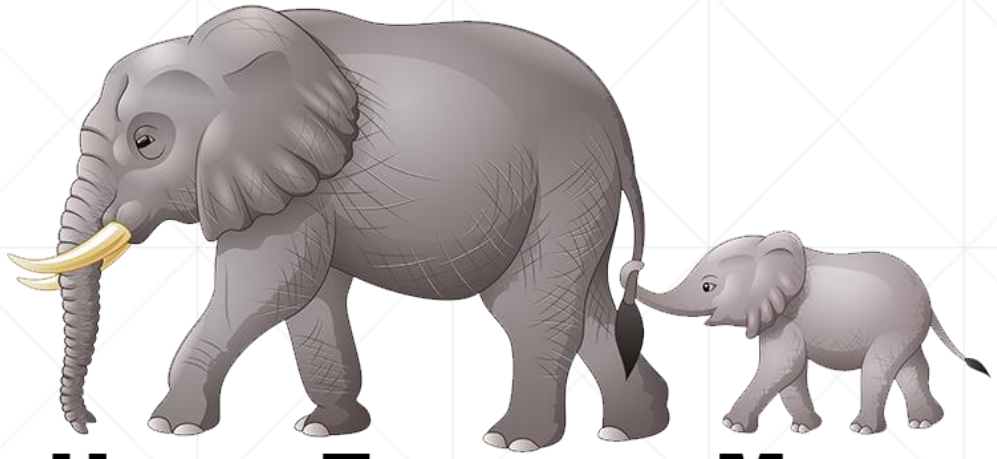
Wednesday, September 18, 2024

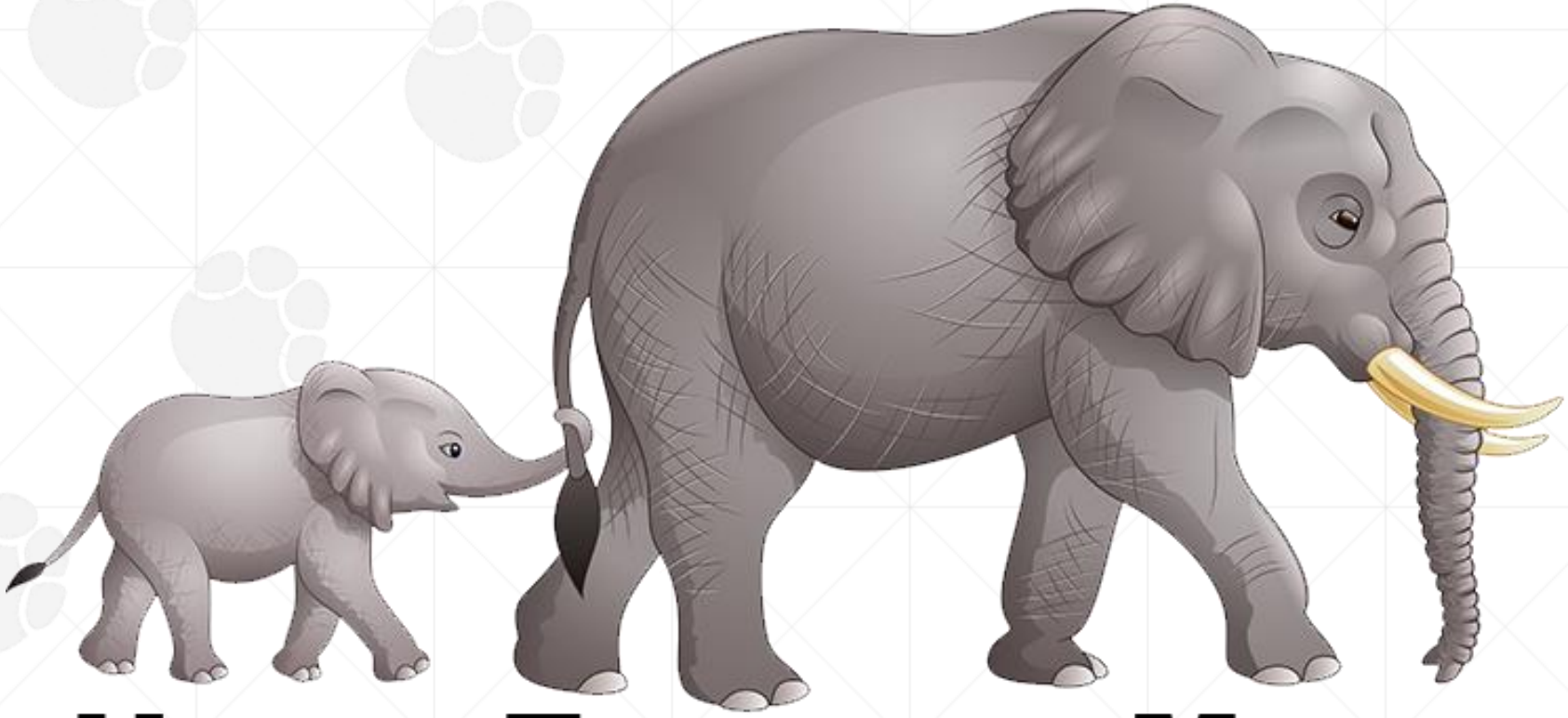


~ PRESENTS ~

Biogas to RNG 101

Presented by Unison Solutions

Sponsored by Unison Solutions



URBANELEPHANTMEDIA

PEER-TO-PEER LEARNING MADE EASY

Sustainability Training for Urban Designers and Policymakers

Randy Rodgers, Director of Big Ideas
Randy@UrbanElephantMedia.com
563-562-2925

UrbanElephantMedia.com

Our Sponsor

UNISON

Our Presenters

Dave Broihahn
President
Unison Solutions

BIOGAS TO RNG 101:

Back to the basics

UNISON

Employee Owned

Overview

- Company founded on January 1, 2000
- Employee Owned: November 2020
- 70 employees (11 engineers)
- 90,000 ft^2 manufacturing facility
- Over 400 systems sold worldwide

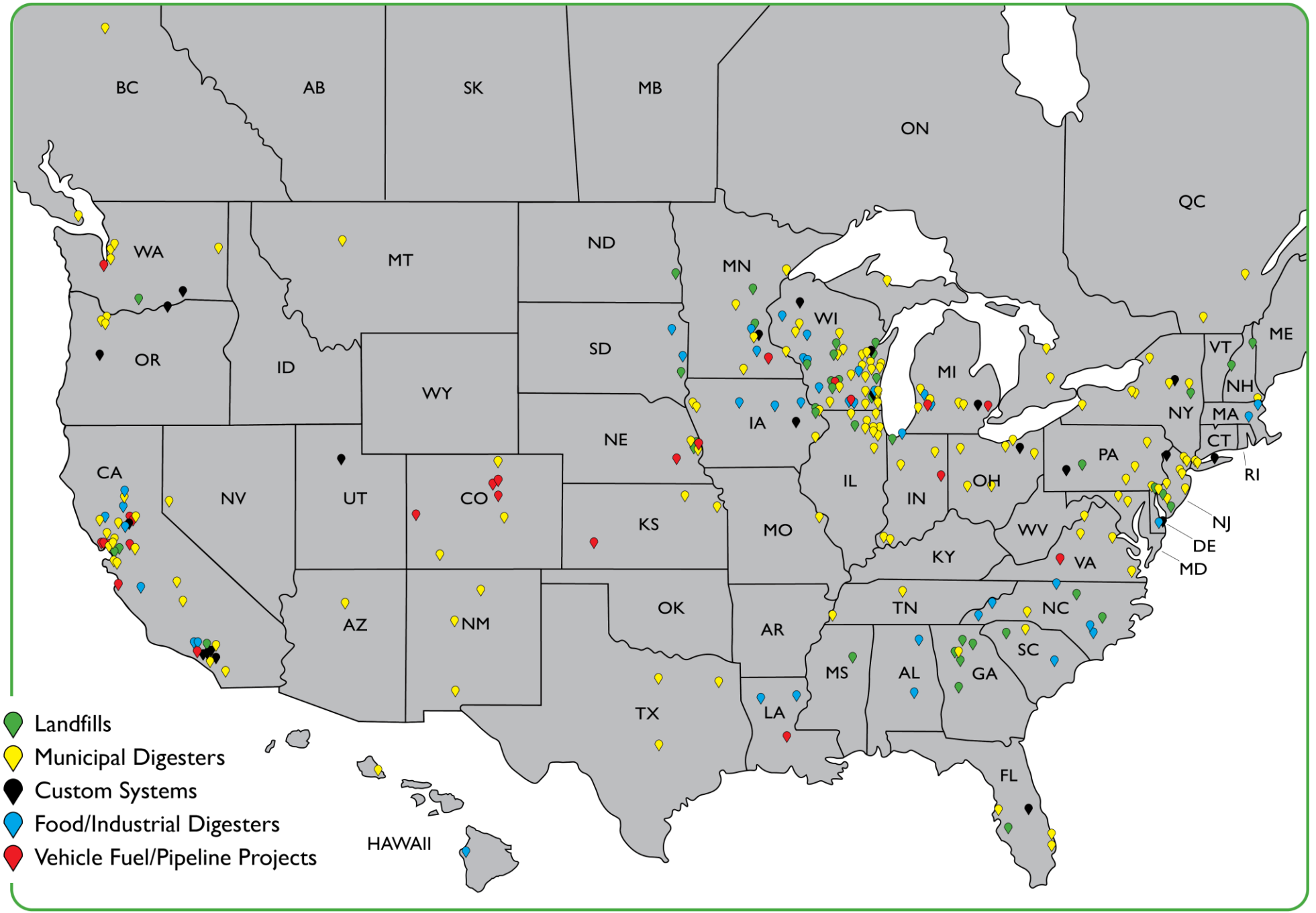
Leaders in Biogas Technology

Proudly manufactured in the USA

Leaders in Biogas Technology

UNISON

Unison project map



Application & project development team

Our professional staff has over 100 years of combined experience in biogas applications

Dave Broihahn, PE
President
24 years

Adam Klaas
Application and Business Development Manager
18 years

Eric Wilgenbusch
Applications Engineer
17 years

Curt Schiesl
Applications Engineer
6 years

Nick Oberbroeckling
Applications Engineer
5 years

Leaders in Biogas Technology

UNISON

Biogas purification & analysis specialists

Our professional staff has over 100 years of combined experience in biogas applications

Kim Murdock-Timmerman
Aftermarket Sales & Service Manager
13 years

Emma Hoefer
Product Specialist
1 year

Leaders in Biogas Technology

UNISON

Engineering team

Our professional staff has over 100 years of combined experience in biogas applications

