



Anaerobic Digestion Basics and Supportive Policies

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WHAT WE'LL SEE TODAY

- 1. Overview of AgSTAR Program**
- 2. Anaerobic digestion basics**
- 3. Overview of various policies and financial programs related to AD**
- 4. Questions and answers**



National Framework for Methane Mitigation

- **Overarching Strategies**

- [U.S. Methane Action Plan](#)
- [USDA Climate Smart Ag and Forestry Strategy](#)
- [Inflation Reduction Act](#)
- [Bipartisan Infrastructure Law](#)
- [Farm Bill](#)



- These national strategies discuss opportunities for supporting anaerobic digester systems on farms

How AgSTAR Works



PARTNERSHIP PROGRAM

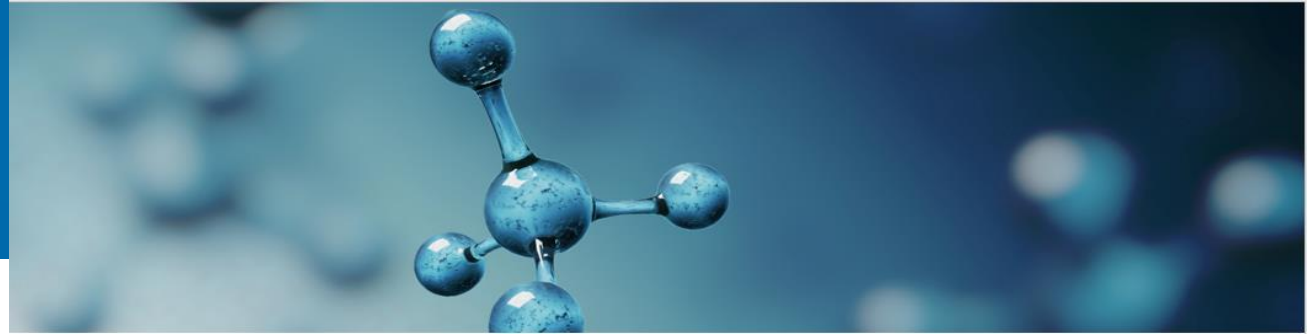
Collaborative program sponsored by EPA and USDA.

- 1 Promote Anaerobic Digestion**
Advancing economically and environmentally sound livestock manure management.

- 2 Strong Ties**
Working with industry, government, NGOs and university stakeholders.

- 3 Helping Hand**
Assisting those who enable, purchase, or implement farm anaerobic digestion projects.

Why methane?

