



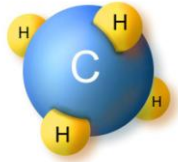
Advancing Energy Independence with Environmental Benefit: *Livestock Manure Digesters*



Chris Voell, National Program Manager
AgSTAR
Washington, DC

AgSTAR Mission

- Voluntary effort of the USEPA jointly sponsored by USDA – since 1993.
- The program encourages the use of methane capture and use (manure digester systems) at US livestock farms.
- These systems reduce methane emissions, achieve other environmental benefits, and generate energy.



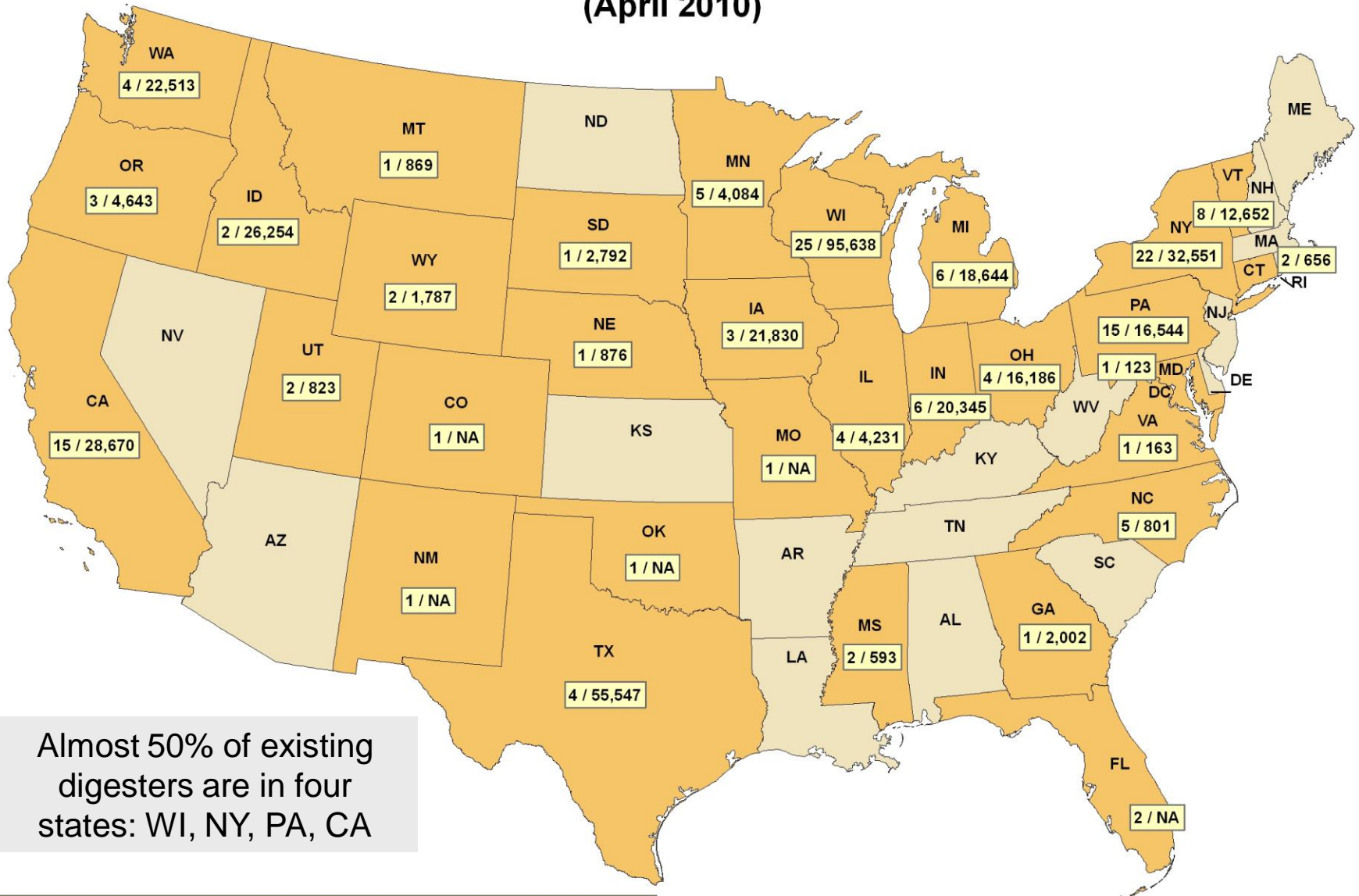
Methane

- Methane is the second most important GHG behind CO₂
 - **Methane emissions currently contribute 1/3 of all anthropogenic (man-made) climate forcing**
- Great source of energy
 - Mitigate greenhouse gasses with potential for ROI
 - Many opportunities to recover (livestock, energy, and waste sectors)

Why advance manure digester systems?

