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July 31, 2018

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
State Capitol, 10th Floor
600 East Boulevard Avenue
Bismarck, ND 58505-0310

Dear Ms. Fine:

Subject: Final Report for Integrated Carbon Capture and Storage for North Dakota Ethanol Production Phase II; Contract No. R-034-043; EERC Fund 22552

Attached is the final report for the subject project. Any additional financial information needed regarding this project is available upon request. If you have any questions, please contact me by phone at (701) 777-5013, by fax at (701) 777-5181, or by e-mail at kleroux@undeerc.org.

Sincerely,

Kerryanne M. Leroux
Principal Engineer

KML/rlo

Attachment

INTEGRATED CARBON CAPTURE AND STORAGE FOR NORTH DAKOTA ETHANOL PRODUCTION – PHASE II

Final Report

(for the period of November 1, 2017 – July 31, 2018))

Prepared for:

Karlene Fine

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EERC DISCLAIMER

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LIST OF ACRONYMS AND NOMENCLATURE

AFE	authorization for expenditures
AOR	area of review
ARB	[California] Air Resources Board
BLM	Bureau of Land Management
CAPEX	capital expenditures
CCS	carbon capture and storage
CFP	[Oregon] Clean Fuels Program
CFS	[Canada] Clean Fuel Standard
CI	carbon intensity
DEQ	[Oregon] Department of Environmental Quality
DMR	[North Dakota] Department of Mineral Resources
DOE	U.S. Department of Energy
EOR	enhanced oil recovery
EPA	U.S. Environmental Protection Agency
FIP	field implementation plan
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation
LCA	life cycle analysis
LCF	low-carbon fuel
LCFS	[California] Low Carbon Fuel Standard
Ministry	[British Columbia] Ministry of Energy, Mines, and Petroleum Resources
OPEX	operating expenses
P&A’d	plugged and abandoned
PDP	process design package
primacy	primary enforcement responsibility
Section 45Q	Enhancement of Carbon Dioxide Sequestration Credit
SGPS	soil gas profile station
UIC	underground injection control

INTEGRATED CARBON CAPTURE AND STORAGE FOR NORTH DAKOTA ETHANOL PRODUCTION – PHASE II

EXECUTIVE SUMMARY

The Energy & Environmental Research Center (EERC), in partnership with Red Trail Energy, LLC (RTE), a North Dakota ethanol producer; the North Dakota Industrial Commission (NDIC); and the U.S. Department of Energy (DOE), developed a pathway for integrating carbon capture and storage (CCS) with ethanol fuel production at the RTE facility near Richardton, North Dakota. The pathway explicitly addresses site-specific data and regulatory compliance needs, building on preliminary results from the Phase I effort to show that commercial CCS continues to be a viable option for significantly reducing CO_2 emissions at the RTE site. Specific objectives for the Phase II study included 1) establishing North Dakota permitting requirements for CCS implementation and West Coast low-carbon fuel (LCF) program requirements for CCS integration with ethanol production, 2) acquiring site-specific data to reduce uncertainty and improve preliminary designs, 3) closing knowledge gaps to refine economics, and 4) developing a community outreach plan.

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_2 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_2 for dedicated storage, enhanced oil recovery (EOR), a food-/chemical-grade CO_2 product, and combinations of these approaches. Results confirmed that RTE's fermentation-generated CO_2 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_2 emissions previously estimated for CCS implementation (~40%) to be maintained even if generating a higher-grade (i.e., EOR or food) CO_2 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 effort was funded in part through the EERC–DOE Joint Program on Research and Development for Fossil Energy-Related Resources Cooperative Agreement No. DE-FE0024233. Nonfederal funding was provided by NDIC and RTE.

INTEGRATED CARBON CAPTURE AND STORAGE FOR NORTH DAKOTA ETHANOL PRODUCTION – PHASE II

INTRODUCTION AND BACKGROUND

The Energy & Environmental Research Center (EERC), in partnership with Red Trail Energy, LLC, (RTE), a North Dakota ethanol producer; the North Dakota Industrial Commission (NDIC); and the U.S. Department of Energy (DOE), developed a detailed pathway for integrating carbon capture and storage (CCS) with ethanol fuel production at the RTE facility near Richardton, North Dakota. The pathway incorporates site-specific data and regulatory compliance needs, building on preliminary results to show that commercial CCS continues to be a viable option for significantly reducing CO_2 emissions at the RTE site.

North Dakota is well-situated to demonstrate the implementation of CCS for commercial small- to medium-scale CO_2 emitters, having both significant ethanol production and suitable geology for carbon storage. Emerging carbon markets on the West Coast also provide a current economic incentive through which these CO_2 emitters in the fuel production industry could pursue carbon incentives and potentially offset the costs of CCS implementation. However, the challenges associated with deploying CCS at this scale are not well studied, as the ethanol industry is often cited as falling below the threshold for large-scale CO_2 production (>1,000,000 tonnes/year) (Fischer and others, 2008). Figure 1 provides a simplified block diagram of this ethanol-CCS process.

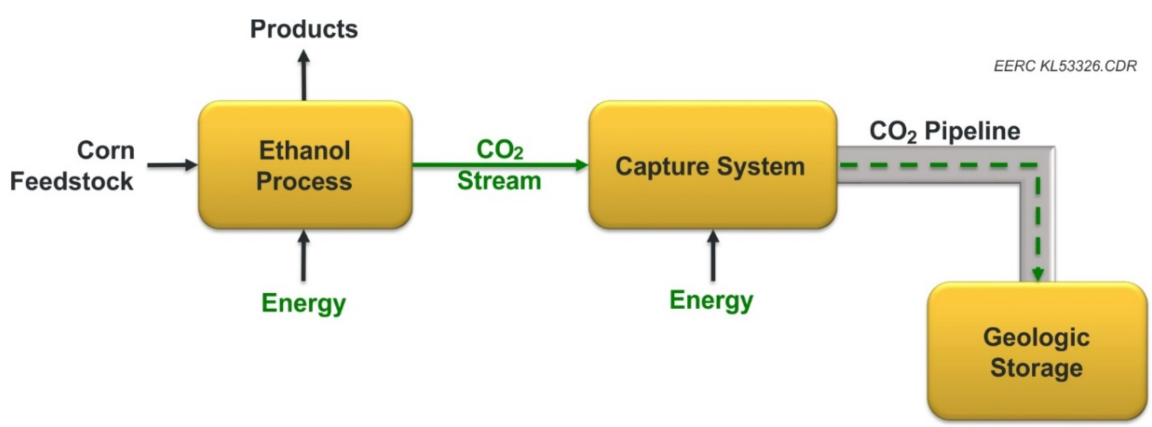

Figure 1. Block diagram of ethanol-CCS process.

The RTE site, in particular, provides an ideal opportunity to examine the commercial deployment of an ethanol-CCS process as it currently distributes ethanol to low-carbon fuel (LCF) markets in California and Oregon. In addition, the site overlies highly suitable geologic formations, which have the potential to store all of RTE's generated CO_2 emissions for decades. The Broom Creek Formation and accompanying sealing formations, present at a depth of approximately 6400 ft directly below RTE's facility in southwestern North Dakota, are expected to make an excellent storage complex for the proposed CO_2 injection (Glazewski and others, 2015; Sorensen and others, 2009; Leroux and others, 2017). The RTE facility generates approximately 163,000 tonnes of CO_2 annually from the fermentation process during ethanol production. Over a period of 20 years, a CCS project at the RTE site could store approximately 3.2 million tonnes of CO_2.

A preliminary assessment study (hereafter referred to as Phase I) successfully assessed the technical and economic prefeasibility of CCS implementation at the RTE facility (Leroux and others, 2017). The Phase I study considered CO_2 capture and transport, site characterization, geologic modeling and simulation, project risk assessment, and a life cycle analysis (LCA). A provisional field implementation plan (FIP) was also developed during Phase I, which provided a concise process for installing equipment and infrastructure specific to the RTE site; described the requirements for permitting and monitoring of a Class VI well, including the technical requirements to gather and generate the necessary data for securing and maintaining related permits; and summarized requirements to attain pathway approvals from LCF programs. Results indicated that commercial implementation of CCS at the RTE facility is technically viable and may be economically favorable by participating in the West Coast LCF programs.

This Phase II effort built upon the Phase I investigation and provides further confidence in moving forward with an in-depth site characterization and engineering effort. Although Phase I results supported the economic viability of CCS for North Dakota ethanol producers through LCF programs, knowledge gaps were identified with regard to regulatory compliance, site-specific processing data, and public outreach. Therefore, specific objectives for Phase II included 1) establishing North Dakota permitting requirements for CCS implementation and up-to-date LCF Program requirements for CCS integration with ethanol production, 2) acquiring site-specific process data to reduce uncertainty and improve preliminary designs, 3) closing knowledge gaps to refine commercial economics, and 4) developing a community outreach plan.

PERMITTING AND PATHWAY REQUIREMENTS

Continued collaboration in Phase II with the NDIC Department of Mineral Resources (DMR) identified the specific criteria necessary to comply with North Dakota's permitting regulations for geologic CO_2 storage. In addition, CCS guidelines for compliance with West Coast LCF programs continued to evolve, specifically the California Air Resources Board (ARB), the Oregon Department of Environmental Quality (DEQ), and British Columbia's Ministry of Energy, Mines, and Petroleum Resources (the Ministry). These entities continue to express interest in collaboration and support of the North Dakota ethanol CCS effort. However, proposed requirements currently detailed by California ARB (e.g., minimum 100 years of postinjection monitoring) will negatively impact the economics of integrating CCS into North Dakota ethanol production.

North Dakota Class VI Program

The North Dakota Underground Injection Control (UIC) Class VI Program provides a detailed process for potential owners or operators that wish to inject CO_2 for the purpose of geologic storage, including requirements to obtain a Storage Facility Permit, a Permit to Drill, and a Permit to Operate prior to commencement of injection activities (North Dakota Industrial Commission, 2013). The program is thoroughly discussed in the Phase I report (Leroux and others, 2017). Since publication of that report, North Dakota has received Class VI primary enforcement responsibility (i.e., primacy). Therefore, further clarification of the specific data needs and monitoring requirements, as well as pore space amalgamation rules, for potential CCS implementation at the RTE site was obtained from the North Dakota DMR.

North Dakota Class VI Primacy

Five years after initial application, North Dakota was granted primacy over a comprehensive set of carbon storage regulations for all aspects of CO_2 injection and storage operations within a UIC Class VI Program. On April 10, 2018, the U.S. Environmental Protection Agency (EPA) Administrator signed North Dakota's application for regulatory primacy over Class VI injection wells, granting the state regulatory authority. On April 24, 2018, EPA published the final rule in the Federal Register, effective immediately, approving North Dakota's application for primacy for Class VI wells located within the state (83 FR 17758, 40 CFR 147). NDIC is now the permitting authority for Class VI wells in North Dakota, formally recognizing the North Dakota UIC Class VI Program.

The North Dakota regulations meet or exceed EPA Class VI requirements and allow NDIC to address some factors that could not be addressed by the EPA. For example, pore space ownership in North Dakota has been defined as the surface landowner (as opposed to mineral rights, which may be separate from the surface landowner). Therefore, the North Dakota Class VI program addresses the opportunity for pore space amalgamation. In addition, EPA requirements do not allow for application of site closure until a minimum of 50 years postinjection, whereas North Dakota's program provides the opportunity to apply for a Certificate of Project Completion a minimum of 10 years postinjection (i.e., with the state assuming liability). Following this certification, the state becomes responsible for the long-term monitoring and management of the storage site. This certification is only issued if the operator shows that the injected CO_2 plume is defined as stable, according to criteria established by North Dakota DMR discussed below.

North Dakota Permitting Discussions

Although the North Dakota Class VI Program is well-detailed, some site-specific requirements for the RTE case study still need clarification. In particular, numerous discussions were held with North Dakota DMR to decipher CO_2 stability definitions, baseline monitoring requirements, pore space amalgamation rules, and options for permitting a stratigraphic test with the intention of completing it as a monitoring well.

The definition of CO_2 stability and extent is critical to both developing site closure plans and determining the area of review (AOR), which is used as a basis for monitoring requirements and pore space rulings. AOR is defined by the North Dakota Class VI Program as "the region surrounding the geologic sequestration project where underground sources of drinking water may be endangered by the injection activity" (NDAC § 43-05-01-01). Based on discussions with North Dakota DMR, an acceptable CO_2 stability determination for drafting a permit is a predicted CO_2 movement of $\leq$ 1 ft per year, following the cease of simulated injection operations from modeling and forecast simulation results. For pore space considerations, the predicted plume extent (CO_2 or pressure, whichever is the larger extent) should be determined by units of 40-acre "tracks" or blocks.

A minimum 1 year of baseline monitoring is recommended by North Dakota DMR authorities, which may begin during development of the Storage Facility Permit. This recommendation is focused on near-surface groundwater and soil gas sampling. Seasonal (e.g., spring, summer, and fall) sampling should be considered to determine natural environmental fluctuations. Existing groundwater wells within the potential AOR are of primary focus for monitoring; i.e., a dedicated groundwater well at the injection site is not mandated. Similarly, dedicated soil gas profile stations (SGPS), which provide more representative vadose zone data than soil gas probes, are not required but may be beneficial on site property for ease of sampling. Other monitoring techniques, such as seismic surveys, may be considered in the required monitoring plan as part of the Storage Facility Permit.

With regard to pore space amalgamation and landowner compensation associated with CO_2 storage sites, North Dakota DMR will follow existing standards of unitization for oil and gas operations. More specifically, when at least 60% of landowners within the AOR agree to pore space leasing agreements, the state can compel the remaining 40% of landowners to agree to terms. Importantly, North Dakota DMR requires pore space leasing agreements be "equitable" among landowners but does not plan to establish any financial guidelines regarding specific compensation amounts. That said, North Dakota DMR does not support staged compensation over time as the injected CO_2 migrates through the storage reservoir, stating that all pore space eventually used for the project should be secured at the time of project initiation. Several approaches for handling pore space economics are being explored, such as stored volume or pressure considerations, and are discussed further in the Economics section.

The Phase I effort identified the drilling of a stratigraphic test hole as a key step toward CCS implementation. This test well will provide detailed site-specific data and examination of the storage complex beneath the RTE site via the collection and subsequent analysis of samples from the target formation and overlying seal and in situ downhole testing. Permitting and completing the stratigraphic test hole as a monitoring well could be economically advantageous; therefore, North Dakota DMR was contacted to determine the specific logistics of coordinating such an effort. North Dakota DMR stated the drilled stratigraphic test well must be either plugged and abandoned (P&A'd) upon conclusion of testing or completed as a monitoring well to avoid potential stability issues. If completed as a monitoring well, the well may be completed in accordance with North Dakota UIC Class I or Class VI permitting standards, which dictate the required materials and construction specifications.

LCF Programs

As part of a Pacific Coast Collaborative to lower greenhouse gas emissions, California, Oregon, and British Columbia continue to develop their respective LCF programs. Carbon intensity (CI) values are assigned to a fuel producer using an LCA-based model (see the Refined LCA section for details), also referred to as an approved pathway. The LCF programs target fuels such as ethanol that demonstrate a lower CI value than standard fuels such as gasoline, estimating carbon credits from the difference and CO_2 market value through the LCF Program. These programs are at varying stages of development:

- California ARB has published draft language in a CCS Protocol for its Low Carbon Fuel Standard (LCFS) program.
- Oregon DEQ's Clean Fuels Program (CFP) remains in the development state, with its carbon market starting in 2016.
- British Columbia's LCFS Program is also well-established but has made no overt attempts for CCS integration into its program.

Formal engagement established during Phase I (face-to-face meetings, Webinars, public hearings, phone calls, etc.) continued through Phase II efforts to provide up-to-date status of these programs.

California LCFS Program

California ARB has been actively generating a CCS Protocol document (California Air Resources Board, 2018), detailing proposed requirements for including CCS into a LCFS pathway for generating carbon credits. The first public workshop to discuss California ARB's 2018 LCFS Preliminary Draft Regulatory Amendment Text was held on November 6, 2017. This included the first full draft of the CCS Protocol for stakeholder and technical review. The CCS Protocol was formally introduced for public comment during the California ARB Public Hearing on April 27, 2018.

The most recent public workshop discussing the proposed changes to the LCFS Program was held on June 11, 2018. Discussion included an overview of revisions made to the proposed CCS Protocol in response to technical and stakeholder comments, with release of these changes for public comment on June 20, 2018. Another workshop with opportunity for public comments may still be possible before the final California ARB vote scheduled for September 26–27, 2018.

Substantial modifications have been made to the entirety of the original document; the most pertinent of these to the RTE case study are summarized below (California Air Resources Board, 2018):

- A Verification section was added, requiring California-licensed oil-gas and geologist professionals to review all submitted data.
- Third-party reviewers must also be California-licensed engineers and professional geologists and cannot have provided services to the applicant 5 years prior to or 1 year following application for Permanence Certification.
- A minimum 15 years after injection ceases, plume stabilization is to be determined by California ARB. Wells cannot be P&A'd until stabilization has been verified.

- The Buffer Account calculation (discussed further in the Potential Market Considerations section) was increased by 5%; liability for repayment of invalidated credits from potential leakage was reduced from 100 to 50 years postinjection, with repayment thereafter to be taken from the account.

- Language was modified to enhance and support links between risk assessment outcomes and chosen techniques included in the monitoring plan (i.e., monitoring should be designed to address specific risks that are identified as part of the risk assessment).

- A significant effort was made to improve definitions of AOR, replace AOR statements with “Storage Complex” requirements, and define plume stability.

- The requirement for a dissipation zone to be included in the storage complex was removed.

The CCS Protocol document as presently written is much like a Class VI Program, while also including provisions for enhanced oil recovery (EOR), directly influencing the processes and methods through which CI improvements will be made. This is a new approach for the California ARB, which generally does not prescribe processing or other requirements for generating pathway approvals and CI values for the production of fuels (i.e., ethanol, oil, natural gas, etc.) within the larger LCFS Program. Some of these proposed regulations have the potential to directly conflict with rules established by the state of North Dakota through its Class VI Program. Uncertainty remains as to how California ARB’s proposed regulations will work with out-of-state entities to address conflicts, even those with primacy.

Oregon CFP

Oregon DEQ established an advisory board for CFP 2018 rulemaking discussion and decisions that focused on improving the effectiveness of the CFP and the efficiency of its processes. Meetings were held February 1, June 28, and July 16, 2018. Topics included but were not limited to the following (Oregon Department of Enviromental Quality, 2018):

- Mechanisms to incorporate verification into various parts of the program.
- Updating of the models used to determine CI values of fuels.
- Consideration of including additional sources of credit generation in the program.
- Alignment of enforcement provisions.

Significant discussion has centered on how closely the Oregon DEQ should follow the California LCFS Program. As part of the Pacific Coast Collaborative, each member has agreed to develop programs that will not conflict with each other. However, there is room for individual program differences, as well as the opportunity to learn from existing programs. For example, similar to California, the Oregon CFP uses the GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) model, originally created by Argonne National Laboratory, to generate CI values. However, the model was modified by the California LCFS Program to generate CI values for direct comparison between fuels and producers, referred to as CA-GREET. Oregon CFP also modified the model, referred to as OR-GREET, specific to Oregon transportation distances and electricity sources. Therefore, Oregon CFP CI values and goals will be different from the California LCFS Program.

Discussions directly with Oregon DEQ regarding inclusion of CCS-integrated fuel production into pathway approvals were encouraging. North Dakota's recent primacy approval was appealing to Oregon DEQ, recognizing the North Dakota Class VI Program as a thorough approach to ensure permanent geologic CO_2 storage. Conversations are currently ongoing to determine the potential for a working relationship between the Oregon program developers and North Dakota regulators.

Canadian Programs

The British Columbia Renewable and Low Carbon Fuel Requirements Regulation (often referred to as an LCFS Program) was adopted in 2008, under the British Columbia Ministry of Energy, Mines and Petroleum Resources (Ministry). Several years of market values have been published on a quarterly basis, the most recent in a July 2018 report (British Columbia Ministry, 2018). Based on the success of the program, the Government of Canada has proposed to implement a federal LCF program.

On December 1, 2017, the British Columbia Ministry invited stakeholders to provide written responses to a Pathway Assessment 2017 document (British Columbia Ministry of Energy, Mines and Petroleum Resources, 2017), containing proposed changes and amendments to the LCF regulation. The British Columbia Ministry then convened a workshop the following January 31, 2018, and proposed a series of short discussion papers regarding the policy improvements in response to the written and verbal comments received during the workshop. None of the comments, however, included any questions or concerns regarding the lack of information for CCS integration. There is no evidence of any significant CCS pathway consideration. CCS is only mentioned in the document as a potential option to achieve emission goals with no pathway details.

The Government of Canada announced on November 25, 2016, that it would develop a Clean Fuel Standard (CFS). On December 13, 2017, Environment and Climate Change Canada published a regulatory framework on the CFS. The framework outlines the key elements of the design of the proposed regulation, CI approach, timing, and potential compliance options such as credit trading (Government of Canada, 2017). Comments received as part of the engagement on technical details will inform the design of draft regulations to be published in late 2018, with publication of final regulations expected mid-2019. Again, CCS has been acknowledged as a potential consideration to achieve emissions goals, albeit including no detailed discussion for integration into LCF Program pathways.

