

Anaerobic Digestion: National Status and Opportunities

Allison Costa

AgSTAR Program Manager, U.S. EPA



Overview

- **Introduction to AgSTAR**
- **Current Status of U.S. Biogas Sector**
- **Additional Details for Livestock AD Sector**
- **Resources & Trends for Biogas Projects**
 - National Mapping Tool
 - Permitting Requirements & Streamlined Processes
 - Diverse Business Models
 - Increased Publicity of AD Projects
 - Increased Activity by States
 - Increased Action by the Federal Government
- **Additional Information**



AgSTAR



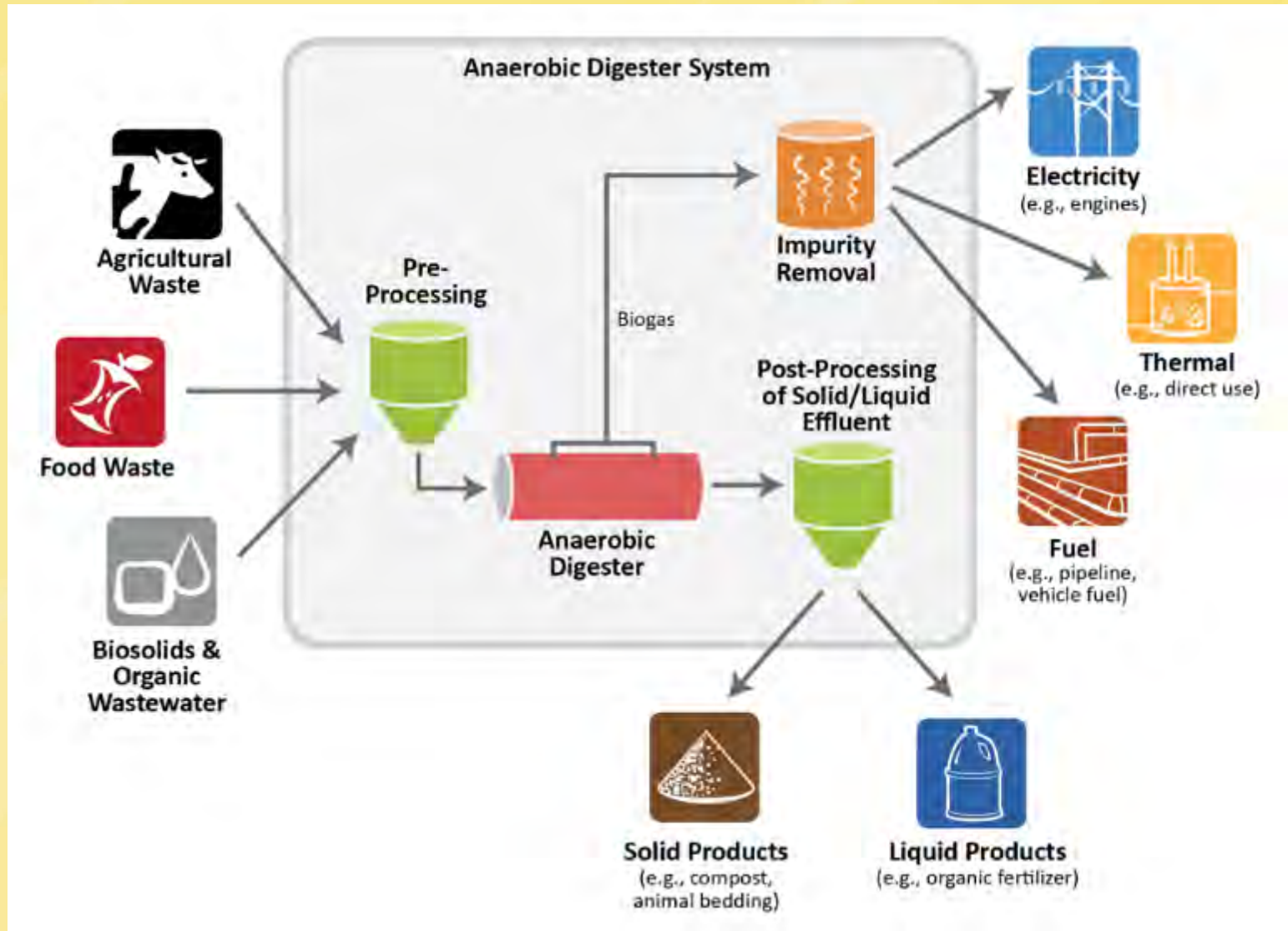
- **Founded in 1994 by U.S. EPA with support from USDA & DOE**
- **Promotes anaerobic digestion (AD) for livestock waste management facilities to reduce methane emissions**
- **Housed in the Climate Change Division**
- **HISTORY:**
 - Demonstration farms & standards development & project development tools →
 - Industry growth & market analysis →
 - State and Regional support
- **Maintain close collaboration with and support from USDA**



Anaerobic Digestion

- Anaerobic digestion is a biological process that occurs when organic matter (in liquid or slurry form) is decomposed by bacteria in the absence of oxygen (i.e., anaerobic). As the bacteria “work,” **biogas** is released, which consists of approximately 60% methane and 40% carbon dioxide.
- This gas can be recovered, treated and used to generate energy in place of traditional fossil fuels.
- The effluent remaining after controlled anaerobic decomposition is low in odor and rich in nutrients.
- Anaerobic digestion systems are often referred to as “anaerobic digesters,” “biodigesters” or “biogas recovery systems.”