- Assist US farmers in:
 - Developing opportunities for **next-generation** on the farm;
 - Renewable energy generation, greenhouse gas reduction, value-added products, and nutrients
 - Expanding opportunities for **rural economic development** and **diversified revenues**
 - Protecting and **conserving natural resources** and **reducing greenhouse gas** emissions; and
 - Producing **renewable energy** and **‘green’** products.

Operating Manure Digesters (April 2010)



Almost 50% of existing digesters are in four states: WI, NY, PA, CA

Number of Operating Projects / Estimated Energy Production (MWh/yr equivalent)
 Total Operating Projects: 151
 Total Estimated Energy Production: 392,000 MWh/yr equivalent

US Operating Digester Overview

Digester Technology		Digesters by Animal Type	
Plug Flow/Modified PF	76	Dairy	107
Complete Mix	36	Swine	19
Covered Lagoon	21	Layers	3
Other		Beef	2
- Induced Blanket Reactor	2	Duck	2
- Fixed Film	1	Beef and Poultry	1
		Broiler	1
Total – 135			
Biogas Use			
Co-generation (electricity and heat)	78		
Electricity	27		
Boiler/Furnace Fuel	14		
Flare Only	6		
Pipeline Upgrade	4		
Vehicle Fuel	1		
- 12 projects have a combination of uses			
- Five projects do not have a use identified			

US Livestock Industry

- Animal Numbers*
 - Swine: 68 million
 - Dairy cows: 9 million
 - Poultry: 2 billion (broilers, layers, turkeys)
- Total Manure Excreted**
 - Dairy cows: 246 million tons/year
 - Swine: 97 million tons/year
 - Poultry: more than 88 million tons/year
 - **More than 430 million tons/year**

* Based on USDA Census of Agriculture (2007)

** Based on USDA NRCS Ag Waste Management Handbook (2008)

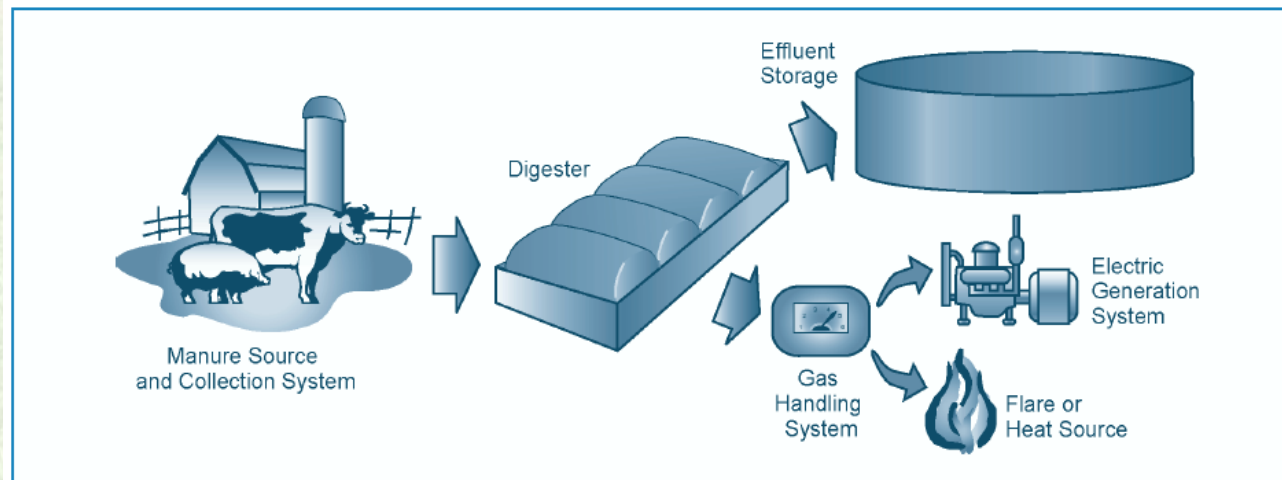
Digester Market Opportunity*

- Candidate Dairy/Hog Farms
 - ~4,000,000 dairy cows on 2,600 farms
 - Manure: 106 million tons/year
 - ~48,000,000 hogs on 5,500 farms
 - Manure: 68 million tons/year
- Energy Potential
 - 13,000,000 MWh/yr OR 150 billion cubic feet methane per year
 - Enough electricity to power 870,000 households
 - Enough methane to heat 3 million households

* Based on EPA AgSTAR Market Opportunities Report (2010)

What are manure digesters?

