

Energy & Environmental Research Center

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January 28, 2021

Ms. Karlene Fine Executive Director North Dakota Industrial Commission (NDIC) 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, "Underground Storage of Produced Natural Gas – Conceptual Evaluation and Pilot Project(s) (HB 1014)"; Contract No. G-049-092; EERC Fund 23984

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) 777-5050 or by e-mail at bkurz@undeerc.org.

Sincerely,

DocuSigned by: Bethany Kurz

Bethany A. Kurz Assistant Director for Integrated Analytical Solutions

BAK/kal

Attachment

c: Brent Brannan, NDIC



UNDERGROUND STORAGE OF PRODUCED NATURAL GAS – CONCEPTUAL EVALUATION AND PILOT PROJECT(S) (HB 1014)

Quarterly 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

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January 2021

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EXECUTIVE SUMMARY

The Energy & Environmental Research Center (EERC) is performing a project to directly address the intent of Section 25 of House Bill 1014 of the Sixty-Sixth Legislative Assembly of North Dakota as signed into law by Governor Burgum, which states that funding will be made available to the EERC for "pilot projects relating to the underground storage of produced natural gas." The overall goal of the proposed effort is to demonstrate the techno-economic feasibility of produced natural gas ("produced gas") injection into non-hydrocarbon-producing subsurface formations in the Williston Basin for future recovery and use or for pressure maintenance and/or enhanced oil recovery (EOR) in a conventional or unconventional oil reservoir. To achieve the project goal, the EERC will partner with North Dakota oilfield producers on up to three pilot project efforts to define and assess the key technical, economic, and regulatory components of each approach. This progress report presents an overview of activities from October 1 through December 31, 2020.

The EERC prepared a presentation and document summarizing a path forward involving partnership with four potential industry partners to evaluate different aspects of produced gas injection for geologic storage and/or EOR. That plan was presented to the Oil & Gas Research Council (OGRC) on October 8, 2020, for approval and/or modification prior to bringing the plan forth to the North Dakota Industrial Commission (NDIC) during its meeting on October 22, 2020. NDIC approved the plan and indicated that the project will be extended to December 31, 2022. Contracting was ongoing at the end of the quarter.

Marathon Oil Company (Marathon) has joined the project to participate in exploratory activities to evaluate the potential of Marathon to participate as a collaborator for a produced gas injection pilot project. A subcontract was finalized between the EERC and Marathon in October 2020. Technical work was initiated.

The EERC requested and received permission from the NDIC Oil & Gas Research Program to subcontract with EOR ETC, LLC (EOR ETC) and Liberty Resources (Liberty) to demonstrate a new technology to facilitate produced gas injection for EOR and/or subsurface geologic storage. Project funds will be used to support implementation and demonstration of the technology; identify and evaluate the scalability of the technology and applicability to various gas injection scenarios; and evaluate the technology performance and costs versus using traditional, cost-intensive approaches for gas compression. Subcontracting is proceeding with EOR ETC and Liberty. EOR ETC and Liberty will provide in-kind contributions to the demonstration.

The EERC holds an unwavering commitment to the health and well-being of its employees, partners and clients, and our 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.

UNDERGROUND STORAGE OF PRODUCED NATURAL GAS – CONCEPTUAL EVALUATION AND PILOT PROJECT(S) (HB 1014) Quarterly Progress Report October 1 – December 31, 2020

INTRODUCTION

The Energy & Environmental Research Center (EERC) is performing a project to directly address the intent of Section 25 of House Bill (HB) 1014 of the Sixty-Sixth Legislative Assembly of North Dakota as signed into law by Governor Burgum, which states that funding will be made available to the EERC for "pilot projects relating to the underground storage of produced natural gas." The overall goal of the proposed effort is to demonstrate the techno-economic feasibility of produced natural gas ("produced gas") injection into non-hydrocarbon-producing subsurface formations in the Williston Basin for future recovery and use or for pressure maintenance and/or enhanced oil recovery (EOR) in a conventional or unconventional oil reservoir. To achieve the project goal, the EERC will partner with North Dakota oilfield producers on up to three pilot project efforts to define and assess the key technical, economic, and regulatory components of each approach.