Updated Phase I FIP

Therefore, if a commercial CO_2 storage project were to be implemented at the RTE site for carbon credits, both North Dakota Class VI regulations and LCF Program requirements could guide site characterization, modeling and simulation, well design, and monitoring efforts. However, until more clarity is achieved with California ARB or Oregon DEQ, the developed FIP remains largely unchanged from the Phase I plans. Discussions with North Dakota DMR provided clarification on near-surface monitoring requirements included in the Class VI Program. Figure 2 shows the updated monitoring plan for the RTE site. Specific changes to the Phase I provisional monitoring program included removal of the suggested dedicated water well, yet retaining sampling and analyses of existing groundwater wells in the estimated AOR. Monitoring program additions were soil gas sampling and analyses. Baseline (preinjection) monitoring will be targeted at potential monitoring and injection well locations, as well as identifying locations for installation of SGPS on RTE property. SGPS could then be used to monitor soil gas throughout a potential CCS project.

Specific requirements proposed by California ARB in the latest revision of the CCS Protocol document were investigated and compared to the North Dakota Class VI Program requirements. Identified differences could also significantly impact financial and logistical viability for CCS-integrated pathways. A summary of these efforts is provided in Table 1. These additional requirements were then compared to the initial FIP generated during Phase I efforts to identify updates, particularly to monitoring and permitting plans.

These additional provisions, while perhaps appropriate for CCS projects conducted within the state of California, place additional financial and technical burdens on potential out-of-state fuel producers attempting to include CCS in their pathway approvals. For example, the significant difference in minimum postinjection time frames between North Dakota DMR and California ARB requirements mean lengthened periods of site access, monitoring programs, data processing requirements, and reporting efforts for the project applicant, North Dakota DMR, and California ARB. Furthermore, the North Dakota and California entities may need to maintain regular communication if a Certificate of Project Completion is issued and North Dakota assumes liability for the site before California provisions have expired. In addition, the current California CCS Protocol language does not appear to allow project operators to take advantage of advanced technology or monitoring techniques that may be developed decades after the start of injection. It is also unclear how practical and realistic monitoring and data storage plans can meet the proposed requirements while also spanning several workforce generations.

UPDATED INFRASTRUCTURE DESIGN

The composition of the fermentation-generated CO_2 stream is a key piece of site-specific operating data, which can have wide-ranging impacts on infrastructure design and operation, such as the addition of downstream technologies capable of removing oxygen from the gas stream to avoid pipeline corrosion issues. Additionally, impurities may initiate precipitation and/or dissolution reactions in the storage reservoir, affecting injectivity of the CO_2. To advance capture, transport, and injection system designs beyond the conceptual stage, a comprehensive baseline sampling program at the RTE facility was needed to document the compositional variability of the CO_2 stream over time during the ethanol production process. Therefore, a gas-sampling program was conducted to define compositional variability of the CO_2 stream during the ethanol production cycle. The results of the gas composition measurements found no detectable oxygen in the gas and minimal variation over time. Using this information, alternative business scenarios for higher-grade CO_2 products (i.e., EOR- or food/chemical-grade CO_2), in addition to injection-grade CO_2, were also investigated, as well as the potential impact these scenarios could have on the Phase I LCA and estimated CI values.

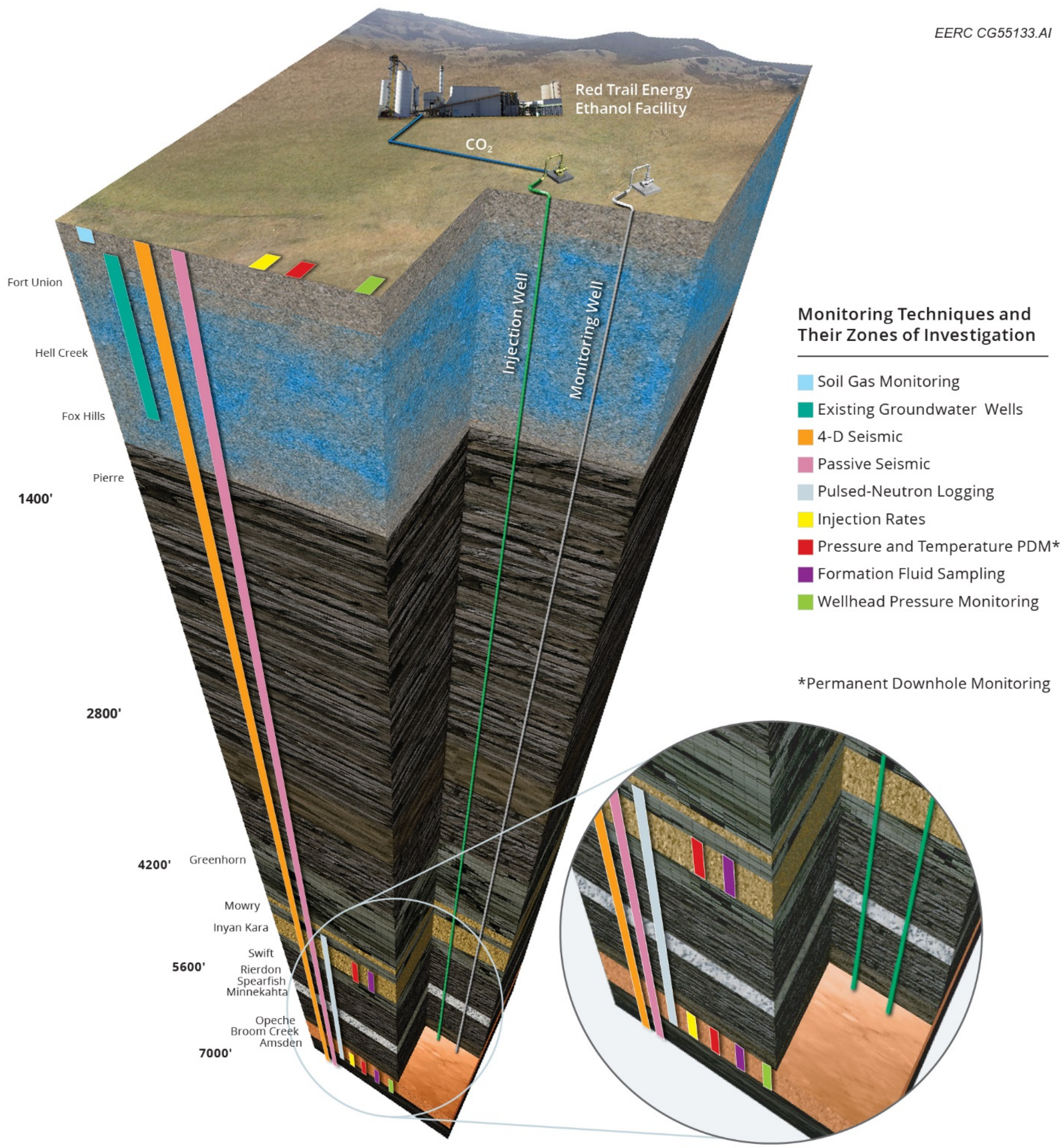

Figure 2. Stratigraphic column illustrating provisional near-surface and deep subsurface regions to be monitored, as well as individual monitoring techniques, for potential geologic CO_2 storage at the RTE site (modified from Leroux and others, 2017).

Table 1. Summary of Additional Requirements for CCS Implementation, Comparing the California ARB-Proposed CCS Protocol to the North Dakota Class VI Program

Topic	Additional Requirement and/or Conflict
Third-Party Review, Verification	CA-licensed professionals must review all application plans and verify any data submitted throughout the duration of the CCS project
Risk Assessment	Must define potential risks within 1%–5% probability (which is not likely technically feasible with current technology)
Near-Surface Monitoring	Includes monitoring of atmospheric conditions and annual vegetation surveys, continues following cessation of injection until plume stability is proven
100-year Postinjection Monitoring	Plume stabilization determination must be demonstrated a minimum of 15 years after cessation of injection (compared to 10 years for North Dakota) Leak detection and soil gas monitoring at or near any wellhead or P&A'd well within the AOR, conducted every 5 years for a postinjection period of 100 years.
Additional data Storage	Data storage for 10 years following 100-year postinjection monitoring (compared to 50 years of postinjection by EPA)
Buffer Account	Reduces credits by 8%–16%, based on calculated financial, social, management, site, and well integrity risks (detailed in the Potential Market Considerations section)

Fermentation Exhaust Analysis

The CO_2 stream generated from the fermentation process at the RTE ethanol production facility was sampled and analyzed to define compositional variability and refine preliminary capture designs. Oxygen must be removed to the specifications of any desired end use, whether dedicated storage in a geologic formation, EOR, or the food/chemical industry. Acceptable oxygen limits determined during Phase I efforts are ≤10 ppmw for EOR-grade and ≤ 30 ppmv for food-/chemical-grade CO_2 products (Leroux and others, 2017).

Sampling of the CO_2 stream exiting the fermenters was conducted March 20–21, 2018, by the EERC at the RTE facility. A vent location was chosen to minimize possible contamination by ambient air from blowing wind. Figure 3 shows the setup used during sampling. Nine samples were taken at a rate of one every 2 hours, collected in gas bags, and analyzed via gas chromatography. Table 2 shows the analysis results, indicating that oxygen was not present above the 100-ppm detection limit in any of the samples. Therefore, the CO_2 generated at RTE should, at a minimum, meet the requirements of an injection-grade CO_2 product, which is less than 4% by volume (Herron and Myles, 2013).

Design Modifications

The primary focus for the RTE case study remains the generation of injection-grade CO_2 for dedicated geologic storage for economic benefit from LCF programs. However, the various LCF

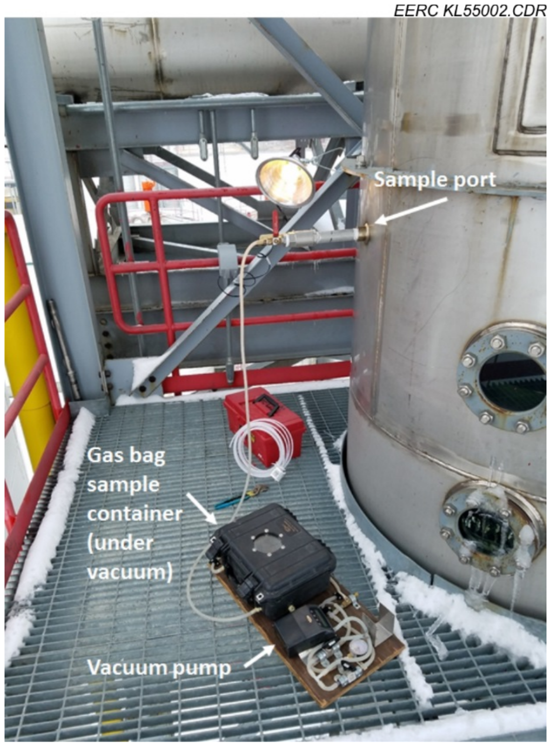

Figure 3. Sampling of the fermentation-generated CO_2 stream at the RTE facility.

Table 2. Analysis Results of RTE Fermentation Exhaust Gas Conducted in March 2018

		Volume %			ppm	
Sample	**Time, hr**	**CO_2**	**N_2**	**O_2**	**N_2**	**O_2**
1	0	100.00	0*	0	<100	<100
2	2	100.00	0	0	<100	<100
3	4	100.00	0	0	<100	<100
4	6	100.00	0	0	<100	<100
5	8	99.63	0.37	0	2370	<100
6	10	100.00	0	0	<100	<100
7	12	100.00	0	0	<100	<100
8	14	100.00	0	0	<100	<100
9	16	99.69	0.31	0	1980	<100
Average		**99.92**	**0.08**	**0**	**483**	**<100**

* Value of "0" indicates component not present or below detection limits of 100 ppm.

programs discussed above remain under development with respect to integration of CCS processes. As such, several business scenarios were considered that could offer some remuneration for a CO_2 capture system. In addition, the specific steps needed to implement a commercial-scale capture system were identified.

Business Scenarios Explored

Business options explored included generation of an EOR- or food-/chemical-grade CO_2 product for existing regional markets while waiting for LCF programs to be finalized. These higher-grade CO_2 products could potentially be sold in existing regional markets. These scenarios will permit CO_2 injection and storage permitting and infrastructure development to begin when pathways for CCS integration within LCF programs are finalized.

Commercial EOR applications typically involve a CO_2 pipeline to the oil field; however, select regional markets (i.e., pilot-scale) require a liquefied CO_2 product delivered via tanker truck. The Phase I capture design for generating an EOR-grade CO_2 product was therefore reviewed to identify potential modifications for appealing to these select markets. The CO_2 liquefaction process, shown in Figure 4, includes molecular sieve dehydration (as opposed to glycol dehydration) followed by refrigeration, liquefaction, distillation, and high-pressure pumping rather than compression. Revisions to the Phase I design also include CO_2 product storage tanks and loadout equipment for tanker transport. For the RTE site, four tanks storing about 500 tons CO_2 each at 250–350 psig and below 0°F is recommended, which is equal to 3 days of inventory. Ambient heating of the storage tanks begins to cause vaporization losses, which over time can be substantial. The recommendation minimizes these losses while still allowing enough volume to deal with plant upsets, trucking interruptions, etc.

The process used to generate a food-/chemical-grade CO_2 product is shown in Figure 5. Following the inlet compression and liquid water removal, the food-/chemical-grade system also incorporates a water wash tower, sulfur removal beds, activated carbon beds for the removal of trace hydrocarbons, molecular sieve dehydration, refrigeration, liquefaction, and distillation (Leroux and others, 2017). The process design for this system also includes product storage tanks and loadout equipment to transport CO_2 via tanker trucks.

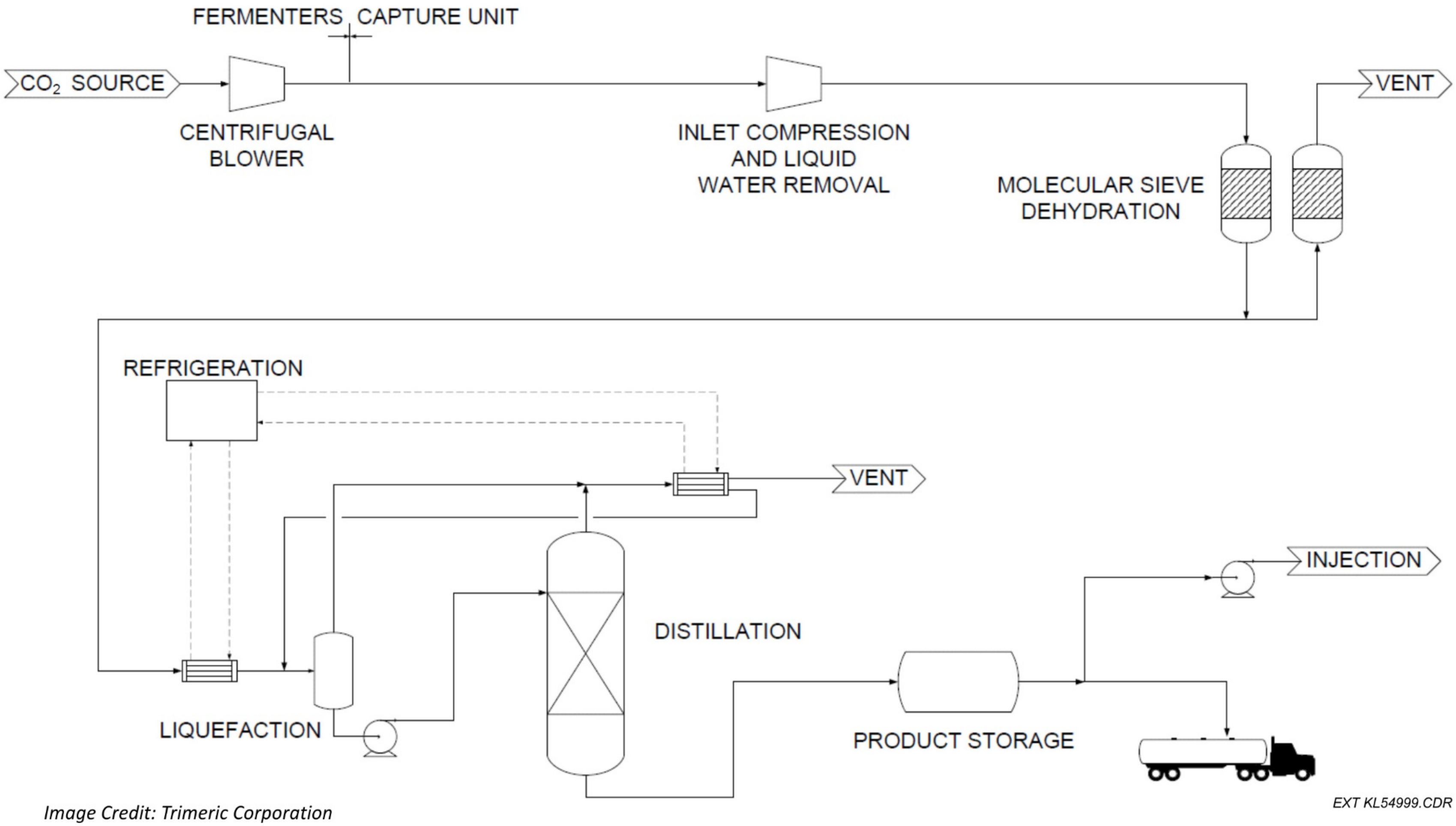

Figure 4. Schematic of the process for generation of an EOR-grade CO_2 product at an ethanol facility (image courtesy of Trimeric Corporation).

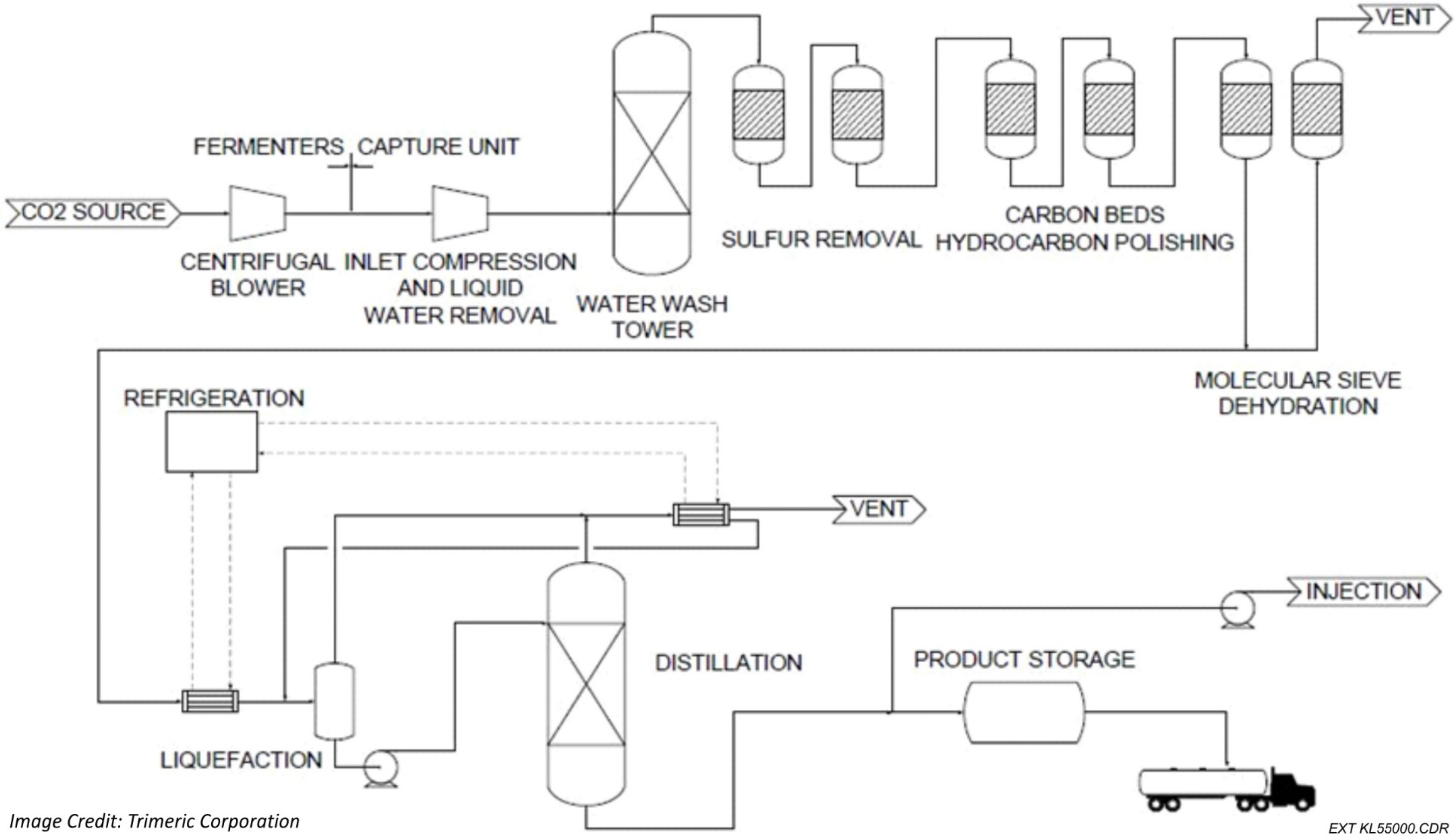

Figure 5. Schematic of the process for generation of a food-/chemical-grade CO_2 product at an ethanol facility (image courtesy of Trimeric Corporation).

