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January 29, 2021

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: Quarterly Progress Report for the Period of October 1 – December 31, 2020, "PCOR 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 e-mail at kconnors@undeerc.org.

Sincerely,

DocuSigned by:
Kevin Connors
1D14EF7CF3CD456...

Kevin C. Connors
Principal Policy & Regulatory Strategist

KCC/kal

Attachment

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

c: Corey Irion, EERC

PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT

Quarterly Technical Progress Report

(for the period October 1 – December 31, 2020)

Prepared for:

Karlene Fine

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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January 2021

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PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT
Quarterly Progress Report
October 1 – December 31, 2020

EXECUTIVE SUMMARY

The Plains CO_2 Reduction (PCOR) Partnership Initiative is one of four projects competitively awarded by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) under the Regional Initiative to Accelerate CCUS (carbon capture, utilization, and storage). The PCOR Partnership Initiative is led by the Energy & Environmental Research Center (EERC) with support from the University of Wyoming (UW) and the University of Alaska Fairbanks (UAF) and includes stakeholders from the public and private sectors. The PCOR Partnership Initiative region includes all or part of ten U.S. states and four Canadian provinces. Four new members were welcomed to the PCOR Partnership Initiative: Midwest AgEnergy Group, LLC, ONEOK, Inc., KAPPA Ethanol Holdings, LLC, and Catahoula Management Services.

A revised project management plan was submitted to DOE to update budget numbers based on Contract Modification 003 and modify due dates for three deliverables (Ds), which included D2 (Topical Report – Storage Optimization), D4 (Topical Report – Regional Business Model Assessment), and D14 (Topical Report – Risk-Based Area of Review).

In lieu of an in-person annual membership meeting in 2020, a series of virtual presentations continued between September 2020 and March 2021 on a variety of topics. A webinar entitled “CCUS Headwinds and Tailwinds” was presented by Mike Nasi, Jackson Walker LLP, on November 18, 2020.

Writing continued on the storage optimization report. A meeting was held with members of the Petroleum Technology Research Centre to discuss potential collaborative efforts in future geologic modeling and numerical simulation focused on the region surrounding the Aquistore site. The project team expanded the previous testing of Open-IAM (open-source Integrated Assessment Model for Phase II of the National Risk Assessment Partnership NRAP, Release alpha 2.1.0-20.05.22) to include an aquifer component model and coupled the outputs with DREAM (Designs for Risk Evaluation and Management Tool, Version: 2020.01-2.0) to test DREAM for optimizing monitoring configurations that minimize time to first detection. Development of a draft risk-based area of review manuscript continued. Development of the PCOR Partnership atlas was ongoing. The DOE RCSP 2025 Infrastructure Roadmap for the PCOR Partnership Initiative region was submitted to DOE.

The EERC holds an unwavering commitment to the health and well-being of its employees, partners and clients, and the global community. As such, precautionary measures have been implemented in response to COVID-19. Staff continue to carry out project-related activities remotely, and personnel supporting essential on-site laboratory and testing activities are proceeding under firm safety guidelines. Travel has been minimized, and protective measures are being undertaken for those who are required to travel. At this time, work conducted by EERC employees is progressing with minimal disruption. Challenges posed by economic variability will be met with open discussion between the EERC and project partners to identify solutions. The EERC is monitoring developments across the nation and abroad to minimize risks, achieve project goals, and ensure the success of our partners and clients. In the event that any potential impacts to reporting, scope of work, schedule or cost are identified, they will be discussed and addressed in cooperation with the project partners.

PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT
Quarterly Progress Report
October 1 – December 31, 2020

INTRODUCTION

The Plains CO_2 Reduction (PCOR) Partnership Initiative is one of four projects operating under the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Regional Initiative to Accelerate CCUS (carbon capture, utilization, and storage). The PCOR Partnership Initiative is led by the Energy & Environmental Research Center (EERC) with support from the University of Wyoming (UW) and the University of Alaska Fairbanks (UAF) and includes stakeholders from the public and private sectors. The membership, as of December 31, 2020, is 194 members. The PCOR Partnership Initiative region includes all or part of ten states (Alaska, Iowa, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming) and four Canadian provinces (Alberta, British Columbia, Manitoba, and Saskatchewan).

