
Red Trail Energy
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Critical Challenges.
Practical Solutions.

Red Trail Energy (RTE) Carbon Capture and Storage (CCS) Project

CCS Technical Workshop 2020

Tokyo, Japan

January 23, 2020

Dustin Willett, Chief Operating Officer
RTE, North Dakota USA

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Outline

- RTE Ethanol Facility
- CCS Drivers
- RTE CCS Project
- Questions

Image Credit: Red Trail Energy

RTE Ethanol Facility

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Red Trail Energy, LLC

Richardton, ND

928 Investors

46 Employees

23 million bushels of Corn

Approximately $350 million of Economic Impact

Over $149 million in Gross Sales

233,000 tons of Coproducts

Coproducts Support 220,000 head of Cattle

64 million gallons of Ethanol

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Investor-Owned since 2007

64-million-gallon-per-year Dry Grind Ethanol Plant:

- Constructed starting July 2005, operating by January 2007
- 180,000–185,000 gallons/day ethanol
- 480–500 tons/day dried distillers grains (DDG's)

Image Credit: Red Trail Energy

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Corn → Ethanol

A bushel of corn weighing 56 pounds:

- 2.82 gallons ethanol (~18.7 pounds)
- 18.0 pounds CO_2
- 18.5 pounds Distillers Grains
- 0.8 pounds Corn Oil

Image Credit: American Corn Growers Foundation

Corn Receiving

- RTE requires 23–24 millions bushels/year corn
- RTE receives corn by truck or hopper rail cars
- The corn receiving system can move 60,000 bushels/hour
- Silos + grind & scalping bin = 1.75 million bushels