Path to Commercialization

A pathway to commercialization was delineated for implementing CO_2 capture for potential geologic storage at the RTE site. The pathway effectively consists of four major steps: 1) development of a process design package (PDP), 2) securing authorization for expenditures (AFE), 3) completion of detailed engineering, and 4) facility construction and commissioning. A brief summary of each step follows, with more detailed listing of activities to achieve commercialization provided in Appendix A.

The PDP and AFE steps add increasing detail to the current facility designs. The PDP is the major process engineering deliverable for the project, resulting in an optimized process design as well as the equipment process performance parameters to support a ±25% cost estimate. Based on the PDP, a Go/No-Go decision will be made whether or not to pursue the project to the next level. The AFE step supports advancement of the process design. It is performed by a detailed engineering firm and produces a more accurate cost estimate (±15% to 20%), which is based on the preparation of mechanical, electrical, structural, and foundation documents and drawings and determination of OSBL (outside battery limits) connections and utility requirements. Using the AFE cost estimate, a Go/No-Go decision is made, which leads to the authorization of the project funds if a Go-decision is made.

Detailed engineering and construction/commissioning are the final steps for a commercial project. Detailed engineering includes a process hazard analysis; finalization of all engineering design documents; preparation of piping isometrics; finalization of the control system philosophy, instrumentation, and control valve data sheets; solicitation of fixed-price bid quality quotations; vendor selection; and ordering of long-lead-time equipment. An experienced construction firm would be chosen for buildout, with plans made for the tie-point installation. Factory acceptance tests and vendor inspections take place, as well as site acceptance testing and loop checks. Finally, the utilities are commissioned, and shakedown and performance testing are conducted to begin commercial operation.

LCA Refined

The LCA completed for the Phase I effort was updated to incorporate the recent processing data from the RTE facility, as well as to further investigate the business scenarios discussed above: 1) injection-grade CO_2 with subsequent storage and 2) EOR- or food-/chemical-grade CO_2 with subsequent storage. The same LCA methodology was applied during this phase of the work as was used during the Phase I effort to permit a direct comparison of the results.

As mentioned previously, the model used by the California LCFS Program to derive CI values for alternative fuels, such as ethanol, is referred to as CA-GREET. Although the current CA-GREET model is only applicable for traditional ethanol production, its method was applied to the operations of a CCS system to estimate CI reduction for an ethanol-CCS process (Figure 6). For a given ethanol producer, the CA-GREET model derives CO_2 emissions associated with corn farming and transportation ("Corn Feedstock") and ethanol fuel production, transportation, and distribution ("Associated CO_2"). This includes emissions associated with the production of electricity used by the facility as well as the combustion of natural gas used for heat. The Phase I

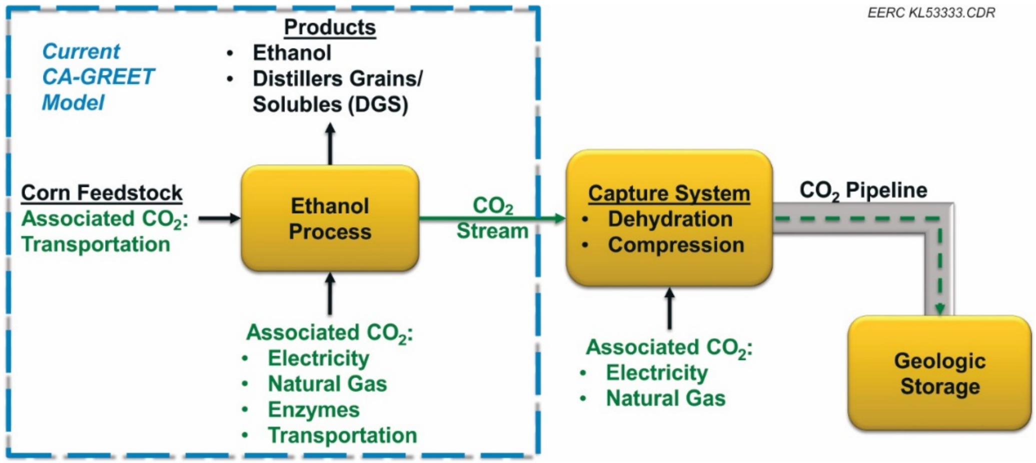

Figure 6. Block diagram showing key elements of ethanol production with CCS.

LCA method modified CA-GREET by including additional emissions associated with CO_2 capture ("Capture System") and emissions reduction associated with potential CO_2 storage in the Broom Creek Formation, where the CO_2 will be isolated from contact with the atmosphere ("Geologic Storage").

Resulting estimated CI values showed a significant reduction compared to the baseline case (i.e., ethanol production without CCS), regardless of the grade of CO_2 product generated (capture system implemented). EOR or food-/chemical-grade capture systems are more energy-intensive than the injection-grade system, and a 10% loss of the CO_2 product stream is expected from molecular sieve dehydration and liquefaction (Leroux and others, 2017). Therefore, an injection-grade CO_2 product with subsequent storage generated an estimated 40%–50% reduction in the CI value while the EOR-/food-grade capture systems with subsequent storage resulted in a somewhat smaller CI reduction of 30%–40% as compared to the baseline case. These scenarios assume all the captured CO_2 is injected for dedicated storage and not used in an industrial (i.e., EOR, food/chemical, etc.) application; should any portion of the CO_2 product be sold instead of stored, an even smaller CI reduction would likely result. Appendix B provides a more detailed summary of the CA-GREET model, default assumptions, and calculations.

UPDATED ECONOMIC ANALYSIS

The economic assessment from the Phase I study was refined with estimated costs and benefits for integration of commercial CCS with ethanol production at the RTE site. The updates presented in this report consisted of determining the potential costs of newly identified requirements for CCS implementation and changes to potential revenue through the developing LCF programs and/or other incentives. The most impactful of these economic factors is the uncertainty surrounding LCF program requirements for CCS integration.

Estimated Costs for CCS Implementation

Potential added expenses were determined for the California CCS Protocol items identified in Table 1 (e.g., third-party reviews, 110-year postinjection data storage, etc.), varying business scenario expenses, and pore space considerations. Of these, it was determined that the additional estimated costs to meet the proposed California CCS Protocol requirements could significantly affect long-term economics.

LCF Program Impact

Many uncertainties are associated with the long-term goals for the storage monitoring from any of the West Coast LCF programs. Based on current information, additional criteria compared to North Dakota Class VI Program requirements includes third-party and verification reviews, a risk assessment and management plan, prescriptive near-surface monitoring, and 100-year postinjection monitoring and data storage. Total expenses for these additions are estimated to make an approximate $24 million impact (Table 3) over the duration of a CCS project implemented at the RTE North Dakota ethanol facility, based on EERC experience regarding engineering and monitoring costs. Relatively speaking, these added expenses could potentially increase overall costs by an average of 30% over the standard project lifetime while also, at a minimum, doubling the lifetime of the project.

Table 3. Estimated Additional Expenses for Integrating CCS into a California LCFS Pathway

Expense Category	Estimate	Requirements
Capital Investment	$0.9M	Third-party review of application, risk assessment and management plan
Annual Operating*	$16.6M	Verification of all submitted data, additional near-surface monitoring until stability proven
Annual Postinjection	$6.2M	Additional data storage, plume stabilization application (5 more years than North Dakota), postinjection monitoring
Total Project Addition	**$23.7M**	

*Estimated costs assume a 20-year injection period of the standard project lifetime.

Capture System Refinement

Expenses were also estimated for the business scenarios of injection- or EOR-grade CO_2 capture with subsequent geologic storage. Capital requirements for the injection- and EOR-grade capture systems were directly related to the purity requirements of the CO_2 product and the corresponding amount of equipment needed to achieve that purity. One time capital expenditures (CAPEX) for the EOR-grade CO_2 is greater than injection-grade capture because of additional equipment needed for oxygen and water removal. CAPEX estimates are shown in Table 4 for injection- and EOR-grade capture systems, at $13.1 million and $14.7 million, respectively (Leroux and others, 2017).

Table 4. RTE Facility Capture Scenario Costs

Capture Facility	Estimated CAPEX	Estimated OPEX
Injection-Grade	$13.1M	$1.4M/year
EOR-Grade	$14.7M	$1.8M/year

The overall operating expenses (OPEX) are estimated at $1.4 and $1.8 million annually for the injection- and EOR-grade capture systems, respectively. OPEX encompasses the annual cost for utilities (electricity and natural gas) and plant labor. Utility costs were updated from the Phase I effort to incorporate more current electric rates and natural gas charges.

The potential necessity for added electrical infrastructure required for CCS implementation at the RTE site was also investigated, based on generation of injection- or EOR-grade CO_2 products, as the capture systems are energy-intensive. The power requirements or electrical loads for the injection-grade and the EOR-grade capture systems are estimated at about 2.7 MW and 3.7 MW, respectively. The maximum electrical capacity limit for the RTE site is 6 MW, with facility usage of 4 MW. Adding a capture system would thus exceed the RTE site electrical capacity. However, RTE is currently investigating an integrated cogeneration system to supply power into their facility, which could generate excess electrical capacity sufficient for either capture scenario. Therefore, no additional electrical infrastructure will be required to accommodate the additional load for CCS integration with the RTE facility.

Pore Space Payments

Although North Dakota DMR has enforced no mandates regarding pore space financing, equitable payment structures among all landowners within the AOR has been stated as a critical goal. Two preliminary approaches are currently being investigated by the EERC in communication with North Dakota DMR regarding potential pore space formulas: 1) volumetric displacement and 2) pressure displacement.

The volumetric-displacement approach estimates the volume of CO_2 at the pressure and temperature conditions within the storage reservoir and equates it as a similar volume of brine (salt water). The estimated volume of brine could then potentially be linked to the saltwater disposal market, for which there is precedence in western North Dakota.

Pressure displacement considers the maximum estimated pressure difference over the AOR for the entirety of a potential storage project. UIC rules restrict injection volumes and rates based on pressure differences to ensure containment within the storage reservoir and integrity of the overlying seals. The estimated pressure difference for injecting a determined volume of CO_2 into the reservoir could be equated to a volume of brine estimated to generate the same amount of pressure in the reservoir, providing a means for estimating potential market value as discussed above.

Potential Market Considerations

Additional potential markets for the Phase II study included assessment of an added LCFS buffer account and tax incentives for dedicated storage or EOR. The LCFS buffer account would effectively reduce the potential credit earnings a project would receive annually through the California ARB program as a means to offset a project's liability through risk management. Tax incentives provide an opportunity for a CCS project to capitalize on tax credits, should the entity have a large enough taxable income to qualify.

California LCFS Program Language

The developing California CCS Protocol states that a percentage of any credits earned from fuel production integrated with CCS must be contributed to a buffer account to ensure against the potential risk of CO_2 leakage from the storage reservoir (California Air Resources Board, 2018). The risk-based calculation (Equation 1) is determined from predefined financial, social, management, site, and well integrity risk ratings (Table 5). The total contribution of credits into this buffer account can thus range from 8% to 16% of total credits. This process must be executed during the application for an LCFS pathway that includes CCS, as well as during every verification event.

Equation 1. Proposed Changes to Buffer Account Calculation from the California CCS Protocol (California Air Resources Board, 2018):

$$CCS\ Project\ Risk\ Rating = 105\% - [(100\% - Risk_{Financial}) \times (100\% - Risk_{Social}) \times (100\% - Risk_{Management}) \times (100\% - Risk_{Site}) \times (100\% - Risk_{Well\ Integrity})]$$

Table 5. Risk Rating Contribution (California Air Resources Board, 2018)

	Rating Range, %	
Risk Type	**Minimum**	**Maximum**
Financial	0	2
Social	0	3
Management	1	2
Site	1	2
Well Integrity	1	3
Buffer Account*	**8**	**16**

* Using the formula shown in Equation 1.

Tax Incentives

Tax credits available through the Bipartisan Budget Act of 2018 under the Enhancement of Carbon Dioxide Sequestration Credit (formerly known and hereafter referred to as Section 45Q) were evaluated as an opportunity to potentially capitalize on a supplemental CO_2 market. The Section 45Q tax credit amounts are established by linear interpolation from $22.66 to $50 per tonne for dedicated storage and from $12.83 to $35 per tonne for EOR each calendar year after

2016 and before 2027 (115th Congress, 2018). These values are shown in Table 6. Given that the credits are only allowable for 12 years, assuming a 2020 start, the credits would be applicable only through 2031.

Table 6. Values of Section 45Q Tax Credits over Time

Storage Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026+
Dedicated Storage, $/tonne	22.66	25.70	28.74	31.77	34.81	37.85	40.89	43.92	46.96	50.00[a]
EOR, $/tonne	12.83	15.29	17.76	20.22	22.68	25.15	27.61	30.07	32.54	35.00*

* To remain constant in value for 2027 and thereafter (adjusted for inflation).

Passing of the new Section 45Q tax credit rules supports CCS economic viability, but it may require creative business acumen to achieve the optimal benefits. A path to market could exist where investors involved with dedicated storage or EOR operators would purchase CO_2 to maximize the available tax credit. In the EOR case, operator(s) claiming the tax credits may also be responsible for adhering to any CO_2 monitoring requirements in the subsurface. Additional aspects of Section 45Q are worthy of note for the RTE case study (115th Congress, 2018); a detailed summary is provided in Appendix C:

- Potential "utilization" with respect to the allowability of various uses for a CO_2 product includes:

  - Fixation of a CO_2 product through biological means of photosynthesis or chemosynthesis.

  - Chemical conversion into a material or chemical compound in which CO_2 is securely stored.

  - "Any other purpose for which a commercial market exists" (except as a tertiary injectant in a qualified EOR or natural gas recovery project) as determined by the Secretary of the Treasury.

- Election of the entity that is allowed to receive the credit – the Secretary is to prescribe regulations regarding this process. RTE would need to use the credits or elect to transfer them to another entity, potentially in exchange for a higher, negotiated CO_2 price.

- Numerous instances in the law specify that the Secretary of the Treasury alone or in consultation with the EPA Administrator and the Energy and Interior Secretaries will "prescribe regulations." This adds uncertainty to the process.

COMMUNITY OUTREACH PLAN DEVELOPMENT

Early, proactive public outreach with stakeholders is key to the success of first-of-its-kind infrastructure development. Because the Phase I work focused only on the technical and economic suitability of CCS implementation at RTE, an evaluation was necessary to determine the outreach efforts needed to support future CCS development at the RTE site. This evaluation focused on the natural environment and human aspects of the region to develop a project-specific outreach plan to be implemented during future program phases. Because the Phase II effort is also a white paper investigation (i.e., no permitting or construction), no outreach to the general public occurred during its execution.

Outreach activities included the following: 1) incorporating project-related discussions with industry and government partners regarding the technical portions of the project as a basis for planning future outreach needs; 2) social characterization of the region based on published information such as demographics, land use, economy, and current and historical energy-related projects; and 3) the preparation of an outreach plan (Appendix D), which serves as a site-specific approach that can also be tailored as future technical project plans are completed. These activities followed DOE best practices for CCS outreach (U.S. Department of Energy National Energy Technology Laboratory, 2017), which specifies an approach to outreach informed about potential issues and concerns from both land use and social perspectives. The evaluation was focused on the RTE site in Richardton, North Dakota, but also investigated the larger regional context of Stark County, shown to be mainly rural and agriculture-based.

Partner Engagement

Major partner engagement activities with RTE included introductory discussions to identify expectations regarding outreach and preferred approaches or methods, such as proactive, consistent information and materials. Further discussions set guidelines for development of the outreach plan that were followed throughout the Phase II effort. In addition, continued discussions with all project-relevant entities (e.g., RTE, North Dakota DMR, etc.) during this period helped inform the evolving outreach narrative with respect to the impact of North Dakota Class VI primacy, Section 45Q tax credits, and West Coast LCF programs.

Outreach Region

The RTE facility is located approximately a half mile southeast of the town of Richardton in eastern Stark County, southwestern North Dakota (Figure 7). The primary outreach region corresponds to Richardton and the population of the adjoining areas served by Richardton. However, a wider context is needed for developing an effective outreach plan and related materials, as the surrounding region can influence those within a study area, particularly in a rural setting. The sections below, therefore, provide information at the county level, including the Richardton study area, with respect to demographics, land cover, and energy development.

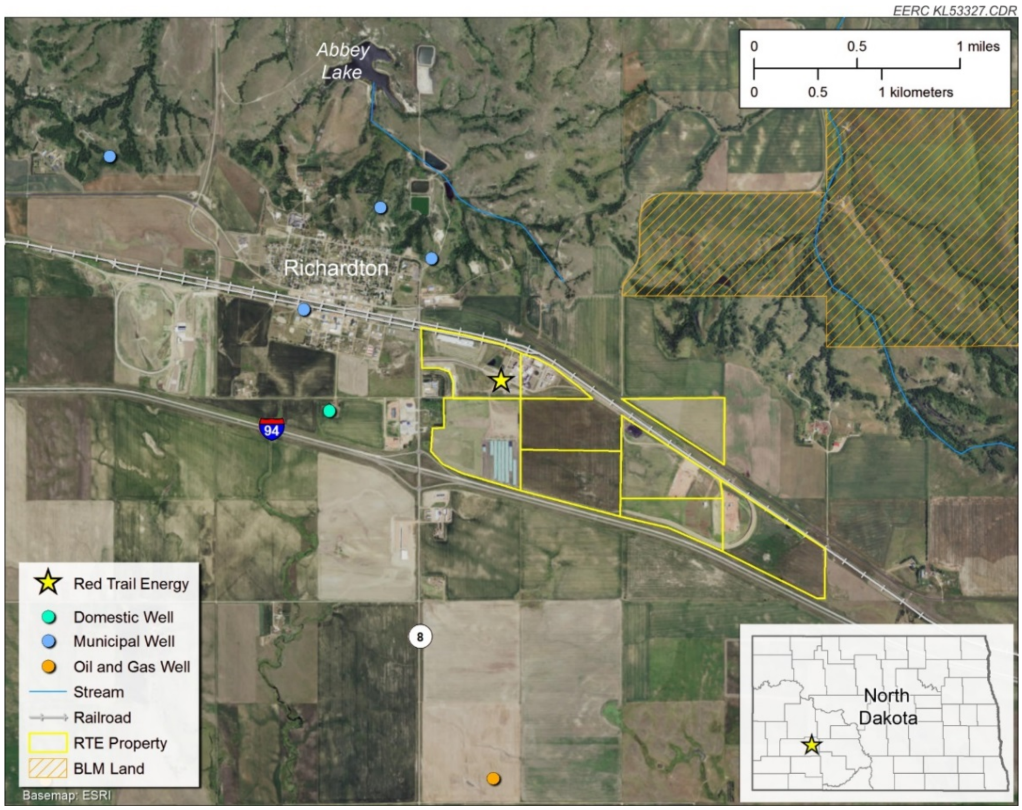

Figure 7. RTE case study area.

Demographics

According to the U.S. Census Bureau (2015), Stark County has a population of about 28,600 people and accounts for 3.8% of North Dakota's population of nearly 755,000. With the recent Bakken energy boom, the population for Stark County has increased by 17.6%, concentrated in the city of Dickinson on the western side of the county. Dickinson (21,100) accounts for three-quarters of the county population and County Commission Districts 1–4. Richardton (660) is the largest town on the eastern side of Stark County, located in the sparsely populated County Commission District 5.

Land Cover

As shown in Figure 8, Stark County is 49% cropland and 41% grasslands. There are approximately 800 farms in the county, with the average size being approximately 1000 acres (U.S. Department of Agriculture, 2017). Urban development accounts for only 4.7% land cover in total, with the bulk of that in Dickinson. In addition, Stark County contains state, wildlife, and recreation areas throughout the region (Figure 9).