- Anaerobic digestion is a biological treatment and stabilization process that consumes organic matter in an oxygen-free environment.
- Manure Digester “**Systems**”:
 - Collect and combust off-gases from liquid, slurry, and semi-solid waste;
 - Separate manure treatment from storage functions, which can result in lower initial installation costs for new or expanding farms; and
 - Could include nutrient treatment component.



Digester Types

Mixed Tank (CSTR)



Covered Lagoon



Anaerobic Sludge Blanket
Attached Media



Plug Flow



Barham Farms, Zebulon, NC



"I want my operation to produce and exist without my neighbors even knowing I'm there. And I want to leave the environment in better shape than I found it."

Julian Barham, speaking about the environmental benefits of the covered lagoon digester at his 4,000-sow farrow-to-wean operation in North Carolina

Geerlings Hillside Farms, Overisel, MI

8,000 wean to finish, Two I-Power 65 kW generators



Eagle Green Energy, Inc.

Brinson Farm Digester Complex

Liquid fertilizer tank

Digester tank

Generator, Lab and Process monitoring

Poultry houses

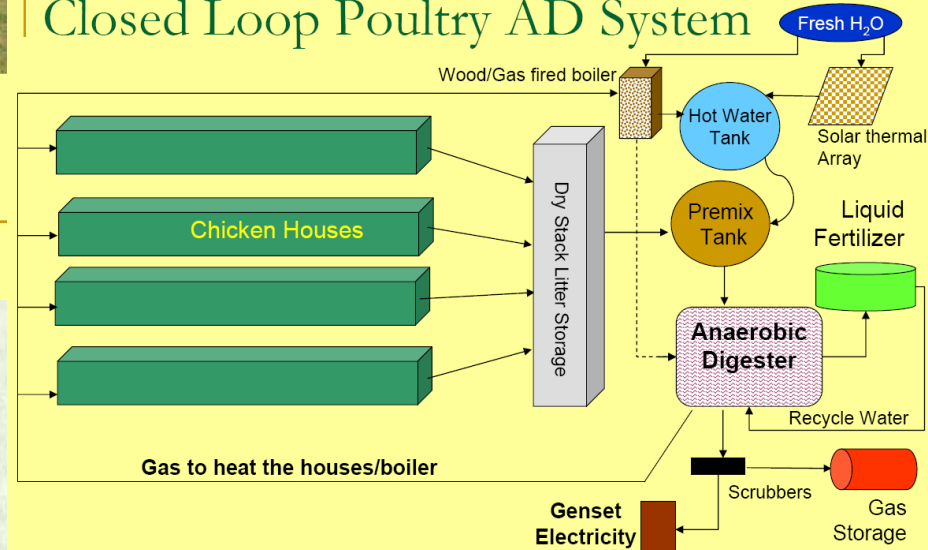


Solar Thermal Array

Scrubbed methane gas storage

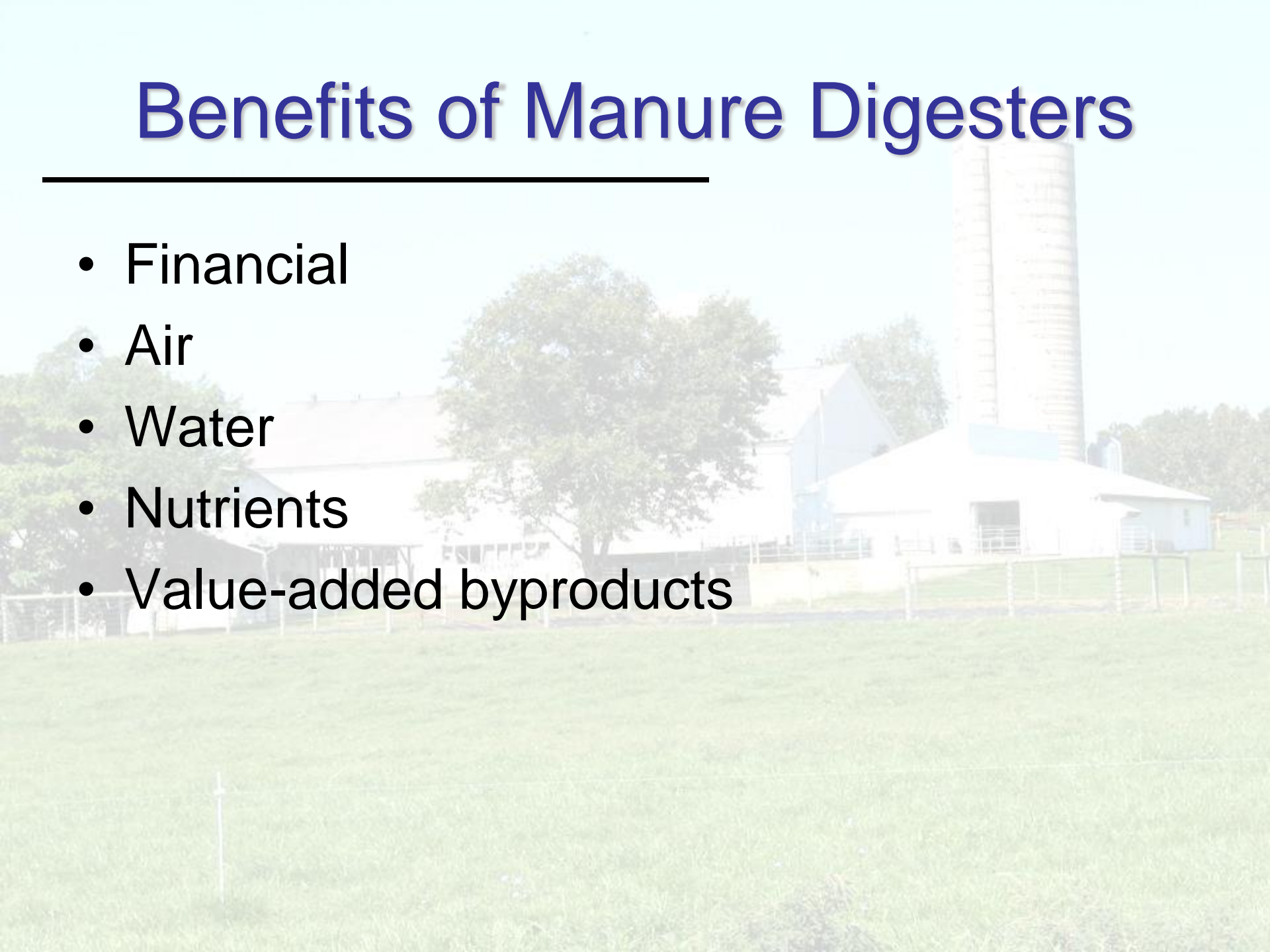
Patent Pending

Closed Loop Poultry AD System



AD Technology proved on dairy and swine farms worldwide and experimental poultry unit operational for four years in the US.