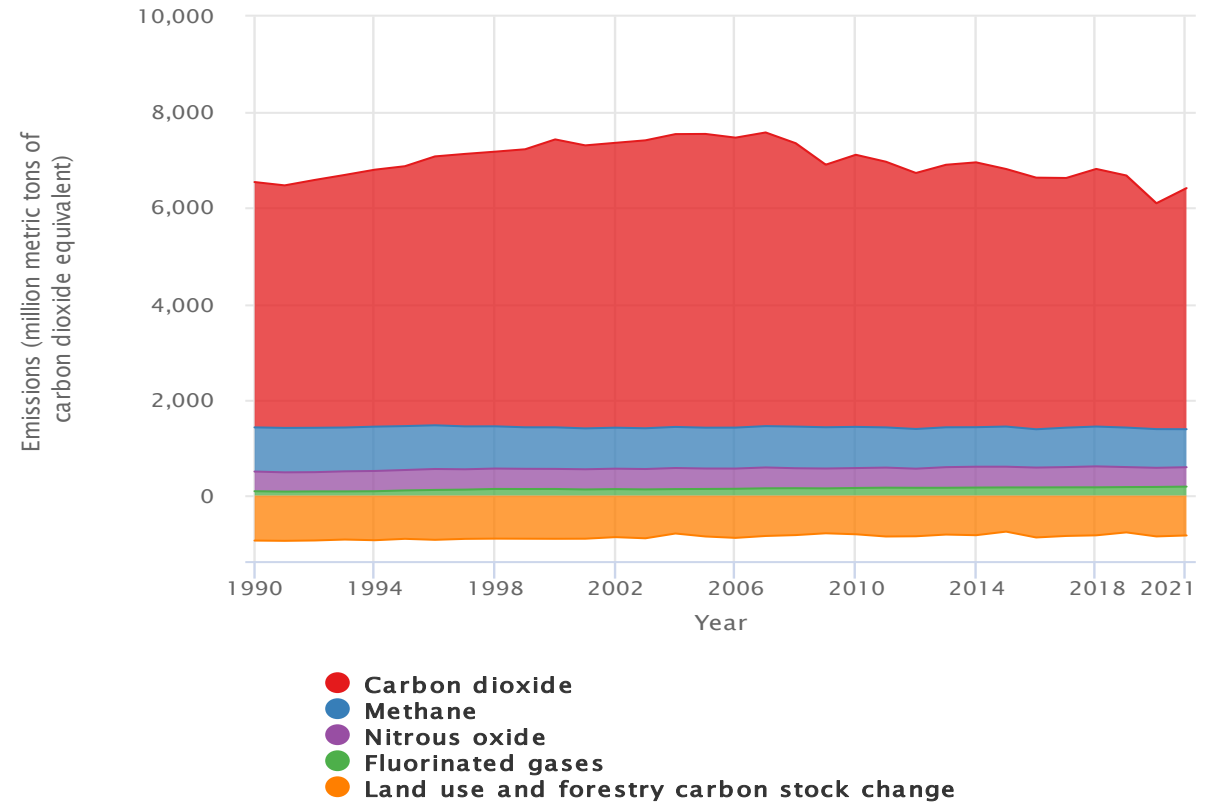


- Methane is the 2nd largest emitted GHG in the United States
- CH₄ has a warming potential 28 times higher than CO₂
- Methane emissions also contribute to ground-level ozone, a health and ecological risk

The Good News:

- Reducing methane emissions today can produce visible results within our lifetimes
- Methane is a valuable energy source
- Methane capture systems have many co-benefits for local communities

