



**Livestock & Poultry
Environmental Learning
Community Webinar Series**

Renewable Natural Gas (RNG) Projects at
Dairy Farms

April 16, 2021

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Agenda

- DTE Energy Overview
- Creating RNG at Dairy Farms
- Benefits of an RNG Project for Dairy Farms
- The Marketplace for RNG
- Host Dairy Farm Supply and Characteristics

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DTE Biomass Energy is a leader in the production of renewable natural gas ("RNG") and electricity

Company Highlights

- DTE Biomass Energy is DTE Energy's subsidiary that owns and operates our biogas assets and has been in the industry for more than 30 years
- Our portfolio includes 7 dairy biogas facilities in Wisconsin along with 17 landfill gas projects in 7 states
- We design, build, own and operate our facilities on a long-term basis
- Have invested over \$250 million in RNG assets since 2017

 <p>Renewable Natural Gas</p> <ul style="list-style-type: none">• Typically at larger dairies and landfills where volumes justify gas clean up investment• Solvent based or membrane technologies used to separate methane from carbon dioxide• Renewable natural gas produced along with environmental attributes <p>Eleven Facilities – 20 MMCFD</p>	 <p>Power Generation</p> <ul style="list-style-type: none">• Landfill or dairy biogas used to fuel either reciprocating engine or turbine driven electric generation• Produce electricity, capacity and environmental attributes (RECS)• Typically long term, fixed price offtake agreements <p>Eleven Facilities – 72 MW</p>	 <p>Medium Btu Gas</p> <ul style="list-style-type: none">• Raw biogas mildly conditioned and direct pipelined to a commercial or industrial end user where it is typically used as boiler fuel• Gas is sold at a discounted price to customer's natural gas alternative <p>Two Sites – 3 MMCFD</p>
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DTE Biomass Energy operates 11 RNG facilities at both dairy farm (7) and landfill (4) host locations

CURRENT DTE RNG PROJECTS

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RNG is produced by extracting methane from biogas derived from the decomposition of organic waste streams

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The first step in creating RNG is to collect the manure and capture the biogas created from its decomposition

Covered Lagoon
 Geomembrane cover is placed over existing lagoon and acts as a giant "balloon" to capture the biogas created from the decomposition of animal manure

Plug-Flow
 Giant underground "swimming pool" with concrete cover, heating, and insulation

Complete Mix
 Giant above ground tank with membrane roof, heating, mechanical agitation and insulation



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The next step is to clean the biogas to achieve pipeline quality standards. There are four primary ways to clean up raw digester biogas into RNG

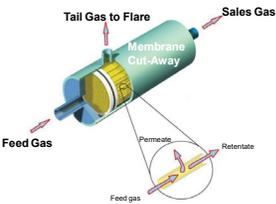
Technology	Process Description	Pros	Cons
Water Wash	Separates carbon dioxide from methane in raw biogas, with the CO2 absorbed into water under pressure	<ul style="list-style-type: none"> Can also absorb the majority of H2S as well Electrically efficient 	<ul style="list-style-type: none"> Requires a large source of water & large use of natural gas (best for larger projects) Large number of moving parts and pumps that can fail
Pressure Swing Absorption	CO2 and other contaminants are absorbed in a regenerative media and released for destruction in a thermal oxidizer	<ul style="list-style-type: none"> Simple process where one vessel is absorbing contaminants while others are in regeneration 	<ul style="list-style-type: none"> Capital costs can be quite high
Amine	CO2 and other contaminants attach to an amine solution and released for destruction in a thermal oxidizer	<ul style="list-style-type: none"> Proven technology used widely in oil/gas industry 	<ul style="list-style-type: none"> Requires a separate H2S removal system

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The next step is to clean the biogas to achieve pipeline quality standards. There are four primary ways to clean up raw digester biogas into RNG (continued)

Technology	Process Description	Pros	Cons
Membranes	used to separate methane from the biogas leaving waste constituents to be destructured via a thermal oxidizer	<ul style="list-style-type: none"> Simple technology, been used in landfill gas projects for years Can also be used to remove most of the H2S from the biogas 	<ul style="list-style-type: none"> High electrical usage Membranes can get fouled with contaminants



This is the technology chosen to date by DTE Biomass Energy for its dairy RNG projects

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DTE's modularized membrane skids compress, separate, dehydrate and polish the biogas into a saleable product ready for transport



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The RNG must be injected into the existing natural gas pipeline infrastructure for transport and delivery to its ultimate customer

- If the RNG facility is located near a natural gas pipeline, then a direct pipeline to interconnect is preferred
- More remote locations require over the road transportation via tube trailers
- The RNG must achieve the same gas specifications as the natural gas in the pipeline
- The gas quality is strictly monitored by the pipeline company



