

Renewable natural gas (RNG) what it means for dairy digesters

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South Campus Anaerobic Digester (SCAD)



- Anaerobic digestion process background
- Integration of digesters on dairy farms
- Renewable natural gas
 - Renewable Fuel Standard
 - Low Carbon Fuel Standard
- Current opportunity & considerations
- Milk and digesters

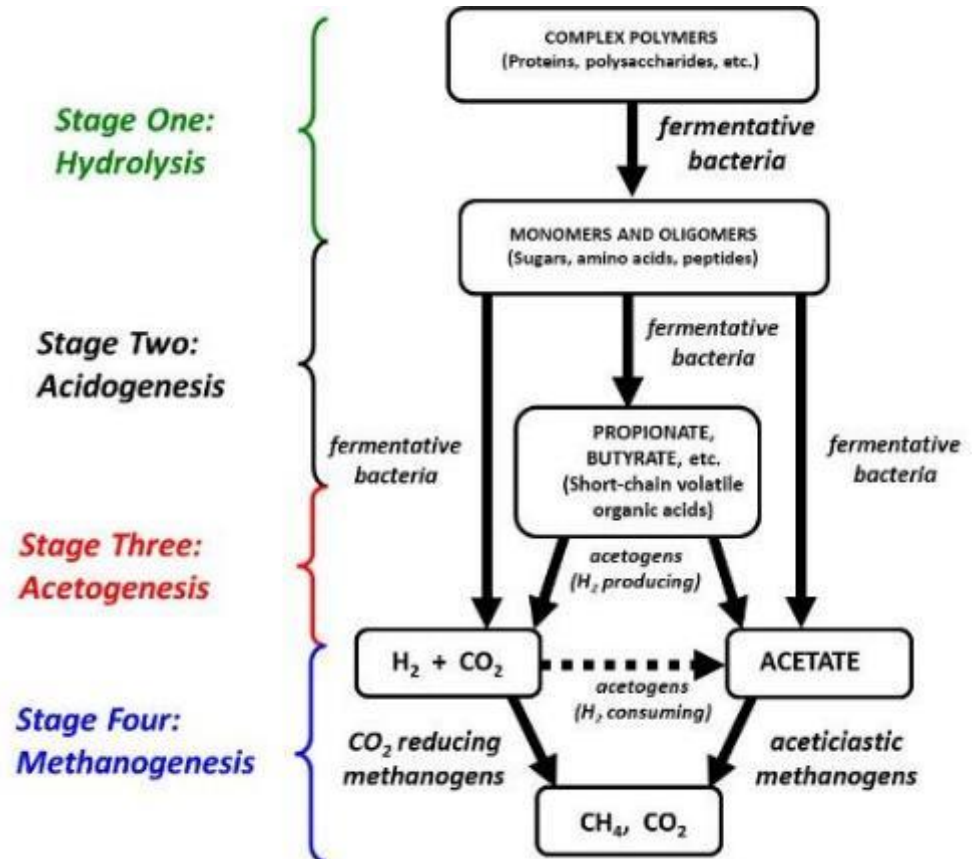


Process

- Naturally occurring microorganisms
- Temperature:
 - Psychrophilic >68°F
 - Mesophilic 95 to 105°F
 - Thermophilic 125 to 140°F
- Oxygen: limited/none
- Time: 4 – 40 days

Products

- Biogas (methane)
 - 60-70% methane
- Stabilized fertilizer



- Benefits
 - Biogas production
 - Odor / emission reduction
 - Volatile solids (chemical oxygen demand) reduction (stabilization)
 - Nutrient conversion: 25+% increase in inorganic nutrients
 - Pathogen reduction
 - Weed seed inactivation
 - Downstream processing benefit: thermal and chemical uniformity
- Myths
 - Volume reduction: <10% in slurry systems
 - Nutrient destruction: \approx 100% of nutrients retained (CH_4 & CO_2)



- Common
 - Covered storage (lagoon)
 - Plug flow
 - Mixed plug flow
 - Complete mix
- Innovative
 - Fixed film
 - Sequencing batch reactor
 - Induced-blanket
 - Two-stage (two-phase)
 - High solid / dry fermentation