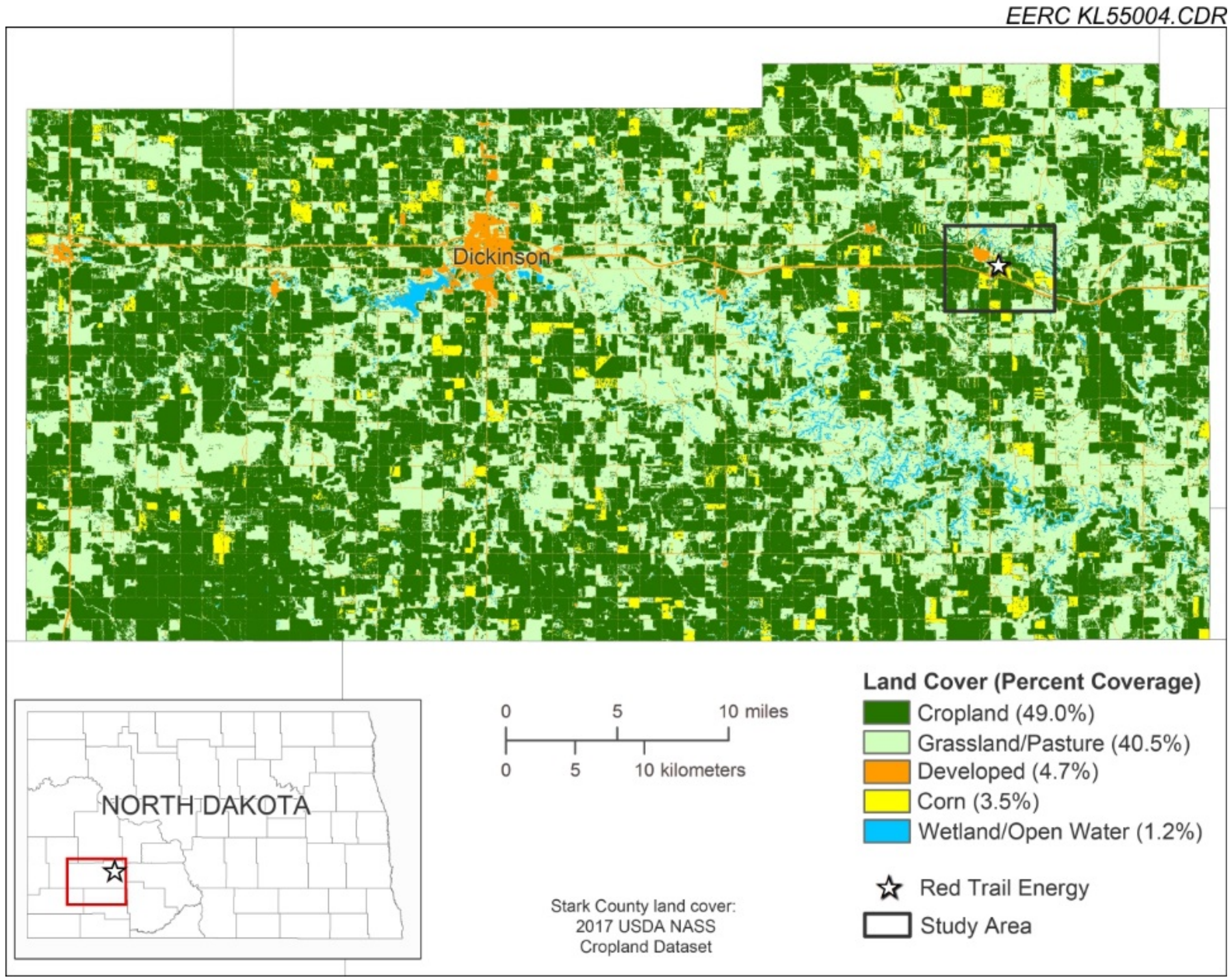

Figure 8. Land cover for Stark County (source: U.S. Department of Agriculture Natural Resources Conservation Services, 2016).

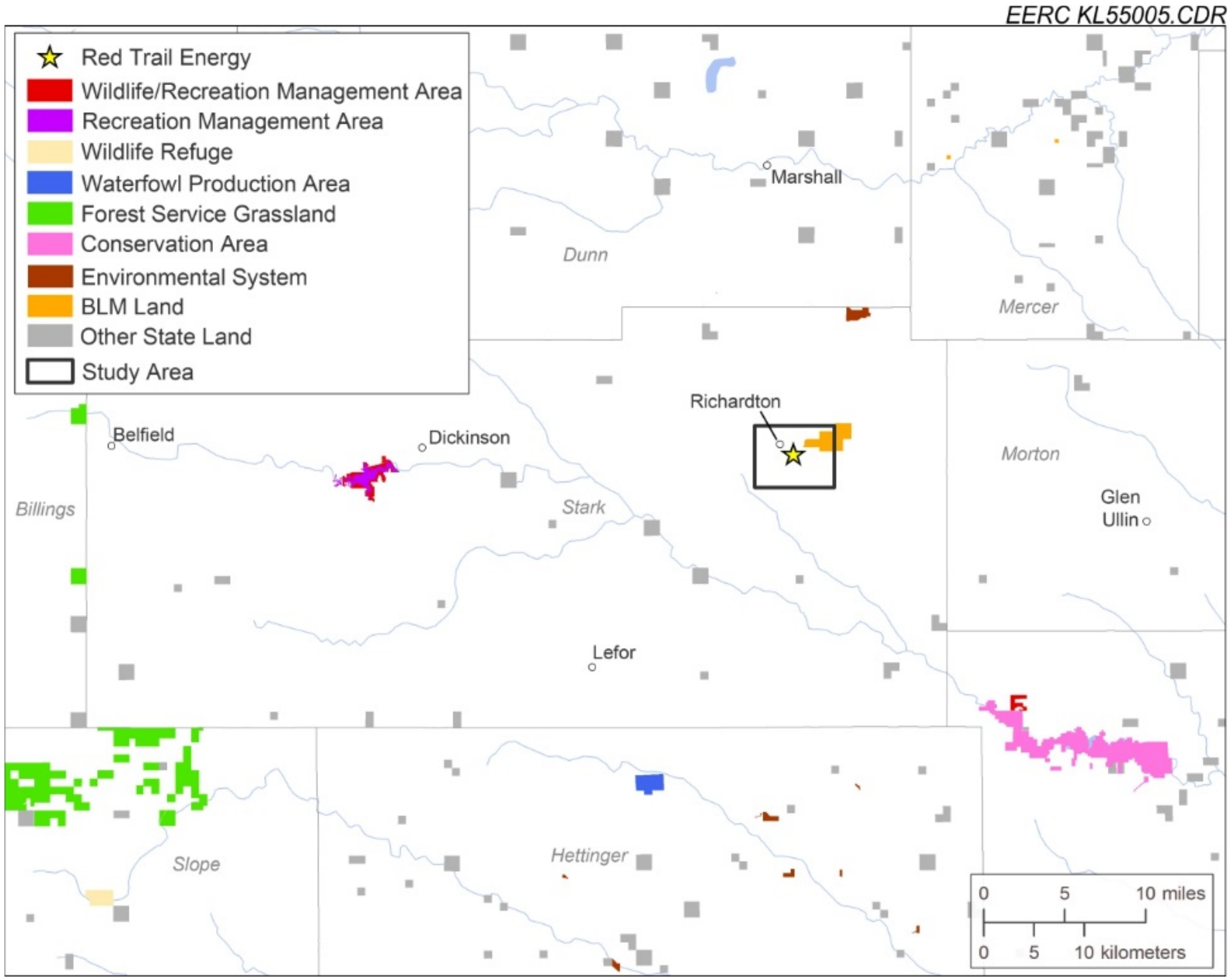

Figure 9. Protected areas in Stark County.

Within the ~20-mi^2 area of study around Richardton (Figure 7), cropland (primarily wheat and corn) accounts for 39% of cover and occurs mainly in the southern and western portions of the study area. Grassland accounts for 38% and occurs mainly northeast of the study area. Developed areas, including the town of Richardton and the adjacent RTE facility, account for 9% of the land area. Bureau of Land Management (BLM) land, corresponding to upland grasses shown in Figures 7 and 9, is located in the northeastern corner of the RTE study area. This BLM land may require additional paperwork for any permitting.

Energy Development

Current and future fossil, biofuels, and wind energy development for Stark County were explored as well (Figure 10). Stark County contains oil, natural gas, and coal resources and is a member of the 20-county Western Dakota Energy Association, which represents counties with fossil energy resources. The majority of oil and gas resources are concentrated in the northwestern quadrant of the county. Major phases of oil and gas exploration and production occurred in the 1970s and 1980s for conventional oil and gas resources. Starting in 2008, the focus has been on exploration and production of the unconventional oil and gas resources of the Bakken Formation. Importantly, the Richardton study area does not have oil and gas production.

Stark County also has abundant lignite coal deposits, but there is currently no mining or power generation in the county. A permit application for the Quintana South Heart Power Project, a power plant on the western side of the county (Figure 10) was submitted to the North Dakota Public Service Commission in 2005 (SourceWatch). A 2.4-million-ton-per-year mine was also proposed. Over time, the application switched back and forth between a power plant and a gasification plant. At one point, the project was a 175-MW integrated gasification combined-cycle power plant that would include CCS with a 90% capture rating; the CO_2 was intended for EOR in western North Dakota and eastern Montana oil fields. The project was formally challenged by the Dakota Resource Council and local landowners beginning in January 2009. With no development or further progression since 2011, the project can be considered effectively withdrawn.

Stark County has significant wind resources for electrical generation, with two projects successfully installed. One wind project close to the RTE study area (Figure 10) was proposed but withdrawn due to strongly polarized public opinion. The projects are as follows:

- Richardton/Gladstone Windfarm (not approved) – proposed for a 7-mile stretch between Richardton and Gladstone, straddling I-94, the project was withdrawn in 2015 (Prairie Business Magazine, 2015).

- Brady 1 Windfarm (approved and active) – located south of Dickinson (25 miles southwest of Richardton), the project began generation in 2016, consists of 87 wind turbines, and provides 150 MW to Basin Electric Power Cooperative (Stults, 2016b).

- Sunflower Windfarm (approved and active) – located south of Hebron (15 miles east of Richardton), the project began generation in December 2016, consists of 52 wind turbines that generate a total of 104 MW, and provides power to Basin Electric Power Cooperative (Stults, 2016a).

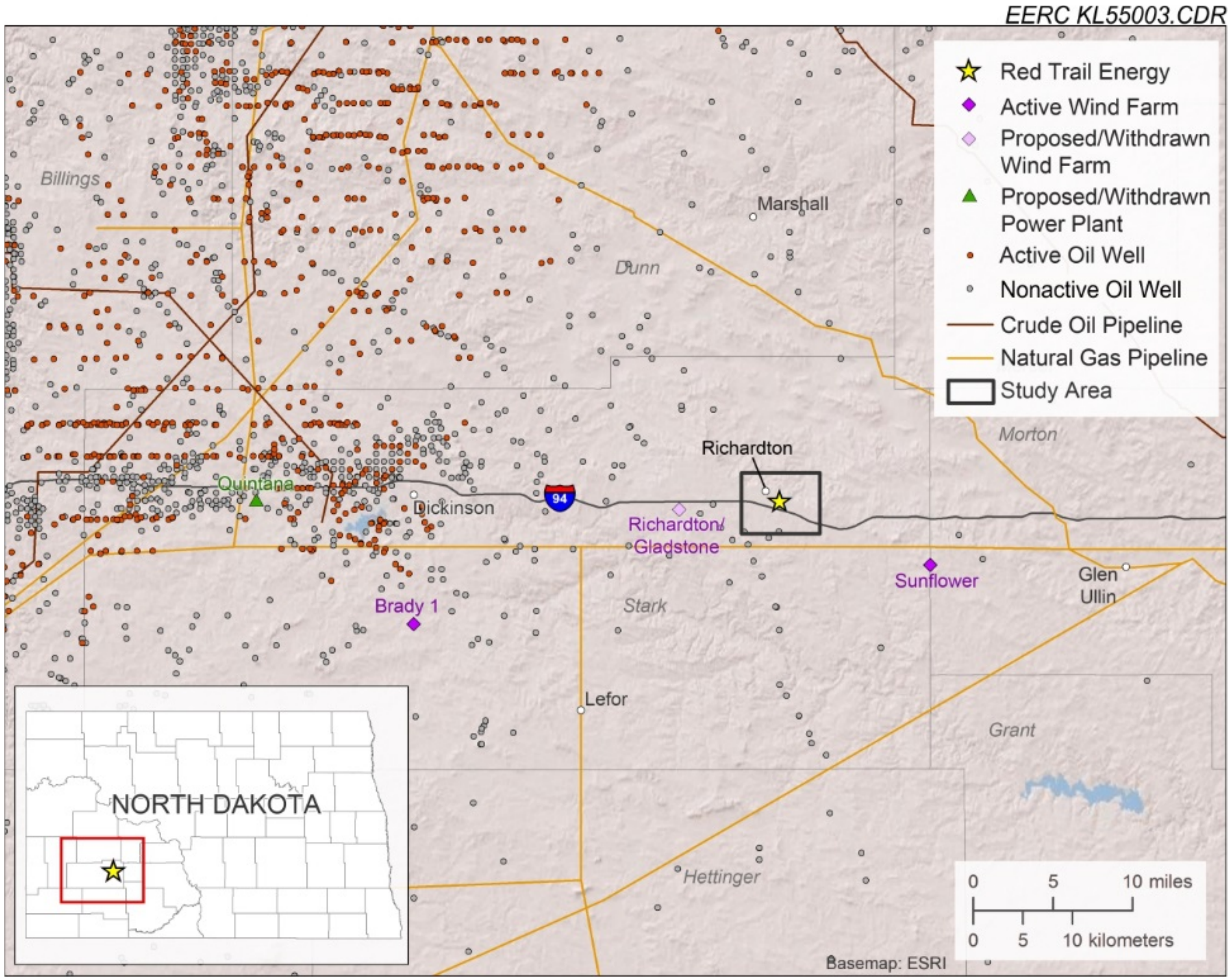

Figure 10. Completed and proposed/withdrawn energy development projects in Stark County.

Biofuels generation in Stark County is limited to the RTE ethanol production facility. The corn-based 50-million-gallon nameplate capacity ethanol plant was commissioned in 2007. Over the past decade, the facility has gained significant energy and processing efficiencies, now producing about 64 million gallons of ethanol annually. The RTE facility generates more than 10% of North Dakota's total ethanol production, using over 20 million bushels of corn annually drawn from the western half of North Dakota, eastern Montana, and northwestern South Dakota. Before the RTE facility and other regional ethanol production, field corn was grown locally for animal feed but the demand related to field corn for ethanol production has raised the prices of farm commodities in general, thereby improving local farm balance sheets.

Economy Dichotomy

Agriculture remains the anchor of the Stark County economy, but starting in the 1970s, fossil, biofuel, and wind energy development added to the economy significantly. The county is essentially divided between a population tied to or dependent on agriculture and a growing population dependent on other activities, notably oil and gas (U.S. Census Bureau, 2015). Landowner viewpoints are often influenced by this divide, i.e., the northwest portion of the county benefits from oil and gas development with the remainder of the county receiving none. This perception could have an impact on outreach efforts and landowner agreements when potential CCS implementation at the RTE site is discussed.

Nonetheless, Richardton has experienced impact from the oil and gas development: a 36% population increase from 2010 to 2015 from 550 to as many as 750 people; a high school at capacity with overflow in the old parochial school facility; $1.7 million in sewer projects; and a new city hall and ambulance bay (Lymn, 2015). Housing shortages related to this growth led to several considerations for new structures or conversion of existing buildings (Wernette, 2015). For example, RTE has board members who reside in the area, but many employees have chosen to live in Bismarck and commute to Richardton. In addition, Halliburton Energy Services sited a 200-acre frac-sand facility to the southwest of Richardton, significantly increasing traffic on local roads, particularly noticed during autumn harvest when corn feedstock is delivered to the RTE facility (Lymn, 2015).

CONCLUSIONS

Building on preliminary Phase I results, Phase II findings have shown that commercial CCS continues to be a viable option for significantly reducing CO_2 emissions at the RTE site. North Dakota DMR and West Coast entities with LCF programs were specifically engaged to track their progress in establishing detailed requirements for CCS implementation. Various business scenarios were considered beyond the generation of injection-grade CO_2 for dedicated storage, including EOR, generation of a food-/chemical-grade CO_2 product, and combinations of these approaches. The economic impact of several carbon markets was explored such as federal incentives, EOR opportunities, and LCF programs. In addition, a detailed outreach plan focused on CCS implementation at the RTE site and the Richardton community was completed.

Although California ARB has shown a willingness to address the concerns of stakeholders, significant challenges remain. Oregon DEQ's program may provide more flexibility with respect to CCS integration to generate a more favorable pathway. Conversely, Oregon DEQ has provided very few details thus far, as they are currently in a much earlier stage of development. Much work remains to develop a successful CCS integration approach that can satisfy the requirements of the North Dakota Class VI Program and one or more of the West Coast LCF programs.

Repeating the LCA from Phase I efforts to include more recent (and efficient) processing data from the RTE facility, Phase II showed the significant potential reduction in CO_2 emissions previously estimated for CCS implementation (~40%) to be maintained even if generating a higher-grade (i.e., EOR or food) CO_2 product. Analytical results confirmed that RTE's fermentation-generated CO_2 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 costs estimated to meet the proposed California CCS Protocol requirements compared to North Dakota Class VI requirements could affect long-term economics significantly. Passing of new tax credit rules for Section 45Q improves CCS economic feasibility but may require additional investors for a small business to achieve maximum benefits. Estimated costs required for electrical upgrade and pore space payments are not expected to detrimentally affect this case study.

A community outreach plan was developed that, in keeping with DOE best practices, will foster effective communication and constructive stakeholder engagement in the region to enable CCS implementation. The study region mainly comprises rural, agriculture-based communities. However, the oil and gas industry is prevalent in neighboring communities in the western portion of the county. These are important considerations, because when stakeholders are informed about potential issues and concerns from both land use and social perspectives, it creates a more constructive environment for project discussions.

NEXT STEPS TO CCS IMPLEMENTATION

Addressing knowledge gaps related to regulatory compliance, LCF program requirements, processing and financing requirements, and public outreach continues to encourage investment toward integrating commercial CCS with North Dakota ethanol production and to support the research effort at the RTE site. The next recommended steps toward implementation include a detailed examination of the storage complex beneath the site, which will be led with a baseline seismic survey to identify specific locations for drilling to collect core samples from the target storage formation and overlying seal. Near-surface baseline monitoring should also begin, including groundwater and soil gas sampling. Professional engineering designs of the potential capture system should be completed, given that compressors can take a full calendar year for manufacture and delivery once ordered. Execution of the outreach plan developed during this Phase II effort is paramount to the success of future activities, especially for baseline monitoring and any related permitting.

Moving forward with the permitting process within the North Dakota Class VI Program is recommended, as it is likely to be the first Class VI permit application submitted under the newly established primacy. The site-specific data to be collected during the baseline seismic survey will aid in establishing the expected AOR and completing the technical evaluation, as required by the Storage Facility Permit. Components of the Storage Facility Permit (e.g. the Corrective Action

Plan, Testing and Monitoring Plan, Postinjection Site Care plan, etc.) can be initiated with the goal of generating a draft permit package. The progress and status of this permit package can then be discussed with North Dakota DMR. Input from North Dakota DMR will be critical to ensure that regulatory concerns are met for this first-of-a-kind effort.

To complete the permit for formal submittal, as detailed in the Phase I FIP, additional analysis of downhole rock and fluid samples and well log data collected from a stratigraphic test well on the RTE site will be required. These activities will provide the data necessary to assess project risks, improve modeling and simulation estimates, and ensure appropriate operational and monitoring plans have been developed. This, in turn, will enable regulators to assess the suitability of the overall CCS implementation plan and the permit applications.

Ongoing communication with California and Oregon regarding development of pathway approvals to include CCS in their respective LCF programs is necessary to maintain a current assessment of economic viability. Plans for obtaining approvals and an update of the LCA model may require revaluation as these pathways continue to develop and details become publically available. Staying abreast of other potential incentive opportunities as well, such as Section 45Q clarifications, may support CCS implementation in the interim or even altogether.

PARTNERS AND FINANCIAL INFORMATION

This project is sponsored by the NDIC Renewable Energy Program, DOE, and RTE. Table 7 shows the budget of $690,000 for this project and expenses through project completion.

Table 7. Budget and Expenses Through July 31, 2018

Sponsor	Budget	Expenses	Remaining
NDIC Cash	$345,000	$341,630	$3370
DOE Cash	$200,000	$198,374	$1626
RTE In-Kind	$145,000	$173,536	$(28,536)
Total Project	**$690,000**	**$713,540**	**$(23,540)**

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APPENDIX A

TRIMERIC NEXT STEPS IN RTE CO_2 RECOVERY PROJECT

TRIMERIC CORPORATION

P.O. Box 826
Buda, TX 78610

Next Steps in RTE CO_2 Recovery Project
05/31/2018

The Red Trail Energy ethanol facility (RTE) is conducting preliminary engineering studies for the design of a facility that will capture and process the carbon dioxide (CO_2) from their ethanol fermenters that is currently vented to atmosphere. Trimeric's previous work has focused on the type of facility to build, the monetary value of the produced CO_2, and injection well locations. RTE has decided to pursue a CO_2 recovery facility design that will allow it to market the captured CO_2 as pipeline-grade CO_2. The CO_2 may be used in fracking operations in the Williston basin and eventually for injection at a local injection well to help realize tax credits and/or more attractive prices for their main ethanol product.

The current cost estimate for the CO_2 recovery facility is a parametric cost estimate, based upon work completed in the past by Trimeric Corporation for other projects. Further work is required to get a more accurate cost estimate for the facility to help RTE make a final decision whether to build the facility or not.

A general list of tasks for the next phases of the project with some details for each step is provided in the following section. At the end of this document is a brief description of Trimeric's approach to these projects in the past. This is not an exhaustive list and should not be considered a complete list of tasks that will happen in the rest of the project, but it should give an overview of how Trimeric envisions this project proceeding based on our experience on similar projects. Some tasks listed here will be done in parallel, particularly once the project begins the construction phase.

