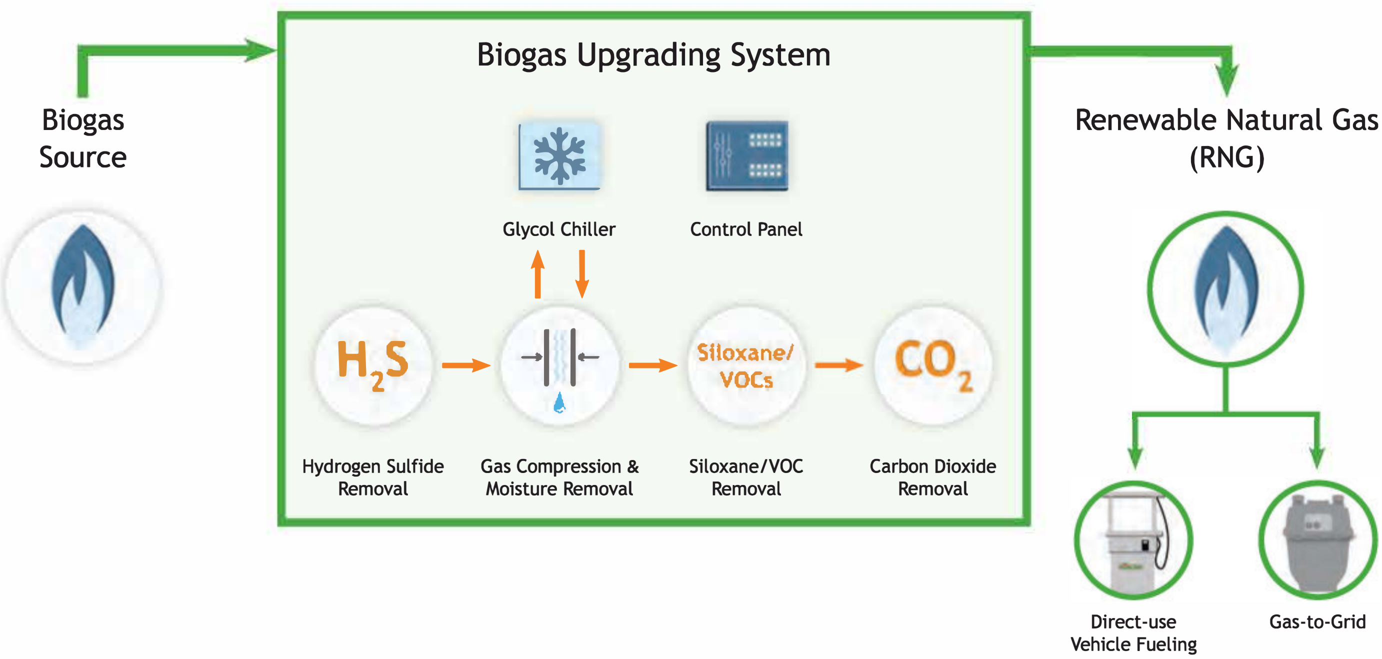
BIOGAS UPGRADING



HOW DOES IT WORK?

- Biogas is piped to the Unison Biogas Upgrading System from a landfill or anaerobic digester
- Constituents including hydrogen sulfide, carbon dioxide, moisture, siloxanes, and other volatile organic compounds (VOCs) are removed to produce renewable natural gas (RNG)
- RNG may be used for direct-use vehicle fueling or injection into the natural gas pipeline per the respective project's specifications

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BIOGAS SPECIFICATIONS

BIOGAS CONSTITUENTS	RAW BIOGAS INLET REQUIREMENTS	SAE J1616 CNG FUEL QUALITY SPECIFICATION	NATURAL GAS PIPELINE FUEL QUALITY **
Methane (CH_4)	50-80%	90% or greater	
Wobbe Index		1,250-1,420 BTU/ft^3	1,290-1,400 BTU/ft^3
Higher Heating Value (HHV)			950-990 BTU/ft^3
Water Content	100% saturated	PWDP 10° below lowest recorded temp	3-7# / MMcf
Carbon Dioxide (CO_2) and Nitrogen (N_2)	20-50%	4.5% maximum	<2-3%
Oxygen (O_2)	0-1%	1%	0.0005% to 0.2%
Hydrogen Sulfide (H_2S)	<1000 ppmv	≤4 ppmv	≤4 ppmv
Siloxanes & Volatile Organic Compounds (VOCs) *	<2000 ppmv	ND as silicon	ND to 1 ppm
Pressure	0-2 psig	3600 psig	50-900+ psig

* *Raw biogas should be analyzed to determine speciated siloxane and VOC concentrations in order to accurately ascertain maintenance costs. Contact Unison Solutions for gas testing services: sales@unisonsolutions.com*