Anaerobic Digester Systems



CURRENT STATUS OF U.S. BIOGAS SECTOR



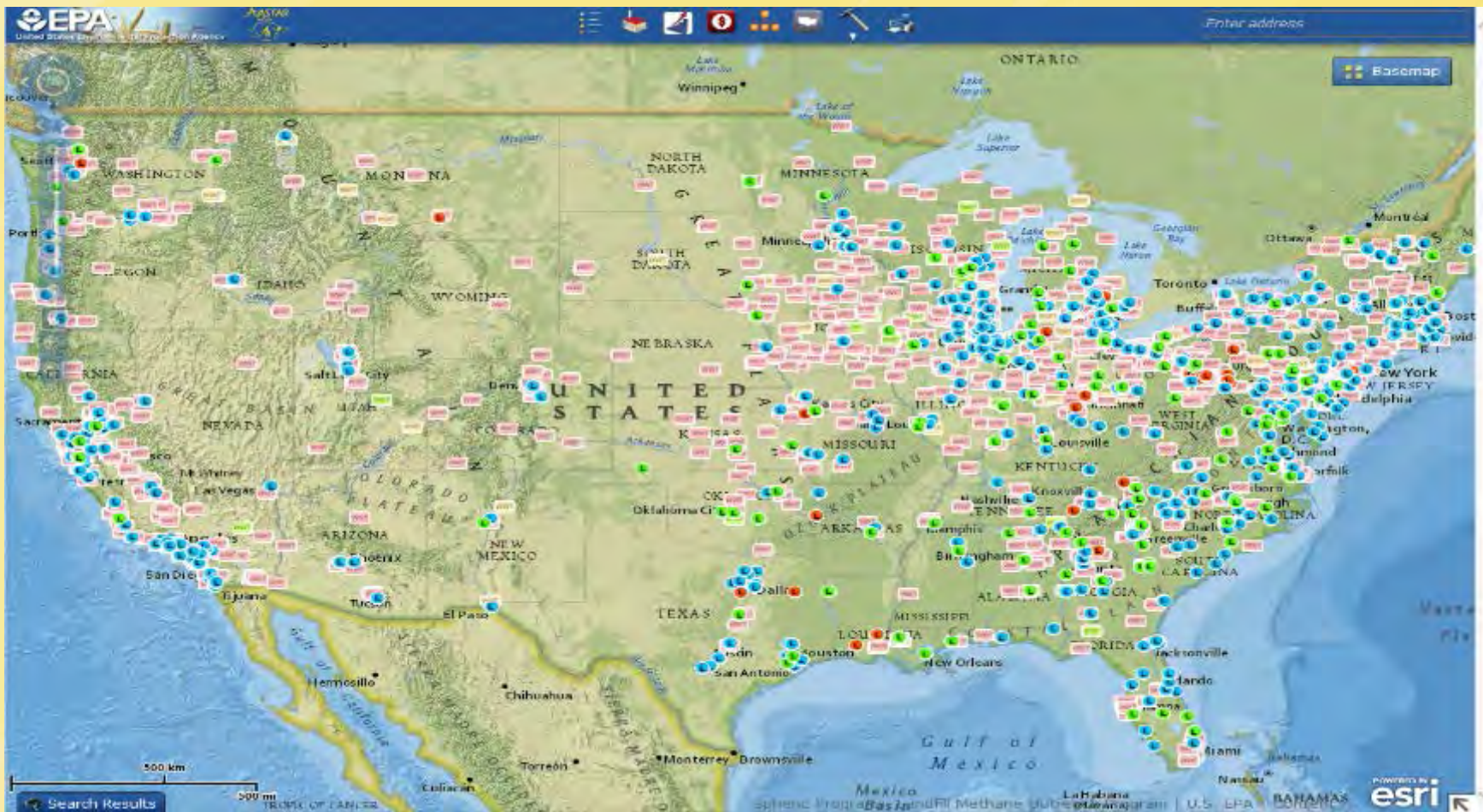
US Biogas Sector: Status & Potential

- **There are vast organic resources available to feed biogas systems in the United States, with the primary feedstock sources being:**
 - livestock manure
 - food waste
 - landfill gas
 - water resource recovery facility biosolids
 - food production residuals
- **Currently, there are 2,000+ projects capturing biogas in these sectors.**
- **There is potential for at least 11,000 additional projects.**

If fully realized, these biogas systems could produce enough energy to power more than 3 million American homes and reduce methane emissions equivalent to 4 to 54 million metric tons of greenhouse gas emissions in 2030, the annual emissions of between 800,000 and 11 million passenger vehicles.

* <http://www.epa.gov/climatechange/Downloads/Biogas-Roadmap.pdf>

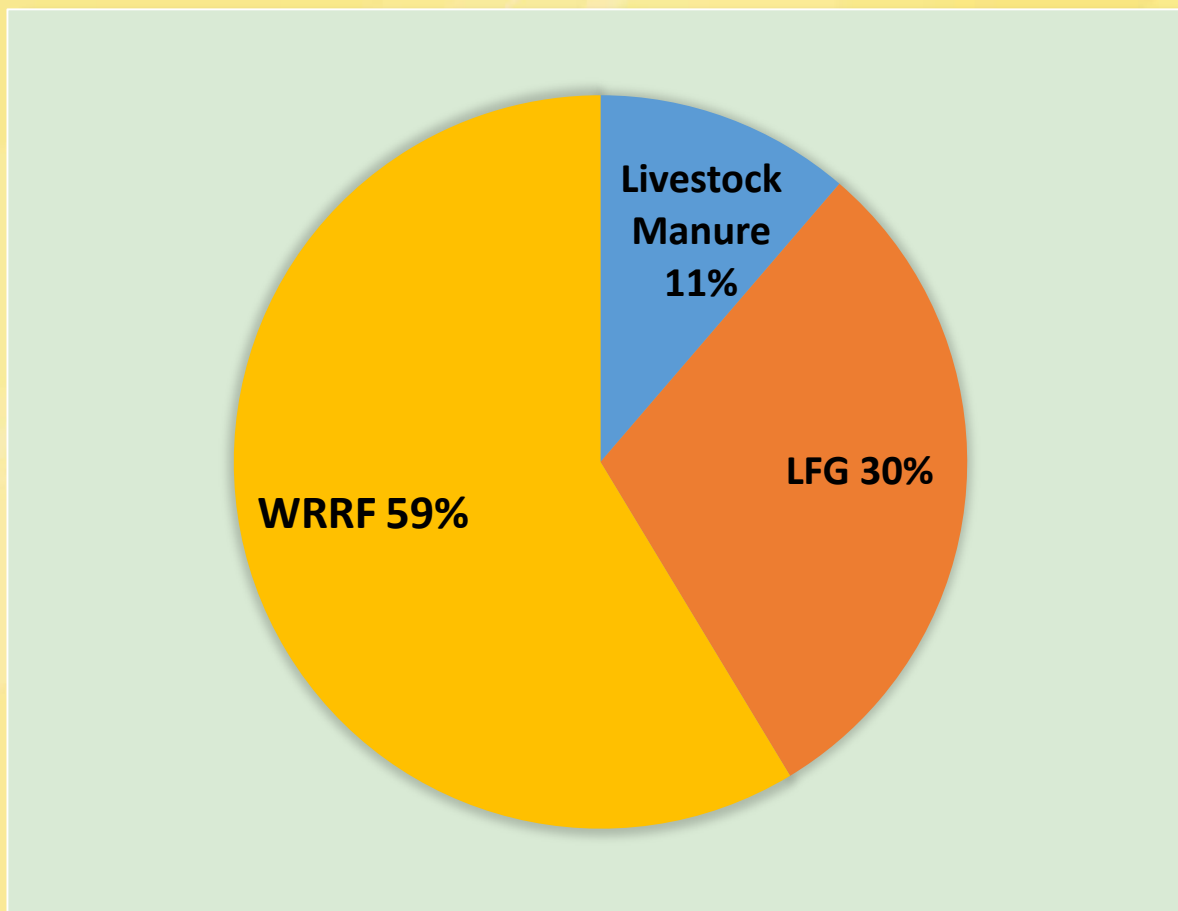
Biogas Recovery Systems Operate in all 50 States



