

# Biogas... What is the Future?

## Biomethane as a Transportation Fuel



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*Leaders in Biogas Technology*

# What is BioCNG™?

Patent pending system to convert biogas from an anaerobic digester or a landfill to a gaseous vehicle fuel.



# Key Definitions

- **CNG** - Compressed Natural Gas
- **LNG** - Liquid Natural Gas
- **RNG** - Renewable Natural Gas (BioCNG™)
- **GGE** - Gasoline Gallon Equivalent, 120,000 BTU/Gal
- **DGE** - Diesel Gallon Equivalent, 140,000 BTU/Gal
- **Biogas** - Methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) produced from the breakdown of waste by bacteria in wastewater treatment facilities and landfills
- **RIN** - A Renewable Identification Number is a serial number assigned to a batch of biofuel for the purpose of tracking its production, use, and trading

# Suitability Factors For Potential Sites

- CNG vehicles on site or in future budget?
  - How many vehicles?
  - What type of vehicles?
  - How often do they need to fill up?
  - Time or fast fill?
- Is suitable biogas available?
- Is natural gas available on site?
- Existing infrastructure
  - CNG infrastructure
  - Biogas Conditioning System

# Suitability Factors For Potential Sites

## Inlet Biogas Quality

Biogas Constituents	Inlet Biogas (Typical)
Methane (CH <sub>4</sub> )	>50%
Carbon Dioxide (CO <sub>2</sub> )	<50%
Nitrogen (N <sub>2</sub> )	<5%
Oxygen (O <sub>2</sub> )	<1%
Hydrogen Sulfide (H <sub>2</sub> S)	<1,000 ppmv
Siloxanes and Volatile Organic Compounds	<2,000 ppbv

# Traditional Biogas System Process Flow Diagram



Digester or Landfill



Hydrogen Sulfide Removal



Gas Compression/  
Moisture Removal



Siloxane/VOC  
Removal



MicroTurbines



IC Engines



Boilers



# BioCNG™ System Process Flow Diagram

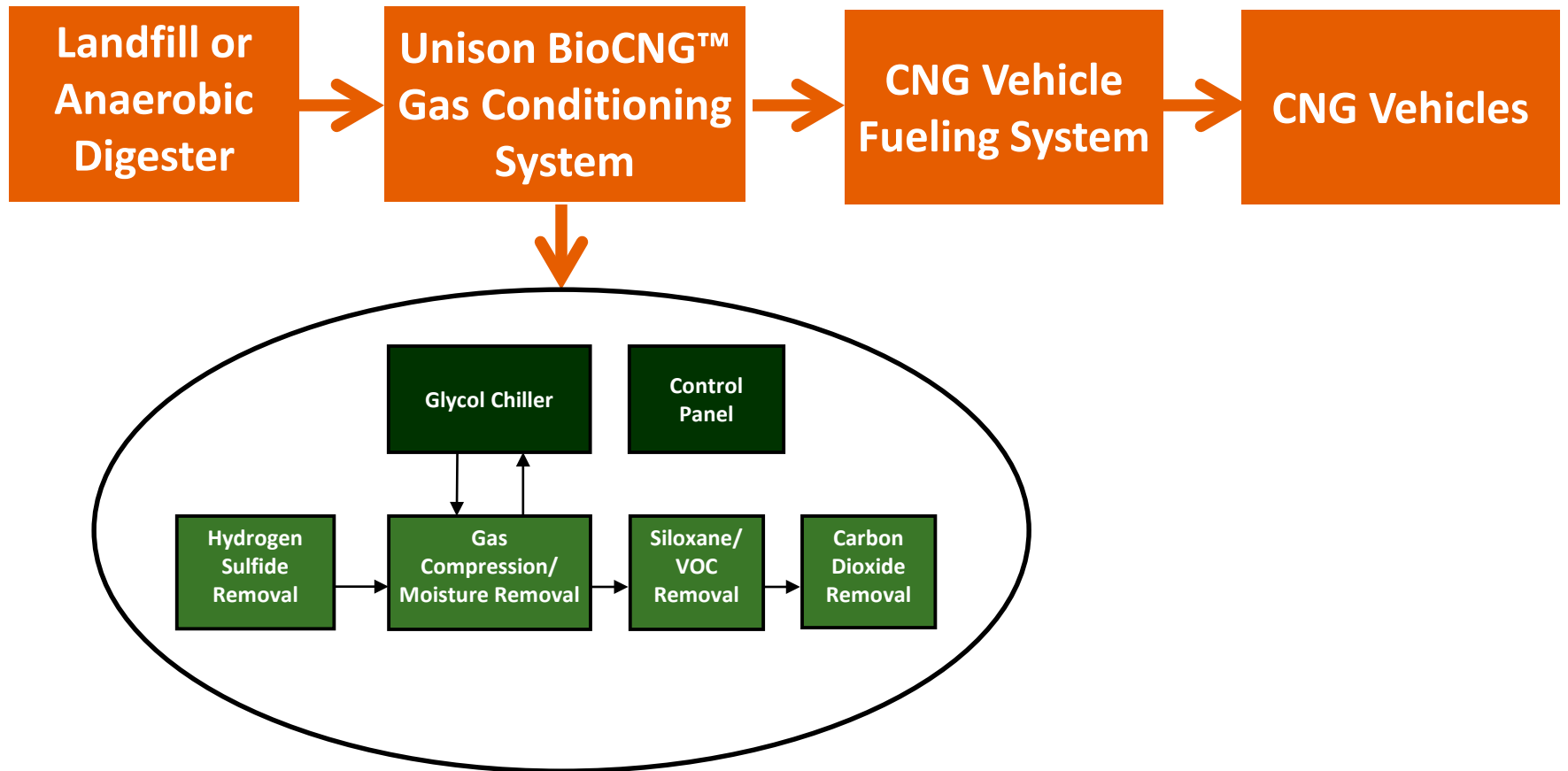
**Addition of Proprietary  
CO<sub>2</sub> Removal System**



