

Renewable Natural Gas “Gold Rush”



August 18, 2022
ATAS Meeting
Scott Martin

Gas

Health Effects

Low

Medium

High

Hydrogen Sulfide (H₂S)

2-20 ppm: nausea, headache, dizziness

100-300 ppm: altered breathing, fluid in lung

500-700 ppm: collapse, death

Methane (CH₄, LEL)

< 0.1% (1000 ppm): not harmful

< 1% (10,000 ppm): no known toxicity

5-15% (50,000 ppm): explosive

Ammonia (NH₃)

5-20 ppm: odor, eye irritation

20-50 ppm: Moderate eye and upper respiratory tract irritation

2500 ppm: chemical pneumonitis, edema, cyanosis, death

Carbon Dioxide (CO₂)

600-2000 ppm: muscle stiffness, drowsiness, poor judgement

5000 ppm: 8-hr maximum

30,000 ppm (3%): increased pulse rate, nausea, mental impairment

Carbon Monoxide (CO)

<9 ppm: comfortable living concentration (35 ppm = 8-hr allowable)

200 ppm: headache, dizziness, nausea in 2 hours

400 ppm: life threatening in 3 hours

Children, elderly, pregnant women are at risk at lower CO concentrations. The concentrations are relevant only at "sea level."

www.gpcch.org

SAFETY MOMENT

Biogas Safety Awareness

Livestock Production



Manure Storage

Under slatted floor
Outside lagoon, pit, or tank

Manure Pumping

Under slatted floor
Outside lagoon, pit, or tank

Foaming Manure

If foaming is present, significant methane risk (see additional materials)

Pressure Washing

Inside building

Sensor Types

H ₂ S	LEL	NH ₃
H ₂ S	LEL	
H ₂ S	LEL	
H ₂ S	LEL	NH ₃

WARNING

HYDROGEN SULFIDE PRESENT IN LANDFILL IF LEAK DETECTED PROMPTLY EXIT AREA AND NOTIFY SUPERVISOR

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05-WS-13256

Renewable Natural Gas



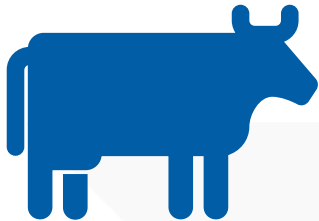
Renewable Natural Gas (RNG) Project Elements

Feedstock



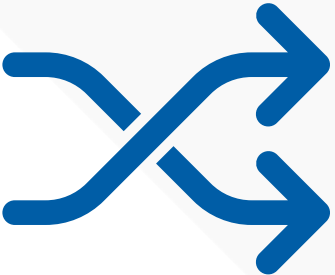
- Collection
- Quality Management

Digesters



- Design
- Optimizing
- Digestate and Odor Management

Gas Processing



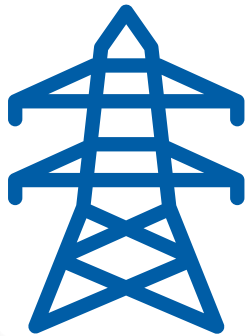
- Pre-Treatment
- Upgrading
- Compression
- PHA