Kevin Deiter, PE
Engineering Manager
Mechanical Engineer
15 years

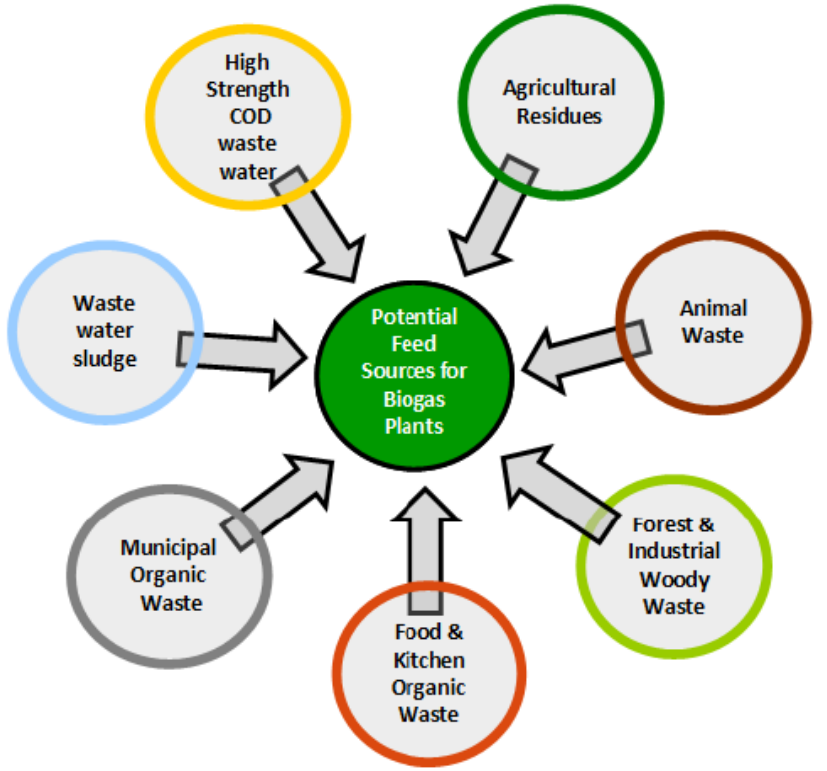
Logan Udelhofen
Mechanical Engineer
6 years

Evan Carlson
Mechanical Engineer
6 years

Chris Hankins
Mechanical Engineer
1 year

Derek Venteicher
Mechanical Engineer
1 year

Anaerobic digesters

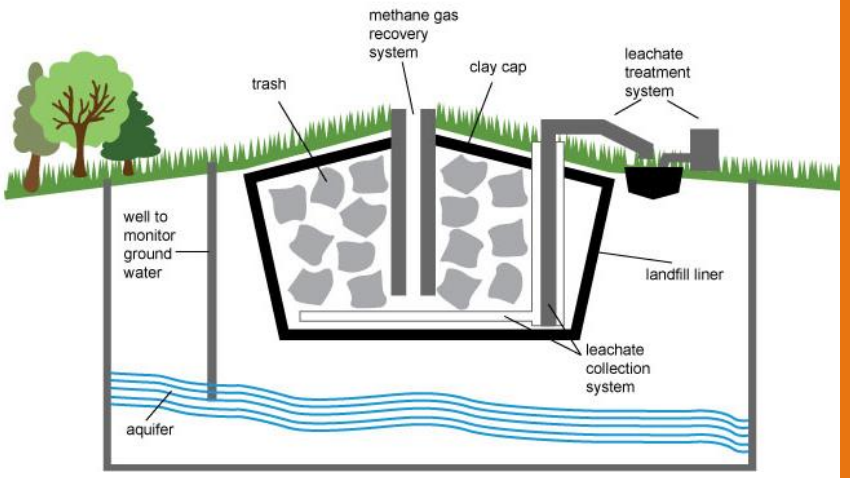


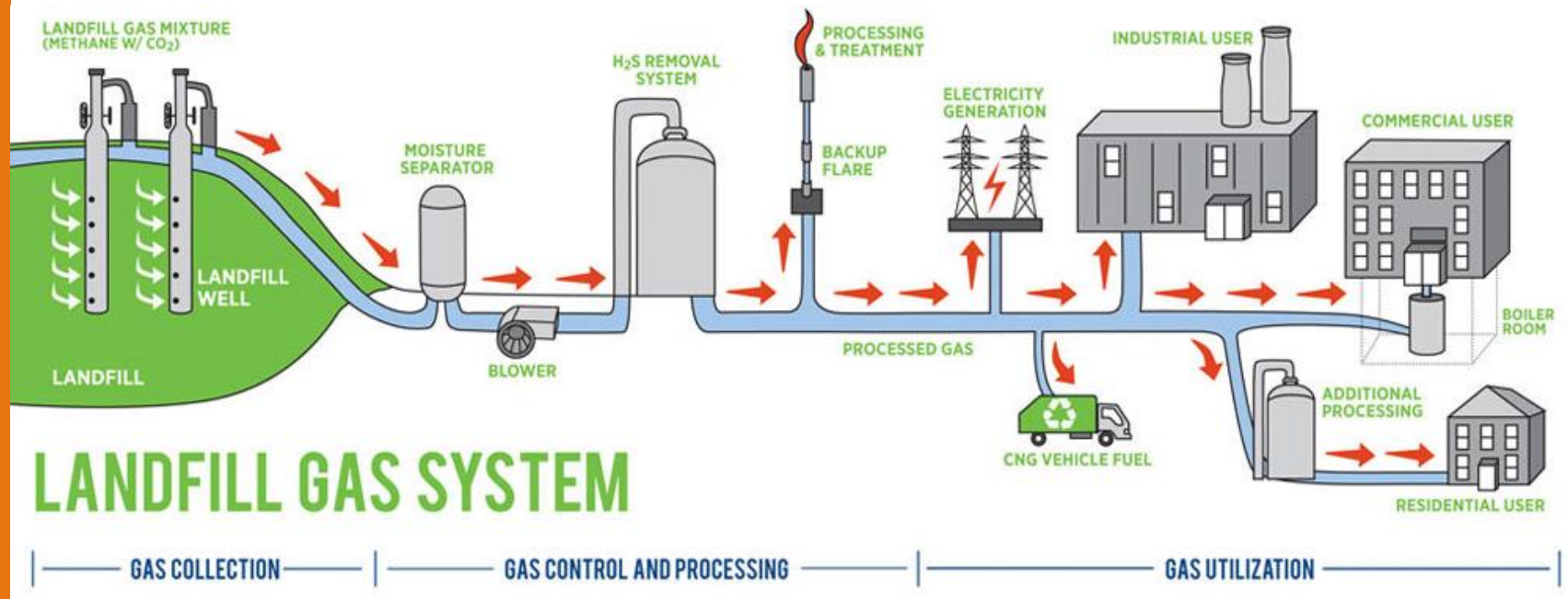
Leaders in Biogas Technology

UNISON

Landfills

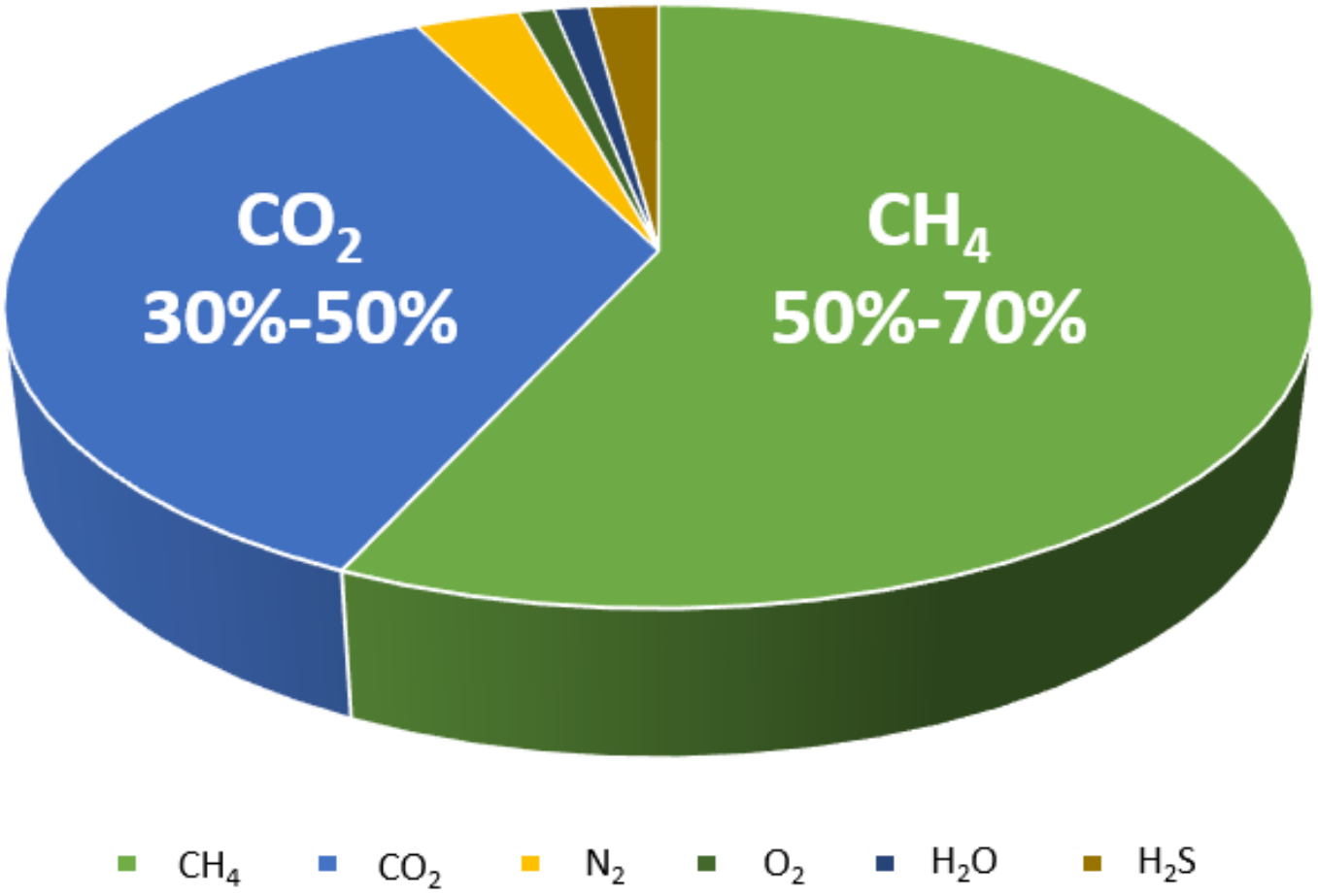
Modern landfill





Biogas constituents

bi·o·gas, ˈbīō ˌgas/, *noun,* gaseous fuel, especially methane, produced by the fermentation of organic matter.



