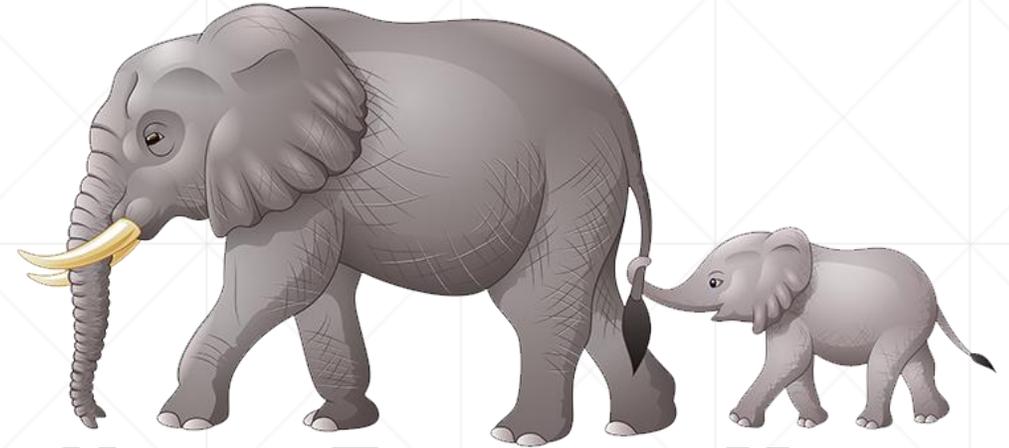


Wednesday, September 22, 2021



**URBAN ELEPHANT MEDIA**

~ PRESENTS ~

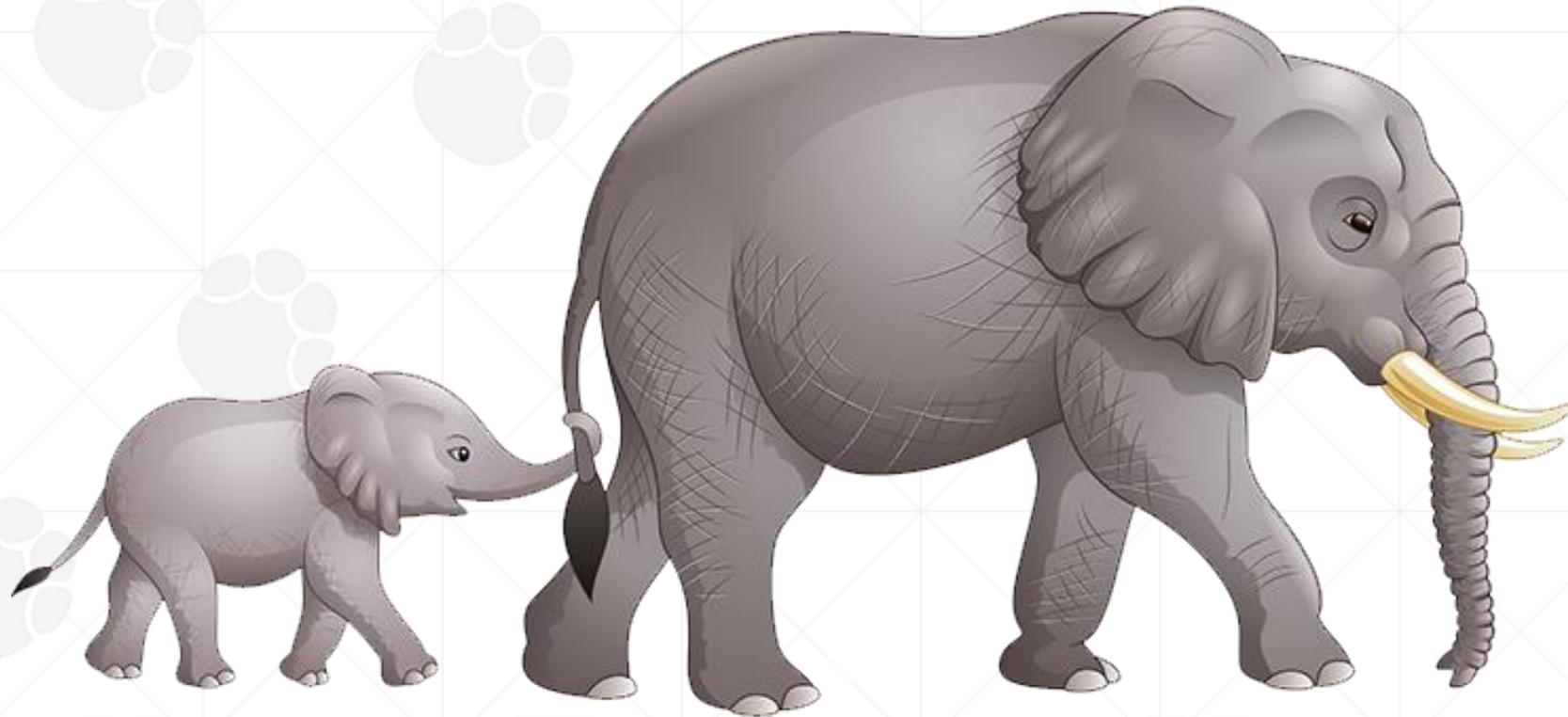
# Upgrading Biogas to RNG

*featuring the City of Lincoln, NE*

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Presented by Unison Solutions and the City of Lincoln

*Sponsored by Unison Solutions*



# URBAN ELEPHANT MEDIA

*PEER-TO-PEER LEARNING MADE EASY*

Sustainability Training for Urban Designers and Policymakers

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**UNISON**  
**SOLUTIONS**



Our Presenters



**Jan Scott**  
*Co-owner*  
*Unison Solutions*





**BIOCNG™**

**UNISON SOLUTIONS**

## Upgrading Biogas to RNG

September 22, 2021

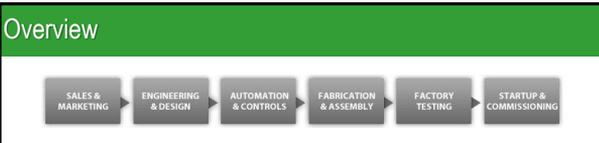
## Overview



- Company founded on January 1, 2000
- Employee owned: November 2020
- 50 Employees (9 Engineers)
- 65,000 ft<sup>2</sup> Manufacturing facility
- Over 330 systems sold worldwide

**BIOCNG™**

## Overview





**UNISON SOLUTIONS**

## Overview



Stainless steel vessel fabrication



Automation, UL 508A, UL 698A, and UL 1203 panel shop



Manufacturing and testing facility

**UNISON SOLUTIONS**

## Custom Manufacturing

- Stainless steel vessel fabrication
- ASME code vessels and piping
- Plate rolling
- Plasma table





**UNISON SOLUTIONS**

## Custom Manufacturing

Enclosures:

- Fabricated panels
- Steel reinforced
- Aluminum construction
- Modified shipping containers





**UNISON SOLUTIONS**

### Custom Manufacturing

New products and technologies



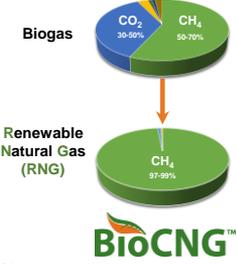

### Field Evaluation Services



- Media optimization
- System review
- Refurbish older systems



### Biogas to RNG





### Over 330 Systems Sold Worldwide




### BioCNG Vehicle Fuel and Pipeline Projects

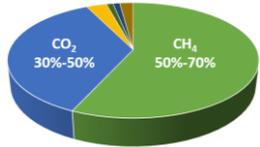
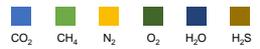



### Know Your Biogas Quality



bi-o-gas, bi0 gas/, noun, gaseous fuel, especially methane, produced by the fermentation of organic matter.

- Methane (CH<sub>4</sub>)
- Carbon dioxide (CO<sub>2</sub>)
- Nitrogen (N<sub>2</sub>)
- Oxygen (O<sub>2</sub>)
- Hydrogen sulfide (H<sub>2</sub>S)
- Moisture
- Particulates
- Siloxanes
- Volatile organic compounds (VOCs)


### Know Your Pipeline Requirements

- Gas quality requirements\***
  - BTU Content
    - Methane
  - Carbon dioxide
  - Oxygen
  - Nitrogen
  - Hydrogen sulfide
  - Siloxanes and VOCs
  - Bacteria
  - Water content
- Tie-in location and requirements**
  - Interconnect fees
  - Pressure
  - Flow
  - Transport to offloading station (virtual pipeline)
    - Compression
    - Tube trailers
- What RNG monitoring is required?**
  - Online
  - Monthly
  - Yearly
  - Single validation test

