Tips for the Successful Development of Renewable Natural Gas Projects

75th Annual Environmental Engineering Conference

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Introductions

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Presentation Overview

- What is RNG?
- RNG Overview and General Project Elements
- Why Co-Digestion
  - Sustainability Drivers
  - Market Drivers
  - Capacity & discharge considerations
- Developing Manure RNG Projects
- RNG Market Discussion
- RNG Project Examples

Typical Constituent / Contaminant					Pipeline Specification
Constituent	**Units**	**Manure / Organics**	**Landfill Gas**	**Municipal WWTP**	
Methane	% by vol	55-70	45-55	55-70	>94% (950 btu/cf)
Carbon Dioxide	% by vol	30-45	25-40	30-45	<2%
Oxygen	% by vol	0-1	**0.25-3**	0-1	<0.001-0.2
Temperature		At the Point of Custody Transfer			<100-120°F
Water Vapor		100% saturated			≤ 7 pounds per million scf
Hydrogen Sulfide	ppmv	200-**10,000**	<1,000	200-3,000	< 4 ppm
Siloxanes	ppmv / ppb	Not Typical	**Typical**	**Typical**	0.01-1 mg Si/m^3

What is Renewable Natural Gas (RNG)?

Biogas can be cleaned, conditioned and injected into natural gas pipelines as Renewable Natural Gas (RNG).

RNG can be used as a feedstock for:

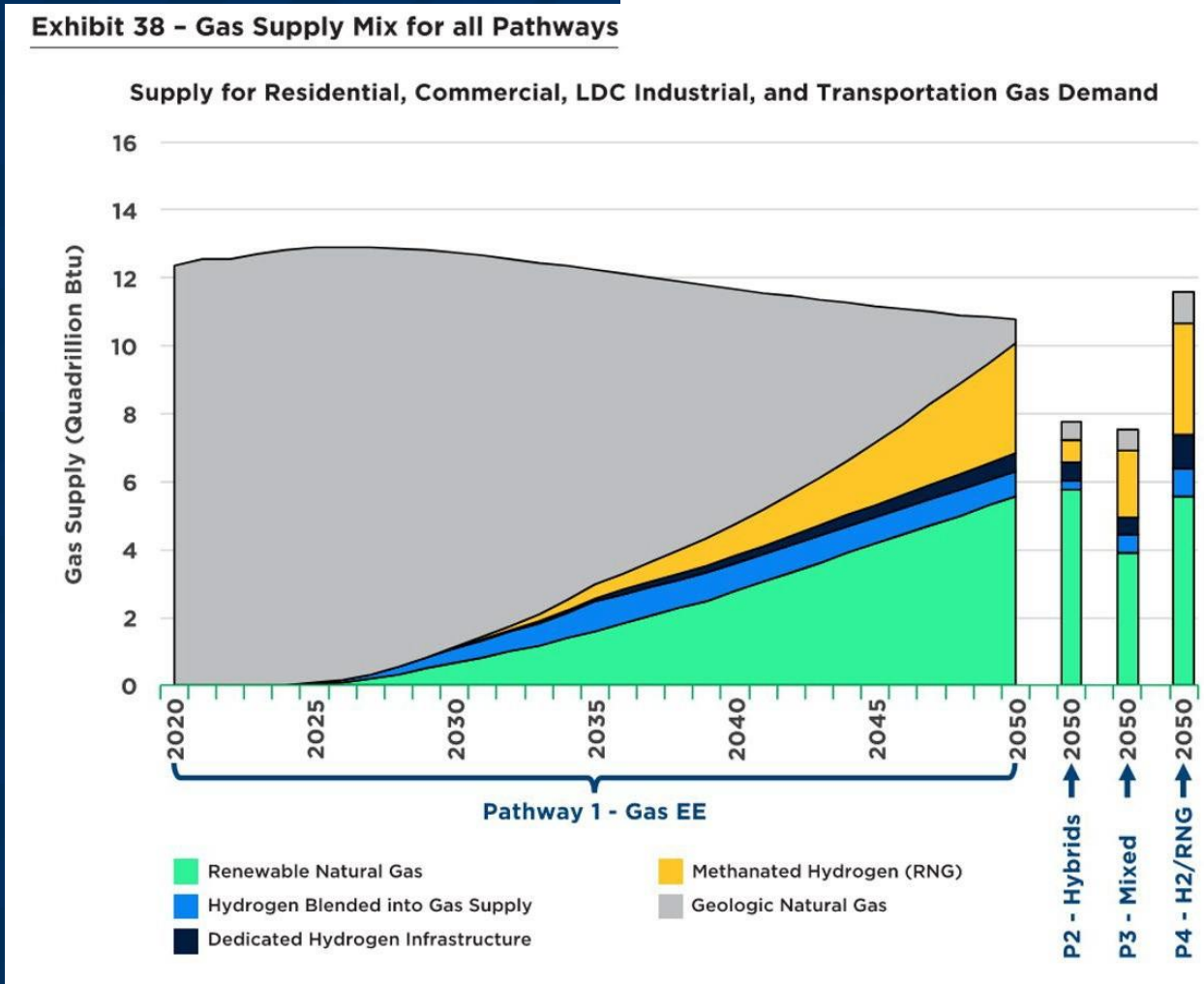
- Transportation
- Fuel Refining
- Pipelines
- Power Generation
- Manufacturing

Biogas Sources

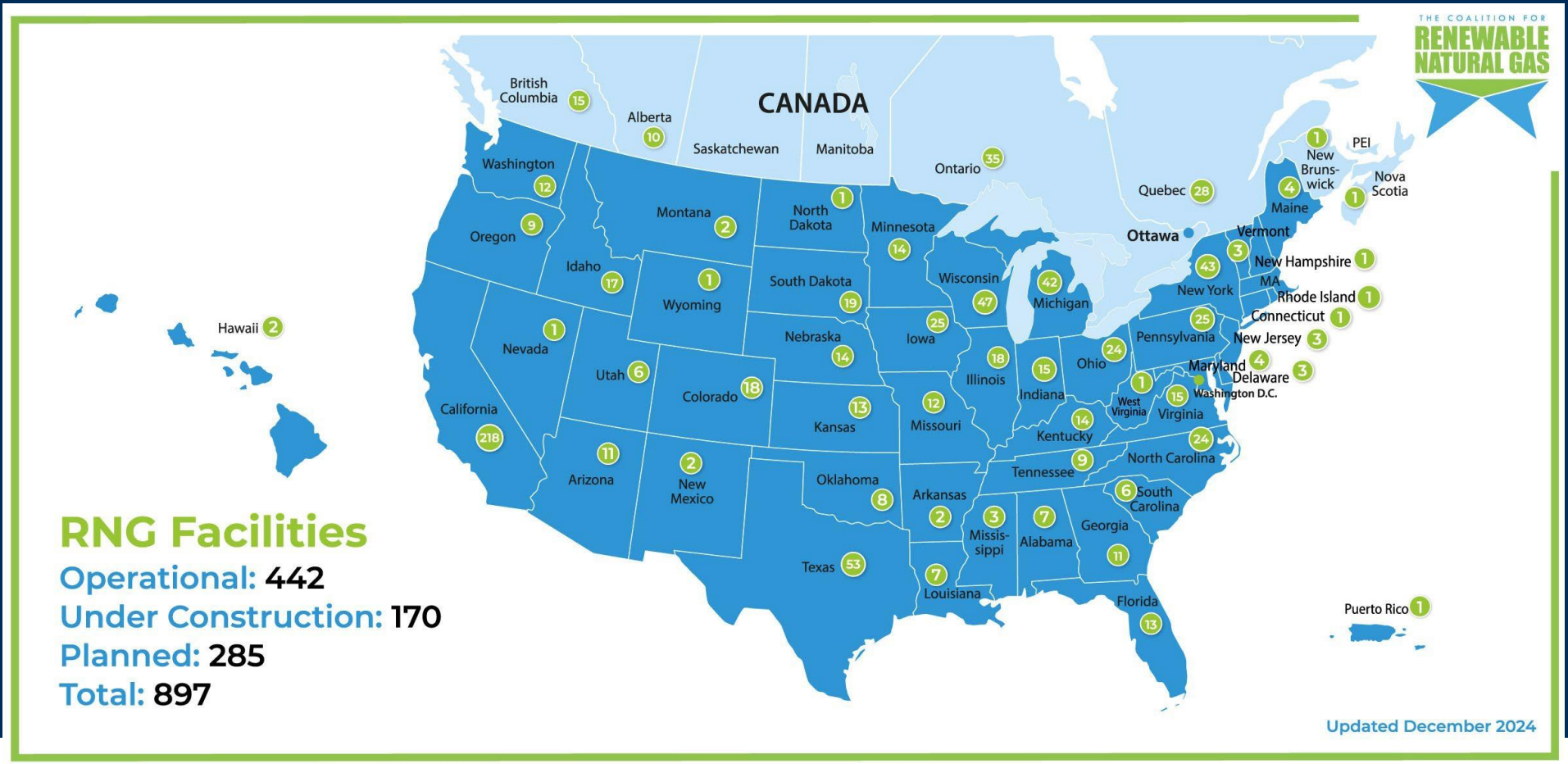
- Agriculture
- Food Waste
- Wastewater
- Landfills

What is Renewable Natural Gas (RNG)

