SUBTASK 1.3 – INTEGRATED CARBON CAPTURE AND STORAGE FOR NORTH DAKOTA ETHANOL PRODUCTION

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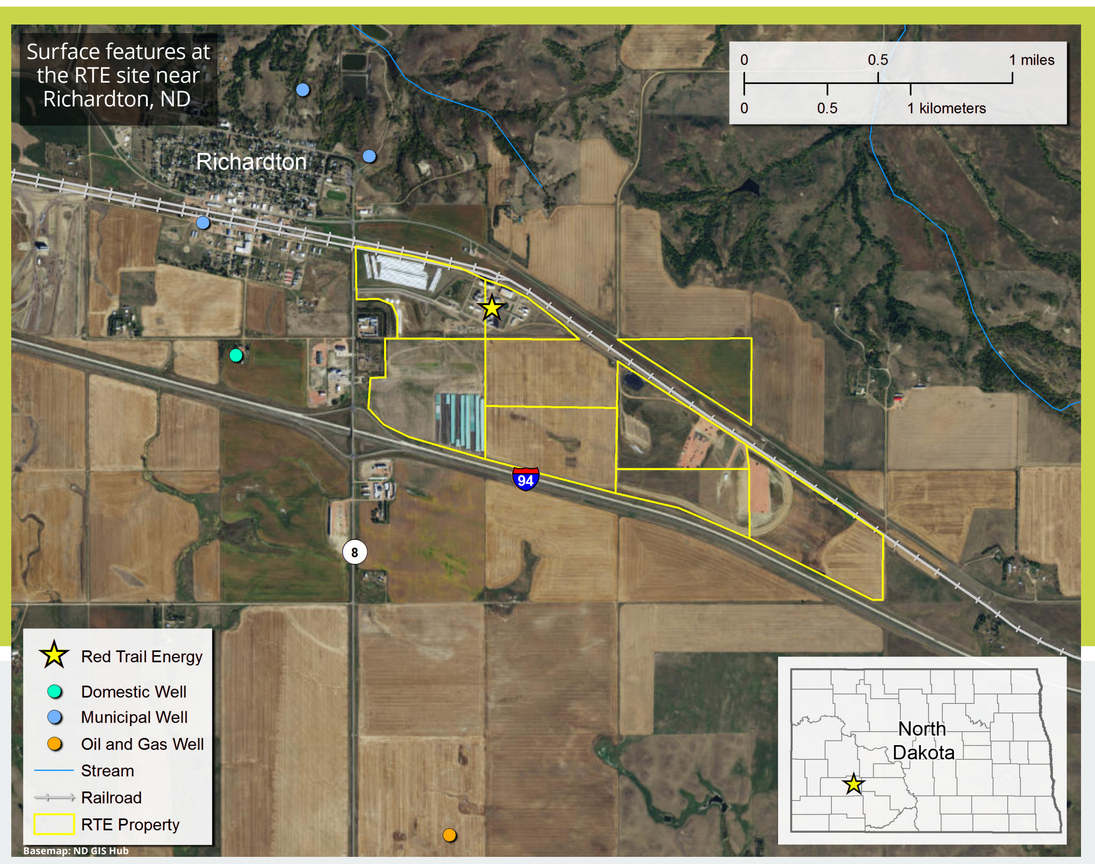
This effort was funded through the EERC–DOE Joint Program on Research and Development for Fossil Energy-Related Resources Cooperative Agreement No. DE-FE0024233.

ABSTRACT

The Energy & Environmental Research Center (EERC), in partnership with the U.S. Department of Energy (DOE), North Dakota ethanol producer Red Trail Energy (RTE), and the North Dakota Industrial Commission (NDIC), conducted a preliminary assessment for integrating small-scale carbon capture and storage (CCS) at an industrial ethanol production facility near Richardton, North Dakota.

This preliminary assessment included a technical evaluation of CCS implementation at the RTE site, development of a provisional field implementation plan (FIP), and economic analysis. Results indicated that commercial CCS is a technically and economically viable option for the significant reduction of CO_2 emissions from ethanol generation at the RTE facility.