Image Credit: Red Trail Energy

Grain Silos and Slurry

Images Credit: Red Trail Energy

Four (4) Fermenters and Beerwell

Vacuum Distillation

Image Credit: Red Trail Energy

Four (4) Centrifuges and Eight (8) Evaporators

Images Credit: Red Trail Energy

Dryers A & B

Dry/Modified Distillers Grains

Images Credit: Red Trail Energy

Staying Cool

Dual Natural Gas Package Boilers

Image Credit: Red Trail Energy

Operating Stations

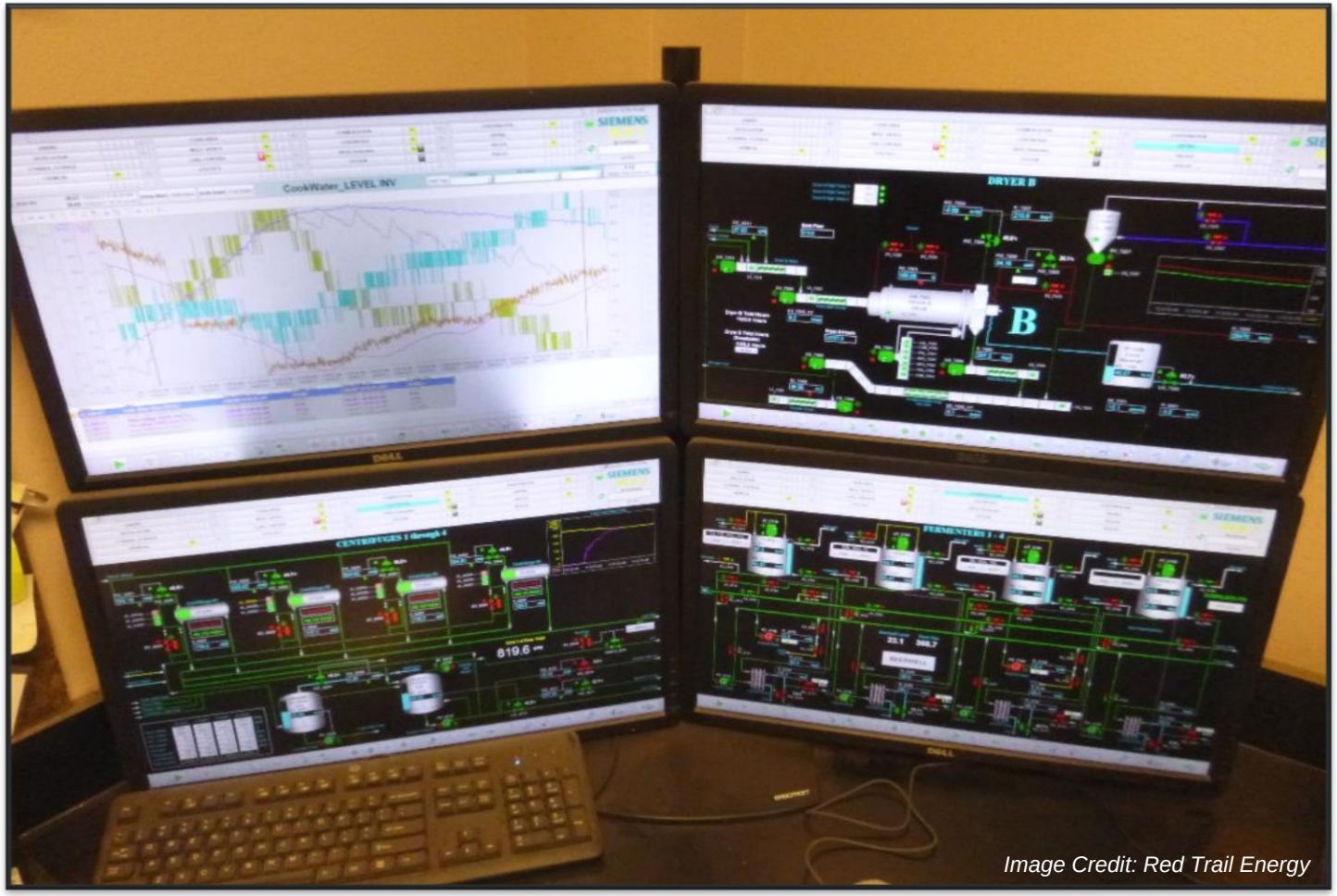


Image Credit: Red Trail Energy

Ethanol Storage

Image Credit: Red Trail Energy

Moving RTE Products by Rail

Images Credit: Red Trail Energy

Fuel Ethanol Stats

Source: Renewable Fuels Association, 2017

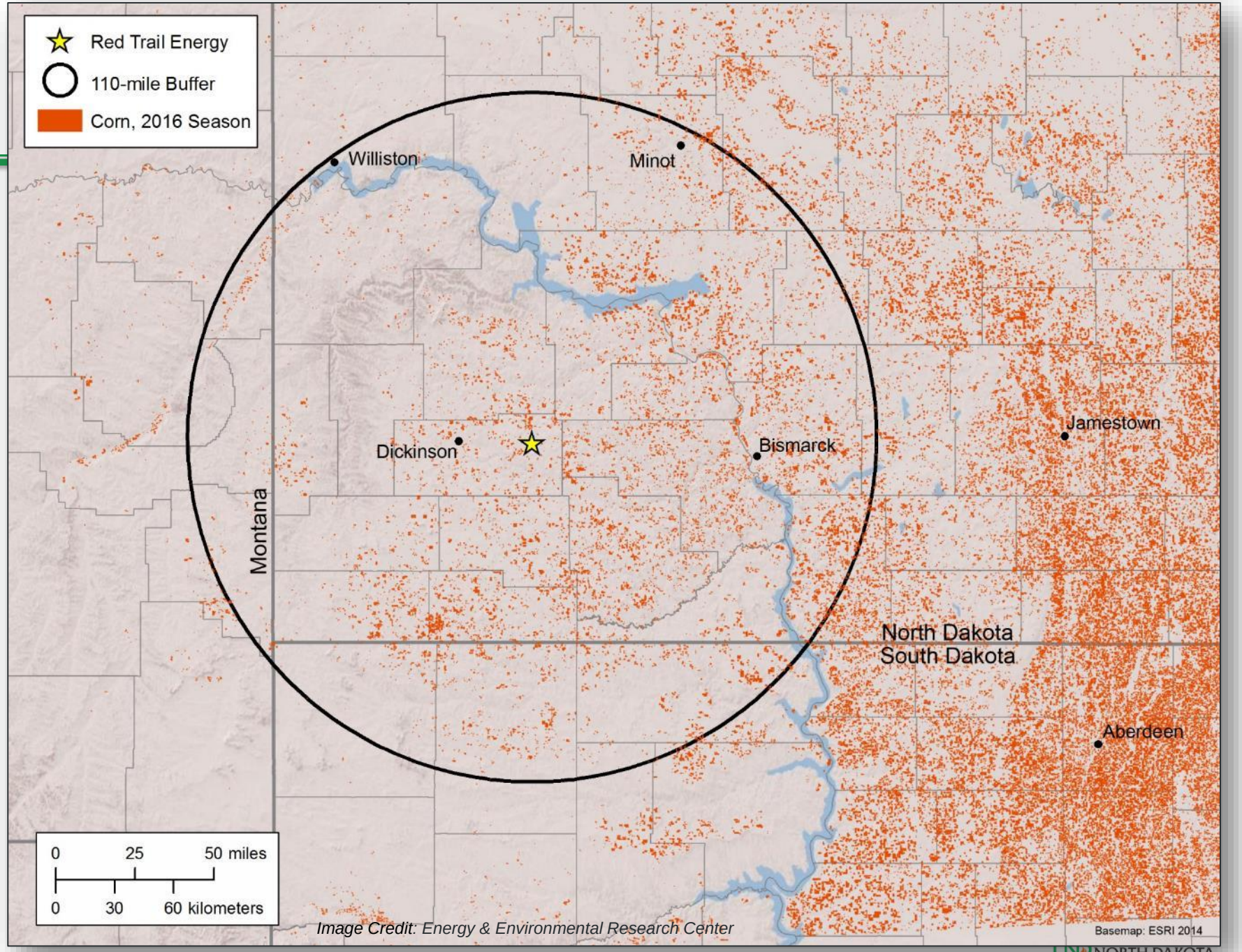
- 90% plants use dry mill process
- 200 US plants, 28 states = 16 billion gallons
  - ➢ ***ND is Top 10 producer***
- US generates 60% global market
  - Exported 1 billion gallons in 2016
  - Canada and Brazil are half market
  - Other leading markets: China, India, Philippines, Peru and South Korea

Image Credit: Red Trail Energy

RTE CCS Drivers

RTE's Growth:

Bound by economics of delivered corn feedstock



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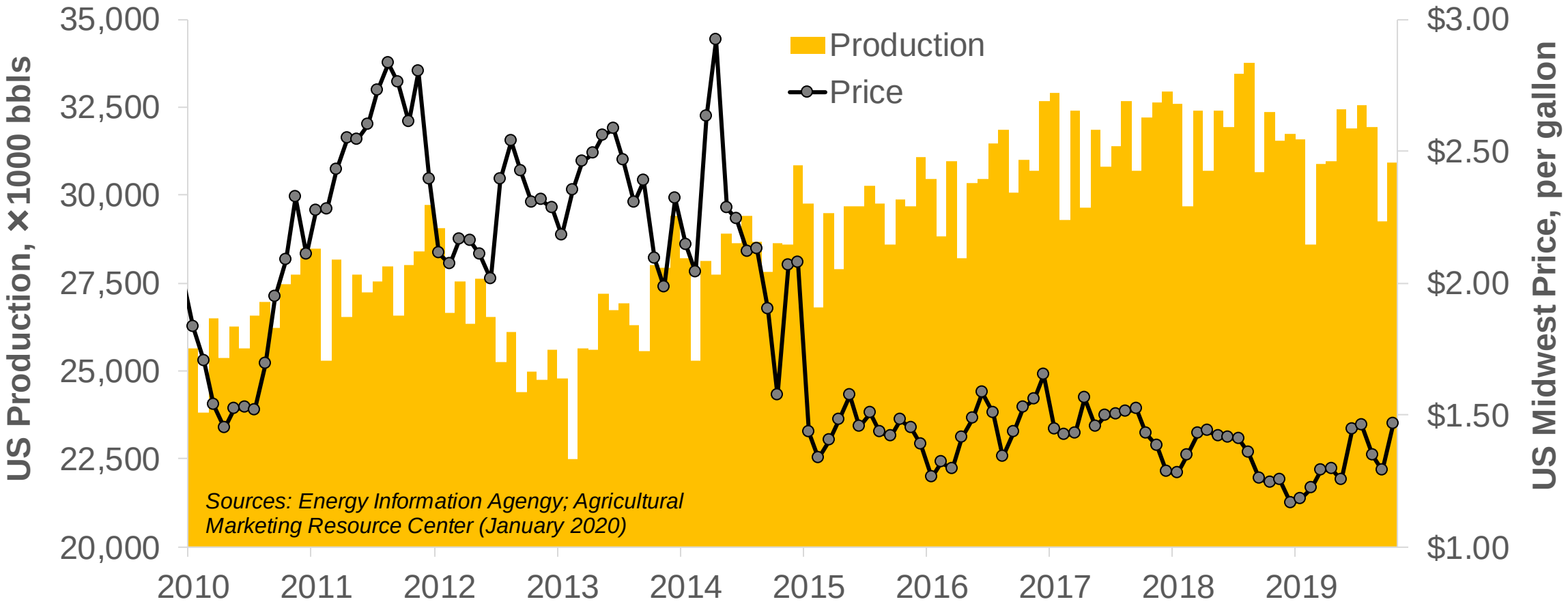
Historic Ethanol Production and Prices



Evolving Ethanol Markets

Low-carbon fuels

- A transportation fuel having a lower “carbon intensity” than conventional petroleum fuels
- Ethanol, Natural gas

Photograph by Lars Plougmann

Low-carbon fuel programs

- California’s Low Carbon Fuel Standard (LCFS)
- Oregon’s Clean Fuels Program
- RTE currently ships ethanol to California, Oregon

Photograph by University of Illinois at Urbana-Champaign

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Lowering the Ethanol Carbon Footprint

- Lower-carbon feedstocks
  - "No-till" agriculture
- Low-carbon business practices
  - Natural gas for production energy (as opposed to coal)
- ***Implementing carbon capture and storage (CCS)***
  - Market advantage over conventional ethanol
  - Applicable for carbon-related US tax credits

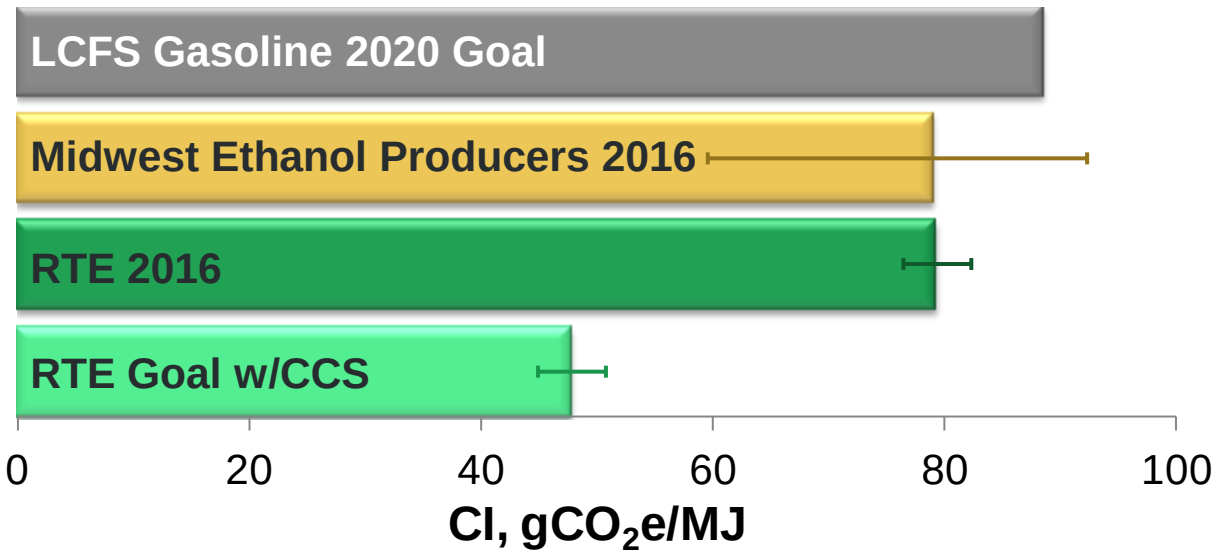
Photographs by Judd McCullum, OpenSource.com, Ishikawa Ken, and Elvis Kennedy,