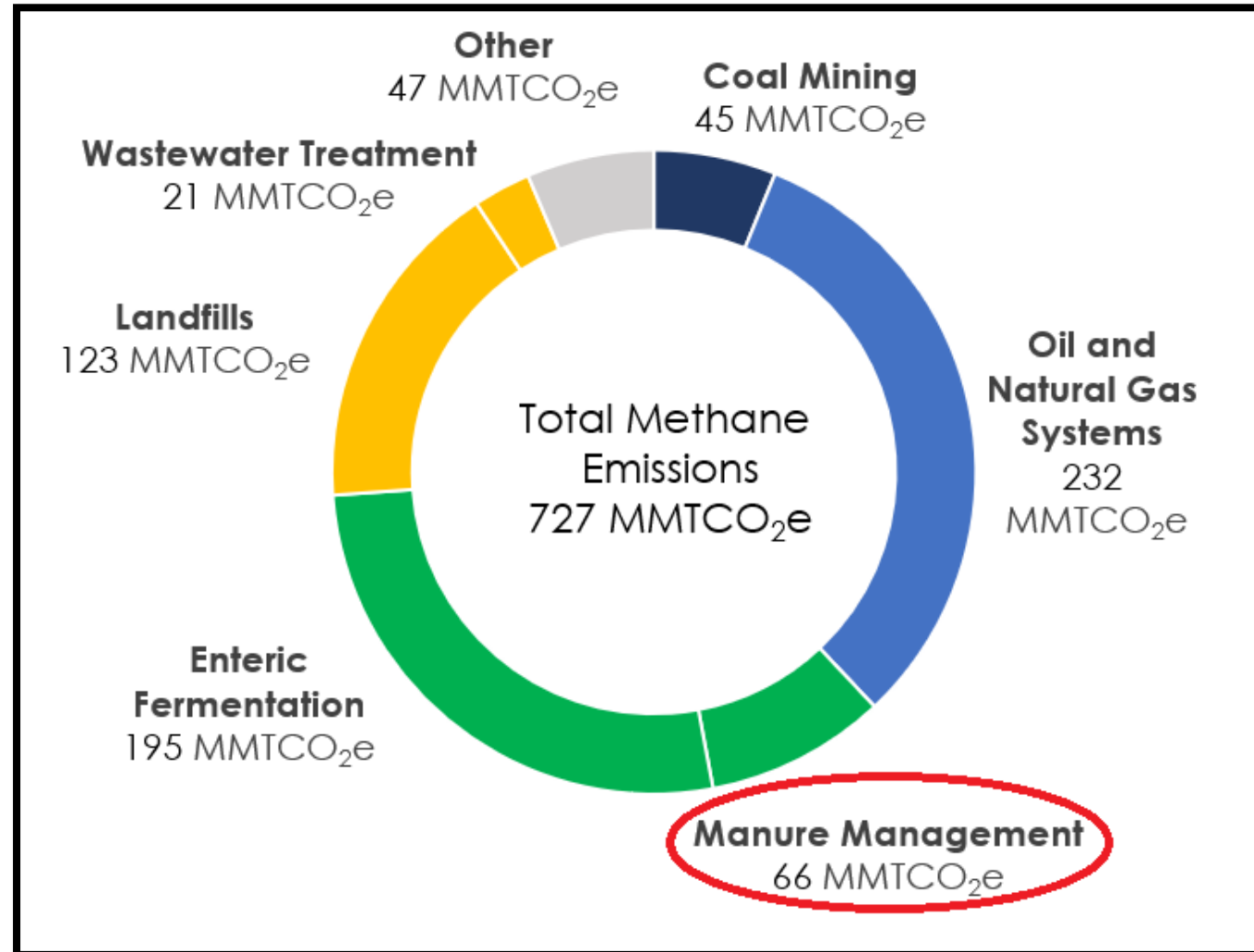
U.S. Greenhouse Gas Emissions by Gas, 1990–2021



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2021.
<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>

Methane Emissions in the U.S. by Sector (in 2021)

- Livestock (dairy, beef, swine, poultry) manure contributes ~9% of US methane emissions, or 66 MMTCO₂e
 - ≈14.7 million cars/yr
 - ≈ 12.8 million homes' electricity/year
- US methane emissions from livestock manure increased 71% between 1990 to 2020



Practices to Reduce Methane from Manure Management

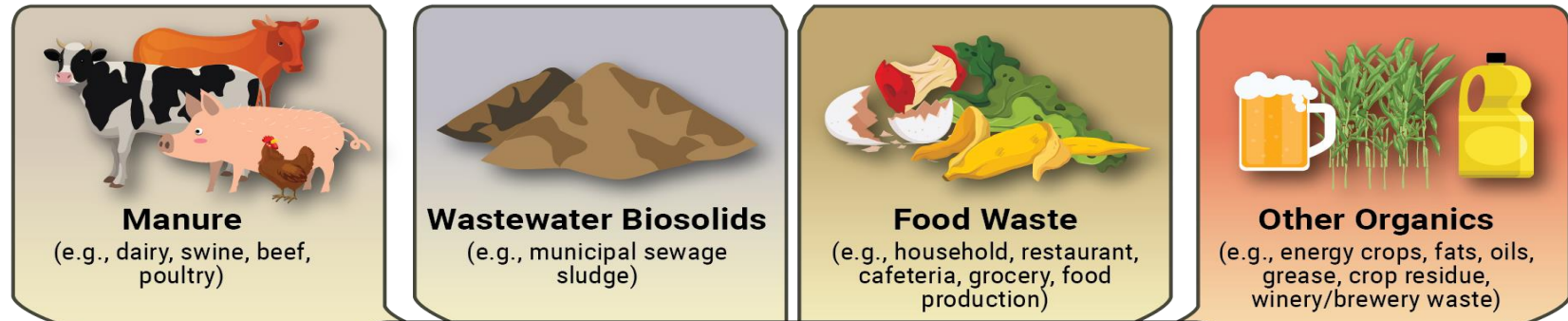
Manure Management Practice	Relative Methane Reductions*
Anaerobic Digestion	🍃 🍃 🍃 🍃 🍃
Daily Spread	🍃 🍃 🍃 🍃 🍃
Pasture-Based Management	🍃 🍃 🍃 🍃 🍃
Composting	🍃 🍃 🍃 🍃 🍃
Solid Storage	🍃 🍃 🍃 🍃 🍃
Manure Drying Practices	🍃 🍃 🍃 🍃 🍃
Semi-Permeable Covers, Natural or Induced Crusts	🍃 🍃 🍃 🍃
Decreased Manure Storage Time	🍃 🍃 🍃 🍃
Compost Bedded Pack Barns	🍃 🍃 🍃
Solid Separation of Manure Solids Prior to Entry into a Wet/Anaerobic Environment	🍃 🍃



