

MINNESOTA BIOGAS:

Overview, Status, Opportunities and Trends

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Great Plains Institute

Presentation to the Minnesota Legislative Energy Commission
September 16, 2014



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PRESENTATION OVERVIEW

1. About GPI and my experience
2. Biogas Basics
3. Biogas Benefits and Challenges
4. Status of MN Biogas Projects
5. International Experience
6. Experience from Other U.S. States
7. Future Trends



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Mission: To transform the way we produce, distribute and consume energy to be both economically and environmentally sustainable.

15-yr. old non-partisan, non-profit that:

1. Develops better energy policy via consensus.
2. Catalyzes deployment of best energy technologies, practices & programs.
3. Provides reliable analysis & decision tools.



MY BIOGAS EXPERIENCE

- Coordinated interdisciplinary research teams for two MN biogas projects
- Public policy research
- Project consulting
- Published biogas reports, fact sheets and case studies



BIOGAS BASICS



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DEFINITIONS

- **Anaerobic Digestion (AD):** A series of biological processes in which microorganisms break down biodegradable materials in the absence of oxygen.
- **Biogas:** A renewable gaseous fuel derived from biological materials. Raw biogas is a mixture of mostly methane (CH_4) – 50 to 80 percent- and carbon dioxide (CO_2) – 20 to 50 percent - and traces of other gases such as hydrogen, carbon monoxide and nitrogen.

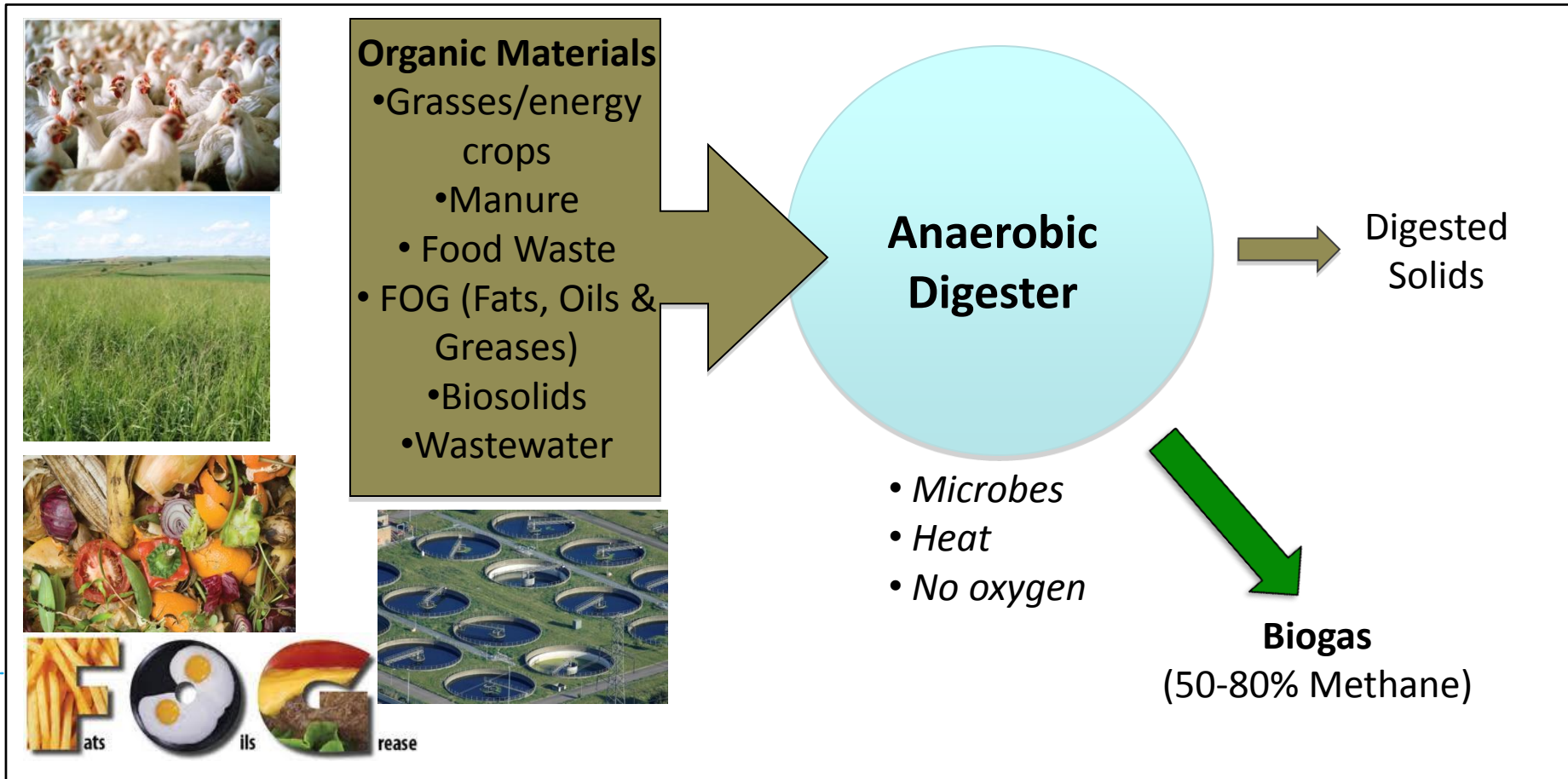
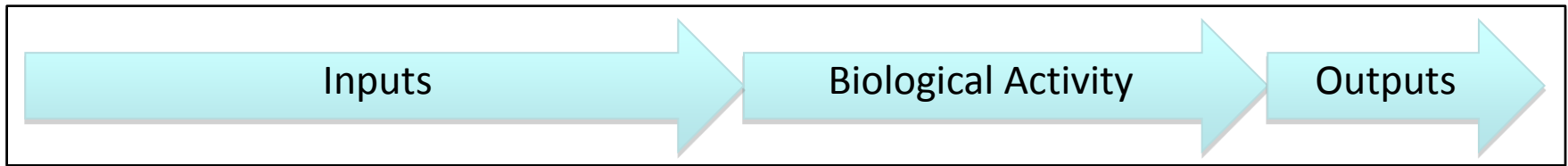


DEFINITIONS

- **Landfill gas (LFG):** Generated during the natural process of bacterial decomposition of organic material contained in municipal solid waste (MSW) landfills. By volume, LFG is about 50 percent methane and 50 percent carbon dioxide and water vapor. Also contains small amounts nitrogen, oxygen and trace amounts of nonmethane organic compounds and inorganic compounds.
- **Renewable Natural Gas (RNG):** Pipeline quality gas derived from biomass resources that is injected into the gas distribution network and is fully interchangeable with natural gas. Produced from anaerobic digestion or thermal gasification of biomass. *Also referred to as biomethane.*