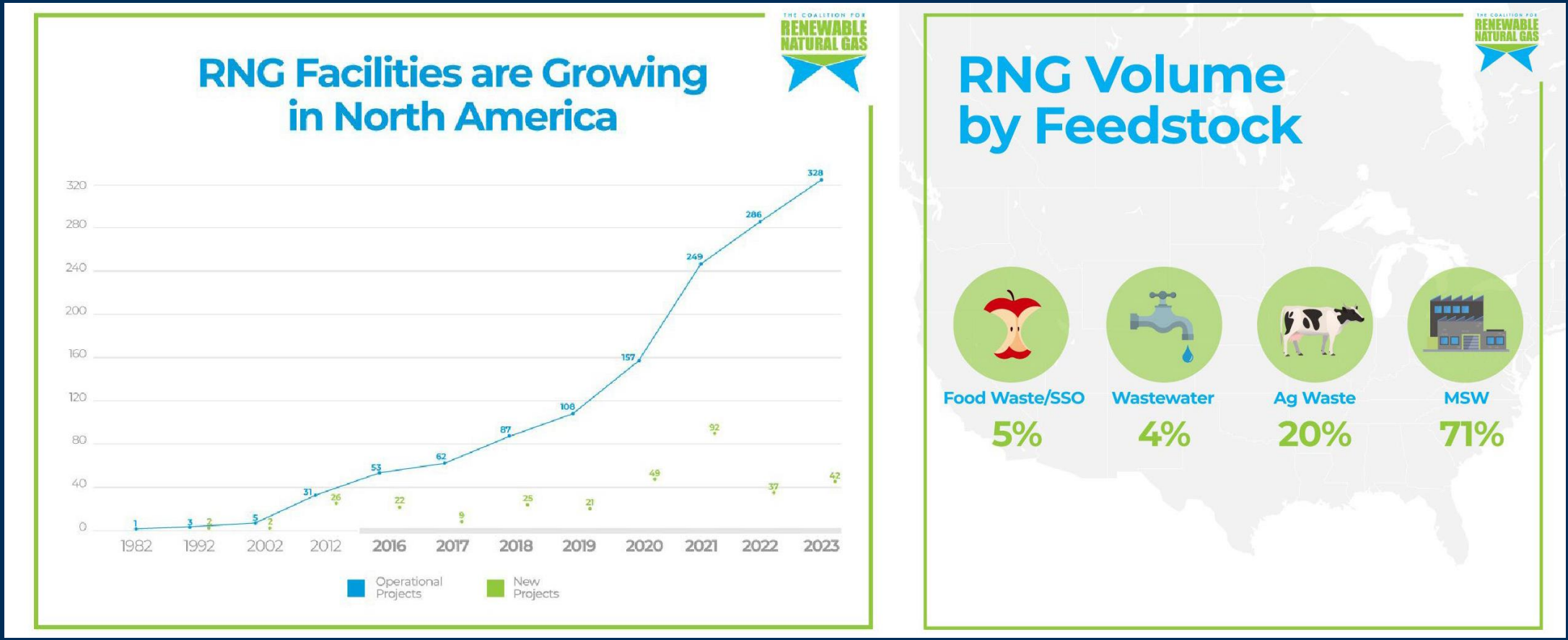
To meet Net-Zero Goals, The American Gas Association predicts that RNG will account for 51% of natural gas supply by 2050.



Active RNG Projects



Active RNG Projects



RNG PROSPECTS

Operational Biogas Systems: 2,478

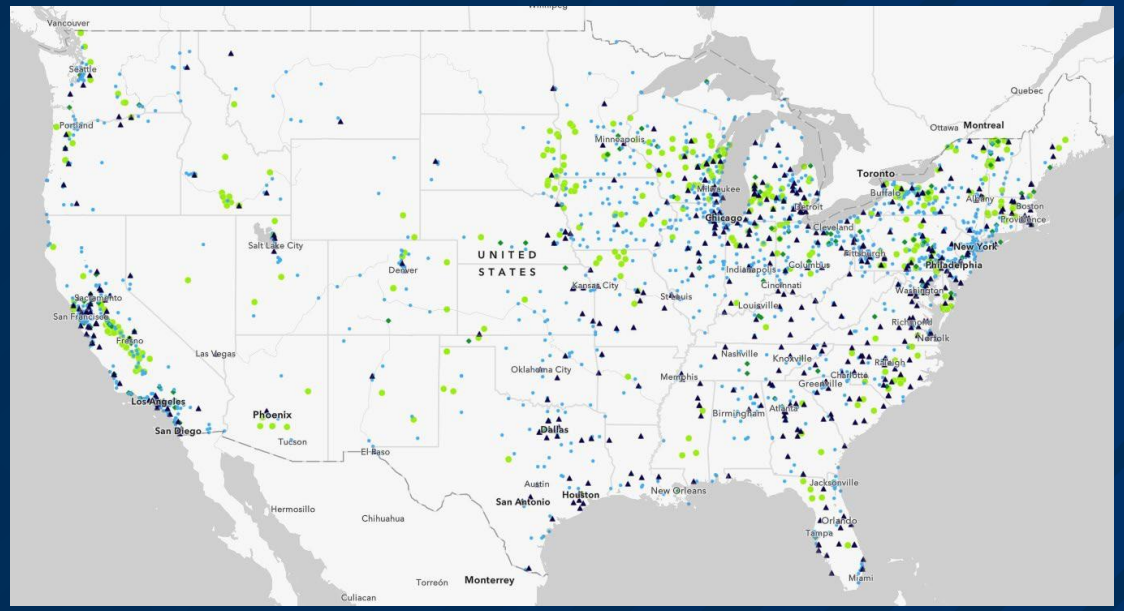
- 566 RNG
- 1,418 Electricity

- 615 on Farm
- 1,169 Wastewater
- 114 Food Scrap
- 580 at Landfills

Potential New Biogas Systems: 24,000

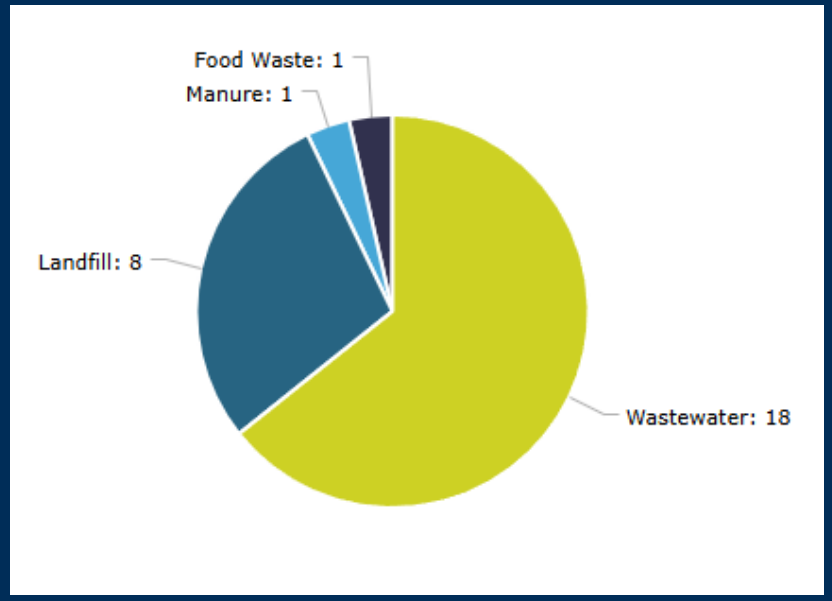
- 17,000 on Farms
- 4,000 Wastewater
- 1,700 Food Scrap
- 740 at Landfills

Information Courtesy of Championing the Biogas Industry | American Biogas Council

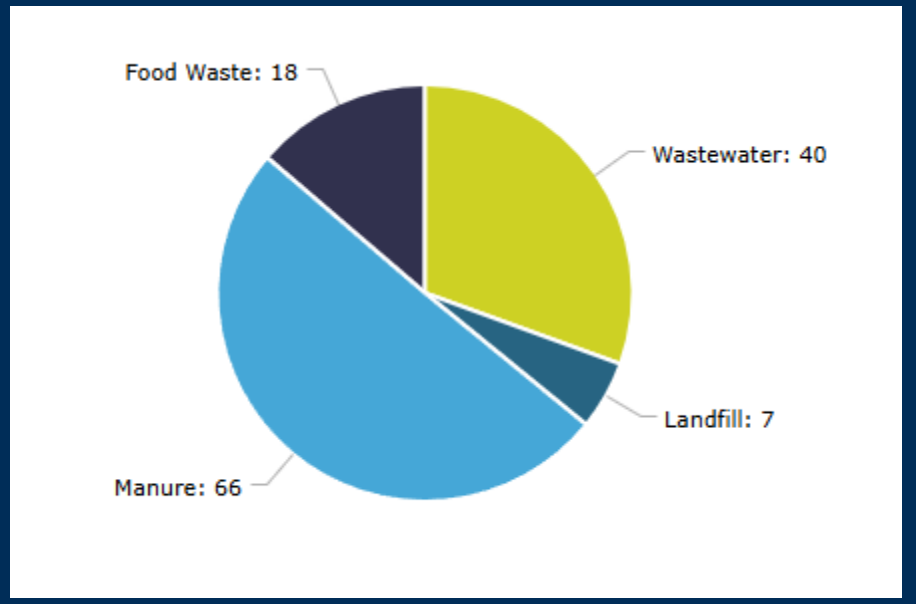


Biogas Use Prospects - Kansas

Current Systems



Potential Systems



Biogas & RNG Project Elements

Feedstock

- Gas Collection Systems
- Quality Management (Digestion)