The goal of the PCOR Partnership Initiative is to identify and address regional capture, transport, and storage challenges facing commercial deployment of CCUS in an expanded region, compared to past initiatives. To achieve this goal, the PCOR Partnership Initiative 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 and needs
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. 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 the DOE 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 Initiative region. Potential business case scenarios will be evaluated, taking into account 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 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:

- Received DOE Contract Modification 004 October 19, 2020. The purpose of the modification was to revise the special terms and conditions, statement of project objectives (SOPO), and budget pages because of administrative errors under Contract Modification 003.

- Submitted a revised PMP on December 4, 2020. The budget numbers were updated to match Contract Modification 003. Due dates for three deliverables (Ds) were modified:
  - D2 (Topical Report – Storage Optimization) (Task 2): moved from December 31, 2020, to April 30, 2021, to ensure the wide array of storage optimization work that exists in the literature is considered and to allow time to complete simulations.
  - D4 (Topical Report – Regional Business Model Assessment) (Task 5): moved from March 31, 2021, to December 31, 2021. UAF is working with industry partners to secure access to data and insight to support the development of this deliverable, and negotiations with these partners has taken longer than originally anticipated.
  - D14 (Topical Report – Risk-Based Area of Review) (Task 3): moved from December 31, 2020, to January 31, 2021, to accommodate the task lead's current workload.

- Continued SOPO and budget allocation revisions for the next round of add-on funding.

- In lieu of an in-person annual membership meeting in 2020, continued a series of virtual presentations held between September 2020 and March 2021 on a variety of topics. Activities included the following:
  - Decided to forego our October webinar in light of the Interstate Oil and Gas Compact Commission (IOGCC) CCUS workshop scheduled for October 28, 2020. An eblast was sent to the members on October 13, 2020.
  - Held the November webinar on November 18, 2020. The webinar, presented by Mike Nasi, Jackson Walker LLP, was entitled "CCUS Headwinds and Tailwinds."

  - Worked on planning the next webinars in the series.

- Presented a status update on the PCOR Partnership Initiative and request for incremental funding to project sponsors North Dakota Industrial Commission (NDIC) Lignite Research Council on November 12, 2020, and NDIC Oil and Gas Research Council on December 16, 2020.

- Engaged in conversations with current and prospective partners regarding their continued involvement in the PCOR Partnership Initiative:
  - Welcomed new members Midwest AgEnergy Group, LLC, ONEOK, Inc., KAPPA Ethanol Holdings, LLC, and Catahoula Management Services.

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

- Complete add-on SOPO revisions and budget and submit to DOE.

- Continue webinar series planning and hold webinars.

- Track progress on project deliverables 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 Initiative region related to stacked storage opportunities; storage performance; monitoring, verification, and accounting (MVA) technology; and subsurface integrity. The EERC will collaborate with PCOR Partnership Initiative members to identify knowledge gaps and address regional challenges through targeted webinars, workshops, reports, and papers.

Progress on Task 2.0 is as follows:

- Work continued on the storage optimization report (D2), including storage formation simulations, cost estimate determinations, and writing text.

- A meeting was held with members of the Petroleum Technology Research Centre (PTRC) on October 22, 2020, to discuss potential collaborative efforts in future geologic modeling and numerical simulation focused on the region surrounding the Aquistore site.

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

- Continue work on D2.
- Continue to work with PTRC.