The primary project objectives are to evaluate the viability of various subsurface formations as storage and/or injection targets, document the facilities and equipment needs and costs for produced gas injection, predict the subsurface storage footprint of the injected gas plume over time, predict gas recovery efficiencies, develop a monitoring plan, and summarize the required regulatory considerations for different injection/storage scenarios. The above information will be obtained from a combination of research activities performed at the EERC and from up to three pilot projects performed in partnership with and including substantial financial investment from oilfield operating companies.

ACCOMPLISHMENTS DURING REPORTING PERIOD

Program Management and Reporting

The EERC will be responsible for managing and reporting of its activities with respect to the implementation and assessment of the pilot projects. Quarterly reports will be submitted to the North Dakota Industrial Commission (NDIC) 1 month after the end of each calendar quarter to provide timely highlights of ongoing research activities. At least one report will be provided to legislative management regarding the results and recommendations of the pilot project(s).

In addition to progress reporting, the relevant data and results needed to assess the overall technical and economic performance of the approach will be compiled and analyzed. The results of the gas injection scenarios that are technically and economically feasible will be used to develop an implementation plan that highlights optimal locations and scenarios for produced gas storage, recovery, and reuse throughout the oil and gas production regions of North Dakota. Key lessons learned from the pilot project(s) will be incorporated into that plan for future development efforts.

The EERC prepared a presentation and document summarizing a path forward involving partnership with four potential industry partners to evaluate different aspects of produced gas injection for geologic storage and/or EOR. That plan was presented to the Oil & Gas Research Council (OGRC) on October 8, 2020, for approval and/or modification prior to bringing the plan forth to NDIC during its meeting on October 22, 2020. The presentation is provided in Appendix A. NDIC approved the plan and indicated that the project will be extended to December 31, 2022. Contracting was ongoing at the end of the quarter.

Marathon Oil Company (Marathon) has joined the project to participate in exploratory activities to evaluate the potential of Marathon to participate as a collaborator for a produced gas injection pilot project. A subcontract was finalized between the EERC and Marathon in October 2020. Technical work was initiated as described in the Marathon Gas Storage Pilot section.

The EERC requested and received permission from the NDIC Oil & Gas Research Program to subcontract with EOR ETC, LLC (EOR ETC) and Liberty Resources (Liberty) to demonstrate a new technology to facilitate produced gas injection for EOR and/or subsurface geologic storage. The technology, which was developed by EOR ETC, works by coinjecting gas and water into a well with a patented liquid assist gas lift system which substantially reduces the size of the gas compressors required for injection because it uses the "weight" of slugs of water in the borehole to help pressurize the formation and injected gas. Because the approach reduces the compression requirements by a factor of five to ten, it eliminates the need for more expensive compressors that are typically needed for high-pressure gas injection. The method will be demonstrated and evaluated on a Bakken petroleum system (Bakken) well owned and operated by Liberty as a mechanism to more effectively build reservoir pressure and improve sweep efficiency for EOR, thereby enhancing mobility control and increasing oil recovery more effectively than other gas-based EOR pilots that have been implemented in the Bakken to date. Given that gas compression is a major cost for any type of subsurface gas injection effort, the technology has the potential to benefit any future gas injection efforts in the state, either for EOR or for temporary geologic storage. Project funds will be used to support implementation and demonstration of the technology; identify and evaluate the scalability of the technology and applicability to various gas injection scenarios; and evaluate the technology performance and costs versus using traditional, cost-intensive approaches for gas compression. Subcontracting is proceeding with EOR ETC and Liberty. EOR ETC and Liberty will provide in-kind contributions to the demonstration.

In July 2020, XTO Energy (XTO) stopped work on evaluation of both pilot projects (referred to as the Minnelusa gas storage and Bakken EOR projects) indefinitely as a result of the downturn in oil prices. A report highlighting the results of the EERC's evaluation was prepared and provided to XTO for review.