1. Develop a process design package (PDP) for the facility. The PDP will provide further details on the facility design and is the major deliverable from process engineering for the project. The PDP result is an optimized process design and equipment process performance parameters to support a +/- 25% cost estimate. Specific tasks and deliverables include:
    a. Develop and finalize block flow diagrams.
    b. Develop and finalize process flow diagrams.
    c. Develop a preliminary plot plan.
    d. Develop preliminary heat and material balance(s).
    e. Develop utility flow diagrams and utility requirements.
    f. Develop process datasheets for major equipment.
    g. Develop preliminary electrical load requirement.
    h. Develop preliminary piping and instrumentation diagrams.
    i. Obtain budgetary quotes for the major equipment. Most of this facility will be skidded equipment.
    j. Complete factored cost estimate for facility with budgetary quotes from vendors (+/- 25%).
    k. Decide on E/P/C strategy to guide decisions on detailed engineering firm.

    l. Go/No go decision for next step.
2. Assuming that the revised cost estimate still justifies the project, engage a detailed engineering firm to develop an AFE-level cost estimate.
    a. Finalize heat and material balance(s).
    b. Finalize utility flow diagrams and utility requirements.
    c. Finalize equipment datasheets for major equipment.
    d. Develop electrical one-line diagrams and other electrical engineering packages.
    e. Revise piping and instrumentation diagrams to “pre-PHA (Process Hazard Analysis)” status.
    f. Identify tie-in points with existing equipment and estimate pipe sizes and routing.
    g. Develop instrument and control valve lists.
    h. Develop control system philosophy, potential tie-in to existing facility DCS.
    i. Develop preliminary structural steel and concrete requirements and preliminary building sizes.
    j. Develop preliminary schedule and procurement strategy.
    k. Revise cost estimate (+/- 15-20%) and conduct formal contingency analysis.
    l. Go/No go decision for next step. Issue AFE for facility detailed design.
3. Complete detailed engineering for facility.
    a. Complete PHA for facility.
    b. Finalize all process, electrical, and mechanical design datasheets.
    c. Complete structural engineering and foundation designs and associated drawings.
    d. Develop and finalize piping drawings (isometrics and other drawings).
    e. Finalize control system philosophy.
    f. Develop and finalize instrumentation and control valve datasheets.
    g. Develop and finalize relief system design.
    h. Detailed Work Breakdown Schedule (WBS)/schedule, procurement strategy, and construction.
    i. Revise vendor quotations for purchase.
        i. Select vendors and order long lead-time equipment if necessary.
4. Facility construction.
    a. Engage appropriate construction firm for construction of the facility based upon procurement strategy.
    b. Schedule tie-point installation during host site outage.
    c. Site grading and prep.
    d. Underground piping installation (if necessary).
    e. Foundation pouring and anchor bolt installation.
    f. Structural steel installation.
    g. Piping installation.
    h. Factory acceptance test (FAT) and inspections for skidded equipment.
    i. Start operator training.
    j. Receive skidded equipment at site and begin installation.
    k. Other equipment installation.
    l. Control system FAT.
    m. Instrumentation and electrical wiring installation.
    n. Finalize operator training.
    o. Procure basic facility consumables (fire extinguishers, eye wash, etc.).

   p. Mechanical completion.
   q. Revalidate PHA.
5. Facility commissioning.
   a. Loop checks.
   b. Pre-Start Up Safety Review (PSSR).
   c. Site Acceptance Test for control system.
   d. Inventory fluids to facility (lube oils, refrigerants, and other consumables).
   e. Commission and start utilities.
   f. Bump motors for rotation.
   g. Run-in for rotating equipment if necessary.
   h. Turn on facility equipment and initial run. Complete loop tuning where possible.
   i. Activate/Regenerate adsorbents.
   j. Dry out low temperature equipment.
   k. Load refrigeration system compressors and cool down low temperature equipment.
   l. Establish operating conditions/specifications and begin to cool down, pressurize, and inventory storage tanks.
   m. Start injection equipment if necessary.
   n. Complete performance test for facility.
   o. Turn facility over to normal operation.

Trimeric can complete most or all of Task 1 (PDP) without engaging other engineering firms as most of the Task 1 details are still work that is completed by process engineers. Trimeric does not currently offer any engineering disciplines besides process engineering, so once the project proceeds past the process design package for the facility, it will be necessary to engage a detailed engineering firm that has other engineering disciplines.

At the end of Task 1, there are options for how RTE/EERC could proceed for the rest of the project development and, in Trimeric's experience, different clients will proceed in a variety of ways. Trimeric can continue to support the project after Task 1, but we would normally transition to an "owner's engineer" role where we work for RTE/EERC to provide oversight of the detailed engineering firm. There will be hundreds of documents to review and approve during the rest of the project and Trimeric can provide process engineering review of those documents if RTE/EERC has a need for us to do so. Trimeric has on past projects helped with operator training, attending and/or facilitating the PHA, tracking action items and resolution, attending FAT/SAT activities, helping with commissioning, etc. We've often stepped up to develop a Process Punch List for completion of the facility and worked with other engineers and trades to see that these items are closed out to the satisfaction of the owner. In short, we can continue in the owner's engineer role all the way through commissioning of the facility if that meets the needs of the project.

APPENDIX B

PHASE II LIFE CYCLE ANALYSIS

PHASE II LIFE CYCLE ANLYSIS

INTRODUCTION

As part of this Phase II effort, the Energy & Environmental Research Center (EERC) conducted a life cycle analysis (LCA) to estimate the reduction of greenhouse gas (GHG) emissions for ethanol produced with carbon capture and storage (CCS) implementation at the Red Trail Energy (RTE) ethanol facility in Richardton, North Dakota. The output of the LCA is an estimate of the carbon intensity (CI) value for the ethanol, which quantifies the life cycle emissions of GHGs associated with the production, transportation, and distribution of the ethanol.

Carbon markets, such as the California Low Carbon Fuel Standard (LCFS) Program and the Oregon Clean Fuels Program (CFP), use the ethanol CI values to estimate carbon credits and CO_2 market value. These programs target fuels such as ethanol that demonstrate a lower CI value than standard fuels such as gasoline, with incentives through the program's CO_2 credit market. Therefore, the California LCFS Program and Oregon CFP provide a current economic incentive through which the ethanol industry could profit from CCS implementation.

The California LCFS Program uses a modified version of GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) to derive CI values for alternative fuels. Argonne National Laboratory created the GREET model using an LCA approach to determine the net carbon emissions from producing a particular fuel. The California LCFS Program modified the GREET model to generate CI values for direct comparison between fuels and producers (CA-GREET). The CA-GREET functional unit for the CI value is grams of CO_2 equivalent per megajoule (gCO_2e/MJ) of a produced ethanol.[1] Similarly, the Oregon CFP also uses a modified version of GREET. This LCA used CA-GREET for all ethanol CI calculations to provide a standard basis of comparison for different CCS scenarios. The remainder of this section summarizes LCA methods and results.

This appendix does not include specific inputs or results related to potential CI values for the RTE facility, as these are proprietary because of the business-sensitive nature of the information. Nor does it contain the detailed analysis of the resulting CI reductions that may be incurred by RTE, as that information is also considered business-sensitive.

RTE ETHANOL FACILITY OPERATING DATA

The inputs used to estimate ethanol CI values were derived from 24 months of operating data collected from RTE's ethanol facility from April 2016 through and including March 2018.

[1] While CO_2 is the most commonly produced GHG, methane (CH_4) and nitrous oxide (N_2O) also act as GHGs in the atmosphere. GHG emissions are expressed in units of "CO_2 equivalents" (CO_2e) using the 100-year global warming potential (GWP) coefficients of 25 for CH_4 and 298 for N_2O (Forster and others, 2007) The GWP coefficient for CO_2 is one. Expressing GHGs in units of CO_2e allows a summation of all three values (CO_2 + CH_4 + N_2O) into a single number, i.e., CO_2e.

These 24 months of data were used to generate a low (5th percentile or P05), middle (50th percentile or median [P50]) and high (95th percentile or P95) estimate for each of the inputs used in the LCA. This approach provides the potential variability in CI values.

CA-GREET-2.0 INPUTS

The LCA used the September 29, 2015, release of the CA-GREET model (hereafter "CA-GREET-2.0")[2] and the "Tier 1 Fuel Carbon Intensity Calculator for the Low Carbon Fuel Standard" (T1 Calculator) within CA-GREET-2.0 to derive all of the ethanol CI values. CA-GREET-2.0 is a spreadsheet model developed in Microsoft Excel® and employs standard spreadsheet functions supported by custom Visual Basic routines to accomplish its calculations. The approach adopted by this study was to input RTE facility-specific data into the T1 Calculator. While some of the T1 Calculator inputs used facility-specific values, other inputs were maintained at their default values. The following list summarizes the key inputs for CA-GREET-2.0 and identifies whether the LCA used facility-specific or default values:

- Ethanol yield (facility-specific)
- Corn farming (default)
- Fertilizer, herbicide, and insecticide use (default)
- N_2O in soil (default)
- Corn transport from the farm fields to the ethanol facility (facility-specific)
- Coproduct credits for distillers grains with solubles (DGS) (facility-specific)
- Energy inputs to ethanol production (natural gas and electricity usage) (facility-specific)
- Ethanol transport and distribution (facility-specific).

All of the LCA modeling used the following inputs for corn and ethanol transport:

- 100% of the corn transported to RTE's ethanol facility arrives by heavy-duty diesel (HDD) over an average transport distance of 73 miles.

- 100% of the ethanol produced at RTE's facility is transported by rail to California over a distance of 1800 miles.

- 100% of the ethanol from the railyard in California to the blending terminal is transported by HDD truck over an average transport distance of 50 miles.

- 100% of the ethanol from the blending terminal to fuel stations is transported by HDD truck over an average transport distance of 71 miles (the default CA-GREET-2.0 value).

Lastly, CA-GREET-2.0 allows the user to modify the electricity mix and crude oil use for the ethanol feedstock and ethanol fuel production. All of the LCA modeling runs used the following inputs for these options:

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[2] Documentation for CA-GREET-2.0 may be found at the following Web site: www.arb.ca.gov/fuels/lcfs/ca-greet/ca-greet.htm (accessed 2018).

- Step 1b) Select Regional Electricity Mix for Feedstock: 7-MROW Mix[3]
- Step 1c) Select Region for Crude Oil Use: U.S. Ave Crude
- Step 2b) Select Regional Electricity Mix for Fuel: 7-MROW Mix
- Step 2c) Select Region for Crude Oil Use: U.S. Ave Crude

Distillers Grains with Solubles

The primary product to which the LCA assigns emissions is ethanol. However, the RTE facility produces both modified DGS (MDGS) and dry DGS (DDGS) as coproducts of ethanol production. These coproducts earn an emission credit for the ethanol.

Greater energy inputs, and therefore commensurately greater CO_2 emissions, are associated with producing DDGS because of the additional drying steps. Consequently, ethanol produced with MDGS as the coproduct has a lower CI value than ethanol produced with DDGS as the coproduct. This technical evaluation considers two end members, 100% MDGS and 100% DDGS, to bracket the lower and upper bounds, respectively, for RTE's ethanol production with CCS.

While disposition and related emissions of corn oil and syrup are different from MDGS and DDGS, their weights were included in DGS coproduct displacement calculations. The error introduced by this simplification is small—especially in light of the alternative which was, since there is no appropriate disposition for these coproducts in the model, to ignore the products.

Denaturant

CA-GREET-2.0 assumes a denaturant content of denatured ethanol of 2.5% (volume per volume, v/v). This study, therefore, used RTE facility-specific inputs for anhydrous ethanol and the default CA-GREET assumptions to estimate the CI increase associated with adding denaturant.

Indirect Land Use

The final component added to the life cycle emissions of denatured ethanol is indirect land use. These are indirect emissions associated with the expansion of land used for corn production. CA-GREET-2.0 uses a default value of 19.8 gCO_2e/MJ of denatured ethanol.

SUPPLEMENTAL CALCULATIONS TO SUPPORT CCS

Although the current CA-GREET-2.0 model is only applicable for traditional ethanol production, its method can be applied to the operations of a CCS system to estimate CI values for ethanol produced with CCS. The EERC analysis uses CA-GREET-2.0 and appends these results to include additional emissions associated with CO_2 capture ("Capture System") and emission credits associated with CO_2 storage in the Broom Creek Formation ("Geologic Storage"). (Figure B-1).

[3] Midwest Reliability Organization (MRO).

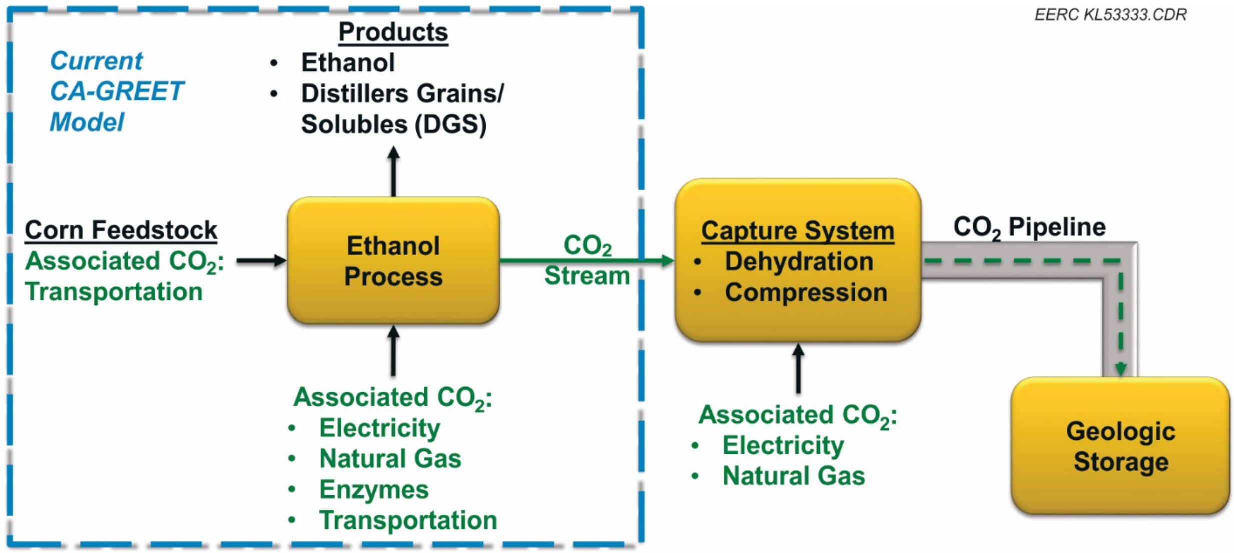

Figure B-1. Block diagram showing key elements of ethanol production with CCS. The blue dashed box represents the boundary of the current CA-GREET2.0 model for deriving CI values associated with ethanol production without CCS. This technical evaluation appended CA-GREET to include additional emissions associated with CO_2 capture ("Capture System") and emission credits associated with CO_2 storage in the Broom Creek Formation ("Geologic Storage").

The additional emissions associated with the CO_2 capture system are attributable to the increased electricity and natural gas usage to capture, dehydrate, and compress the CO_2. Additional processing would be required for higher-grade CO_2 products to meet the specifications for enhanced oil recovery (EOR) or the food/chemical industry. The LCA evaluated the different types of CO_2 capture systems:

- Injection-grade CO_2 capture for dedicated geologic storage.
- EOR-grade CO_2 capture for potential use in EOR applications, followed by dedicated geologic storage.
- Food-/chemical-grade CO_2 capture for potential use in food/chemical markets, followed by dedicated geologic storage.

The EOR- and food-grade capture systems require a greater amount of electricity per tonne of captured CO_2 and generate a lower percentage of CO_2 product than the injection-grade capture system. The following inputs were used in the supplemental calculations to quantify additional emissions associated with CO_2 capture and emission credits associated with CO_2 storage (Leroux and others, 2017):

- All models assume 99.92% dry CO_2 purity by weight (see Table 2 in main report).

- The electrical usage for injection-, EOR-, and food-grade capture assumes 118.8, 152.1, and 152.5 kWh/tonne CO_2, respectively.

- All models assume an additional natural gas requirement of 7 scf/tonne CO_2 for all three capture systems.

- The capture efficiencies are assumed to be as follows:
  - Injection-grade: 99% capture efficiency with a range from 98.5% to 99.5%.
  - EOR- and food-/chemical-grade: 90% capture efficiency with a range from 85% to 95%.

SUMMARY AND CONCLUSIONS

A site-specific LCA was completed to derive CI values for ethanol produced at the RTE facility modified with CCS. This LCA used the CA-GREET model, RTE facility-specific inputs, and supplemental calculations to include additional emissions associated with CO_2 capture and compression and emissions credit for geologic CO_2 storage.

All of the models show that producing ethanol with CCS results in a significant reduction in the ethanol CI value, ranging from a 30% to a 50% reduction as compared to the baseline case (ethanol production without CCS). The injection-grade CO_2 product with subsequent storage generated an estimated 40%–50% reduction. EOR-/food-grade capture systems resulted in an estimated 30%–40% reduction with subsequent storage as compared to the baseline case.

These results suggest that amending RTE's ethanol facility with CCS will result in a significant reduction in life-cycle CO_2 emissions, regardless of the grade of CO_2 product generated (capture system implemented).

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APPENDIX C

SECTION 45Q ASSESSMENT FOR THE RTE CASE STUDY

SECTION 45Q ASSESSMENT FOR THE RTE CASE STUDY

Title 26 U.S.C. is the Internal Revenue Code of which Section 45Q establishes credit for carbon oxide sequestration that is considered a business credit against tax. Two major laws have defined 45Q: Public Law 110-343, the Emergency Economic Stabilization Act of 2008 (EESA) enacted October 3, 2008, and Public Law 115-123, the Bipartisan Budget Act of 2018 (BBA) enacted February 9, 2018. The original law established credits for disposal of carbon dioxide of $20 per tonne for secure geologic storage and $10 per tonne for use of carbon dioxide as a tertiary injectant in a qualified enhanced oil or natural gas recovery project. Among other stipulations, the credit was attributable to the person that captured and physically or contractually ensured the disposal of or use as a tertiary injectant—subject to regulations prescribed by the Secretary of the Treasury—and the credit was adjusted for inflation commencing 2010. P.L. 110-343 also established a limit of 75,000,000 tonnes carbon dioxide, which, when surpassed, would suspend the credit for following years. The BBA increased acceptable composition from carbon dioxide to carbon oxides, added a class of utilization, and increased the flexibility of many aspects of the original law as well as the magnitude of the credit. Many of BBA's provisions apply exclusively to carbon capture equipment placed in service at a qualified facility on or after the date of enactment of BBA.

The following assessment assumes RTE capture equipment is placed in service on or after BBA's date of enactment and that it will not elect credits provided by the 2008 law. Table C-1 exhibits the credit schedules specified in the BBA. Figure C-1 compares the historical EESA credit schedule with BBA's schedule and indicates that a significant increase in the inflation adjustment factor would be required for the EESA credit schedule to exceed the BBA schedule for disposal, use, and utilization. It was not apparent within BBA whether election of the original credit schedule would also place taxpayers that elect the original schedule under the 75,000,000 tonne rule. However, Figure C-2 indicates that if there are no changes to the law and historical capture rates continue, the credit will be suspended after 2020. Figure C-3 exhibits the effect of inflation on the credit schedule by comparing the mandated schedule with inflation adjustment of 1.5% and 4% per year. The approximate average adjustment recognized by the Internal Revenue Service during 2009-2017 is 1.5%.