Digesters

- Design
- Digestate / odor management
- Operations consulting

Gas Processing

- Pre-treatment
- Upgrading
- Compression
- PHA

Gas Logistics

- Interconnects
- Metering stations
- ROW acquisition
- Route permitting

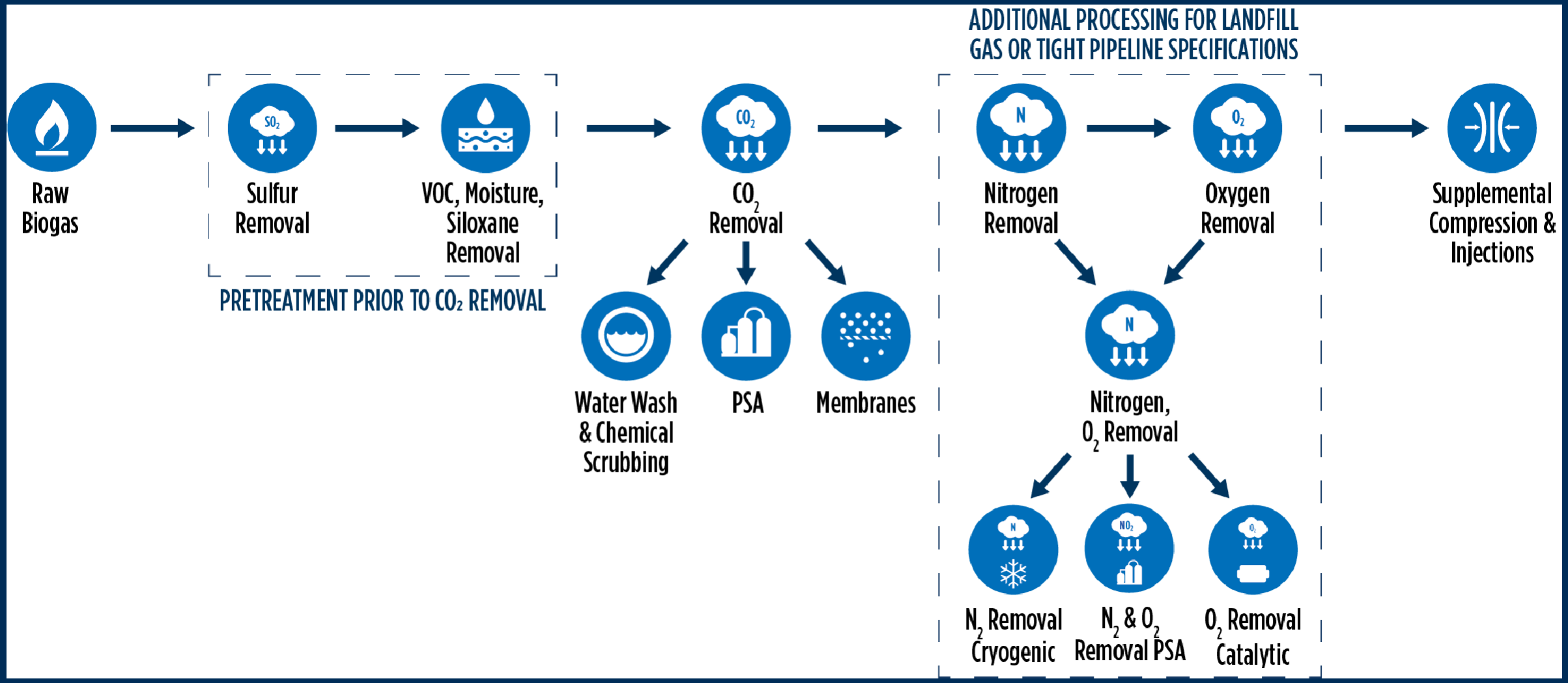
Electrical

- Interconnects
- Substations
- Electric generation
- Standby power

Compliance

- Air
- GHG
- Waste
- Wastewater

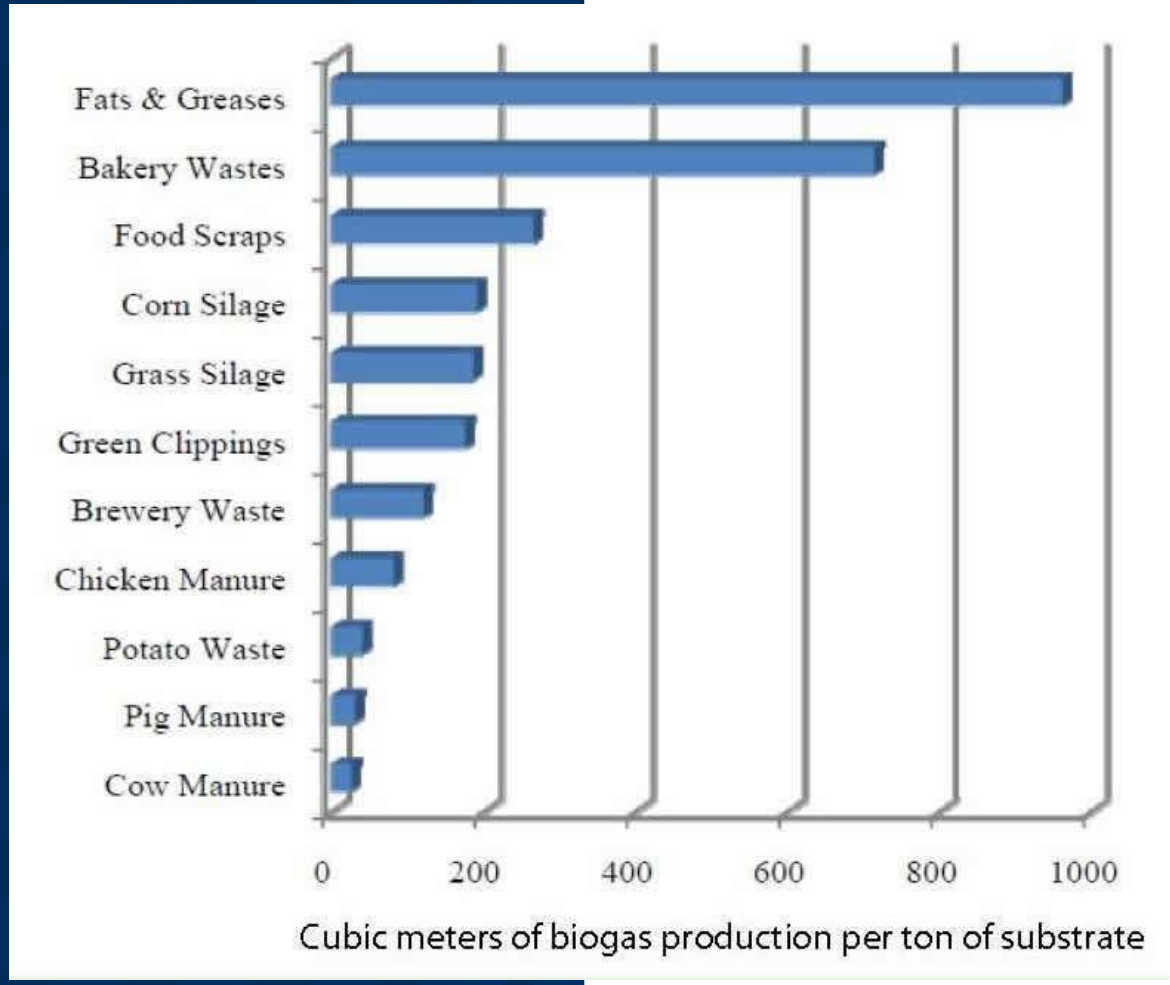
Gas Treatment / Upgrading Options



WWTP and Co-Digestion Considerations

Co-Digestion of Food Waste In Kansas

- ~ 600k Tons of food waste landfilled /year.
  If digested, it would offset approximately:
  - 200k MTCO2e.
  - 22 Million Gallons of Gasoline
  - 42,000 Vehicles Annually
  - Baseline: National Average (Mix of landfills with and without collection systems)



Co-Digestion of Food Waste In Kansas

Can bring in additional revenues / reduces costs through:

- Increased biogas production
- Environmental Attributes
- Tipping fees waste acceptance