Gas Logistics



- Interconnects
- Metering Stations
- ROW Acquisition
- Route Permitting

Electrical



- Interconnects
- Substations
- Electric Generation
- Standby Power

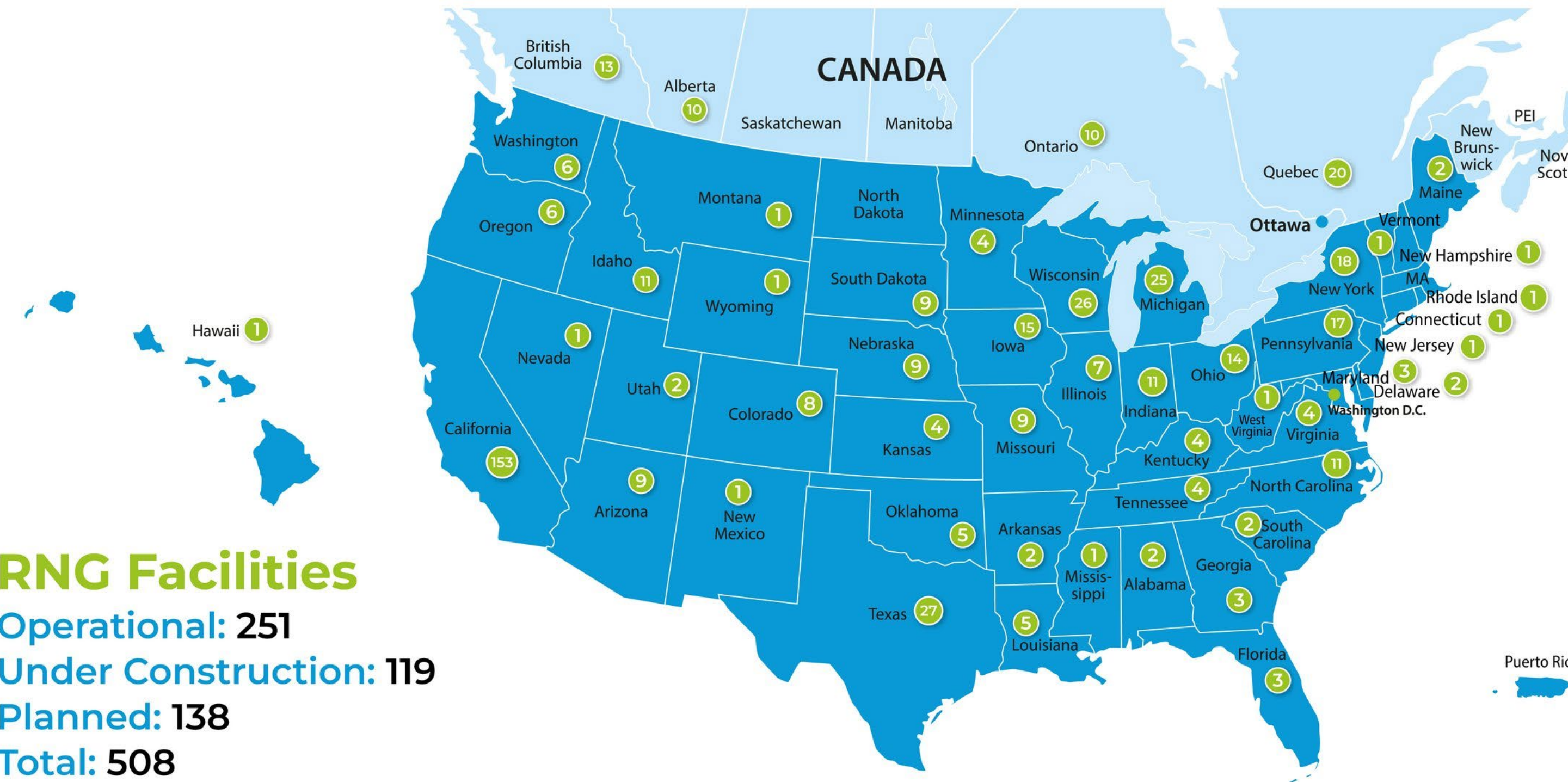
Compliance



- Air
- GHG
- Waste
- Wastewater

RNG Market Overview

THE COALITION FOR
**RENEWABLE
NATURAL GAS**



RNG Facilities

Operational: **251**
Under Construction: **119**
Planned: **138**
Total: **508**

Source: <https://www.rngcoalition.com/infographic>

RNG Project Types

	FOOD WASTE	AGRICULTURE / LIVESTOCK	WWTP	LANDFILL GAS
OPERATIONAL	13	115	26	76
UNDER CONSTRUCTION	4	82	3	20
PLANNED	10	69	1	27
SUSPENDED	1	0	0	0
CANCELLED	7	16	4	8
FUTURE POTENTIAL	5	6	5	7
TOTAL (INCL CANCELLED)	39	288	39	138

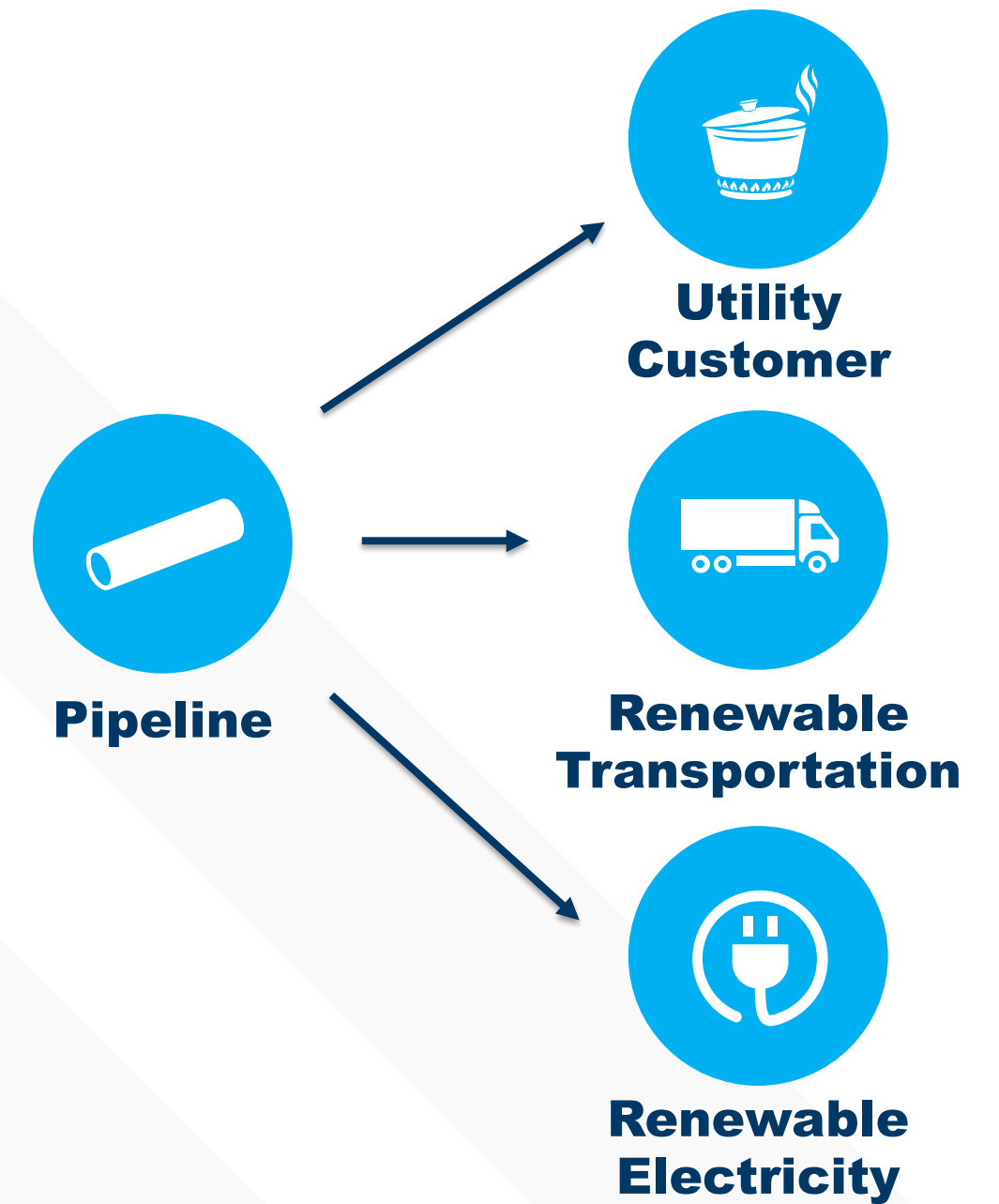
Mintz, M. and Vos, P. *Database of Renewable Natural Gas (RNG) Projects: 2021 Update*, Argonne National Laboratory, January 2022, <https://www.anl.gov/es/reference/renewable-natural-gas-database>.

