

On-farm Anaerobic Digestion in the U.S.

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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.

- State agencies
- Agricultural extension offices
- Universities
- Non-governmental organizations



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

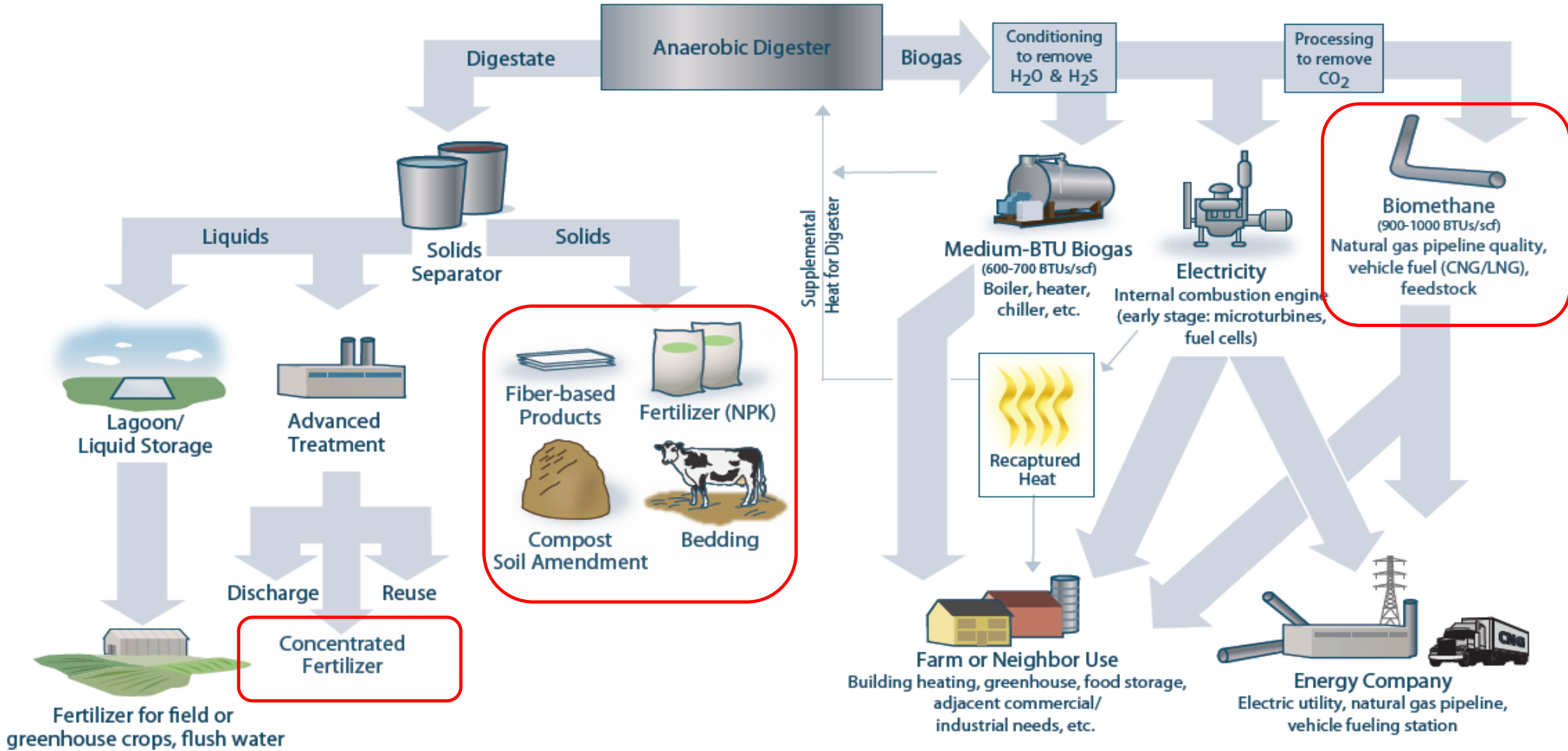
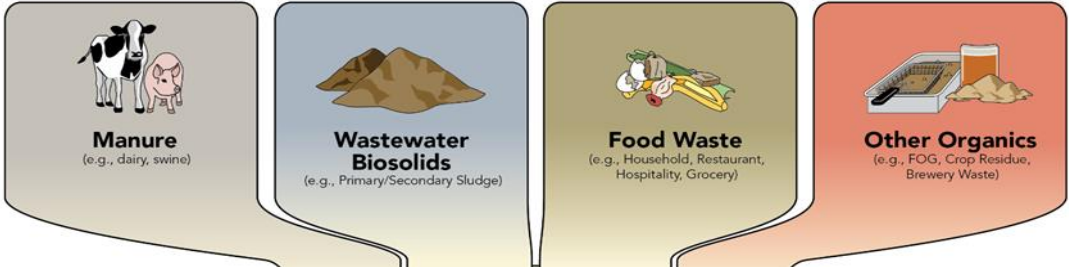
- Odor control, public education

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.



