	1956.2	2180.8	2405.4	2630.0	2854.6	3079.2	3303.8	3528.4	3752.9
Cumulative Baseline Costs	8729.0	9842.8	10956.6	12070.4	13184.2	14298.0	15411.8	16525.6	17639.3	18752.9
Actual Incurred Cost										
Federal Share	1823.3	1157.3	1223.0							
Nonfederal Share	335.8	195.6	481.7							
Total Incurred Costs	2159.1	1352.9	1704.7							
Cumulative Federal	7931.5	9088.9	10311.9							
Cumulative Nonfederal	1842.7	2038.3	2520.0							
Cumulative Incurred Costs	9774.2	11127.1	12831.8							
Variance										
Federal Share	(934.1)	(268.1)	(333.8)							
Nonfederal Share	(111.2)	29.0	(257.1)							
Total Variance	(1045.3)	(239.1)	(590.9)							
Cumulative Federal	(934.1)	(1202.3)	(1536.1)							
Cumulative Nonfederal	(111.1)	(82.1)	(339.2)							
Cumulative Variance	(1045.2)	(1284.3)	(1875.2)							