Co-Digestion Considerations

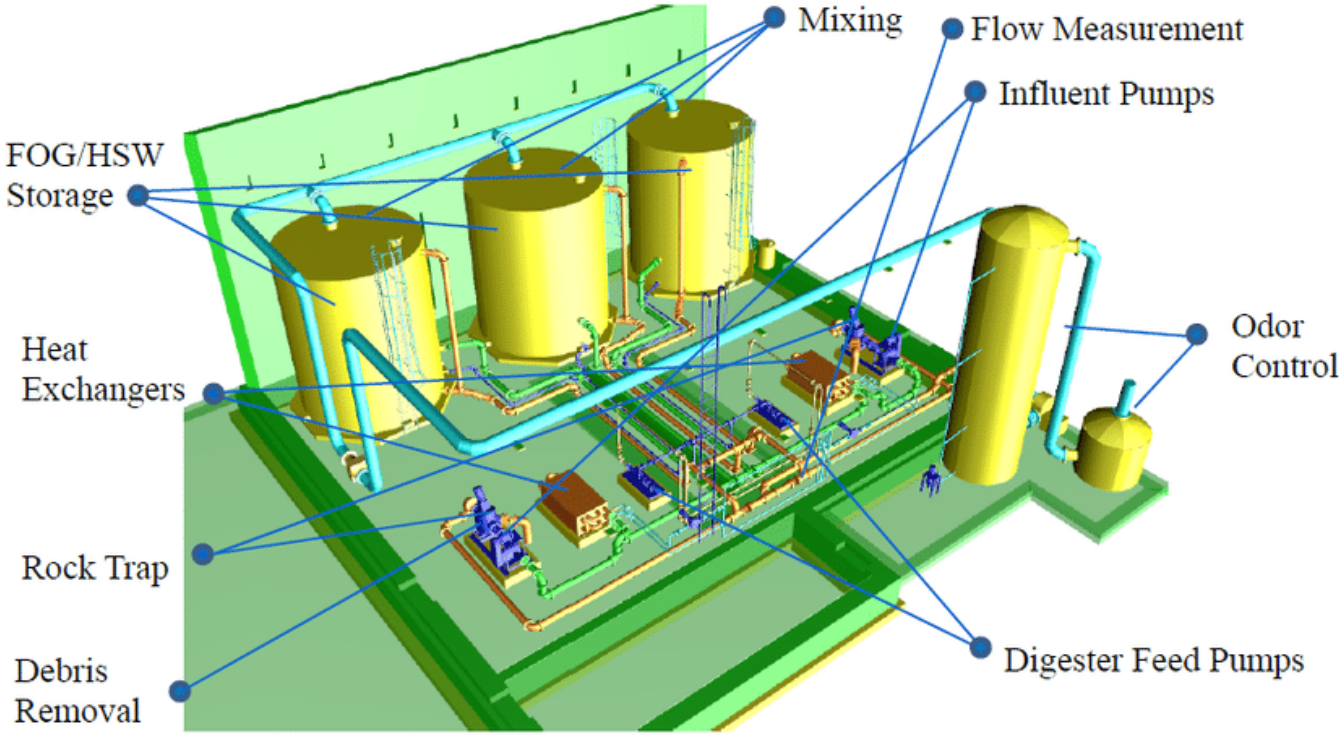
Collection & Pre-Processing

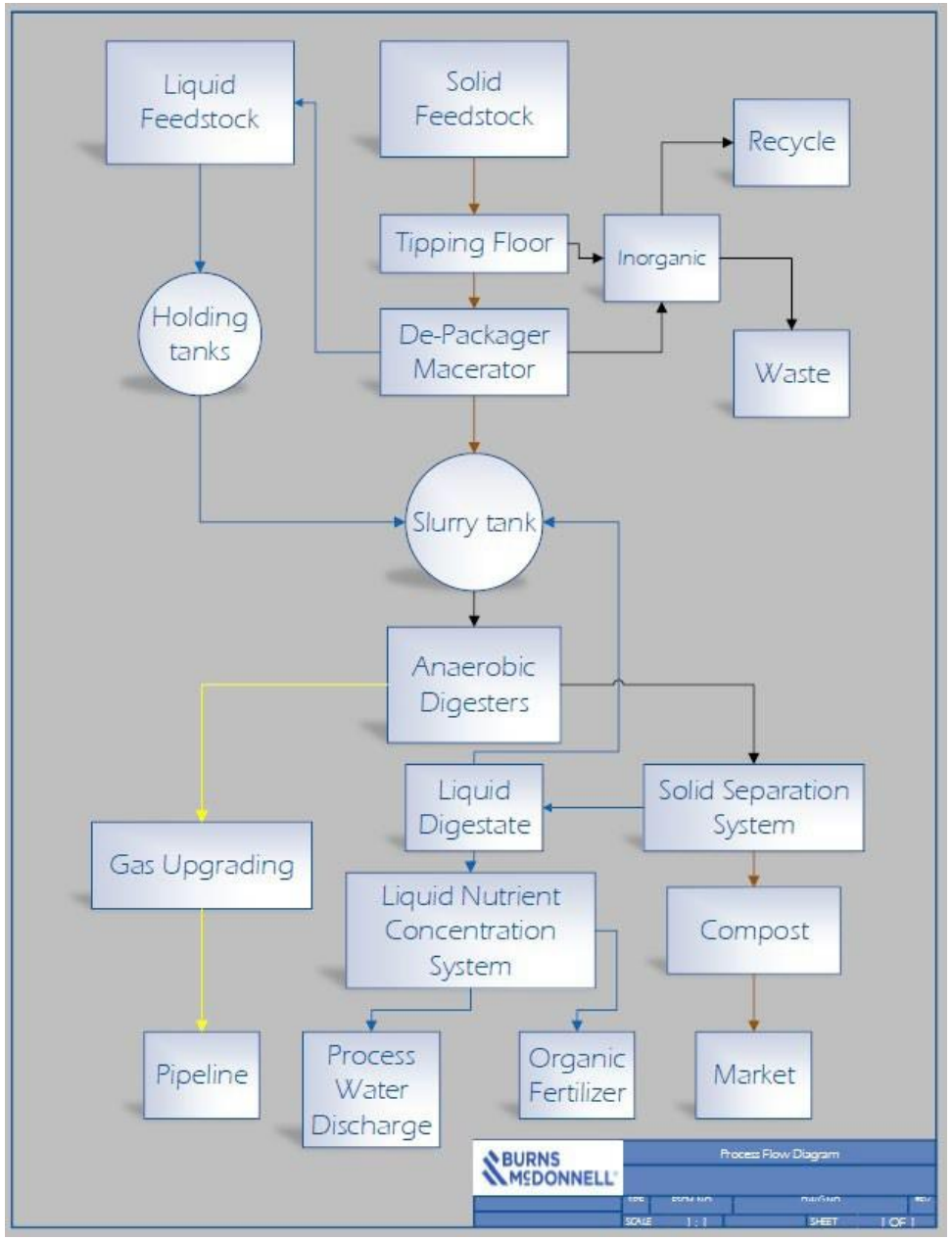
- Pre-consumer wastes, FOG (easier)
- SSO (varies by source, but requires training and learning new behaviors)
- Grit / contaminant removal, more labor intensive, more energy

Effluent Management

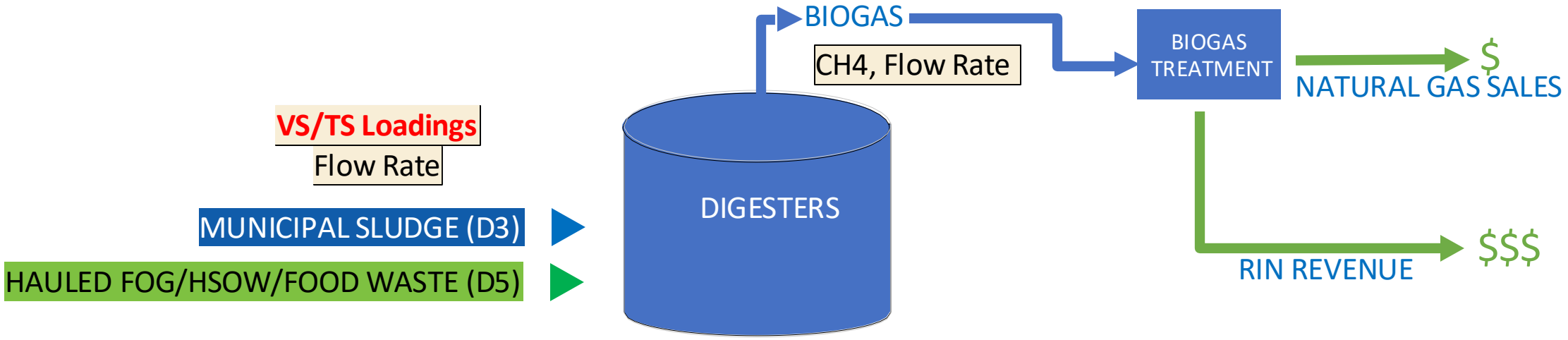
- Can increase N, P, and dissolved solids (impacts to treatment capacity)
- Digestate characteristics altered, contamination could alter current beneficial uses

Co-Digestion Pre-Processing





Co-Digestion – RIN Apportionment



Method 1

- Biogas Production Data with Sludge (cellulosic only)
- Calculated cellulosic converted fraction from data
- Difference in Total Biogas and Converted Cellulosic Fraction = Non-Cellulosic Fraction (D5)

Method 2

- Use a predetermined cellulosic converted fraction
  - 0.15 kg methane / kg of VS
  - Difference in Total Biogas and Sludge Biogas = Non-Cellulosic Fraction (D5)

