CCUS: Use of CO_2 from Ethanol Production for EOR

Conestoga Energy Partners, LLC

An overview of a Kansas-based carbon capture, use, and storage project.

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- ✓ Conestoga Energy Partners, LLC founded in 2006
- ✓ Originally founded by feeders and farmers
- ✓ Composed of 480 investors representing teachers, farmers, parents & community leaders
- ✓ Annual production of 205 million gallons of low carbon renewable ethanol across three plants

Arkalon Ethanol 110 MG

Bonanza BioEnergy 55 MG

Diamond Energy 40 MG

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Focused on Low Carbon Fuel Production

- ✓ Points of differentiation:
  - ✓ Largest domestic user of grain sorghum
  - ✓ Locally sourced feedstock
  - ✓ First ethanol company to capture and store CO_2
- ✓ Four fuel pathways registered with LCFS since 2011
- ✓ Carbon Intensities range from 67 gCO_2e/MJ - 79 gCO_2e/MJ

Farming and Processing →

- Non-irrigated
- Minimal fertilizer
- No drying
- Large scale production

Feedstock Transport →

- Locally sourced and transported

Ethanol Production →

- CO_2 CCS
- NG-fired CHP
- High efficiency APCs
- WDG transported locally

Ethanol Transport

- Exclusively on rail

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Conestoga's Goal for CCUS

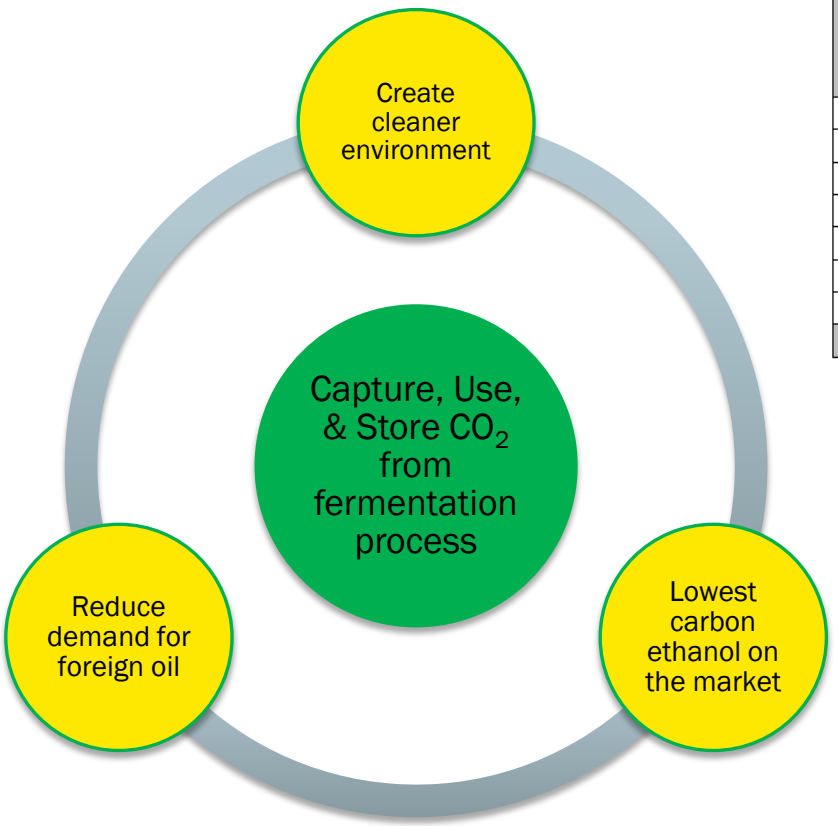

Table 3-1 Industrial Plants in the US with CCS[11,12,13,14,15,16,17,18,19]

Anthropogenic CO_2 Emission Source	No. of Plants	Estimated CO_2 Emissions (1,000 Metric tonnes per day)	No. of Plants with CCS
Fossil fuel-fired Power Plants	2,802	6,254	1
Gas Processing Plants	516	230	8
Ethanol Plants	210	100	2
Hydrogen Plants (non-refinery)	74	25	1
Hydrogen Plants (refinery)	70	55	0
Ammonia Plants	27	28	3
Ethylene Oxide Plants	10	7	1
TOTAL	**3,709**	**6,699**	**16**

ACR Methodology for GHG Emission Reductions From CCS Projects v1.0

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Bonanza BioEnergy CCUS EOR

- ✓ Occurs within 15 mile radius of Garden City, KS
- ✓ Operational since 2012
- ✓ Captures ~ 100,000 tCO_2 annually

Nationalatlas.gov

CAPTURE	TREATMENT	TRANSPORT	USE AND STORAGE
CO_2 produced via fermentation of sorghum and corn feedstocks	Dehydration and compression of CO_2	Via dedicated pipeline	CO_2 utilized for EOR and recycled.