\*Requirements vary depending on pipeline tariff

### Steps to a Successful RNG Project

```

    graph LR
      A[Identify pipeline or direct vehicle fueling] --> B[Determine inlet gas quality]
      B --> C[Confirm final RNG quality requirements]
      C --> D[Determine equipment required]
  
```

Good working relationship with your manufacturing and supply partners



### Biogas Renewable Energy Project

Biogas - Methane

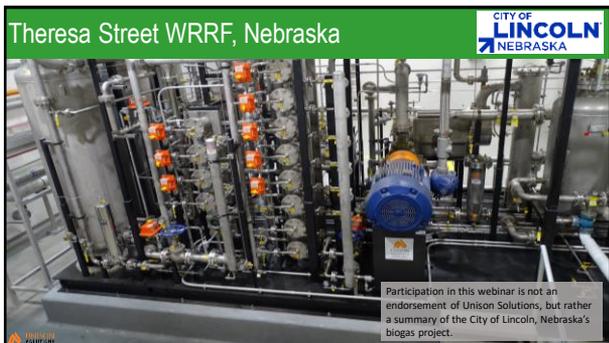
### Theresa Street WRRF, Nebraska

- 27 MGD Plant
- 400 scfm
- Municipal and industrial waste
- Effluent from the plant is sent to UNL's Innovation Campus to heat and cool its building
- Energy Neutral/Net Zero plant

**Original equipment**

- 2 - Engine generators, 450 kW
- Digester heat from CHP
- Backup natural gas boiler

### Energy Neutral



### Know Your Raw Biogas Quality

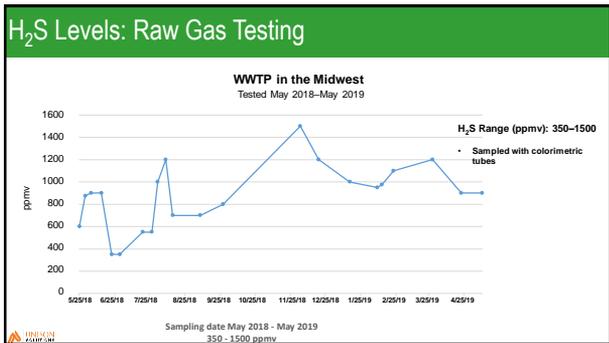
- Methane (CH<sub>4</sub>) 50-70%
- Carbon dioxide (CO<sub>2</sub>) 30-50%
- Nitrogen (N<sub>2</sub>) 1-5%
- Oxygen (O<sub>2</sub>) 0-2%
- Moisture 30-100% R.H.

- Hydrogen sulfide (H<sub>2</sub>S) 0-10,000 ppm
- Siloxanes
- Volatile organic compounds (VOCs)

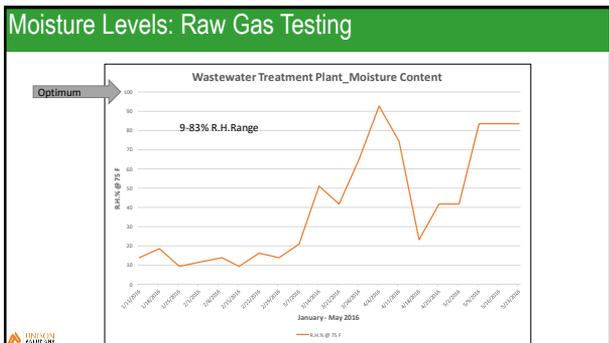
Legend: CO<sub>2</sub> (blue), CH<sub>4</sub> (green), N<sub>2</sub> (yellow), O<sub>2</sub> (dark green), H<sub>2</sub>O (dark blue), H<sub>2</sub>S (brown)

### Hydrogen Sulfide (H<sub>2</sub>S)

- Where does H<sub>2</sub>S come from?
  - Landfills: the breakdown of calcium sulfate used in building materials
  - Digesters: sulfate-reducing bacteria (SRBs) convert the sulfate ion to sulfide
- Equipment damage from corrosion (hydrosulfuric acid)
- SO<sub>x</sub> emissions
- Health and safety issues
- Odor control
- Causes fouling of siloxane/VOC removal media
- Measure levels with either lab testing, colorimetric tubes, or on-site meter