Table 1. Project Deliverables

Deliverable (D) No. and Title	Planned Completion Date	Actual Completion Date	Verification Method	Comments
D1 – Project Management Plan	30 days after contract definitization	2/21/2020	PMP file submitted to DOE Project Manager (PM)	
D2 – Report – Storage Optimization	4/30/2021		Topical report submitted to DOE PM	Moved from 12/31/2020
D3 – Report – Stacked Storage Opportunity Assessment	6/30/2021		Topical report submitted to DOE PM	
D4 – Report – Regional Business Case Assessment	12/31/2021		Topical report submitted to DOE PM	Moved from 3/31/2021
D5 – Report – Subsurface and Legacy Well Integrity	12/31/2021		Topical report submitted to DOE PM	
D6 – Report – MVA Strategies	6/30/2022		Topical report submitted to DOE PM	
D7 – Report – Evaluation of Risk Management	9/30/2022		Topical report submitted to DOE PM	
D8 – Report – Regional Permitting Guidance	9/30/2022		Topical report submitted to DOE PM	
D9 – Report – Infrastructure, Scale-Up, and Techno-Economic Assessments	12/31/2022		Topical report submitted to DOE PM	
D10 – Report – NRAP Testing and Validation	3/31/2023		Topical report submitted to DOE PM	
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		Topical report submitted to DOE PM	Moved from 12/31/2020
D15 – PCOR Partnership Atlas	3/31/2021 and 3/31/2023		Atlas 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		Reported in subsequent quarterly report	
M4 – Regulatory Roundup Scheduled	3/31/2021		Reported in subsequent quarterly report	
M5 – Data Share with National Lab for NRAP Assessment	6/30/2021		Reported in subsequent quarterly report	
M6 – GHGT-16[1] Abstract Submitted	1/31/2022		Reported in subsequent quarterly report	
M7 – BP1 EDX[2] Submitted	3/31/2022		Reported in subsequent quarterly report	
M8 – Draft Journal Article Completed	11/30/2022		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] 16th International Conference on Greenhouse Gas Control Technologies.
[2] Energy Data eXchange.

Task 3.0 – Data Collection, Sharing, and Analysis

In Task 3.0, the project team will collaborate with other DOE Fossil Energy (FE)-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:

- Subtask 3.1 – Data Sharing:
  - The EERC has compiled details of several commercial-scale geologic models (geomodels) that were developed in Schlumberger's Petrel and their associated numerical reservoir simulations that were conducted using Computer Modelling Group's Generalized Equation-of-State Model compositional reservoir simulator, GEM (CMG GEM). This modeling and simulation catalog also includes attributes about the different models, for example, file types, file sizes, model domain, reservoir layers, simulation time, injection wells, and CO_2 mass injection targets. The

modeling and simulation catalog will help to identify potential files that could be shared to accelerate CCUS technology development. In addition, the catalog will provide a basis for NRAP tool testing in Subtask 3.2.

- Subtask 3.2 – NRAP Validation:
  - The project team attended the following NRAP webinars:
    - Attended the NRAP Virtual Annual Program Review Meeting held November 4–5, 2020.
    - Participated in the NRAP panel discussion entitled "Panel Discussion: How Can NRAP Better Engage with CCUS Demonstration and Deployment Efforts?" on November 5, 2020.
  - NRAP tools testing is ongoing with the following activities:
    - Expanded the previous testing of Open-IAM (open-source Integrated Assessment Model for Phase II of the National Risk Assessment Partnership NRAP, Release alpha 2.1.0-20.05.22) to include an aquifer component model. The testing will evaluate the FutureGen 2.0 Aquifer component model, which predicts the impact that CO_2 and brine leakage from the storage reservoir might have on overlying aquifers. The FutureGen 2.0 Aquifer component model predicts the size of "impact plumes" according to four metrics: pH, total dissolved solids (TDS), pressure, and dissolved CO_2.
    - Coupled the outputs from the expanded testing of Open-IAM with DREAM (Designs for Risk Evaluation and Management Tool, Version 2020.01-2.0) to test DREAM for optimizing monitoring configurations that minimize time to first detection. The team generated preliminary results that are undergoing internal quality assurance/quality control (QA/QC).
    - The previous testing of RROM-Gen (Reservoir Reduced-Order Model – Generator Tool, Version: 2016.11-1.2) and testing of NRAP-Open-IAM and DREAM represent the complete set of NRAP tools that will be tested under Task 3. The results of the testing will be compiled into a summary report (D10).
  - A representative of DOE NETL asked the EERC to participate in a new SBIR that was awarded to Illinois Rocstar LLC to build a tool based on NRAP-Open-IAM, but with a commercial-quality, well-designed user interface and a seamless distribution platform (potentially cloud-based). Virtual meetings were held between the EERC and Illinois Rocstar LLC on October 9, 2020, and December 14, 2020.
  - A pre-final draft of a manuscript entitled "Risk-Based Area of Review (AoR) Estimation to Support Injection Well Storage Facility Permit Requirements for CO_2 Storage Projects" was developed and is undergoing internal review. The paper presents a workflow and modeling approach for delineating a risk-based AoR to support a U.S. Environmental Protection Agency (EPA) Class VI storage facility permit for a CO_2 storage project. The manuscript will be submitted as D14 – Topical Report – Risk-Based Area of Review by January 31, 2021.