Agricultural complete mix



Horizontal plug flow



Fixed film



Municipal complete mix



Covered lagoon



Technology Comparison

Characteristics	Covered lagoon	Plug flow	Mixed plug flow	Complete mix	Fixed film	Induced blanket	Two-stage	High solids
Vessel material	In-ground clay & synthetic	In-ground tank	In/Above ground tank	In/Above ground tank	Above ground tank	Above ground tank	Above ground tank	Above ground vault
Technology level	Low	Low	Medium	Medium	Medium	High	High	Medium
Heating	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TS range (%)	3-6	11-13	3-15	3-15	<1	<4	5	>20
Loading rate (kg VS/m ³ /d)	<0.20	1-6	1-6	1-10	5-10	5-10	2.4	?
Retention time (days)	60+	15+	15+	15+	<4	<5	10-13	>28

- Easy material to make biogas from
- Considerations:
 - Farm type
 - Manure collection, treatment, & storage
 - Bedding
 - Manure age
 - Additives and animal health
 - Contaminants



Manure Characteristics Vary

Housing	Bedding	Collection Frequency/Type	TS (%)	VS (%)	FS (%)	VS:TS (%)
Freestall	Sand	As excreted	15.0	12.8	2.6	85.3
		Daily scrape	23.7	7.3	16.4	30.8
		Sand separator effluent	5.4	3.2	4.5	59.4
Dry lot	Dried manure solids	As excreted	14.3	11.5	2.8	80.7
		Daily scrape	21.9	15.1	6.7	69.3
		Weekly scrape	58.8	22.6	36.2	39.1

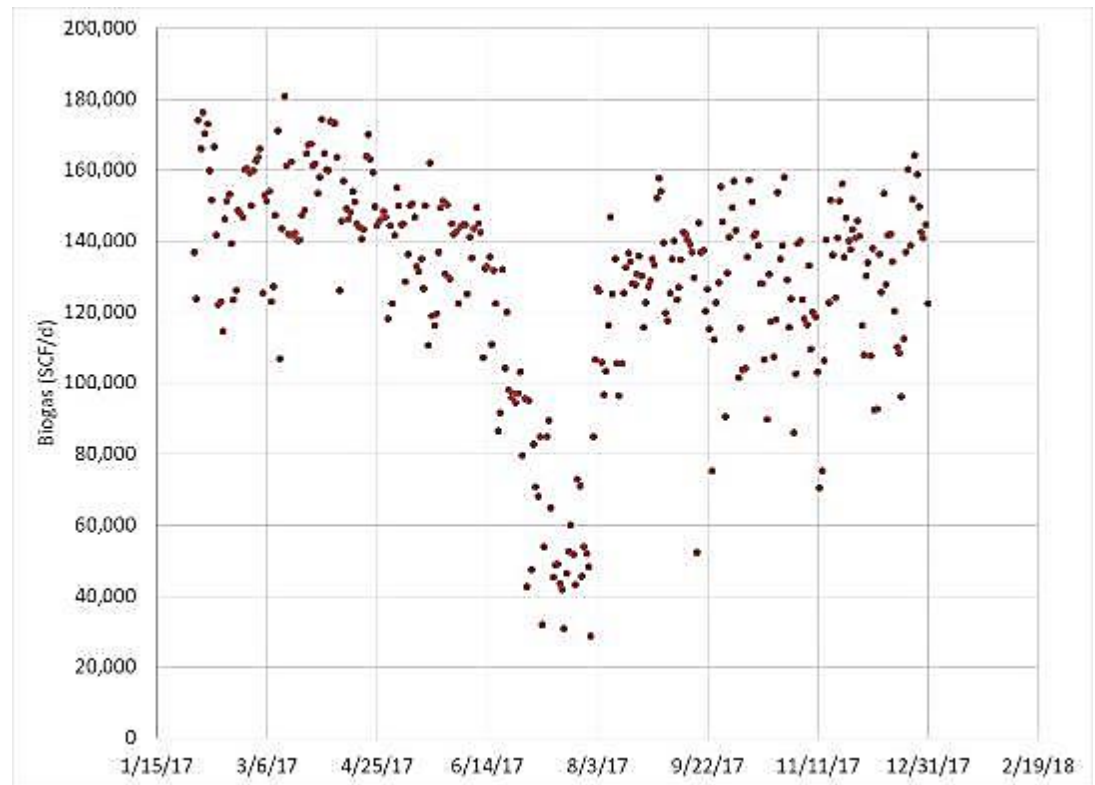
Source: http://northeast.manuremanagement.cornell.edu/Pages/General_Docs/Events/3.Dana.Kirk.pdf