Market Drivers



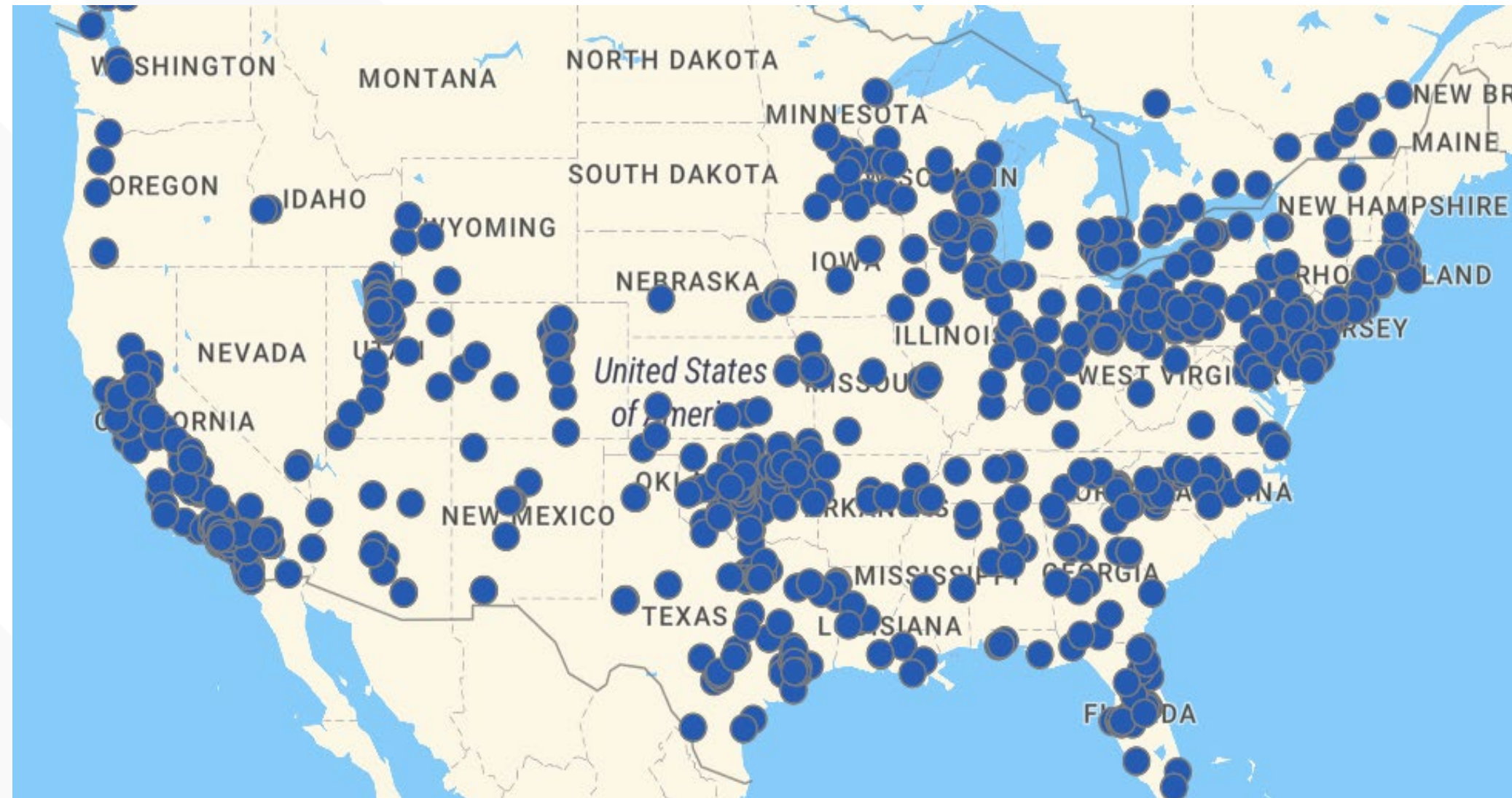
RNG End Markets

- ▶ Commercial CNG Fleets (e.g. UPS, Waste Management)
- ▶ CNG Fueling Station Companies (e.g. Trillium, US Gain, Clean Energy, Others)
- ▶ LCFS / RFS
 - California
 - Oregon
 - Washington
 - Emerging States
- ▶ Renewable Fuel Production Facilities
 - Ethanol, Renewable Diesel
- ▶ Natural Gas Utilities
 - Cost Recovery States (Missouri)
 - Individual Consumers (voluntary, state-based)
 - Institutional Facilities (Universities, Health Care, etc.)
 - Commercial Entities with ESG Commitments / Goals

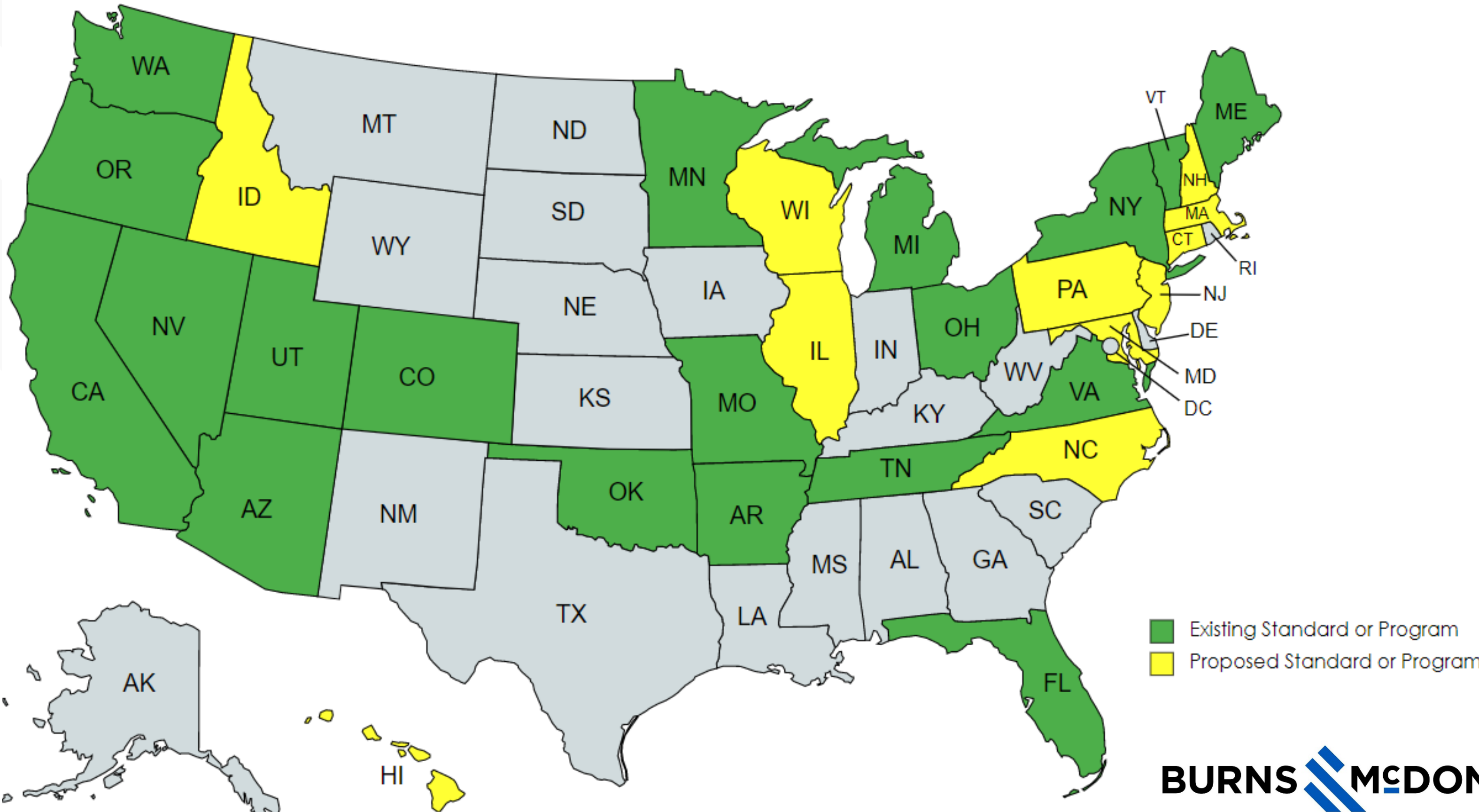


Institutional O&G – Renewable Investments

- ▶ Approximately 20 Natural Gas Utilities
 - Operating in ~ 40 States
- ▶ Midstream Companies
 - Corporations and MLP's
- ▶ Major Oil Companies
 - BP
 - Chevron
 - Marathon
 - Shell
 - Valero
- ▶ Commercial Supply
 - Graphics:
 - USDOE AFDC
 - Clean Cities