The CCS Advantage

USA IRS Tax Incentive

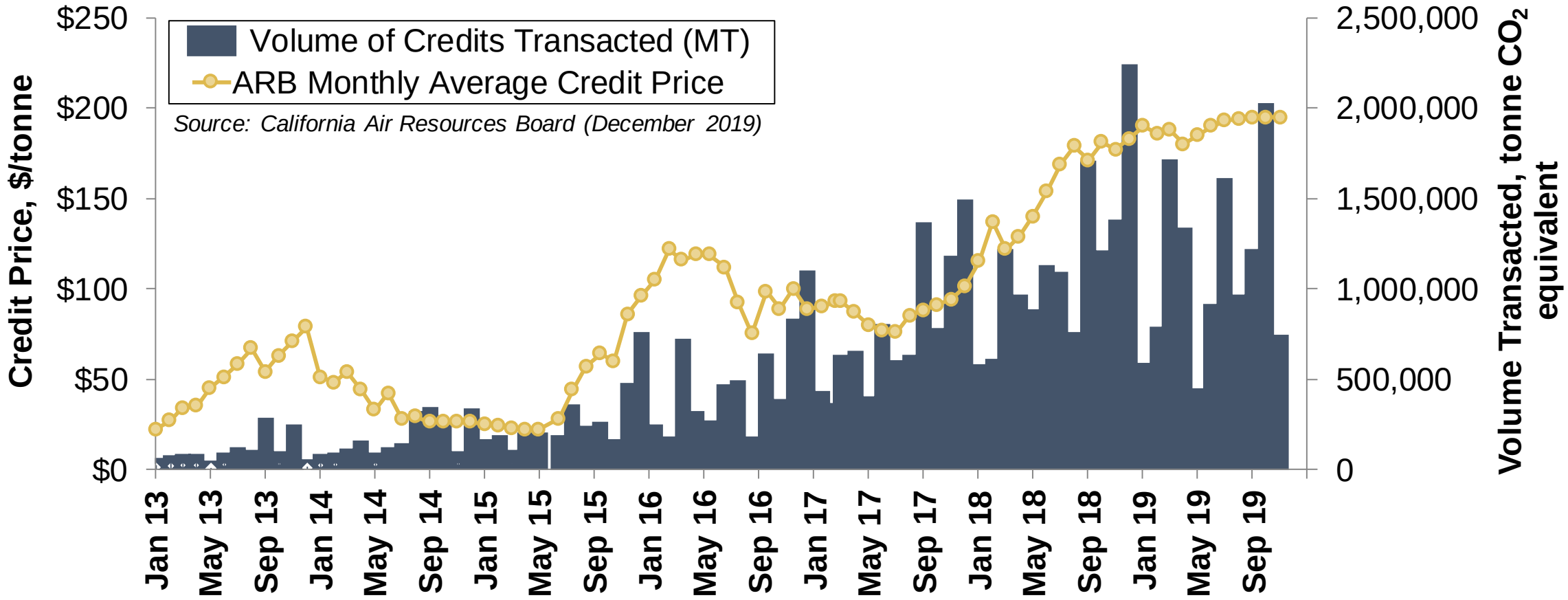
- Up to $50/tonne CO_2 for dedicated storage
- Construction before 2024
- Credits allowable for 12 years.