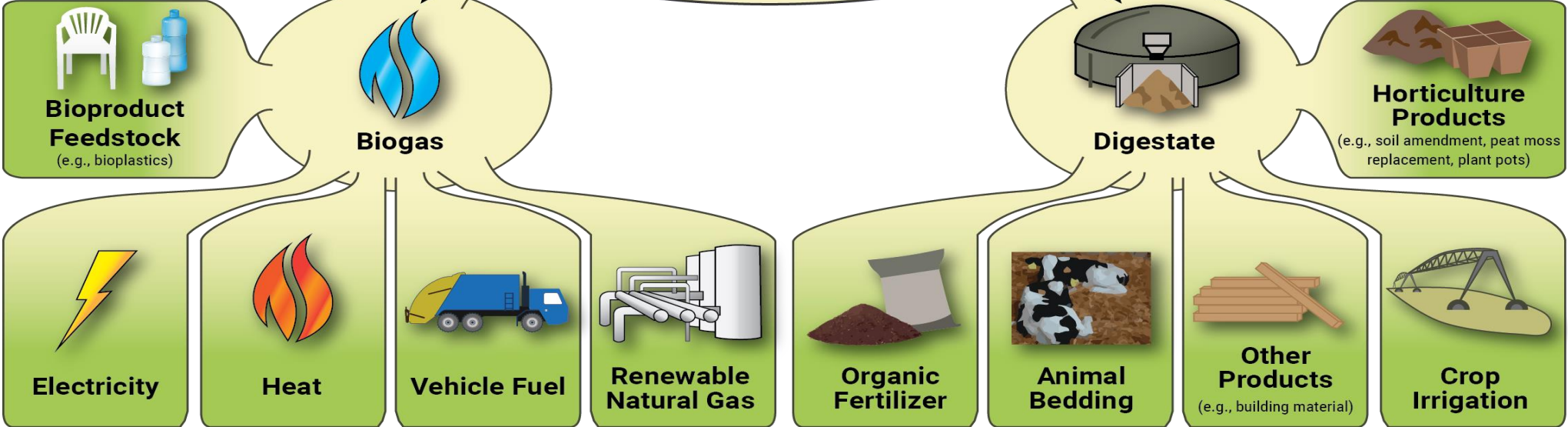
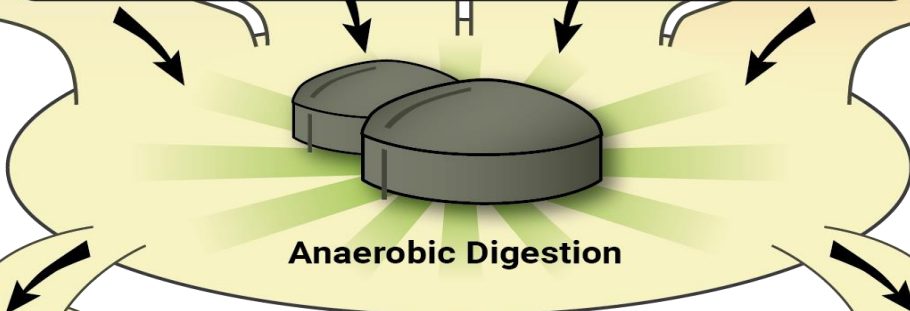


Anaerobic Digesters are a tool to improve manure management

How does anaerobic digestion work?