Developing Manure RNG Projects

Site Selection

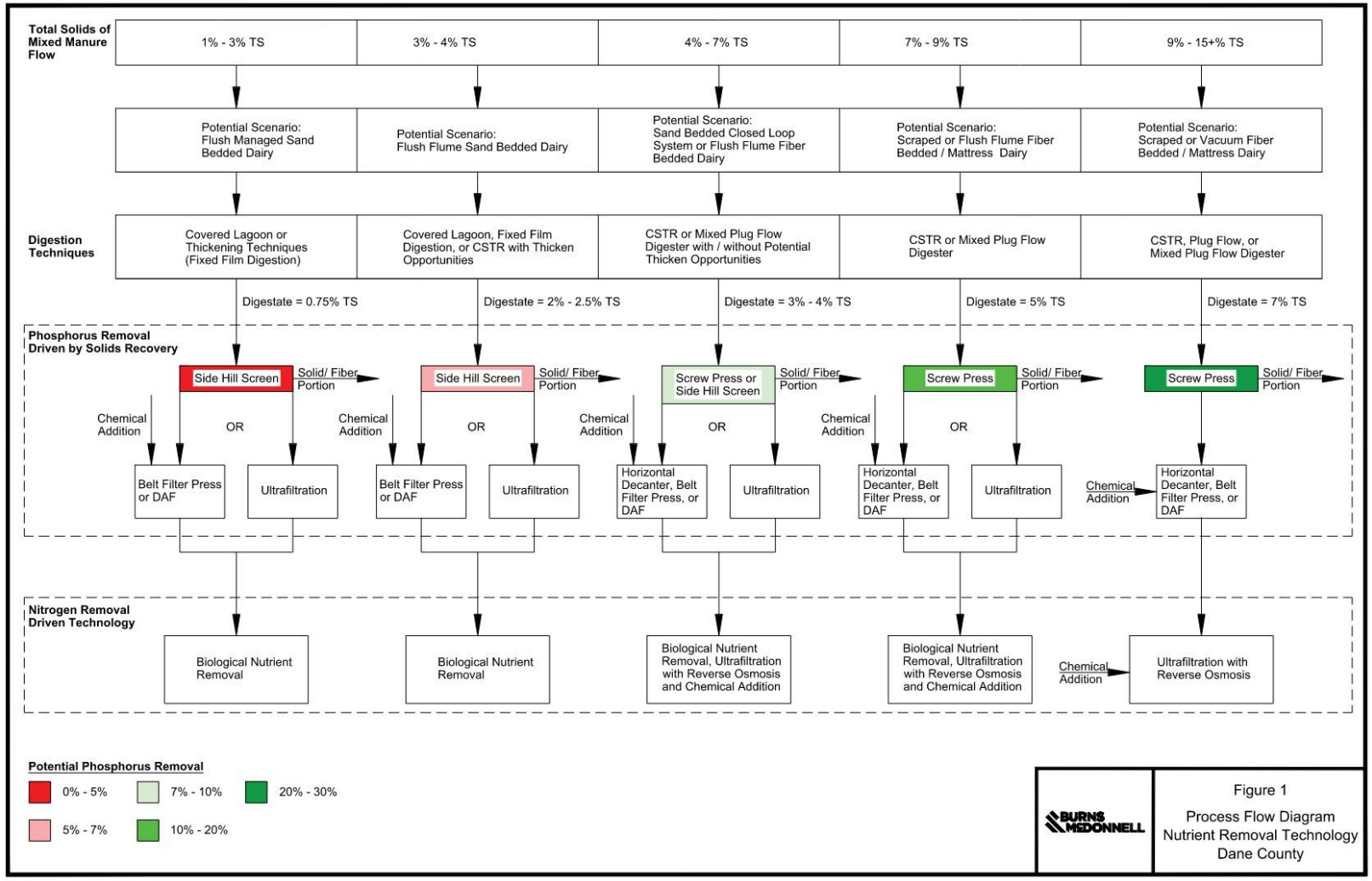
Appendix A - Matrix Ranking Criteria

BURNS McDONNELL			Ranking Criteria
State: Wisconsin	**Criteria**	**Imp. Factor**	
Host Site Development			
Land Availability *Available Space and Transportation Infrastructure to Site a Community Digester*	Land Availability	3	% of land zoned for agriculture, 3 > 60%, 2 = Between 60% - 40%, 1 = Between 20% - 40%, 0 < 20%
	Vehicle Access	3	3 =State/US Highway, 2 = County Highway, 1 = Local Roads
	Interstate, Rail, or Major Highway Access	1	3 = Yes; 1 = No; If the township has one and not the other, 2 can be used.
	Grading Considerations	2	3 = Flat; 2 = mostly flat; 1 = flat portions, some hills; 0 = mostly hilly
Population Density	Population Density and Growth	2	3 => 50 people/sq. mile; 2 = Between 275 - 50 people/sq. mile; 1 = Between 275 - 1700 people/sq. mile; 0 =< 1700 people/sq. mile
Utility Availability *Distance to Utilities*	Availability of 3-Phase Power Lines	3	3 = Yes; 0 = No
	Availability of Natural Gas Pipelines	3	3 = multiple (5+) pipelines available, 2= several (3-4) pipelines available, 1 = pipelines (1-2) available, 0 = no pipelines in the area
Environmental & Permitting Considerations *Distance to Environmentally Sensitive Areas*	Navigable Lake, Pond, River, or Stream Nearby	1	% of land that is a body of water, 3 < 0.5%, 2 = Between 0.5% - 1%, 1 = Between 1% - 2%, 0 > 2%
	Wetlands Impacts nearby	2	% of land that is wetland, 3 < 5%, 2 = Between 5% - 10%, 1 = Between 15% - 10%, 0 > 15%
	Distance to Groundwater	2	3 => 10'; 2 = Between 10-5'; 1 = Between 5"-3'; 0 =< 3'.
	Nutrient Loading (TMDL)	3	% of land within the Yahra Rivershed. 3 > 85% reduction in Yahara Watershed, 2= Between 30% - 85% reduction in Yahara Watershed, 1 < 30% reduction in the Yahara Watershed. 0= No improvement of the Yahara Watershed
	Floodplains	1	% of land within a floodplain, 3 < 5%, 2 = Between 5% - 10%, 1 = Between 15% - 10%, 0 > 15%
	County Zoning	1	3 = Yes; 1 = No
Manure Availability			
Manure Availability *Cattle and farm availability*	Head of Cows per Township	3	3 = > 7,500 head; 2 = Between 7,500 - 5,000 head; 1 = Between 5,000 - 1,000 head; 0 = < 1,000 head
	Ratio of Cows/Farms	2	3 => 300; 2 = Between 300 - 150; 1 = Between 150 - 50; 0 =< 50
	Number of Farms	2	3 = > 30 farms; 2 = Between 30 - 15; 1 = Between 15 - 10; 0 = < 10

Several important factors to consider when selecting a site:

- Land availability
- Urban / rural environment
- Environmental & Permitting
- Feedstock availability (manure)

Manure and Nutrient Management



Manure Management

- How is manure collected / processed?
- The TS content of the manure will drive digestion technology

Nutrient Management (Post-Digestion)

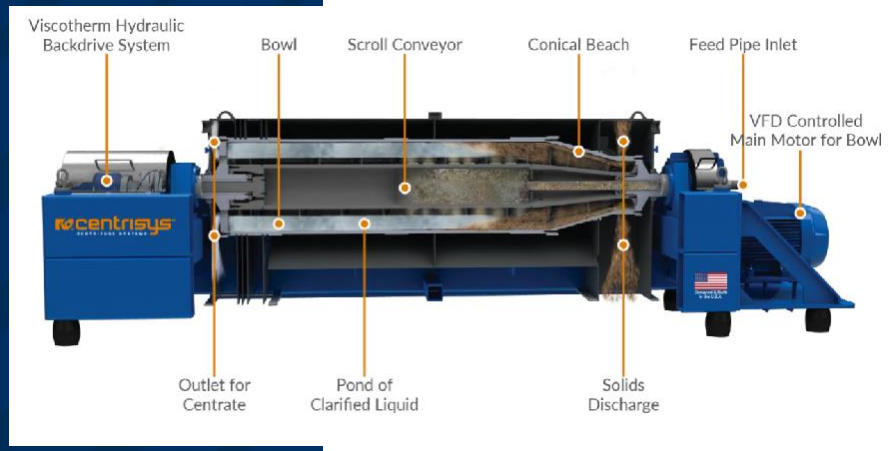
- Nutrients such as N and P can be recovered for land application or removal from the watershed.
- The solid or fiber portion of the digestate can be reused as bedding or compost
- The TS content of the digestate will drive nutrient recovery technology

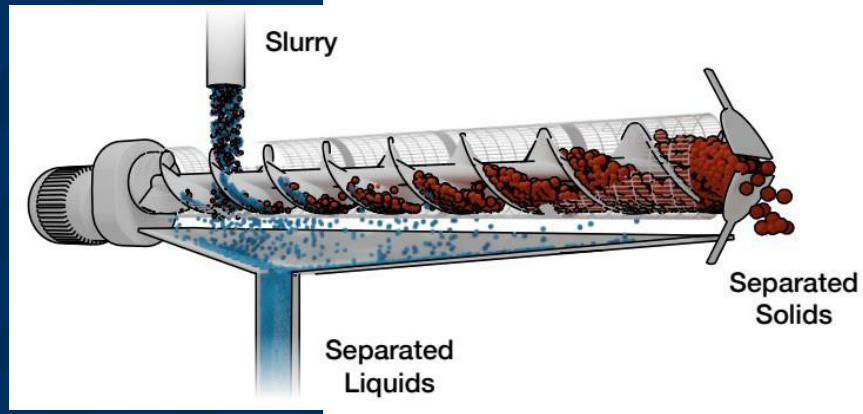
Nutrient Recovery

Nutrient Recovery Technologies

- Side Hill Screen
- Screw Press
- Horizontal Decanter
- Belt Filter Press
- Dissolved Air Floatation (DAF)

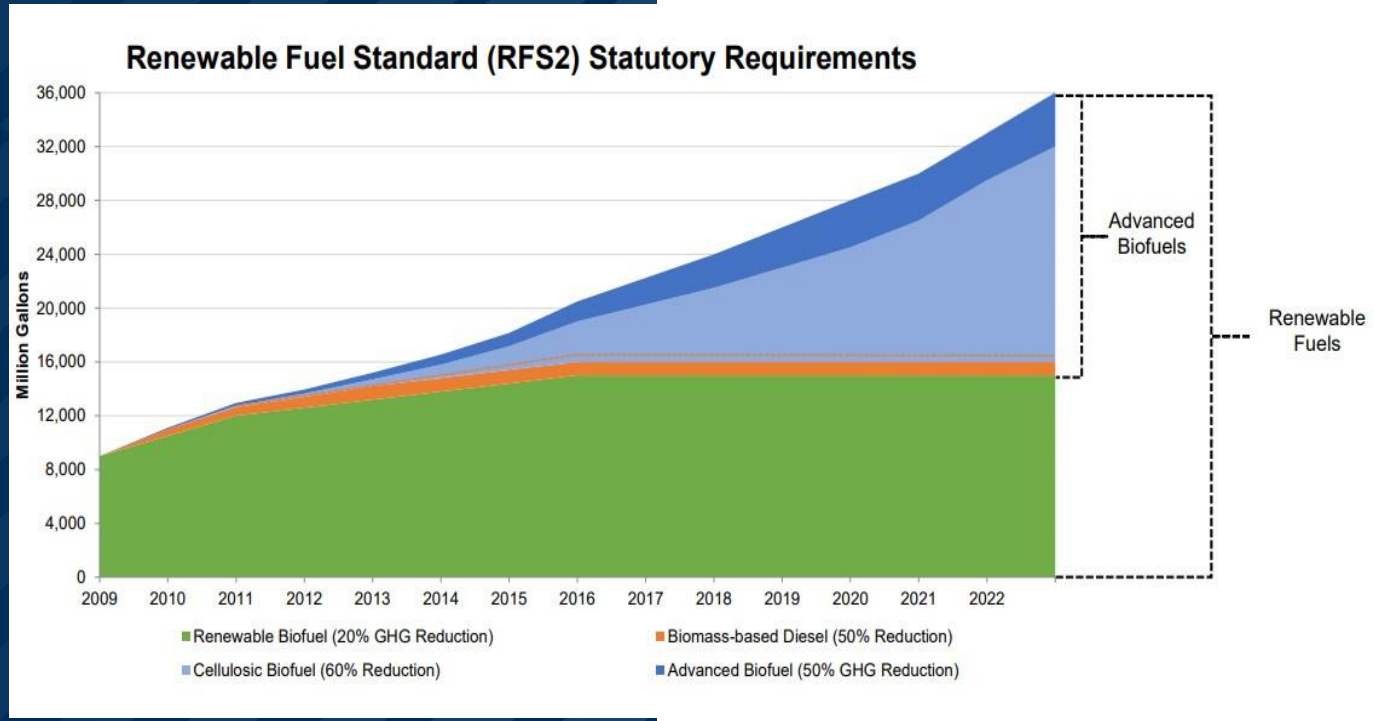
Technology selection will depend on the TS content of the digestate, the nutrients desired for recovery, and the level of nutrient removal required for discharge