Dairy Farm Types & Manure “Age” – Biogas

Housing	Bedding	Collection Frequency/Type	Biogas Potential Ave. (ft ³ of biogas/lb of VS%)
Freestall	Sand	Sand separator effluent	6.4
Dry lot	Dried manure solids	As excreted	8.8
		Daily scrape	8.2
		Weekly scrape	5.4

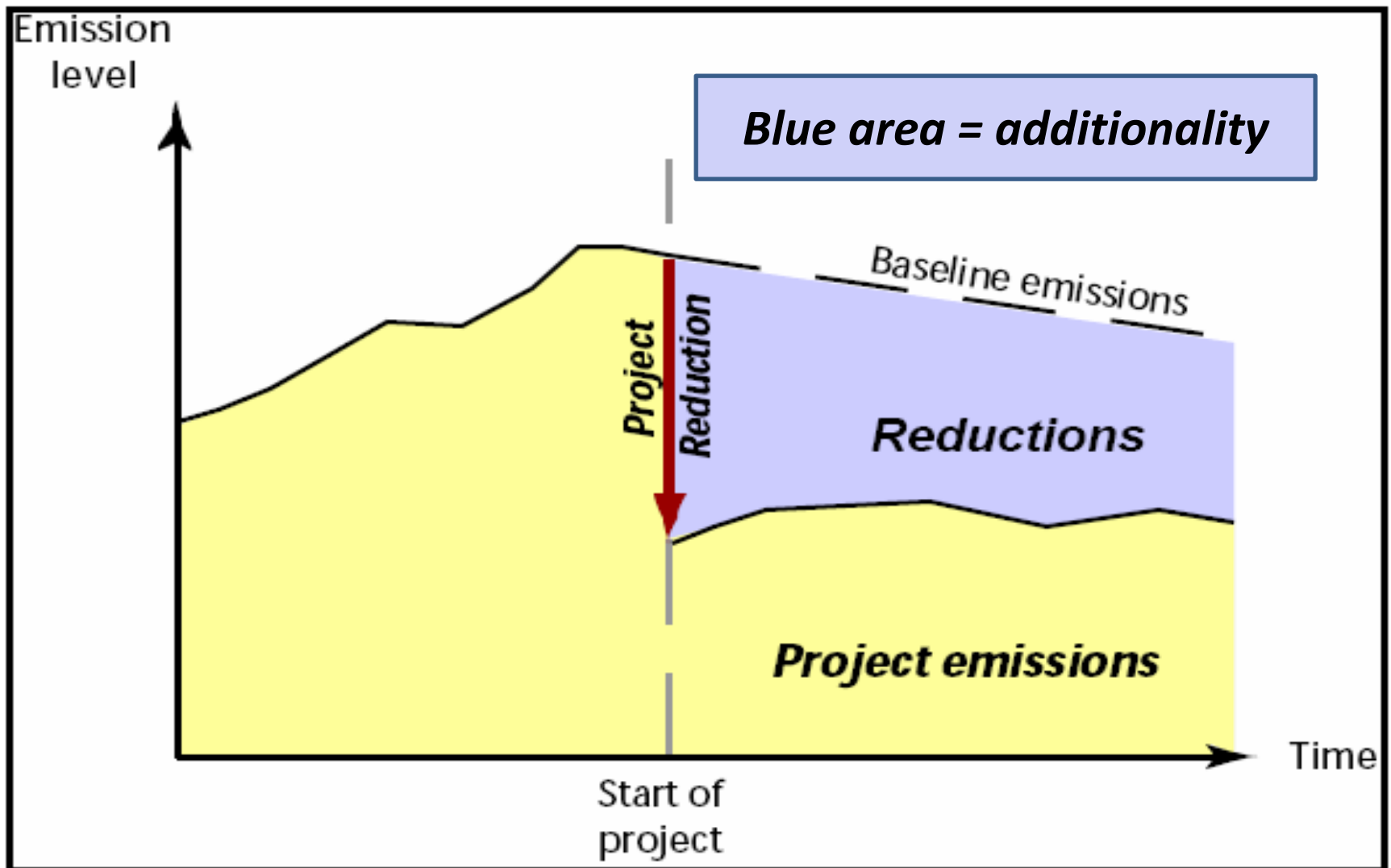
- Manure age
- Additives and animal health
- Contaminants