Table C-1. BBA Credit Schedule

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Geologic Disposal	22.66	25.70	28.74	31.77	34.81	37.85	40.89	43.92	46.96	50.00
Injectant and Other Utilization	12.83	15.29	17.76	20.22	22.68	25.15	27.61	30.07	32.54	35.00

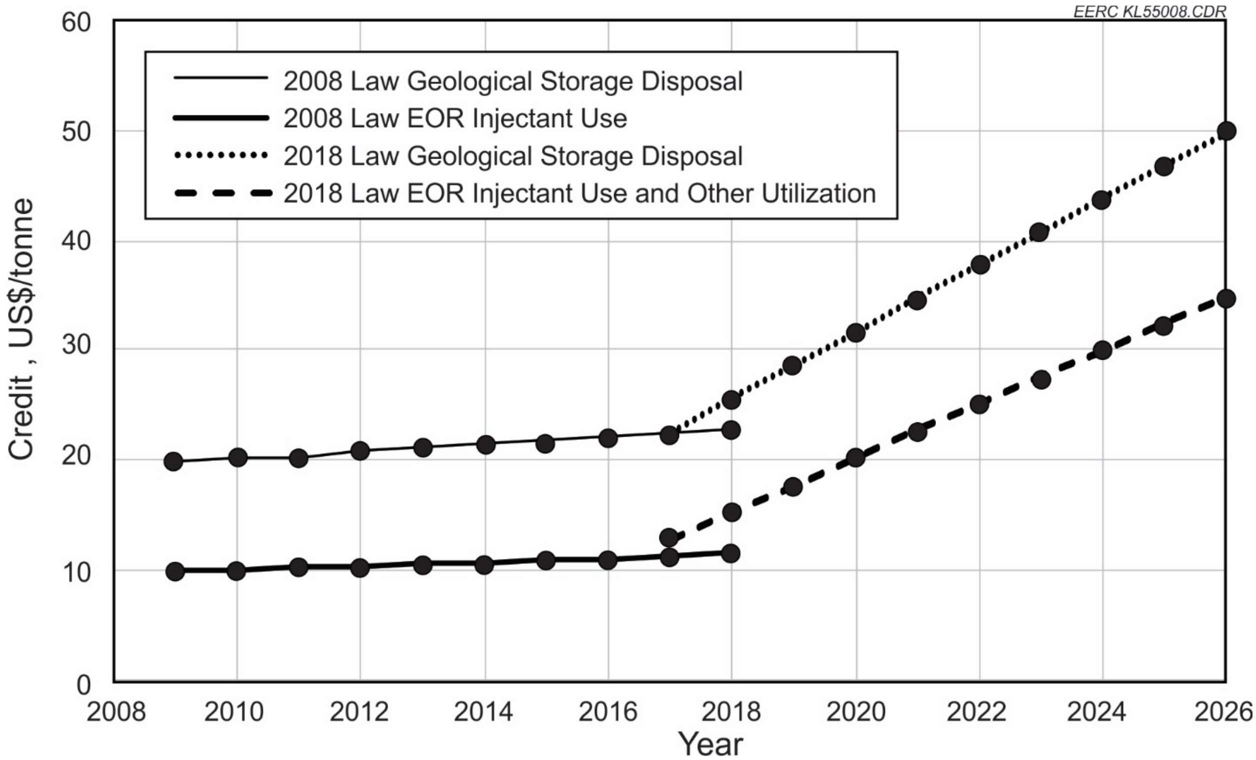

Figure C-1. Historical and mandated credit schedules of the EESA and BBA.

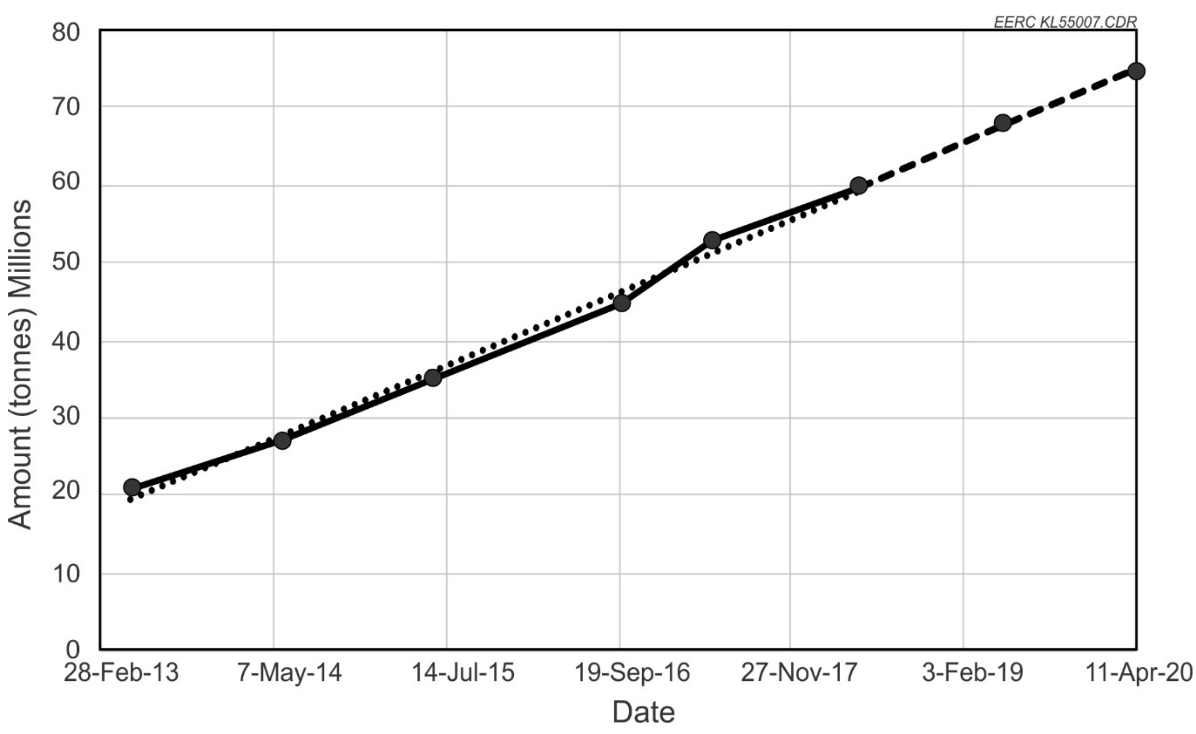

Figure C-2. Reported and projected aggregate amount of qualified CO_2 that has been captured and disposed of or used.

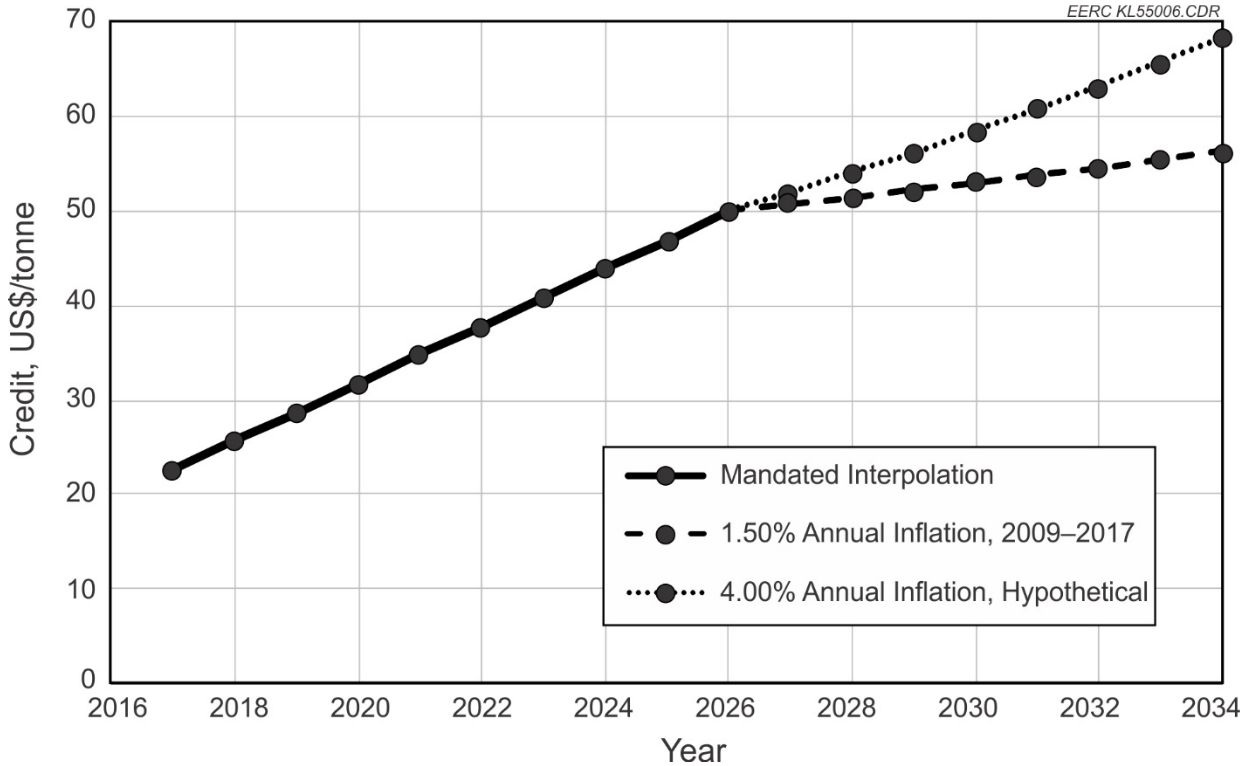

Figure C-3. Mandated and projected credit schedule for qualified carbon oxide captured and disposed of in secure geologic storage.

BBA establishes numerous stipulations regarding what makes up qualified carbon oxide and a tertiary injectant, what is a qualified facility and a qualified enhanced oil or natural gas recovery project, what are the geographical and temporal constraints to capture and disposal, use or utilization of carbon oxides, and what defines the annual inflation adjustment, to name a few. The following are likely to be of special interest to RTE:

- Potential "utilization"
- Election of entity that is allowed credit
- Temporal issues
- Secretary prescribes regulations issue

Utilization of carbon oxide: EESA established the qualified final disposition of carbon dioxide to be disposal in secure geologic storage or use as a tertiary injectant in a qualified enhanced oil or natural gas recovery project in secure geologic storage. The Secretary of the Treasury, along with the U.S. Environmental Protection Agency (EPA) Administrator and the Secretaries of Energy and the Interior were to establish regulations for determining adequate security measures. BBA has similar language that introduces uncertainty into treatment of the credit. BBA also introduces another class of disposition for carbon oxides: utilization. Utilization of qualified carbon oxide means 1) fixation of carbon oxide through biological means of photosynthesis or chemosynthesis, 2) chemical conversion into a material or chemical compound in which the carbon oxide is securely stored, and 3) "any other purpose for which a commercial market exists" (except tertiary injectant as described previously) as determined by the Secretary. Utilization requires the "taxpayer to demonstrate based upon an analysis of life cycle greenhouse gas emissions" (subject to requirements of the Secretary) that the emissions "were 1) captured and permanently isolated from the atmosphere or 2) displaced from being emitted into the atmosphere." Lifecycle greenhouse gas emissions has the same meaning as in the Clean Air Act, 42 U.S.C. 7545(o)(1)(H), except "product" is substituted for "fuel." Again, "requirements by the Secretary" introduces uncertainty into treatment of the credit, especially in defining "permanent." It would not be unreasonable to assume that beverages would not be considered "permanent." However, if carbon dioxide was produced strictly for the purpose of beverage utilization and an existing carbon dioxide emission could be captured and displace (eliminate) the for-purpose carbon dioxide generation—and this could be demonstrated in a lifecycle greenhouse gas analysis—such utilization could satisfy the code.

Election of entity that is allowed credit: BBA states that for carbon capture equipment originally placed in service at or after the date of BBA enactment, credit is attributable to "the person that owns the carbon capture equipment and physically or contractually ensures the capture and disposal, utilization or use as a tertiary injectant." However, it does permit that person by election to allow credit to the person that disposes of, utilizes, or uses the qualified carbon oxide as a tertiary injectant and lose attributability to the owner. The Secretary is to prescribe regulations regarding this process, which again introduces uncertainty.

Temporal issues: As noted, the above assumes that RTE will install and operate the carbon capture equipment in a specified manner. Specifically, it must place the equipment in original service on or after the date of enactment of the BBA. BBA limits the time the credit can be attributed to 12 years beginning on the date that the equipment was originally placed in service. Credits will be adjusted for inflation after calendar year 2026 based upon gross national product implicit price deflators from the prior year and base year of 2025. Note that a qualified facility is any industrial facility the construction of which begins before January 1, 2024, and construction of carbon capture equipment begins before that date. Alternatively, the original planning and design for such facility includes installation of carbon capture equipment which captures not less than 25,000 tonnes for an ethanol facility that emits into the atmosphere less than 500,000 tonnes annually or not less than 100,000 tonnes for other ethanol facilities (BBA does not refer explicitly to ethanol facilities; subparagraphs relevant to ethanol facilities were extracted from BBA).

Secretary prescribing regulations issues: Numerous instances in BBA specify the Secretary [of the Treasury] or Secretary in consultation with the EPA Administrator and Secretaries of Energy and the Interior will prescribe regulations which add uncertainty to the BBA.

APPENDIX D

PHASE II OUTREACH PLAN FOR RED TRAIL ENERGY CASE STUDY

PHASE II OUTREACH PLAN FOR RED TRAIL ENERGY CASE STUDY

INTRODUCTION

The Red Trail Energy (RTE) carbon capture and storage (CCS) effort is investigating the feasibility of and business case for secure, permanent, geologic storage of carbon dioxide from ethanol production. Led by the Energy & Environmental Research Center (EERC), the 12-month effort is funded by the U.S. Department of Energy (DOE) and RTE. The project began August 2017 and is scheduled for completion in July 2018.

Outreach is an integral part of the overall project and encompasses any project-related activity that has public contact or exposure. The overall goal for implementing project outreach is to develop and implement a strategy to engage with stakeholders and to create an environment that allows them to make informed decisions regarding the project within their community and the region. Internal outreach efforts create an effective, informed team that can act as knowledgeable spokespeople for the project. External outreach is triggered by any project-related activity that has public contact or exposure. This includes actions by the outreach team on behalf of the project, by project management, the technical team, or partners.

This Phase II outreach plan lays a foundation for public engagement related to a potential permanent CO_2 storage project near Richardton, North Dakota. The plan's various components answer five key questions that the outreach team needs to know to create and implement a comprehensive and successful outreach campaign (Table D-1). The outreach plan is intended to be a starting point for RTE and the EERC to implement outreach efforts during future phases of the project.

Table D-1. Relating Outreach Plan Content to Key Project Story Questions

Questions to Answer		Plan Content
1	What are we trying to achieve and how do we best work together to achieve it?	• Goal, approach, and success measures • Partner roles • Audiences • Implementation considerations and guidelines
2	What is our story?	• Outreach narrative, themes, and messages
3	How will audiences hear our story?	• Engagement strategies • Outreach toolkit
4	When do we need to tell the story?	• Preliminary outreach time line matched to technical time line and partner considerations
5	Who heard the story, and what do they think about it?	• Tracking and assessment

OUTREACH GOAL AND APPROACH

The RTE CCS outreach effort is designed as an integral part of the overall project. The long-term goal of RTE CCS outreach is to develop and implement a strategy to engage with key stakeholders to ensure that they have the background needed to make an informed decision regarding the RTE CCS project with respect to their community and the region.

RTE CCS outreach encompasses any project-related activity that has public contact or exposure. This includes actions by the outreach team on behalf of the project, by project management or the technical team, or by partners on behalf of the project. The outreach time line is keyed to the project time line. The project time line is continuous and seamless between phases, and elements of the time line build on previous actions and events. The time line has outreach actions that precede the public phase of outreach and proceeds through the end of the project and into the postoperation management phase (e.g., North Dakota certification of project completion).

Outreach will be guided by a strategic outreach plan developed by the Energy & Environmental Research Center (EERC) in collaboration with RTE. Initial activities will focus on team and capacity building. RTE will take the public lead assisted by the EERC as appropriate. The EERC will act to ensure a robust outreach toolkit for support of outreach activities. The EERC will also play a central role in ensuring team communication, robust tracking, and planning and assessment capabilities.

The outreach plan is designed to provide a conceptual and temporal framework for delivering timely accurate information to key stakeholder audiences regarding CCS and carbon capture utilization and storage (CCUS), the current RTE CCS activities, and the long-term potential of RTE CCS in context of CCS/CCUS in general and related activities in the region and beyond.

The plan is designed to mesh with the time lines and activities of the RTE CCS technical program as well as the commercial development program. The plan is designed to function within the local context, provide roles for the project participants, build on the foundation of DOE Best Practices for CCS outreach and on the team's knowledge of the region's social character, as well as its outreach experience, expertise, and capabilities. The plan is a living document that will be updated periodically. Components of the plan include:

1. A central project narrative that portrays context and reason for project, is technically accurate, portrays who is involved, the time line and the possible project outcomes and next steps (i.e., who, what, when, where, and why). The central narrative reflects the considerations of DOE, partners, key stakeholders, and the regulatory and technical aspects of the RTE CCS activities and CCUS in general.

2. A set of outreach strategies that ensure opportunity for engagement across the range of audiences throughout the period of performance and assigns roles to implement, track, and assess the strategies.

3. A set of information formats, venues, and messages in support of the outreach strategies tailored to the concerns and issues of individual audiences and utilizing formats and language appropriate to those audiences.

4. Protocols and capabilities for tracking, reporting, and assessing the outreach materials and activities and assessing impact.

IMPLEMENTATION GUIDELINES

RTE CCS outreach will function under the following guidelines:

- All partners will work from a single consistent narrative-derived message on goals, activities, outcomes, and benefits (consensus based content developed by the EERC and approved by RTE and other partners).

- Partners are free to stress different individual talking points around benefits consistent with individual company goals/objectives but need to maintain accommodate these within and maintain the integrity of the central consensus-based project narrative.

- The outreach team will develop and regularly update consistent talking points regarding the project itself and our partnership to ensure a consistent narrative/message.

- All press releases and public statements will come from materials that have been reviewed and approved by the outreach team and approved by partners; statements/products will be shared on a timely basis.

- Outreach will be augmented by a Talking Points Document (project explanation, dates, time frame, scope of work, objectives, benefits, next steps, etc.), fact sheets and FAQs, and other aids such as approved PowerPoint slides for partner use in public and internal presentations.

- Basic information will be online (and tracked and assessed) at the RTE CCS Web page on the EERC's PCOR Partnership Web site as well as pages for the RTE LLC Web site.

- Dropbox or ftp folder housing all materials to share among the partners.

- Periodic internal review and assessment of the outreach program in light of measures of success.

- Quarterly progress updates to partners and customers/members/regulators.

PROJECT PARTNERS

RTE, the client, and project-site host will be the primary face of the project at the local level. The EERC, as technical lead, will play a supporting role on the local level and a more prominent role with respect to interaction with technical audiences and the regulatory community as well as informing the RTE outreach team on technical issues. Other partners and technical groups will play roles as assigned by the consensus-based outreach plan.

AUDIENCES

The RTE CCS outreach plan defines seven basic audiences: industry, media, officials, educators, public, technical groups, and environmental nongovernment organizations (NGOs). A preliminary breakdown for audiences and subgroups is below. This list is a starting point for determining how much and what type of outreach for each of the potential stakeholder audiences:

1. Project Partners Consist of Four Groups
   a. Project Partners – Managers/Board
      i. Managers Working with Project on Outreach
      ii. Other Notable Personnel
      iii. Board of the Partner Company
   b. Project Partners – Employees
      i. Current Employees
      ii. Retired Employees
   c. Project Partners – Customers/Members
      i. Partner Customer/Members (in case of a cooperative) or Customer Base Arranged by category of Relationship, Method of Engagement etc.
   d. Project Partners – Industry
      i. Industry Sector Peers (e.g., other ethanol plants, grower associations, advocacy groups) by Category

2. Media Consist of Four Groups
   a. Print Media
      i. National
      ii. Regional
      iii. Local
   b. Radio
      i. National
      ii. Regional
      iii. Local
   c. Television Media
      i. National
      ii. Regional
      iii. Local
   d. Web Media
      i. Project Partners

ii. Media
iii. Community Facebook
iv. Independent Bloggers

3. Officials Consist of Two Main Groups Elected and Nonelected at Several Jurisdiction Levels
   a. Elected
      i. National
      ii. State
      iii. County
      iv. Municipal
   b. Regulatory
      i. Federal
      ii. State
      iii. County
      iv. Local

4. Educators Are Grouped by Geographic Area
   a. Regional
   b. State
   c. Local
   d. Extension

5. General Public Is Divided by Geographic Area and Can Be Further Subdivided
   a. Regional
   b. State
   c. Local
   d. Project Area

6. Technical Groups Are Subdivisions of the Energy and CCUS (carbon capture utilization and storage) Technical Community
   a. DOE Regional Carbon Sequestration Partnerships (RCSPs, such as the EERC's Plains CO_2 Reduction [PCOR] Partnership)
   b. International Energy Agency Greenhouse Gas R&D Programme (IEAGHG)
   c. Others

7. Environmental NGOs Are Divided by Geographic Area, Subdivided by Focus etc.
   a. International
   b. National
   c. Regional
   d. State
   e. Local

OUTREACH NARRATIVE, THEMES, AND MESSAGES

Having a single coherent story is essential to create an effective, informed team that can act as knowledgeable spokespeople for the project. The story needs to be consistent whether presented as a one-sentence sound bite, a paragraph synopsis, or a project fact sheet. The messages are intended to be a foundation for expansion and customization as needed over the course of the project. Below is an example of the sound bite sentence.

RTE CCS Sound Bite
Product 1 (Version 1)
The RTE CCS effort is looking to address environmental concerns and strengthen the local economy by investigating the feasibility of and business case for secure, permanent, geologic storage of carbon dioxide from ethanol production.

Appendix D1 contains example text for paragraph and one-page detailed descriptions of the project as well as related considerations and corresponding themes/messages useful for telling a consistent project story. These are organized in the following tables:

Table D1-1. High-Level Considerations and Outreach Attributes
Table D1-2. High-Level Societal Considerations for RTE CCS Attribute
Table D1-3. Stark County Development Plan Considerations and RTE CCS Attribute
Table D1-4. Stark County Development Plan (Natural Resources Section) Considerations and Project Attributes

AUDIENCE ENGAGEMENT STRATEGIES

Approximately 20 outreach strategies are proposed for the RTE CCS effort. The strategies cover seven audiences and offer opportunities for engagement over the multiyear course of the effort. The audiences represented in Appendix D2 Tables D2-1–D2-7 and include the following:

Table D2-1	Project Partner and Peer Audiences
Table D2-2	Media Audiences
Table D2-3	Elected and Regulatory Officials
Table D2-4	Educators
Table D2-5	General Public
Table D2-6	Technical Groups
Table D2-7	Environmental NGOs

These strategies will be used as a basis to populate the outreach time line. *Note: more detailed description for select strategies and individual campaigns related to specific activities on the time line will be developed in future phases based on this framework.*

OUTREACH TOOLKIT

A list of outreach materials to be used in support of the outreach strategies described in Appendix D2 is attached in Appendix D3 (Table D3-1). The toolkit materials incorporate the outreach themes and messages from Appendix D1 and are geared as appropriate to fit the needs of individual audiences described above.