States with Policies or Legislation in favor of RNG



Incentives – Transportation Fuel

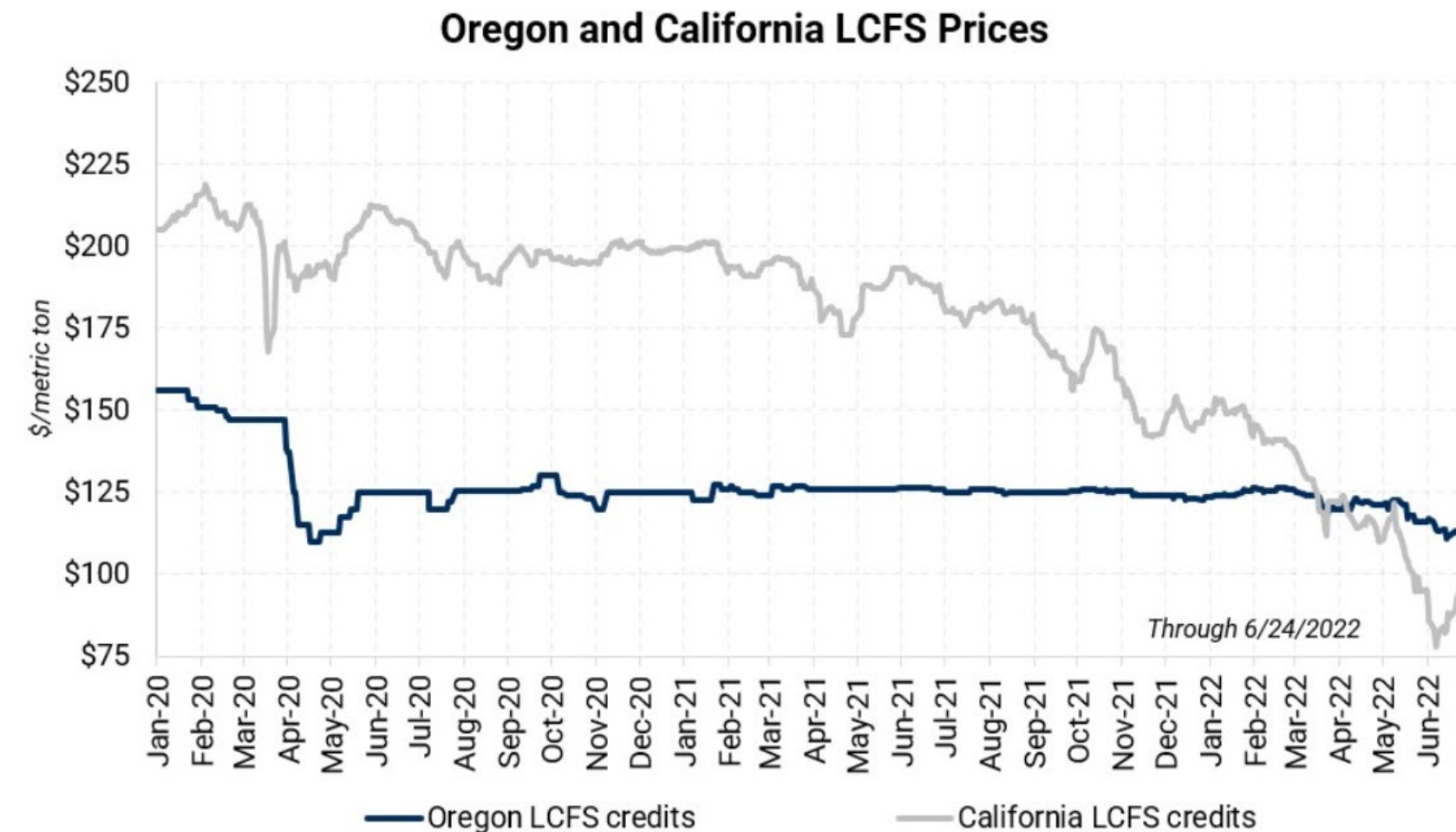
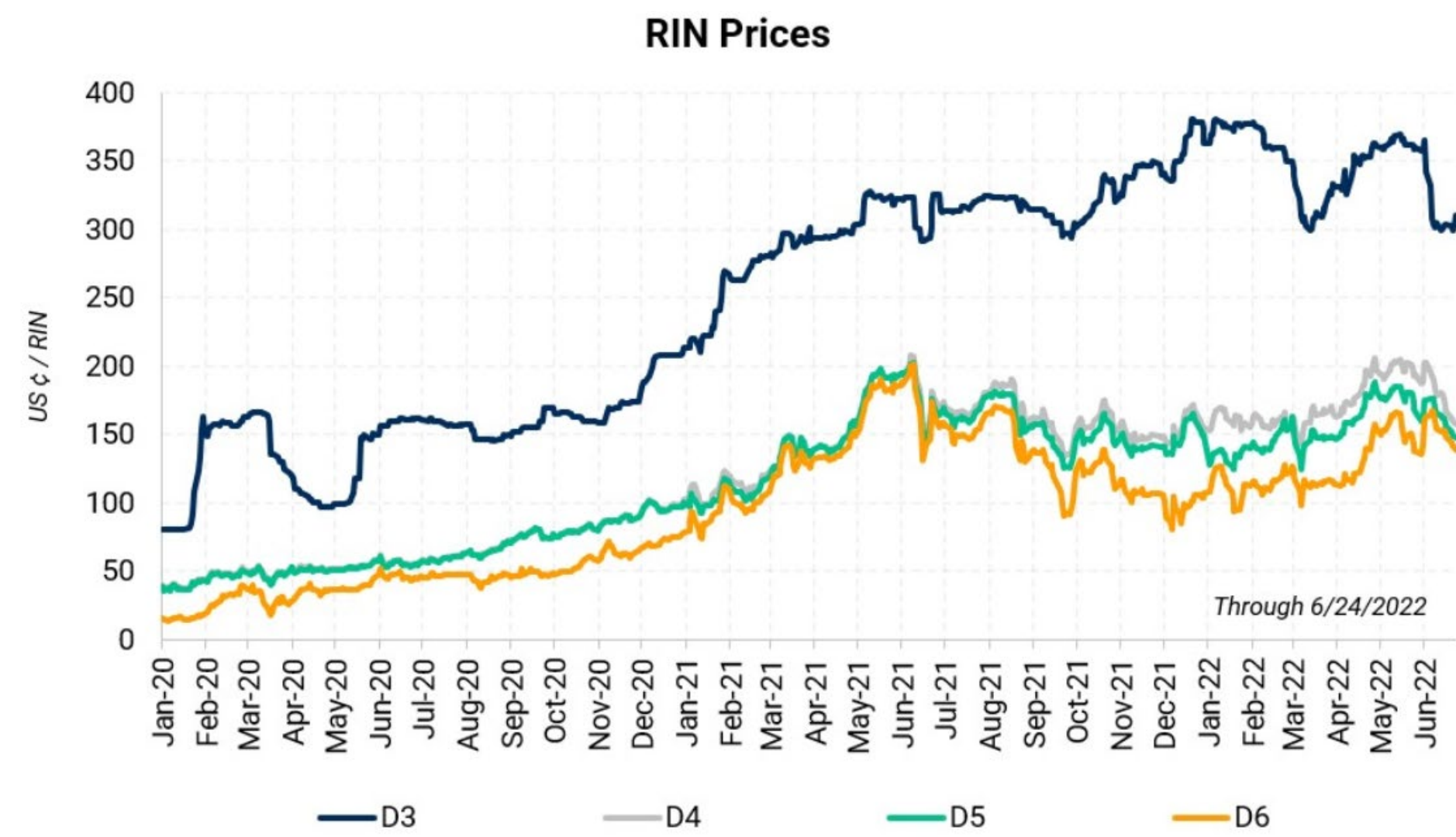
▶ Renewable Fuel Standard Credits (RIN's) [per GGE]