- Methane, CH_4
- Carbon Dioxide, CO_2
- Nitrogen, N_2
- Oxygen, O_2
- Hydrogen Sulfide, H_2S
- Moisture
- Particulates
- Siloxanes
- Volatile Organic Compounds

Gas sampling and shipping supplies

Box with limited quantity label

Metal can, lid, and sealing ring

Flexible tubing

Hose barb fitting

Tedlar bag with valve

Chain of custody

Summa canister with fittings

Biogas testing

Before starting a project, we recommend the following biogas tests be performed:

- **Major components:**
  Methane, Nitrogen, Oxygen, Carbon Dioxide, and Btu calculation
- **Siloxanes, by speciation:**
  Up to 8 compounds common to biogas
- **Sulfur compounds, by speciation:**
  Includes hydrogen sulfide, mercaptans, and other sulfide compounds
- **Volatile Organic Compounds, (VOC) by speciation:**
  Follows EPA TO-15 protocol

EPA pathway testing-gas constituents

Gas quality constituent	Pipeline	Units	Raw biogas	RNG
Oxygen (O_2)	0.0005	Vol %	0.55%	0.15 ppmv 0.000015%
Hydrogen Sulfide (H_2S)	0.25	Grains/100 scf	1,100,000 ppbv	120 ppbv
Mercaptan Sulfur (R-SH)	0.5	Grains/100 scf	1380 ppbv	ND
Total Sulfur (TS)	5	Grains/100 scf	1,101,455 ppbv	ND
Carbon Dioxide (CO_2)	2	Vol %	38.10%	0.30%
Water vapor	5	lbs/MMscf	>100 lb/MMcf	<2 lb/MMcf
Interchangeability (AGA Research Bulletin No. 36) GPA 2286_Wobbe Index			616	1347
Temperature	≤100	°F	80°F	51°F
Hydrocarbon dew point	0	°F @ 500 lbs/in²	-31.0°F at 500 psig	-132°F at 500 psig
Higher heating value (Gross)	950-1100	Btu/scf	601 Btu/scf	1008 Btu/scf

- Raw biogas validates your source of biogas
- RNG validates meeting pipeline specs
- Both sets of tests must include all pipeline specs for the project

Grand Rapids WRCC, Michigan

- 400 MGD plant
- Municipal waste
- 2-400 scfm systems
- Oxygen removal system
- Start-up: December 2021
- Pipeline injection-DTE energy pipeline

Moisture, bacteria, CO_2 and siloxane/VOC removal

PSB Industries deoxo system

H_2S removal

Leaders in Biogas Technology

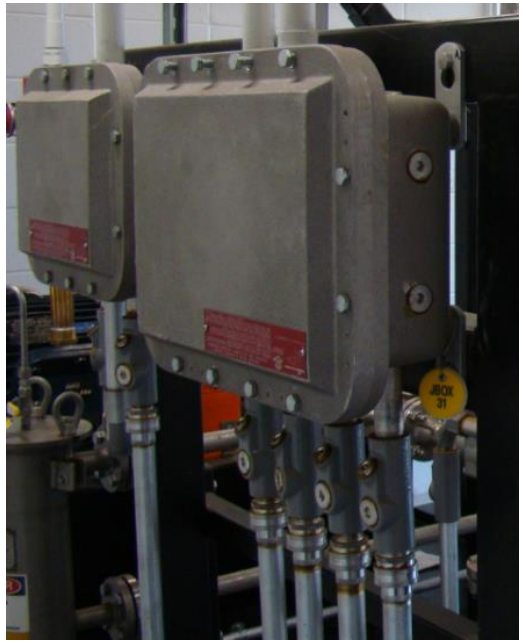
Design considerations

- Site conditions
- Installation requirements
- End-use technology
- Discharge gas conditions

Hazardous locations

Locations where fire or explosion hazards exist due to flammable gases

Per NFPA 820, gas processing equipment shall be rated Class I Division 1 and located in a classified area



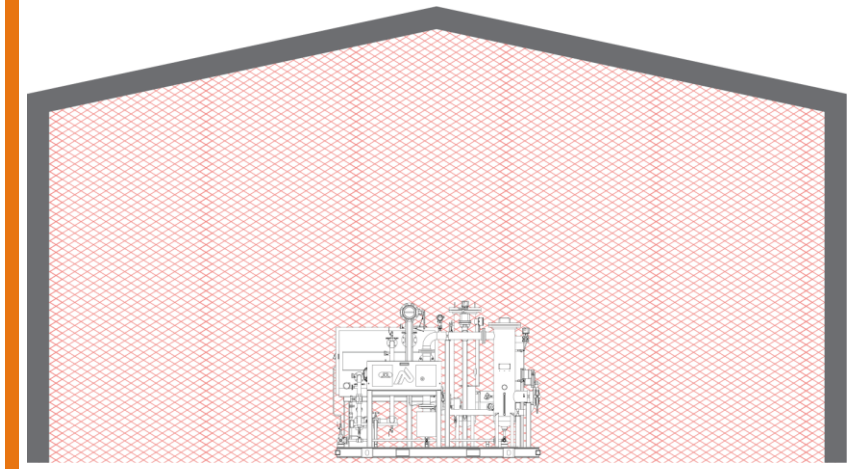
NFPA 820 - Hazardous locations

Class I Division 1 Classified Area

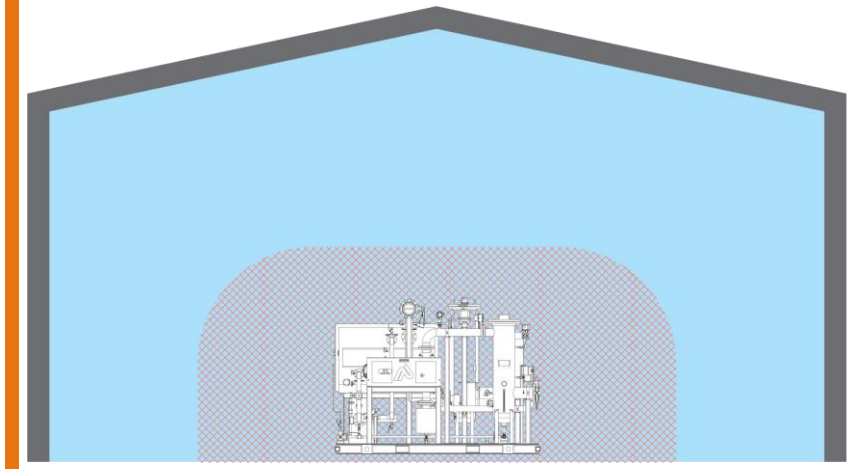
Class I Division 2 Classified Area

Standard for Fire Protection at Wastewater Treatment Facilities

This room has no ventilation or is ventilated with less than 12 air changes per hour.



This room is continuously ventilated at 12 air exchanges per hour.
Class I Division 1 Classified area
(5’ envelope around gas processing equipment)