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)

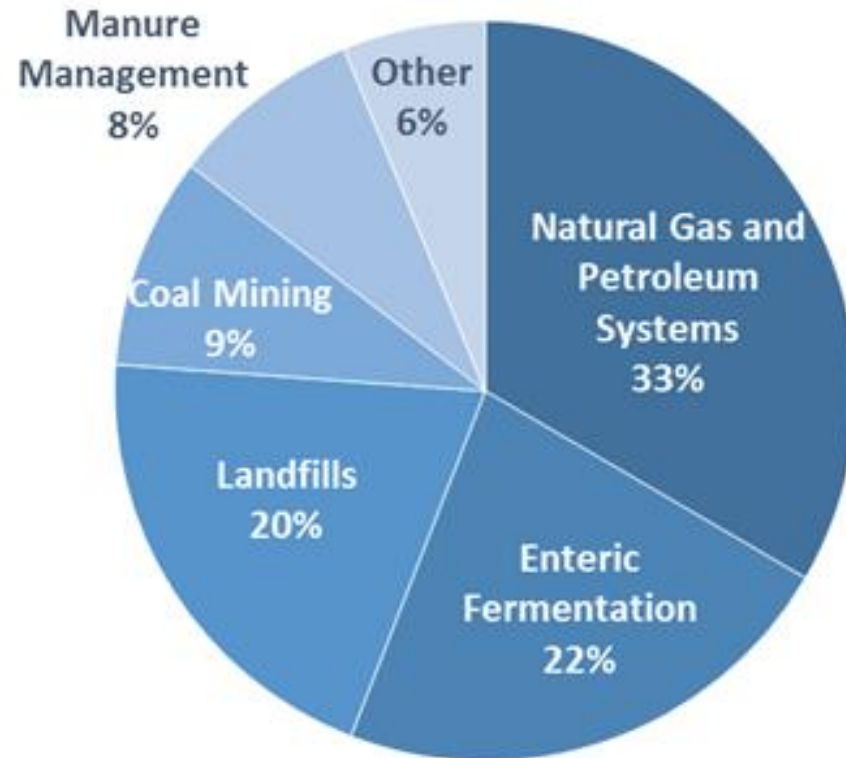
- More than 50% from six states – North Carolina, Georgia, Arkansas, Alabama, Mississippi, Texas

Cattle Production (\$76.4B)

- Market up 25% since 2007
- 44% from three states – Texas, Kansas, Nebraska



U.S. 2014 Methane Emissions, By Source



- Total U.S. methane emissions in 2014 = 730.8 MMTCO₂e
- Portion from waste sector (landfills; wastewater; composting) = 164.7 MMTCO₂e
- Portion from agriculture sector (manure management) = 61.2 MMTCO₂e

Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014 (April 2016)

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

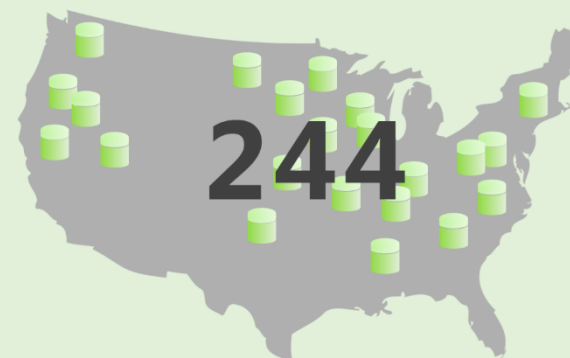


2 million passenger cars

for one year



There are currently



livestock anaerobic digester systems across the U.S.