Benefits of Manure Digesters

- Financial
 - Air
 - Water
 - Nutrients
 - Value-added byproducts
- 
- A photograph of a farm scene. In the foreground, there is a lush green field. In the middle ground, a large white barn with a blue roof is visible. To the right of the barn, a tall, cylindrical metal silo stands prominently. The background shows more trees and a clear sky.

Financial

- Waste management system with potential for return on investment
 - Reduce on-farm energy purchases (electricity, natural gas, propane, fuel, etc.)
 - Energy revenues
 - Electricity or biogas sale
 - Fiber use or sales (primarily dairy manure)
 - Tipping fees for neighbor's manure or other organic wastes (co-digestion of other organic wastes)
 - Carbon credits
 - Reduce purchase of bedding (dairy) and sale
 - Reduce purchase of commercial fertilizers and sale

Air Quality

- Significant reduction of odors from storage and field application
- Reduce greenhouse gas emissions (methane)
- Control other emissions (H_2S , ammonia, VOCs)
- Offset vehicle emissions from transportation (bedding, fertilizer)

Water Quality

- Stabilize manure organics (reduce BOD/COD)
- Significantly reduce pathogens
- Reduce rainwater intrusion
- Allow for more appropriate fertilizer application timing
- Alternate disposal option for organic waste streams (whey, food processing, etc.)

