PIPELINE QUALITY RENEWABLE NATURAL GAS

Presentation to Whatcom PUD

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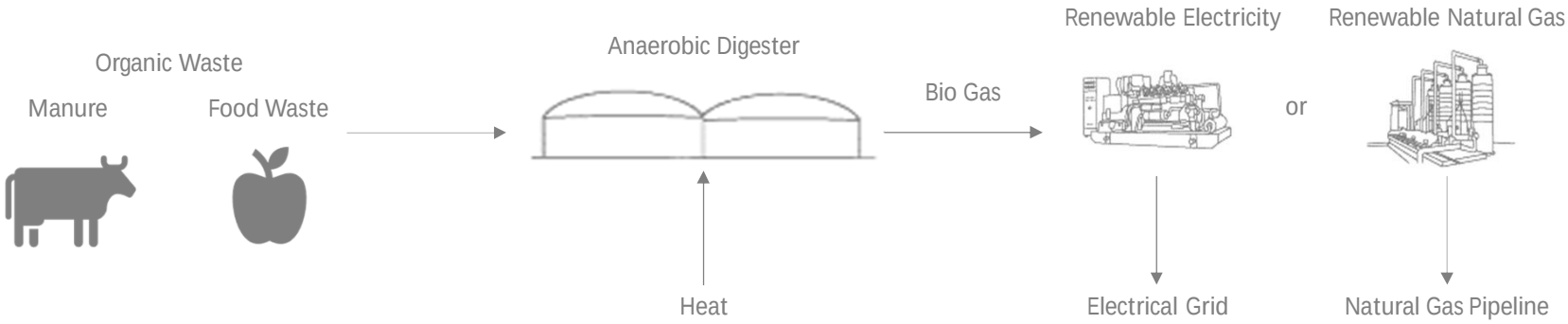
Anaerobic Digestion



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What is Pipeline Quality Renewable Natural Gas (RNG)?

- Biogas is a product of the anaerobic decomposition of organic material (i.e. manures, food scraps, municipal wastewater) that occurs at dedicated anaerobic digestion facilities. 50-60% Methane.

- Renewable Natural Gas (RNG) is biogas that is upgraded to natural gas pipeline quality standards such that it may blend with, or substitute for, geologic natural gas. 98%+ Methane

(a) Dairy manure anaerobic digester (Edaleen Dairy, WA); (b) biogas scrubbing (Fair Oaks Dairy, IN); (c) Milk truck fueling with RNG (Fair Oaks IN)

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Examples

- ✓ Yard Waste—California
- ✓ RNG—Fuel Haul Fleet
  - ✓ 450 Trucks
  - ✓ 99% GHG reduction
- ✓ 120,000 tons/year of yard waste

- ✓ Dairy Manure—Indiana
  - ✓36,000 cows
- ✓RNG—Fuel Milk Fleet
  - ✓42 Trucks
  - ✓2M diesel gallons/y
- ✓½ million visitors/year

- ✓ Landfill and WWTPs
- ✓ RNG—Haul Fleets
- ✓ Co-Digestion Food Scraps

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Two Types of Available Credits

Beyond value from its BTUs RNG fuel can receive two important credits.

- Federal Renewable Fuel Standard (RFS)—Enacted 2007, legislated through 2022.
  - The RFS provides Renewable Identification Number (RINs) credits for renewable fuels used in the US for transportation. The RINs are classified into 4-key classifications of D-codes (D3-6), depending on the level with which the reduce lifecycle greenhouse gases and/or utilize cellulosic feedstock.
  - RNG is a renewable fuel approved within RFS program and is classified as either D3 or D5.
  - D3 is the most valuable as it is cellulosic—manure qualifies as D3. D5 is of lesser value and off-farm organics into the digester qualify as D5.

- California Low Carbon Fuel Standard (LCFS)—Reauthorized 2017, legislated through 2030.
  - If the RNG enters a pipeline connected to California, for theoretical transportation use in California, then the fuel qualifies for the California program.
  - The program works by assigning a carbon index (CI) to each type of fuel or RNG. The lower the CI, the more LCFS credits that are assigned, increasing its value as a fuel. Manure-based RNG has one of the lowest CI scores of any renewable fuel.