Over 2000 Operating Systems

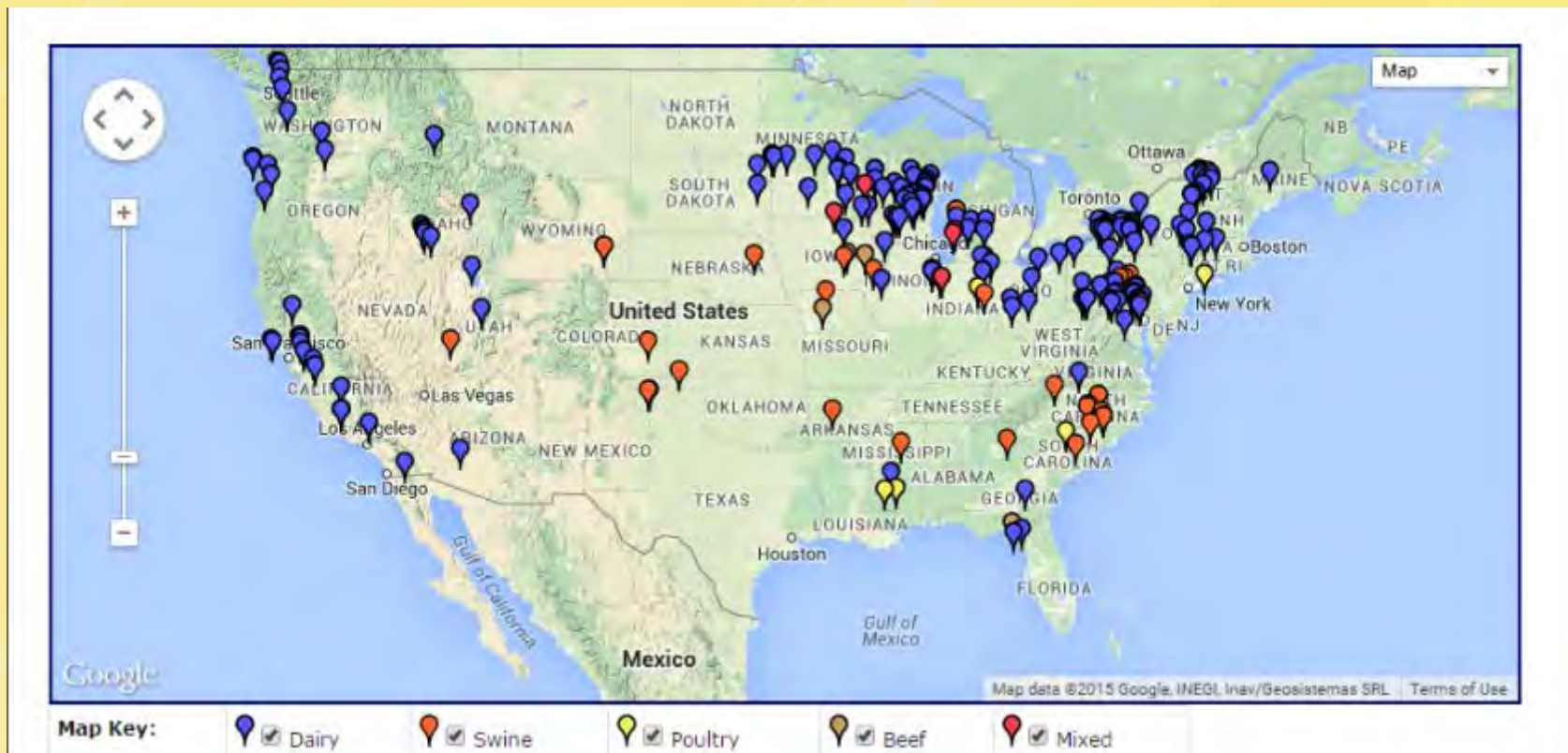
Distribution of Biogas Recovery Systems

- Biogas recovery systems are most common in the wastewater sector, followed by the landfill gas and livestock sectors.