**Potential Energy Produced**  
Vehicle Fuel  
Electricity  
Heat



# BioCNG™ System Process Flow Diagram

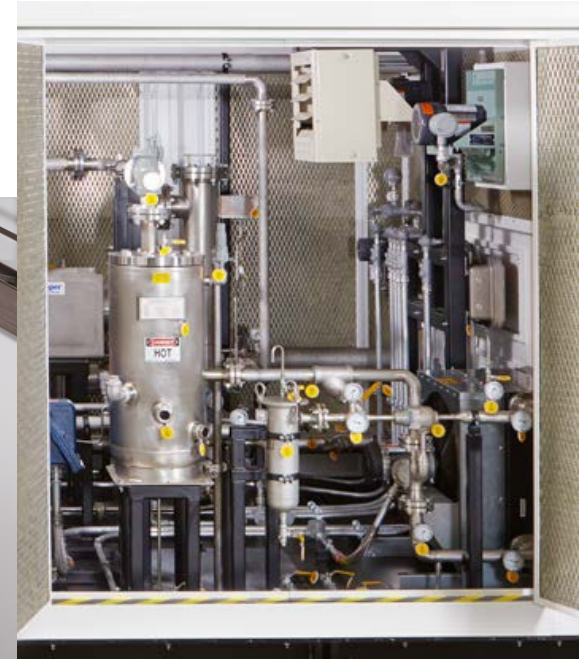


# BioCNG™ - Models

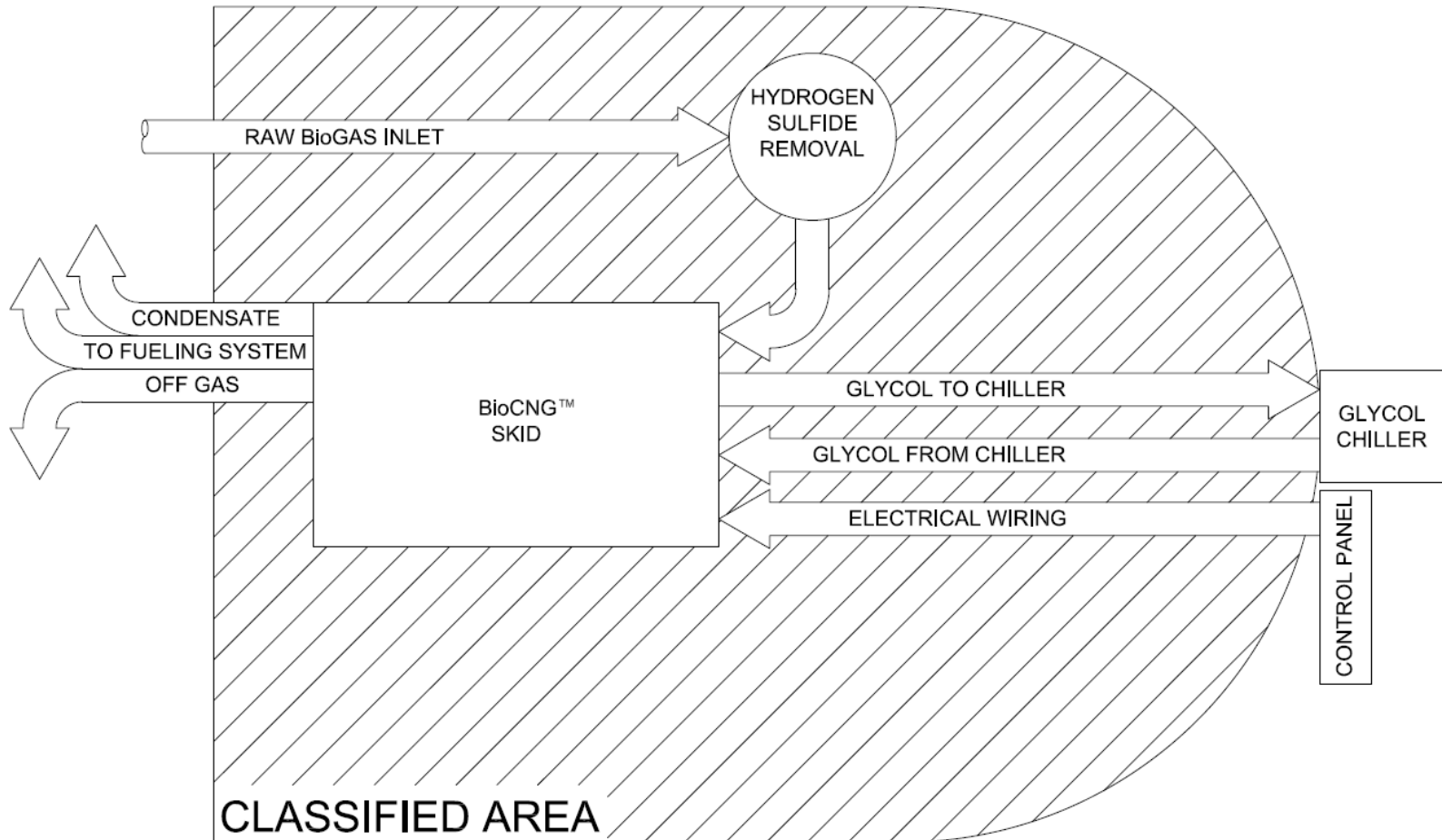
Model	Biogas Inlet Flow (scfm)	Fuel Production (GGE/day)
BioCNG™ 50	50	200 - 275
BioCNG™ 100	100	375 - 550
BioCNG™ 200	200	775 - 1100