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Two Types of Projects

- **PIPELINE INJECTION**
  - Large landfill, WWTF, and manure projects have potential for pipeline injection projects, depending upon pipeline distance/interconnect costs and valuation of the biogas credits.
  - Industry strongly focused on conversions of existing CHP projects to pipeline but are starting to get a limited number of greenfield projects.

- **CHP and WHEELING OF ELECTRICITY TO CALIFORNIA/OREGON for EV-FUELING**
  - Given the higher costs to scrub raw biogas to pipeline quality as well as typically more costly interconnects, an option of slightly smaller but still large projects is to maintain CHP electrical production but wheel the power to states that will give vehicle fuel credits while fueling EV-vehicles.

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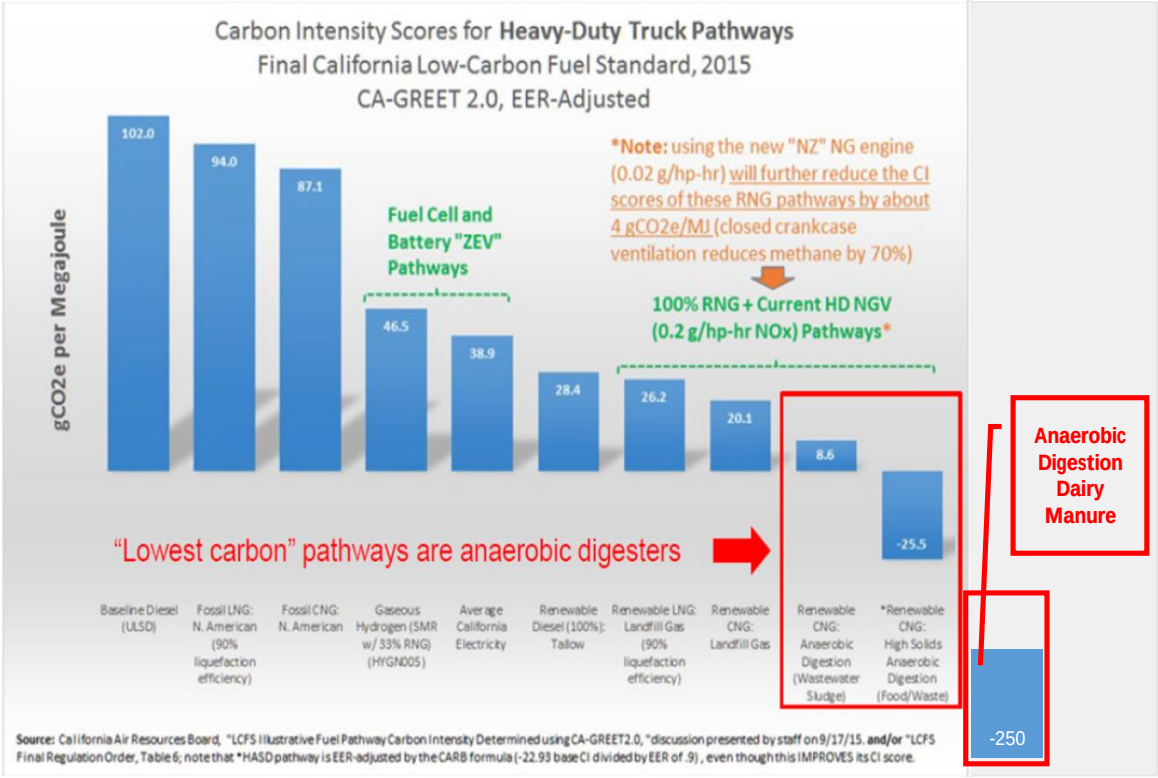
Regenis constructed/operated facility near Jerome Idaho—Dairy Manure 1,200 SCFM raw biogas

LIFECYCLE ANALYSES and CARBON INDEX

Pathways/CI

- Each renewable fuel pathway has its well-to-wheels carbon lifecycle analysis (LCA) completed
- If your pathway/fuel has lower LCA than existing fuels, then its use will lower average CI and help meet state targets (CA—20% reduced by 2030)

- For comparison
  - Fossil Diesel: 100 MJ/g CO_{2eq}
  - Manures: -150 to -400 MJ/g CO_{2eq}
  - Manures are carbon negative, since the projects not only make renewable energy but mitigate natural release of GHGs!!!