Renewable Natural Gas (RNG)

- Commodity natural gas
- Renewable Fuel Standard Renewable Identification Number
- Low Carbon Fuel Standard Credit





- Landfill gas
- Biogas from
 - WWTP “activated sludge and biosolids – which are aerobically treated residuals from the processing of municipal wastewater solids” (22% cellulose, 36% hemicellulose, 21% lignin)
 - Anaerobic digesters that process predominantly cellulosic materials, including animal manure, crop residues, and/or separated yard waste
- Other feedstocks which do not meet the 75% cellulosic threshold can generate a D5 RIN



Transfer Years

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
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Data Sets

RIN Price Data ▼

RIN Price Data

Transfer Date ... Fuel (D Code) QAP Service T... RIN Price Transfer Year

Dimensions

- Transfer Date by Week
- Transfer Year
- RIN Year
- Fuel (D Code)
- QAP Service Type

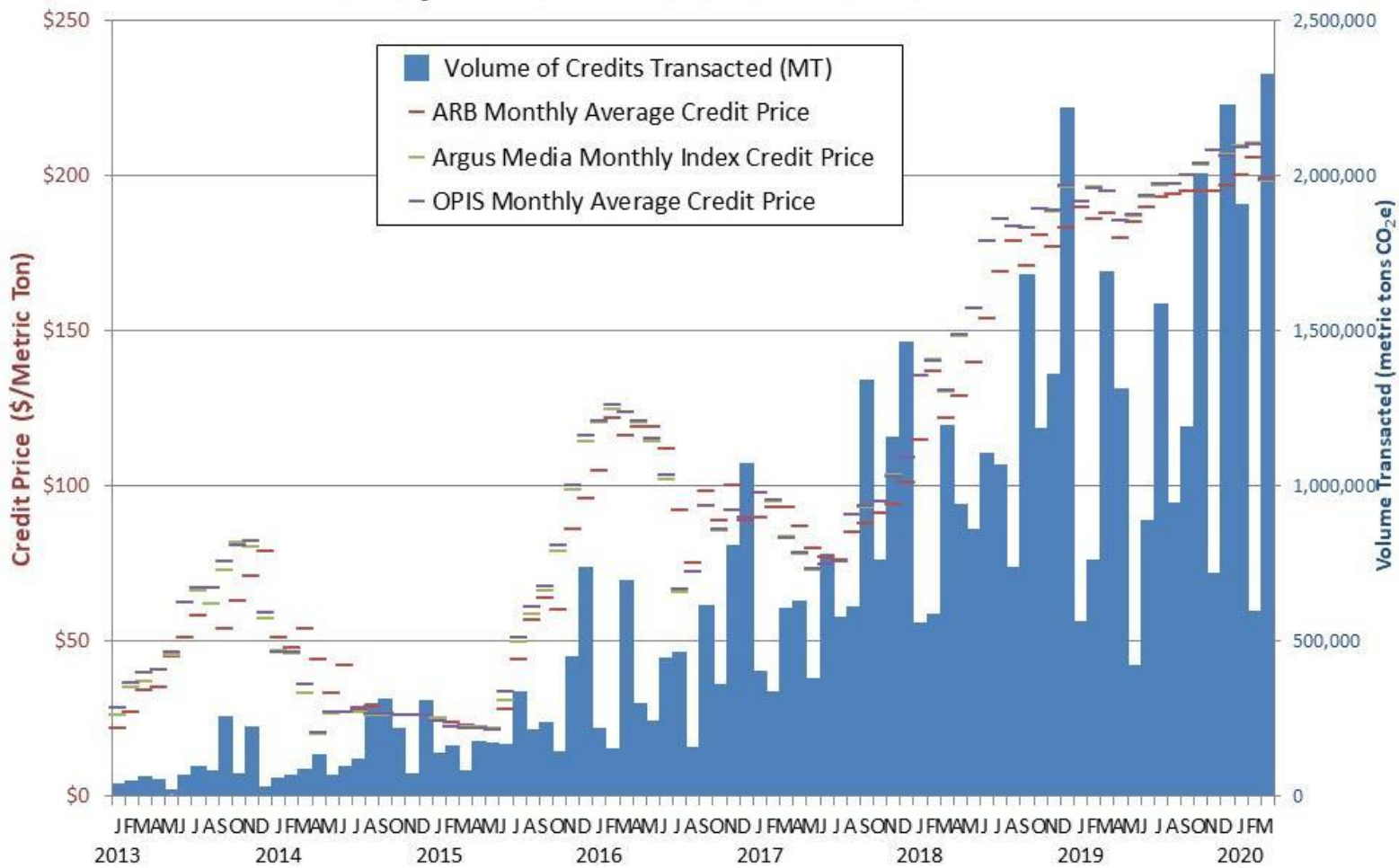
Measures

- RIN Price

Transfer Date by Week	Fuel (D Code)	QAP Service Type	RIN Price	Transfer Year
03/16/2020	D6	Q-RIN	\$0.19	2020
03/16/2020	D6	Unverified	\$0.09	2020
03/23/2020	D3	Q-RIN	\$1.33	2020
03/23/2020	D3	Unverified	\$0.51	2020
03/23/2020	D4	Q-RIN	\$0.53	2020
03/23/2020	D4	Unverified	\$0.52	2020
03/23/2020	D5	Q-RIN	\$0.43	2020
03/23/2020	D5	Unverified	\$0.56	2020
03/23/2020	D6	Q-RIN	\$0.25	2020
03/23/2020	D6	Unverified	\$0.23	2020
03/30/2020	D3	Q-RIN	\$1.52	2020
03/30/2020	D4	Q-RIN	\$0.56	2020