California LCFS Program: Carbon Intensity (CI) by Fuel Type



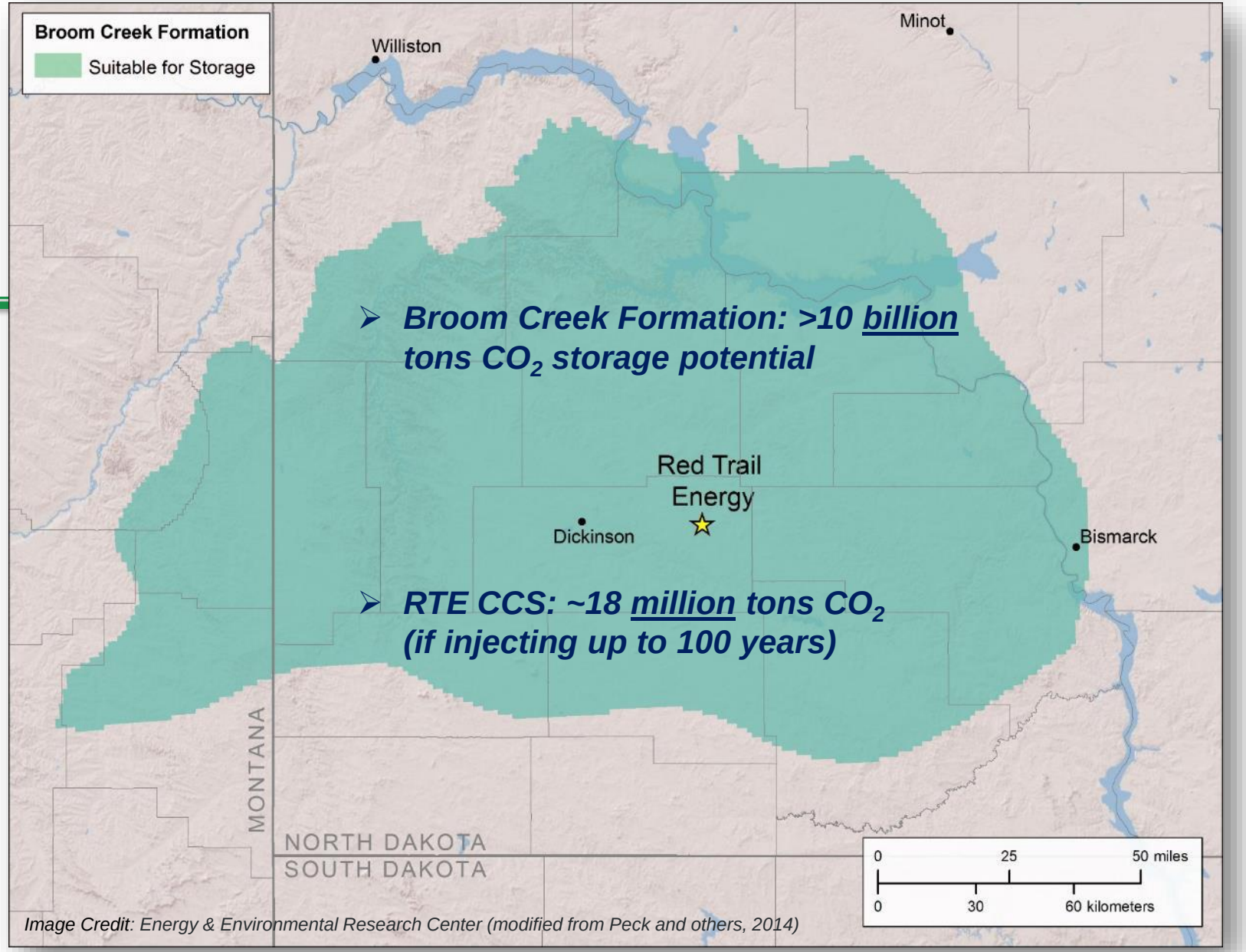
Source: California Air Resources Board (July 2016)

California's LCFS Credit Market



RTE Site: *Excellent CCS Case Study*

- Carbon capture
  - 180,000 tons of CO_2 per year from fermentation
  - Nearly pure CO_2 stream
- Carbon storage
  - Broom Creek Formation
  - 6400 ft directly below RTE facility, ~300 ft thick



➢ ***Broom Creek Formation: >10 billion tons CO_2 storage potential***

➢ ***RTE CCS: ~18 million tons CO_2 (if injecting up to 100 years)***

Image Credit: Energy & Environmental Research Center (modified from Peck and others, 2014)

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RTE CCS Project

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RTE CCS Project:

Funding and Technical Partners

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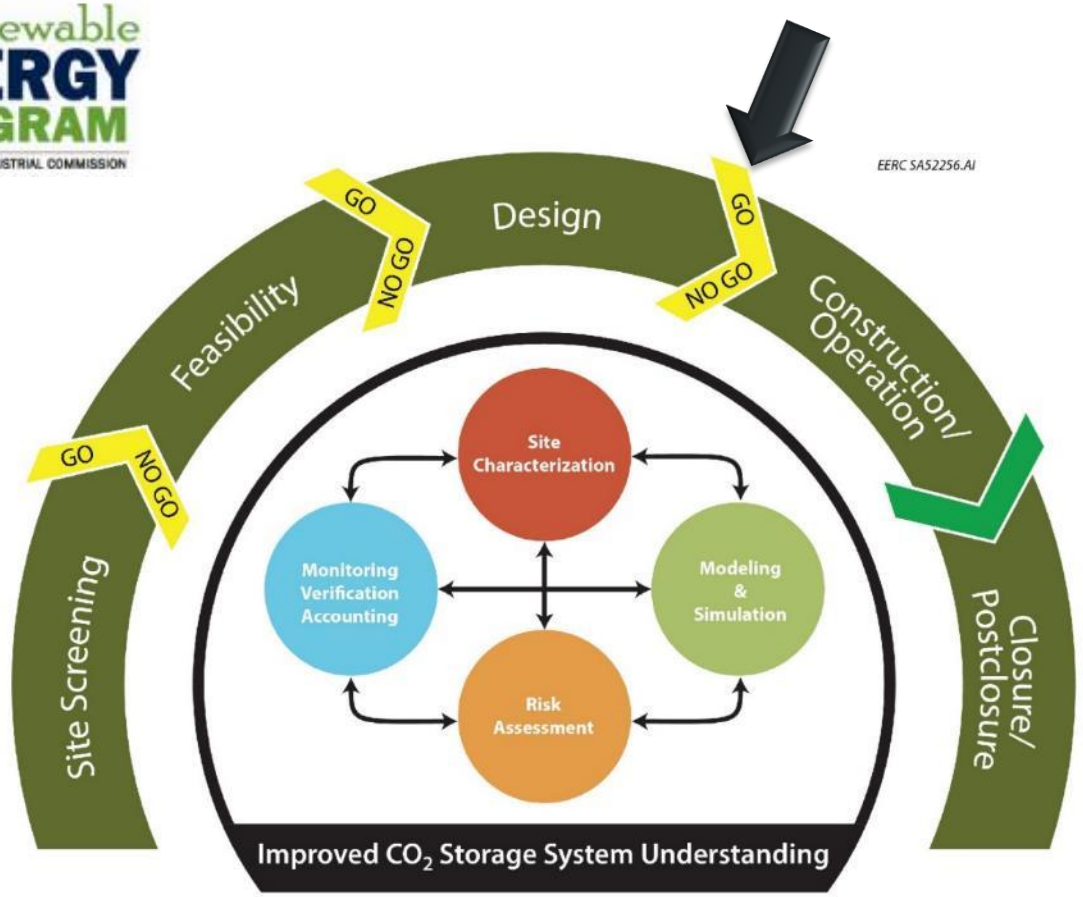
renewable ENERGY PROGRAM
NORTH DAKOTA INDUSTRIAL COMMISSION

