Biogas in Wisconsin:

Status, opportunities and challenges

Center for Land Use Education **December 2018**

Photo 1: Dairy Biogas Anaerobic Digester Facility, Clean Fuel Partners, LLC, Dane, Wisconsin

WHAT IS BIOGAS?

Biogas is a clean renewable gas locally produced from organic waste materials such as food waste, agricultural residues and animal manure, energy crops, industrial organic waste and sewage sludge. Biogas production involves a natural process called “Anaerobic Digestion” in which bacteria and other microorganisms break down and digest carbon rich organic materials in the absence of oxygen. This process generates a mixture of methane and carbon dioxide, called biogas.

WHERE DO THE WASTES COME FROM?

Farms

Agricultural wastes from crop cultivation and food production, livestock or farm manure.

Food Processing Facilities

Wastes from food processing at breweries, cheese factories, meat processors and related industries.

Wastewater Treatment Plant

Sewage sludge from municipal wastewater treatment and high strength wastewater from local industries.

Landfills

Edible and inedible food and other organic wastes from home, restaurants, caterers, supermarkets that often end up in landfills.

Figure 1: Waste sources for biodigestion

WHY BIOGAS?

Biogas is an important homegrown renewable source of energy that has multiple benefits:

- ***Energy security***: Provide local energy security by generating heat and/or electricity or by upgrading into a transport fuel.
- ***Cleaner environment***: Reduce soil and water contamination by removing excess nutrients such as phosphorous and nitrogen, reduce air pollution, and decrease the amount of methane released.
- ***Improved public health***: Reduce odors, nuisance and pathogens, decrease risk of drinking water pollution and related diseases.
- ***Strengthened economy***: Reduce volume and cost of waste remediation, minimize operational costs of dairies, farms, and industries, help create green business label, diversify farm income, and increase local investment and employment opportunities.

HOW IS BIOGAS PRODUCED?

Biogas is produced by processing organic wastes through anaerobic digestion and separating the gas from its coproducts. Figure 2 shows the generic steps and processes.

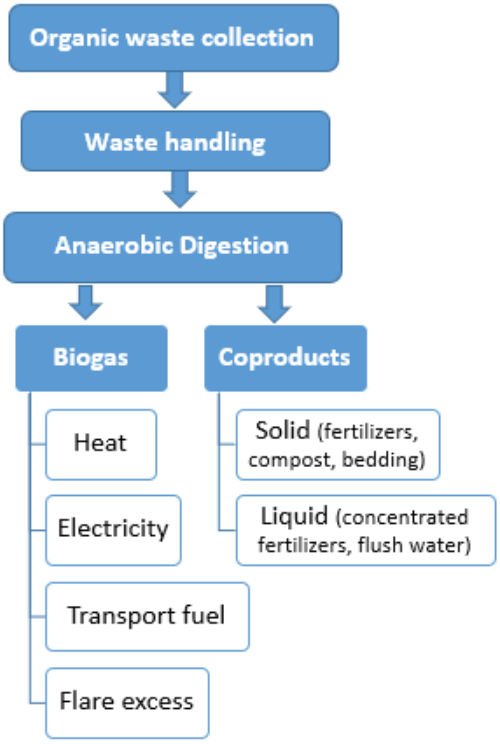

Figure 2: Biogas production steps, process and uses (Adapted from EPA AgStar)[1]

BIOGAS SYSTEMS

A biogas production system is typically comprised of the following components:

- Pre-storage tanks and/or pads where wastes are collected and stored
- Grinder/mixer involves machinery to grind and mix the wastes
- Reactor tank where the process of waste breakdown and digestion takes place in the absence of oxygen
- Biogas storage tanks that store the produced biogas
- Gas utilization equipment and heat exchanger convert the gas into heat and electricity
- Liquid-solid separator screens the remaining materials
- Remaining materials are sent to post storage tanks or pads

Anaerobic digester

Electrical generation from methane produced by digester

Separator sorts solid and liquid coproducts

Solid coproduct

Figure 3: Some elements of the biodigestion process

The biogas production systems can vary depending on type of wastes and their moisture content, size, mixing method, operating temperature of anaerobic digestion and the flow of feedstock into digester such as batch or flow. Design of the systems can vary widely in engineering and customization to match specific feedstocks as shown in Figure 4.

