On-farm Anaerobic Digestion in the U.S.

NICK ELGER, EPA AGSTAR
About Me - Nick Elger

Currently manage AgSTAR and coordinate agricultural AD projects with the Global Methane Initiative

Grew up in West Bend, WI

Attended UW-Washington County

Graduated from University of Minnesota – BS Environmental Sciences, Policy and Management
Overview

Introduction to AgSTAR
Overview of U.S. Biogas Industry
Elements of Successful Anaerobic Digestion (AD) Projects

Trends for Livestock Biogas Projects
- Diverse Business Models
- Emerging Eco-Markets for Coproducts
- Food Waste Diversion
- Renewable Natural Gas to Vehicle Fuel
AgSTAR Program

20+ year collaborative voluntary program of USDA and EPA.

Strong ties to industry, government, NGO and university stakeholders.

Promotes the use of anaerobic digestion systems to advance economically and environmentally sound livestock manure management.

Assist those who enable, purchase or implement anaerobic digesters by identifying project benefits, risks, options and opportunities.
Program Partners

- Engage in state-to-state collaboration
- Help to shape national priorities
- Overcome barriers
- Learn about trends and new developments
- Share best practices and lessons learned
- Improve access to technical information

Wisconsin AgSTAR Partners

- Department of Agriculture, Trade and Consumer Protection
- Department of Commerce
- Department of Natural Resources
- Public Service Commission
- State Energy Office
- Wisconsin Energy Institute
- University of Wisconsin Oshkosh - Environmental Research and Innovation Center
Benefits of Advanced Manure Management

Conservation of agricultural land for future generations
- Nutrient management, water quality, air emissions

Diversify farm revenue to balance commodity uncertainty
- Energy, fertilizer, animal bedding

Rural economic growth based on project support and ancillary business development
- Project construction and operations, agriculture tourism, horticulture medium and products

Farm growth opportunities based on public acceptance of operations
- Odor control, public education

Support safe, affordable food production
- Pathogen destruction, animal health
All of the opportunities presented will not be appropriate for all digester systems based upon technical and financial constraints.

Digester

- Manure (e.g., dairy manure)
- Wastewater Biosolids (e.g., Primary/Secondary Sludge)
- Food Waste (e.g., Household, Restaurant, Hospitality, Grocery)
- Other Organics (e.g., Pulp, Crop Residues, Grocery Waste)

Biogas

- Conditioning to remove H₂O & H₂S
- Processing to remove CO₂

Liquids

- Solids Separator

- Solids

- Lagoon/Liquid Storage
- Advanced Treatment

- Solids

- Discharge
- Reuse

- Concentrated Fertilizer

- Fertilizer for field or greenhouse crops, flush water

- Fertilizer (NPK)
- Compost Soil Amendment
- Bedding

- Fiber-based Products

- Medium BTU Biogas (600-200 BTUs/cf)
- Boiler, heater, chiller, etc.

- Electricity
- Internal combustion engine (early stage: microturbines, fuel cells)

- Biomethane (600-1000 BTUs/cf)
- Natural gas pipeline quality, vehicle fuel (CNG/LNG), feedstock

- Energy Company
- Electric utility, natural gas pipeline, vehicle fueling station

- Recaptured Heat

- Farm or Neighbor Use
- Building heating, greenhouse, food storage, adjacent commercial/industrial needs, etc.
U.S. Livestock Sector Overview

Dairy Cattle & Milk Production ($35.5B)
- 33% of market from two states – California, Wisconsin; 75% from top 10 states
- 77% of farms were family or individually owned

Hog and Pig Farming ($22.5B)
- Market up 25% from 2007
- Top three states 55% of market – Iowa, North Carolina, Minnesota

Poultry and Egg Production ($42.8B)
- More than 50% from six states – North Carolina, Georgia, Arkansas, Alabama, Mississippi, Texas

Cattle Production ($76.4B)
- Market up 25% since 2007
- 44% from three states – Texas, Kansas, Nebraska

Total U.S. methane emissions in 2014 = 730.8 MMTCO$_2$e

Portion from waste sector (landfills; wastewater; composting) = 164.7 MMTCO$_2$e

Portion from agriculture sector (manure management) = 61.2 MMTCO$_2$e

Livestock Anaerobic Digester Systems in the United States

There is potential for about 8,000 additional livestock anaerobic digester systems in the U.S.