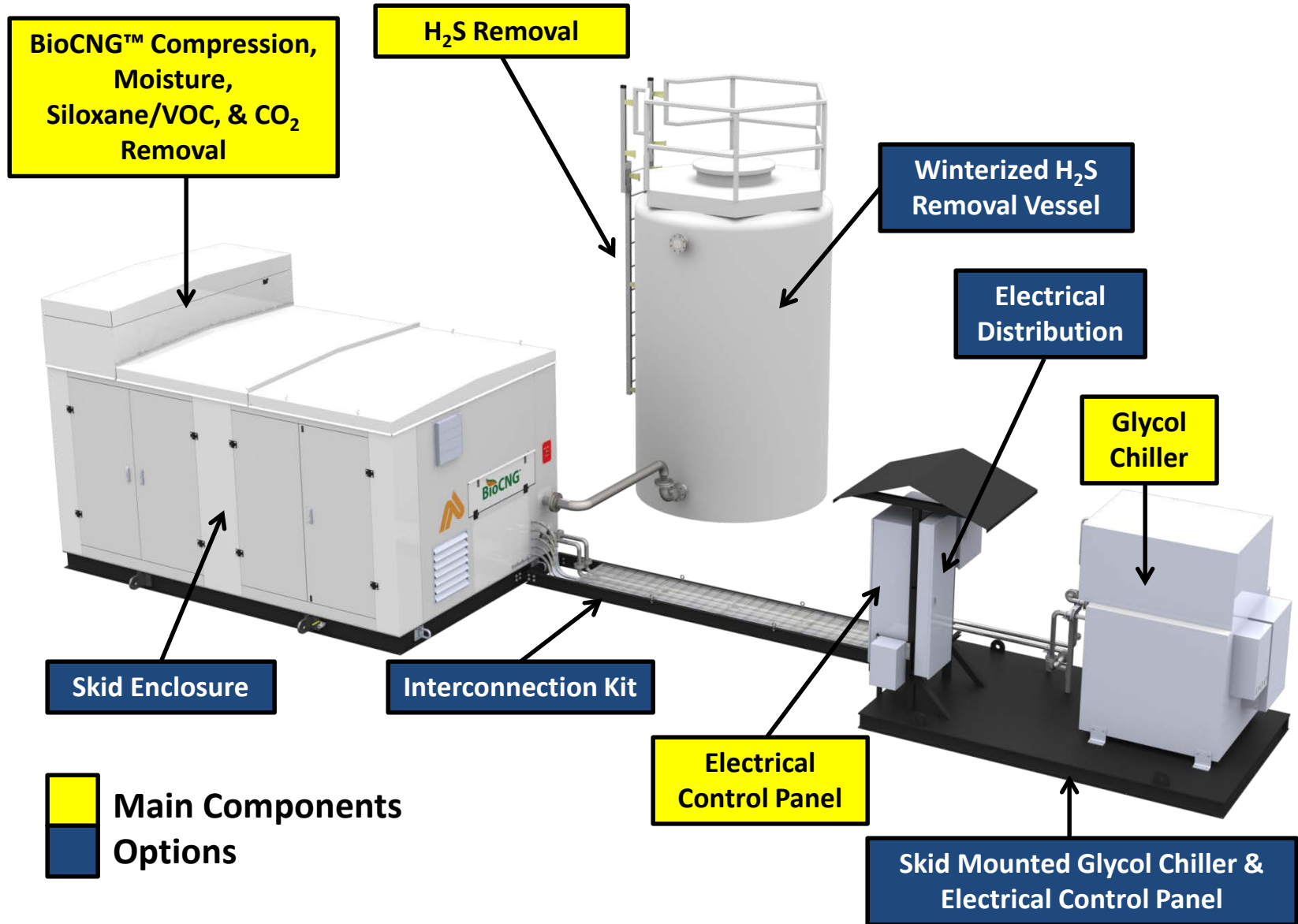
# BioCNG™ - Models



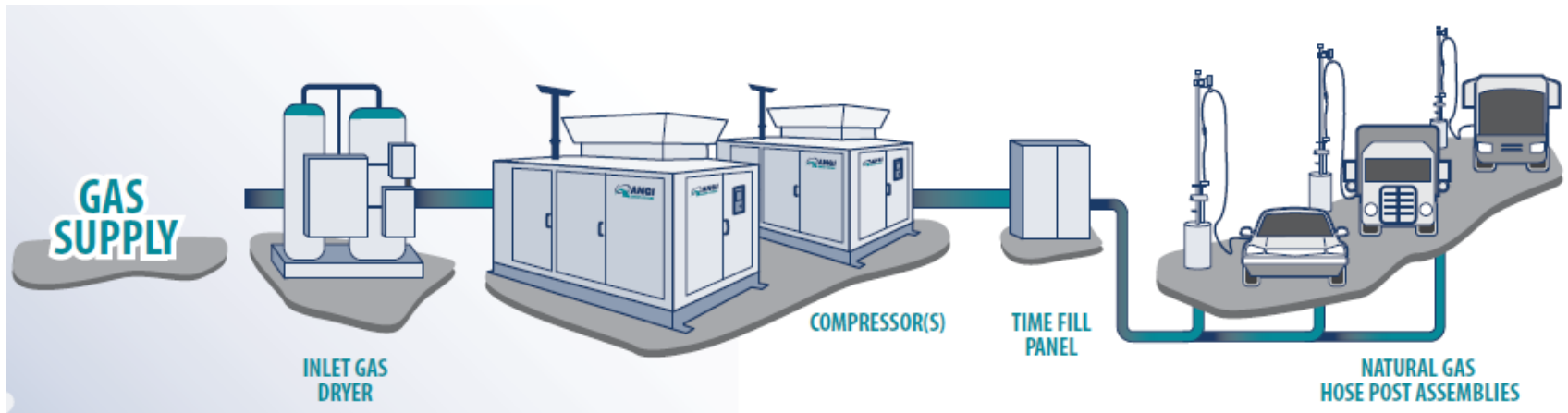
# BioCNG™ - Site Layout



# BioCNG™ - Options



# Vehicle Fuel Stations - "Time Fill"

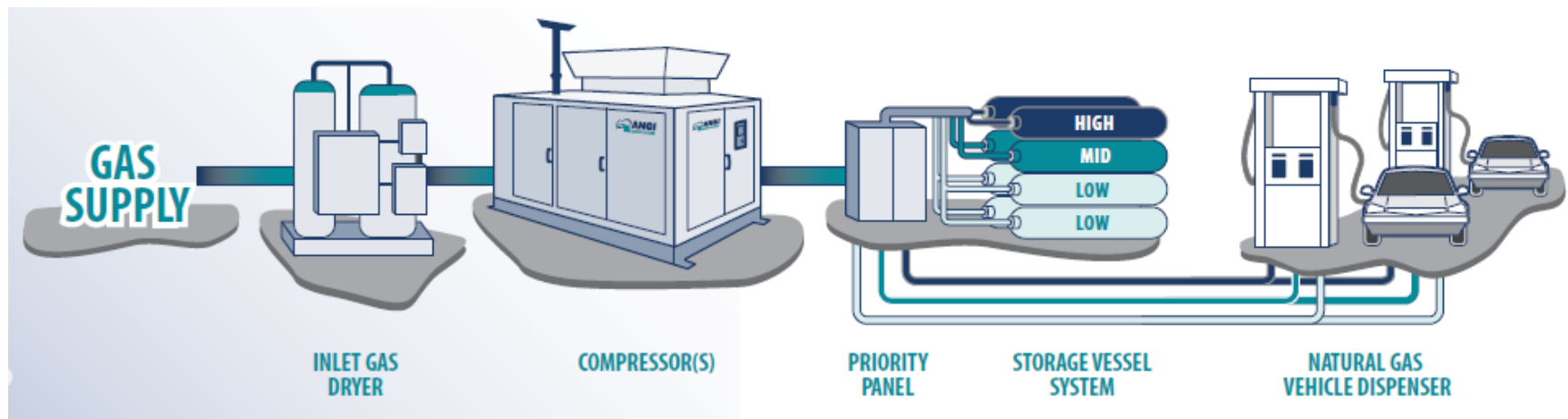


# Vehicle Fuel Stations - “Fast Fill”

## Compression and Storage



## Fast Fill



# “Fast Fill” Fueling Process



# Natural Gas Vehicle Types

There are three types of NGVs:

- **Dedicated:** These vehicles are designed to run only on natural gas
- **Bi-fuel:** These vehicles have two separate fueling systems that enable them to run on either natural gas or gasoline.
- **Dual-fuel:** These vehicles are traditionally limited to heavy-duty applications, have fuel systems that run on natural gas, and use diesel fuel for ignition assistance

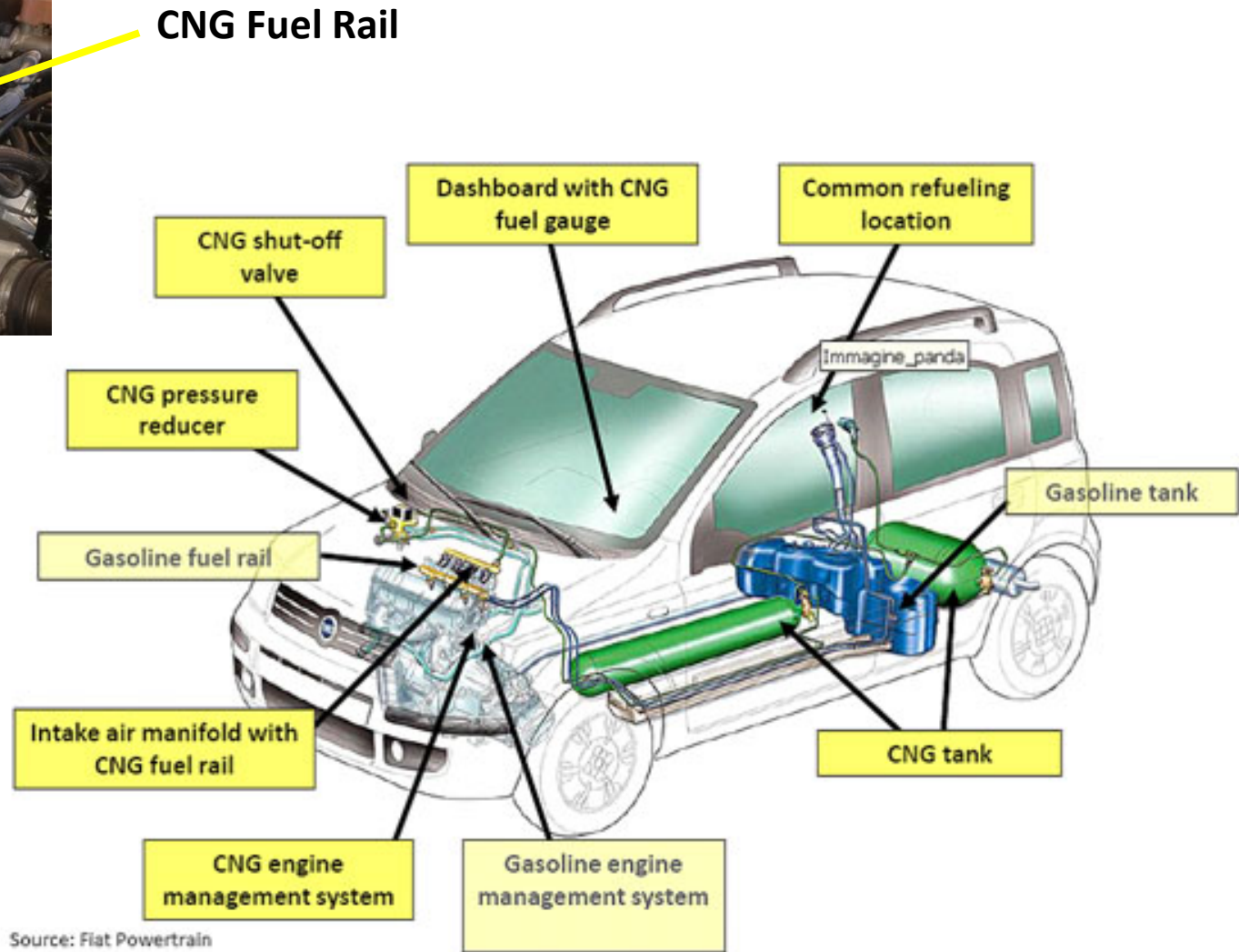
# Natural Gas Vehicles



# CNG Vehicle Layout



Ford F-150 Engine



Source: Fiat Powertrain

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# Natural Gas Vehicles



Model	Ford F150	Waste Hauler	School Bus
BioCNG™ 50	16	5	4
BioCNG™ 100	32	10	8
BioCNG™ 200	64	20	16

*\* Assumes 1 fill per day per vehicle*



# NGV Resources

- **ngvamerica.org**
- **US Department of Energy**
  - <http://www.eere.energy.gov/cleancities/>
  - <http://www.afdc.energy.gov/fuels/naturalgas.html>
- **US EPA - Renewable Fuel Standards**



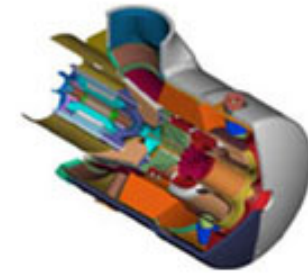
# Janesville, WI WWTP Overview

- Founded in 1835
- Located on the Rock River, in southeast Wisconsin
- Area: 33 sq miles
- Population: 63,500
- Design Capacity of 19.8 million gallons of sewage per day (MGD)
- Thermophilic-mesophilic anaerobic digestion
- Produces 100,000 to 130,000 ft<sup>3</sup> per day of digester gas
- Generates 1,600 dry tons of biosolids per year