NFPA 70 - Article 500

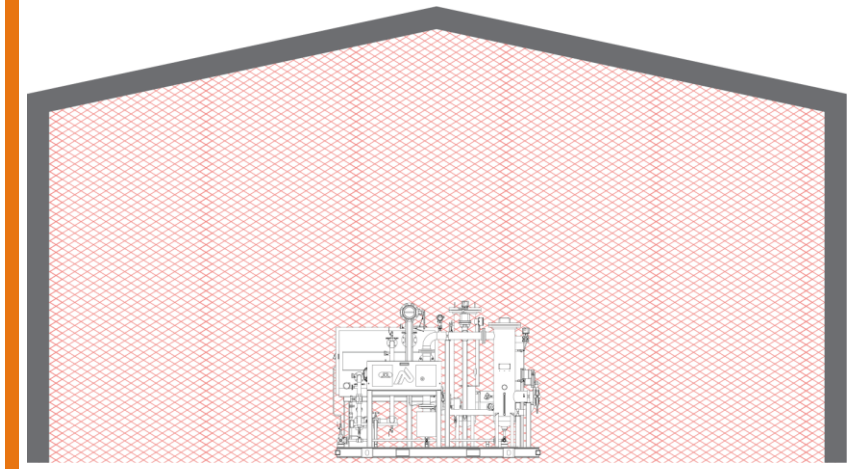
Class I Division 1 Classified Area

Class I Division 2 Classified Area

National Electric Code

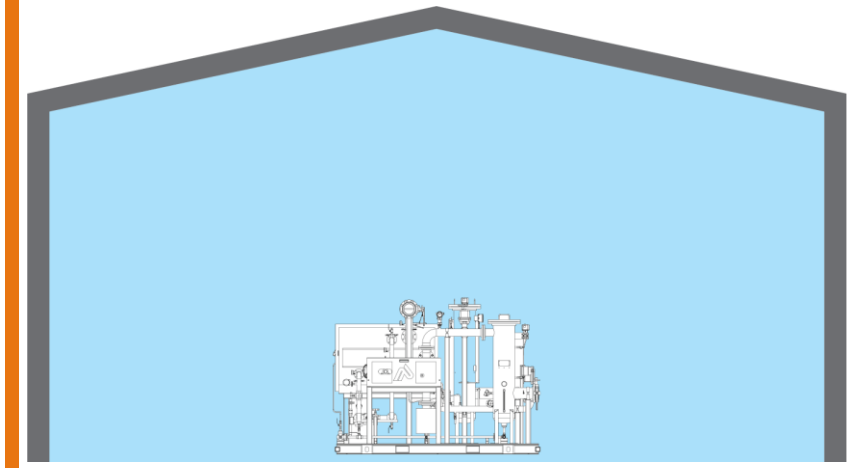
Class I, Division 1

Where gases exist under normal operating conditions

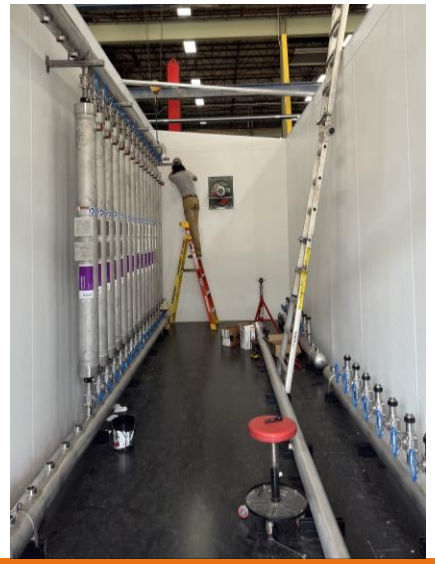


Class I, Division 2

Where gases are contained or prevented by positive mechanical ventilation



Enclosures: purpose-built vs. containerized



Advantages of purpose-built enclosures

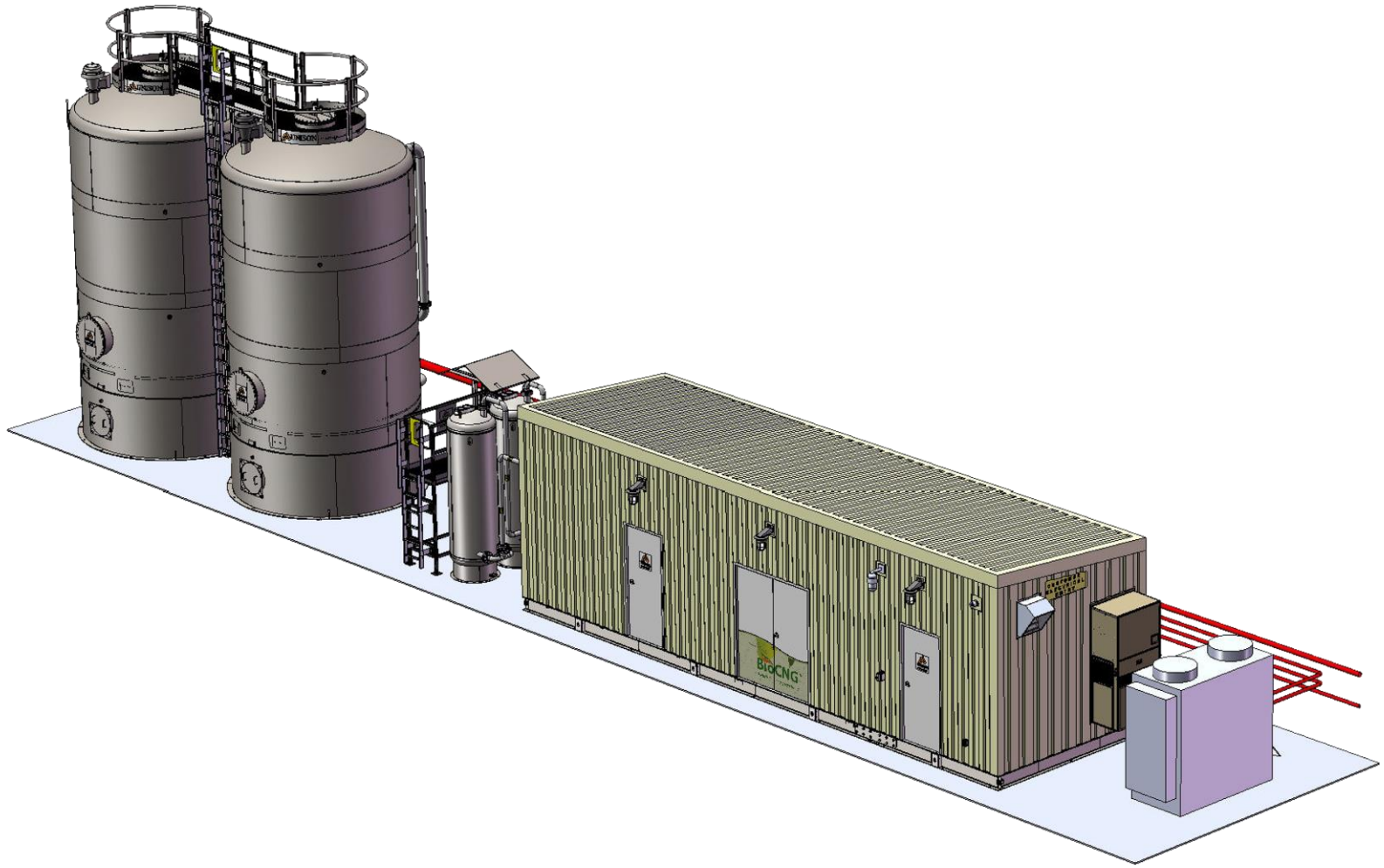
- Customization
- Higher quality cold weather protection
- Higher quality sound attenuation
- Ease of assembly
- Consistent quality control of product
- Price competitive

Ease of installation

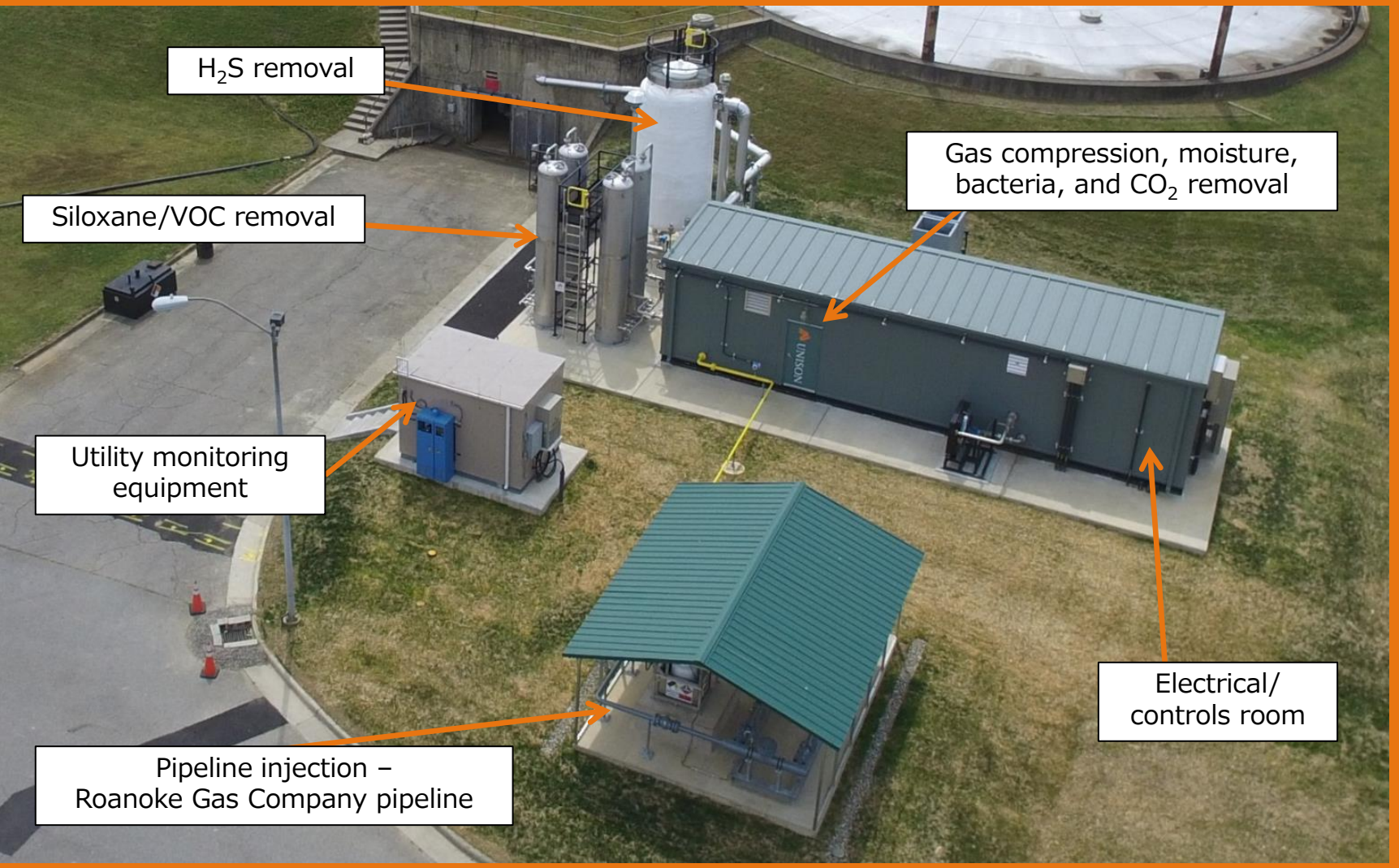
Enclosures with electrical rooms

Ease of installation

- Reduce on-site installation time
- Defined interconnections
- Limited contractor scope
- On-site electrical – pre-commissioned prior to shipment



Ease of installation



- Roanoke Regional WPCP, VA
- 37 MGD plant
- Municipal wastewater
- 400 scfm
- Owned and operated by the natural gas utility
- Start-up: April 2023

System design checklist

- Site conditions
- End-use technology
- Inlet gas conditions (gas testing)
- Discharge gas conditions

Equipment	H_2S	Siloxanes
Turbine	<5,000 ppmv	<100 ppbv
Linear generators	ND	100 ppbv
IC engine	<100 - 500 ppmv	<100 - 1,000 ppbv
Boiler	<100 - 500 ppmv	<500 - 2,000 ppbv
Vehicle fuel	<4 ppmv	<100 ppbv
Pipeline	Utility requirements	Utility requirements