Midwest Projects

Wisconsin – 39

Minnesota – 7

Michigan – 8

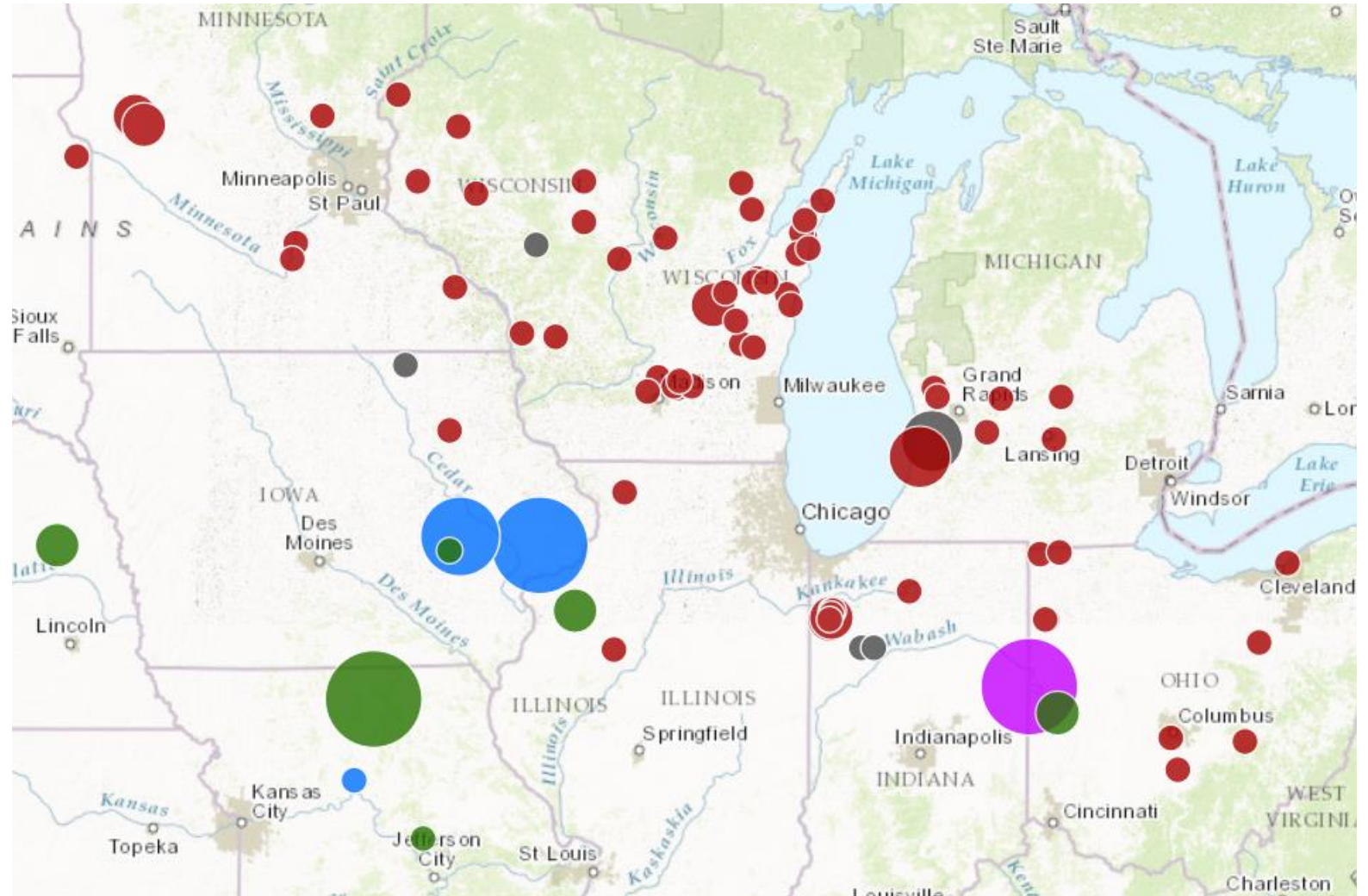
Iowa – 5

Illinois – 3

Ohio – 11

Indiana – 10

Missouri - 3



United States AD Project Stats

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

System Type	Count	Percentage
Plug Flow*	102	42%
Complete Mix	90	37%
Covered Lagoon	35	14%
Induced Blanket Reactor	5	2%
Anaerobic Sequencing Batch Reactor	3	1%
Fixed Film	2	1%
Unknown	5	2%