Operational Livestock AD Projects

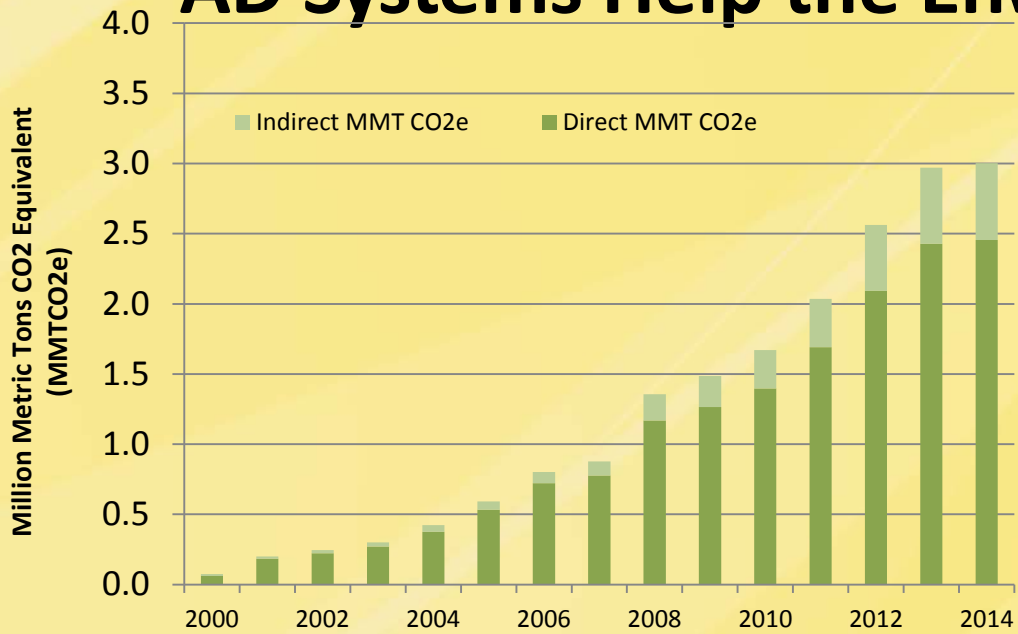
~ 250 projects



* Note: Map reflects operational livestock AD systems as of November 2014.



AD Systems Help the Environment Directly



- AD systems capture and destroy methane, a potent greenhouse gas
- In 2014, livestock AD systems reduced emissions by 3 MMT_{CO₂e}

Emission Reductions Equivalent to:



CO₂ emissions from burning 16,086 railcars of coal

or



Carbon sequestered by ~77,000,000 tree seedlings grown for 10 years

or

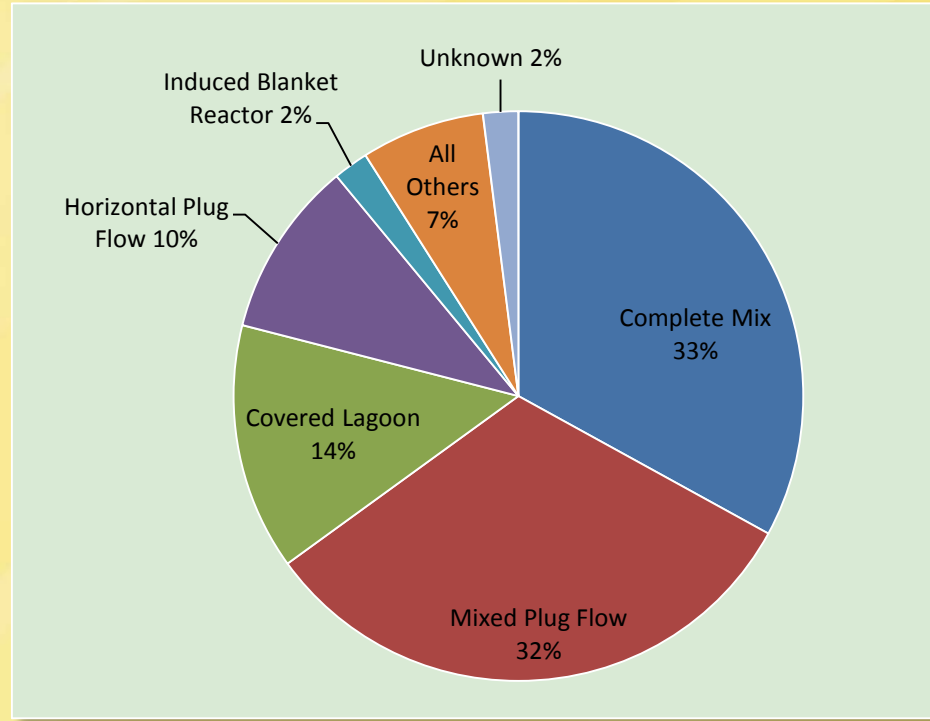


CO₂ emissions from electricity use of 412,655 U.S. homes in one year

Equivalency results calculated at www.epa.gov/cleanenergy/energy-resources/calculator.html