Bonanza BioEnergy, LLC. → PetroSantander, Inc.

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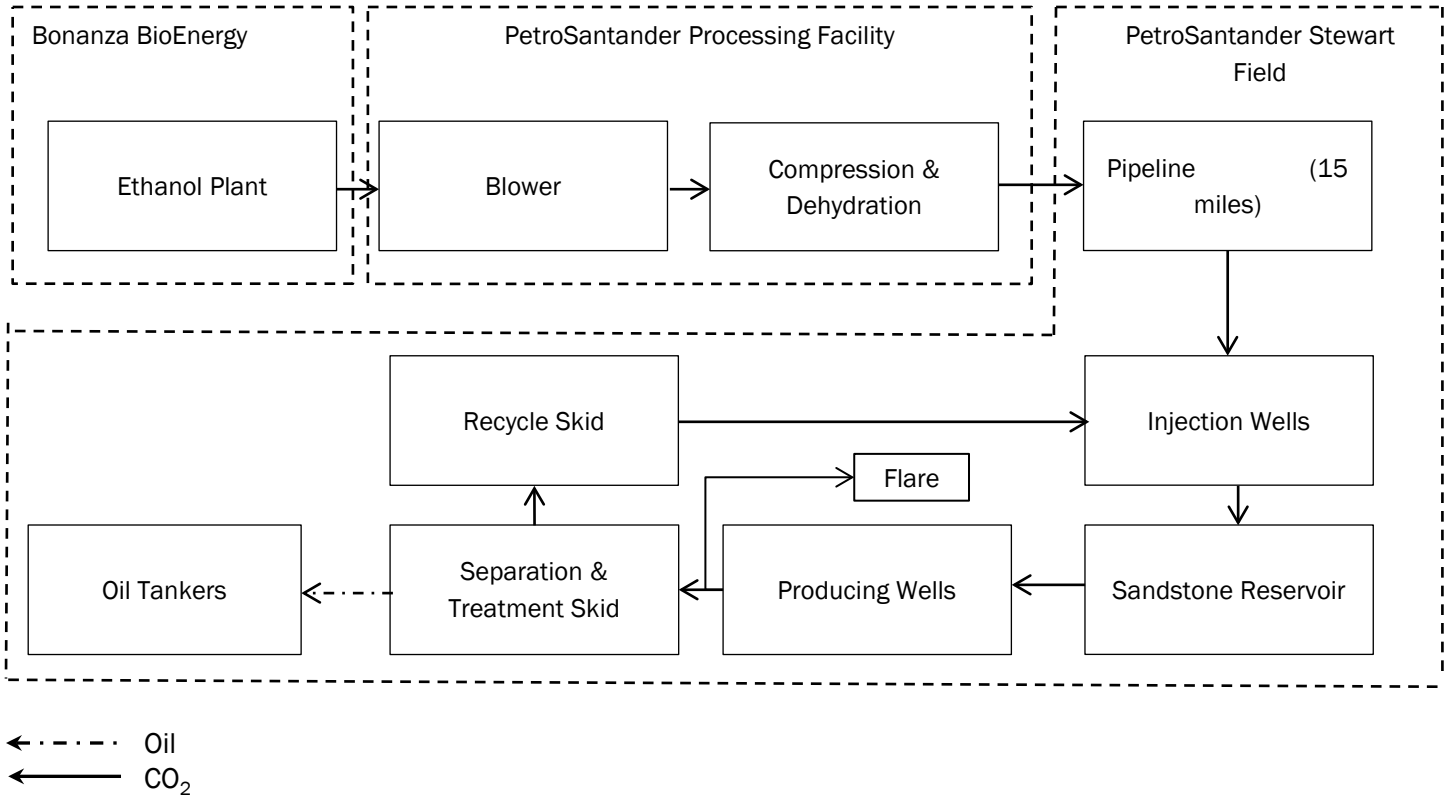
Process Flow



CO_2 Capture at Ethanol Plant

- ✓ 20 million bushels of grain processed
- ✓ [CO_2] > 99%
- ✓ Captured from fermenter stacks in 24” header pipe
- ✓ Blowers direct CO_2 to treatment & compression plant

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CO_2 Treatment and Compression

- ✓ Dehydration
- ✓ 3-stage compression to 1500 psi
- ✓ Powered by electricity
- ✓ Custody transfer meter and in-line analyzer after skid.