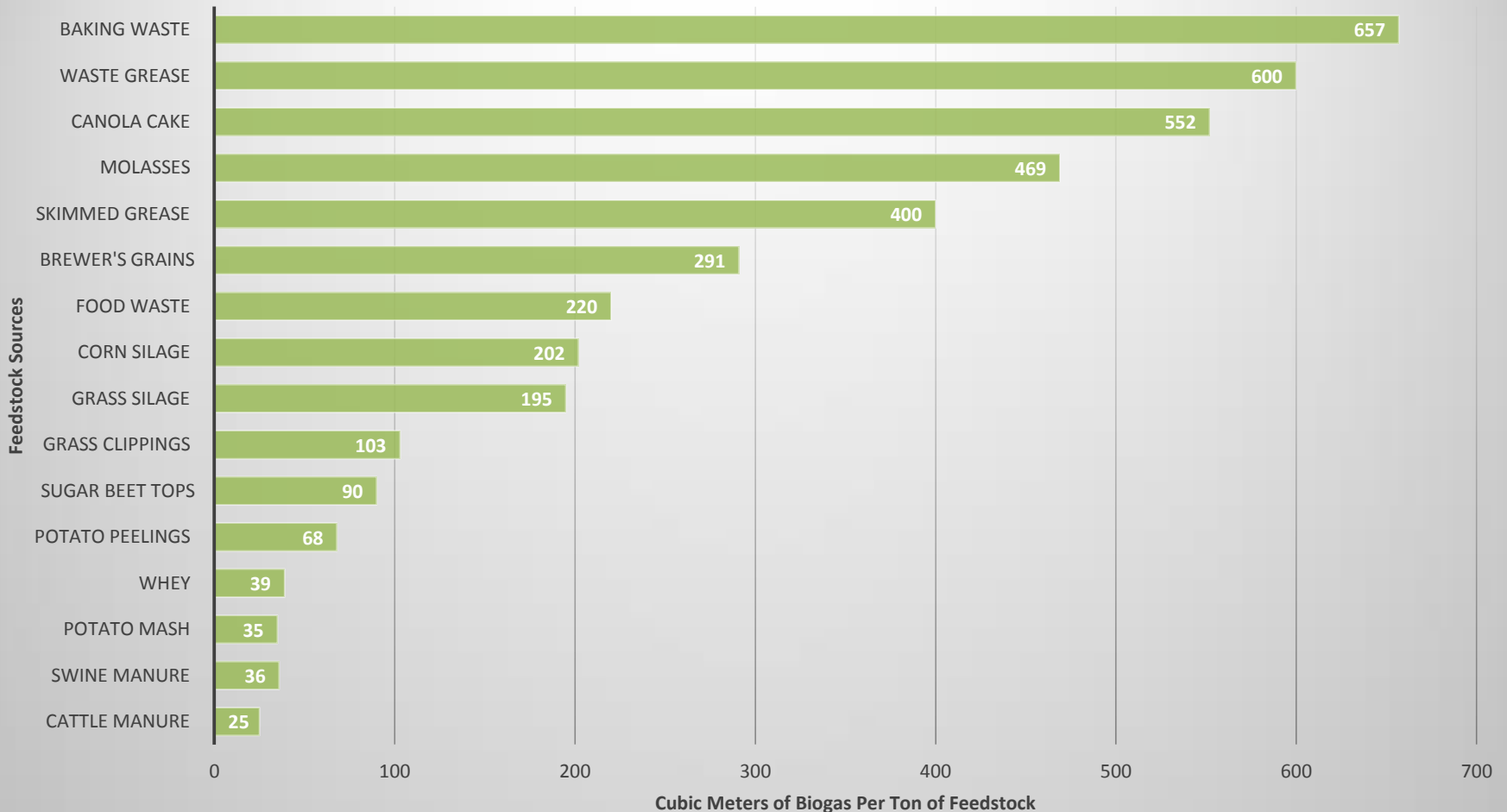


What is Biogas? – Inputs and Process



DIFFERENT FEEDSTOCKS YIELD DIFFERENT AMOUNTS OF BIOGAS

Potential Biogas Yields (cubic meters/ton)



Source: Effenberger, Bavarian State Research Center for Agriculture

BIOGAS APPLICATIONS

Agricultural



Photo credit: Five Star Dairy (WI)

Industrial



Photo credit: Kreig and Fischer

Wastewater Treatment



Photo credit: iStock



Photo credit: City of Flint Michigan

Landfill



Photo credit: King County (WA) Solid Waste Division

ANAEROBIC DIGSTION TECHNOLOGY

Four General Categories

1. Covered Anaerobic Lagoon



Photo credit: Environmental Credit Corporation



Photo credit: Extension

2. Plug Flow



Photo credit: University of Minnesota Extension



Photo credit: EPA AgStar

ANAEROBIC DIGSTION TECHNOLOGY

Four General Categories

3. Complete Mix



Photo credit: Viessmann Group



Photo credit: Process Engineering

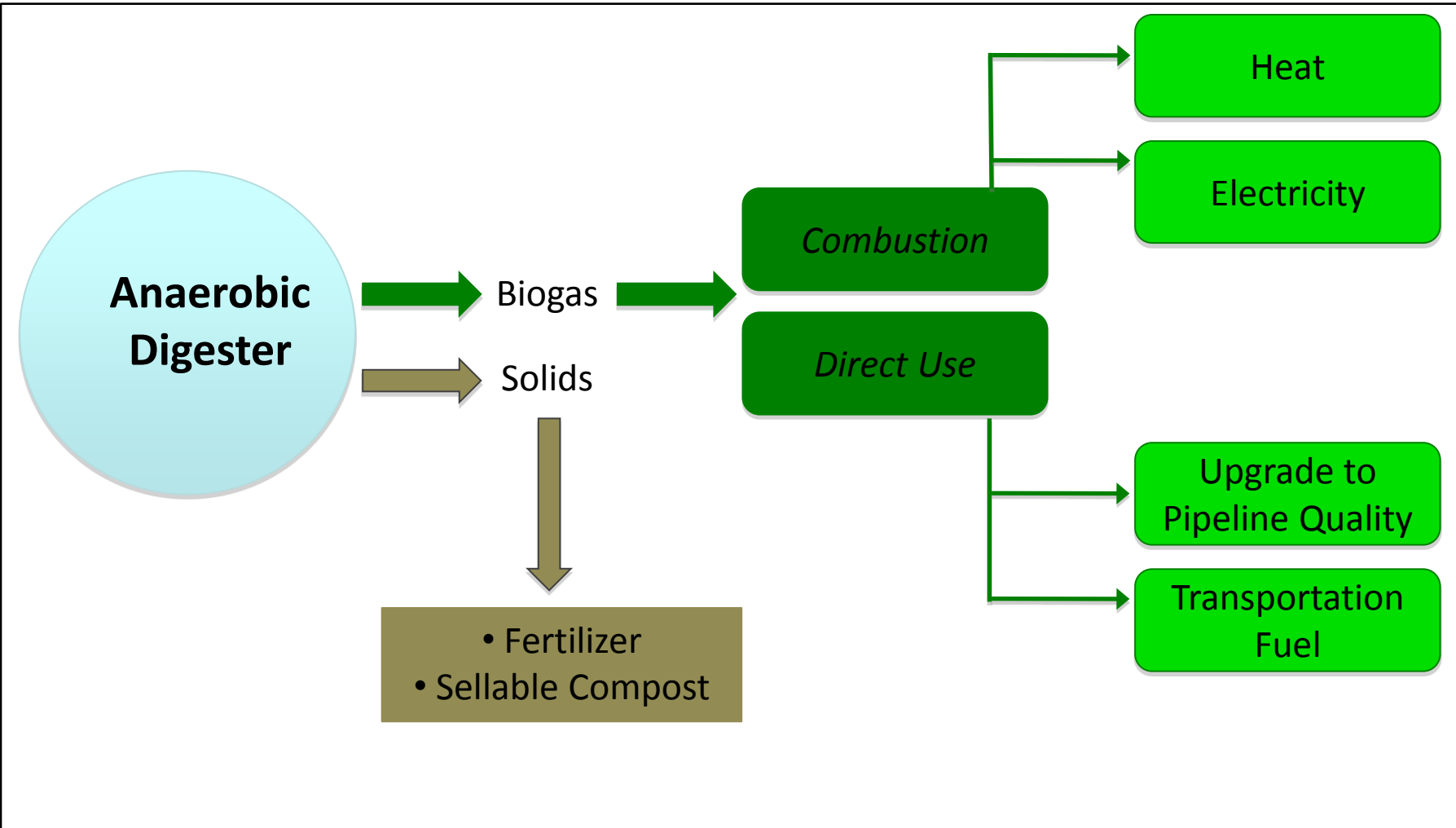
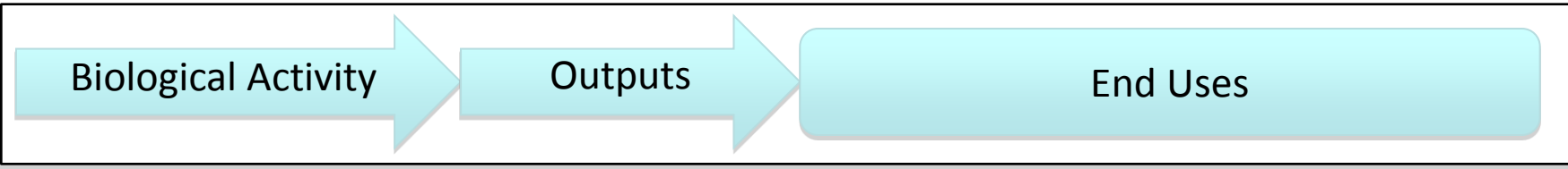
4. Dry Digestion



- 1 Biomass Storage
- 2 Mixing Platform
- 3 Fermentation Chamber
- 4 Flexible Gas Storage
- 5 Biogas Boiler
- 6 CHP
- 7 Electric Grid Connection
- 8 To District Heating