Biogas to RNG process flow

BioCNG™

H_2S removal

Gas compression/ moisture removal

Siloxane/VOC removal

CO_2 removal

CNG vehicle fueling station

Vehicle fuel/pipelines

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Biogas constituents

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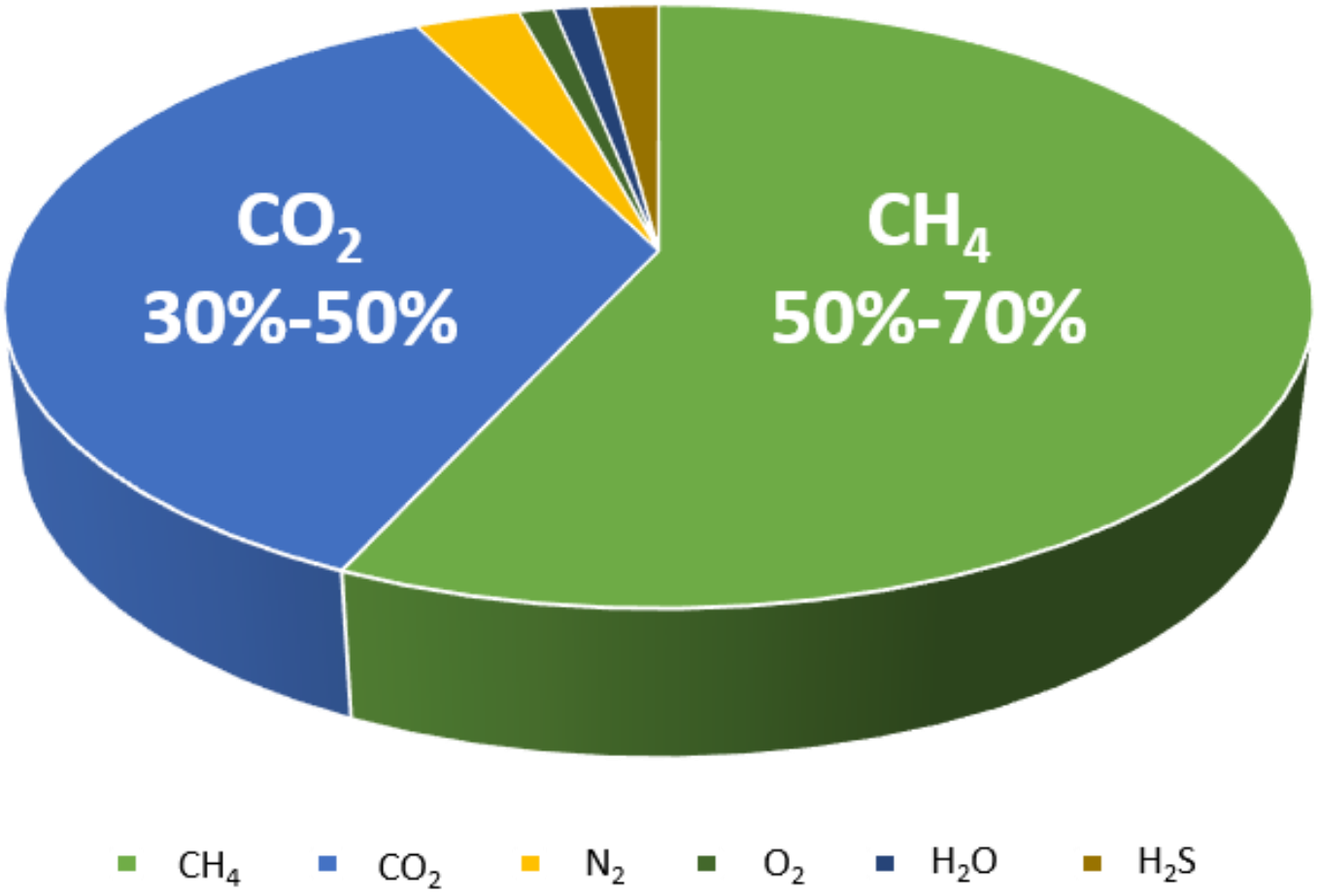

- Methane, CH_4
- Carbon Dioxide, CO_2
- Nitrogen, N_2
- Oxygen, O_2
- **Hydrogen Sulfide, H_2S**
- Moisture
- Particulates
- Siloxanes
- Volatile Organic Compounds

Hydrogen Sulfide, H_2S

- Equipment damage from corrosion (Hydrosulfuric Acid)
- SO_x emissions
- Health and safety issues (1000 ppm will cause an individual to lose consciousness)
- Odor control
- Causes fouling of siloxane removal media

H_2S removal at the digester

- Ferric hydrate powder
- Added directly to the digester on a daily basis
- Can be used alone or in conjunction with fixed-bed media systems

New bag

After 7 days

H_2S removal system

BioCNG™

H_2S removal

Gas compression/ moisture removal

Siloxane/VOC removal

CO_2 removal

CNG vehicle fueling station

Vehicle fuel/pipelines

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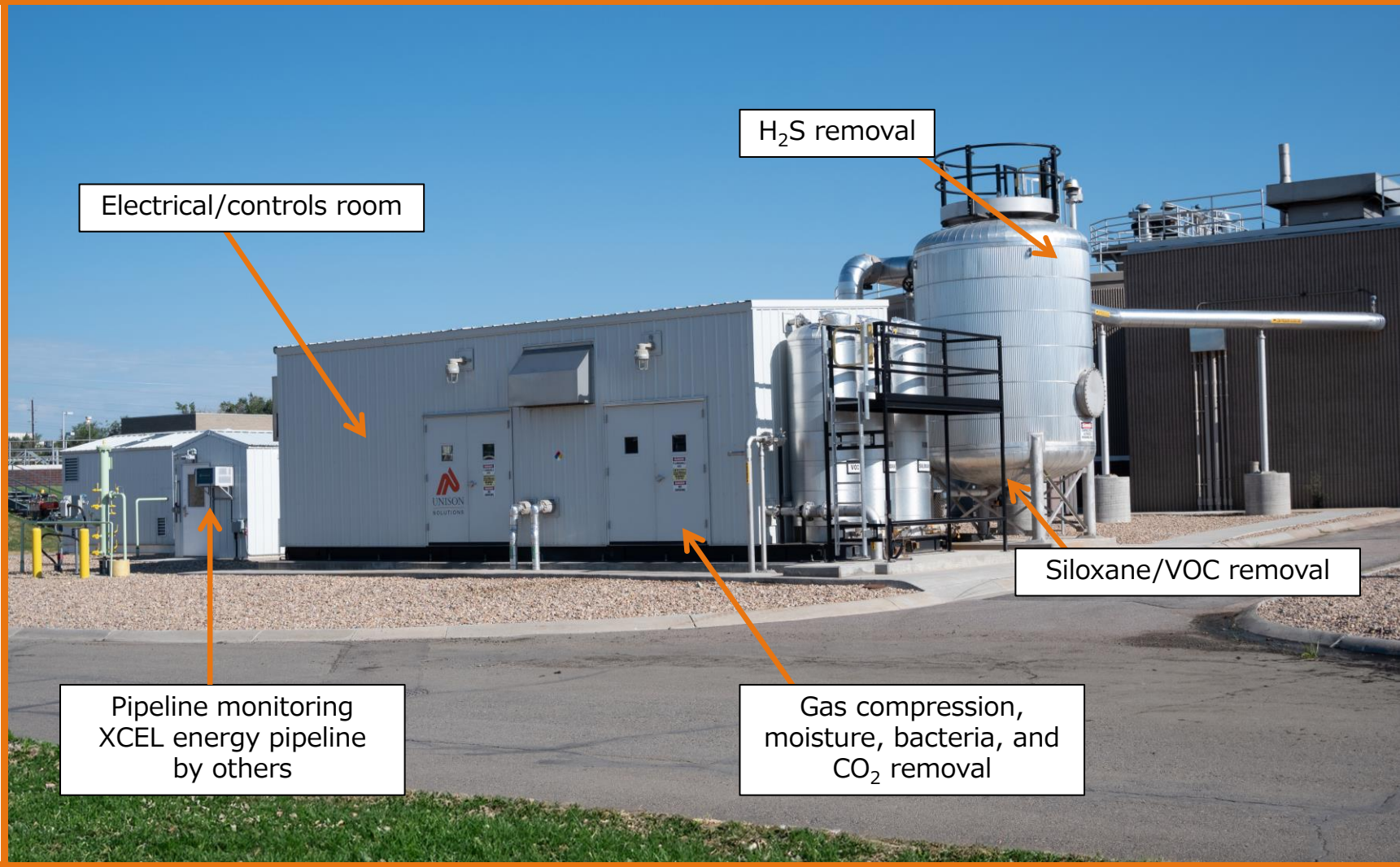
Hydrogen Sulfide removal systems

- Filtration medias
  - Wood based
  - Clay based
  - Ferric hydroxide
  - Carbon
- For sites with high H_2S
  - Biological systems
  - Chemical systems

South Platte Renew, Colorado

SOUTH PLATTE RENEW
OWNED BY LITTLETON/ENGLEWOOD

- Littleton-Englewood, CO
- 20 MGD plant
- 400 scfm
- Start-up: October 2019



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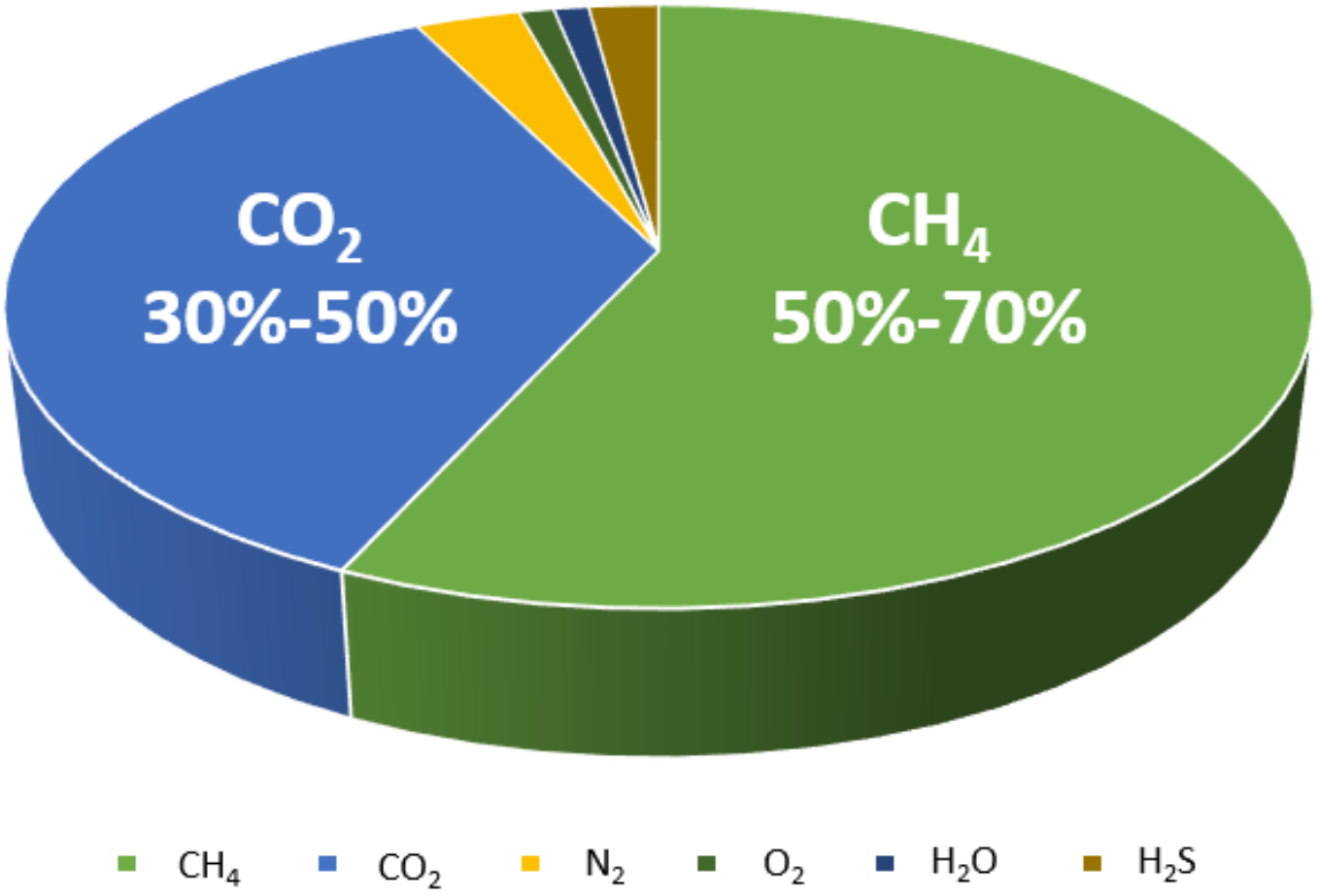