RNG Markets

Renewable Volume Obligations (billion RINS)	2023	2024	2025
Cellulosic biofuel (D3)	0.84	1.09	1.38
Advanced biofuel (D5)	5.94	6.54	7.33



Renewable Fuel Standard (RFS)

WWTP Solids = Cellulosic Biofuel (D3)

Food Waste = Advanced Biofuel (D5)

Biointermediate to include: “biogas used to make a renewable fuel other than RNG”

EPA's original goal was 16 billion gallons of cellulosic biofuel by 2023.

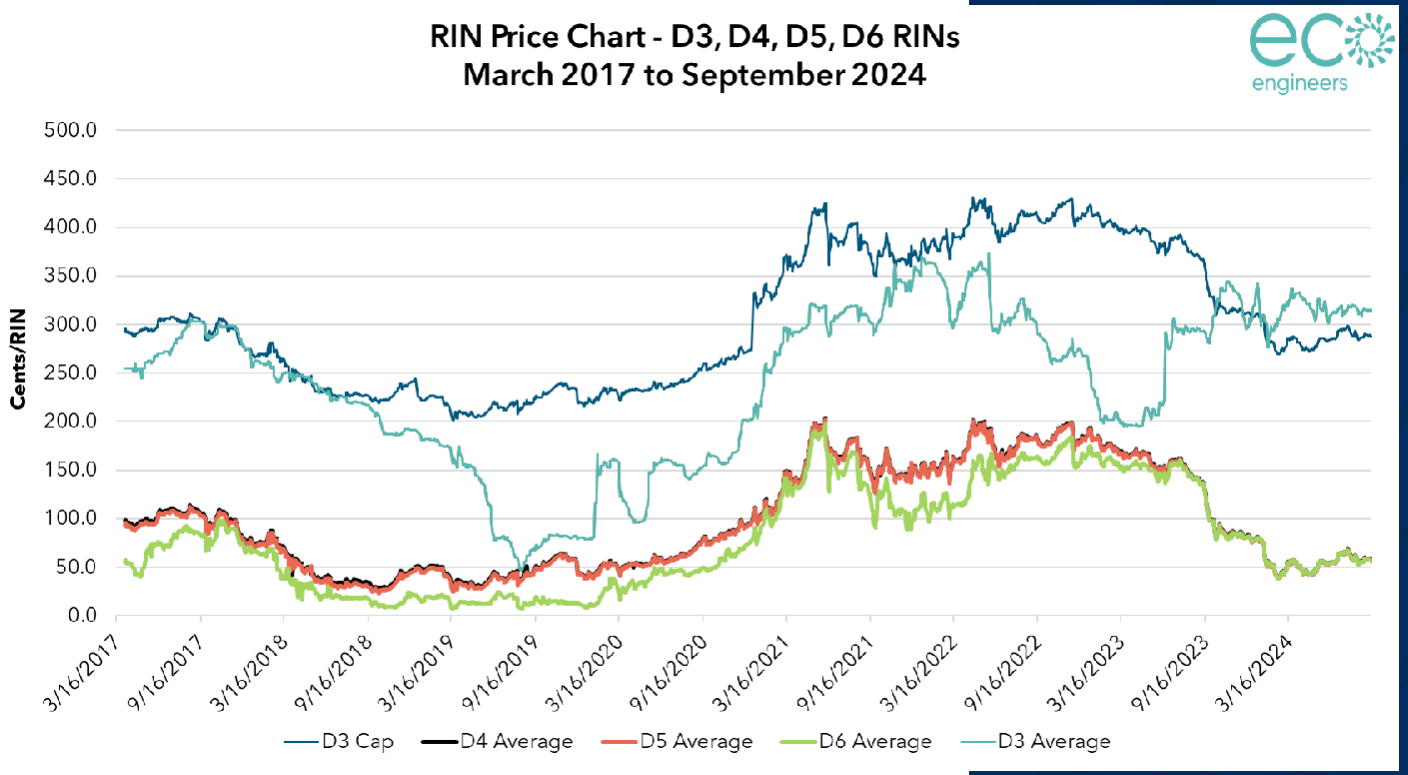
RNG Pricing as of Feb 25, 2025

D3 RIN: $2.50

= $30 / MMBtu

D5 RIN: $0.80

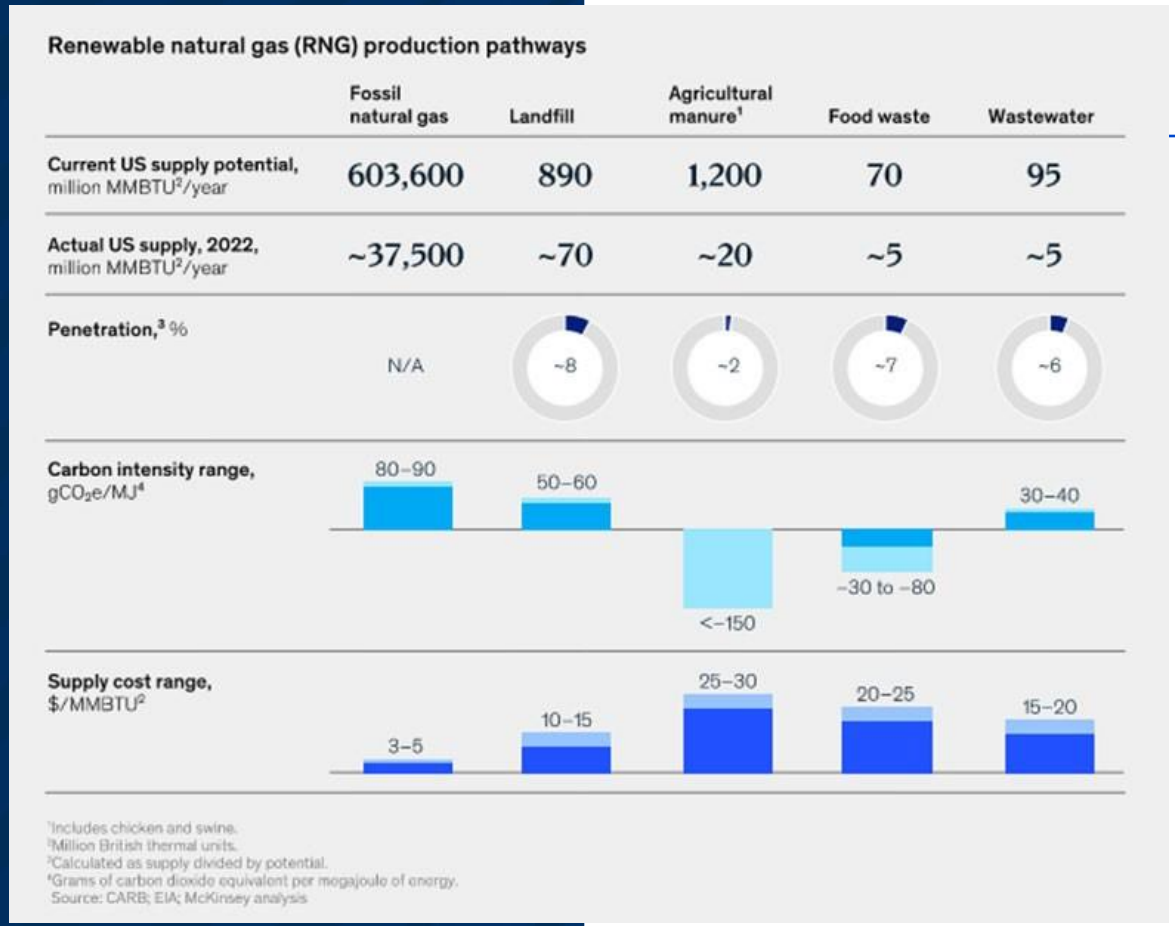
= $9 / MMBtu



MARKET DRIVERS

RNG Supply

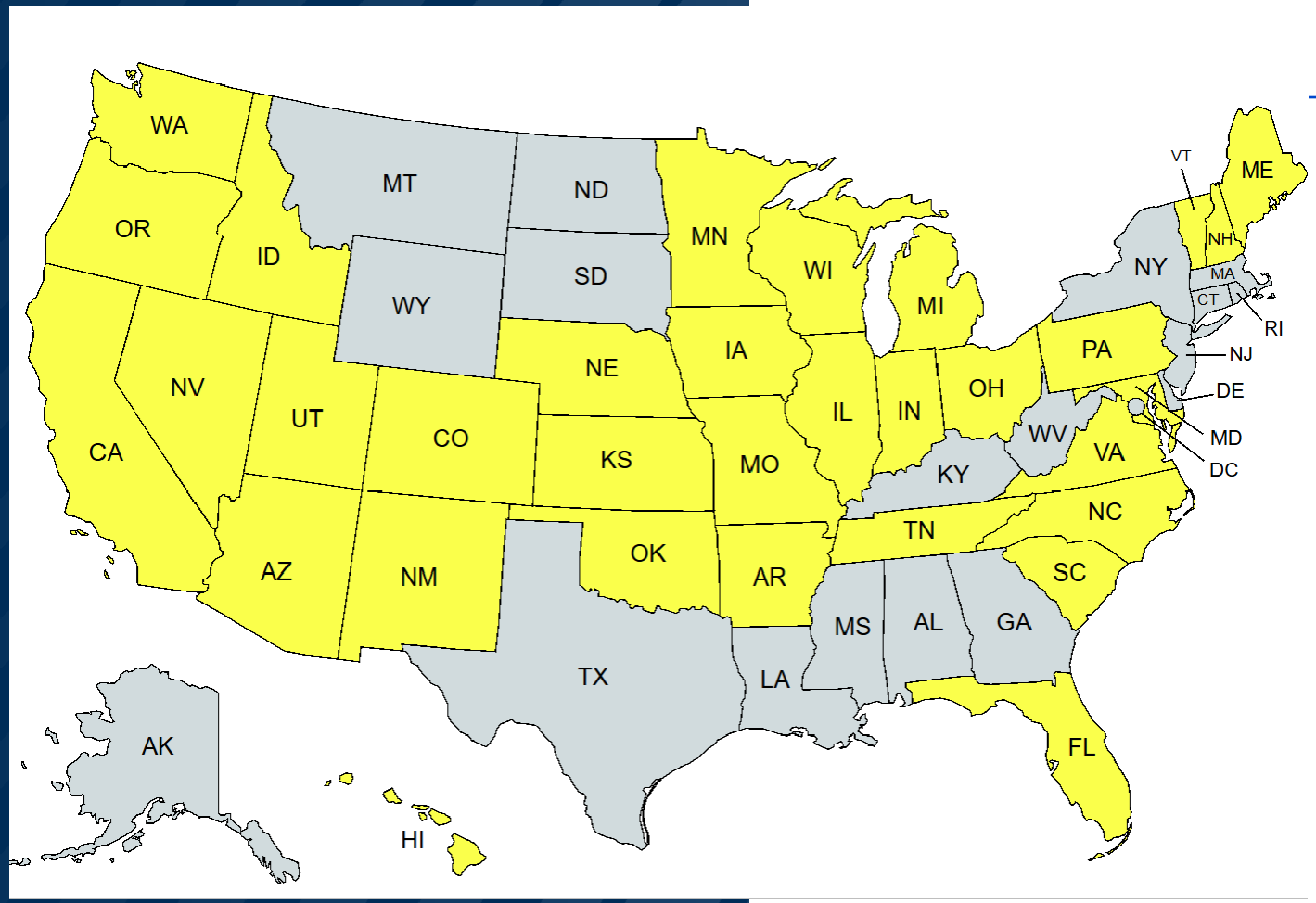
- Currently < 1% of Natural Gas
- By 2030 RNG Supply 7x 2020 Levels (EIA)
- By 2050 RNG Supply 27x 2020 Levels (EIA)
- Supply only at 2/3 of expected demand



MARKET DRIVERS

RNG Demand

- Voluntary Demand
  - Renewable Thermal Certificates
  - Utility Incentives
- Regulatory Incentives
  - EPA Renewable Fuels Standard
  - State Low-Carbon Fuel Standards
- Funding Incentives
  - State grants/funding programs
  - Inflation Reduction Act