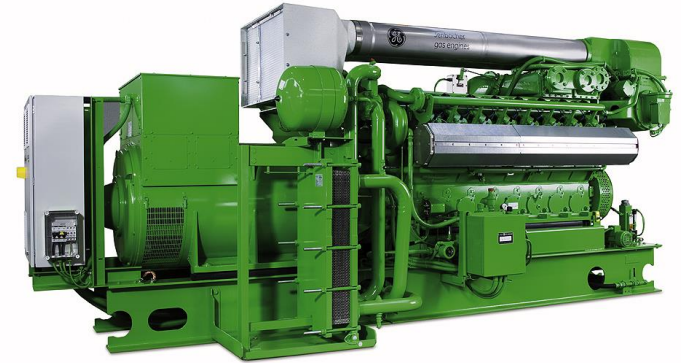


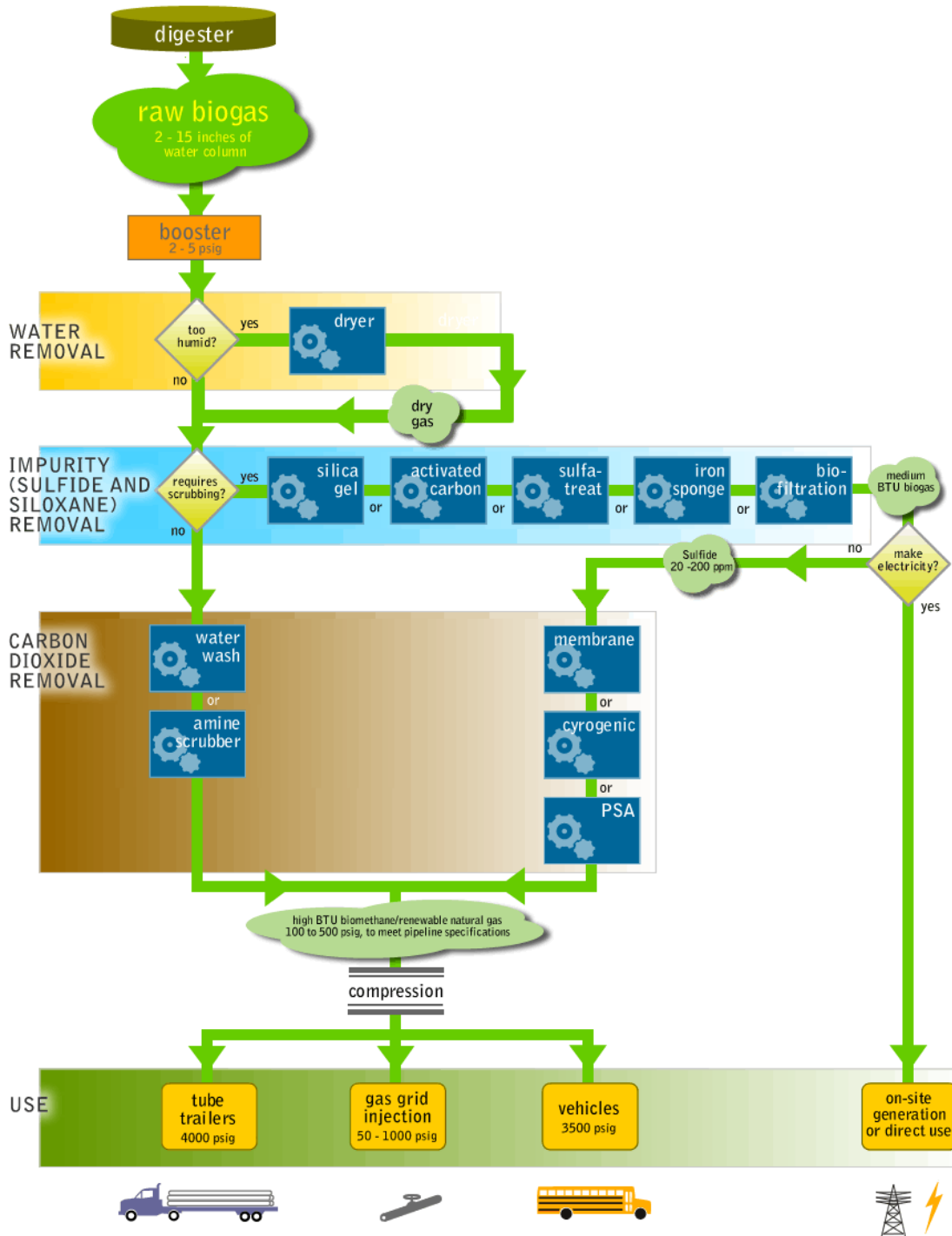
What is Biogas? – Outputs and End Uses



BIOGAS UTILIZATION

- Electricity and/or heat
- Renewable natural gas
- Transportation fuel
- Emerging opportunities
 - High value chemicals or products





BIOGAS UPGRADE PROCESS & TECHNOLOGY

Graphic produced by:



Promoting the Anaerobic Digestion
and Biogas Industry

BIOGAS BENEFITS AND CHALLENGES



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BIOGAS BENEFITS - ENVIRONMENTAL

- Recovery of Nutrients
- Reduced Pathogens
- Reduced Carbon Emissions
- Effective Waste Management Tool
- Water Quality Improvements
 - Paired with good management practices
- Establishment of Energy Crops



BIOGAS BENEFITS - ECONOMIC

- Constant and Flexible Source of Energy Sales or Savings
- Source of Heat
- Avoided Waste Disposal
- Environmental Credits
- Nutrient Recovery
- Can Operate in Conjunction with Composting Operations



BIOGAS CHALLENGES

- Difficult Economics
- Consistent and Reliable Feedstock Supply
- Lack of Supporting Infrastructure or Service Technicians
- Complex Permitting – Feedstock Variability
- Less Public Policy Support
 - Compared to other renewable energy sources



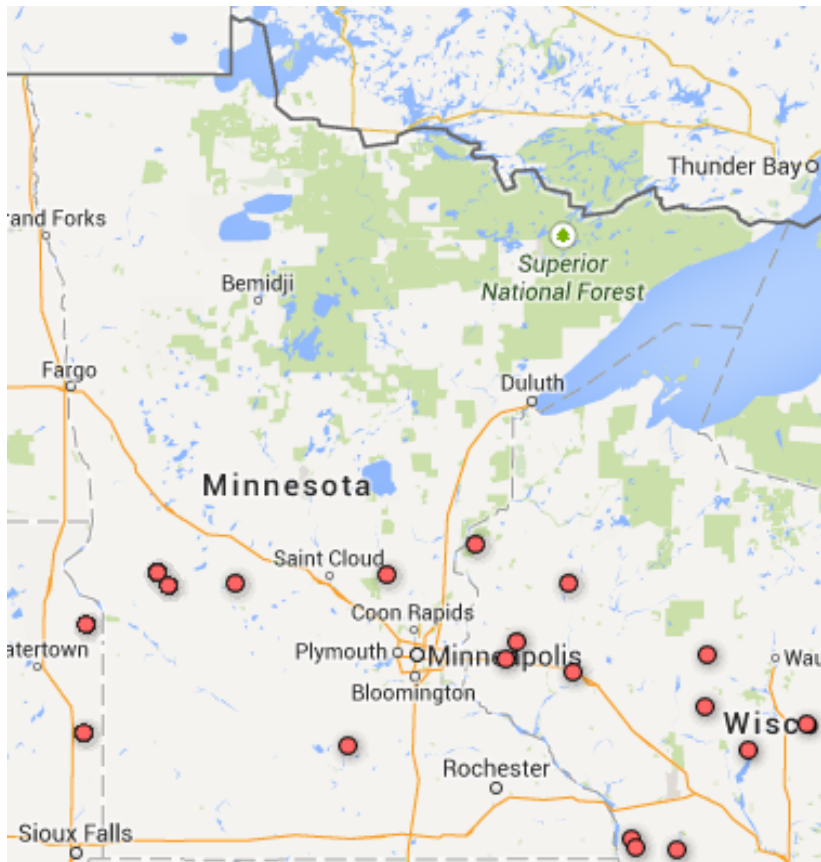
OPERATIONAL BIOGAS PROJECTS IN MINNESOTA



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AGRICULTURAL



Agricultural Operation Name	City	Population Feeding System
District 45 Dairy	Hancock	5,520
West River Dairy	Morris	6,300
Jer-Lindy Dairy Farm (non-operational)	Brooten	270
Haubenschild Dairy Farm	Princeton	900
Northern Plains Dairy	St. Peter	3,000

Map produced by:

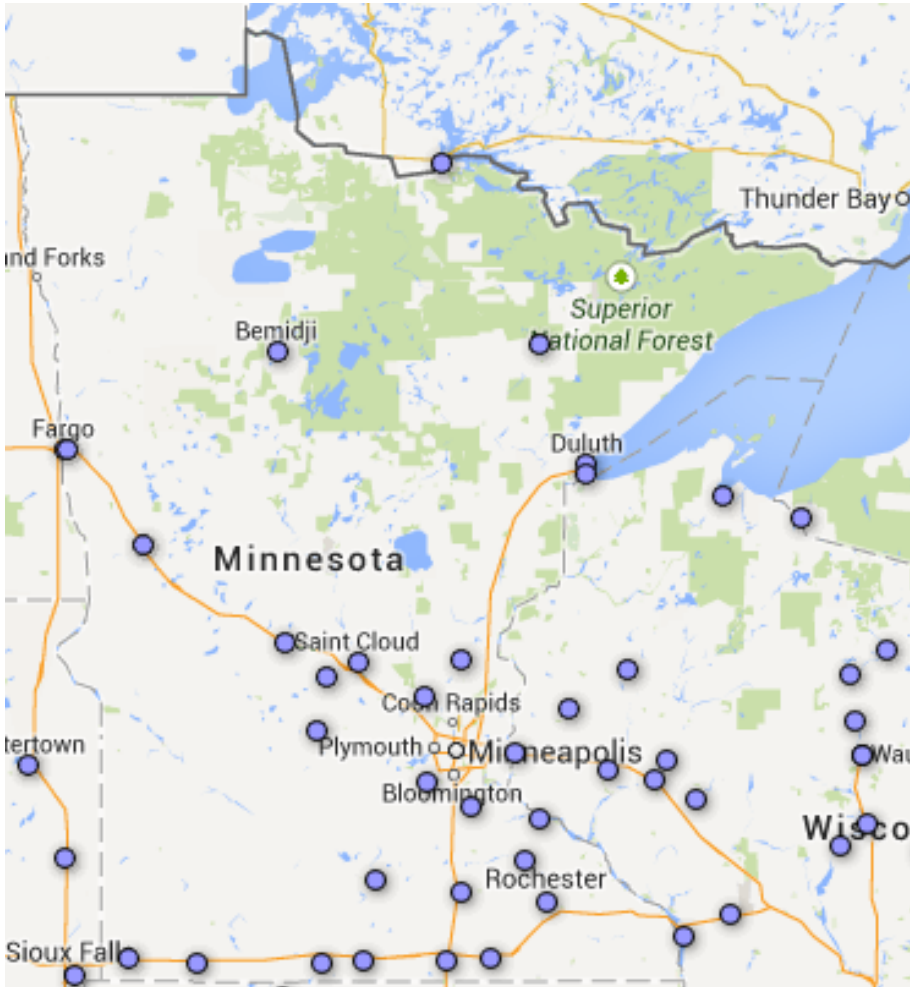


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Interactive map with data available at
www.americanbiogasCouncil.org/biogas_maps.asp

WASTEWATER



- Albert Lea Wastewater Treatment Facility
- Austin Wastewater Treatment Plant
- City of Blue Earth Wastewater Treatment Facility
- Cambridge Wastewater Treatment Facility
- Western Lake Superior Sanitary District (Duluth)
- City of Elk River Wastewater Treatment Plant
- Fairmont Wastewater Treatment Facility
- Empire Wastewater Treatment Facility (Farmington)
- Fergus Falls Wastewater Treatment Plant
- North Koochiching Area Sanitary District
- City of Litchfield Wastewater Treatment Facility
- City of Luverne Wastewater Treatment Plant
- Melrose Treatment Facility
- City of Moorhead Wastewater Treatment Facility
- Owatonna Wastewater Treatment Facility
- Red Wing Municipal Wastewater Treatment Facility
- Rochester Water Reclamation Plant
- Blue Lake Wastewater Treatment Facility (Shakopee)
- St. Cloud Wastewater Treatment Plant
- Virginia Wastewater Treatment Plant
- Worthington Wastewater Treatment Facility
- City of Zumbrota Wastewater Treatment Facility

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LANDFILL



Facility Name	City
Crow Wing County Sanitary Landfill	Brainerd
East Central Sanitary Landfill	Mora
Elk River Sanitary Landfill	Elk River
Anoka Ramsey Sanitary Landfill	Anoka
Waste Disposal Engineering Sanitary Landfill	Andover
Pine Bend Landfill	Inver Grove Heights
Burnsville Sanitary Landfill	Burnsville
Spruce Ridge Landfill	Glencoe

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INDUSTRIAL

- Biogas applications integrated into industrial process
 - Treatment of existing waste streams
 - Provides a source of process energy
- Emerging market opportunity