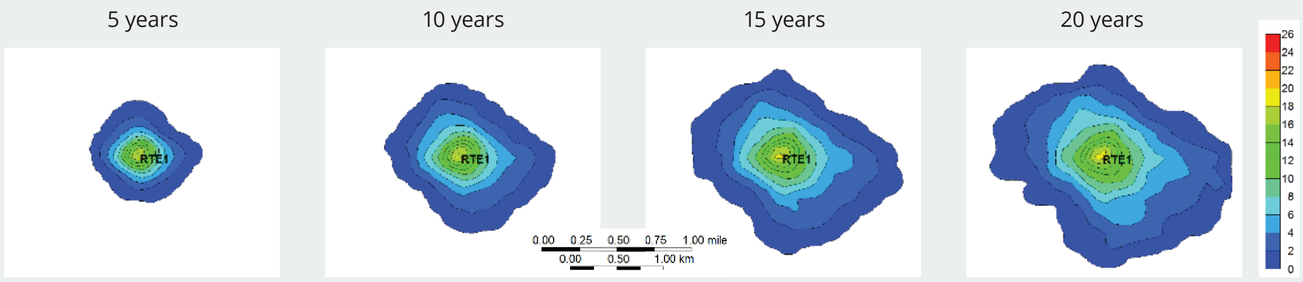
The RTE facility produces approximately 163,000 tonnes of CO_2 annually from the ethanol fermentation process. If a CCS project is implemented, the RTE site could store approximately 3.2 million tonnes of CO_2 during a 20-year period of injection.



TECHNICAL AND ECONOMIC FEASIBILITY

Reservoir Simulation

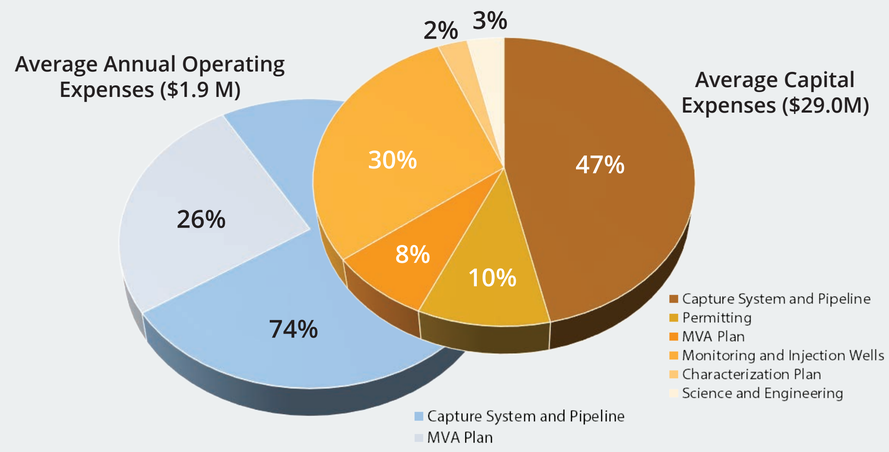
Reservoir simulations were used to estimate minimum CO_2 injection pressure requirements, the extent of pressure buildup within the reservoir (pressure plume), and the lateral distribution of CO_2 saturation extent (CO_2 plume). Simulation results suggest a potential CO_2 plume diameter of approximately 1.4 to 2.0 miles after 20 years of injection at the RTE site.