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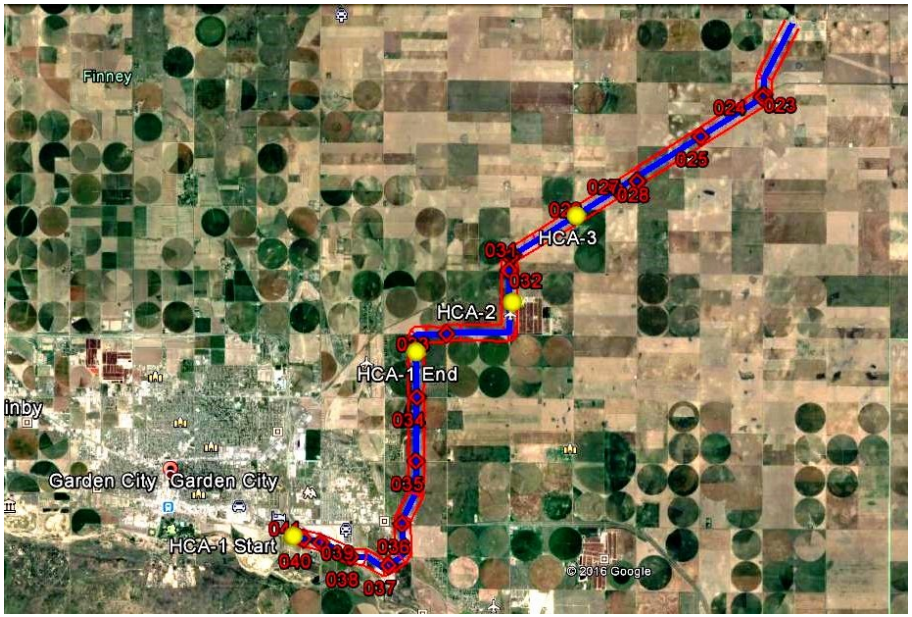
CO_2 Transport

- ✓ 15 miles
- ✓ Dedicated 4” line
- ✓ Federally regulated
- ✓ Metering:
  - Metered on both ends
- ✓ Monitoring:
  - Fully automated pressure monitoring
  - Auto shut-off if pressure exceeds +/- 10%



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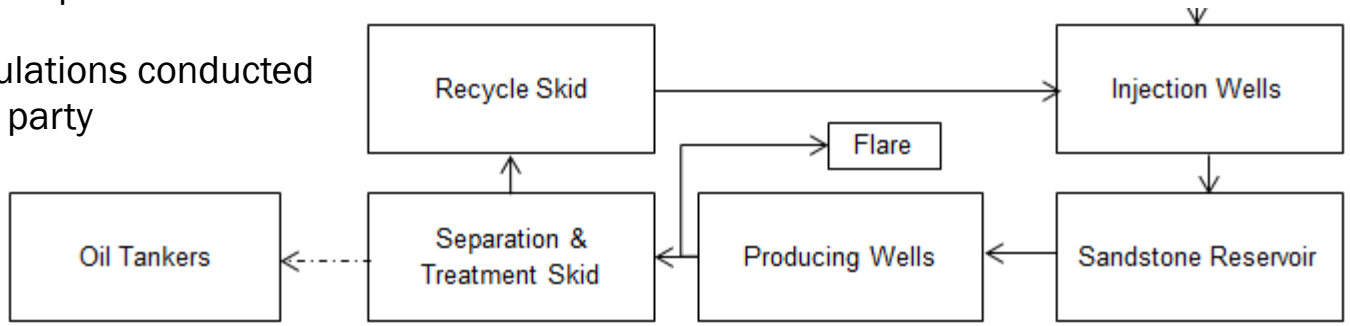
CO_2 Use and Storage

- ✓ WAG injection at 4800 ft
- ✓ Stainless steel casing per KS state CO_2 EOR requirements
- ✓ Powered by electricity and associated NG
- ✓ Metering & Monitoring
  - Metered at pipeline outlet, post-producing wells, post-recycle skid
  - Oil / H_2O / CO_2 composition analyzed pre Separation & Treatment
  - In-line analyzer post recycle skid
  - All lines monitored for pressure fluctuation with auto shut-off
  - Mass balance calculations conducted by independent 3rd party



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Considerations for QM Development

QM Objective	Commercial Considerations	Suggested Approach
Ensure permanence	• O&G operators may retrieve CO_2 for use at a new site.	• Require a covenant to be filed which prohibits release of stored CO_2. • If no covenant, allow for projects to compensate for reversal.
Provide approach to quantify EOR-specific CO_2 leak/venting	• Scheduled maintenance on pipelines may require purging. • Lightning strikes in the field, etc. may lead to fire and require gas blow down. • Injection equipment may fail.	• Include specific equations in the QM to quantify venting events based on parameters that can be verified. • Ensure Monitoring Plan addresses how operational disruptions are identified, documented, and mitigated.
Appropriately define physical boundary for EOR projects	• Capture sites are unique. • Project may source multiple CO_2 streams.	• Clearly define project emission sources directly associated with capture activity. • Be cognizant of program overlap. • Ensure mass balance data requirements are met but don't overburden parties who aren't seeking credit.
Clearly identify the responsible party associated with the project	• The party responsible for CO_2 capture may be the one seeking credit for complying with the QM.	• Allow for flexibility in the definition of the "responsible party".

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