- D3 ~ \$3.00
- D5 ~ \$1.50

▶ State Low Carbon Fuel Credits [per Metric Ton]

- CA ~ \$100
- OR ~\$115

Feedstock	CI Score	RIN (\$/MMBtu)	LCFS (\$/MMBtu)	TOTAL (\$/MMBtu)
Landfill Gas	30 to 60	\$40	\$5	\$45
WWTP	30 to 50	\$40	\$6	\$46
Food / Organics	-80 to +20	<u>\$17*</u>	\$14	\$31
Dairy / Swine	-500 to -300	\$40	\$50	\$90



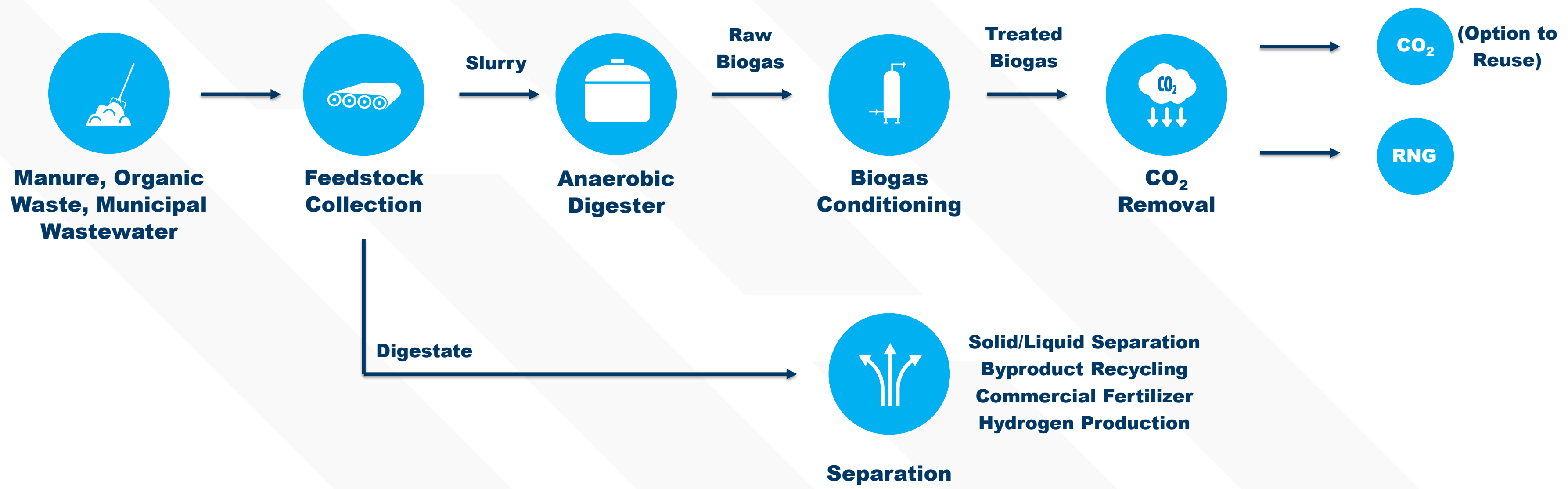
California – Senate Bill (SB) 1383 and SB 1440

- ▶ SB 1383 - Organic waste in landfills emit 20% of California's methane
 - CalRecycle
 - Sets targets to reduce disposal of organics in landfills
 - Reduce GHG emissions
 - 75% reduction of organics by 2025
 - Took effect January 2022
- ▶ SB 1440 – Pipeline Biomethane Standards / Requirements (First Renewable Gas Standard in the United States)
 - CPUC – Approved February 2022
 - Focuses on organic wastes diverted from landfills for production of biomethane
 - 8 million tons per year goal of diverted organic waste AD to RNG
 - 12% of gas to be RNG by 2030 (73 bcf / year)

RNG Process & Feedstock Considerations



Anaerobic Digestion Process Overview



General AD Considerations

▶ Manure AD

- Routine collection/conveyance optimizes gas production
- Water usage drives digester sizing
- Farmers don't like to be told what to do on their farms
- Understand nutrient management plan requirements

▶ Food Waste / Organics AD

- Contamination in = Contamination out
- Digestate marketability depends on the quality of the digestate and proximity to end markets
- State regulations are variable with respect to composting

