Dairy Digester Emissions Matrix Assumptions

Introduction: Dairy Digester Emissions Matrix

Our goals are to:

- Identify appropriate lifecycle pathways for methane from dairy digesters
- Develop generalized scenarios (which are not applicable to specific projects)
- Determine reasonable assumptions for models that use an uncovered lagoon as the baseline scenario
- Generate emissions values using the CA-GREET 2.0 model

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Introduction: Dairy Digester Emissions Matrix

Digesters-to-Fuels Provide GHG Benefits:

- Net positive benefits in GHG reductions vs. uncovered lagoons and will likely generate LCFS credits
- The point of the matrix is to identify potential differences in non-GHGs for developers to consider
- Matrix is generic by design and doesn't substitute for actual carbon intensity determinations under the LCFS program
- Specific pathways and credits for actual projects will continue to be determined within the LCFS program

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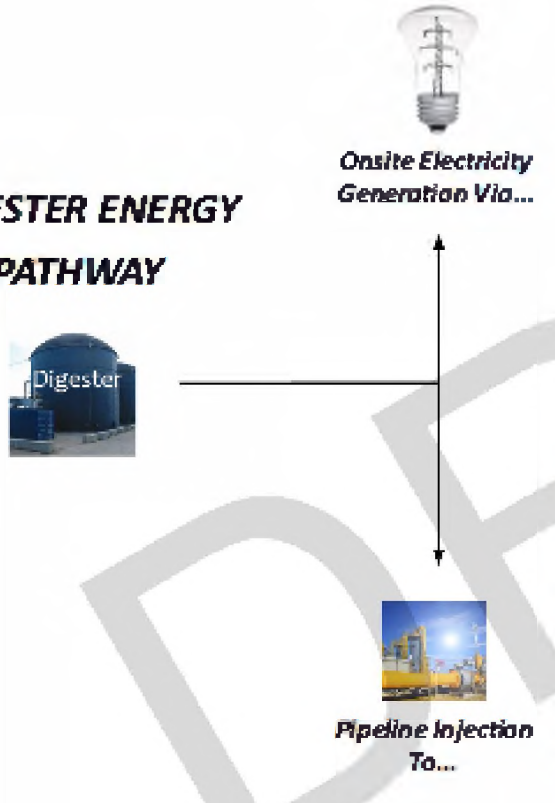
Dairy Digester Emissions Matrix

(Stationary Use Comparison with Uncovered Lagoon)

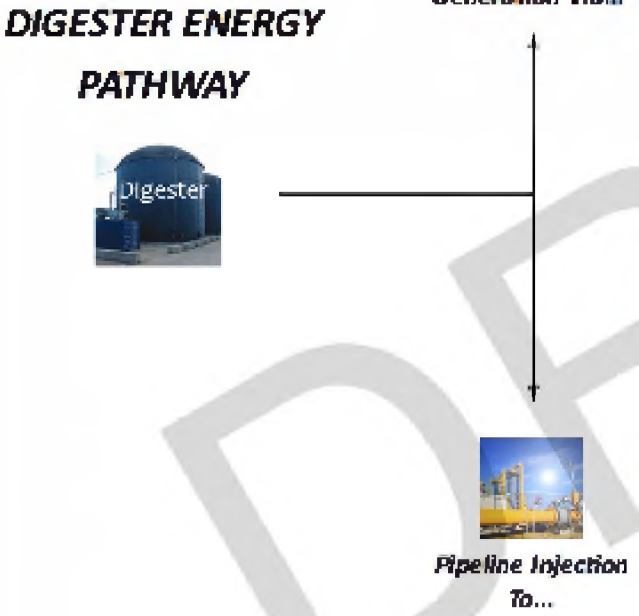


	IMPACTS	CO_2e	NOx	PM	CO	SOx	VOCs	H_2S	NH_3	N_2O	WQ
Reciprocating Engines	Local										
	Remote										

	IMPACTS	CO_2e	NOx	PM	CO	SOx	VOCs	H_2S	NH_3	N_2O	WQ
Grid Electricity	Local										
	Remote										
Microturbines	Local										
	Remote										
Fuel Cells	Local										
	Remote										

Dairy Digester Emissions Matrix

(Transportation Use Comparison With Uncovered Lagoon)



	IMPACTS	CO_2e	NOx	PM	CO	SOx	VOCs	H_2S	NH_3	N_2O	WQ
Reciprocating Engines	Local										
	Remote										

	IMPACTS	CO_2e	NOx	PM	CO	SOx	VOCs	H_2S	NH_3	N_2O	WQ
Renewable CNG	Local										
	Remote										
Grid Electricity	Local										
	Remote										
Renewable Hydrogen	Local										
	Remote										
Microturbines	Local										
	Remote										
Fuel Cells	Local										
	Remote										

Matrix Terminology

***Biomethane*:** methane derived from the digestion of organic material that has been upgraded to a level suitable for pipeline injection and applications that can include equipment or vehicular use

***Biogas*:** digester gas for onsite use that has not been upgraded for pipeline injection

***On-site*:** emissions or fuel use occurring *on* the dairy farm

***Off-site*:** emissions or fuel use occurring *off* the dairy farm

***Local*:** emissions or fuel use occurring on-site plus emissions or fuel use occurring before gas is injected into a pipeline or electricity is placed on the grid

***Remote*:** emissions or fuel use occurring after gas is injected into a pipeline or electricity is placed on the grid, including grid electricity use impacts for on-site equipment power

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Matrix Assumptions

General Methods and Assumptions (All Scenarios):

Emissions model: CA GREET 2.0

Source of values for entry into model: air quality district emission values, manufacturer specifications, Cap-and-Trade Program Livestock Offset Protocol

Methane 20-year global warming potential: 72

Assumed dairy size: 5,000 cows

Dairy type: freestall with flush manure management

Open lagoon methane emissions (baseline): TBD

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Matrix Assumptions

Biogas Producing Covered Digester Scenario/Assumptions:

Emissions calculated on local and remote basis

Solid-liquid manure separation implemented

Digester type: double-lined covered lagoon (no heating or mixing)

Digester cover leak rate: 5%

Effluent pond, digester maintenance, and unplanned venting emissions: TBD

Projects must meet applicable air district's best available control technology (BACT) emission standards

Peripheral equipment uses grid electricity

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Matrix Assumptions

On-Site Use Scenario/Assumptions:

Reciprocating engines

- Biogas is upgraded to air district and manufacturer's requirements (not pipeline-quality)

- Efficiency – 32.8%

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Matrix Assumptions

Off-Site Use Scenario/Assumptions:

All off-site use of fuel will be from pipeline-quality biomethane processed from an on-site upgrading unit

Renewable natural gas – for fueling

- Distance from initial pipeline injection to fueling station: 100 miles

Power plant generation – producing electricity fed to grid

- Facility is a large combined cycle power plant

Renewable hydrogen – for fueling

- Produced from pipeline biomethane using steam methane reformation
- Distance from biomethane injection point to reforming facility: TBD
- Distance hydrogen trucked/pipelined from reforming facility to fueling station: TBD

Microturbine – producing electricity fed to the grid

- Efficiency – 29%,

Fuel cells (solid oxide) – producing electricity fed to the grid

- Efficiency – 57%
- Transportation emissions comparison baseline (for all pathway options intended for transportation fuel use): heavy-duty diesel trucks

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Contact Information

Questions and comments can be directed to the Subgroup #2 comment docket accessible from the Dairy and Livestock Working Group website at:

https://www.arb.ca.gov/cc/dairy/dsg2/dsg2.htm

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