Feedstocks can be digested singularly or in combination (co-digestion)



- Just add:
1. Organic Feedstock
 2. Heat
 3. Bacterial consortium
 4. Time
- And eliminate oxygen

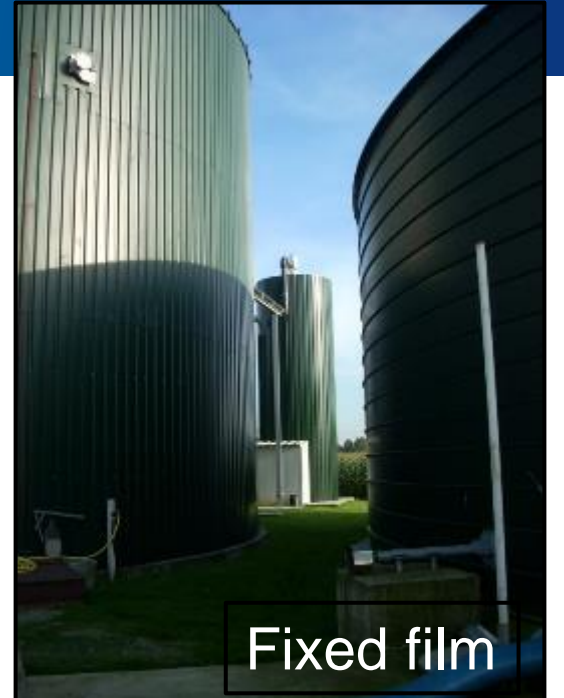
Digester Types



Covered lagoon



Agricultural complete mix



Fixed film



Municipal complete mix



Plug Flow

Environmental Benefits: Air Quality

- **Reduction in methane emissions, contributor to ground-level ozone and ammonia**
 - Collection and use of biogas from U.S. farms reduced methane emissions by 10.43 MMT of CO₂e in 2022. (AgSTAR Data and Trends)
 - Lower emissions reduce the risk of respiratory illness and reduce climate impacts.
- **Odor Reduction**
 - Less odor improves the farm's relationship with the community.



Patterson Farms, Auburn, New York

- Odor issues related to its newly constructed, 4.5-million-gallon earthen manure storage pond
- Mechanical separation eliminated odor from manure solids, but odors persisted with liquids stored in earthen pond
- Complete mix digester installed in 2005 and has been successfully controlling odor since

Environmental Benefits: Water Quality and Soil Health

- **Improvement of local water quality**
 - Reduce pathogens and nutrients from leaching into surface and groundwaters.
- **Processed digestate can be used as a soil amendment or organic fertilizer**
 - Returns nutrients to the soil.
 - [Blue Spruce Farm in Vermont](#) dewateres digestate, yielding low-solids irrigation water and a nutrient-rich solid product.
- **Digestate application can increase crop yield**
 - May minimize or offset the use of fertilizers.



Picture: Blue Spruce Farm

Energy Benefits

- **Produces renewable energy from collected and processed biogas**
 - Manure-based AD projects generated approximately 2.42 million megawatt-hours in 2022 (AgSTAR Data and Trends).
- **Energy Independence**
 - Many digesters can provide all on-farm energy needs.
 - Produces baseload energy or “dispatchable power” for use during peak hours.
 - Excess power can be provided to the local grid.



Butler Farms Lillington, North Carolina

- Produces 540,000 kWh of electricity annually
- On-site microgrid can operate independently and provide power to the farm and surrounding homes, which helps avoid prolonged outages following severe weather events.