Pulp and
Paper
Facilities



Biofuel
Production
Facilities



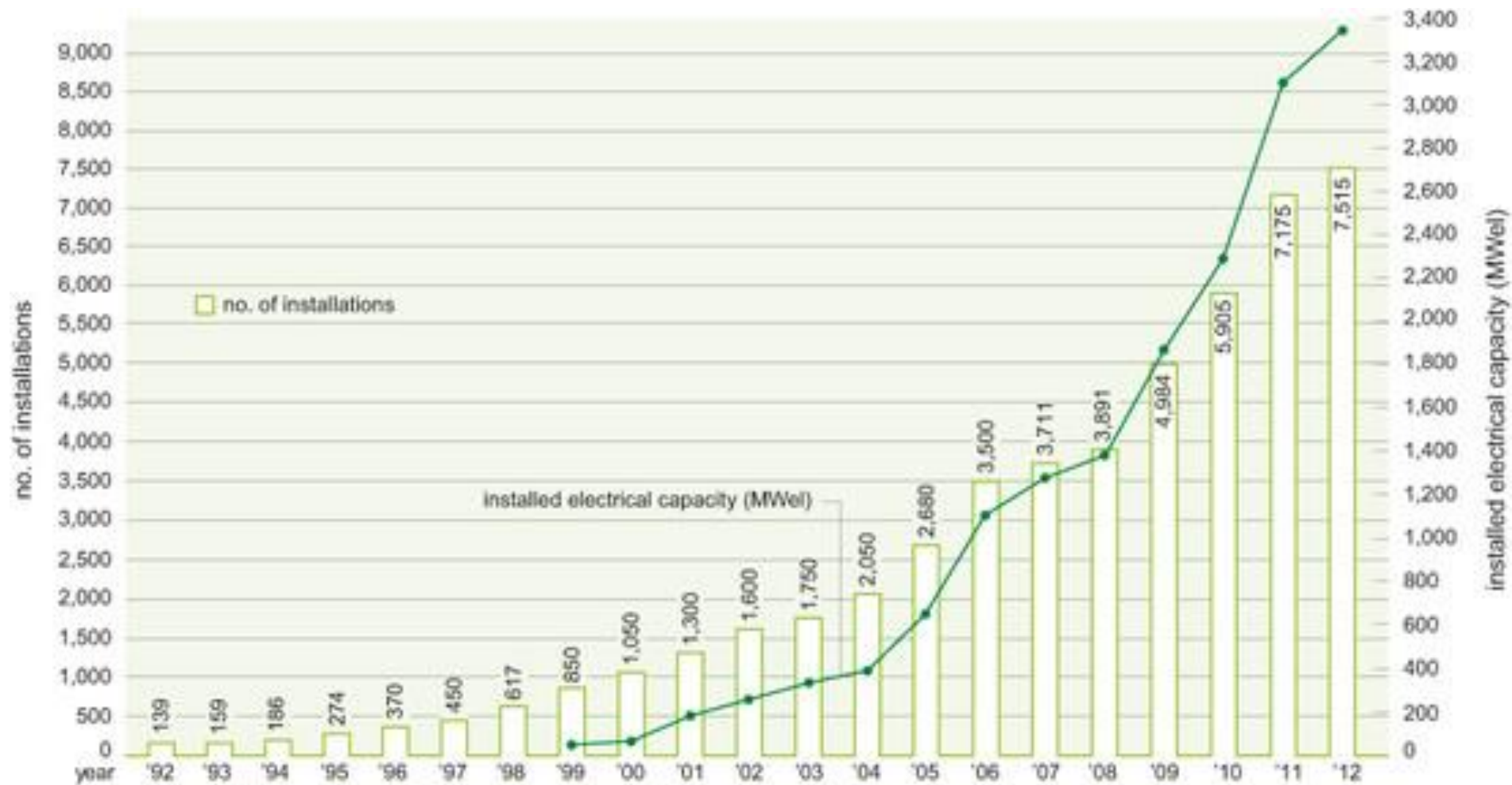
INTERNATIONAL BIOGAS EXPERIENCE



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GERMANY

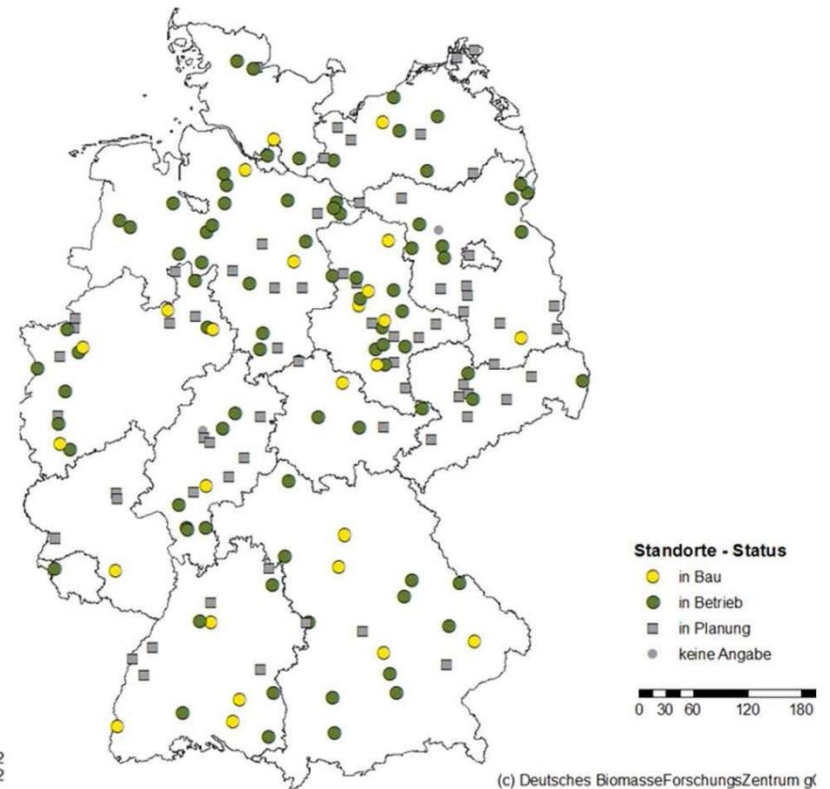
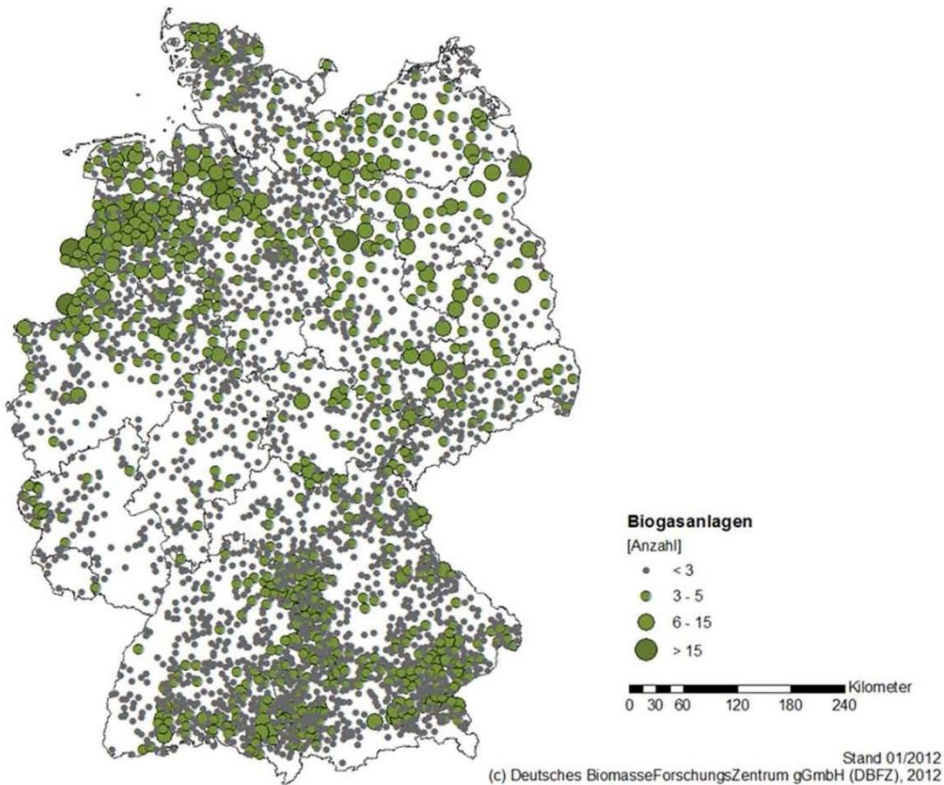


Source: German Biogas Association

GERMANY

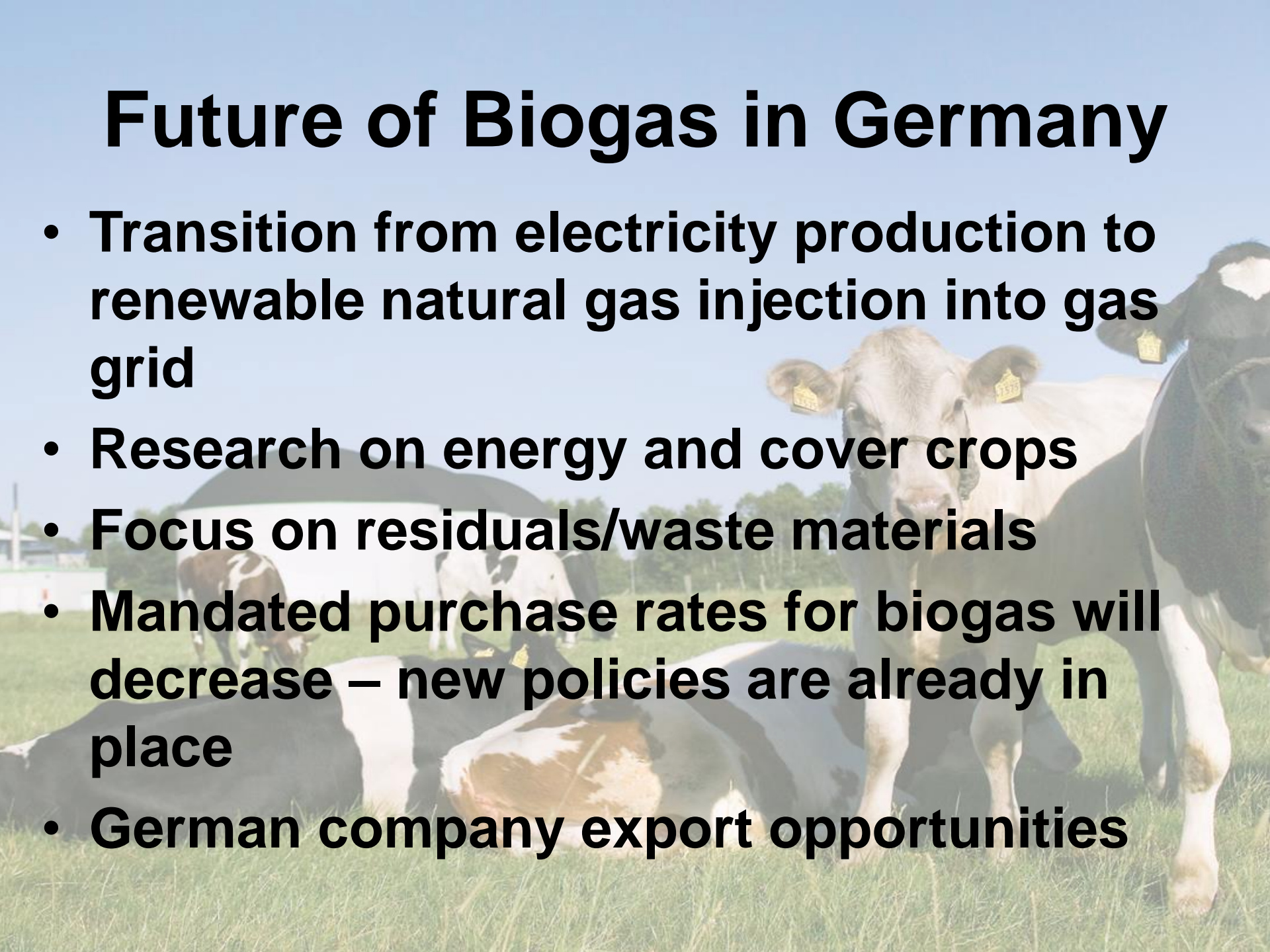
Around 7200 biogas plants with electricity production in CHP (combined heat and power) in front of the biogas plant