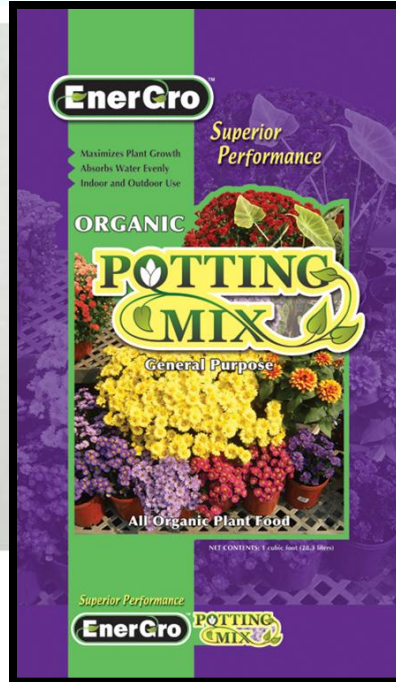
Value-Added Benefits

- Opportunities for manure fiber use.
 - Bedding, horticulture products, building materials, pelletized fertilizer, soil amendments and compost
- Increased organic fertilizer use on- and off-site
 - Reduced fossil fuel-based fertilizer production and consumption

Value-Added Byproducts



Fiberboard/Decking



Building Materials

Cow Pots



Horticulture – soil/peat replacement

Parameter	Impact
Odor	Substantial reduction
Greenhouse gas emissions	<p>Methane—substantial reduction (19,300 tons per yr on a carbon dioxide equivalent basis)</p> <p>Carbon dioxide—669 tons per yr associated with the reduction in fossil fuel use to generate electricity</p> <p>Nitrous oxide—No increase or decrease from the baseline of 0</p>
Ammonia emissions	No significant reduction
Potential water quality impacts	<p>Oxygen demand—substantial reduction (~15,600 lb per yr)</p> <p>Indicator organisms and potentially pathogens—significant reduction (Fecal coliforms: ~90%) (Fecal streptococcus: ~75%)</p> <p>Nutrient enrichment—no reduction</p>
Energy production and utilization	<p>Biogas captured—118,503 ft³/day</p> <p>Biogas utilized—76,076 ft³/day</p> <p>Biogas energy produced—82.7x10⁶ Btu/day</p> <p>Biogas energy utilized—53.1 x10⁶ Btu/day</p> <p>Electricity generated—4,172 kWh/day</p>
Economic impact	<p>Significant increase in net farm income (~\$108,000 per year after recovery of capital invested in 6.6 years)</p>

Summary Results:

AN EVALUATION OF A COVERED ANAEROBIC LAGOON FOR FLUSHED DAIRY CATTLE MANURE STABILIZATION AND BIOGAS PRODUCTION

March 2008

**Digesters do
not solve
nutrient issues!**

Nutrient Management

- Digesters do not solve nutrient issues, however...
 - Anaerobic digesters provide energy (methane) that could help drive nutrient treatment/removal systems (electricity, heat, fuel, mechanical)
 - Better manure feedstock for treatment technologies (post-digestion)
 - More homogenous
 - Altered composition of manure
 - With solids separation, easier transport of N and P in solids fraction
 - Better crop/land application
 - More consistent product
 - More 'plant-available' nitrogen (must be applied properly) – more predictable uptake
- Critical component of a 'system'



USDA/EPA Cooperation

- Interagency Agreement signed by USDA Secretary Vilsack and EPA Administrator Jackson on May 3, 2010.
- *“This is a smart way to transform what would be a harmful greenhouse pollutant into a source of renewable energy -- and make a profit for American farmers,”* said EPA Administrator Lisa P. Jackson.
- *“The farms and ranches that dot our countryside can contribute greatly to addressing America’s long-term energy challenges and the partnership we are announcing today will not only help generate renewable energy, but provide new income opportunities for farmers and ranchers,”* said Agriculture Secretary Tom Vilsack.