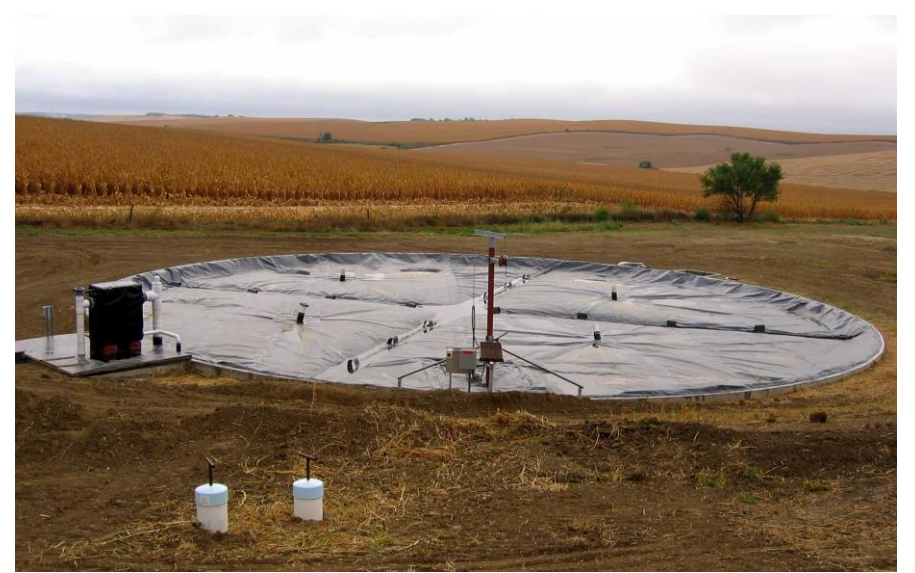
Table 2: End Uses of Biogas in 2015

End Use	Count	Percentage
Combined Heat and Power (CHP)	122	50%
Electricity	82	34%
Boiler/Furnace Fuel	16	7%
Flared Full Time	15	6%
Unknown	7	3%