# Janesville, WI WWTP Renewable Energy Systems

- **Electricity generated from biogas**
  - Microturbines with heat recovery
- **Solar Energy**
  - Photovoltaic cells on Administration Building
- **Effluent-source Heat Pump**
- **BioCNG for Vehicle Fuel**
- **Grants and Funding**
  - Focus on Energy
  - Alliant Energy
  - State of WI Energy Office



# Janesville, WI WWTP Incentives for Energy Projects

Janesville Wastewater Grants		
Focus on Energy	Turblex Aeration Blowers	\$17,672
Focus on Energy	Biogas Project 95%	\$131,499
Focus on Energy	Admin Building Solar Array	\$45,000
Alliant Energy	Admin Building Solar Array	\$24,000
Focus on Energy	Building 35 Lights	\$393
Focus on Energy	Other WWTP Lights	\$496
Focus on Energy	WWTP VFDs	\$14,980
Focus on Energy	Biogas Project 5%	\$6,922
Focus on Energy	Admin. Building HVAC	\$6,010
Focus on Energy	Operations Building HVAC	\$1,500
State Energy Office	Bio-CNG Project-Gas Storage	\$125,000
	<b>Wastewater Total</b>	<b>\$373,472</b>

# Janesville, WI WWTP Incentives for Energy Projects

## Janesville Water Utility Grants

Focus on Energy	Water Admin Building HVAC	\$531
Focus on Energy	Pumping Station VFDs	\$138,000
	<b>Water Total Grants</b>	<b>\$138,531</b>
	<b>Total Energy Grants</b>	<b>\$512,003</b>

# Janesville, WI WWTP Timeline

## PHASE 1

## PHASE 2

**(4) CR65-ICHP  
Capstone  
MicroTurbines**



**November 2010**

**Gas Storage  
Sphere**



**July 2011**

**January 2012**

**BioCNG Add-On**



**March 2012**

**Summer 2012**

**140scfm Gas  
Conditioning System**



**(1) CR200 Capstone  
MicroTurbine**



**Vehicle Fueling  
Station**



# Janesville, WI WWTP

## Biogas To Energy System (Phase I)

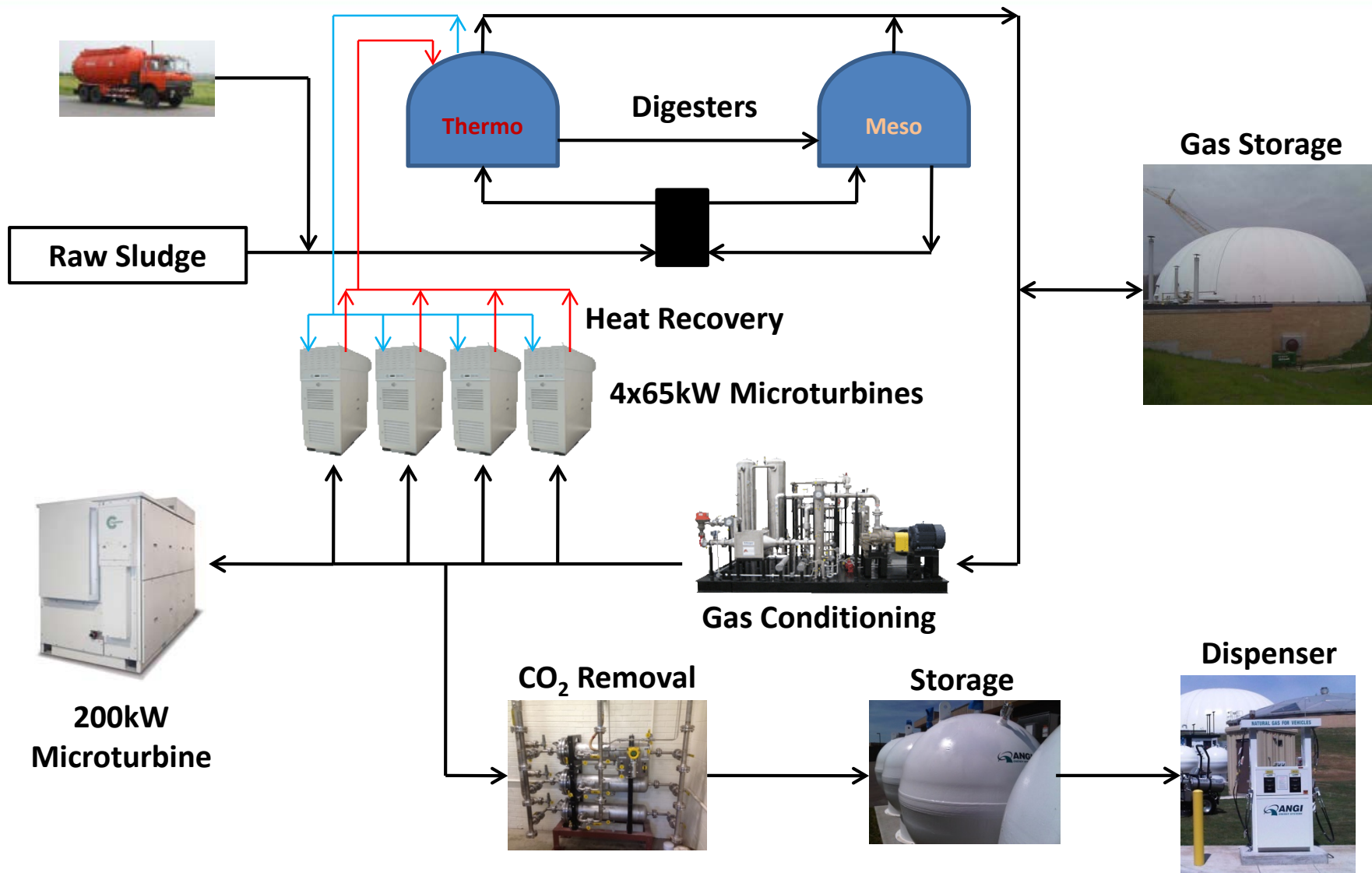
- **Digester upgrades**
- **Sludge-to-Sludge Heat Exchanger**
  - Recovers heat from thermophilic digested sludge
- **Gas Storage System**
  - New dual membrane system
  - 107,000 cu ft capacity
- **Gas Conditioning and Compressor System**
  - Moisture and particulate removal
  - Siloxane removal
- **(4) 65kW Microturbines with Integral Heat Recovery**
  - Grid connect mode
  - WWTP has power purchase agreement with the electric utility
  - \$ 0.12 /kWh on peak