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- **Moisture**
- **Particulates**
- Siloxanes
- Volatile Organic Compounds

Compression/moisture removal systems

BioCNG™

H_2S removal

Gas compression/ moisture removal

Siloxane/VOC removal

CO_2 removal

CNG vehicle fueling station

Vehicle fuel/pipelines

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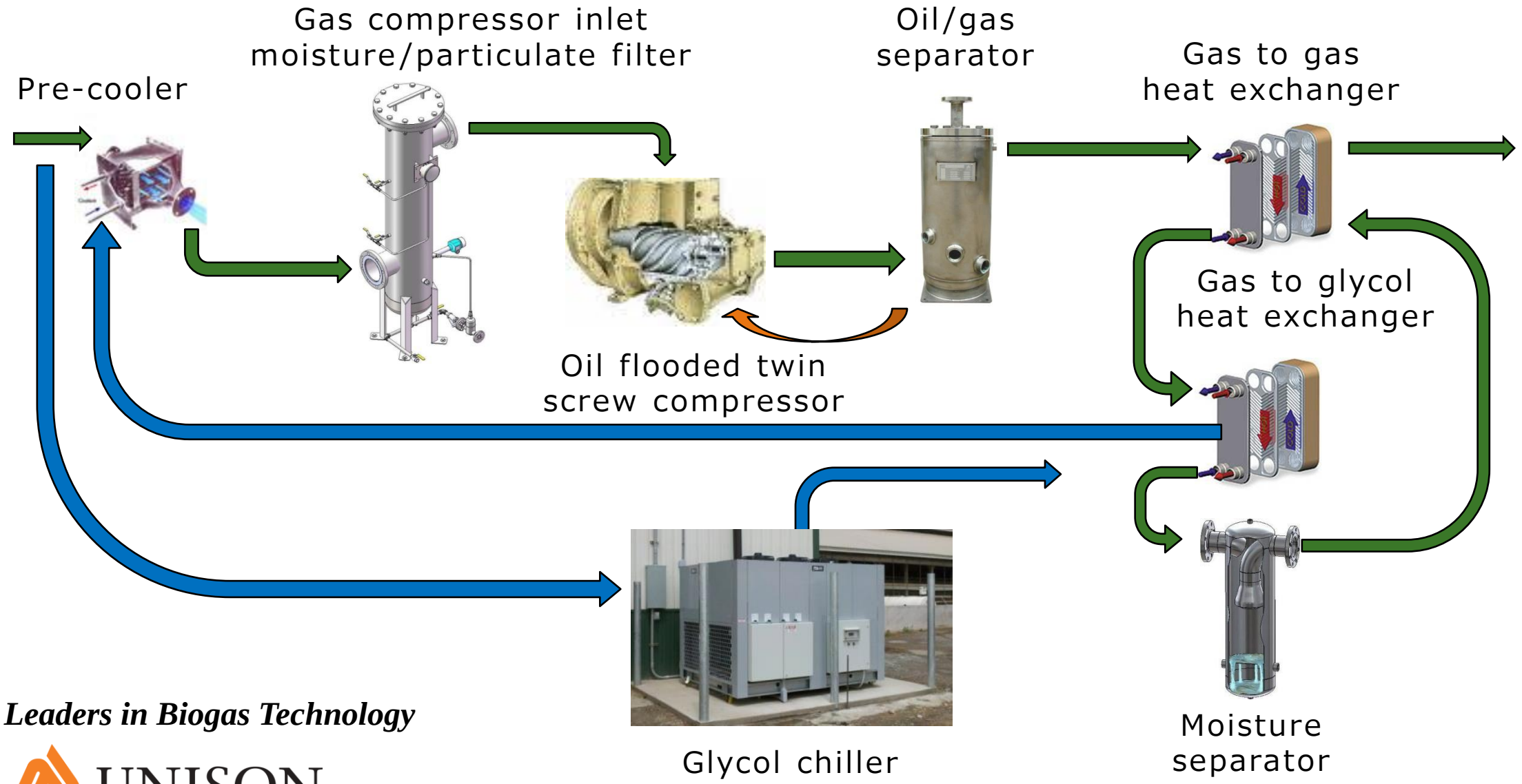
Compression/moisture removal

- Two stage condensate removal process to protect the compressor and the end use equipment
- Designed for up to 200 psig, particulate free and relative humidity less than 25%

Compression/moisture removal



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Theresa Street WRRF, Nebraska

CITY OF LINCOLN NEBRASKA

- 27 MGD
- 400 scfm
- Municipal waste
- Start-up: September 2020

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Biogas constituents

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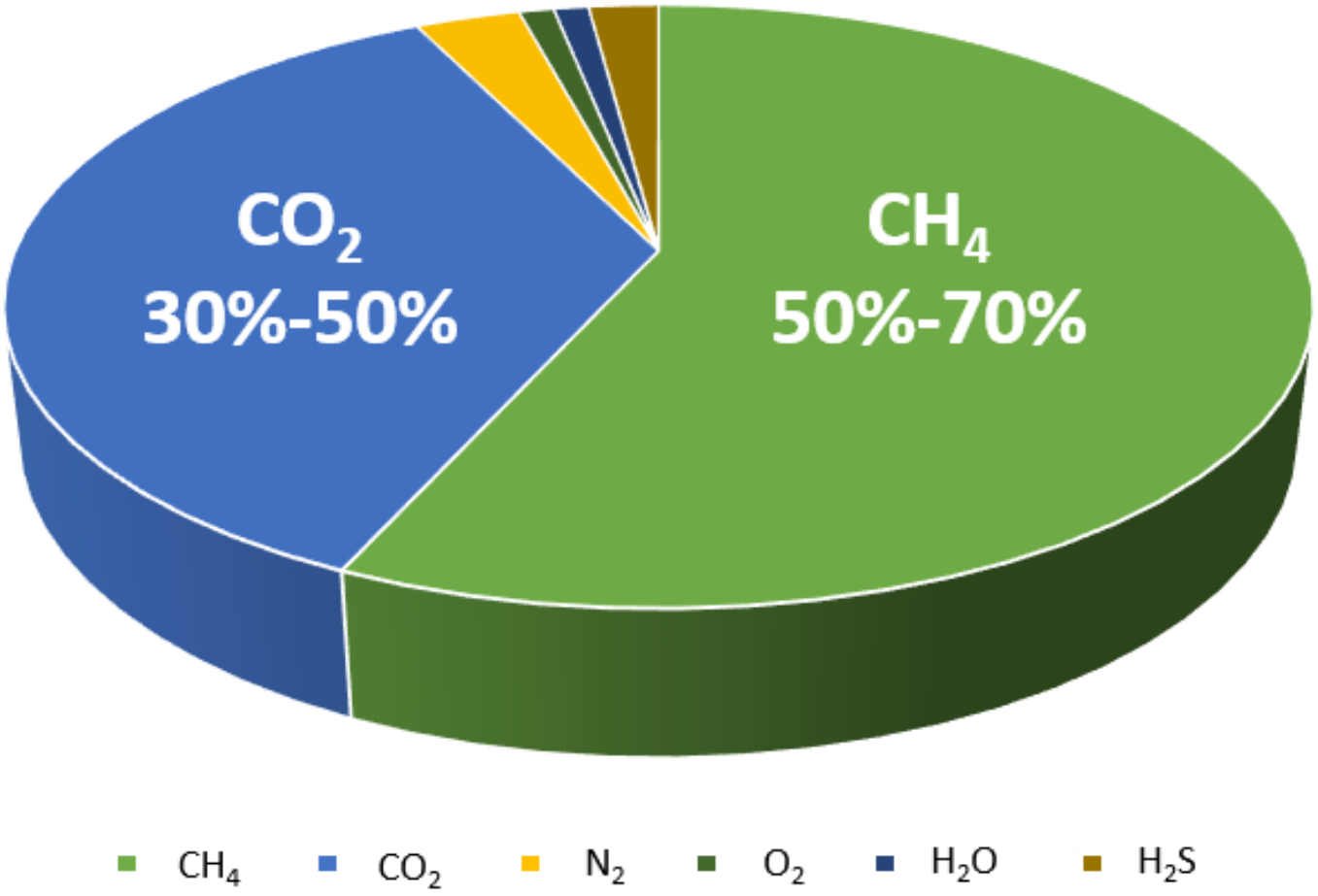

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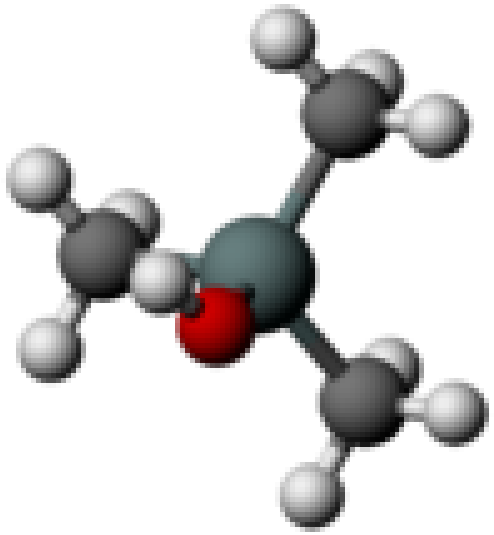
- Moisture
- Particulates
- **Siloxanes**
- **Volatile Organic Compounds**



- Silica and organic compounds are combined (Organosilicon)
- Used in many consumer and *industrial products *(listed as silicones as the ingredient on products)*

▪ Shampoo	* Dry cleaning solutions
▪ Conditioner	* Windshield cleaning products
▪ Deodorant	* RTV silicone cleaner
▪ Food additives	* Pipe dope/sealant

- Siloxanes break down in landfills and digesters, and combine with the methane gas

What is a Siloxane?

Siloxane impact on equipment

Engines

- When methane gas is used as a fuel, the siloxanes form SiO_2 Silicon Dioxide, and precipitate to a hard deposit on surfaces
- Significant impact on electrical generation systems
- Increased downtime for maintaining equipment
- Increased costs for components, i.e. spark plugs, valve seats
- Engine rebuild time is more frequent

Is a siloxane removal system needed?

