

**EMISSIONS FROM BIOGAS-FUELED DISTRIBUTED GENERATION UNITS**  
**Part 3: Greenhouse gas reduction and other benefits of biogas upgrading?**

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Biogas obtained from anaerobic digestion of livestock manure is complex mixture containing ~60% methane (CH<sub>4</sub>) and other less valuable gases. Upgrading the biogas to reduce contaminants and increase the CH<sub>4</sub> concentration is advantageous for several reasons<sup>[1]</sup>. These are summarized below:

**GREENHOUSE GAS REDUCTION**

Combustion of biogas for electrical generation significantly reduces greenhouse gas emissions compared to fossil fuels as biogas which is generated from renewable organic materials is considered CO<sub>2</sub> neutral. Biogas upgrading then further improves the greenhouse gas emissions reduction benefits of this renewable fuel. Combustion of upgraded (cleaner, higher CH<sub>4</sub> concentration) biogas improves the capacity factor (ratio of actual electrical output to potential electrical output over a period of time) of engine-generator sets. When operated at higher capacity factors (maximal energy per run time), emissions per energy generated are reduced. Some have also shown that combustion of gas with a higher CH<sub>4</sub> concentration generates slightly less CO<sub>2</sub><sup>[2]</sup>, though this is not always the case<sup>[3]</sup>. Some biogas upgrading processes can also reduce greenhouse gas emissions. For example, biological biogas upgrading processes using bacterial or algal heterotrophs converts CO<sub>2</sub> to oxygen<sup>[1]</sup>. This form of upgrading essentially sequesters the carbon from CO<sub>2</sub> in microbial biomass, preventing emission of the greenhouse gas.

**INCREASING VALUE**

Carbon dioxide (CO<sub>2</sub>) is the biggest contaminant of biogas (~30-40%).

Removing CO<sub>2</sub> can improve the specific caloric value of the biogas or the potential energy output. Where infrastructure permits, CO<sub>2</sub> can almost completely be removed to generate biomethane (> 95% CH<sub>4</sub>) which can be sold into a natural gas grid or used as transportation fuel. Carbon dioxide is typically removed by physical/chemical scrubbing technologies at large industrial scales<sup>[1]</sup>.

Some US dairy farms are upgrading biogas to biomethane. This fuel is then used by the farms' fleet vehicles and/ or sold to energy companies. There are also additional benefits as renewable energy credits for the upgrading of biogas to biomethane.

**REDUCE GENERATION OF HAZARDOUS EMISSIONS**

Hydrogen sulfide (H<sub>2</sub>S) in biogas will lead to SO<sub>x</sub> in exhaust gases if not removed prior to combustion. Hydrogen sulfide can be removed by chemical/physical means. These include an iron sponge where H<sub>2</sub>S is adsorption onto iron coated filter media and scrubbers where H<sub>2</sub>S is captured by a liquid absorbent. More typically H<sub>2</sub>S is removed from biogas by biological processes. When properly designed, in-situ microaerobic removal is used where a limited amount of air injected into the anaerobic digester head space facilitates sulfur oxidizing bacteria to convert H<sub>2</sub>S into elemental sulfur. Biotrickling filters (sometimes referred to as scrubbers) are more commonly used for H<sub>2</sub>S removal. These systems harness sulfur oxidizing bacteria immobilized on inorganic packing media in a reactor column to convert H<sub>2</sub>S to elemental sulfur then sulfate. A liquid phase is cycled to help absorb H<sub>2</sub>S

from the passing effluent and deliver H<sub>2</sub>S and nutrients to the bacteria<sup>[1]</sup>.

Ammonia (NH<sub>3</sub>) is a trace contaminant of biogas generated from the co-digestion of protein rich food wastes. During combustion of this biogas, the NH<sub>3</sub> can be converted to NO<sub>x</sub> emissions. Ammonia can be removed from biogas by stripping or bubbling the gas through a liquid sorbent<sup>[4]</sup>. As NH<sub>3</sub> concentrations in biogas are typically very low, these systems may be more applicable to barn and manure storages, than to biogas.

### REDUCE ENGINE CORROSION

Impurities such as H<sub>2</sub>S, NH<sub>3</sub> in the presence of water can cause significant corrosion of biogas plumbing, engine-generators sets and other farm infrastructure. Removal of these impurities can significantly reduce

system maintenance, increase life, and reduce operational costs.

In NYS, dairies typically use condensation sumps, demisting systems, chillers or combinations of these to remove moisture from biogas. Desulfurizing systems are increasingly used by NYS dairies to improve the quality of biogas and reduce corrosion. Typically, biotrickling filters are used, but there are farms using digesters designed for microaerobic treatment and at least one farm using iron sponge technology. As mentioned above NH<sub>3</sub> removal is not typical.

*To learn more about biogas upgrading, and the specifics of biotrickling filters, see the Fact Sheet series on the topic.*

### FACT SHEET SERIES

#### Emissions from biogas-fueled distributed generation sources

- Part 1: What are the potential emissions from engine-generation sets?
- Part 2: What are the current emission regulations for New York State?
- Part 3: Greenhouse gas reduction and other benefits of biogas upgrading.
- Part 4: How do operators of engine-generation sets meet applicable emission regulations?

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