If fully realized, these digesters could produce 257 billion cubic feet per year of biogas. That's enough energy to power:

- 1 million American homes for one year, or provide natural gas to fuel
- 2 million passenger cars for one year

There are currently 244 livestock anaerobic digester systems across the U.S.:

- 195 on dairy farms
- 32 on swine farms
- 17 on farms with poultry, beef, or a combination of animal types
Anaerobic Digester Projects in the U.S.
Midwest Projects

Wisconsin – 39
Minnesota – 7
Michigan – 8
Iowa – 5
Illinois – 3
Ohio – 11
Indiana – 10
Missouri - 3
# United States AD Project Stats

## Table 1: Designs for the 242 Operating Anaerobic Digesters in 2015

<table>
<thead>
<tr>
<th>System Type</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug Flow*</td>
<td>102</td>
<td>42%</td>
</tr>
<tr>
<td>Complete Mix</td>
<td>90</td>
<td>37%</td>
</tr>
<tr>
<td>Covered Lagoon</td>
<td>35</td>
<td>14%</td>
</tr>
<tr>
<td>Induced Blanket Reactor</td>
<td>5</td>
<td>2%</td>
</tr>
<tr>
<td>Anaerobic Sequencing Batch Reactor</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>Fixed Film</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>Unknown</td>
<td>5</td>
<td>2%</td>
</tr>
</tbody>
</table>

## Table 2: End Uses of Biogas in 2015

<table>
<thead>
<tr>
<th>End Use</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Heat and Power (CHP)</td>
<td>122</td>
<td>50%</td>
</tr>
<tr>
<td>Electricity</td>
<td>82</td>
<td>34%</td>
</tr>
<tr>
<td>Boiler/Furnace Fuel</td>
<td>16</td>
<td>7%</td>
</tr>
<tr>
<td>Flared Full Time</td>
<td>15</td>
<td>6%</td>
</tr>
<tr>
<td>Unknown</td>
<td>7</td>
<td>3%</td>
</tr>
</tbody>
</table>
Digester Types

- Above ground complete mix
- In ground complete mix
- In ground plug flow
- Covered lagoon
Biogas Energy Use

Internal combustion engine for electricity generation

Biogas to pipeline quality biomethane processing facility

Housing unit for internal combustion engine
Ancillary Systems

Digestate solids screwpress

Solid food waste collection bay

Nutrient recovery DAF system

Biogas handling equipment
US Energy Production from Livestock AD
Elements of AD System Success

Technically sound and commercially viable:
- Feedstock management (contracts, food waste)
- AD technology selection (feedstocks, climate, goals, manure v. co-digestion)
- Solids separation (fiber and liquid use)
- Digestate and nutrient use (crop nutrients, animal bedding)
- Energy production (on v. off-farm, electric, heat, fuel)
- Odor control (neighbor relations, business growth)
- Operation & maintenance (digester, energy production, farm staff v. 3rd party)
- Viable business model (outside investment, project partners)
- Nutrient Recovery???
What’s Happening in the U.S. Market?
Business Models

Yippee Farms, Lancaster, PA
- 850 head dairy; co-digestion with food waste; electricity production; planned farm expansion; farmer investment; solids separation (not operational)

Fair Oaks Farms, Fair Oaks, IN
- 30,000 head dairy; Biomethane production; nutrient recovery; public education; third party ownership and operation; solids separation for bedding

Bar-Way Farm/Vanguard Renewables, Deerfield, MA
- 300 head dairy; co-digestion with food waste; third party ownership model that includes dairy farmers; electricity production; solids separation
Growing Digestate Solids Market

**Magic Dirt**

- Primary component is dairy manure fibers.
- Magic Dirt will be on the shelves at ½ of the Walmart stores in the U.S. in 2017.
- Each cubic yard of Magic Dirt used avoids about one ton CO2e.

**Cow Pots**
Changing Waste Paradigm

Photo: Vanguard Renewables

[Logo: Zero Waste to Landfill by 2020]

Photo: Molly Farrell Tucker, BioCycle (1/2013), Charleston County Fosters Food Waste Composting
On-Site Organics and Food Waste Recovery
Innovative Non-Farm Business Models

CleanWorld Sacramento Biodigester and Atlas ReFuel, CA
- 100 TPD food waste digester; 1,300 GGE of BioCNG per day for 45 Atlas Hauling and Sacramento County vehicle fleets.

St. Landry Parish and Progressive Waste, LA
- Small municipal landfill produces and supplies BioCNG fuel under long-term off-take agreement; satellite fueling
Hog Manure Biogas to Renewable Natural Gas (Roeslein Energy, Missouri, USA)
RNG Growth is Significant: Over Half of Natural Gas Vehicle Fuel in California is RNG

Source: CARB Website LCFS Quarterly Data, 12/11/2015

Q3 2015: 17.6 MM DGEs of RNG
RNG production for transportation fuel grew by 5x between 2013 and 2015. It is on pace to triple in volume by 2018.
EPA Nutrient Recycling Challenge – Phase II

The Nutrient Recycling Challenge

[Diagram showing various stakeholders and organizations involved in the challenge, including American Biogas Council, National Milk Producers Federation, Tyson Foods, Inc., Smithfield Foods, USDA, NRCS, Iowa State University, and others.]
Take-Aways

Technology choices are important, but viable business model is critical

With low energy prices in most areas, must have a diversified revenue portfolio to drive project

Growing interest in broader eco-markets aspects of AD systems gaining traction

Great opportunity to regain public trust
Join AgSTAR for our upcoming webinar

Innovative Business Models for Anaerobic Digestion

March 15th 2:00 – 3:00 P.M. ET
For more information:

www.epa.gov/agstar

Nick Elger
Elger.Nicholas@epa.gov

Photo courtesy of Michigan State University