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RNG—The Value Proposition

Revenue Sources

- Commodity price of product (thermal or electricity)
- Federal RFS RIN
  - D3: Cellulosic (Manure only projects)
  - D5: Food waste projects
- California LCFS credits are MJ of produced biogas X the CI score—so better CI, more credits, more money
- This combined revenue is equivalent to
  - $10-11/diesel gallon equivalent
  - $0.25-0.29/kWh

Parameters	Scenario 1	Scenario 2	Scenario 3
Holstein Wet Cow Equivalents (HWCE)	3,000	3,000	3,000
Biogas Productivity (ft3 biogas/HWCE/day)	115	115	115
Estimated CI Score	**-250**	**-225**	**-200**
CH4 Content (%)	57%	57%	57%
RNG Pipeline Required BTU (BTU/ft3/RNG)	985	985	985
CH4 Slip in Scrubber (% Saved)	98%	98%	98%
CH4 Content RNG Pipeline Required (%)	97%	97%	97%
System Runtime (%)	98%	98%	98%
Value Commidity Gas ($/MMBTU)	$3.00	$3.00	$3.00
Value D3 RIN-100% ($/Credit)	$1.56	$1.56	$1.56
Value LCFS--100% ($/Credit)	$190.00	$190.00	$190.00
Gas Results			
Annual RNG Output	**70,001**	**70,001**	**70,001**
Monetary Results			
Commodity Gas	$ 210,003	$ 210,003	$ 210,003
D3 Federal RINs	$ 1,280,634	$ 1,280,634	$ 1,280,634
California LCFS	$ 4,397,895	$ 4,051,822	$ 3,705,749
Total	**$ 5,888,532**	**$ 5,542,459**	**$ 5,196,386**

Change CI score, change revenue

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RNG—The Value Proposition

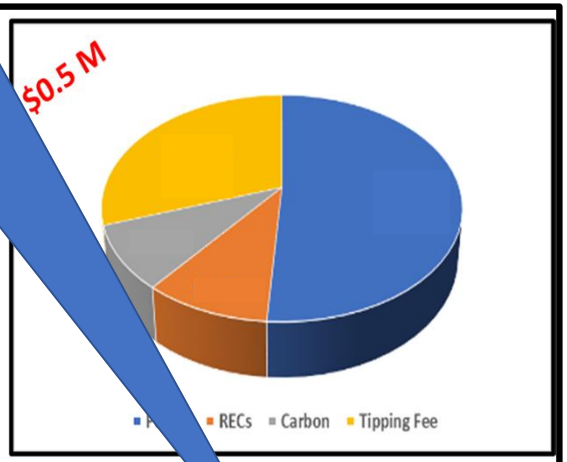
If CHP EV-vehicles, lose the RFS RINs and figure out wheeling

Local Example

- Existing local CHP project
- It is paying back its debt and generating small positive cash flow
- Potential for much greater revenue selling renewable vehicle fuel
  - RNG
  - Electricity

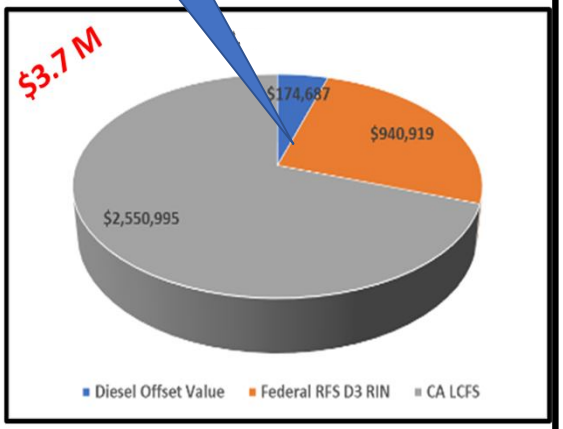
Electric—Existing

- $505,696/year in gross revenue, not including fertilizer products on back
  - Operations—$185,000/year
  - Interest/depreciation on $4M capital
- Many years for payback (~7 years)
- Can ONLY get ½ the electrical price now, with new project



RNG—Future

- $3,666,602/year in gross revenue, not including fertilizer products on back
  - Operations—$250,000/year
  - Interest/depreciation on $7M capital
- Extra revenue thanks to federal/state incentives for renewable transport fuel
- Potential for early payback (~3 years)



UNCERTAINTY IN INCENTIVES

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RNG—The Value Proposition

Why not switch to RNG?