Around 83 Biogas plants with upgrading the biogas to biomethane in operation (further plants projected within the next years)

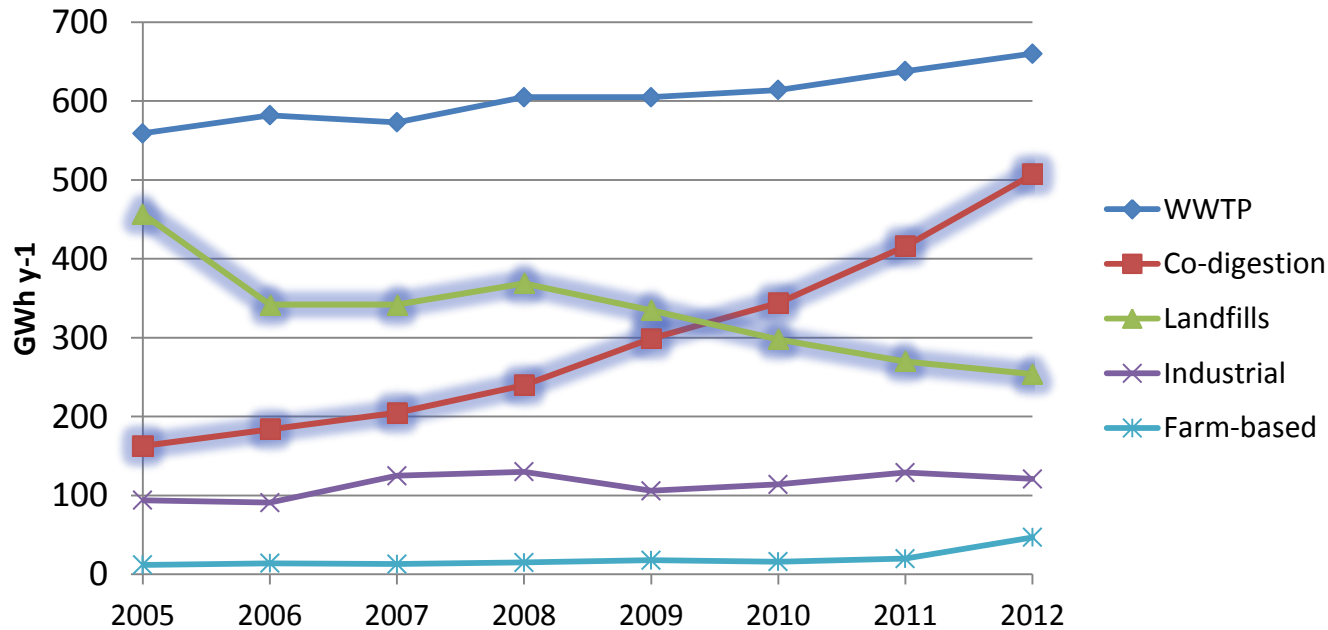


Source: German Biomass Research Center, January 2012

Future of Biogas in Germany

- **Transition from electricity production to renewable natural gas injection into gas grid**
 - **Research on energy and cover crops**
 - **Focus on residuals/waste materials**
 - **Mandated purchase rates for biogas will decrease – new policies are already in place**
 - **German company export opportunities**
- 

SWEDEN



During 2012, 353 GWh vehicle-fuel was produced from foodwaste replacing about 30 millions liters of petrol. 725 000 tonnes biofertilizer is produced yearly in Sweden.

Type	No of plants 2012
WWTP	135
Co-digestion	21
Industrial	5
Farm-based	26

Vehicles Using Biogas and Natural Gas in Sweden



Light vehicles



Heavy vehicles



Buses



Trains



SWEDEN

- Minnesota and Sweden Memorandum of Understanding (MOU) on Bioenergy Cooperation
- Near-term Focus on Biogas Cooperation



Presentations from the Minnesota/Sweden Sustainable Transportation meeting available at, www.betterenergy.org/swedensustainabletransport



EXPERIENCE FROM OTHER U.S. STATES



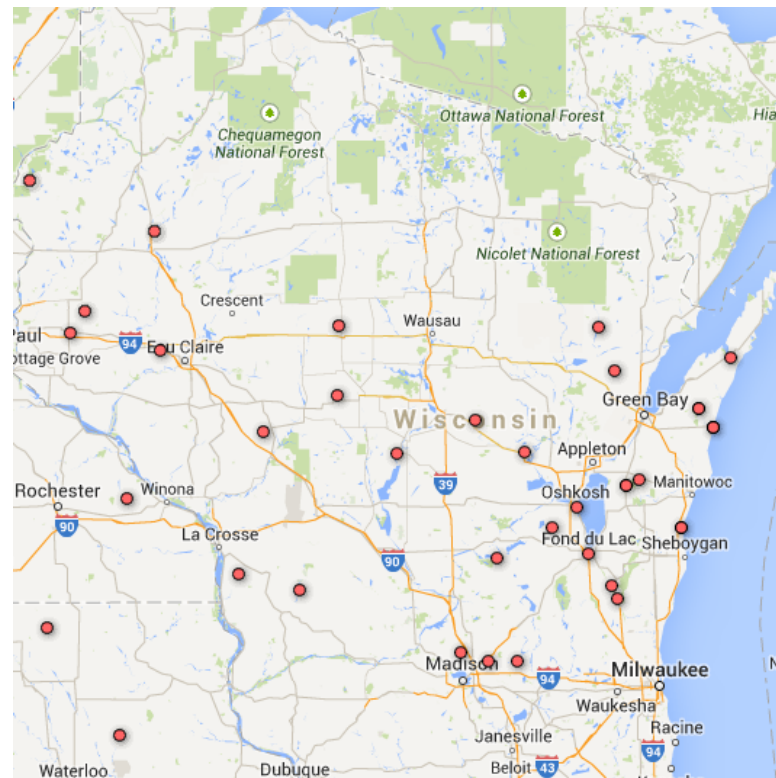
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WISCONSIN – SUCCESS FACTORS

- State Grant Program
- Biogas Roundtable
- Voluntary Utility Tariffs
- Local Technology Providers
- Favorable Regulatory Environment
- State Leadership

Agricultural Biogas Operations - WI



Map produced by:



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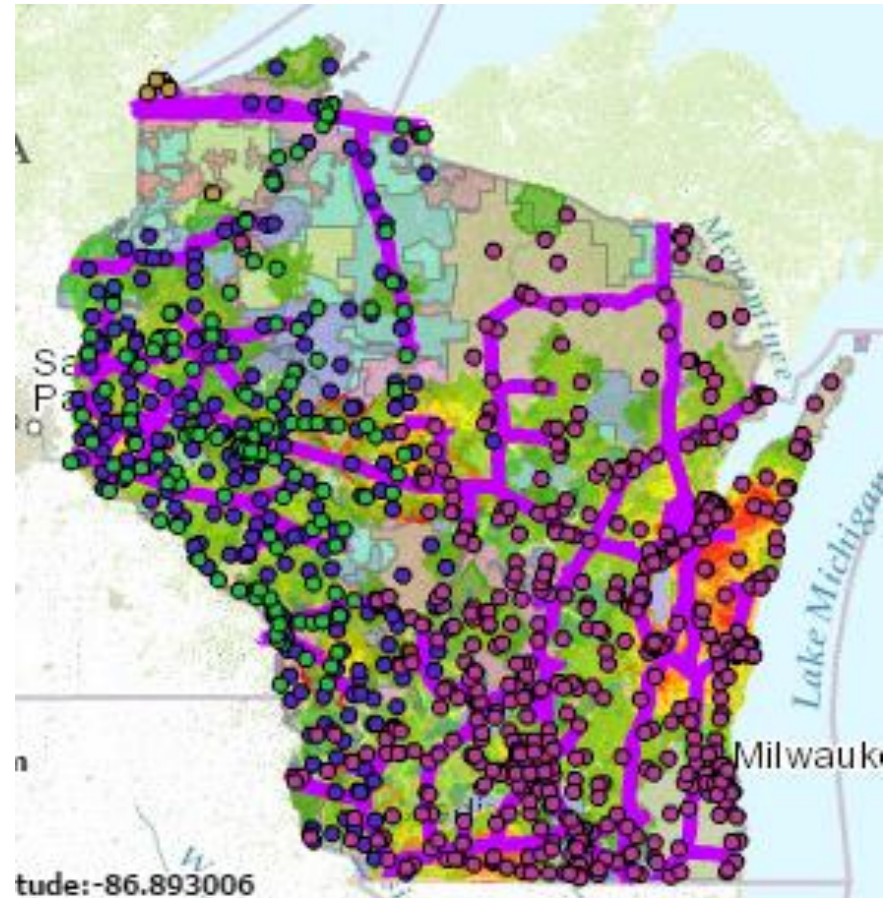
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Promoting the Anaerobic Digestion
and Biogas Industry