Marathon Gas Storage Pilot

Weekly technical meetings are held with team members from Marathon and the EERC. Working meetings between project team members are held on an as-needed basis. Progress includes the following:

- Received an initial area of interest from Marathon and started compiling digital data.
- Digitized core data publicly available from NDIC.
- Cleaned and organized publicly available well log data from NDIC.
- Identified additional core data in the NDIC core library for potential testing and description.
- Built a summary Petrel project to review public data.
- Completed review of the Marathon structure grid.
- Marathon began an interpretation of petrophysical well logs that will be provided to the EERC for modeling efforts.

FUTURE ACTIVITIES

The planned activities for the next quarter are detailed as follows.

Program Management and Reporting

A contract modification from NDIC is anticipated in January 2021.

A report highlighting the key findings and lessons learned from the evaluation of the XTO pilot projects was provided to XTO for review. The EERC anticipates receiving the reviewed report back from XTO in January 2021, after which it will be finalized and sent to NDIC. It is also anticipated that one or more presentations summarizing the key results of the evaluations will be prepared and given to NDIC and members of the legislature (as requested).

It is anticipated that contracting will be completed with EOR ETC and Liberty and planning activities initiated.

Marathon Gas Storage Pilot

Exploratory activities will continue to aid Marathon in its decision-making process to determine whether to participate as a collaborator for a produced gas injection pilot project. Activities are anticipated to include core analyses; incorporation of petrophysical, PVT (pressure, volume, temperature), seismic, and core analysis data in modeling and simulation; and regulatory and surface facility discussions.

PARTNERS AND FINANCIAL INFORMATION

The project is sponsored by the NDIC Oil and Gas Research Program. Table 1 shows the budget of \$6,000,000 from NDIC, as listed in HB 1014, and expenses through the reporting period. Once specific pilot project(s) are identified, attendant detailed budgets will be developed. It is expected that pilot project partner(s) will provide substantial cost share that will be documented to the greatest degree possible.

		Actual Expenses	
Sponsors	Budget	as of 12/30/2020	Balance
NDIC	\$6,000,000	\$711,225	\$5,288,775
Industry Share – In-Kind	\$6,000,000	-	\$4,971,880
XTO – In-Kind	_	\$1,028,120	—
Marathon – In-Kind	-	\$0	—
Total	\$12,000,000	\$1,739,345	\$10,260,655

Table 1. Budget and Expenses to Date

* An estimate for the total expected in-kind cost share from industry partners is not available. Industry partners will periodically report actual costs to the EERC, which will be subsequently presented in the quarterly report.



APPENDIX A

UNDERGROUND STORAGE OF PRODUCED NATURAL GAS: PROJECT UPDATE AND PROPOSED PATH FORWARD

EERC. NORTH DAKOTA.

Energy & Environmental Research Center (EERC)

UNDERGROUND STORAGE OF PRODUCED NATURAL GAS: PROJECT UPDATE AND PROPOSED PATH FORWARD

Update with the Oil and Gas Research Council October 2020

John Harju

Vice President for Strategic Partnerships, EERC

2019 LEGISLATION

- Section 25 of House Bill 1014 states that \$6MM will be made available to the EERC "for pilot projects relating to the underground storage of produced natural gas."
- Goal is to partner with North Dakota oilfield producers on pilot projects to define and assess the key technical, economic, and regulatory components of produced natural gas ("produced gas") injection into geologic targets in the Williston Basin.



Photo: Grand Forks Herald



EXPECTED OUTCOMES

- Demonstration of up to 3 different produced gas injection concepts:
 - Temporary gas storage in saline formations.
 - Gas injection into a conventional oil field.
 - Gas injection into the Bakken/Three Forks.
- Provision of key information to the state, the oil and gas industry, and other interested parties needed to assess the techno-economic viability of produced gas storage and/or injection into the subsurface as a means of:
 - Achieving gas capture requirements.
 - Expanding Bakken oil production.
 - Conserving the state's resources.



PROGRESS TO-DATE

- The EERC partnered with XTO Energy on an assessment of two gas injection concepts, including:
 - Temporary produced gas storage in the Broom Creek Formation.
 - Produced gas injection in the Bakken/Three Forks for EOR.
- Due to the oil price decline, XTO decided to put the projects on hold indefinitely.
- Key findings, including recommendations for consideration during the next legislative session are being summarized into presentations and a report, which are imminent.