### H<sub>2</sub>S Removal Media Costs: Media, Removal, Disposal



### How Siloxanes Affect Equipment

- When methane gas is used as a fuel, the siloxanes form silicon dioxide (SiO<sub>2</sub>) and form a hard deposit on surfaces
- Significant impact on electrical generation systems
  - Increased down time for maintaining equipment
  - Increased costs for components, i.e. spark plugs, valve seats
  - Engine rebuild time is more frequent

### Siloxane/VOC Removal Media Costs: Media, Monitoring, Removal, Disposal

- Coconut Shell
- Wood
- Coal
- Extruded Pellets
- 4 x 8 Mesh Chips
- Silica Gel - Spheres
- Silica Gel - Irregular Shapes

### Suitability Factors for Media Systems: Siloxanes, Hydrocarbons, and VOCs

Chemical structures shown: Benzene ( $C_6H_6$ ), Heptane ( $C_7H_{14}$ ), Hexamethylcyclotrisiloxane (D3), and Octamethyltrisiloxane (L3). A diagram illustrates a porous media structure with internal and external surfaces.

### Biogas Testing

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

- Major Components**
  - Methane
  - Nitrogen
  - Oxygen
  - Carbon dioxide
  - BTU calculation
- Sulfur Compounds**, by speciation
  - Hydrogen sulfide
  - Mercaptans
  - Other sulfide compounds
- Volatile Organic Compounds (VOCs)**, by speciation
  - Follows EPA TO-15 protocol
- Siloxanes**, by speciation
  - Up to 8 compounds common to biogas

These compounds will also need to be tested on a regular basis to determine media change out intervals

### Manure → Biogas → Energy

- Biogas upgraded to RNG or electricity production
- Estimated opportunities of 8,000 farms (beef, dairy, & swine) suitable for a renewable energy project
- Potential of over 171 million MMBTU/year

<https://www.epa.gov/agstar/agstar-data-and-trends>

### Electricity Production: Loyd Ray Farms, North Carolina

- Swine-to-waste energy system
- 8,600 head, feeder-to-finish operation
- 50 scfm compressor system feeds a 65 kW Capstone turbine for electricity production

### Moisture Removal Only Onsite

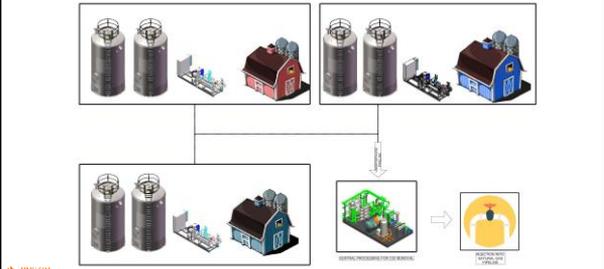
Diagram illustrating the process of moisture removal only onsite, showing the flow from a farm through a compressor, a moisture removal unit, and a turbine.

### Dedicated Pipeline to Central Processing

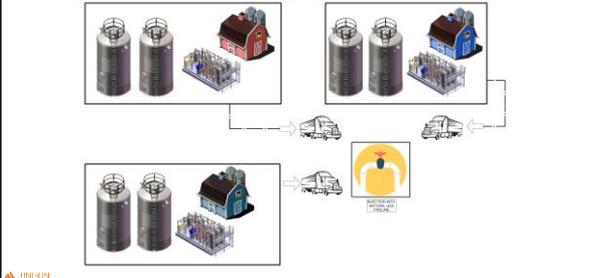


- Five in-ground digesters ≈ 60,000 hogs
- Gas compression/moisture removal
  - Four 60 scfm compressor systems
  - One 140 scfm compressor system
- Two injection compressors (1,050 psig)

### H2S Removal & Moisture Removal Onsite



### Virtual Pipeline



### Biogas Upgrading Summary

**BIOGAS**






**PIPELINE INJECTION**

- Equipment to meet pipeline spec/tariff
- Interconnect fees for utility
- Fuel testing to pipeline requirements

**VEHICLE FUELING**

- Less stringent fuel specification
- Fueling infrastructure on site
- Vehicles committed to using fuel



### Thank You!

Please contact us directly to discuss your biogas upgrading or custom manufacturing requirements.

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[www.unisonsolutions.com](http://www.unisonsolutions.com)

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