BioCNG™

H_2S removal

Gas compression/ moisture removal

Siloxane/VOC removal

CO_2 removal

CNG vehicle fueling station

Vehicle fuel/pipelines

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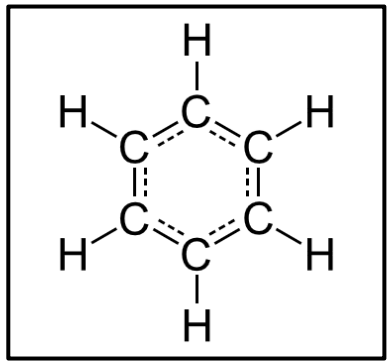
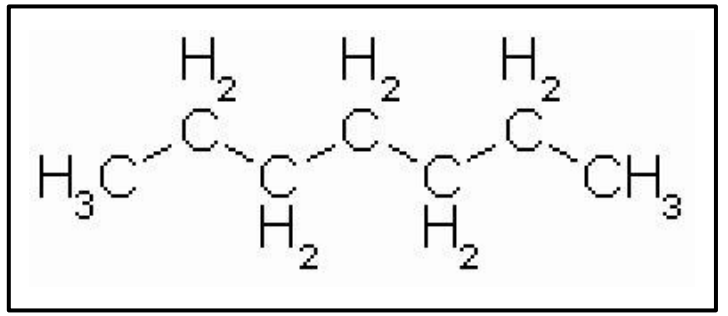
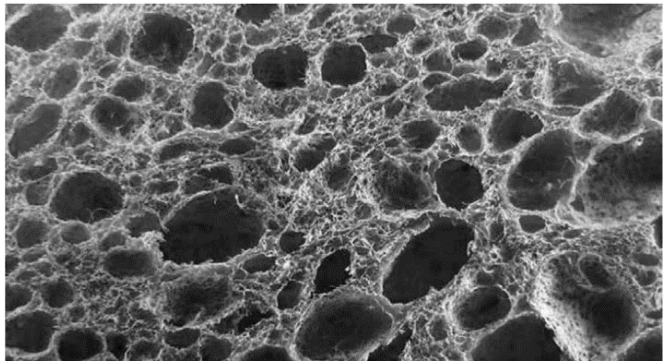
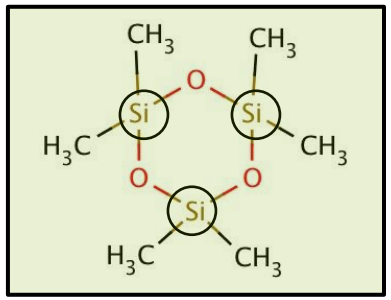


Benzene (C_6H_6)

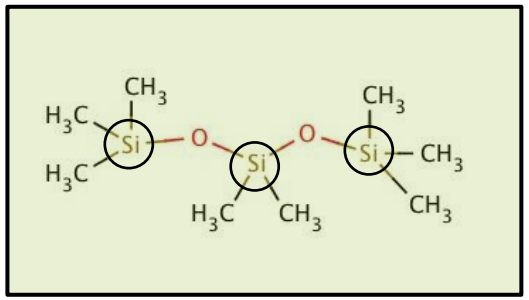


Heptane (C_7H_{16})

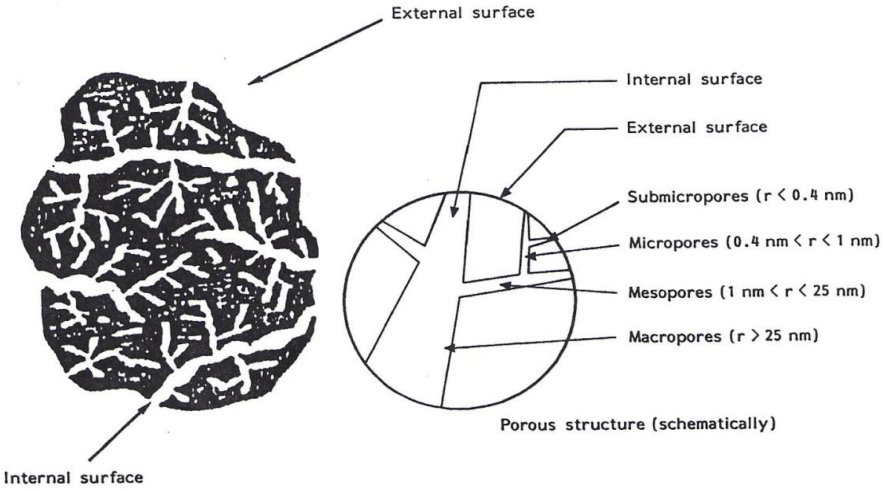




Hexamethylcyclotrisiloxane (D3)



Octamethyltrisiloxane (L3)



Siloxanes and VOCs

Coal

Wood

4x8 mesh chips

Silica gel-irregular shaped

Coconut shell

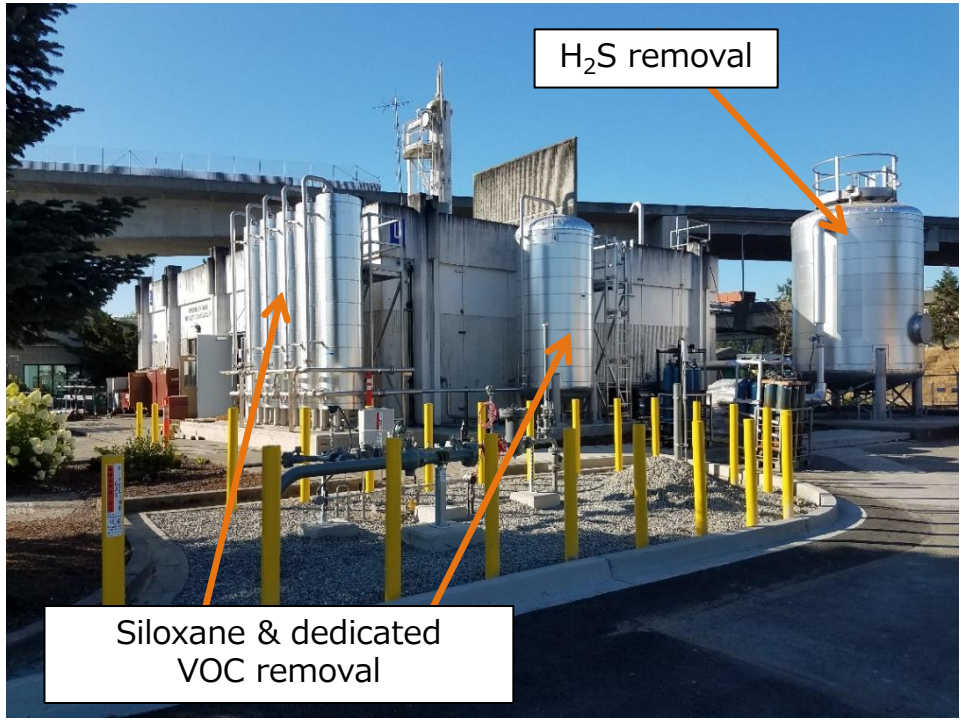
Extruded pellets

Silica gel-spheres

Siloxane/VOC removal

Pacific NW facility

- 130 MGD Plant
- Municipal waste
- 300 scfm system
- Start-up:
  Fall 2022



Pipeline injection – PSE

Moisture, bacteria and CO_2 removal

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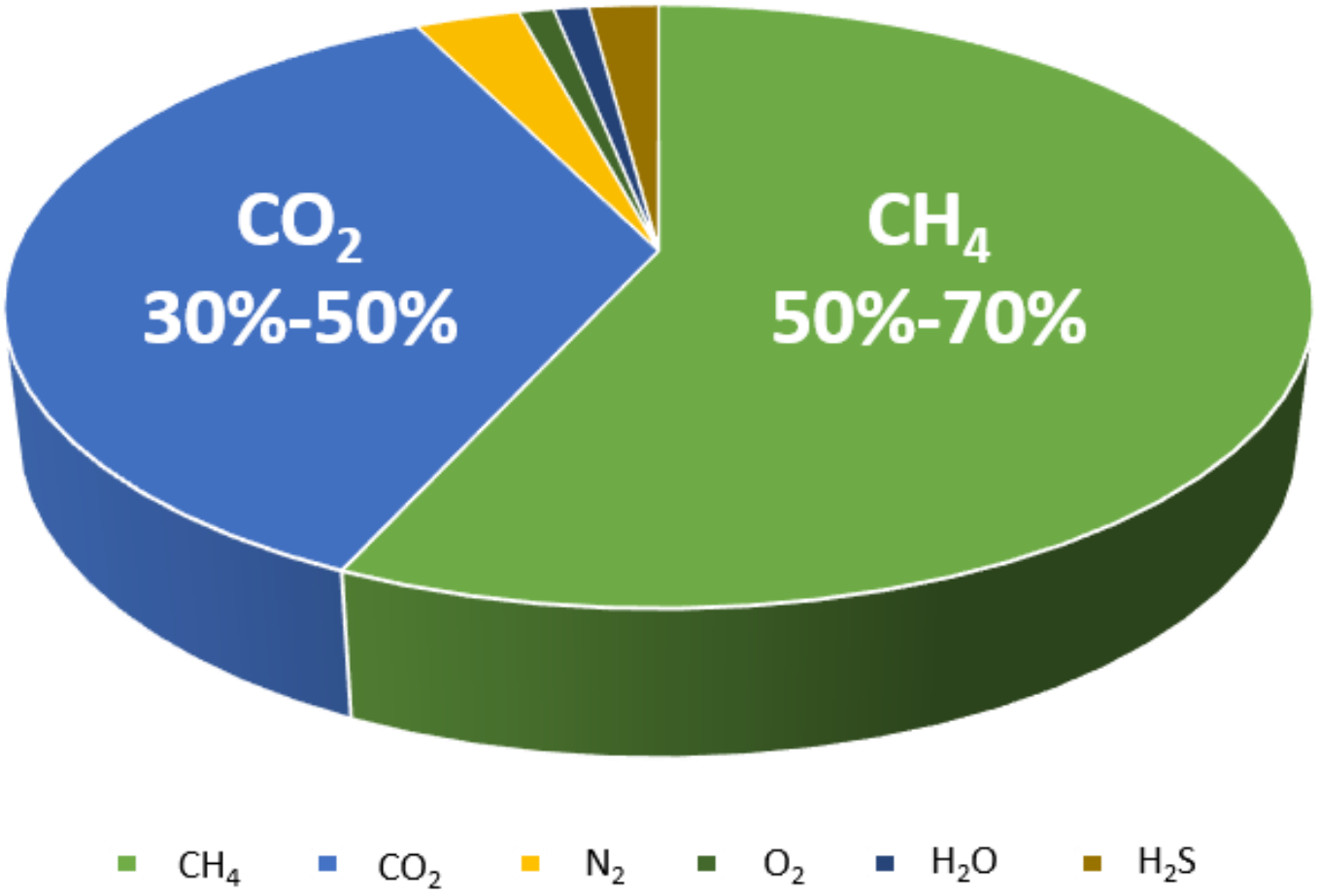