MARKET DRIVERS

- Regulated Utilities Self Developing RNG Projects
  - Voluntary Tariffs
  - Rate Cases to Build RNG Production Facilities
  - Rate Cases to Build RNG Interconnects
- Clean Fuel Standards
- Non-Regulated Utility Counterparts
  - Tax Exemptions

MARKET DRIVERS

Kansas

Black Hills Voluntary RNG and Carbon Offset Program

$5.00 per 20.5 Therm Block per month

The program allows residential and small commercial customers buy a set number of 20.5 therm blocks to offset natural gas emissions.

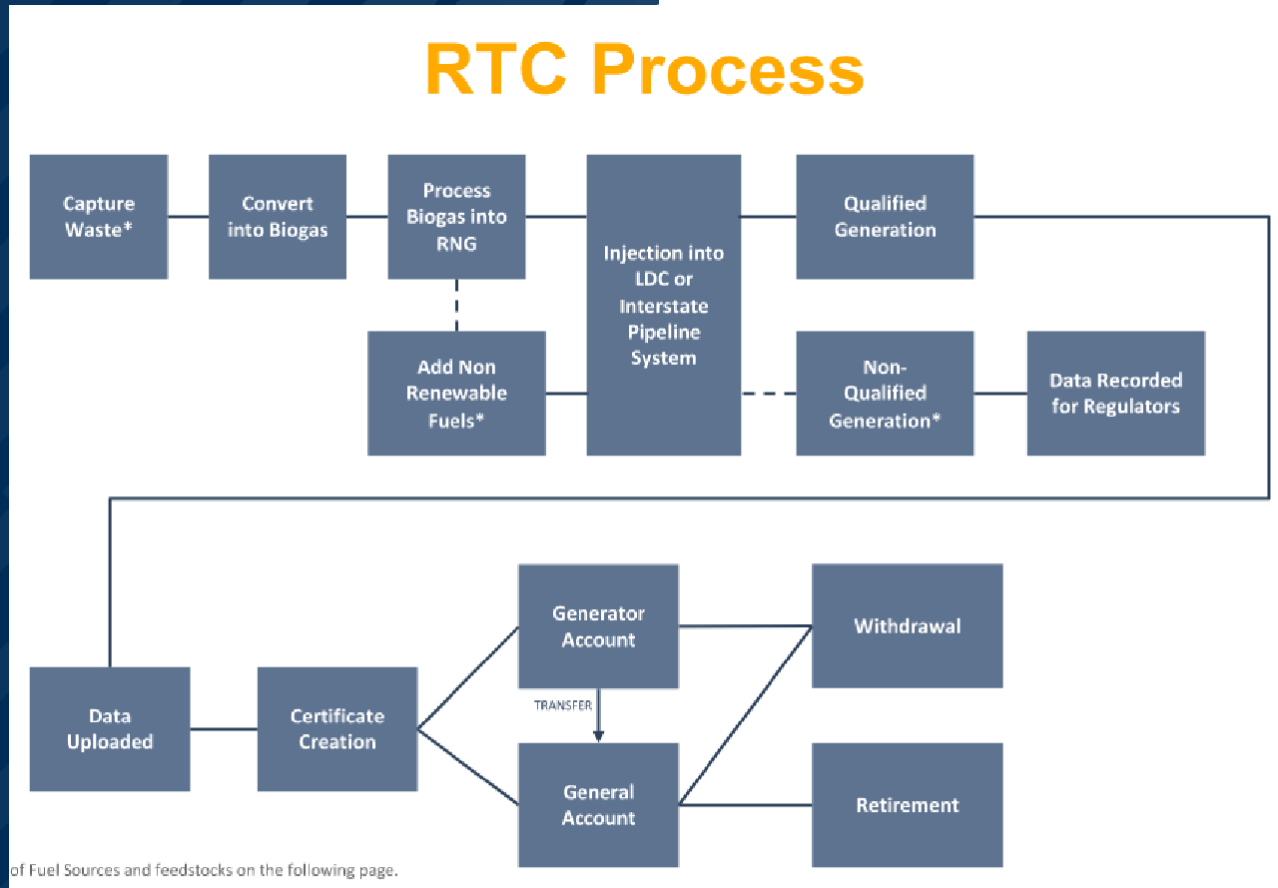
The program is currently in a pilot period that ends on December 31, 2026

RTC

Marketplace

Renewable Thermal Credits (RTC)

- Tracking System for Retirement of Thermal Credits
- M-RETS
- Confirmed CI Pathways



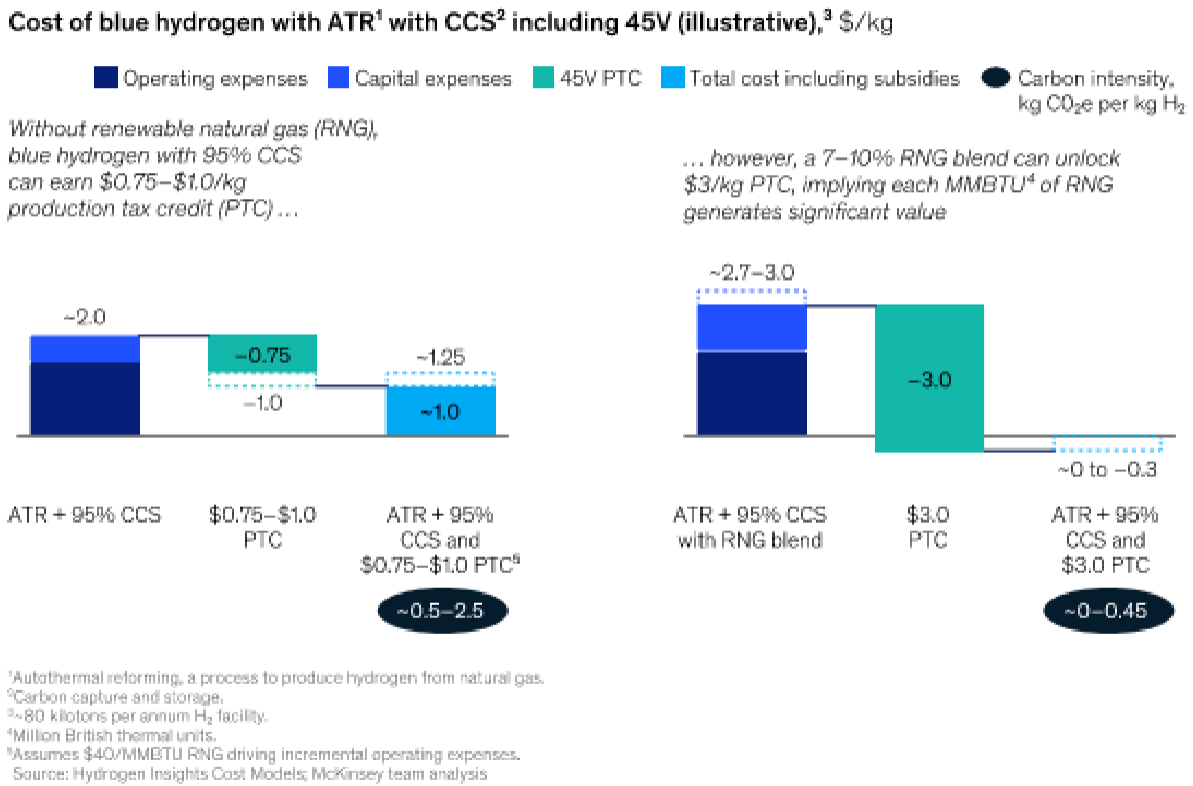
M-RETS Renewable Th

Other Market Drivers for RNG

- H2 Production to Receive to PTC
- Biogenic CO2 as a Byproduct
- RNG to Other Countries
- SAF
- Sustainable Fertilizers/Nutrient Management

Exhibit 2

Renewable natural gas can potentially unlock incentives for low-carbon hydrogen production.