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

TRIMERIC CORPORATION

Schlumberger

CMG COMPUTER MODELLING GROUP LTD.



Phase I Summary
Nov 2016 – May 2017

- Technically feasible: ~40%–50% net CO_2 emissions reduction
  - CO_2 capture and transport
  - Site characterization, geologic modeling and simulation
  - Life cycle analysis (LCA), risk assessment
- Economic viability: Possible through low-carbon fuels programs or other incentives
- Completed preliminary Field Implementation Plan (FIP)
  - CO_2 capture system and pipeline
  - Permitting plan; monitoring, verification, accounting (MVA) plan
  - Well design, geologic characterization and testing plan

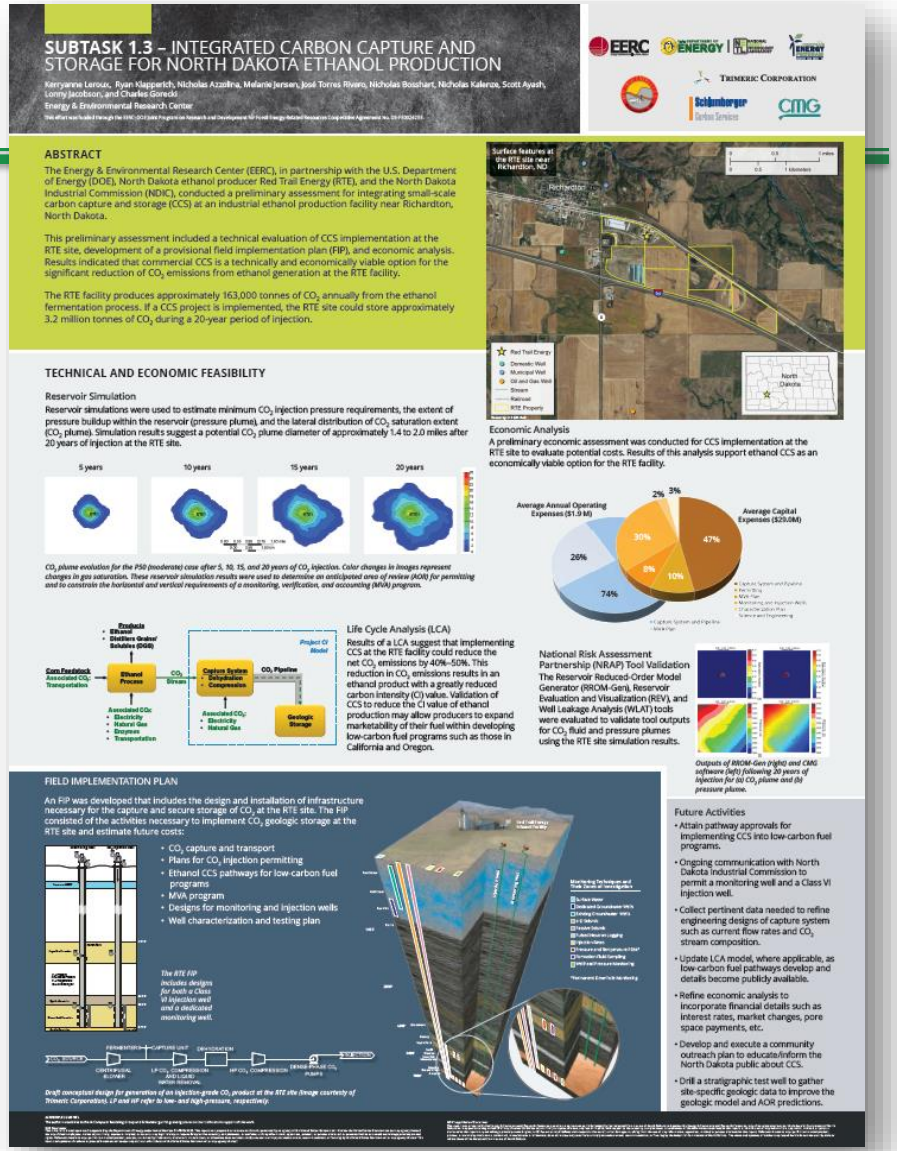


Image Credit: Energy & Environmental Research Center

Phase II Summary

Nov 2017 – July 2018