USDA Funding for Digesters

- Conservation Loan Program (FSA)
- Environmental Quality Incentives Program (NRCS)
- Conservation Innovation Grants (NRCS)
- Rural Energy for America Program – feasibility studies, grants, loan guarantees (RD)
- Business and Industry Loan Guarantees (RD)
- Value Added Producer Grants (RD)
- Electric Loan Program (RD-RUS)
- Sustainable Agriculture Research and Education Funding Opportunities (NIFA)

Funding On-Farm Biogas Recovery Systems: A Guide to Federal and State Resources, which is available at www.epa.gov/agstar/resources/funding.html.



FPFC

Farm Pilot Project Coordination, Inc.
Technologies for Nutrient Management

About FPFC

FPFC Mandate

FPFC's specific mandate is to oversee the implementation and administration of a Pilot Project Program to demonstrate economically viable innovative treatment technology systems that reduce the nutrient content of the waste stream from AFOs by 75 percent or greater. Funding for approved Pilot Projects comes from monies appropriated by Congress and overseen by the **Natural Resource Conservation Service (NRCS)**, a division of the **United States Department of Agriculture**.

- Dairy, swine, and poultry manures
- Various technologies
- Reports, videos
- www.fppcinc.org



Cow manure dried in vacuum bed for minimal weight transportation, liquid used as fertilizer

White Technologies, Inc. and North Florida Holstein

- FPPC has funded a vacuum dewatering project in Bell, Florida at North Florida Holstein dairy. This large facility is undergoing initial start up and commissioning.



Cow manure separated into solids, liquids and gas

Agricultural Waste Solutions & Inland Empire Utilities Agency

- FPPC has worked with Agricultural Waste Solutions to test a gasification system on a municipal water site in Chino, California. This system is currently being evaluated against the anaerobic digester on site for efficiency comparison.



Converting swine and cow manure into fuel and fertilizer

Phase 3 Development & Investment, LLC and the Geerlings Hillside Farm

- This project is installed on a swine facility in Overisel, Michigan. FPPC is working with Phase 3 to measure performance of the integrated technologies and the anaerobic digester on site.



Poultry waste becomes revenue generating fertilizer

R&J Partnership & Creekwood Farms

- Creekwood Farms is a layer operation in Lake Mills, Wisconsin. R&J Partnership is working to test and develop in-vessel composting that will yield organic fertilizer from both poultry litter and mortalities.

● Phase 3 Developments & Investments, LLC.

● Status: **Complete**



Geerlings Hillside Farm
Overisel, Michigan



FINAL REPORT: Phase 3
Developments



Farm description/project location:

This project utilizes mixed animal waste from both swine and dairy. A series of waste treatment technologies (i.e. screw press and dissolved air flotation) have been integrated with an anaerobic digester to provide a complete system. Ultimately producing electrical power may be incorporated at a later date. The pelletization and transport of nutrients off site to organic fruit farms and other potential end users also takes place.

AgSTAR Resources

- **General Outreach**
 - Annual AgSTAR Conference, AgSTAR Digest newsletter, Farm Extension Events, Workshops
- **Project Development**
 - *Managing Manure with Biogas Recovery Systems*
 - *Industry Directory*
 - *Funding Guide for Federal and State Resources*
 - *Market Opportunities for Biogas Recovery Systems*
- **Technical Analysis**
 - A Protocol for Quantifying and Reporting the Performance of Anaerobic Digestion Systems for Livestock Manures
 - Mass Balance Waste Management Evaluations
 - Dairy and Pig Manure Case Studies
- **Project Evaluation Tools**
 - AgSTAR Handbook - A Manual for Developing Biogas Systems at Commercial Farms in the United States
 - FarmWare - develops project specific feasibility assessments



Free Screening for Farms

- Dairy/swine farms
- Preliminary look at incorporating AD on your farm
- Can follow-up with more in-depth pre-feasibility assessment

Online at:

<http://www.epa.gov/agstar/projects/dairy.html>

<http://www.epa.gov/agstar/projects/swine.html>

AgSTAR
An EPA Partnership Program

You are here: EPA Home » AgSTAR Home » Ad Screening Form: Dairy Facility

Ad Screening Form: Dairy Facility

1. Farm Location and General Information

* Farm Name: * Contact Person:

Company Name (if applicable):

Phone No.: * Email:

Farm Address: * County:

2. Livestock Population

If the farm is divided into different sites, please use a different screening form for each site.