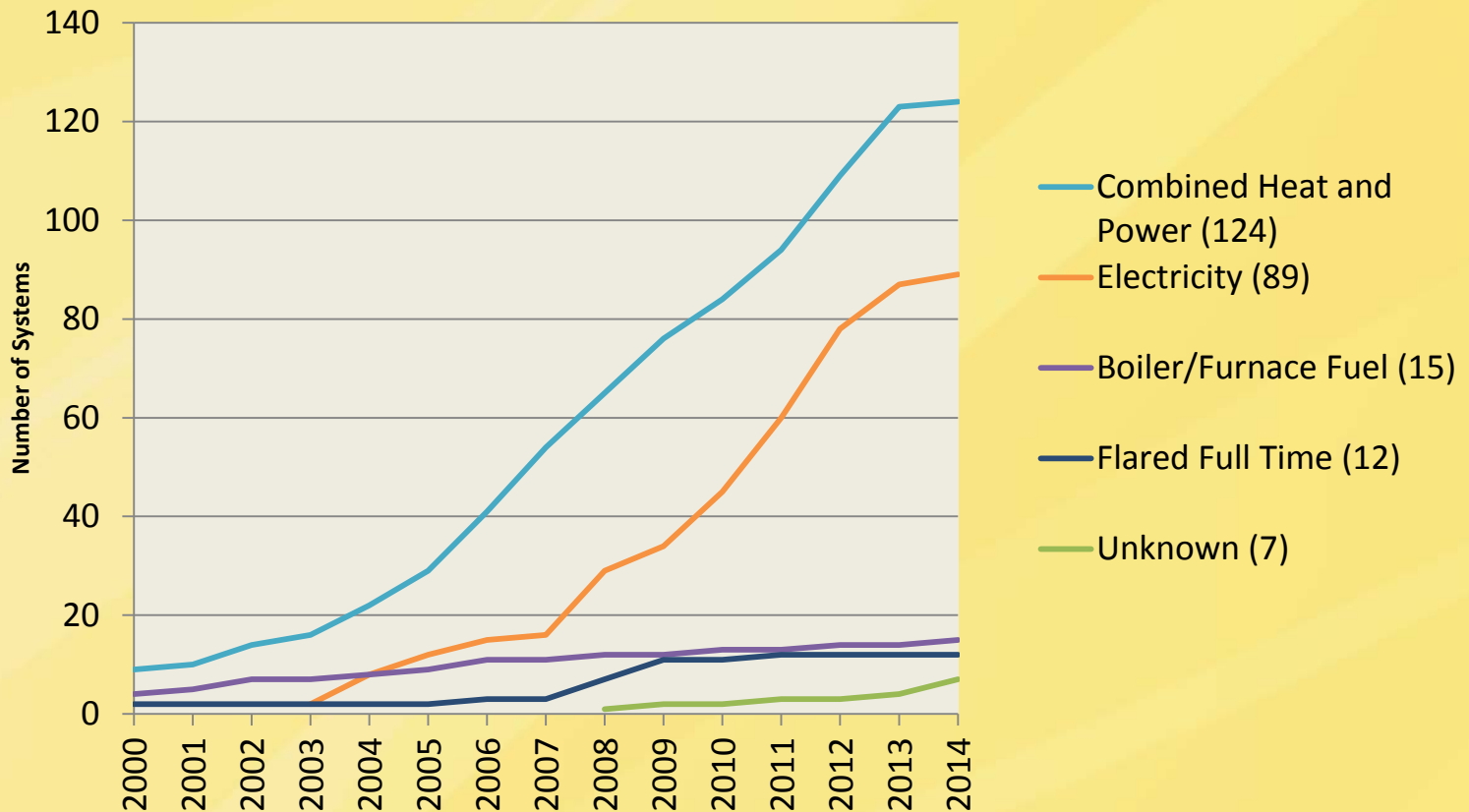
Livestock AD System Technologies

- **Mixed plug flow and complete mix AD systems are the dominant technologies in the livestock sector.**



Livestock AD Biogas Uses

- Combined Heat & Power continues to be the most common end use
- Electricity projects generated 900 million kWh electricity (2014)
- Non-electricity projects generated 40.0 million kWh of electricity equivalent (2014)



Livestock AD Facilities with Codigestion

- Many operational systems use only livestock manure, but a significant number are now designed for codigestion.

Examples of Codigestion Wastes

Food waste

Organic wastes

Wastewater

Substrates

Whey

Grease and other restaurant waste

Off-farm waste

Food industry waste

Mixed biomass

Crude glycerine

Wastes from surrounding community

Lessons from Codigestion Facilities

* Agree on condition for delivered feedstock

* Pre-processing is critical – invest in robust chopping/grinding equipment

* Establish terms for ‘toxic’ feedstocks

* Record-keeping is essential

* Communicate, communicate, communicate

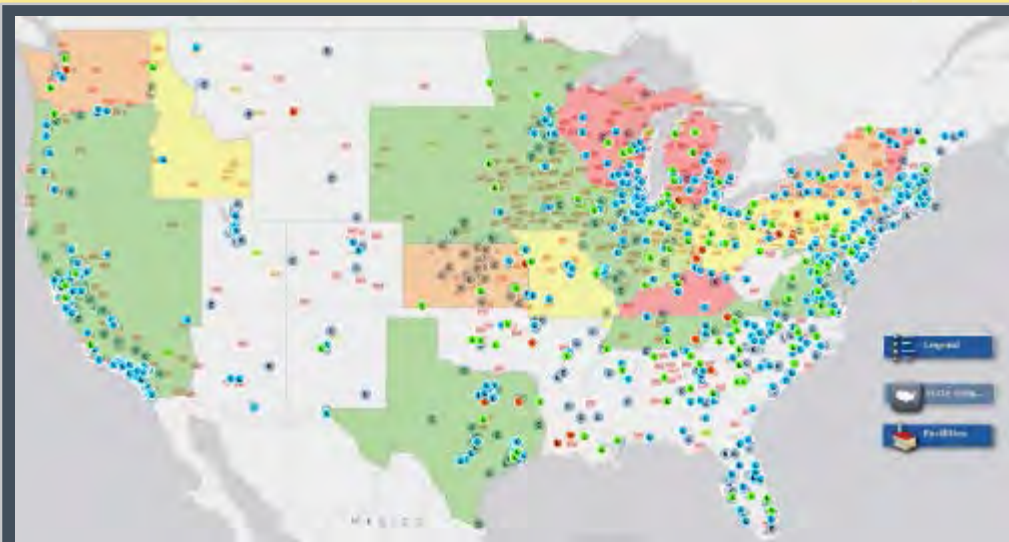
AD in the Food Waste Sector

- **Nationwide, there are almost 60 AD facilities processing (or being constructed to process) food wastes**
 - Stand-alone (municipal) systems: 36
 - Industrial processing systems: 21
- **Additionally,**
 - 25 WWTPs accept (or plan to accept) food waste/FOG
 - 41+ livestock ADs accept food waste
- **22 states have food-only AD facilities**
- **27 states have AD facilities processing food waste**
 - Most: California (19)
 - 2nd Place: Vermont & Massachusetts
- **IL: 1 stand-alone facility under construction**

* Note: all numbers are estimates

TRENDS AND RESOURCES FOR BIOGAS PROJECTS

National Mapping Tool – Big Picture



Biogas Facilities and Federal Investments

Biogas operations at landfills and wastewater treatment plants, composting facilities and state-to-state comparison of federal investments in anaerobic digestion

Dairy Farms and Potential

AD projects on dairy farms and color ramps illustrating potential growth areas based on census data of the U.S. agriculture sector



Livestock AD Codigestion Permitting Requirements by State

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Permitting Practices for Co-digestion Anaerobic Digester Systems

The ability to co-digest manure and organic waste provides digester owners and operators with an opportunity to increase biogas production. Many states have air, solid waste, and water permitting requirements for these systems. As the number of operational systems increases, AgSTAR anticipates requirements will continue to be refined.

