



January 30, 2020

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, 2019,
“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,

A handwritten signature in black ink, appearing to read "Bethany Kurz", is written over a faint, larger version of the same signature.

Bethany A. Kurz
Assistant Director for Integrated Analytical
Solutions

BAK/rlo

Attachment



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

Quarterly Progress Report

(for the period October 1 – December 31, 2019)

Prepared for:

Karlene Fine

North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
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**UNDERGROUND STORAGE OF PRODUCED NATURAL GAS – CONCEPTUAL
EVALUATION AND PILOT PROJECT(S) (HB 1014)
Quarterly Progress Report
October 1 – December 31, 2019**

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 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, 2019.

The EERC completed a contract with an interested project partner, XTO Energy (XTO). Two pilot project activities have been identified and will be referred to as the Minnelusa gas storage and Bakken enhanced oil recovery projects. Weekly conference calls were initiated and focused on the Minnelusa gas storage project.

The EERC worked with XTO to understand the requirements for gas storage and determine key regulatory and permitting, tax consideration, and pore space leasing activity questions.

A geocellular model of the gas storage complex was built. Data needed for developing a simulation model were collected, and preliminary simulations were initiated. The EERC worked closely with XTO on these activities.

**UNDERGROUND STORAGE OF PRODUCED NATURAL GAS – CONCEPTUAL
EVALUATION AND PILOT PROJECT(S) (HB 1014)
Quarterly Progress Report
October 1 – December 31, 2019**

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 will be to evaluate the viability of various subsurface formations as storage and/or injection targets, to document the facilities and equipment needs and costs for produced gas injection, to predict the subsurface storage footprint of the injected gas plume over time, to predict gas recovery efficiencies, to develop a monitoring plan, and to 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 our 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.

During the past quarter, the EERC established a cost-share agreement with XTO Energy (XTO) that would entail the EERC performing an evaluation of potential pilot project locations. Two pilot project activities have been identified and will be referred to as the Minnelusa gas storage and Bakken EOR projects.

Weekly conference calls were initiated with XTO to discuss the status of the projects and next steps.

Minnelusa Gas Storage Pilot

Collaboration with Project Partner and NDIC Department of Mineral Resources (DMR)

The EERC will collaborate with the project partner(s) and NDIC DMR to define the key regulatory considerations for the pilot project(s), to assist with project permitting, and to define and implement site monitoring techniques.

During the past quarter, the EERC worked with the XTO Minnelusa team to understand the requirements for gas storage and determine key regulatory and permitting, tax consideration, and pore space leasing activity questions to ask NDIC DMR and other entities at meetings in January 2020.

Laboratory Activities

Laboratory-based activities will be performed to characterize the potential gas injection targets to better understand the gas storage potential, to predict gas injection rates, and to evaluate the overlying formation as a reservoir seal. If the site has potential for EOR, additional laboratory tests will be performed to evaluate the minimum miscibility pressure (MMP) required for effective EOR and to estimate the potential incremental oil recovery achieved by produced gas injection.

No activities in this area were performed during the reporting period.

Modeling and Simulation

Geologic and/or simulation models of the injection targets will be developed to estimate the injectivity of the target, gas storage potential, gas and water recovery rates, stored gas plume extents in the formation and, if applicable, incremental oil recovery. The modeling and simulation results will be used to help design and inform the field demonstration tests.

A geocellular model of the storage complex (Broom Creek and Amsden Formations [Minnelusa Group] reservoir and Opeche Formation seal) was built by integrating publicly available data and previous geological interpretations made by XTO. Regional Broom Creek porosity and permeability data were used to estimate the distribution of petrophysical properties within the reservoir.

Data needed for developing a simulation model, such as relative permeability curves, pressure–volume–temperature (PVT) data, etc., were collected. Preliminary simulations were initiated to evaluate the gas plume extension focused on a certain injection period.

Surface Facility Planning

The EERC will assist with surface facility planning, including identification and pricing of the gas conditioning and compression components, brine disposal options, stored gas recovery system requirements (if applicable), and other surface-related infrastructure. Depending on the nature and duration of the pilot project, equipment rental options may also be evaluated as an alternative to purchasing equipment.

Surface facility planning activities focused upon clarifying roles and responsibilities of the EERC based upon the capabilities and expectations of XTO. This was accomplished through the kickoff and weekly project teleconferences. The EERC solicited produced gas properties and wellhead conditions from XTO, which will contribute to a preliminary design basis for the surface facility. The team was reminded that, depending on how compression is procured, purchase of a new compressor could become a critical path activity for the project.

Bakken EOR Pilot

Collaboration with Project Partner and NDIC DMR

The EERC will collaborate with the project partner(s) and NDIC DMR to define the key regulatory considerations for the pilot project(s), to assist with project permitting, and to define and implement site monitoring techniques.