Economic Benefits

- Diversifies revenue of the farm
- Opportunity to create new local jobs
- Partnerships with local businesses
 - Outsource co-digestion feedstocks from other farms or the community
 - [Monument Farms Dairy in Weybridge, Vermont](#) receives waste from Vermont Hard Cider, LLC, offsetting Vermont Hard Cider waste transportation costs.
 - [Noblehurst Farms in Linwood, NY](#) founded Natural Upcycling to collect **food waste and scraps** for use in their anaerobic digester.



Barstow's Longview Farm, Hadley, Massachusetts

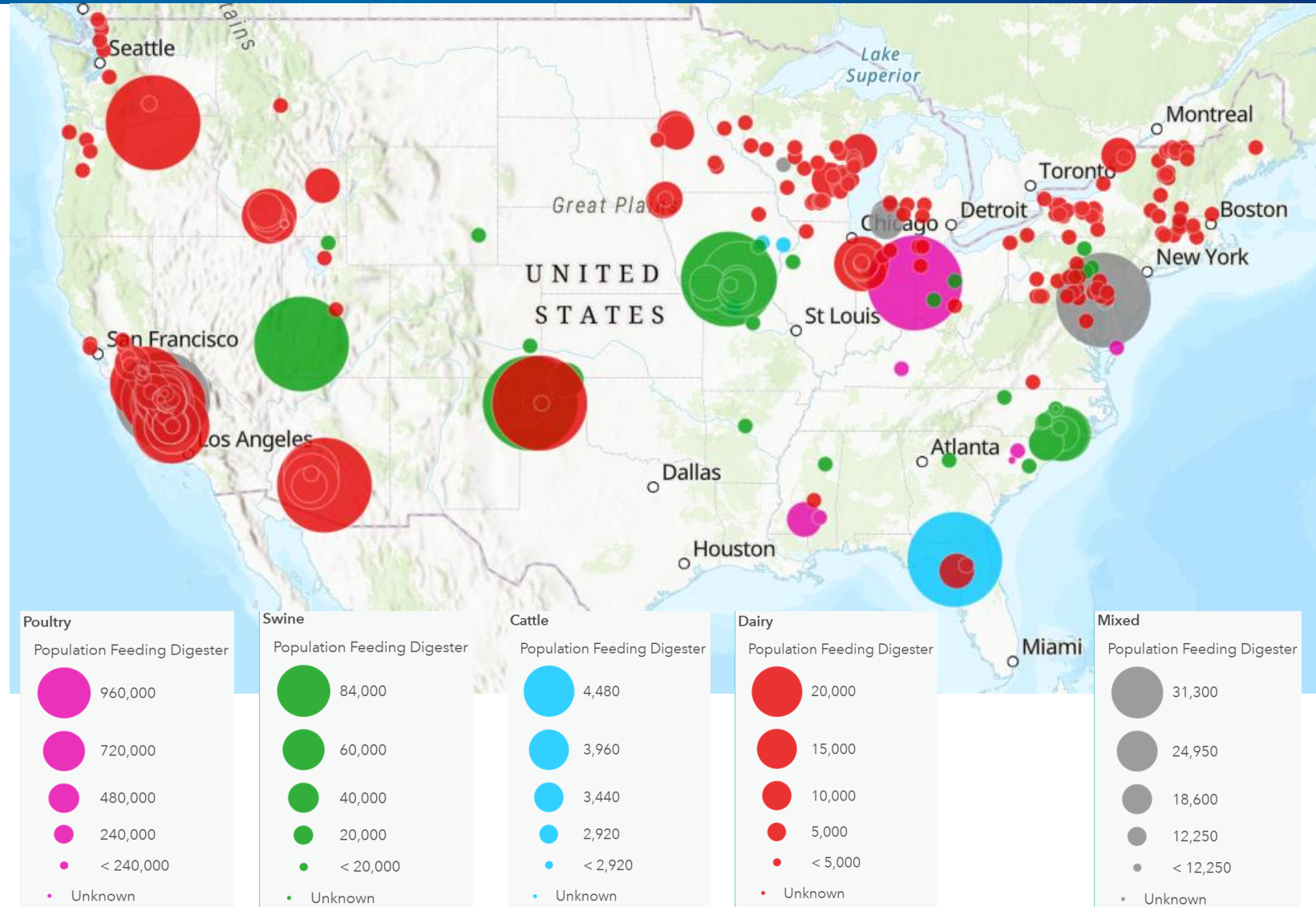
- Longview Farm, Vanguard Renewables, and Cabot Creamery/Agri-Mark Co-Operative partnered together to create a closed-loop lifecycle.
- Farm waste and wastes from food distributors are used in the anaerobic digestion system which generates energy to the farm, producers, and distributors.