Below is an overview of federal regulations and air, solid waste, and water permitting requirements for selected states. These requirements vary by state and change frequently so developers and owners should consult the appropriate State Environmental Agency before construction or operation of an anaerobic digester (AD) system. Proposed changes to state permitting requirements are also provided below.

- Federal Regulations
- Selected State Permitting Requirements
- Proposed Changes to State Permitting Requirements

Federal Regulations

Federal Air Regulations
 State air permits may be required if on-site combustion devices trigger federal emissions thresholds and other federal regulatory permitting requirements. Combustion devices with an emissions below federal thresholds may avoid permitting requirements. Federal air permitting requirements include:

- Internal combustion engines must meet federal emission standards (40 CFR Part 60) for non-road engines. These standards include thresholds (e.g., 250) for nitrogen oxides (NO_x), hydrocarbons, carbon monoxide (CO), and particulate matter (PM). The engine may be certified by EPA to meet the standards or the engine manufacturer may provide a not-to-exceed guarantee.
- Smaller models of spark ignition internal combustion engines must also meet federal regulations (40 CFR Part 60, Subpart 333). These standards include thresholds for NO_x, CO, and volatile organic compounds. Engines greater than 200 horsepower require initial and periodic performance testing; smaller engines require initial testing. Alternatively, engine manufacturers may have engines certified by EPA to meet these requirements.
- Steam generating units constructed after June 19, 1984 and with a heat capacity over 10 million British Thermal Units (BTU) per hour must meet federal requirements which place limits on PM, sulfur dioxide, and NO_x (40 CFR Part 63, Subpart D3 or 40 CFR Part 95, Subpart D3).
- Boilers with a heat capacity over 10 million BTU per hour are subject to National Emission Standards for Hazardous Air Pollutants (40 CFR 63 Subpart DDDDD). Regulated pollutants include PM, arsenic, cadmium, chromium, lead, manganese, mercury, and nickel.

State Permitting Requirements

- California
- Illinois
- Indiana
- Iowa
- Maine
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Montana
- New York
- Ohio
- Oregon
- Pennsylvania
- Texas
- Vermont
- Washington
- Wisconsin

Proposed Changes to State Permitting Requirements

- Georgia
- Maryland
- Nevada

Overview of States Permitting Requirements

State	Air		Solid Waste			Water		
	State Specific Thresholds	RCRA Subtitle D Requirements	Codigestion Requirements	Manure-Liely Exemption	Offsite Waste Acceptance Requirements	NPDES	State CADD Requirements	Codigestion Requirements
California*		✓	✓	✓				✓
Illinois				✓	✓			
Indiana	✓		✓	✓	✓		✓	✓
Iowa				✓				✓
Maine				✓	✓			
Massachusetts					✓			
Michigan	✓		✓	✓			✓	✓
Minnesota			✓	✓			✓	✓
Mississippi								
Montana	✓		✓	✓				
New York			✓					✓
Ohio			✓					✓
Oregon	✓							
Pennsylvania*							✓	
Texas	✓							
Vermont				✓				✓
Washington			✓	✓				✓
Wisconsin			✓					✓

Proposed State Permitting Changes

Proposed Changes to State Permitting Requirements

Some states have proposed changes to existing regulations that could affect the permitting requirements of AD systems. A brief description of the proposed changes is provided below.

Georgia — Permitting is regulated by the Georgia Department of Natural Resources Environmental Protection Division.

GA Solid Waste Permitting

- The proposed amendments to Chapter 391-3-4 include a Solid Waste Handling Permit exemption for facilities that meet "Feedback Category A", which includes agricultural residues that are generated and processed onsite. For the proposed amendments, anaerobic digester facilities are considered to be Class B facilities, which may process category A, B, C, and D feedstocks.

Maryland — Permitting is regulated by the Maryland Department of the Environment (MDE).

MD Solid Waste Permitting

- A recently introduced House bill (HB 1163) concerning anaerobic digestion facilities — said House and said Maryland was reviewed by the MDE. MDE has given its approval (DCE) (2/1/2015). The bill would add new language that would enable MDE to adopt regulations that would place a tiered system of permits or approval for AD facilities based on factors such as type of feedstock and facility size, as well as installation design and operational conditions.



Trend: Streamlined/Consolidated Permitting Requirements

Example: California

California — The state of California implements a consolidated permit process that clarifies the permitting process for dairy digester projects. Several resources specific to dairy digesters are available on the California Environmental Protection Agency's (Cal/EPA) Dairy Digesters website.

CA Air Permitting

- The **California Air Resources Board (CARB)** oversees 35 districts; each district has different requirements depending on location. For example, in San Joaquin Valley, manure AD systems must follow a **permitting process (PDF)** (1 pg, 10K) that includes applications describing the equipment that will be installed with the AD system.
- Combustion devices may require permits if the devices are operating over federal thresholds.
- If organic waste is added, the type of organic waste may cause additional permit requirements.

CA Solid Waste Permitting

- **CalRecycle** is the responsible agency under the Compostable Compostable, the requirements for AD systems are established (which may be up to 10 years annually).
- Facilities with up to 12,500 more than 12,500 yd³ n

CA Water Permitting

- The **California Department of Water Resources** farms in California are in place systems and centralized **Impact Report (PDF)** (21



Trend: Diverse Business Models

New Project Financing Tools

AgSTAR is developing a guide to the major steps to determine financing needs for anaerobic digestion systems.

The guide contains links to fact sheets, calculators, models and other sources of related information.

