Opportunities and Risks of Carbon Markets for Dairies, Digesters & Beyond

Carbon Market Economics and Risks

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Seeing the Forest through the Trees

The Forest: Improving dairy sustainability.

U.S. Dairy Net Zero Initiative
Accelerating progress toward the 2050 environmental goals by advancing research and technology, on-farm pilots and new market development.

NESTLÉ’S NET ZERO ROADMAP
March 2023

The Trees: The multitude of risks facing dairy farmers to achieve the sustainability goals of the forest.
Risk and opportunity

• Developing regulatory and voluntary carbon markets

• Developing science on quantifying carbon capture, sequestration, etc.

• Risk creates potential for profits or losses

• *Methane capture investment by the dairy farm faces risk in all 5 agricultural risk categories*
5 Risk Categories

1. Production risk – *Variation in yield*
   - Measurement and variance in biogas yield (methane to CO\textsubscript{2}e)
   - Depends on system AD vs lagoon cover, temperature, electricity vs natural gas
   - Engineering design, construction and potential capacity constraints
   - Maintenance and management

2. Market risk – *Variation in input and market prices*
   - Regulation created (i.e. LCFS) market and methane capture incentives
   - Developing voluntary carbon markets for methane / CO\textsubscript{2}e capture
   - Electricity and natural gas prices
   - Value from RINs and potentially eRINs

3. Finance risk – variation in cash flow
   - Long investment recovery period – 15+ years
   - Tax incentives – Depreciation; Federal Investment Tax Credits
   - Low dairy milk production profitability & ability to cover biogas losses

4. Legal risk – Legal and regulatory rules
   - Policy permanence – adverse policy initiatives
   - Contracts, Nondisclosure clause in contracts, new biogas LLC

5. Human risk – Business risks from dealing with people and new management challenges
Anaerobic Digestion Production of Gas and Electricity

Feedstocks can be digested singularly or in combination (co-digestion)

Manure (e.g., dairy, swine, beef, poultry)
Wastewater Biosolids (e.g., municipal sewage sludge)
Food Waste (e.g., household, restaurant, cafeteria, grocery, food production)
Other Organics (e.g., energy crops, fats, oils, grease, crop residue, winery/brewery waste)

Biogas

Electricity
Heat
Vehicle Fuel
Renewable Natural Gas
Organic Fertilizer
Animal Bedding
Other Products (e.g., building material)
Crop Irrigation

Digestate

Horticulture Products (e.g., soil amendment, peat moss replacement, plant pots)

Bioproduct Feedstock (e.g., bioplastics)

Clean Fuel Standard (WA), LCFS (CA) Prices, RINS (Fed RFS), Incentives

https://www.epa.gov/agstar/how-does-anaerobic-digestion-work
Renewable Natural Gas (RNG) from Dairy Manure

Value of RNG from Dairy manure Anerobic Digestion
1. Commodity natural gas price
2. Low carbon fuel credits (LCFS in CA, CFS WA)
3. RINS (Renewable Identification Numbers)
   “Currency” of the Federal Renewable Fuel Standards (RFS) Program
   RVO = Renewable Volume Obligation to sell, set by EPA rulemaking

Example lifecycle of a Renewable Identification Number (RIN)

* RVO = Renewable Volume Obligation

RINs - D3 cellulosic, D5 advanced, D4 biodiesel, D6 corn ethanol

Weekly D3 RIN Prices 2019 through 2023 ($/RIN)

D3 RINS: “cellulosic” includes landfill biogas and agricultural digesters (Dairy)

RIN (Renewable Identification Number) is a 38-character number assigned (“tied”) to each physical gallon of renewable fuel produced or imported.

How much “support” will D3 prices have from future RVOs

<table>
<thead>
<tr>
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<th>2023</th>
<th>2024</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulosic biofuel (D3)</td>
<td>840,000,000</td>
<td>1,090,000,000</td>
<td>1,380,000,000</td>
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<tr>
<td>Percent Change (YoY)</td>
<td>130%</td>
<td>127%</td>
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Trend in Natural Gas Prices (2020 to 2024)

https://tradingeconomics.com/commodity/natural-gas
CME Natural Gas Futures Outlook

CME Natural Gas Futures Contract Prices
($ / MMBtu Data collected 1/24/2024)

Average: $2.87

Mar 2024: $2.18
Apr 2024: $2.21
May 2024: $2.31
Jun 2024: $2.47
Jul 2024: $3.63
Aug 2024: $2.69
Sep 2024: $2.67
Oct 2024: $2.76
Nov 2024: $3.16
Dec 2024: $3.64
Jan 2025: $3.92
Feb 2025: $3.74
Weekly Average CA LCFS Price 2019 through Jan 2024

$ / MT

https://ww2.arb.ca.gov/resources/documents/weekly-lcfs-credit-transfer-activity-reports
## Estimate revenue per cow generated from natural gas

A dairy cow generates about 22.5 MMBTU / Year

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
<th>Quantity</th>
<th>Revenue</th>
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</thead>
<tbody>
<tr>
<td>Sale of gas</td>
<td>$2.50 / mm btu</td>
<td>22.5 mm btu</td>
<td>$ 56.25</td>
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<tr>
<td>D3 RINs</td>
<td>$3.00 / RIN</td>
<td>254 RINs / cow</td>
<td>$ 762.00</td>
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<tr>
<td>LCFS</td>
<td>$68.27 / MT</td>
<td>16.13 / cow</td>
<td>$ 1,101.20</td>
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<tr>
<td>Total / cow</td>
<td></td>
<td></td>
<td>$ 1,919.45</td>
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<tr>
<td>Milk revenue</td>
<td>$18.5 / cwt milk price</td>
<td>23,000 lbs</td>
<td>$ 4,255.00</td>
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</table>

Anaerobic Digestion Production of Gas and Electricity

Profitability of AD generating electricity consideration

https://www.epa.gov/agstar/how-does-anaerobic-digestion-work
EPA continues to assess the comments received on proposed regulations governing the generation of Renewable Identification Numbers (RINs), which are RFS compliance credits, for electricity made from renewable biomass that is used for transportation fuel (eRINs). The EPA will continue to work on potential paths forward for the eRIN program, while further reviewing the comments received on the proposal and seeking additional input from stakeholders to inform potential next steps on the eRIN program.
Daily Wholesale Electricity Price Trades at Northwest Mid-Columbia Hub
$/MWh 2020 through 2023

https://www.eia.gov/electricity/wholesale/#history
Selected price hub locations for wholesale electricity and natural gas reported by Intercontinental Exchange

Note: Colored areas denote Regional Transmission Organizations (RTO)/Independent System Operators (ISO)
Data source: U.S. Energy Information Administration based on Ventyx Energy Velocity Suite
Conclusions - Refocus on the Forest – Dairy Sustainability

• Commitment to dairy sustainability – Net Zero Initiative

• Recognize the value trends for capturing methane for
  • Natural gas
  • Electricity
  • Emerging technologies eg. hydrogen capture technology

• Recognize growing importance of carbon credit incentives
  • Programs supporting clean fuel standard
  • Voluntary carbon market
  • Regulated or compliance carbon market
  • [https://carboncredits.com/carbon-prices-today/](https://carboncredits.com/carbon-prices-today/)

• Low profit potential of Anaerobic Digestion without Incentives
  • Slow growth in dairy anaerobic digestion systems until California air quality regulation and incentive
Discussion and Questions

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