▶ Both: Develop robust contingency plans for odor management and facility O&M



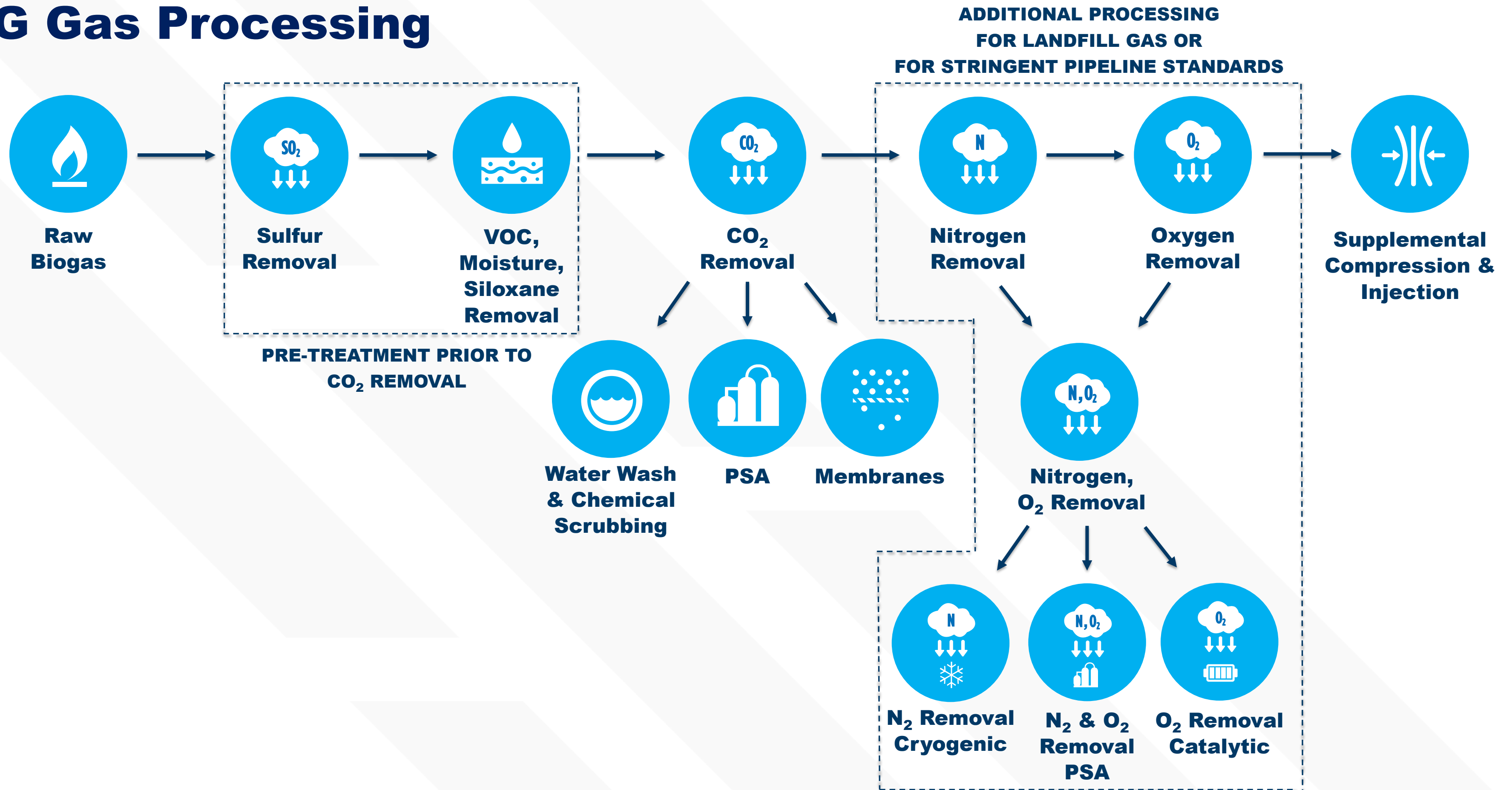
RNG Gas Processing – Contaminants Present

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

Typical Monitoring

- H₂O Analyzer
- H₂S Analyzer
- Total Sulfur
- Pressure
- Temperature
- O₂ Analyzer
- Gas Chromatograph

RNG Gas Processing



Project Examples



Landfill RNG Feasibility, Development & Compliance

Hamm Landfill | Kansas



**Plant Inlet Capacity 3,000 scfm,
Expandable to 4,000 scfm.
(~3 mmsfd)**

**Gas Collection System
150 Wells**

7-mile Pipeline (Southern Star)

