

**Contract No. R-034-043**

**“Integrated Carbon Capture and Storage for North Dakota Ethanol Production - Phase II”**

Submitted by University of North Dakota Energy & Environmental Research Center (EERC)

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**PARTICIPANTS**

<b>Sponsor</b>		<b>Cost Share</b>	
EERC through Department of Energy Funding (cash)	\$200,000		
Red Trail Energy (in-kind)	<u>\$145,000</u>		
Subtotal Cash Cost Share		\$345,000	
North Dakota Industrial Commission		<u>\$345,000</u>	
Total Project Cost			\$690,000

Project Schedule – 9 months  
Contract Date – January 2, 2018  
Start Date – November 1, 2017  
Completion Date – July 31, 2018

Project Deliverables:  
Quarterly Report: January 31, 2018 ✓  
Quarterly Report: April 30, 2018 ✓  
Final Report: July 31, 2018 ✓

**OBJECTIVE/STATEMENT OF WORK:**

This project will build on the feasibility study for integrating carbon capture and storage (CCS) of CO<sub>2</sub> emissions from Red Trail Energy to reduce net CO<sub>2</sub> emissions associated with ethanol production that was completed in Phase I. The goal of this phase is to reduce knowledge gaps in regulatory, processing, and financial requirements and thus encourage investment toward integrating commercial CCS with ND ethanol production in order to realize CO<sub>2</sub> market credits from low carbon fuel (LCF) programs.

Specifically, the project will generate:

- Permitting pathways for implementing CCS in North Dakota
- Up-to-date qualification requirements for LCF programs.
- Site-specific data leading to reduced uncertainty and close knowledge gaps.
- Updated Phase I project designs.
- Analysis of improved economics.
- A community outreach plan

This project could help North Dakota ethanol plants capitalize on national low-carbon fuel markets. It would assist in defining the regulatory pathway for Class VI well permitting and provide greater understanding of LCF programs and how they integrate with North Dakota primacy.

**STATUS:**

The contract has been executed.

**1/30/2018:** First quarterly report received. The report states in part: Participated in the November 6, 2017 Public Workshop to discuss California Air Resources Board’s (ARB) 2018 Low Carbon Fuel Standard (LCFFS) Preliminary Draft Regulatory Amendment Text. Upon request from ARB, the EERC reviewed the document and provided a list of technical comments, questions, and concerns, focused on incorporation of carbon capture and storage (CCS) into the ARB Low-Carbon Fuel Standard. The EERC communicated with the Department of Mineral Resources concerns regarding

the ARB document creating complexities between state entities which regard to regulating CCS efforts.

**4/30/18:** Second quarterly report received. The report states in part: Reviewed California ARB's draft CCS protocol document released for public comment, which details the proposed requirements for including CCS into a potential LCF pathway for generating carbon credits. Participated in Oregon DEQ's first Advisory Board Meeting on February 1, 2018, via Webinar, discussing the development of its Clean Fuels Program (CFP). Traveled to Portland, Oregon, March 21–22, 2018, to discuss the draft CCS monitoring plan and CFP time line/direction with Oregon DEQ. Identified contacts within British Columbia's LCF Program and compiled/reviewed current program documents.

Continued communication with DMR regarding the public comment and hearing schedule for California ARB's draft CCS document, noting significant differences from the North Dakota CCS program, particularly with regard to monitoring and reporting requirements. Communication with DMR regarding CFP development by Oregon DEQ to potentially incorporate CCS requirements into permit. Potential complexities with regard to regulating CCS between state entities are being identified.

The EERC traveled to the RTE facility in Richardton, North Dakota, on March 20, 2018, to conduct sampling of the CO<sub>2</sub> stream for compositional analysis. Successfully collected nine samples through the duration of the fermentation process. Completed RTE CO<sub>2</sub> stream sampling analyses of all samples collected, which showed no oxygen content down to 100-ppm detection. Results of the CO<sub>2</sub> analysis indicate that a capture system designed for dedicated geologic storage would not require oxygen removal; therefore, no design changes are anticipated.

Reviewed the revised 45Q tax credit (from the Bipartisan Budget Act of 2018) to incorporate in the project's estimated economics. Updated potential revenue estimates from Phase I with current carbon market values from California and Oregon LCF Programs.

Completed compilation and preliminary review of social characterization information/background for Stark County, North Dakota. Catalogued RTE CCS public media coverage (2016 to present) to assess level and frequency of reporting and exposure to information thus far. Held Webinar with RTE February 21, 2018, to review and discuss the outreach planning approach. Completed the first draft of the outreach plan (in five "batches") for internal review and subsequent RTE review; first and second draft batches now completed with RTE review. Updated fact sheet generated during Phase I to include Phase II efforts.