WISCONSIN BIOGAS DEVELOPMENT MAP

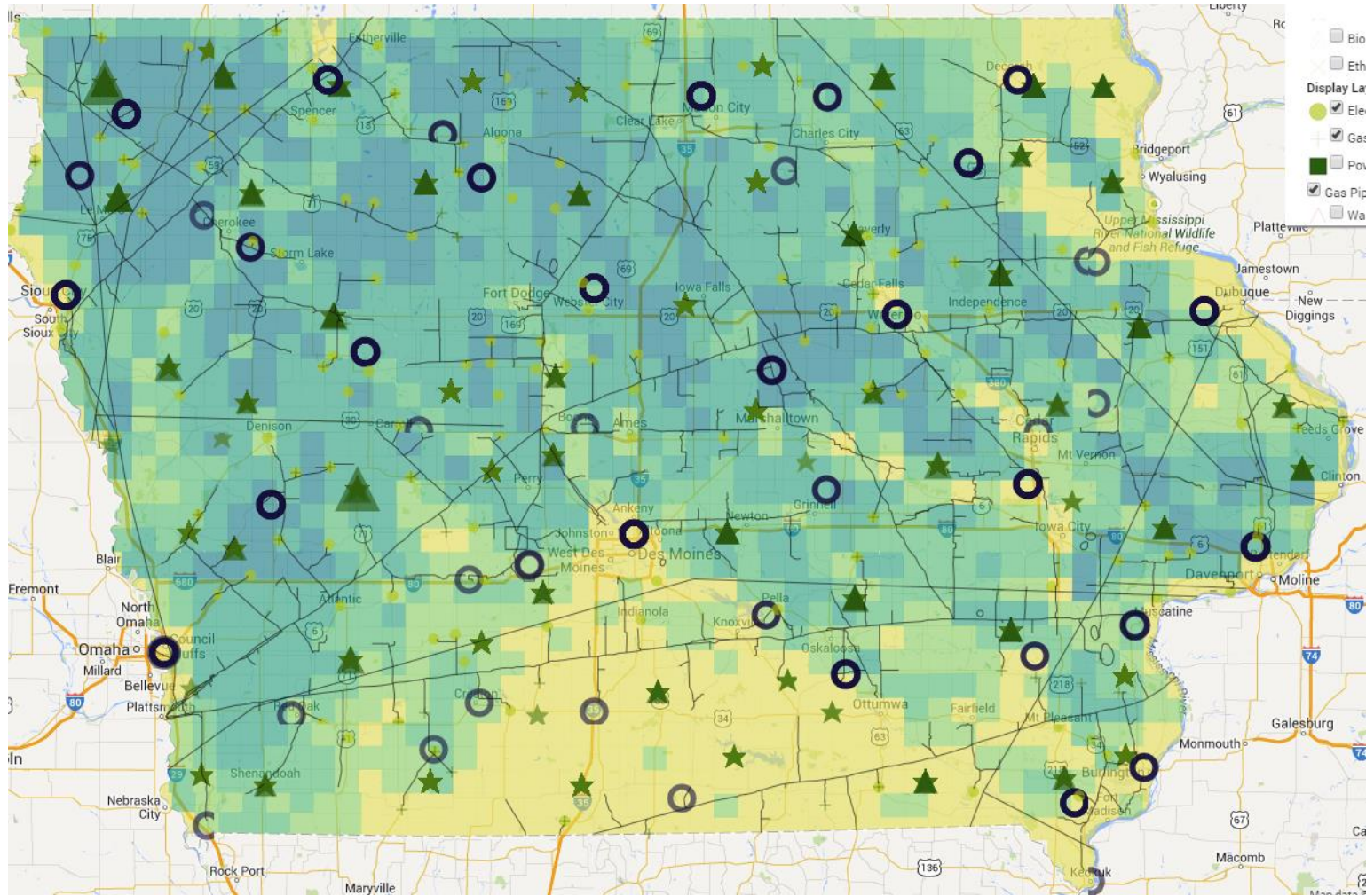
- Natural Gas Pipelines
- Utility Substations
- Electric Service Territory
- Dairy Processing Plants
- Dairy Farms



Map produced by Baker Tilly for WI State Energy Office. Interactive map available at, <http://bakertilly.com/insights/biogas-map>



IOWA BIOGAS DEVELOPMENT MAP



Map produced by EcoEngineers for IA Economic Development Authority. Interactive map available at, <http://www.ecoengineers.us/ibam/>



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Emmetsburg, Iowa

POET-DSM Cellulosic Ethanol

- Utilization of anaerobic digestion and solid fuel biomass boiler
- Offsets process energy at both the cellulosic and grain ethanol plants
 - Reduces natural gas use by 80 percent



Fort Collins, CO

New Belgium Brewery

- On-site Process Water Treatment Plant
- Biogas fuels a 292 kW engine with heat recovery
- Meets ~15 percent of electricity needs
 - Offsets \$60,000/year in electricity costs



Photo credit: New Belgium Brewery



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Fair Oaks, Indiana

Fair Oaks Dairy

- 1.5 million SCF biogas per day
- Displaces 1.5 million gallons of diesel fuel per year
- Fueling station in Sellersburg, Indiana
- Fuels fleet of milk delivery trucks and municipal vehicles



Columbus, Ohio

Quasar Energy

- 3,600 gallons of gasoline equivalent per day
- Municipal wastewater biosolids, food/beverage waste and fats, oils, and greases.
- Onsite refueling with public access



FUTURE TRENDS



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CENTRAL/REGIONAL SYSTEMS

- Collect multiple feedstock for processing in single facility
- Advantage to boost overall biogas production
- Can be located near natural gas injection sites
- Can help to address water quality issues in a watershed



Dane County Community Digester



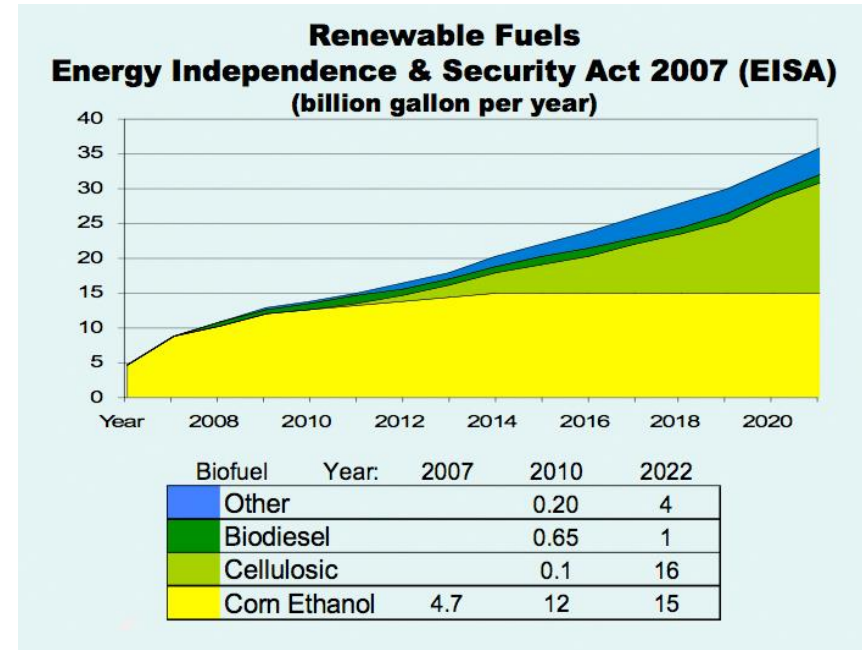
BIOGAS AS A TRANSPORTATION FUEL

- Upgraded and compressed biogas as a transportation fuel (bioCNG)
 - Can serve large vehicles and fleets
- Multiple projects outside of Minnesota already in operation or development
- High value market for biogas
 - improved project economics



Federal Renewable Fuel Standard

- 36 billion gallons by 2022
- Mandates increasing renewable fuel supplies for transportation fuels
 - Biogas is as a qualifying fuel to generate credits
 - 77,000 Btu = 1 gal. renewable fuel
 - Advanced or cellulosic biofuel