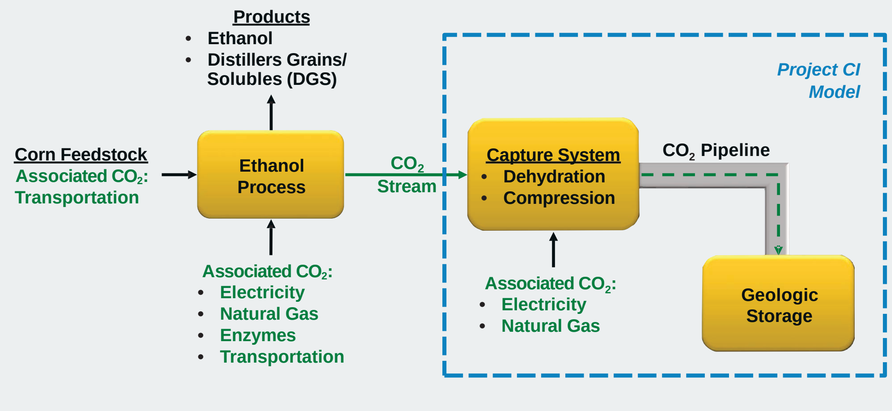


CO_2 plume evolution for the P50 (moderate) case after 5, 10, 15, and 20 years of CO_2 injection. Color changes in images represent changes in gas saturation. These reservoir simulation results were used to determine an anticipated area of review (AOR) for permitting and to constrain the horizontal and vertical requirements of a monitoring, verification, and accounting (MVA) program.

Economic Analysis

A preliminary economic assessment was conducted for CCS implementation at the RTE site to evaluate potential costs. Results of this analysis support ethanol CCS as an economically viable option for the RTE facility.



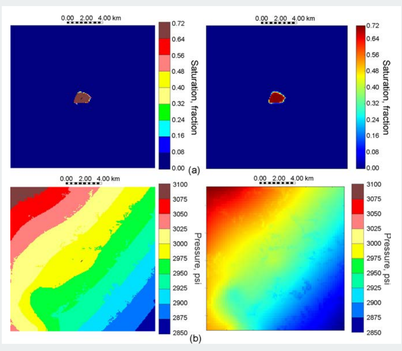


Life Cycle Analysis (LCA)

Results of a LCA suggest that implementing CCS at the RTE facility could reduce the net CO_2 emissions by 40%–50%. This reduction in CO_2 emissions results in an ethanol product with a greatly reduced carbon intensity (CI) value. Validation of CCS to reduce the CI value of ethanol production may allow producers to expand marketability of their fuel within developing low-carbon fuel programs such as those in California and Oregon.

National Risk Assessment Partnership (NRAP) Tool Validation

The Reservoir Reduced-Order Model Generator (RROM-Gen), Reservoir Evaluation and Visualization (REV), and Well Leakage Analysis (WLAT) tools were evaluated to validate tool outputs for CO_2 fluid and pressure plumes using the RTE site simulation results.

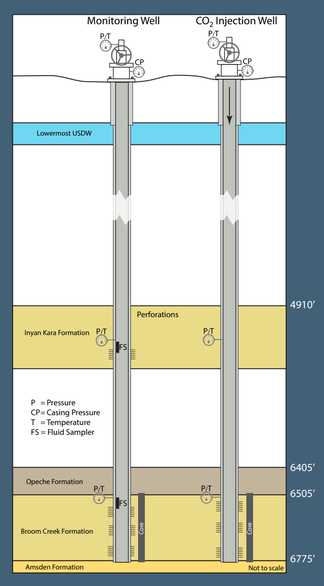


Outputs of RROM-Gen (right) and CMG software (left) following 20 years of injection for (a) CO_2 plume and (b) pressure plume.

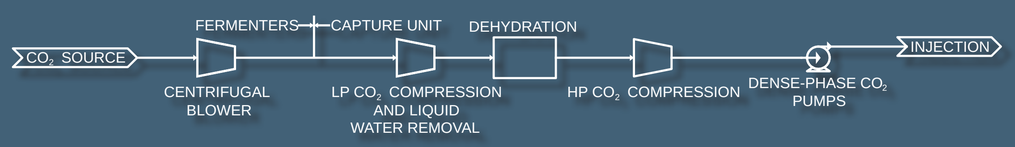
FIELD IMPLEMENTATION PLAN

An FIP was developed that includes the design and installation of infrastructure necessary for the capture and secure storage of CO_2 at the RTE site. The FIP consisted of the activities necessary to implement CO_2 geologic storage at the RTE site and estimate future costs:

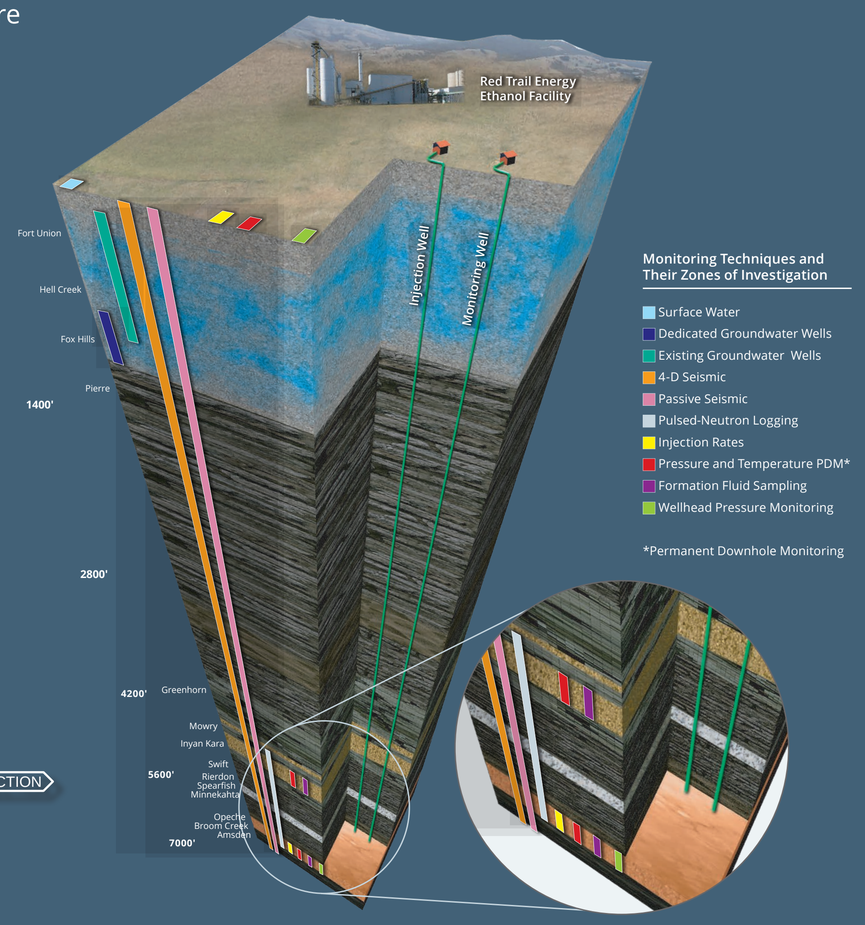
- CO_2 capture and transport
- Plans for CO_2 injection permitting
- Ethanol CCS pathways for low-carbon fuel programs
- MVA program
- Designs for monitoring and injection wells
- Well characterization and testing plan



The RTE FIP includes designs for both a Class VI injection well and a dedicated monitoring well.



Draft conceptual design for generation of an injection-grade CO_2 product at the RTE site (image courtesy of Trimeric Corporation). LP and HP refer to low- and high-pressure, respectively.



Future Activities

- Attain pathway approvals for implementing CCS into low-carbon fuel programs.
- Ongoing communication with North Dakota Industrial Commission to permit a monitoring well and a Class VI injection well.
- Collect pertinent data needed to refine engineering designs of capture system such as current flow rates and CO_2 stream composition.
- Update LCA model, where applicable, as low-carbon fuel pathways develop and details become publicly available.
- Refine economic analysis to incorporate financial details such as interest rates, market changes, pore space payments, etc.
- Develop and execute a community outreach plan to educate/inform the North Dakota public about CCS.
- Drill a stratigraphic test well to gather site-specific geologic data to improve the geologic model and AOR predictions.

ACKNOWLEDGMENTS

The authors would like to thank Computer Modeling Group and Schlumberger for granting access to their software in support of this work.

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