An abstract was submitted January 5, 2018, to the International Conference Greenhouse Gas Control Technologies (GHGT-14) panel for consideration to present at the Melbourne conference in October 2018. An update of the project was presented to the Oregon DEQ in relation to the emerging CFP developments; the updated fact sheet was also distributed.

The project now has a dedicated Web page on EERC's Plains CO<sub>2</sub> Reduction (PCOR) Partnership site, summarizing the overall effort: [www.undeerc.org/pcor/CO2SequestrationProjects/RedTrail.aspx](http://www.undeerc.org/pcor/CO2SequestrationProjects/RedTrail.aspx).

The University of North Dakota online news, UND Today, published an article March 22, 2018, focused on the project: <http://blogs.und.edu/und-today/2018/03/catch-and-decrease/>.

7/31/18: Final report has been submitted and is available online. The report states in part:

The EERC and RTE engaged with the North Dakota Department of Mineral Resources (DMR) to follow developments and provide up-to-date information toward establishing detailed requirements for CCS implementation in North Dakota. Discussions with North Dakota DMR involved the multistage permitting process for geologic CO<sub>2</sub> storage in North Dakota, as now regulated under the approved North Dakota Underground Injection Control Class VI primacy. DMR is supportive of CCS efforts in North Dakota, while maintaining a priority on protecting North Dakota resources and people.

Discussions with the California Air Resources Board (ARB) and Oregon Department of Environmental Quality (DEQ) further defined evolving CCS qualification requirements for potential revenue through their LCF markets. California ARB's CCS Protocol, as currently proposed, is extremely prescriptive, potentially adding significant cost and prohibitive liability time frames to North Dakota permitting requirements. Oregon DEQ's Clean Fuels Program is still in development, with major decisions on hold awaiting California's final program decisions to determine the extent to which they will be followed in Oregon. British Columbia Renewable & Low-Carbon Fuel Requirements Regulation also has an established LCF Program with several years of market values published; however, no details for incorporating CCS into program pathways have been provided. Therefore, significant uncertainty remains regarding how these LCF programs will work within North Dakota regulations for effective CCS implementation.

The composition of fermenter gas at the RTE facility was tested to vet and refine preliminary capture, transportation, and well infrastructure for several business cases. Market considerations included generation of injection-grade CO<sub>2</sub> for dedicated storage, enhanced oil recovery (EOR), a food-/chemical-grade CO<sub>2</sub> product, and combinations of these approaches. Results confirmed that RTE's fermentation-generated CO<sub>2</sub> stream would not require oxygen removal equipment within the capture system for dedicated storage at the RTE site. Detailed steps for professional engineering designs and ultimate installation of the capture system were identified, which are commercially well-established for ethanol facilities. The life cycle analysis from Phase I efforts were also repeated using more recent processing data from the RTE facility, as well as the various business scenarios, and showed the significant potential reduction in CO<sub>2</sub> emissions previously estimated for CCS implementation (~40%) to be maintained even if generating a higher-grade (i.e., EOR or food) CO<sub>2</sub> product.

The economic impact of several carbon markets was explored considering federal incentives, EOR opportunities, and LCF programs. Passing of new tax credit rules for the Enhancement of Carbon Dioxide Sequestration Credit under the Bipartisan Budget Act of 2018 (formerly known as Section 45Q) improves CCS economic feasibility but may require additional investors for a small business to achieve maximum benefits. Estimated costs required for an electrical upgrade and pore space payments are not expected to detrimentally affect the economic viability of CCS. However, the costs estimated to meet the proposed California CCS Protocol requirements, in particular, with

regard to the added monitoring and liability time frames compared to North Dakota Class VI requirements, could significantly affect long-term economics of CCS implementation.

Lastly, a detailed outreach plan for the implementation of CCS at the RTE site and the Richardton community was completed. The study region comprises mainly rural, agriculture-based communities. The community outreach plan, in keeping with DOE best practices, was designed to foster effective communication and stakeholder engagement in the region with respect to the CCS project.

Addressing and reducing the knowledge gaps related to regulatory compliance, processing and financing requirements, and public outreach have resulted in an updated analysis that supports the continuation of the CCS research effort at the RTE site. The next steps toward commercial implementation include a detailed examination of the storage complex beneath the site, which will include a baseline seismic survey to identify specific locations for drilling to collect core samples from the target formation and overlying seal. Preengineering capture designs will be generated, and the outreach plan will be executed. In addition, dialogue will continue with North Dakota regulators and LCF Program authorities to ensure compliance with CCS guidelines and requirements.

This contract is now closed.

Updated 10/12/2018