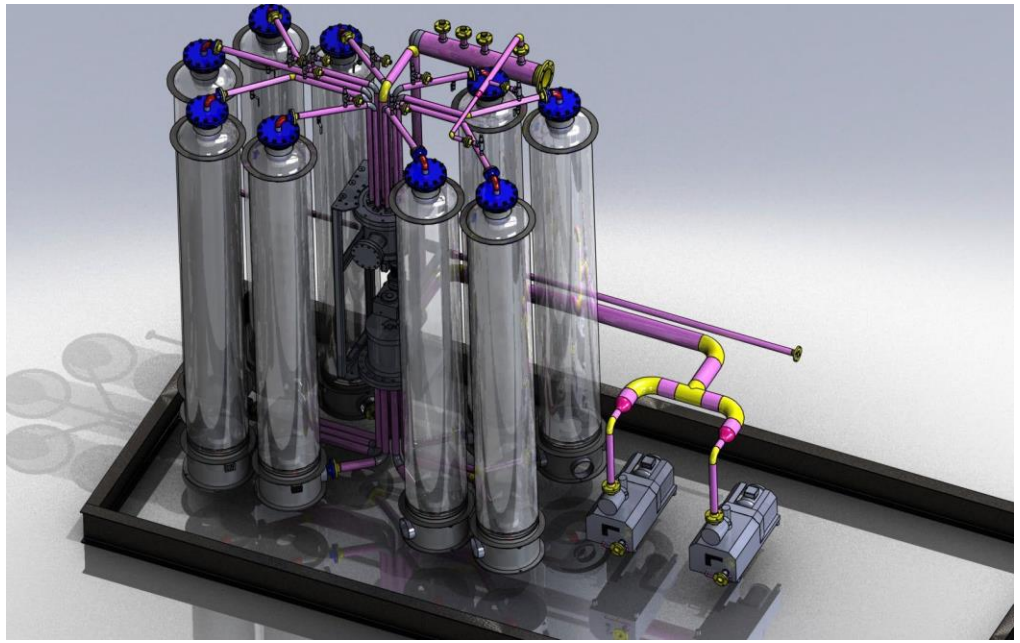


[1]Autothermal reforming, a process to produce hydrogen from natural gas.
[2]Carbon capture and storage.
[3]~80 kilotons per annum H_2 facility.
[4]Million British thermal units.
[5]Assumes $40/MMBTU RNG driving incremental operating expenses.
Source: Hydrogen Insights Cost Models; McKinsey team analysis

[19] *Pathways to commercial liftoff: Clean hydrogen*, U.S. Department of Energy, March 2023.

RNG Project Examples

CASE STUDY



Biogas Upgrade to Renewable Natural Gas

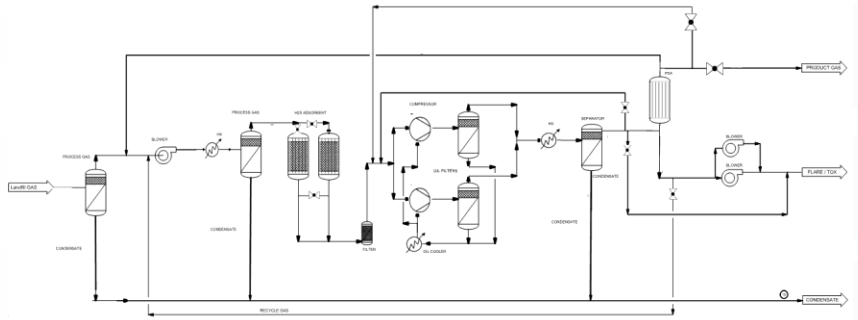
Confidential Client |California

Engineering Services

- Design, Bidding Support, Construction Support
- Startup, Commissioning and Acceptance Testing
- Weekly Monitoring of System Performance

Feedback

Municipal Wastewater Biogas



CASE STUDY

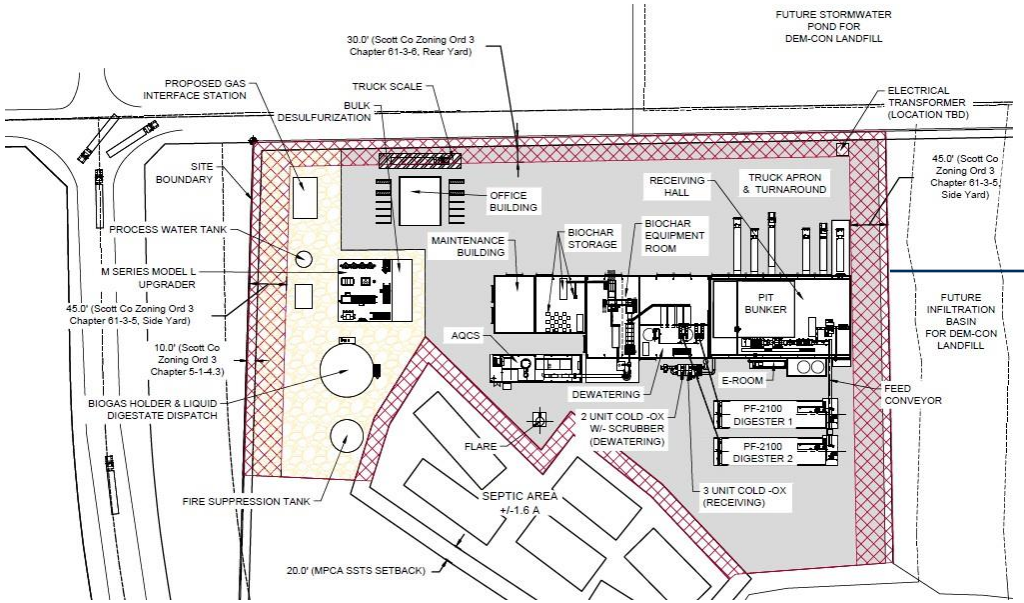
WWTP and RNG EPC

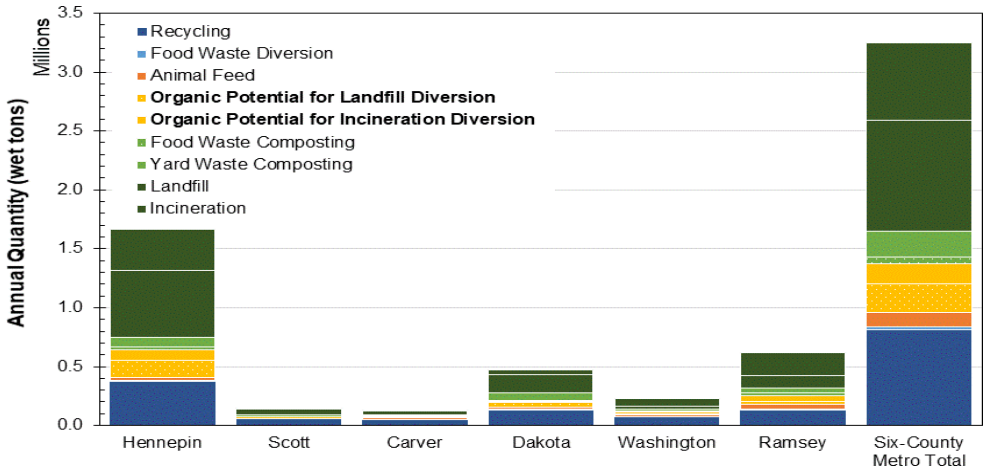
SPIRE |KCMO P3

Progressive Open Book EPC

- Current THP Project
- Long History Working at WWTP
- 900 Scfm
- Supporting Utility as Design-Build Partner
- RNG Process Evaluation / Design
- Permitting
- Construction / Commissioning

Food Waste to RNG





Dem-Con

Feasibility Study & Construction Documents

Developed biogas, solid, and liquid quantity and characteristics used for the market analysis

End-Use Options Biogas:

- Electricity
- Heat
- Local transportation fuel
- RNG to Pipeline

Digestate:

- Pelletizing
- Land application
- Compost
- Treatment at WWTP
- Pyrolysis

CASE STUDY

Dairy RNG Program

Confidential Client | Multiple States

Brownfield & Greenfield Design

- 14+ Dairy Sites
- 3,000 – 10,000 Head
- Gas Upgrading Design Standardization
- Manure / Digester Design Standardization
- Pipeline / Interconnect Design
- PHA/HAZOP
- Permitting Support
- 3 Brownfield Sites with Existing ADs
- 11 Greenfield Sites

Thank You