- Technically feasible: ~30%–40% net CO_2 emissions reduction for liquefied CO_2
  - Analyzed fermentation exhaust gases, modified design and refined LCA
  - Established permitting pathways and updated Phase I FIP
    - North Dakota Class VI Program
    - Low-Carbon Fuel Programs
- Economic viability: Requirements for incentive programs add complications
- Developed detailed Community Outreach Plan

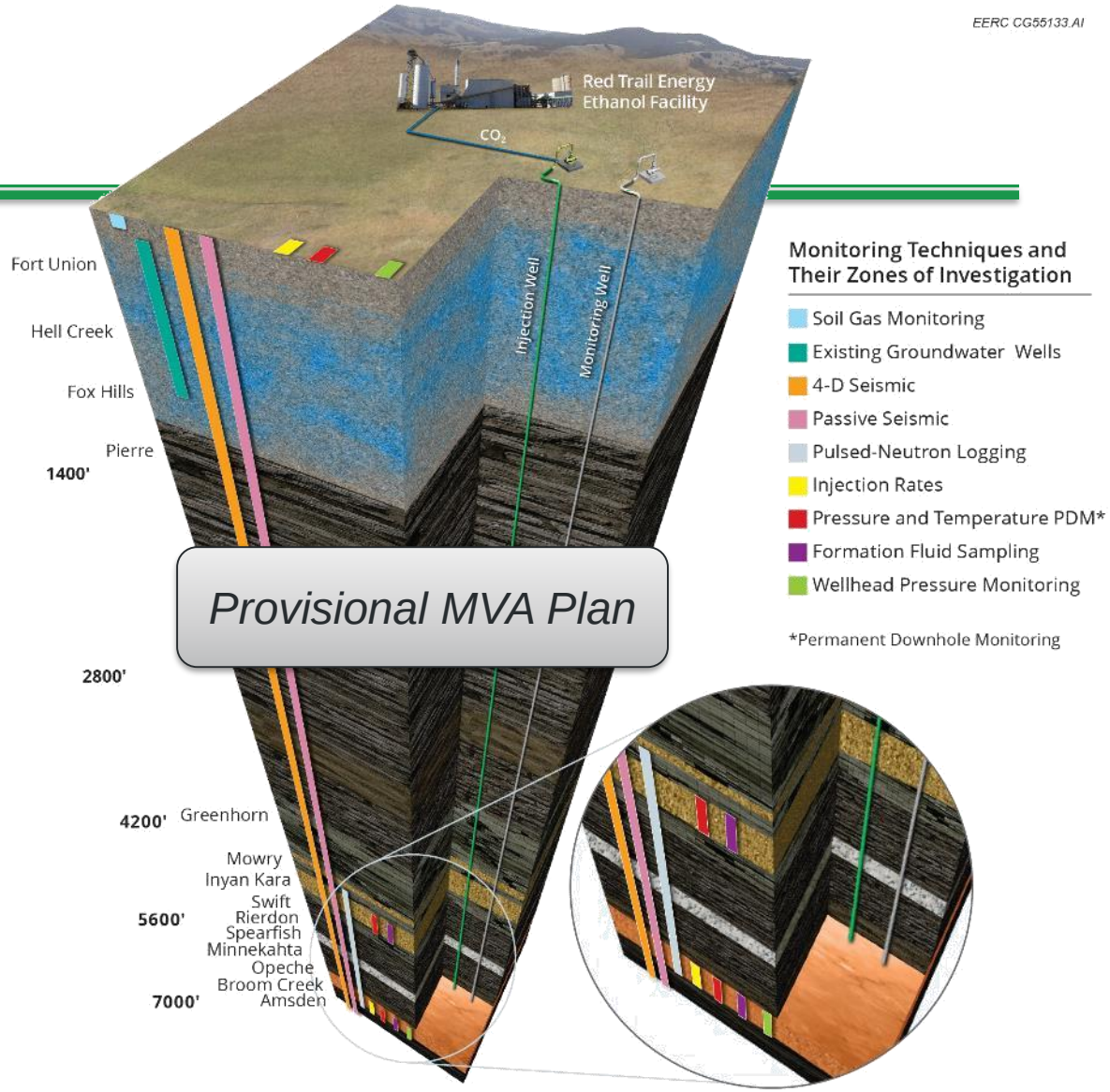


Image Credit: Energy & Environmental Research Center (Leroux and others, 2018)

Phase III Summary
Dec 2018 – May 2020

➢***Design package for implementation of first commercial CCS project in ND.***

✓ Develop CO_2 Capture Process Design Package (PDP)

✓ Initiate monitoring and characterization plans
- Near-Surface monitoring (water and soil gas)
- Reservoir characterization (seismic survey)