# Janesville, WI WWTP

## Biogas To Energy System (Phase II)

- 200kW microturbine
- High Strength Waste Receiving
- CO<sub>2</sub> Removal Module for BioCNG production
- CNG compressor
- CNG Fuel Dispenser
- CNG high pressure storage spheres

# Janesville, WI WWTP Biogas-To-Energy



# Janesville, WI WWTP

## Biogas Treatment Requirements/Considerations

- ✓ Hydrogen Sulfide Removal (Existing iron sponge)
- Gas Compression
- Moisture Removal
- Siloxane/VOC Removal



# Janesville, WI WWTP

## Gas Conditioning System (Phase I)



- Began operation November 2010
- Removes moisture, particulates, and siloxane from digester gas
- Compresses gas to pressure required by MicroTurbines
- 140 cfm capacity

# Janesville, WI WWTP

## Gas Treatment Process

- Chiller- Cools gas to 35F to remove moisture and some siloxane and other impurities.
- Compressor- pressurizes gas for application to microturbines
- Adsorptive media filters: Silica Gel and activated carbon provide siloxane and VOC removal to protect microturbines and CO<sub>2</sub> removal membranes

# Janesville, WI WWTP

## Biogas Treatment Requirements/Considerations

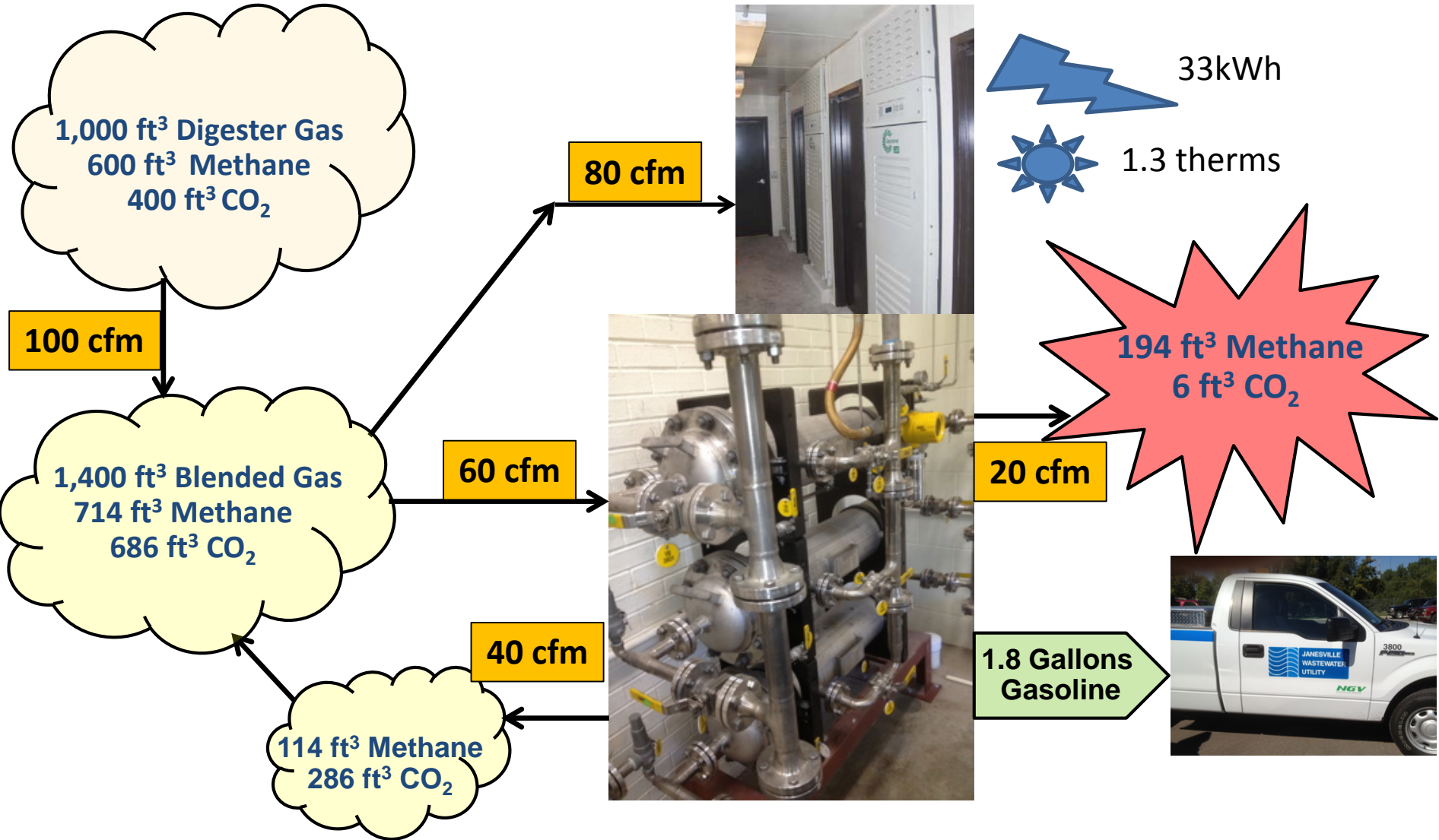
- ✓ Hydrogen Sulfide Removal
- ✓ Gas Compression
- ✓ Moisture Removal
- ✓ Siloxane/VOC Removal
- Carbon Dioxide Removal
- Fuel Requirements:
  - Engine Manufacturers Specifications, SAE J1616