Because XTO has already obtained a permit from the NDIC DMR for a rich-gas EOR project, the EERC will not be assisting XTO with respect to project permitting. As the project progresses, the EERC will assist with the implementation of site monitoring techniques, if needed.

Laboratory Activities

Laboratory-based activities will be performed to characterize the potential gas injection targets to better understand the gas storage potential, to predict gas injection rates, and to evaluate the overlying formation as a reservoir seal. If the site has potential for EOR, additional laboratory tests will be performed to evaluate the MMP required for effective EOR and to estimate the potential incremental oil recovery achieved by produced gas injection.

No activities in this area were performed during the reporting period.

Modeling and Simulation

Geologic and/or simulation models of the injection targets will be developed to estimate the injectivity of the target, gas storage potential, gas and water recovery rates, stored gas plume

extents in the formation and, if applicable, incremental oil recovery. The modeling and simulation results will be used to help design and inform the field demonstration tests.

No modeling and simulation activities were conducted for the Bakken EOR pilot in this period.

Surface Facility Planning

The EERC will assist with surface facility planning, including identification and pricing of the gas conditioning and compression components, brine disposal options, stored gas recovery system requirements (if applicable), and other surface-related infrastructure. Depending on the nature and duration of the pilot project, equipment rental options may also be evaluated as an alternative to purchasing equipment.

No activity this reporting period.

FUTURE ACTIVITIES

The planned activities for the next quarter are detailed below.

Program Management and Reporting

The EERC will continue to work with XTO on the cost-share agreement. Weekly conference calls will continue with XTO to discuss the status of the projects and next steps.

Minnelusa Gas Storage Pilot

Collaboration with Project Partner and NDIC DMR

Meetings with the NDIC DMR, the North Dakota Governor's Natural Resources Advisor, the North Dakota Tax Department, and the North Dakota State Trust Lands are scheduled for January 22, 2020. A follow-up meeting with the NDIC DMR will be scheduled as the project progresses to provide an update and address any remaining permitting considerations.

Laboratory Activities

Potential laboratory analyses to better understand the injection target and overlying seals will be identified in the next quarter.

Modeling and Simulation

Future modeling activities include integration of local Broom Creek Formation core data that were unavailable during the initial round of modeling and simulation. Additional geocellular models will be built to characterize the geological uncertainty in petrophysical properties of the reservoir. The structure of the model will be updated with input from XTO.

Simulation activities will include finishing preliminary simulation and sensitivity analysis. The team will investigate influential parameters on the operational side and different operational scenarios for surface modeling and cost evaluation purpose.

Surface Facility Planning

Current activities will continue into the next quarter through an activity-specific teleconference in early 2020, recurring project teleconferences, and a face-to-face discussion at a January 2020 meeting. In addition to those activities, the EERC will ascertain, to the extent permitted by the proprietary nature of the information, relevant standards and procedures with which XTO complies in designing and procuring surface equipment.

Bakken EOR Pilot

Collaboration with Project Partner and NDIC DMR

The EERC will assist XTO as needed with respect to future collaborations with NDIC DMR.

Laboratory Activities

Future laboratory activities, including MMP determination and swelling test are being discussed by the EERC and XTO. Specific tests will be identified, and fluid samples will be provided by XTO during the next quarter.

Modeling and Simulation

An EERC–XTO update meeting will be held to discuss the detailed EOR plan and modeling/simulation tasks. A geologic model with main Bakken oil-bearing units, i.e., Upper Bakken, Middle Bakken, Lower Bakken, and Three Forks, will be developed based on the available well logs, core data, and seismic data, etc.

Production data will be collected to analyze the well performance in the study area. PVT data will be used to develop a representative equation-of-state (EOS) model for the reservoir fluids. Fracture and matrix properties will be collected to estimate the stimulated reservoir volume. These collected data sets will then be integrated into the geologic model to build a dynamic simulation model, which will be used to conduct history match, sensitivity study, EOR prediction, etc.

Surface Facility Planning

EERC's role will be determined through an activity-specific teleconference in early 2020, recurring project teleconferences, and a face-to-face discussion at a January 2020 meeting. The EERC will ascertain, to the extent permitted by the proprietary nature of the information, relevant standards and procedures with which XTO complies in designing and procuring surface equipment.

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.

Table 1. Budget and Expenses to Date

Sponsors	Budget	Actual Expenses as of 12/31/19	Balance
NDIC	\$6,000,000	\$65,708	\$5,934,292
Industry Share – In-Kind	\$6,000,000	\$931,309	\$5,068,691
Total	\$12,000,000	\$997,017	\$11,002,983