Examples of Resources Available from the Project Financing Guide

Title	Version
Cost of Renewable Energy Spreadsheet Tool (CREET)	Anaerobic Digestion, version 1.3



Trend: Increased Publicity and Recognition of AD Projects

Recent Industry Awards

- ✓ American Biogas Council (ABC)
- ✓ Innovation Center for US Dairy (ICUSD)

The screenshot displays the EPA AgSTAR website. At the top, the EPA logo and navigation menu are visible. The main content area features a map of the United States with numerous colored markers indicating project locations. Below the map, there is a section titled "Congratulations to Recent Winners of Industry Awards" which lists several organizations that have won awards for their anaerobic digestion systems. The list includes Sensenig Dairy in Kirkwood, PA; Vander Haak Dairy in Lynden, WA; Joseph Gallo Farms in Atwater, CA; Agri ReNew in Stockton, CA (Siewers Family Farms); Lawnhurst Energy, LLC in Stanley, NY; and Michigan State University in East Lansing, MI. A blue ribbon icon is placed next to the list. To the right of the main content, there are sections for "What's New", "Events", and "Frequent Questions".

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Events
Frequent Questions

How do you produce energy from manure? more »
How do I know if anaerobic digestion makes sense for my farm? more »
How are digester projects...

Congratulations to Recent Winners of Industry Awards
AgSTAR would like to congratulate the following organizations with anaerobic digestion systems who recently won industry awards for their operations:

- Sensenig Dairy in Kirkwood, PA
- Vander Haak Dairy in Lynden, WA
- Joseph Gallo Farms in Atwater, CA
- Agri ReNew in Stockton, CA (Siewers Family Farms)
- Lawnhurst Energy, LLC in Stanley, NY
- Michigan State University in East Lansing, MI

Get more details »

Interested in updates? See the AgSTAR Listserve.

USDA provides a number of resources related to anaerobic digesters on US farms. Learn more about Rural Development and Natural Resources Conservation Service resources.

Trend: Increased Publicity and Recognition of AD Projects

Farm Project Profiles

The following profiles highlight operations, lessons learned, and case studies of farm-based anaerobic digesters throughout the United States. As farm-based anaerobic digestion continues to grow, we can learn from past successes, challenges, and opportunities.

Operating Project Profiles
AgSTAR develops brief profiles of farm-based anaerobic digestion systems located throughout the United States and tracked in AgSTAR's project database to promote activities across the country.

Dormant Project Profiles
AgSTAR collects information on several closed facilities. As the use of anaerobic digesters continues to grow and evolve in the United States, closed facilities can offer lessons learned to those operating or planning for anaerobic digestion on a farm.

Other Project Case Studies
AgSTAR and other anaerobic digestion stakeholders have developed additional case studies with information on operations, outputs, benefits, challenges, and opportunities to further support understanding of anaerobic digestion projects on the farm.

Operating Project Profiles

AgSTAR compiled several examples of farm projects that utilize different digester types, animals, and have varying outputs.

Farm/Project Name	State	Digester Type	Animal Type
Baldwin Dairy (PDF)	WI	Modified Mixed Plug Flow	Dairy
Clover Hill Dairy, LLC (PDF)	WI	Mixed Plug Flow	Dairy
Foster Brothers Dairy Farm / Clear Horizon LLC (PDF)	WI	Complete Mix	Dairy
Rye Star Dairy Farm (PDF)	WI	Complete Mix	Dairy
Gardendale Farms (PDF)	WI	Mixed Plug Flow	Dairy
Green Valley Dairy (PDF)	WI	Complete Mix	Dairy
Holsum Dairy - Irish Road (PDF)	WI	Mixed Plug Flow	Dairy
Holsum Dairy - Irish Road (PDF)	WI	Mixed Plug Flow	Dairy
Marsden Farms (PDF)	WI	Complete Mix	Dairy
Sunrise Dairy (Formerly Suning Community Dairy) (PDF)	WI	Complete Mix	Dairy
Van Cleef Farms (PDF)	WI	Complete Mix	Dairy
Wild Horse Dairy (PDF)	WI	Complete Mix	Dairy

Farm Project Profiles

- ✓ Operating Project Profiles
- ✓ Dormant Project Profiles
- ✓ Other Project Case Studies

Trend: Increased Action by States

Organics Diversion Policies: CA, VT, MA, RI, CA
+ Austin, NYC, Portland, San Francisco, Seattle

- 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



Trend: Increased Action by the Federal Government

Climate Action Plan:

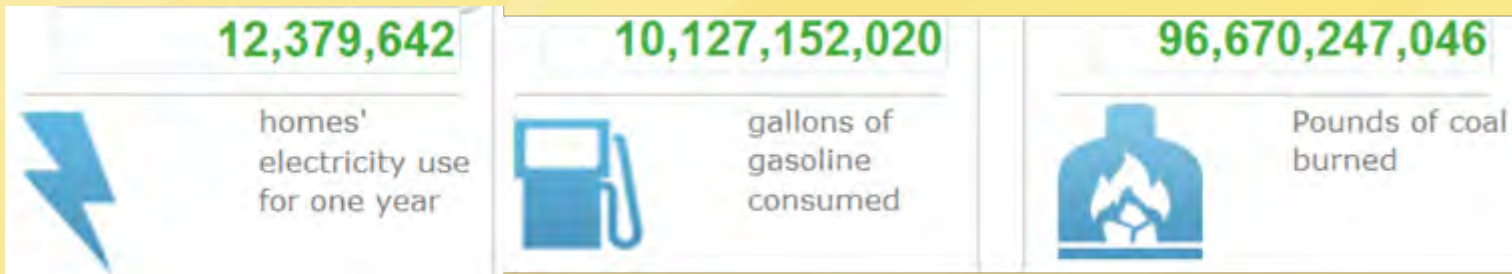
- **President Obama released a Climate Action Plan in June 2013.**
- **The plan's 3 key pillars contain actions to:**
 - Cut domestic GHG emissions.
 - Prepare the U.S. for the impacts of climate change.
 - Continue U.S. leadership in international efforts to combat global climate change.
- **Supports Administration's climate goal:**
 - Reduce U.S. GHG emissions in the range of 17% below 2005 levels by 2020.