- Prepare CCS Permit Application Package
- Evaluate economic viability → Up-to-date requirements for CO_2 markets/incentives
- Execute Public Outreach Plan → Develop Public Outreach Package

Image Credit: Energy & Environmental Research Center

➢***UPDATE: Permit to Drill recently approved for Stratigraphic Test Hole***

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RTE CCS Project: Accomplishments

- ✓ Established technical feasibility
  - Approx. 40% net CO_2 emissions reduction
- ✓ Established preliminary economic viability
  - Low-carbon fuels (LCF) programs, federal incentives, etc.
- Developed, initiated Community Outreach Plan
  - ✓ Conducted 2 local open houses
  - ✓ Updates with state/county/city officials
  - ✓ Topical fact sheets (for landowner interactions)

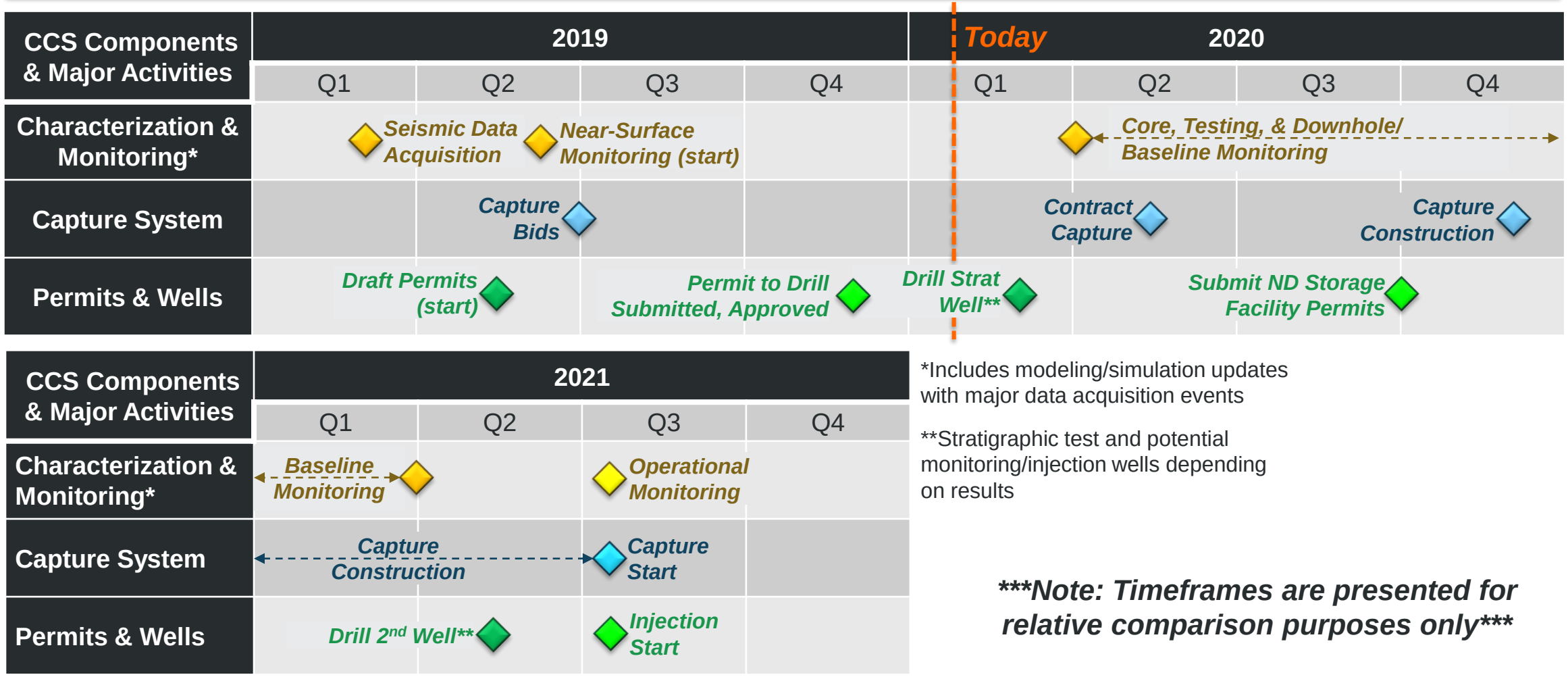
- Developed, initiated Field Implementation Plan
  - ✓ CO_2 Capture Process Design Package
  - ✓ Near-surface sampling and seismic survey
  - ✓ Characterization and testing design
  - ✓ Permit to Drill for stratigraphic test hole

RTE CCS Project: Next Steps

- Drill stratigraphic test hole
  - Core analyses and downhole testing
  - Update modeling and operation plans
  - Start downhole baseline monitoring
- Acquire Class VI permit and LCFS pathway
  - Complete all required plans
  - Submit all required documentation
- Install capture facility
  - Contract and construction
  - Shakedown operation
  - Integrate with CO_2 injection, geologic storage system

Image Credit: Energy & Environmental Research Center

Potential RTE CCS Activities Timeline



*Includes modeling/simulation updates with major data acquisition events

**Stratigraphic test and potential monitoring/injection wells depending on results

Note: Timeframes are presented for relative comparison purposes only

Questions?

Image Credit: Energy & Environmental Research Center

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