CONTENT AND END USE OF BIOGAS

Typical biogas contains 50 to 70 percent methane and 30 to 40 percent carbon dioxide with trace amount of

Figure 4: Types of Biodigesters

other gases. Biogas can be used to produce heat and/or electricity. It can also be upgraded into bio-methane by removing carbon dioxide and other gases. Bio-methane is also called renewable natural gas (RNG) and injected into natural gas pipelines. RNG can also be compressed and used as fuels for vehicle engines called compressed natural gas (CNG).

STATUS OF BIOGAS IN WISCONSIN

Wisconsin is one of the early adopters and leading states in the nation to produce renewable energy from anaerobic digestion systems. The Wisconsin Biogas 2016 survey[2] reports that currently there are 136 operating anaerobic digester (AD) systems in Wisconsin that include: 81 municipal wastewater digesters, 21 industrial wastewater digester and 34 agricultural digester systems. In addition, there are 35 operational landfills with biogas capture systems as shown in Figures 5 and 6.

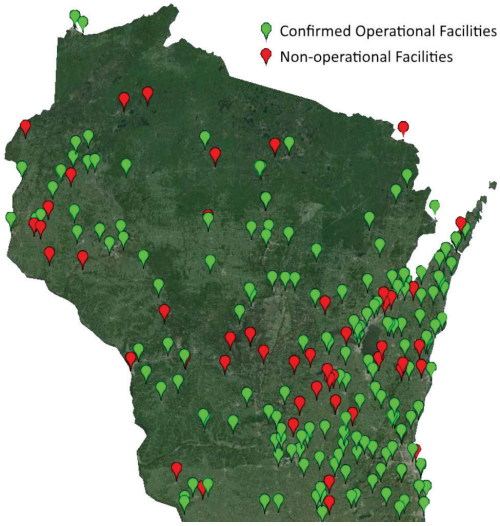

Figure 5: Location of Biogas Facilities (Courtesy of Office of Energy Innovation, Wisconsin Biogas Survey 2016)[2]

Biogas from these systems is converted into millions of British Thermal Units (Btu) in heat and supports the capacity to generate 140 Megawatts of electricity. Biogas from a few landfill and municipal plants is currently converted into CNG to use directly as a vehicle fuel or inject into the pipelines as RNG. Flaring excess biogas is common throughout the systems.

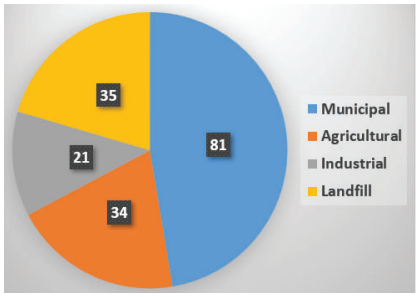

Figure 6: Number of Anaerobic Digesters and Landfill Systems in Wisconsin, (Adapted from Wisconsin Biogas survey 2016)[2]

BIOGAS POTENTIAL IN WISCONSIN

Wisconsin's biogas sector has growth potential. A wide range of available feedstock waste, the size of dairy farms and the presence of various food processing industries make the state an ideal candidate for biogas production.[5] Wisconsin can take advantage of the full potential of producing 90 thousand tons of methane per year to generate 266 thousand Megawatt-hours (MWh) electricity each year[3] as shown in Figures 7 and 8.

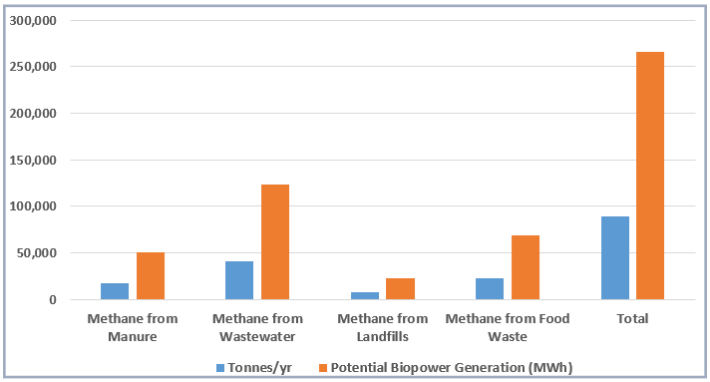

Figure 7: Wisconsin methane generation potential by waste sources[3]