OUTREACH TIME LINE

Outreach activities should coordinate with and, in many cases, precede technical activities (ideally by 3–4 months) in order to provide timely information, maintain transparency, and establish trust with target audiences. Outreach should also anticipate and continually prepare to meet the information needs of target audiences. To accomplish this, the preliminary time line illustrated in Figure D-1 superimposes outreach activities (orange) on key technical aspects of the effort (yellow) and relevant external events (blue).

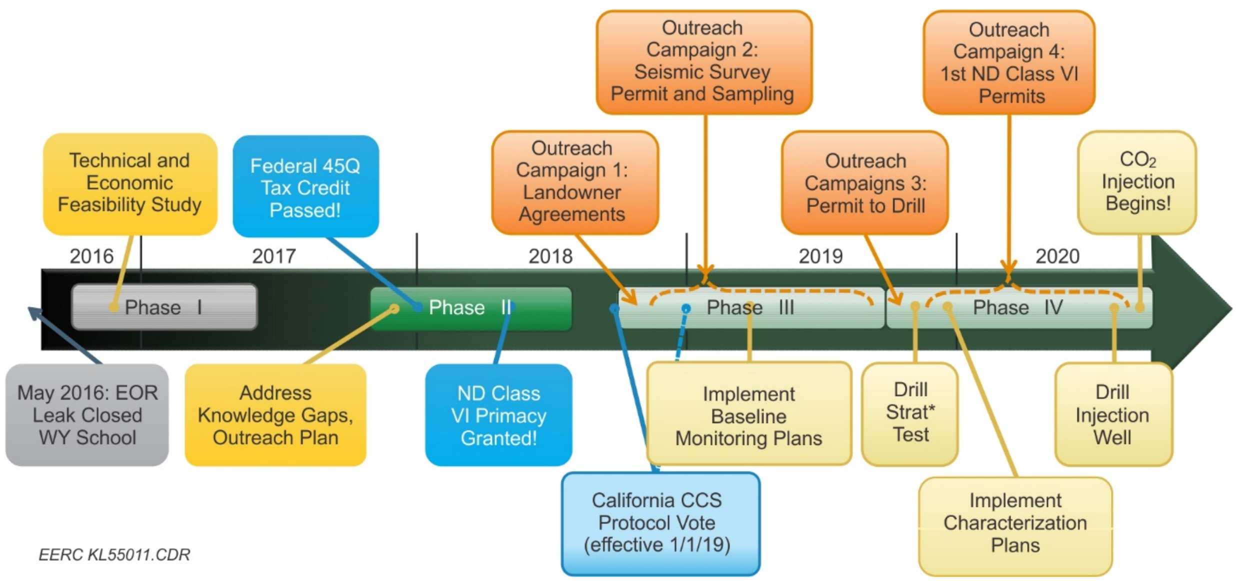

Figure D-1. Rudimentary time line of outreach activities in relation to technical activities and other relevant events (*stratigraphic test).

Where appropriate, the outreach time line will be organized into campaigns that match key technical project, regulatory, market, or business actions. A continuous time line over the three stages of CCS operations is recommended: 1) baseline or preinjection, preceding any permitting or landowner discussions; 2) operational, during injection; and 3) postinjection, during site monitoring through certification of project completion (i.e., transfer of liability to the state of North Dakota). The time line is, therefore, a living or open document that will be revised and updated as needed in consultation with project managers, advisors, and partners. A preliminary outline is provided in Appendix D4 (Table D4-1).

TRACKING AND ASSESSMENT: THE OUTREACH EVALUATION PROCESS

Assessing the effectiveness of communication to reach the targeted audience and generate a positive response is critical to the success of any outreach campaign. The assessment attempts to determine whether the target audience heard the message, how the message was perceived, and what changes in the audience resulted. Evaluation also facilitates continued improvement to materials and guidance for ongoing and/or future activity development.

For the RTE CCS outreach effort, all outreach activities and materials will be conceived of, developed, distributed or implemented, and evaluated within the formal evaluation process. The components of engagement strategies and outreach products (described in the toolkit) will be individually documented, characterized, and evaluated against defined measures of success. Feedback and lessons learned will be incorporated into product updates and/or subsequent events and activities.

As shown in Table D-2, the evaluation process involves three steps[1]:

- Inputs – What happens before and during the activity by the project team?
- Outputs – What is delivered, when/where/how, and to whom (target audience)?
- Outcomes – What are the results of outreach on target audiences?

Inputs – Outreach Planning and Production

Inputs cover all the pertinent information and action required to create materials and/or develop activities for a particular outreach campaign (e.g., planning materials for an open house and holding the open house). Inputs thus take the form of any discussions within the EERC team, as well as with RTE representatives. They include the research and development of materials and/or an activity concept. The manner in which materials are disseminated and activities executed is also an important component of the inputs step.

Once public outreach is initiated, the inputs step will incorporate a feedback element. Feedback solicited during and following presentations and for individual outreach products as part of the outputs step and assessed in the outcomes step (discussed further in the sections below) will be used as inputs for subsequent campaigns. These inputs are evaluated with other lessons learned and may be used to update materials and/or improve activities and overall messages. Proper record keeping and data management at this step are imperative to reference decisions made on research results, discussions, and lessons learned from previous outreach campaigns.

[1] Macnamara, J., 2016, PR Measurement Summit 2016—Jim Macnamara's Keynote Speech Presentation. www.slideshare.net/CARMA_Global/pr-measurement-summit-2016-jim-macnamaras-keynote-speech-presentation (accessed April 30, 2018).

Table D-2. RTE Outreach Evaluation Process for Each Campaign or Action

Steps	Content	Method/Action	Examples
Inputs	Product(s)/material(s) development and production, activity conception and execution	Research audience(s), create and produce materials, develop and implement activities (incorporating any lessons learned from previous campaigns)	Discussions with team, advisors, and stakeholders (including program experience); data management of material/activity versions
Outputs	Product distribution, activity reach	Track number and location of products/activities, types of audiences exposed and reached, etc.	Track Web visits, news stories, product distribution, presentations, etc.; record feedback; quarterly review and reporting
Outcomes	Impact on audience knowledge or outlook	Evaluate changes in knowledge/outlook	Assess knowledge level and nature (positive/negative) of news stories, feedback, etc.; develop lessons learned for future outreach

Outputs – Tracking and Documentation

Once an outreach campaign has been executed, the outputs step involves documenting and categorizing all strategies to reach and educate the intended audience. Categories include documenting the development path, update history, distribution or degree of visibility and, in select cases, outcomes. The EERC outreach team has an established three-pronged system of tracking outreach responses: direct feedback from targeted audiences during or following a campaign, external media occurrences, and online social media activities. The breadth and depth of tracking RTE CCS outreach efforts will be determined in discussion with RTE during the inputs step.

Direct tracking uses standardized forms that describe the action, event, or activity of an outreach campaign; list the products distributed; characterize the audiences; and compile any immediate feedback received. Feedback can be obtained from interviews with field staff regarding public interaction and direct responses from audiences through feedback forms, comment cards, and meeting minutes (e.g., classroom sessions, presentations). All data collected are stored in an isolated outreach-tracking database that produces standardized reports. The tracking software has a geographic information component (i.e., GIS) to generate thematic maps that display outreach activities by region. If deemed appropriate by the EERC–RTE team, results could also be placed within the regional context developed during the PCOR Partnership Program.

Media coverage is defined as reports or articles related to the RTE CCS effort covered on external outlets such as television or radio or found in newspapers or magazines, including both print and online news sources. Nikki Massmann, EERC Director of Communications, will track information on media releases, inquiries, stories, and interviews and gather information on the character of the response.

An RTE CCS project Web page is currently hosted on the EERC's PCOR Partnership Web site. For the EERC's Web pages, Google Analytics Universal is used to track and assess Web activity. This no-cost Google product provides standardized data analysis on user interaction and is capable of limited customized research. Social media posts from the EERC and RTE will also be incorporated into the database.

Outcomes – Assessment of Impacts on Audience Attitudes or Behaviors

The final step of the outreach evaluation process is outcomes, which assesses the outputs tracked and, therefore, the success of the outreach campaign. Outcomes consider the target audience's frequency and level of engagement, as well as the quality of interaction and feedback. These results are then evaluated against established measures of success, as shown below:

- Neutral to positive public results among stakeholder groups based on qualitative and semiquantitative feedback obtained from the outputs step.
- Overall neutral to positive coverage by media based on content assessment of published stories and radio/television pieces.
- Maintaining a continual level of communication about the project through primary (direct interaction with audiences) and secondary pathways (e.g., number, content, and frequency of news media print stories).
- Positive assessment of outreach performance during period reviews from the project partners, managers, and advisors.

Lessons learned will be generated from the results of this assessment by the outreach team, to be shared and discussed with the project team and RTE. As mentioned previously, these findings will be then used to improve materials, activities, and/or overall messages for subsequent outreach campaigns. All results will be stored in the isolated outreach data management system.

It is important to note that the EERC's outreach approach is focused on exposing stakeholders to information, characterizing the distribution of the information, and using qualitative informal measures to assess the state of outreach. In keeping with this approach, the EERC currently does not plan to define an opinion baseline or assess attempts at information transfer overall or for an audience segment within a particular stakeholder group or area. If it is deemed pertinent by the EERC–RTE team to establish a formal baseline through surveys or focus groups and measure impact, that will be discussed by the team during the input step of an outreach campaign.

APPENDIX D1

OUTREACH NARRATIVE, THEMES, AND MESSAGES

OUTREACH NARRATIVE, THEMES, AND MESSAGES

OUTREACH NARRATIVE CONTENT

RTE CCS Sound Bite
Product 1 (Version 1; DRAFT)

The RTE CCS effort is looking to address environmental concerns and strengthen the local economy by investigating the feasibility of and business case for secure, permanent, geologic storage of carbon dioxide from ethanol production.

RTE CCS One-Paragraph Description
Product 2 (Version 1; DRAFT)

The Red Trail Energy (RTE) carbon capture and storage (CCS) research project is investigating the integration of CCS with RTE's ethanol facility near Richardton, North Dakota. This combination has the potential to reduce net CO_2 emissions and increase the value of RTE's ethanol when sold in states with low-carbon fuel programs. The Broom Creek Formation, a thick sandstone layer located approximately 6400 feet directly below the Richardton facility, is the target injection zone for potential geologic storage of the CO_2. According to previous studies conducted by the Energy & Environmental Research Center (EERC) in Grand Forks, North Dakota, this formation is well suited to safely and permanently store all of RTE's fermentation-generated CO_2 deep underground. The EERC manages the project with support from the North Dakota Industrial Commission Renewable Energy Program, the U.S. Department of Energy, and RTE; other technical partners include Trimeric Corporation, Schlumberger Carbon Services, and Computer Modelling Group. For more information, contact Charles Gorecki, Director of Subsurface R&D, EERC, cgorecki@undeerc.org, 701-777-5355; or Dustin Willett, Chief Operating Officer, RTE, dustin@redtrailenergy.com, 701-974-3308.

RTE CCS One-Page Detailed
Product 3 (Version 1; DRAFT)

1. The Red Trail Energy (RTE) carbon capture and storage (CCS) research project is investigating the feasibility of integrating CCS with RTE's ethanol facility near Richardton, North Dakota. Utilizing CCS has the potential to reduce net CO_2 emissions and increase the value of RTE's ethanol when sold in states with low-carbon fuel programs.

2. CCS is the practice of capturing CO_2 emissions from an industrial facility before they are released to the atmosphere and then transporting the CO_2 to a site for secure, permanent storage deep underground. Commercial technologies to capture CO_2 emissions from the fermentation process already exist, and commercial CO_2 injection is currently practiced in 150 locations in the United States alone.

3. The RTE CCS research project is looking at the technical and business cases for implementing CCS at the Richardton facility. A 6-month feasibility study undertaken from late 2016 to spring

2017 showed promising results of technical and economic viability. The current phase of research will further refine the regulatory, processing, and financial requirements for CCS implementation, improving the pathway toward commercial success.

4. The technical investigation was focused on determining the compatibility of the Richardton facility to CO_2 capture technology and an initial assessment of the geology deep underground beneath the facility. The business investigation is focused on determining if the estimated capital and operation costs balance against the potential increased revenue that a lower-carbon ethanol may generate.

5. Geologic CO_2 storage requires a deep porous layer to hold the CO_2 and overlying impermeable rock layers as seals. According to previous studies conducted by the Energy & Environmental Center (EERC), the area has geology well-suited for secure, permanent CO_2 storage. The Broom Creek Formation, a thick sandstone layer located approximately 6400 feet directly below the Richardton facility, is thus promising as a storage target. This layer is thus being considered in the RTE investigation to safely and permanently store RTE's fermentation-generated CO_2 deep underground.

6. The EERC in Grand Forks, North Dakota, manages the project with support from the North Dakota Industrial Commission Renewable Energy Program, the U.S. Department of Energy, and RTE. Other technical partners in this research include Trimeric Corporation, Schlumberger Carbon Services, and Computer Modelling Group.

7. The Phase II project will run from November 2017 to July 2018. If results are promising, the next phase of research would include drilling at the RTE site to collect core samples from the target formation and overlying seals for a detailed investigation of the potential CO_2 storage complex.

8. For more information, contact Kerryanne Leroux, project manager, EERC, kleroux@undeerc.org 701-777-5013; Charles Gorecki, Director of Subsurface R&D, EERC, cgorecki@undeerc.org, 701-777-5355; or Dustin Willett, Chief Operating Officer, RTE, dustin@redtrailenergy.com, 701-974-1105.

OUTREACH THEMES AND MESSAGES

Table D1-1. High-Level Considerations and Outreach Attributes

No.	Issue	RTE CCS Outreach Attribute
1	Funding agencies (NDIC, DOE) have state/national-level policy goals, program goals, and legal and technical requirements	Outreach strategy and communication plan put project in global and regional context of CCUS, outreach program based on PCOR Partnership outreach best practices, seamless outreach continuum from PCOR Partnership Program into RTE CCS project.
2	Industry partners have stakeholders, legal requirements, and business interests	Strategy and plan reflects industry partner considerations, positions, and intentions through central consensus-based outreach model featuring collaboration between core EERC outreach project team (Task 2) and Outreach Advisory Board (project partner representatives).
3	Public stakeholders have personal and community-based concerns over economics, safety, and quality of life	Community-based concerns addressed in outreach strategy and communication plan informed by social characterization research of published data and information augmented with audience focus groups and interviews (TBD) and interviews with partner and EERC outreach and technical personnel.
4	Audiences have differences in geographic distribution, relation to project, concerns, and engagement styles	The outreach strategy and communication plan is designed to address concerns for each group using timing, formats, language, and approaches that optimize the potential for exposure to, and uptake of, the project information
5	The 2-year project arc contains a number of public activities (e.g., field activities)	The outreach plan is designed to be proactive and to establish and maintain relationships with partners and public stakeholder audiences from project inception, through field activities, and through the announcement of results.
6	Feasibility project may be the first step in a multiyear process leading to a commercial-scale venture (or not)	The outreach plan provides a foundation for follow-on outreach related to future CCUS project phases, if warranted.

Table D1-2. High-Level Societal Considerations for RTE CCS Attribute

No.	Issue	Project Attribute (sample theme/message)
1	Societal desire for sustainable transportation fuel	Projects like the RTE CCS effort not only reduce emissions at the processing facility but in a lower carbon footprint on the road as well, making an already-clean fuel even more environmentally friendly.
2	Societal desire for low-carbon fuel (conventional pollutants, CO_2)	Projects like RTE CCS are important to proactively demonstrate the viability of reducing CO_2 emissions from ag processing facilities.
3	Potential for federal CO_2 emissions control regulations	Projects like RTE CCS are important to proactively demonstrate the viability of reducing CO_2 emissions from ag processing facilities.
4	Potential for more stringent air quality regulations (conventional pollutants)	Projects like RTE CCS are important to proactively demonstrate the practical viability of reducing CO_2 emissions from human activities at ag processing facilities. Projects like RTE CCS not only reduce emissions at the processing facility but in a lower carbon footprint on the road as well, making an already-clean fuel even more environmentally friendly.
5	Groundwater protection	Groundwater is a precious resource for agriculture and communities and industry in North Dakota, and RTE has a stake in ensuring secure, long-term storage of CO_2 emissions from industrial sources with no impact to groundwater resources.
6	Concern over potential seismic activity	North Dakota is seismically stable, and RTE is working with technical experts and state officials to ensure secure, long-term storage of CO_2 emissions from industrial sources in tune with the local geologic setting
7	Full disclosure by project	RTE CCS is a homegrown project that is dedicated to transparency through ongoing engagement with officials, media, landowners, and the general public.
8	Timely communication by project	RTE CCS is a homegrown project that is dedicated to a timely communication through ongoing engagement with officials, media, landowners, and the general public.
9	Project decision making process	RTE CCS is a homegrown project that is dedicated to a timely and transparent process with clear decision points shared through ongoing engagement with officials, media, landowners, and the general public.
10	Local economic conditions	RTE CCS is a homegrown project that supports the continued viability of the ethanol industry in the county, state, and region.
11	Project siting issues	RTE CCS is a homegrown project that is working in collaboration with state and local officials to ensure an open win-win process for landowners and the general public for CO_2 capture, transport, and storage facilities.

Table D1-3. Stark County Development Plan Considerations and RTE CCS Attribute

No.	Stark County Plan Themes	RTE CCS Attribute
1	Effectively plan for and manage growth	Twenty-five year operation plan and plan for subsequent long-term monitoring/stewardship
2	Efficient use of public lands	NA
3	Retain the viability of agricultural activities	Subsurface resource development with minimal surface footprint
4	Identify and promote economic opportunities	Builds on a new subsurface resource and emerging market opportunity to add value to supply and process chain for locally produced agricultural commodity and helps ensure viability of a local industry
5	Identify, preserve, and promote the wise use of natural resources	Builds on a new subsurface resource and emerging market opportunity to add value to supply and process chain for locally produced agricultural commodity and helps ensure viability of a local industry
6	Protect and enhance the environment	Reduces the impact to the atmosphere in North Dakota in a secure, sustainable manner (back up with data from life cycle analysis; operation design; and monitoring, verification, and accounting)
7	Partner with the cities, state and federal governments in the provision of recreational opportunities	NA
8	Ensure consistency with other planning processes	Coordinating with all appropriate government agencies and regulatory bodies at all levels: federal, state, county, and municipal
9	Ensure adequate provision of public facilities and services	NA
10	Preserve historic, cultural, and archaeological resources	NA

Table D1-4. Stark County Development Plan (Natural Resources Section) Considerations and Project Attributes

No.	Stark County Plan Requirement	RTE CCS Attribute	Comments
A	A1. Stark County is fortunate to have abundant natural resources—coal, oil, gas, wind, uranium—with current and potential future development.	A1.1. Pore space is a newly recognized natural resource. A1.2. Pore space is a subsurface geologic resource like coal, oil, and natural gas, albeit regulated separately from mineral rights. A1.3. Pore space adds value to the land.	
	A2. It also has a delicate watershed system and soils conducive to erosion.	A2.1. …and groundwater resources (not mentioned here) that are intimately tied to surface water.	
	A3. The stewardship of natural resources often results in polarized opinions.	A3.1. True – want win-win solutions.	
	A4. All acknowledge the need to protect our natural resources.	A4.1. True – want win-win solutions.	
	A5. Technologies need to be developed that meet human population and economic needs in such a manner that allows the environment to sustain and regenerate its resources.	A5.1. Development/use need to be win-win; need to have a fair cost/benefit to society and environment. A5.2. Development needs to allow environment to sustain and regenerate (no impact or acceptable impact to "resources"). A5.3. Developers need to define resources with the county (and other stakeholders) and work from there. *Aside – Heavy on the environmental side (what about society?)*	
B	B1. Goal: Encourage the wise and proper use or development of the county's natural resources.	B1.1. Pore space is the resource that we want to develop. B1.2. Regulations are in place for the ownership and "leasing" and "use" of the pore space. B1.3. Regulations are in place for the development and operation of the systems to utilize the pore space. B1.4. Regulations are in place to make remuneration for problems to pore space owners. B1.5. Regulations are in place to address environmental and safety issues from the operation of the permanent storage site.	