**15 Private Easements
2 Levee Crossings**

Air Permitting

**Ongoing
Compliance/Monitoring**

Market Assessment for RNG and other By-Products from AD

Dem-Con Companies | Minnesota

Design Criteria Development – Mass & Energy Balance

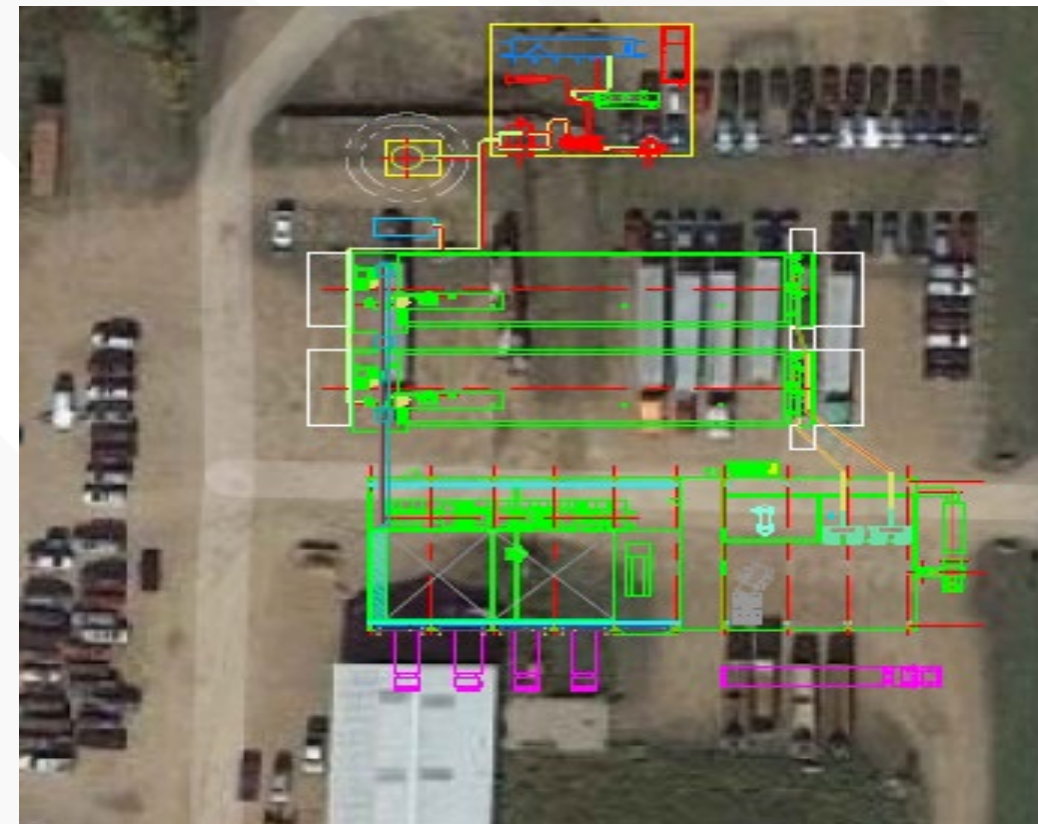
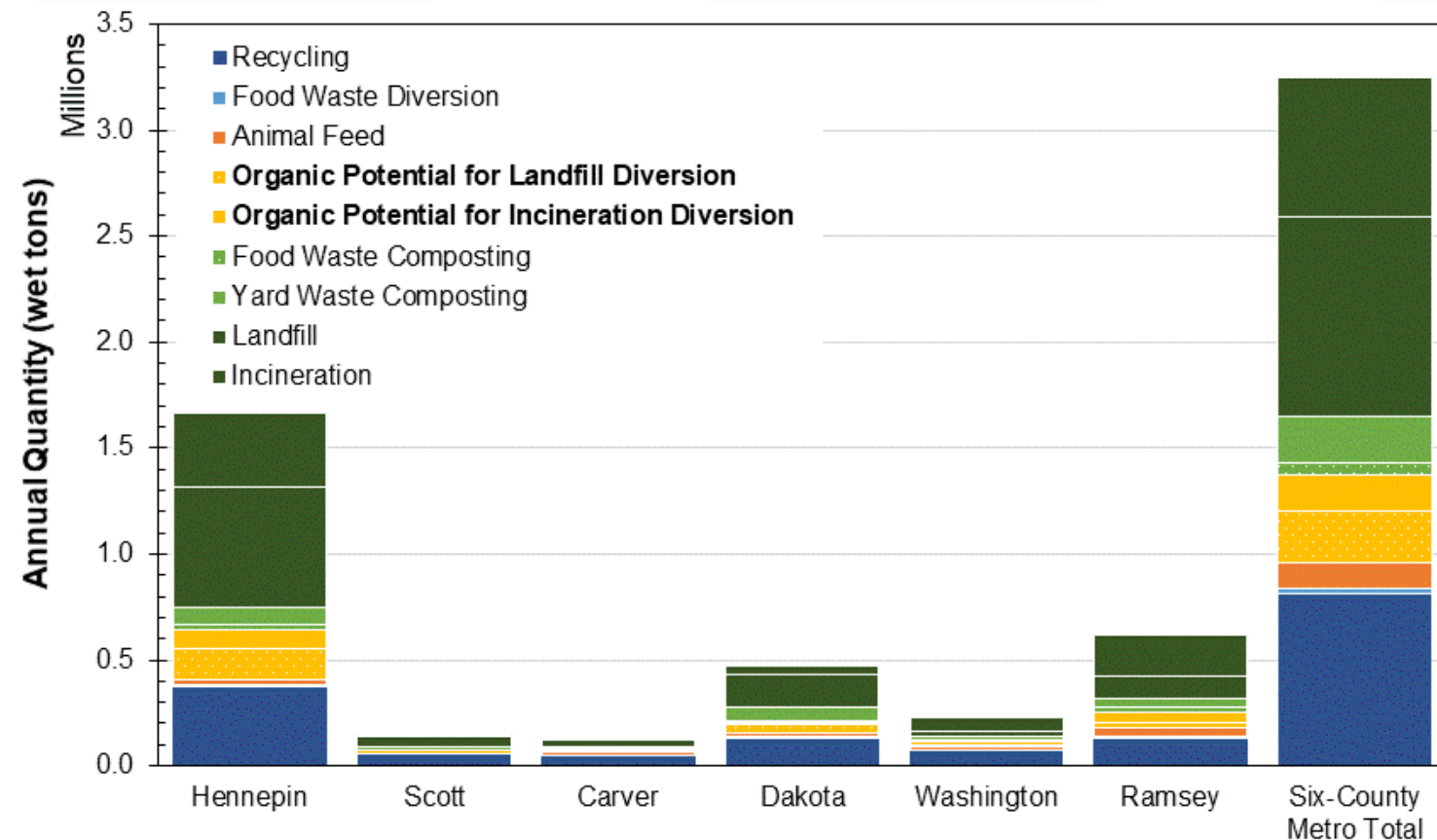
- Developed biogas, solid, and liquid quantity and characteristics used for the market analysis

End-Use Options

- **Biogas** – Electricity, Heat, Transportation Fuel, Pipeline
- **Digestate** – Pelletizing, Land Application, Compost, Recirculation, Treatment at WWTP

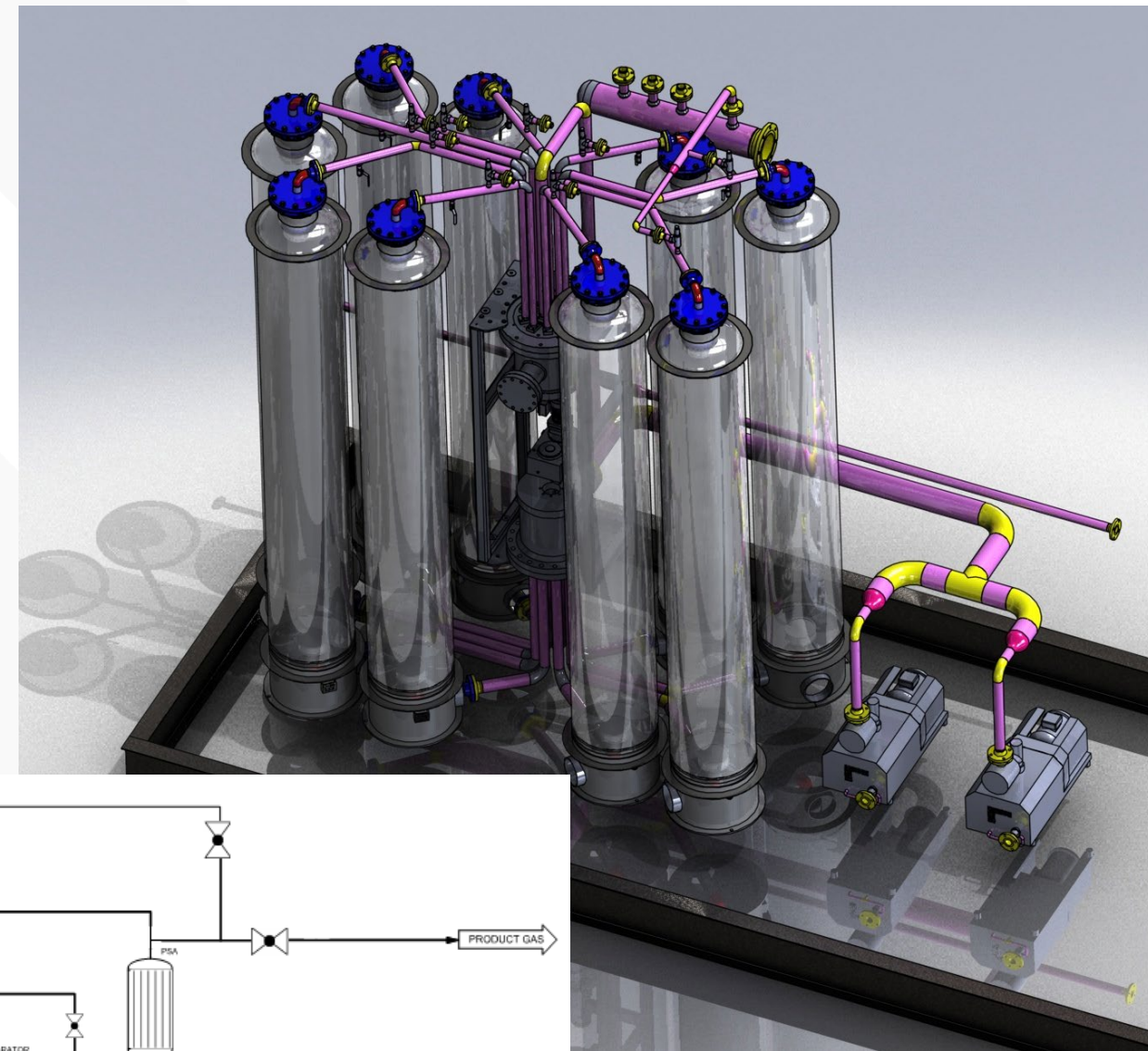
Grant Funded
 Scott County, Minnesota
 Recycling Infrastructure,
 Innovation and Outreach Grant