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

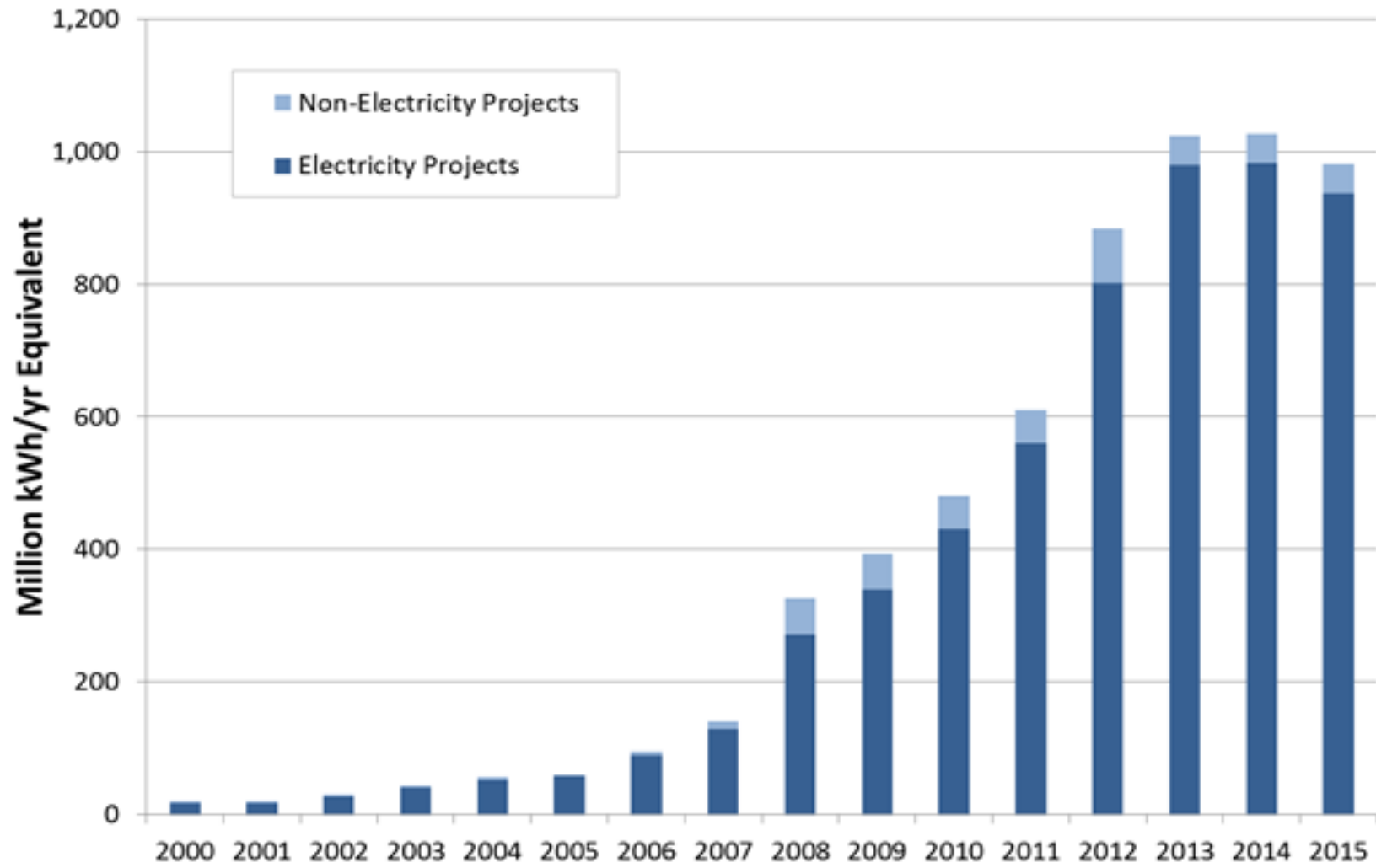


Biogas handling equipment



Nutrient recovery DAF system

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



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.

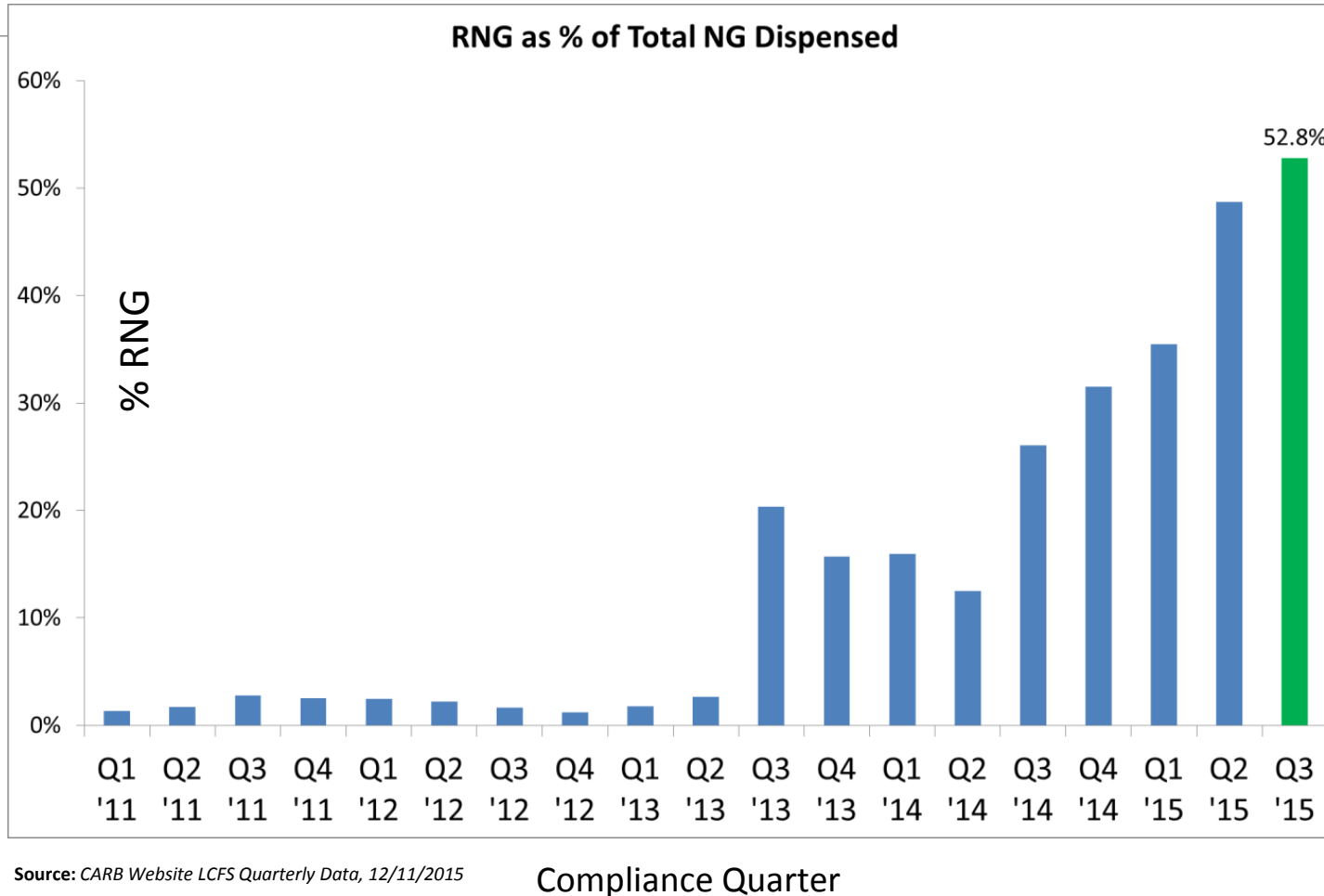
St. Landry Parish and Progressive Waste, LA