- Subtask 3.3 – Machine Learning:
  - The EERC continues to support the SMART (Science-Informed Machine Learning for Accelerating Real Time Decisions in Subsurface Applications) Initiative through the PCOR Partnership Initiative. The EERC is directly involved in Tasks 1, 2, 4, 5,

and 6 of the SMART Initiative and is participating in the crosscutting groups for algorithms and data.

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

- Subtask 3.1: Continue to catalog available geomodels and reservoir simulations that could be shared to accelerate CCUS technology development.

- Subtask 3.2: Continue to participate in the NRAP webinar series to learn about existing and forthcoming NRAP tools. Continue to troubleshoot and test the suite of NRAP tools described above. Meet with Illinois Rocstar LLC to provide feedback about NRAP-Open-IAM. Summarize the RROM-Gen, NRAP-Open-IAM, and DREAM testing results into D10 (Report – NRAP Testing and Validation). Submit D14 (Risk-Based Area of Review).

- Subtask 3.3: Continue to track SMART Initiative activities to identify opportunities to leverage CO_2 storage project data sets for the validation and testing of ML-based approaches to modeling CO_2 and/or pressure in the subsurface.

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 Initiative region and will be communicated through outreach activities.

Progress on Task 4.0 is as follows:

- Worked on development of the PCOR Partnership atlas (D15).

- Investigating the use of SimCCS, a software platform for carbon capture and storage (CCS) infrastructure design.

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

- Develop a preliminary plan for acquiring input data for statewide economic models within the PCOR Partnership Initiative region.

- Submit the PCOR Partnership atlas (D15).

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 Initiative 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 FE program goals.

Progress on Task 5.0 is as follows:

- Submitted the DOE RCSP 2025 Infrastructure Roadmap for the PCOR Partnership Initiative region to DOE on October 1, 2020. The vision for the next 5 years includes a description of Commercial Business Models Driving CCUS in the PCOR Partnership Initiative region, identifying the business models that will drive commercial development and what innovations are necessary to accelerate the deployment of new CCUS projects.

- Provided PCOR Partnership comments on the DOE Storage Infrastructure Roadmap to DOE Headquarters. The document contained several comment boxes, as well as some suggested text-level edits for consideration. Some suggested text and key references were provided.

- Worked with EERC personnel to understand the CCS permitting process in North Dakota. There is coordination with the North Dakota CarbonSAFE project, a separate DOE-funded effort, working on permitting a CCS project in the PCOR Partnership region.

- Began investigating potential business cases in the region using a regional trunkline with multiple stationary sources.

- The new PCOR Partnership Initiative website was populated with technical content, graphics, and resources. All site content was reviewed for technical accuracy, graphics and images were added throughout the site, and educational resources were chosen.

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

- Continue to engage regulators in the PCOR Partnership region and begin to plan the Regulatory Roundup Meeting.

- Each of the five business cases described in the draft 2025 road map for the PCOR Partnership Initiative will be researched and defined and a plan developed to meet the stated vision. This includes the following:
  - Consider various ownership options.

- Consider various combinations of capture, transportation, dedicated/associated storage, and production of low-carbon fuels.
- Provide an assessment of the maturity and potential rate of growth of these business models.
- Provide guidance on how each business model can leverage existing infrastructure, tax policies, financial incentives, and investment vehicles/insurance instruments to facilitate CCUS commercialization throughout the PCOR Partnership Initiative region.

CHANGES/PROBLEMS

The EERC is operational and open for business. Personnel who are not essential for on-site operations have transitioned to working from home. Essential project, laboratory, and field-based activities are proceeding with the incorporation of the Centers for Disease Control and Prevention (CDC), the state of North Dakota, and the University of North Dakota (UND) guidelines associated with COVID-19, and mitigation measures have been implemented.

In collaboration with project partners, the EERC is continually assessing potential impacts to project activities resulting from COVID-19 and/or the U.S. economic situation.

In the event that any potential impacts to reporting, scope of work, schedule, or cost are identified, they will be discussed and addressed in cooperation with the DOE PM.

SPECIAL REPORTING REQUIREMENTS

None.