WHERE WE ARE AT AND NEXT STEPS

- We are seeking the OGRC's recommendation to the NDIC of a proposed path forward for the EERC that entails using the allocated NDIC funds to partner with 2 large, publicly-traded companies and 2 smaller, private equity-backed companies on various gas storage/injection pilot projects.
- The diverse injection scenarios proposed by each company would build our knowledge of the technical and economic feasibility of various produced gas storage/injection approaches in the Williston Basin.

Budget and Expenses to Date						
Sponsors	Budget	Actual Expenses/Cost Share as of 9/30/20	Balance			
NDIC	\$6,000,000	\$608,300	\$5,391,708			
Industry Share – In-Kind	TBD	\$1,028,120	TBD			
Total	TBD	\$1,636,412	TBD			



GAS STORAGE IN A CONVENTIONAL RESERVOIR

- Partner: A large, publicly-traded company.
- Goal is to investigate the feasibility and possible implementation of temporary produced gas storage in a depleted conventional reservoir.
- Focus is on storage, not EOR.
- The proposed location has a structural feature that will help prevent the lateral migration of the injected gas and, thereby, improve gas recovery.



Modified from the following: https://www.uncoverenergy.com/ideas/hail-to-the-shale/

GAS STORAGE IN THE BAKKEN

- Partner: A large, multinational, publicly-traded company.
- Goal is to evaluate gas reinjection strategies into the Bakken Petroleum System (BPS) as a mechanism to mitigate flaring.
- Although EOR impacts will be evaluated, the focus will be on low P gas reinjection to mitigate flaring, not optimization for EOR.
 - Compression requirements are anticipated to be much lower than for EOR.



Image courtesy of Prairie Public.



GAS STORAGE IN CONJUNCTION WITH SWD

- Partner: Small, private equity-funded company.
- The project entails co-injection of gas in conjunction with saltwater disposal (SWD) in the Inyan Kara Formation (Dakota Sandstone) at a location that appears to have structural closure.
 - The concept is that the gas would gravity separate and be trapped by the structural closure to allow for effective gas recovery.
- The company's goal is to temporarily store gas to bring additional BPS wells online at a location that currently has limited gas takeaway capacity.
 - Gas would be recovered and sold at a later date when pipeline capacity becomes available.



Source: University of Melbourne



DEMONSTRATION OF A TECHNOLOGY TO BETTER ENABLE GAS INJECTION

- Partner: Small, private equity-funded company.
- Goal is to demonstrate a new approach to gas injection that entails co-injection of water and gas to reduce the compression requirements needed for gas injection.
 - Reduces the compression requirements by a factor of five to ten because it uses the "weight" of slugs of water in the borehole to help pressurize the formation and injected gas.
 - Eliminates the need for high-pressure, expensive compressors that are typically needed for high pressure gas injection.
 - The technology will be demonstrated and evaluated on a BPS well owned by the company as a mechanism to more effectively build reservoir pressure and improve sweep efficiency for EOR.



MOVING FORWARD

- The EERC is seeking input and approval from the OGRC on the proposed pilot projects to continue evaluating the feasibility of temporary subsurface gas storage as a means of mitigating flaring in North Dakota.
- The EERC is requesting that the OGRC make a recommendation to the NDIC in support of the proposed plan to move forward.
- Due to the impacts of the COVID19 pandemic complete testing of the proposed projects may require carryover of appropriated funding into the 2021-2023 biennium.



Source: National Park Service



PROGRAM PRODUCTS

- Interim Products (October/November 2020):
 - Presentations updating the OGRC and Industrial Commission of the EERC's progress.
 - Identification of regulatory uncertainty regarding:
 - Pore space and notification of surface owners (with lack of regulatory clarity, current assumption is 100% notification/concurrence).
 - Timing of tax and royalty payments (prior to injection or following recovery).
 - A report detailing the work performed with XTO.
- Presentation of current findings to the 2021 Legislative Assembly.
- Final Products:
 - Lessons learned and a roadmap for future implementation.
 - Recommendations for additional legislative action and/or regulatory clarity.



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