- High capital cost for gas scrubbing equipment
  - Need to get rid of existing gensets and install new gas scrubbing/compression equipment

- High cost of utility interconnection
  - $3.4M interconnection estimate for a project relatively close to a large pipeline
    - Almost as much as the original digester project

- Gas Specification Variability
  - Each utility has their own gas specification
  - No national or state standard

- Revenue uncertainty
  - Based on federal and state credits that can be impacted by legislation
  - Long term contracts available at a discounted price

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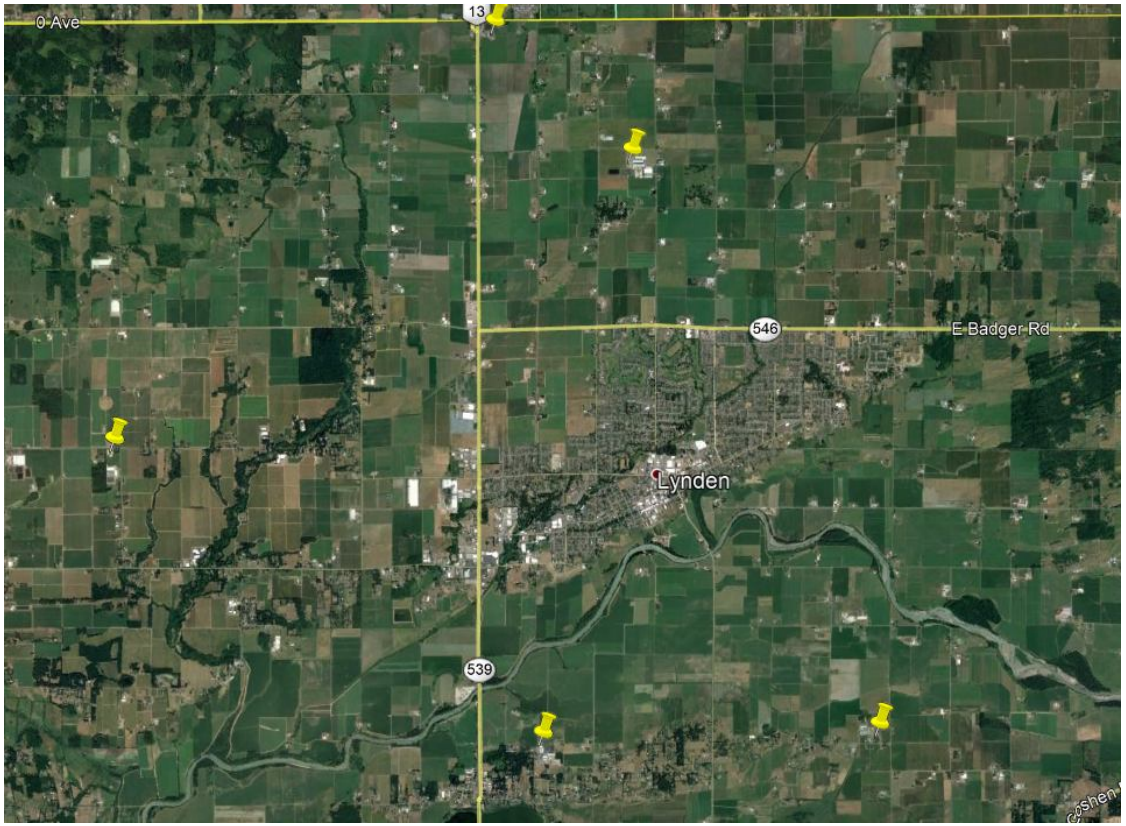
Local Digester Projects

- Five digesters in Whatcom County
- Expiring Power Purchase Agreements
- Largest produces approximately 250 SCFM biogas
  - Too small for stand alone RNG project
- Potential eLCFS Projects



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Potential PUD Role

RNG Projects

- Assistance with pipelines
  - Connecting projects to each other
  - Connecting upgraded gas to the pipeline

- Assistance with offtakes
  - Is there an opportunity to sell locally produced RNG to local refineries to get mutual benefit?

eLCFS Projects

- Wheeling power out of Whatcom County to Oregon/California

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Questions?

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