Where are digesters found?

- **343 active digesters in the U.S. (as of Jan. 2023)**
 - **290 Dairy**
 - **46 Hog**
 - **8 Poultry**
 - **9 Beef**

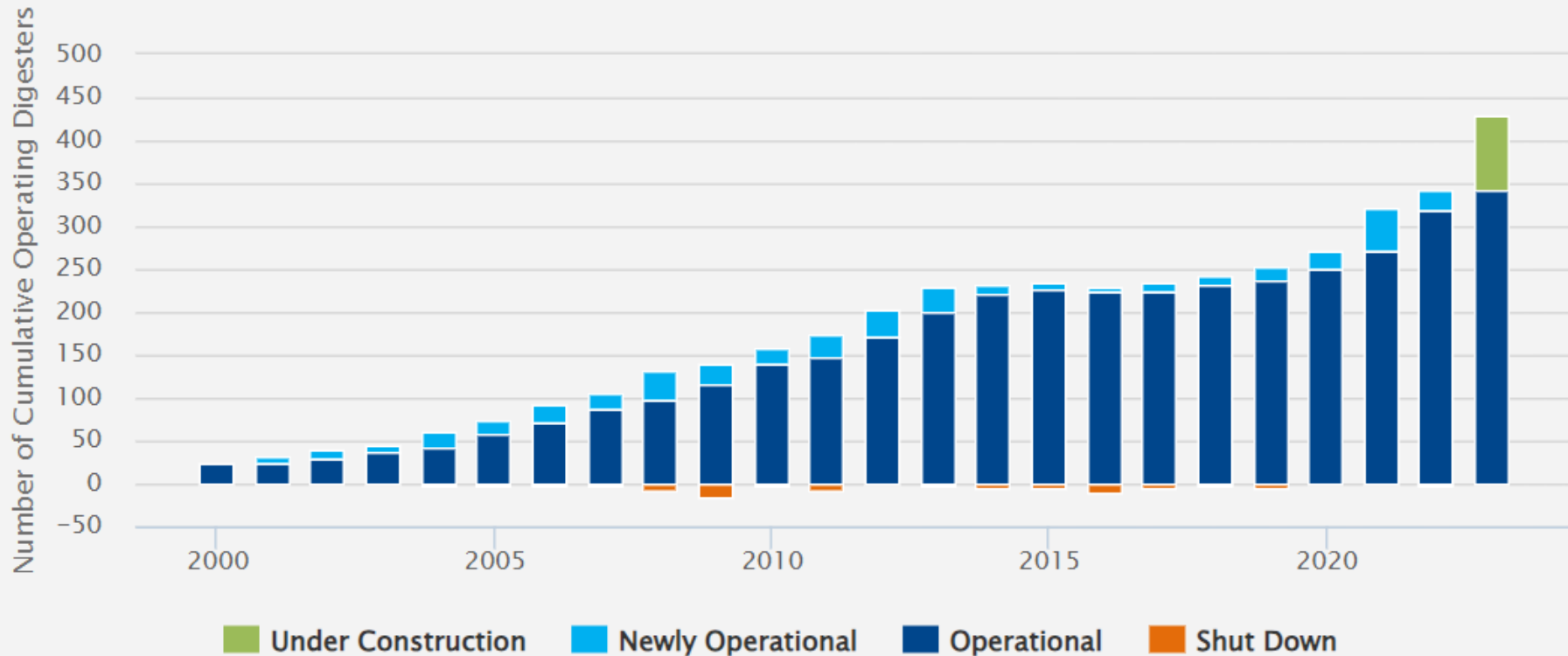
Note: Total exceeds 343 because some systems accept manure from more than one animal type.