** *Natural gas pipeline fuel specifications vary depending on the utility.*

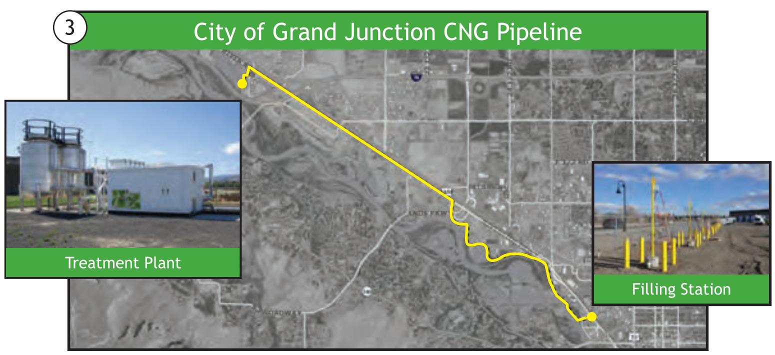
METHODS OF DELIVERING RNG TO VEHICLES

2


4


RNG

1. On-site storage/fueling
2. Virtual pipeline
3. Dedicated pipeline

3


Gas-to-Grid

4. Injection station
5. Natural gas pipeline

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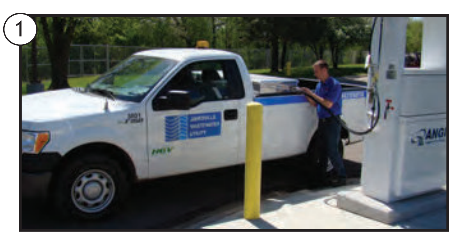

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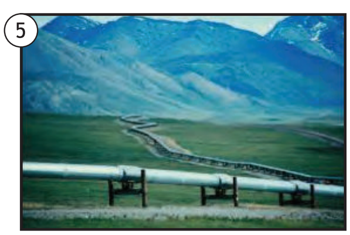


ON-SITE RNG PRODUCTION AND FUELING

- Converts biogas to renewable natural gas that meets SAE J1616 specifications
- Has a production cost of $.70 to $1.25/GGE*, with the potential for renewable fuel credits such as RINs and LCFS
- May be supplemented or paralleled with natural gas
- May be integrated with existing cogeneration systems
- Allows for existing CNG fueling system to be utilized

** Dependent on inlet biogas quality*

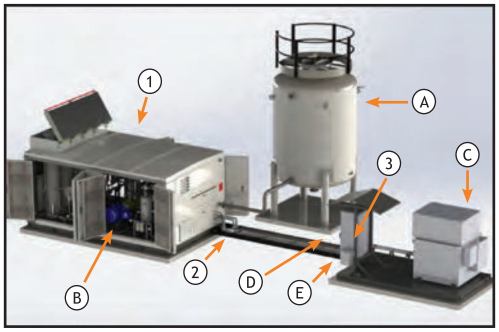
PERFORMANCE SPECIFICATIONS

BioCNG™

Biogas Inlet Flow Required (scfm)	100	200	400
Fuel Production (GGE/day)	370-600	740-1200	1480-2400
Fuel Production (DGE/day)	320-520	640-1040	1280-2080

What are GGE and DGE? *Gasoline Gallon Equivalent (GGE) defines the amount of alternative fuel needed to equal the energy content of one liquid gallon of gasoline (114,000 BTUs). Diesel Gallon Equivalent (DGE) defines the amount of alternative fuel needed to equal the energy content of one liquid gallon of diesel (129,500 BTUs).*

SYSTEM COMPONENTS AND OPTIONS



Standard Sub-Systems

- Ⓐ H_2S removal
- Ⓑ Skid
  - Gas compression/moisture removal
  - Siloxane/VOC removal
  - CO_2 removal
- Ⓒ Glycol Chiller
- Ⓓ Control panel
- Ⓔ Gas Analyzer

Options

- ① Skid enclosure
- ② Easy-install kit
- ③ Electrical distribution

BIOGAS UPGRADING TO PIPELINE SPECIFICATIONS

Typical biogas begins with 60-80% methane, 20-40% carbon dioxide and is 100% saturated. Our upgrading system removes moisture and particulates from the gas, while the selective multi-stage membrane system reduces carbon dioxide. The final renewable natural gas quality has a methane content of 98% or higher and less than 2% carbon dioxide. Depending on inlet gas quality, removal of hydrogen sulfide and siloxanes may also be necessary.

Our engineering staff designs each system to specific pipeline specifications and site requirements. All of our systems are built to Class I, Div 1 specifications and are thoroughly tested before leaving our facility to ensure a quick installation and startup.

Dubuque, Iowa-based Unison Solutions is the leader in biogas technology. Since 2000, we have designed and manufactured biogas upgrading systems that produce RNG for vehicle fuel, SAE J1616-quality or pipeline-quality fuel, and biogas conditioning systems that produce fuel to operate all types of cogeneration equipment.

Our systems are designed to meet each client's specific requirements and are customized based on the inlet gas quality.

Contact our sales engineers to discuss your specific requirements: sales@unisonsolutions.com

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