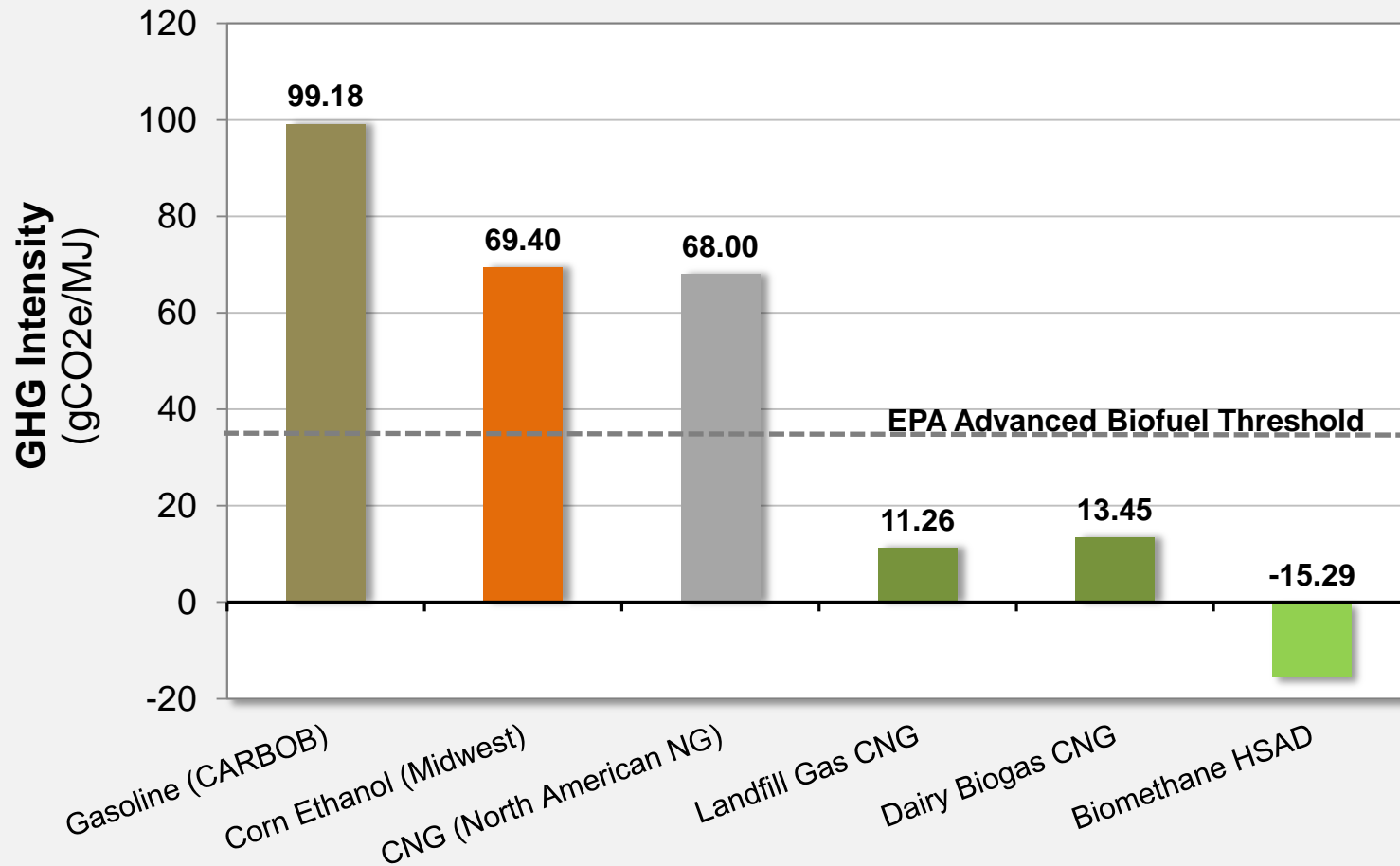


Federal Renewable Fuel Standard

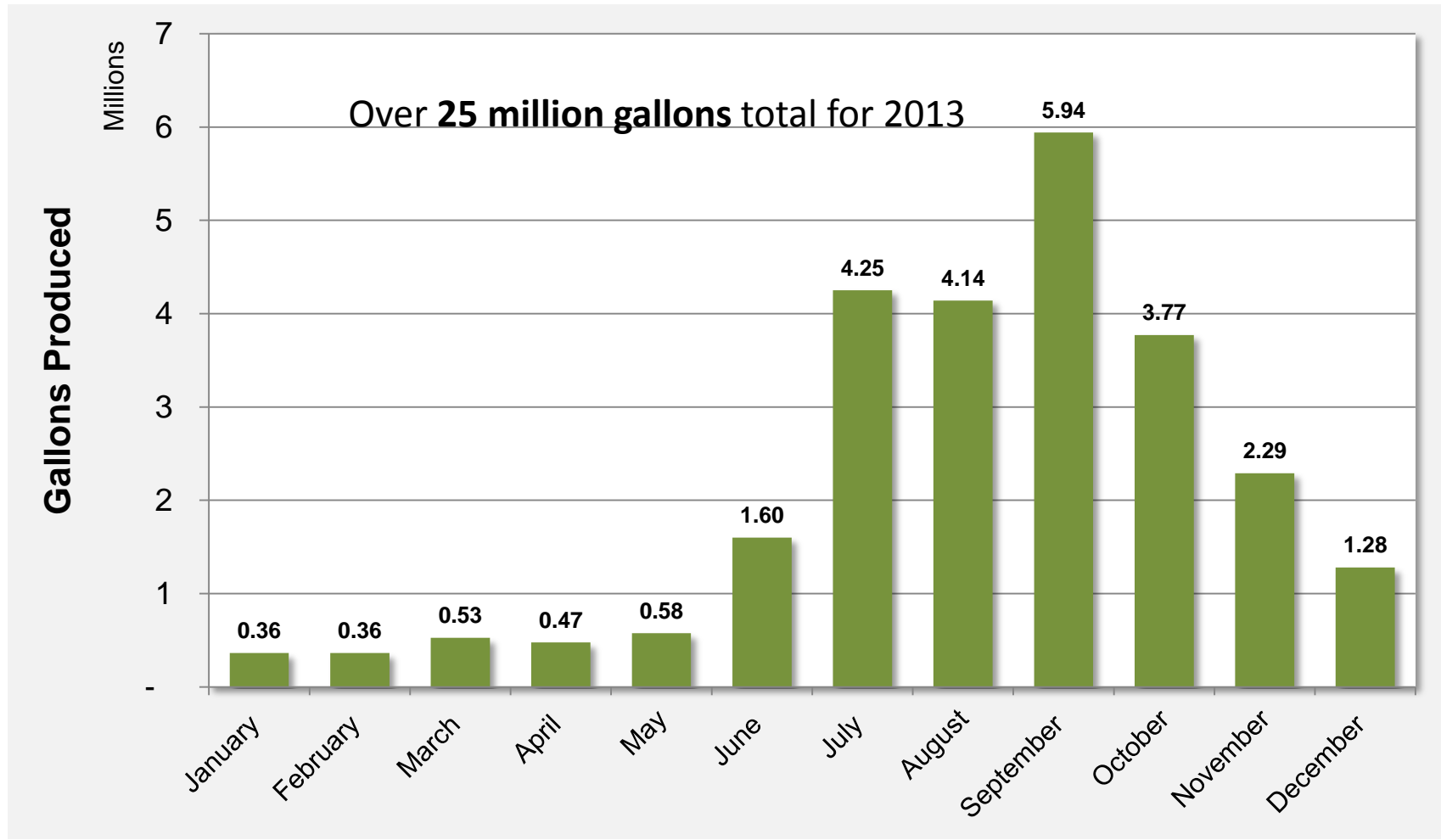
Source: GLBRC



Biogas-based Fuel Offers Substantial GHG Reductions



RFS Biogas Gallons in 2013



RESIDENTIAL AND COMMERCIAL ORGANIC COLLECTION

- Source separated organics can be a feedstock for biogas projects
- Work in conjunction with composting facilities
- Capture energy value to meet community energy needs



Summary

- **Biogas is able to supply a reliable and constant source of renewable energy**
- **Biogas has flexible inputs (feedstocks) and outputs (utilization options)**
- **Enormous opportunity to use biogas to help meet energy needs and serve markets not met by other renewable technologies**
- **Minnesota could put effort into convening stakeholders and assessing the available resource**



THANK YOU

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