Table D1-4. Stark County Development Plan (Natural Resources Section) Considerations and Project Attributes (continued)

No.	Stark County Plan Requirement	RTE CCS Attribute	Comments
C	C1. Recognize the potentials and capabilities of the land and its uses, particularly in regard to natural resource development.	A1.1. Pore space is a newly recognized natural resource. A1.2. Pore space is a subsurface geologic resource like coal, oil, and natural gas, albeit regulated separately from mineral rights. A1.3. Pore space adds value to the land (new revenue stream for landowners).	
	C2. Maintain Stark County's clean and favorable environment.	A5.1. Development/use need to be win-win; need to have a fair cost/benefit to society and environment. A5.2. Development needs to allow environment to sustain and regenerate (no impact or acceptable impact to "resources"). B1.3. Regulations are in place for the development and operation of the systems to utilize the pore space. B1.4. Regulations are in place to make remuneration for problems to pore space owners. B1.5. Regulations are in place to address environmental and safety issues from the operation of the permanent storage site.	• Minimal surface footprint. • Deep underground; does not interact with surface or near surface. • Potential impacts are nonhazardous and readily mitigated.
	C3. Discourage the misuse of productive agricultural land.	A5.1. Development/use need to be win-win; need to have a fair cost/benefit to society and environment. A5.2. Development needs to allow environment to sustain and regenerate (no impact or acceptable impact to "resources"). B1.3. Regulations are in place for the development and operation of the systems to utilize the pore space. B1.4. Regulations are in place to make remuneration for problems to pore space owners. B1.5. Regulations are in place to address environmental and safety issues from the operation of the permanent storage site.	• Minimal surface footprint. • Deep underground; does not interact with surface or near surface. • Potential impacts are nonhazardous, and readily mitigated.

Continued . . .

Table D1-4. Stark County Development Plan (Natural Resources Section) Considerations and Project Attributes (continued)

No.	Stark County Plan Requirement	RTE CCS Attribute	Comments
C	C4. Preserve adequate quantities and quality of ground and surface water supplies.	A5.1. Development/use need to be win-win; need to have a fair cost/benefit to society and environment. A5.2. Development needs to allow environment to sustain and regenerate (no impact or acceptable impact to "resources"). B1.3. Regulations are in place for the development and operation of the systems to utilize the pore space. B1.4. Regulations are in place to make remuneration for problems to pore space owners. B1.5. Regulations are in place to address environmental and safety issues from the operation of the permanent storage site.	• Minimal surface footprint. • Deep underground; does not interact with surface or near surface. • Potential impacts are nonhazardous and readily mitigated.
D	D1. Stark County supports the establishment of county natural, recreational or historical preservation areas.	NA	
	D2. Stark County supports proper planning for impacts resulting from, coal, oil, natural gas, wind, uranium, or other natural resource development.	A1.1. Pore space is a newly recognized natural resource. A1.2. Pore space is a subsurface geologic resource like coal, oil and natural gas or groundwater.	
	D3. Stark County supports the prohibition of mining activities within a 2-mile radius of the jurisdictional limits of any incorporated city within the county.	D3.1. This resource activity will occur within the jurisdictional limit of Richardton. D3.2. The resource development is occurring over a mile beneath the surface. D3.3. The low-level adverse risk resulting from the resource development will be well controlled and will naturally decrease over time (plume will move away from the jurisdiction).	Will (did) the facility receive an exception or statement of support with caveat from the County Commission? On what grounds?
	D4. Stark County supports an inventory and reclamation program aimed at abandoned coal and uranium mines and barrow pits in the county.	NA	Does the county require (or is it in our interest to offer) to have this site on GIS and described in inventory?

Continued . . .

Table D1-4. Stark County Development Plan (Natural Resources Section) Considerations and Project Attributes (continued)

No.	Stark County Plan Requirement	RTE CCS Attribute	Comments
D	D5. Stark County supports the preservation of open spaces and natural features in private and public developments.	NA	Will RTE take a minimalist approach to the appearance of the site that would facilitate acceptance?
	D6. Stark County supports the identification of and protection of available and potential sources of surface and groundwater.	D6.1. Groundwater resources have been a focus of the paper studies done to date in the prefeasibility investigations. D6.2. Field activities in a Phase III (next step) will complete the characterization of the water resources (surface and subsurface), risk from development, and the strategies (MVA) available to mitigate risk of impact or the impact themselves, should they occur.	• Minimal surface footprint. • Deep underground; does not interact with surface or near surface. • Potential impacts are nonhazardous, and readily mitigated.
	D7. Stark County supports coordination with the Stark County Water Resources District with respect to drainage issues and new development.	D7.1. RTE CCS project is coordinating with all appropriate government agencies and regulatory bodies at all levels: federal, state, county, and municipal.	
	D8. Stark County supports the identification of prime and unique farmland locations.	NA	

Continued . . .

APPENDIX D2

AUDIENCE ENGAGEMENT STRATEGIES

Table D2-1. Audience Segment – Project Partners and Peer Audiences

	Internal Working Group/Advisory Session	Presentation to Internal Partner Audiences	Partner-Based Social Media, Newsletter, Web Site, or Trade Publication	External Meetings
Project Outreach Advisor (s)	January 16, 2017, internal project kickoff meeting in Richardton Planned Outreach Advisory Board Webinars and meetings over course of the project February 2018 to August 2018 (in future phases if warranted)	–	–	–
Senior Managers	January 16, 2017, internal project kickoff meeting in Richardton Planned Outreach Advisory Board Webinars and meetings over course of the project February 2018 to August 2018 (in future phases if warranted)	–	–	–
Board Members	–	Presentation by EERC technical team member at RTE Annual Meeting 2017; attendance by EERC at 2018 annual meeting (in future phases if warranted)	–	–
Active Employees	–	**Future phase:** Presentation by EERC technical team or RTE managers using Outreach PPT for internal presentations	**Future phase:** Richardton community open house invitations and information blurbs on social media employees	–
Retired Employees	–	–	**Future phase:** RTE – Richardton community open house invitations and information blurbs on social media	–
Cooperative Member/ Consumers	–	Presentation by EERC technical team member at RTE Annual Meeting 2017; attendance by EERC at 2018 annual meeting (in future phases if warranted)	**Future phase:** RTE – Project summary to members using newsletter or social media RTE – Richardton community open house invitations and information blurbs on social media – RTE to employees	–
Industry Peers	–	–	**Future phase:** RTE or EERC social media updates to industry peers on monthly basis	**Future phase:** EERC or RTE presentation to annual ethanol industry meeting such as North Dakota Ethanol Council, Renewable Fuels Association, National Corn Growers EERC or RTE presentation to PCOR Partnership Annual Meeting (starting 2017) (in future phases if warranted)

Table D2-2. Audience Segment – Media

	Outbound from Project EERC Press Release, Media Advisory	Response/Inbound from Media Interview with Media; Media Site Visit, Media News Story	Outbound from Project EERC/Partner News Article, Announcement Op Ed
Print News Media	• EERC press release or media advisory (or partner press release or advisory) for Phase I project funding (8/9/16) • EERC press release or media advisory (or partner press release or advisory) for Phase II project funding (12/21/17) **Future phase:** • EERC press release (or partner press release or advisory) for any project milestone (field activity, permit, government action, project announcement, etc.)	**Future phase:** EERC/partner response to inquiry (press kit materials)	**Future phase:** For example, community open house paid announcement
Radio News Media	**Future phase:** • EERC press release or media advisory (or partner press release or advisory) for Phase II project funding • EERC press release (or partner press release or advisory) for any project milestone (field activity, permit, government action, project announcement, etc.)	**Future phase:** EERC/partner response to inquiry (press kit materials)	–
Television News Media	**Future phase:** • EERC press release or media advisory (or partner press release or advisory) for Phase II project funding • EERC press release (or partner press release or advisory) for any project milestone (field activity, permit, government action, project announcement, etc.)	**Future phase:** EERC/partner response to inquiry (press kit materials)	–
Web	**Future phase:** Post materials on Web as appropriate	–	Project Web page on PCOR Partnership public Web site in the project section (live since August 2017) (and in future phases if warranted) **Future phase:** Weekly EERC blurbs on EERC social media, e.g., Facebook, Twitter, Instagram, YouTube Partner Web posts, e.g., Web site, Facebook, YouTube
Trade Press	**Future phase:** RTE or EERC articles in industry trade publications	–	–

Table D2-3. Audience Segment – Officials[1, 2]

	One on One, Individual	Testify or Present to Board, Small Group	Presentations to Conferences, Meetings
National Elected	**Future phase:** Letter invitations to project event like community open houses, groundbreaking, announcement	–	–
State Elected	**Future phase:** Letter invitations to project event like community open houses, groundbreaking, announcement	–	**Future phase:** • Attendance and/or booth or presentation at Western Governors, Governor's Ethanol Coalition • Part of EERC-hosted Energizing North Dakota (annual, May)
County Elected	**Future phase:** Letter invitations to project event like community open houses, groundbreaking, announcement	**Future phase:** Project introduction and periodic project updates	**Future phase:** Presentation to county-level conference such as North Dakota Association of Counties
Municipal Elected	**Future phase:** Letter invitations to project event like community open houses, groundbreaking, announcement	**Future phase:** Project introduction and periodic project updates	–
National Regulatory	–	–	–
State Regulatory	**Future phase:** • Inquiries on seismic permits • Inquiries on drilling permits	**Future phase:** • Hearing/testimony/presentation of permit application for seismic • Hearing/testimony/presentation of permit application for drilling/coring	**Future phase:** • Included in annual Regulatory Roundup for regional state oil and gas regulatory hosted by EERC-led PCOR Partnership • Part of EERC-hosted Energizing North Dakota (annual, May)
County Regulatory	**Future phase:** County permit forms	**Future phase:** Permits applications and approvals from counties (drilling)	–
Municipal Regulatory	**Future phase:** Municipal permit forms	–	**Future phase:** Attendance and/or presentation North Dakota League of Cities Conference (annual, September)

[1] Additional primary through EERC blog blurbs sent monthly (includes government officials).
[2] Secondary through news media (radio, television, and print and their Web sites).

Table D2-4. Audience Segment – Educators/Students[1, 2]

	One on One, Individual	Educator Conference Presentations	Classroom Presentations, Site Tours, Displays	Curricula, Classroom Materials
Regional		**Future phase:** Include project materials in presentation at LEC regional teacher workshop (annual, June)	–	–
State		–	–	–
District	**Future phase:** Invitation to community open house events	–	–	–
Local	**Future phase:** • Invitation to community open house events • Contact with local principals and teachers to discuss possible activities	**Future phase:** Provide a teacher session at a state teacher conference	**Future phase:** Presentations, workshops, site tours for classes or individual students	**Future phase:** • Develop local curricula or classroom activity related to the project and involving project personnel as mentors • Student projects mentored by project personnel
Extension	–	–	–	–

[1] Additional primary through EERC blog blurbs sent monthly (includes government officials).
[2] Secondary through news media (radio, television, and print and their Web sites).

Table D2-5. Audience Segment – General Public[1, 2]

	Media, Web Pages, Announcements, Invitations, Local Displays	Community Open House	Presentations to Groups and Social Clubs	Focus Groups
Regional[2]	**Future phase:** Web pages and news media coverage[2]	–	–	–
State[2]	**Future phase:** Web pages and news media coverage[2]	–	–	–
Local[2]	**Future phase:** Individual contact with landowners in association with project technical activities Paid announcement in the local papers regarding community open house; Facebook boosted invitations to local residents Web pages and news media coverage[2]	**Future phase:** Community open house events announcements, event, follow-up news media coverage	**Future phase:** TBD	**Future phase:** TBD
Project Area Landowners	**Future phase:** Focused statements or pieces in news media, Web, etc.	**Future phase:** Targeted meetings for landowners involved in the project activities	–	–

[1] Additional primary through EERC blog blurbs on social media, signage on fieldwork sites.
[2] Secondary through news media (radio, television, and print and their Web sites)

Table D2-6. Audience Segment – CCS and Other Technical Groups [1, 2]

	Contractor Meeting	Presentation or Poster at Technical Conference, Proceedings	Refereed Journal Article	Working Group or Task Force
DOE	Periodic contactor meetings (expected to continue in future phases)	DOE Mastering the Subsurface Review Meeting, Pittsburgh, PA, August 1–3, 2017 (poster) DOE Mastering the Subsurface Review Meeting, Pittsburgh, PA, August 13–16, 2018 (poster) (expected to continue in future phases)	–	Updates on RTE outreach and technical activities to DOE RCSP Outreach Working Group (PCOR Partnership) (status in future phases TBD)
IEAGHG	–	IEAGHG GHGT-14, Australia, November 2018 (future phases TBD)	Carbon Capture and Storage Elsevier – journal article on the project (future phases TBD)	–
NDIC–Renewable Energy Council	RTE Phase I proposal RTE Phase I final report and Phase II proposal (expected to continue in future phases)	Renewable Energy Council Meeting, Bismarck, ND, July 21, 2016 Renewable Energy Council Meeting, Bismarck, ND, October 17, 2016 (future phases TBD)	–	–
State Regulators	• Oregon Department of Environmental Quality (DEQ) • California Air Resources Board (ARB) • NDIC Department of Mineral Resources (DMR) (expected to continue in future phases)	• Private Meetings, DEQ, Portland, OR, December 15, 2016, and March 22, 2018 • Private Meeting, ARB, Sacramento, CA, January 30, 2018 • Private Meeting, DMR, Bismarck, ND, July 7, 2017 (expected to continue in future phases)	–	–

[1] Additional primary through EERC blog blurbs sent monthly (includes government officials).
[2] Secondary through news media (radio, television, and print and their Web sites).

Table D2-7. Audience Segment – Environmental NGOs [1, 2]

	Presentation or Poster at Technical Conference, Proceedings	Working Group or Task Force	Direct Contact/Discussions/Dialogue
International	IEAGHG GHGT-14, Australia, November 2018 (future phases TBD)		
National	IEAGHG GHGT-14, Australia, November 2018 (future phases TBD)	Discussions with environmental NGOs through the DOE RCSP Outreach Working Group (PCOR Partnership) (future phases TBD)	
Regional	IEAGHG GHGT-14, Australia, November 2018 (future phases TBD)		TBD
State	IEAGHG GHGT-14, Australia, November 2018 (future phases TBD)		TBD
Local	IEAGHG GHGT-14, Australia, November 2018 (future phases TBD)		TBD

[1] Additional primary through EERC blog blurbs sent monthly (includes government officials).
[2] Secondary through news media (radio, television, and print and their Web sites).

APPENDIX D3

OUTREACH TOOLKIT

OUTREACH TOOLKIT

The table below contains a list of the types of materials that would be developed. These materials would incorporate the outreach themes and messages to an appropriate degree and be tailored to the target audience identified in the strategy section.

Table D3-1. Summary Listing of Materials in RTE CCS Outreach Toolkit [DRAFT]

Category	Item	Status[1]
	Outreach Components	
Approved Language	Project summary sentence	Draft
	Project summary paragraph	Draft
	Two-page project summary	Draft
Building Blocks	Project logo (TBD)	TBD
	Standard header and footer	TBD
	2-D simplified geologic column graphic	Draft
	Study area map graphic	Draft
	Seismic survey graphic	Final
	3-D simplified geologic column graphic	Draft
	Casing layers graphic (characterization well)	Draft
	Drilling, coring, and logging photographs (characterization well)	TBD
	Before and after site photographs (characterization well)	TBD
	Capture equipment images/schematic	TBD
	CO_2 generation to injection/storage schematic	TBD
	Formal Products	
Fact Sheets	Carbon Capture and Storage for North Dakota Ethanol Production (original)	Final
	Carbon Capture and Storage for North Dakota Ethanol Production (Phase II Update)	Final
	Carbon Capture and Storage for North Dakota Ethanol Production (future phase updates)	TBD
Activity FAQs	Geophysical Survey Other TBD	TBD
Web Content[2]	"CCS for North Dakota Ethanol Production" Web page http://undeerc.org/PCOR/CO2SequestrationProjects/RedTrail.aspx	Final
	Project location map with project fast facts text http://undeerc.org/PCOR/CO2SequestrationProjects/	Final
	UND Today blog entry: http://blogs.und.edu/und-today/2018/03/catch-and-decrease/; also republished in EERC SOLUTIONS electronic newsletter	Final
	Future blog/newsletter articles	TBD
Project Presentations	Technical audience presentation	TBD
	Partner Employee/General Audience presentation slide deck	TBD
	Partner Employee/General Audience presentation script	TBD
	Secondary Classroom presentation	TBD

Continued . . .

Table D3-1. Summary Listing of Materials in RTE CCS Outreach Toolkit [DRAFT]

Community Events	**Event welcome banner**	**TBD***
	Event station title signs	TBD*
	Event directional signs	TBD*
	Sign in sheet	TBD*
Community Events (cont.)	Outreach posters; example topics: • Energy with a Smaller Carbon Footprint • Reasons to Investigate Carbon Capture and Storage • Investigating Geology for CO_2 Storage Potential • Geologic Feasibility – *Evaluating the Character and Performance of the Storage Zone* • RTE CCS – *Investigating Dedicated CO_2 Storage for RTE* • RTE – *Local Project with National Implications*	TBD*
	RTE CCS event handout; example topic: *Investigating Dedicated CO_2 Storage for RTE*	TBD*
Feedback Forms	School classroom and field activities feedback form	TBD*
	Event comment card	TBD*
Field Work	Site signage (sample)	TBD*
	Landowner letter (sample)	TBD*
Social Media	Social media posts to drive content to Web site information about the project	TBD*
	Open house Facebook events	TBD*
	EERC channels: Facebook, Twitter, Instagram, YouTube	TBD*
	RTE channels	TBD*
Video[3]	Video short(s) (examples available in clip library on PCOR Website)	TBD
Media Kit[4]	Items from the above Outreach Toolkit contents selected as appropriate for the request; typically include news releases, project fact sheets, and photos.	TBD

[1] Definition of status categories:

- Final: item has been completed and approved; if appropriate, item may be updated in future phases.
- Draft: item has been discussed; approval/implementation expected as part of future phases.
- TBD: content would be determined based on needs of future phases.
- Templates developed under other projects are available.

[2] Items housed on PCOR Partnership public Web site.
[3] This is a possibility for consideration.
[4] Media kit is customized to fit the request; contains images and background.

APPENDIX D4

OUTREACH TIME LINE

OUTREACH TIMELINE

The outreach time line shown in Table D4-1 is an example. Actual time lines will be populated based on assessment of the particular project phase in consultation with RTE and EERC technical staff and management.

Table D4-1. Sample Time Line for Outreach Activities Related to Drilling a Strat-Test* (see Outreach Campaign 3 in Figure 1)

Month	Technical/Project Actions	Example Outreach Actions
1	Planning meeting(s)	• Hold strat-test planning session: – Review the technical time line – Present draft outreach time line • Discuss and come to agreement on initial plan and time line for strat-test outreach campaign. • Implement agreed outreach plan and time line for the campaign featuring fact sheet(s), slide deck(s), public presentation(s), press release(s), social media updates, a community open house, and drill site tours for select audiences. • Initiate contact with school district to invite teachers to participate in classroom activities and/or drill site tour; prepare a schedule for developing classroom activities that add value to the experience. • Finalize/approve 1-page strat-test fact sheet describing related activities. • Update RTE CCS fact sheet to reflect current project phase for public audiences.
2	State drilling permit prepared	• Schedule presentations: – Stark County Commission – Richardton municipal government – Richardton school principal or school board • Commence community open house preparations: – Logistics – Content for posters, handouts, comment sheets – Designated project personnel (scheduling and travel) • Prepare initial draft materials for open house and drill site signage. • Brief RTE employees (RTE assisted by EERC); use approved slide deck, project fact sheet, and strat-test fact sheet. • Continue to engage teachers interested in classroom activities/drill site tour.

Continued . . .

Table D4-1. Sample Time Line for Outreach Activities Related to Drilling a Strat-Test* (see Outreach Campaign 3 in Figure 1) (continued)

Month	Technical/Project Actions	Example Outreach Actions
3	State drilling permit (minimum of 30 days for approval) submitted	• Give initial presentation (invite to drill site?): – Stark County Commission – Richardton municipal government – Richardton school board/schools • Disseminate press release on the project, the strat-test, presentations, time line, and upcoming community open house. • Finalize open house logistics and materials and drill site signage. • Collaborate with teachers on classroom activities to be carried out in conjunction with the open house and/or drill site tour.
4	State drilling permit process proceedings	• Send community open house invitations: – By letter to key groups (government officials, school officials, community leaders) – RTE employee invitations – Advertisement in the paper • Print final open house materials and drill site signage. • Continue to engage teachers interested in classroom activities/drill site tour.
5	State drilling permit approved Drill site preparation (dirt work, pad installed, equipment installed)	• Hold community open house event: – Materials: posters, handouts, signage, comment sheets – Refreshments – Project personnel at open house stations • Debrief on the event with project personnel and review written comment sheets. • Send out press releases on open house, upcoming drilling, and sampling. • Install site drilling signage.
6	Rig setup, active drilling, geologic sampling, and geophysical logs Drilled hole plugged and pad removed*	• Update drill site signage as drilling progresses. • Provide drill site tours for community leaders, decision makers, and school classes. • Implement classroom activity related to project; debrief project personnel and teachers. • Schedule presentations to county and municipal government. • Disseminate press story on tours and/or school activities; time line for project and when results expected.
7	Results evaluation and reporting	• Schedule update presentation: – Stark County commission – Richardton municipal government

* Assumes a separate site for the monitoring well for example simplicity.