# Janesville, WI WWTP CO<sub>2</sub> Removal System (Phase II)



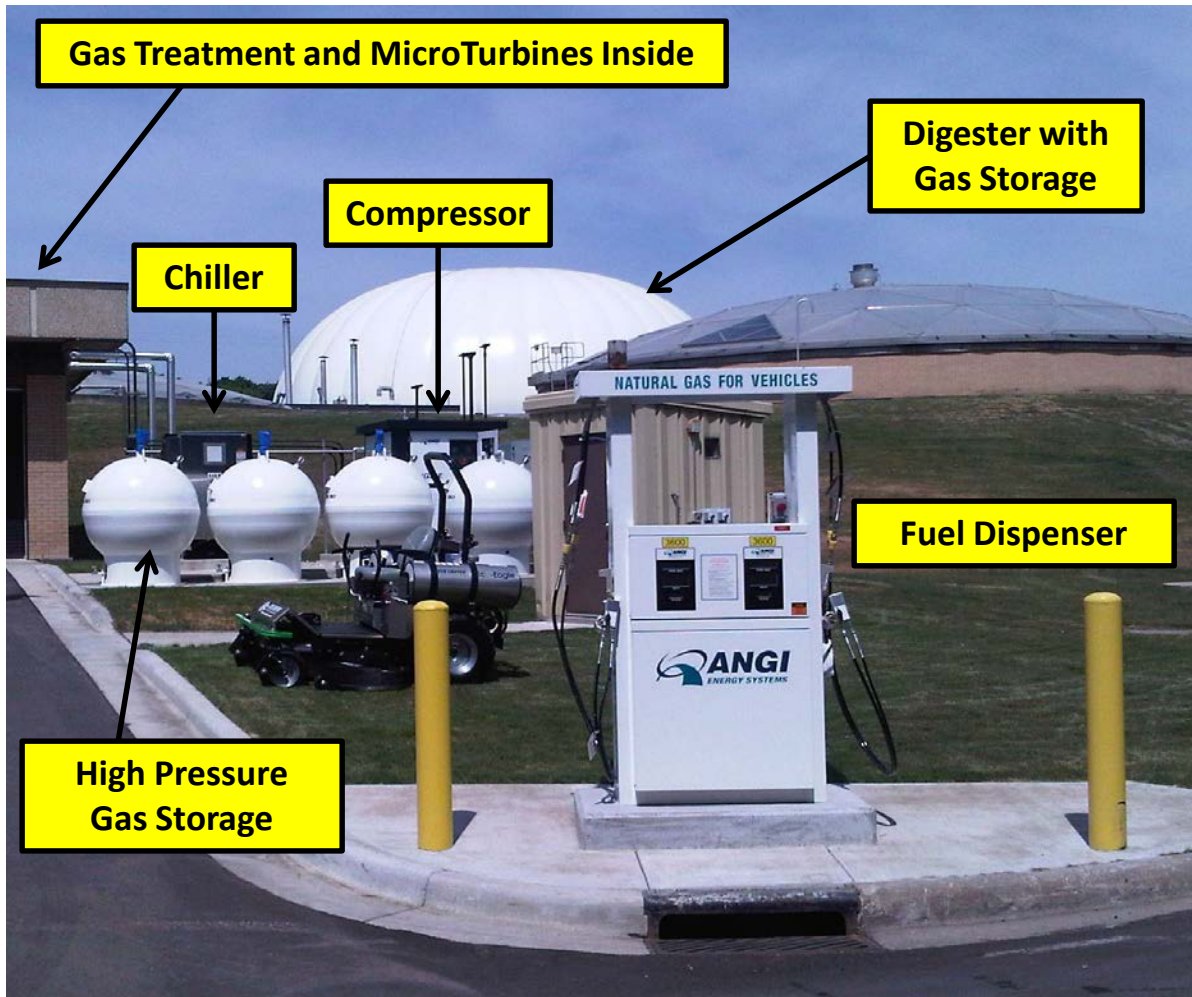
- Concentrates methane from 60% to more than 90% by removing CO<sub>2</sub> and other gases.
- Required to make digester gas suitable for vehicle fuel.

# Janesville, WI WWTP CNG Fuel Balance



# Janesville, WI WWTP

## BioCNG Storage and Filling Station (Phase II)



- 100 gallons gasoline equivalent storage sphere.
- Fill-up time comparable to conventional fuel station.

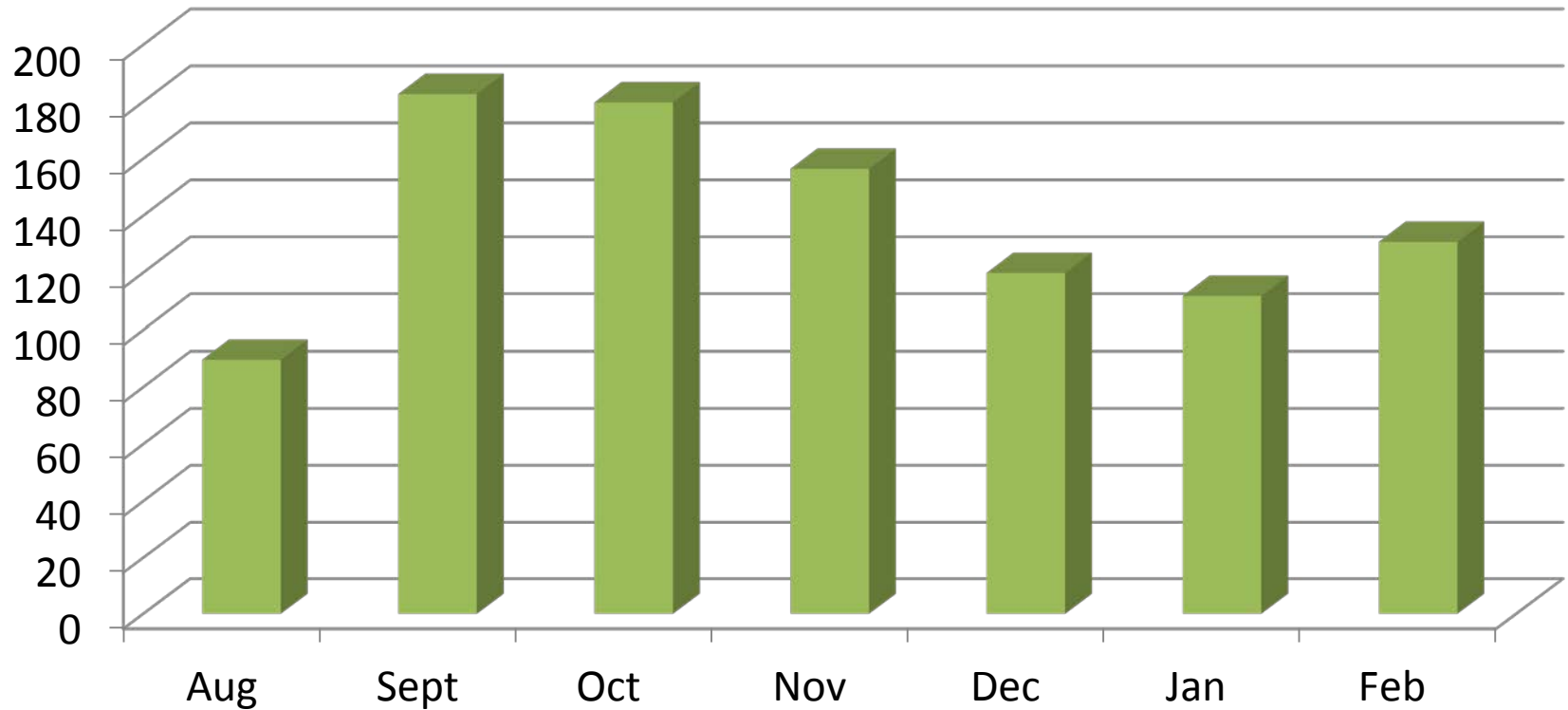
# Janesville, WI WWTP CNG Vehicles (Phase II)