Methane based biopower generation potential is much higher if crop and wood-based biomass residues are also considered. Based on the estimated amount and type of available waste materials, the American Biogas Council (ABC) estimates that 1,341 new biogas projects could be developed in Wisconsin including 1,293 in dairy, 30 in municipal wastewater plants, 13 in food processing and 5 in landfills.[4] ABC also estimates that these new biogas projects could create 36 thousand new jobs and reduce carbon emissions significantly.[4]

CHALLENGES

Significant challenges remain to ensure the sustainable and economical operation of biogas facilities in Wisconsin:[2, 5]

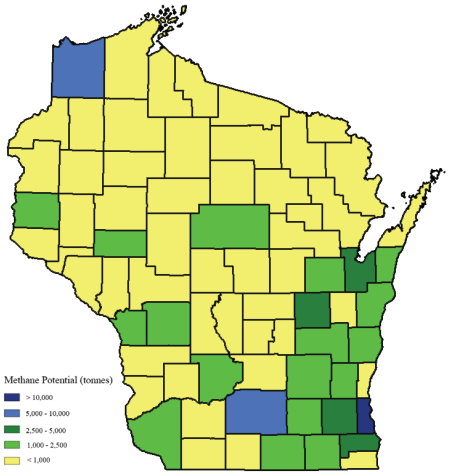

Figure 8: Wisconsin methane generation potential by county, NREL Biogas Potential in the United States[3]

- Insufficient policy support and incentive programs for biodigesters
- Removing barriers to selling electricity or biogas to utility or interstate producers
- Supporting cost-effective and safe operation of biogas electricity generators
- Securing viable project financing
- Establishing favorable environmental regulatory compliance standards and fair tipping fees.
- Enhancing public awareness, information sharing and inter-sector collaboration

MOVING FORWARD

- Biogas is a potential solution to help meet sustainability goals of Wisconsin communities that are focused on renewable energy and alternative fuels.
- More focus on small-scale distributive energy systems is important to build resilient communities.
- Adequate supportive Wisconsin regulatory and tax policies, financial incentives, and investment options are necessary to stimulate the growth of biogas facilities.
- Policy consensus can help address the biogas challenges and utilize the full potential of strengthening local energy security, a stronger economy, a cleaner environment and improved health in Wisconsin.

References

1. EPA Anaerobic Digestion: https://www.epa.gov/anaerobic-digestion
2. Wisconsin Biogas Survey Report: https://psc.wi.gov/Documents/OEI/WisconsinBiogasSurveyReport.pdf
3. National Renewable Energy Laboratory (NREL): https://www.nrel.gov/gis/biomass.html
4. American Biogas Council– Wisconsin profile: http://www.americanbiogascouncil.org/State%20Profiles/ABCBiogasStateProfile_WI.pdf
5. Biogas Opportunity in Wisconsin: https://energy.wisc.edu/sites/default/files/Biogas_Opportunity_in_Wisconsin_WEB.pdf

Other Resources

AgSTAR National Mapping Tool: https://www.epa.gov/agstar/agstar-national-mapping-tool

Bakertilly Biogas economic model and toolkit: https://bakertilly.com/insights/biogas-economic-model-and-toolkit (toolkit)

Wisconsin manufacturers in the biogas supply chain: http://lc.legis.wisconsin.gov/media/1099/2-15-12biogashandout.pdf

BIOFerm Energy Systems: https://www.biofermenergy.com/

Wisconsin Energy Policies: http://programs.dsireusa.org/system/program?fromSir=0&state=WI

Acknowledgments

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Photo 1, Figure 3 photos: Shiba Kar; Figure 1 photos: Pexels except for Wastewater Treatment truck photo: Chris Lefebvre; Figure 4 on-farm digester photo: Gundersen Envison; wastewater digester photo: Chris Lefebvre; food processing digester photo: Renew Wisconsin

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