Trend: Federal Action

Strategy to Reduce Methane Emissions

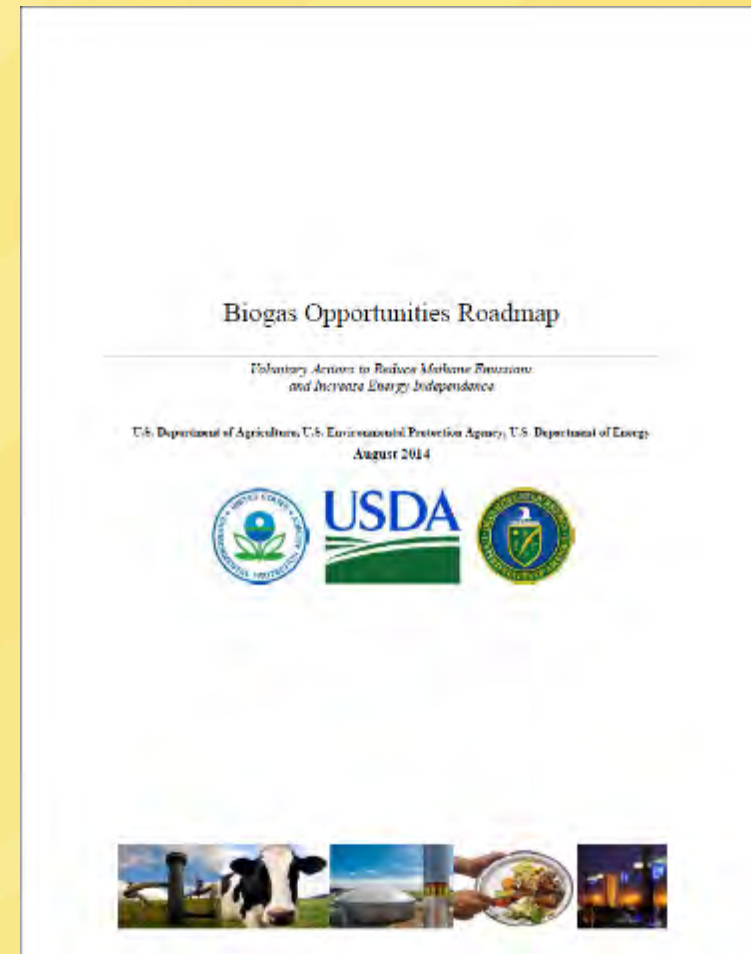
- The Climate Action Plan called for the development of an interagency methane strategy, which was published in March 2014.
- *Why focus on methane reductions?*
 - Methane is a powerful GHG.
 - The recovery and use of methane provides many important co-benefits (economic, public health, & safety).
 - Low-cost technologies and best practices are already widely available and used in key sectors.
- The steps in this strategy could potentially reduce GHG emissions up to the equivalent of 90 million metric tons of carbon dioxide in 2020, which is equivalent to:



Trend: Federal Action

Biogas Opportunities Roadmap: Voluntary Actions to Reduce Methane Emissions and Increase Energy Independence

- Action item from Interagency Methane Strategy; published in August 2014.
- Jointly developed by USDA, DOE and EPA in conjunction with the American Biogas Council & Innovation Center for US Dairy.
- Goal: Stimulate expanded use of biogas systems by leveraging resources of multiple government agencies.



Biogas Opportunities Roadmap

Purpose:

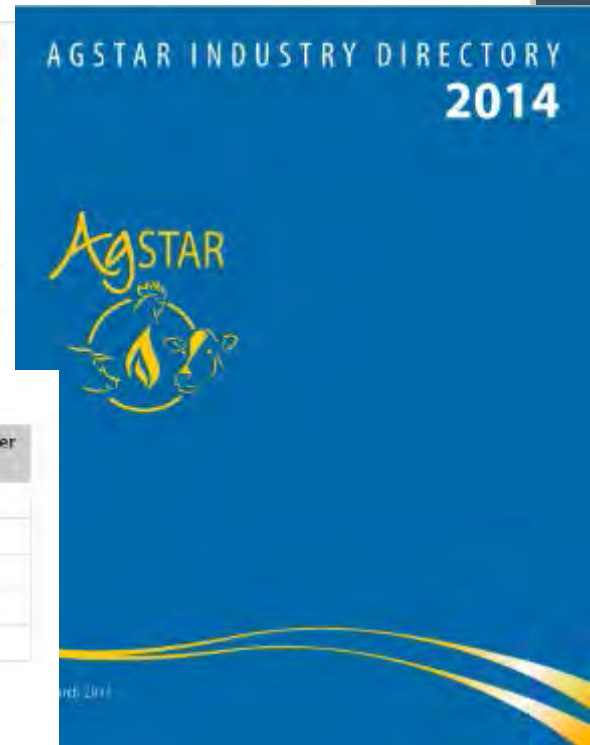
- Encourage interagency collaboration.
- Bring attention and legitimacy to emerging technologies to help attract greater private sector investment.
- Identify government program modifications & research needs that could enhance the rate of growth of these systems.

Areas of Focus:

- Promoting biogas utilization through existing agency programs;
- Fostering investment in biogas systems;
- Strengthening markets for biogas systems and system products; and
- Improving communication and coordination.

Additional Resources

- ✓ Listserv messages
- ✓ Vendor Directory
- ✓ Livestock Anaerobic Digester Database



Anaerobic Digester Database

(last updated January 2015)

The Excel spreadsheet below provides basic information for anaerobic digester systems in the United States. The spreadsheet has multiple tabs to show the following:

- Operational Digesters and Digesters Under Construction
- Shut Down Projects
- Operational Beef Projects
- Operational Dairy Projects
- Operational Poultry Projects
- Operational Swine Projects
- Count of Operational Projects by Animal Type

Download XLS viewer [EXIT.PDF \(viewer\)](#)

Comprehensive Livestock Digester Database (XLS) (xls)

Farm Type	Number of Digester Projects
Beef	8
Dairy	202
Mixed	6
Poultry	7
Swine	39



Additional Information

www.epa.gov/agstar

agstar@epa.gov