03/30/2020	D4	Unverified	\$0.51	2020
03/30/2020	D6	Unverified	\$0.18	2020



CA LCFS Performance 2013-2020



- Qualifiers
 - Storage depth (>1 m) and duration (> 1 month)
- Baseline modifiers
 - Ambient temperature
 - Cleanout frequency & timing
 - Treatment that reduces solids to lagoon
- Biogas control system modifiers
 - Biogas production & methane content
 - Treatment that reduces solids to lagoon
 - Lagoon covers
 - Process energy consumption



Manure Management	CI Score	Credit Price (\$/mton)	Gasoline Equiv. (\$/gal)
Limited storage or extensive separation	-50	\$200	\$3.32
	-100	\$200	\$4.48
Sand & solid separation	-150	\$200	\$5.63
	-200	\$200	\$6.79
Scrape to lagoon, no solids loss	-250	\$200	\$7.95
	-300	\$200	\$9.11

- Understand qualification & experience of the team
 - History with dairy projects
 - Engineering understanding of dairy farm operations
 - Fund strength & project timing track record
- Partner Investment strategy
 - Farm value proposition; lump sum, net revenue, gross revenue...
 - Long-term partner or build and exit
 - Impact on your equity/value
- Project complexity
 - Manure processing/treatment
 - Manure/biogas transport



- Easy material to make biogas from!
- Great opportunity for MI dairy industry
- Impact on your dairy operation – will not be insignificant
- Maximize your value proposition
- Seek guidance – legal, financial & technical
- Need to address some State specific challenges (EGLE, MPSC)



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