- 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)



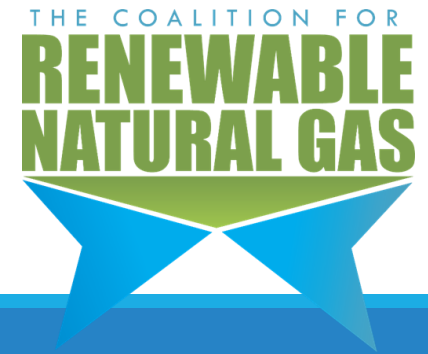
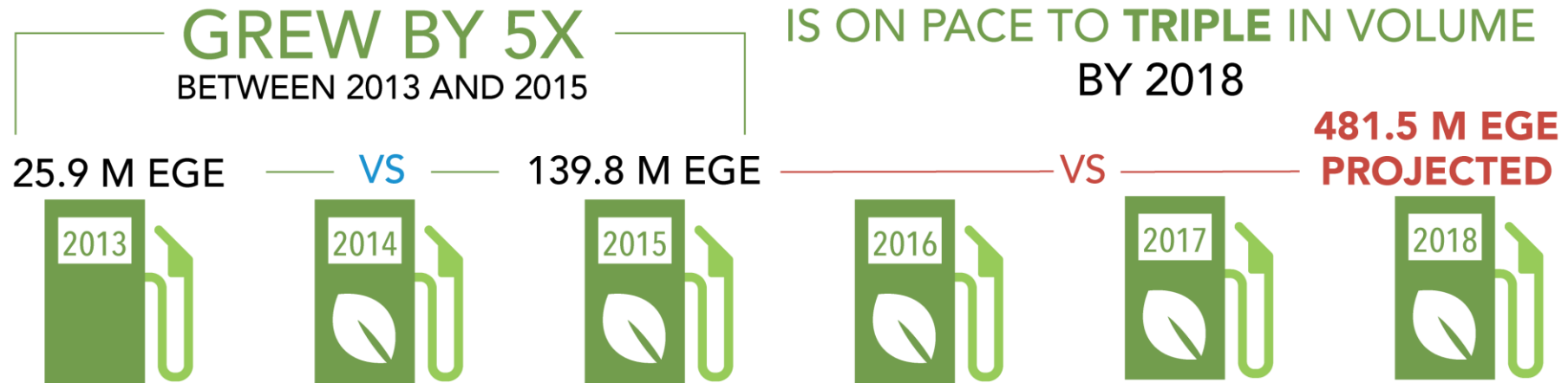
RNG Growth is Significant: Over Half of Natural Gas Vehicle Fuel in California is RNG



Q3 2015:
17.6 MM DGEs
of RNG



RNG PRODUCTION FOR TRANSPORTATION FUEL



EPA Nutrient Recycling Challenge – Phase II



The Nutrient Recycling Challenge



U.S. Environmental Protection Agency



American Biogas Council



NMPF National Milk Producers Federation



Cooper Farms



Marquette University



Tyson Foods, Inc.



World Wildlife Fund



USDA U.S. Department of Agriculture



Smithfield Foods



Dairy Farmers of America



Innovation Center for U.S. Dairy



Water Environment & Reuse Foundation



Washington State University



CowPots



ASABE American Society of Agricultural and Biological Engineers



Ben & Jerry's



Iowa State University



Newtrient, LLC



Cabot Creamery Cooperative



National Pork Producers Council



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

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Photo courtesy of Michigan State University