Regulatory Review
 State & Local Regulatory
 Considerations
 County Ordinance & Policy
 Review



Biogas Upgrade to Renewable Natural Gas Project

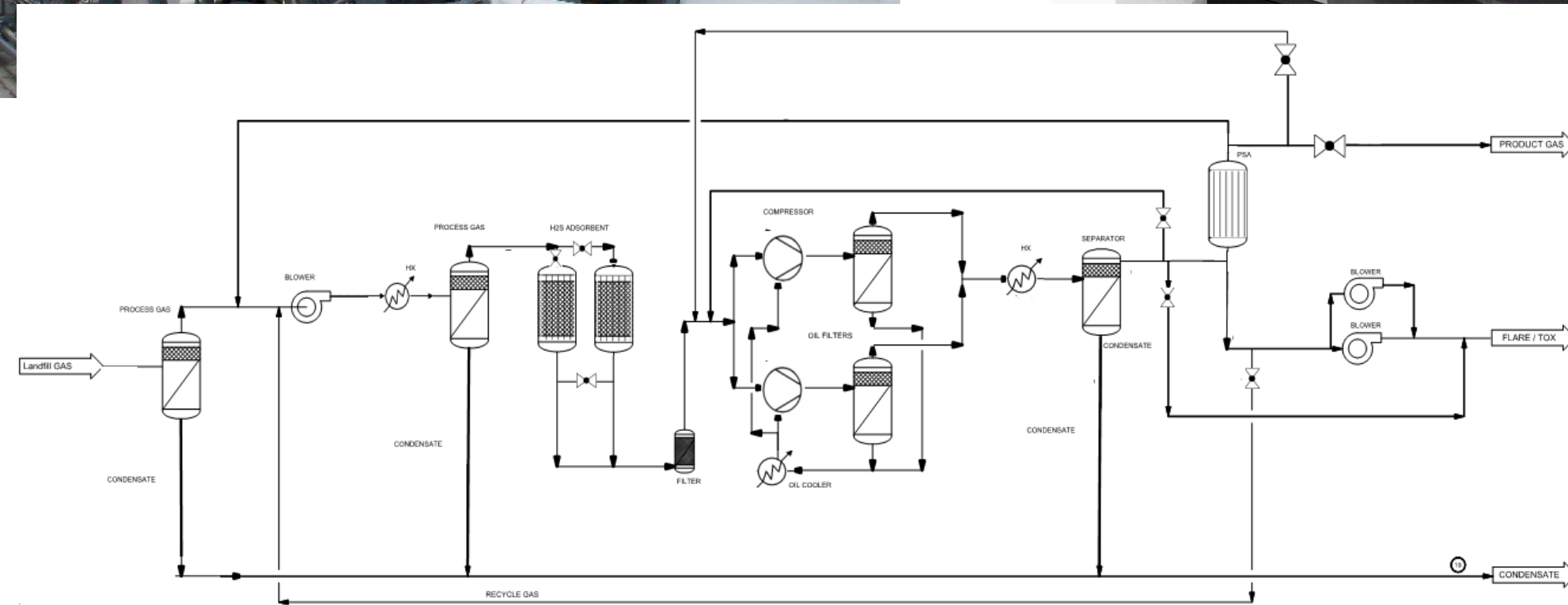
Confidential Client | California



Demonstration Project

System Monitoring over a period of 12 Months

Successfully Demonstrated Compliance with Pipeline Quality Specifications



Campus Food Waste, Agricultural Waste and Biosolids AD to RNG

Emory University | Georgia

Design / Development:

- ▶ Siting
- ▶ Food waste process equipment/facilities
- ▶ Biosolids handling/conveyance
- ▶ Anaerobic digestion
- ▶ Digestate process equipment/facilities
- ▶ Education facilities
- ▶ Biogas processing equipment
- ▶ End-use interconnection requirements

Stakeholder Engagement

- ▶ Campus leadership/ operations
- ▶ Students
- ▶ Faculty
- ▶ Community members

Procurement Contract:

- ▶ Technical specifications and commercial framework for construction and 3rd party operations contract.



Grant Funded

EPA “Winning on Reducing Food Waste Initiative”

Financial

Evaluation of Cost Benefits
Capital / Operations Cost Estimating
SROI Evaluations

Regulatory Review

State & Local Regulatory Considerations
County Ordinance & Policy Review

Potential End Uses

Upgrading RNG to Pipeline
Combined Heat & Power

RNG Pipeline Permitting, Land Acquisition, Design

Challenge 1: Political support at the county and city level but political opposition at the township level.

- County owned landfill
- Township:
 - Receives revenue from existing biogas to electricity project.
 - Owns several parcels along the pipeline route – high prices for easements.

Solution:

- Anticipate resistance from parties that stand to lose from project development.
- Anticipate opposition and develop relationships w/ landowners for alternate routes.
- Entrenched emotions are sometimes hard to change, even with money.

Challenge 2: Creating a sense of urgency among landowners.

- The project is very schedule driven and the land acquisition stage is critical path.
- The project owner does not have any condemnation authority.
- The landowners don't have schedule pressure.

Solution:

- Present an incentive schedule, after the landowner has provided a counter-offer.
 - Allows the project owner to justify a structured counter-offer.
 - Allows the landowner to an incentive for signing earlier.
- Continue to establish backup routes and property owners.



Questions?



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