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Our Wisconsin dairy RNG operations produce enough energy to replace nearly 7 million gallons of fossil fuel motor gasoline equivalents



DTE's RNG Project Structuring

- Develop "clusters" in order to take advantage of economies of scale
 - Multiple farms / digesters into one RNG processing facility
- Both direct pipeline injection, as well as "virtual pipelines" (trucking RNG)
 - Part of DTE's strategy is to have a "hub" situated directly on top of a natural gas pipeline
- As technology & investment in the RNG space continues, smaller sized dairy farms become viable host sites

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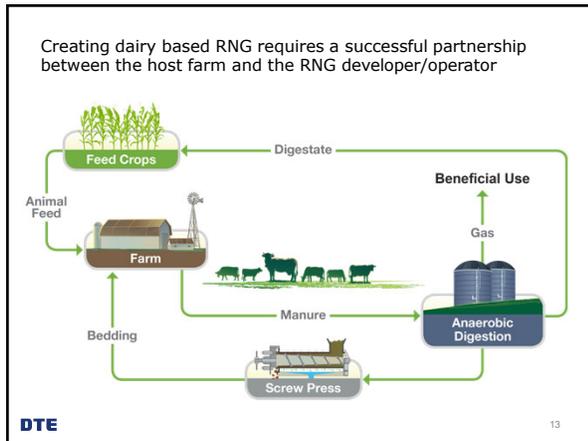
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An RNG project provides both environmental and economic benefits to host farms as well as the local community

Environmental

- Prevents the release of methane created by the decomposition of manure directly into the atmosphere as this methane is captured in the digesters and refined into RNG
- Resulting odor reduction, as the malodorous emissions (sulfur compounds) from the digester gases (impurities or "tail gas") are destroyed in the thermal oxidizer
- Digesters destroy 99.9% of fecal pathogens (1,000-fold reduction), significantly improving water quality
- Allows for application of digested manure when crops can best absorb nutrients, reducing run-off into groundwater and water streams
- RNG used as a fuel in trucks and buses displaces more carbon intensive fossil fuels (gasoline / diesel)

Economic

- Farms enjoy monetary compensation from the RNG project owner not tied to milk prices
- The construction of digesters and infrastructure benefitting the farm
- Job creation for the local community (construction of the facility, project operations as well as ongoing needs from local contractors)

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The demand for RNG continues to increase due to the environmental benefits created

Vehicle Fuel

- RNG earns a strong premium in the vehicle fuel market primarily through two government incentive programs
- On the federal side, the Renewable Fuel Standard (RFS), was passed into law in 2005, with bipartisan support, in an effort to reduce dependence on foreign oil and encourage domestic biofuel production
 - RNG qualifies under the RFS cellulosic category, which provides the greatest lifecycle greenhouse gas emissions reductions in the program
- The State of California's Low Carbon Fuel Standard (LCFS) is part of a suite of programs designed to meet California's mandate to reduce GHG emissions 40% below 1990 levels by 2030
 - The LCFS program drives carbon reduction from transportation fuels by allowing biofuels producers to generate credits proportional to their carbon emissions savings

Voluntary Customers

- More public and private entities are acquiring RNG, either the physical product, or just the environmental attributes, as part of carbon emission reduction commitments they have made

Utilities

- More and more natural gas utility companies are implementing "Green Gas" programs for its customers, in which customers pay an additional cost for RNG in order to reduce/offset household carbon emissions

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RNG earns strong premiums in the vehicle fuels market primarily through two government incentive programs

RNG PRICING (\$/MMBtu)

Component	Price Range (\$/MMBtu)
Natural Gas	\$3-4
RFS RINS	\$9-23
LCFS	\$31-50
Total	\$43-\$77

Dairy RNG Projects (\$43-\$77)
 LFG RNG Projects (\$12-\$27)

- Federal and state incentive programs have driven strong premiums for RNG when it is utilized as a vehicle fuel
- Premiums from the federal Renewable Fuel Standard (RFS) and the California Low Carbon Fuel Standard (LCFS) have helped to drive growth

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Farm herd size, manure quantity/quality, and access to a natural gas pipeline are key variables to determine viable dairy based RNG projects



Larger farms and/or a "pod" of smaller farms is critical for project success



Biogas production is a function of manure quality/quantity and retention time



An RNG project must have access to a natural gas pipeline, which ideally is located nearby the project, otherwise the RNG must be trucked to the pipeline for injection

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Thank you for your time today

Please feel free to reach out with any questions



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