Milking Herd	* Average Number	Milk production, lb per cow-day
Lactating	<input type="text"/>	<input type="text"/>
Dry	<input type="text"/>	<input type="text"/>

Replacement Herd	* Average Number	Average weight, lb
Calves	<input type="text"/>	<input type="text"/>
Replacement heifers	<input type="text"/>	<input type="text"/>

3. Method of Confinement and Manure Storage

Please indicate hours per day in each type of confinement facility.

	Milking center	Flushed barn	Scraped barn	Flushed outdoor lot	Scraped outdoor lot	Pasture
* Lactating cows	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
* Dry cows	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
* Calves	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
* Heifers	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

* Do you separate manure solids? No Yes If so, how?

* How do you store manure and how often do you remove it?



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New to anaerobic digestion? Let [AD 101](#) walk you through a biogas recovery system. (Photo: GE Energy, Jenbacher gas engines)

[1](#) [2](#) [3](#)

U.S. Environmental Protection Agency's AgSTAR Program is a voluntary outreach and educational program that promotes the recovery and use of methane from animal manure.

[More About US](#) »



EPA and USDA Team Up

Administrator Lisa P. Jackson, US EPA, and Secretary Tom Vilsack, USDA, announced a new interagency agreement promoting renewable energy generation and slashing greenhouse gas emissions from livestock operations.

[More Information](#)

What's New



Methane to Markets

[Energy more »](#)

September 15, 2010
- 36 Governments to Meet in Mexico on Greenhouse Gas Reductions, Clean

June 14, 2010 - Spring Digest Available [more »](#)



May 25, 2010 - AgSTAR Conference Presentations Are Posted. [more »](#)

Events

Frequent Questions

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





You are here: [EPA Home](#) » [AgSTAR Home](#) » [Projects](#)

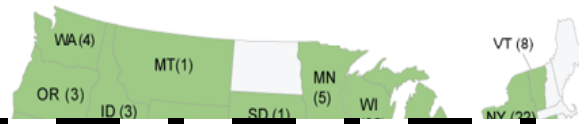
Projects

Operating Anaerobic Digester Projects

As of July 2010, AgSTAR estimates that there are 157 anaerobic digester systems operating at commercial livestock farms in the United States. The [AgSTAR database](#) provides more detailed information about operating projects.

Number of Operating Digesters | Total Energy Production Number of Operating Digesters (July 2010)

Select a state for a list of operational digester projects.



Farm Project Profiles

Anaerobic digester systems can be installed successfully at operations that collect manure as a liquid, slurry, or semi-solid. Existing farms use a variety of different types of digester designs and energy use technologies. Details about operating projects can be reviewed by clicking on a state in the above map or the full list of operating projects is available [here \(XLS\)](#) (80K, [Download XLS Viewer](#) [EXIT Disclaimer](#)). In-depth profiles of select projects are available [here](#).

[↑ Top of page](#)

Anaerobic Digester Database

(last updated July 2010)

The Excel spreadsheets below provide basic information for anaerobic digester systems in the United States. The spreadsheets show projects in the following stages: construction, operational, shutdown, and cancelled. [Download XLS viewer](#) [EXIT Disclaimer](#).

- [Anaerobic digesters, sorted by operational status and by state \(XLS\)](#) (106K)
- [Operational anaerobic digesters, sorted by state \(XLS\)](#) (80K)
 - [Dairy projects \(XLS\)](#) (69K)
 - [Swine projects \(XLS\)](#) (31K)
 - [Poultry \(XLS\)](#) (24K)
 - [Beef cattle \(XLS\)](#) (38K)

Farm Type	Number of Digester Projects
Dairy	126
Swine	24
Poultry	5
Beef	2

These data were compiled from a variety of sources. AgSTAR cannot guarantee the accuracy of these data. AgSTAR encourages farm operators, project developers, financiers, and others involved in the development of farm digester projects to provide updates and corrections to these data by [contacting AgSTAR](#).

Major Hurdles

- State, Federal and Coop/Utility Energy Policies
 - Tariffs/rates
 - Net Metering
 - Interconnection
 - Contract/PPA Negotiation
 - System Upgrades
- Access to Capital / Federal Incentives
- Permitting / Regulatory
 - Air emissions from energy generation equipment
 - Co-digestion of manure and other organic wastes
- Bottom Line – manure biogas energy cannot compete in most places with fossil fuels
- *** Adding nutrient treatment/removal will add cost – hopefully revenue, too!



For more information...

www.epa.gov/agstar

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