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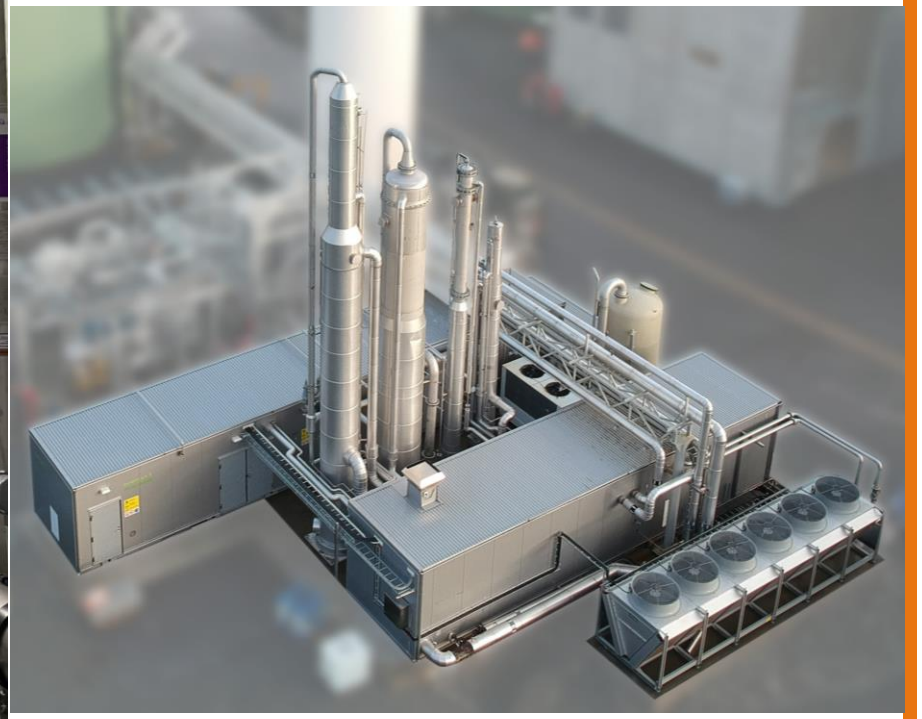
- Moisture
- Particulates
- Siloxanes
- Volatile Organic Compounds

Biogas upgrading technologies



- Membrane separation
- Chemical absorption

- Membranes have a few hundred miles worth of fiber in one cartridge
- Each hollow fiber has a size on the micron scale, smaller than a human hair

Membrane separation

Pleasant Grove WWTP

- Roseville, CA
- 12 MGD Plant
- Gas flow: 400 scfm
- Fast-fill: municipal bus fueling
- System component redundancy
- 2 – 10’Ø x 12’ ss H_2S vessels – 1,000 ppm
- Redundant compressors inside enclosure with sound attenuation

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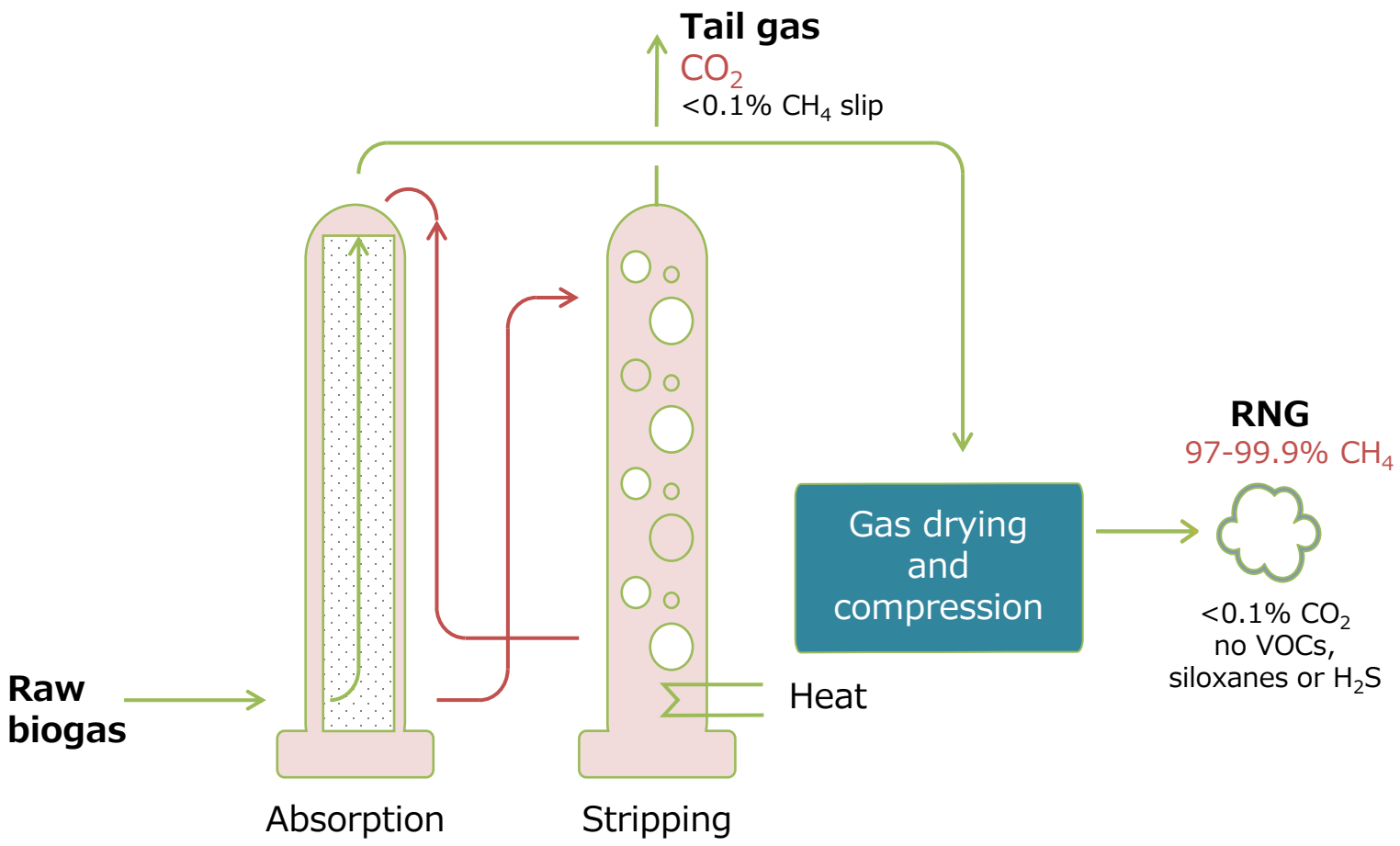
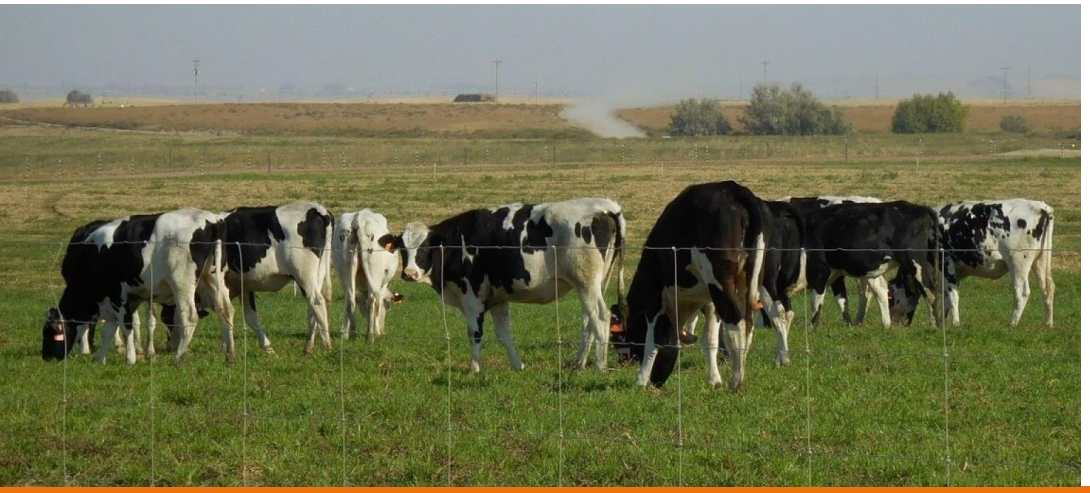
Puregas CA technology

- CO_2 separation via chemical absorption and stripping of amine
- Low pressure (~12 psig) operation reduces electrical demand, increases plant availability
- Lowest methane slip to tail gas stream (< 0.1%) of biogas upgrading technology options
- Flexibility to treat H_2S in raw biogas or in tail gas



Threemile Canyon Farms



- Location: Boardman, OR
- Biogas feedstock: dairy manure
- Plant capacity: 3,500 scfm
- Puregas CApure upgrading technology with 99.934% methane recovery
- Heat integration between CApure plant and substrate pre-heat train upstream of covered lagoon digesters
- Start-up date: 2019

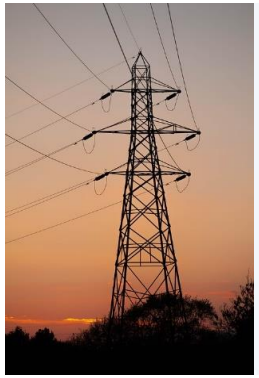
Shell New Energies Junction City

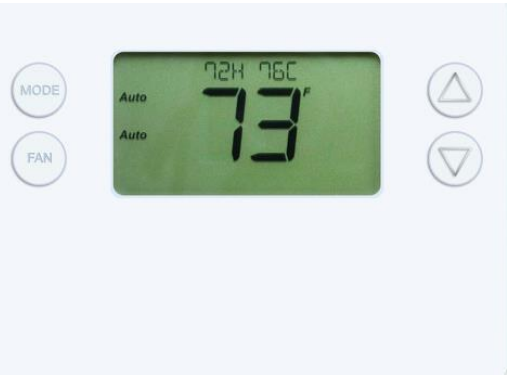
- Location: Junction City, OR
- Biogas feedstock: dairy manure and straw/grass residuals
- Plant capacity: 3500scfm
- Puregas CApure upgrading technology
- Prefabricated equipment modules fully factory-tested
- Start-up: 2021

Q & A

Biogas

Electricity, heat, fuel for vehicles, pipeline injection





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