- Handle the same as conventional vehicles.
- Use the same engine with few modified components.
- Can switch from petroleum to CNG at push of a button.
- Bi-Fuel vehicles have additional tanks which can limit storage space.

# Janesville, WI WWTP BioCNG Usage

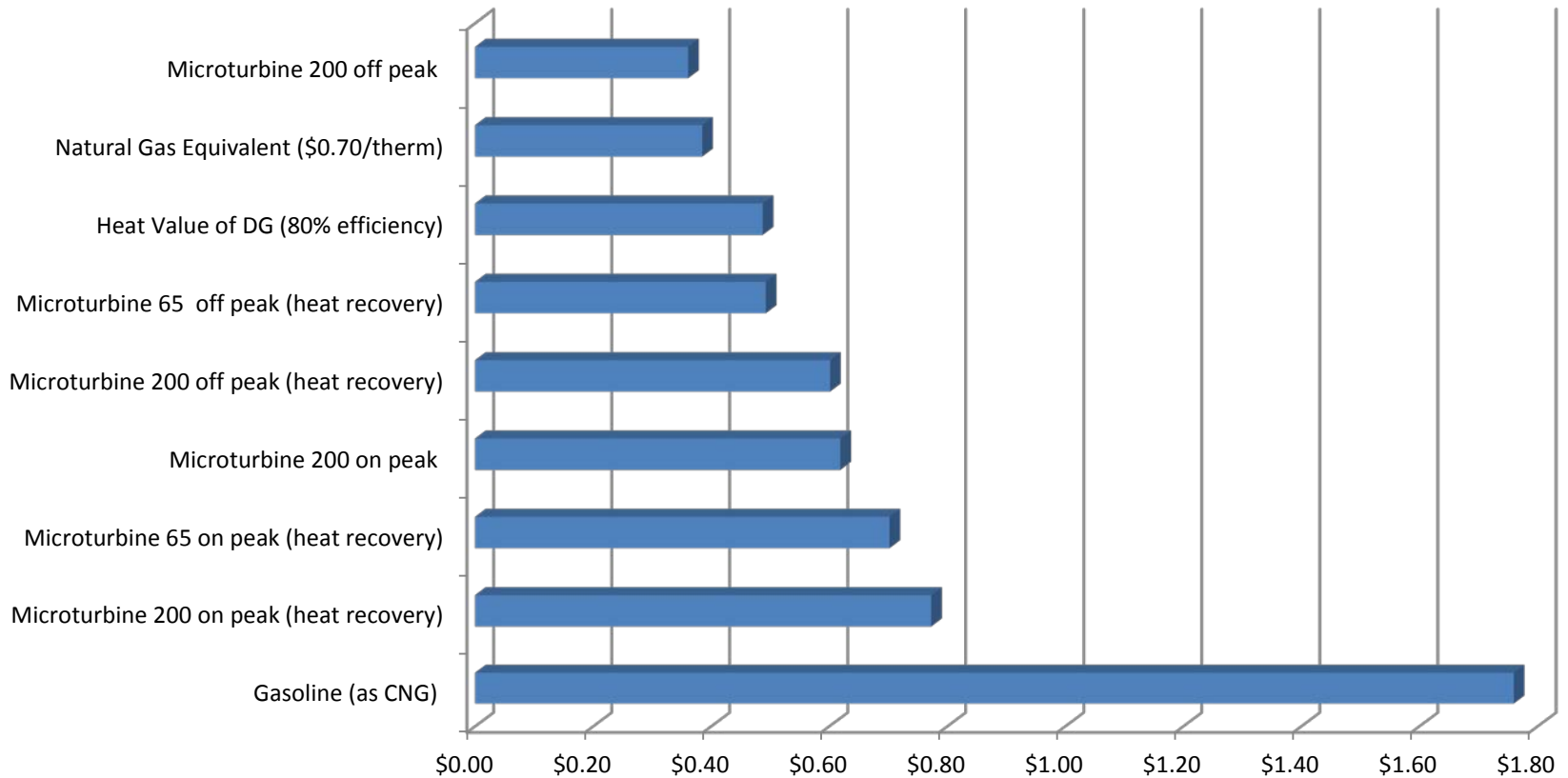
**Gasoline Equivalent Gallons per Month  
for BioCNG (2012-2013)**



# Janesville, WI WWTP

## CNG is Highest Value Use For Digester Gas

Relative Value of 100 cuft of Digester Gas by Usage



# Janesville, WI WWTP Renewable Revenue

- 1,672,000 kWh generated in 2011 from biogas
    - \$ 154,000 in electricity sales
    - \$ 77,665 thru June 2012 (\$ 155,330 annually)
  - 64,300 therms of recoverable heat
    - \$ 47,600 in purchased energy savings
  - 22,000 kWh of solar electricity generated in 2011
    - \$ 1,100 in revenue\*
  - 1,800 GGE of BioCNG annually @ \$4.00 gal=\$7,200/yr
    - Use will grow as vehicles are added.
- \* Feed-in tariff not available

Thank You!

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