The Complimentary Relationship Between CHP and CCS

Presented by:
Bernie Hoffman, P&E Solutions LLC

American Coalition for Ethanol
Annual Conference
August 11, 2022
Geography of Carbon

- California now (CARB LCFS driving other markets)
- Oregon now (Oregon Clean Fuels Program)
- British Columbia now (BC-LCFS)
- Washington State/Puget Sound implementing reporting now, carbon reduction begins January, 2023
- Balance of Canada, Ontario (Canada Clean Fuel Standard) Regulations final this year. In force December, 2022
- Colorado Clean Fuel Standard feasibility study
- Possible Federal LCFS or Clean Fuel Standard?
- Minnesota, Iowa, South Dakota, Nebraska all being discussed/studied
- NESCAUM (Northeast States for Coordinated Air use Management)
- Expanding low carbon fuel markets provide access to everyone; **no longer just for the “West Facing” plants.**
Why is CHP & CCS such a special “union”?

• Bottom line; with the proposed CO$_2$ CCS Pipelines and existing proven CCS Geologic Reservoirs, well over half of the US Ethanol Plants will have access to Carbon Capture and Sequestration. Resulting in significant carbon score reductions and 45Q Tax Credit opportunities.

• Low Carbon Fuel Standard and Clean Fuel Standard markets continue to develop and emerge, creating more opportunities for Ethanol Plants to monetize carbon score reductions.
Proposed CO$_2$ CCS Pipeline Projects

- Summit Carbon Solutions
  - 12 Million Tons CO$_2$/year
- Navigator CO$_2$ Ventures/Heartland Greenway
  - 15 Million Tons CO$_2$/year
- ADM/Wolf Carbon Solutions
  - 12 Million Tons CO$_2$/year
- Catahoula Resources/Chief Industries (Nebraska)
  - 7 Million Tons CO$_2$/year
CHP Benefits

Direct energy cost savings
30%-60% depends on plant design
Eliminate extra utility charges like demand and time of use
Energy savings + carbon benefits = payback in 2 years possible
Deliver greater value to your shareholders
10% CHP investment Tax Credit through 2024

Carbon intensity reduction averages 11%
Lower risk of cyber hacking
Ability to make more steam to de-bottleneck or expand
EPA classifies CHP as “advanced” technology

High thermal efficiency 90%+
Grid independence
CARB classifies CHP as “innovative” technology
Solar technology to capture CO₂ off turbine exhaust

Greater reliability
lower risk of unplanned outages
Small footprint, around ½ acre
Idle existing high maintenance boiler
CHP Compliments to other Technologies

- Carbon Capture and Sequestration
  - Digester on site at Ethanol plant
  - Digest “capability” of plant streams
  - Fuel turbine with Biogas more savings more CI Reduction
  - 53% Est. Total Energy Savings

- Mole Sieve Membrane Addition
  - 48% Est. Total Energy Savings

- Dryer Exhaust Heat Recovery Technology
  - 49% Est. Total Energy Savings

- High Protein DDS Upgrade
  - 50% Est. Total Energy Savings

- Plants with Steam Tube Dryers
  - 45% Est. Total Energy Savings

*Anything with Electric load and/or steam demand*
Plant Modeling Results

Actual Plant Data

- **Inputs:**
  - 118 MMGPY Ethanol Plant
  - Plant Power Demand 6.8 MW
  - Estimated CCS Equipment Power Demand 6.0 MW
  - Plant Steam Load 160,000#/hr.
  - Plant CO\(_2\) Production 300,000 Tons/yr.

- **Solution:**
  - One Solar Titan 130 PGM LoNO\(_x\) Gas Turbine Generator Set Making 14MW
  - One Rentech HRSG making:
    - 68,000#/hr. Steam from Turbine Exhaust
    - 92,000#/hr. Steam from Duct Burner Co-firing
  - Max Steam Capacity is 300,000#/hr.

- **Results:**
  - Direct Energy Savings of $7.2 Million/year
  - Carbon Score Reduction Estimate of 39gm CO\(_2\) e/MJ
  - Estimated Value of CI Reduction $34.5 Million /yr.**
  - 100% of Required Electricity from Turbine
  - 100% of Required Steam from HRSG

- **Additional CCS Opportunity**
  - Solar is developing technology to capture CO\(_2\) off the turbine exhaust
  - Additional 75,000 Tons/yr. available from a single Titan 130 for this project

*Does not include 45Q Value
**CI Value Based on LCFS Credit as of 8/2/22 @$85/MT carbon, $0.0075/1 gmCO\(_2\) e/MJ reduction
Who We Serve

Industries

• Co-generation/ Distributed Generation—We create energy-efficient systems that allow producers to generate power and put waste heat to work at the same time.

• Ethanol Plants—We support this carbon driven evolving, renewable industry with our full range of capabilities.

Renewable Natural Gas—Also called sustainable natural gas or biomethane, this exciting biogas market is one focus for our renewable capabilities.

• Bulk Terminals—We help industrial facilities meet their storage, transport and throughput goals.

• Renewable Diesel—This growing alternative fuel market is another place where P&E Solutions' capabilities shine.

• Refining—With years of experience in the petroleum industry, P&E has a reputation for safe, reliable refinery work.

• Power Generation—Founded on serving power plants, we have extensive experience with coal, natural gas and fuel-oil power facilities.

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Questions?

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Thank You

For further information contact:
Bernie Hoffman
316-833-6474
Bernie.Hoffman@peconstruct.com