- **104 (~30%) digesters combine manure with other feedstocks such as:**
 - **Brewery/distillery spent grain**
 - **Dairy processing wastes (e.g., whey)**
 - **Food waste**
 - **Agricultural residues**



Farm Digester Market Growth

Manure-based Anaerobic Digesters Operating in the U.S.
(Updated through January 2023)



343  **Current Digesters**

Growth projected to exceed 500 digesters in next 3 years

Potential for over 8,000* digesters on farms in U.S.



Source: AgSTAR Digester Database

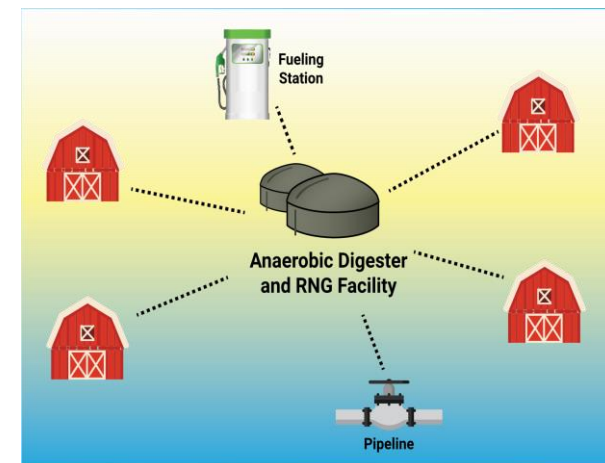
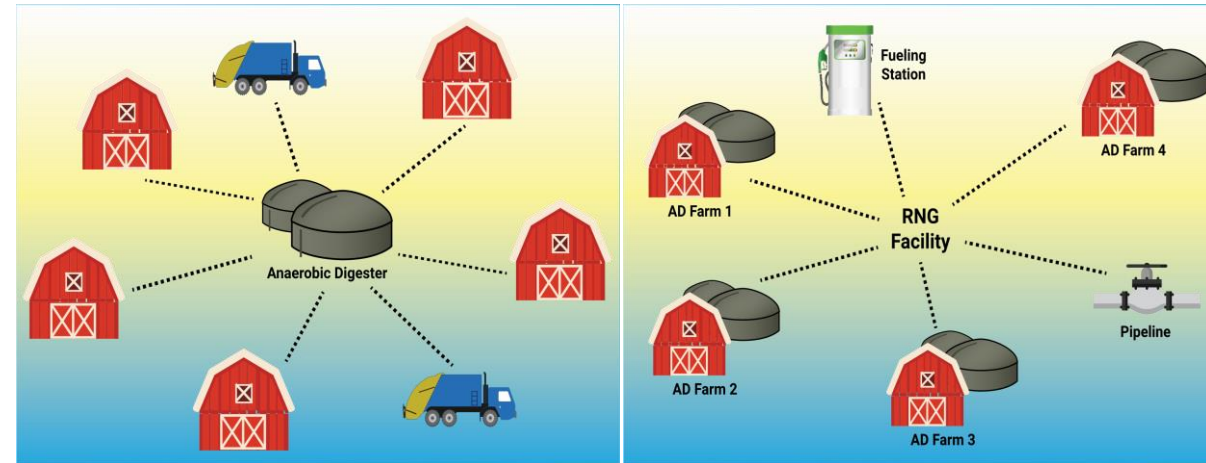


Business Models for Anaerobic Digester Systems



Owner & Operator Models

- Successful business models:
 - Maximize sources of revenues (e.g., digestate, nutrients, energy, fuel, tipping fees);
 - 3rd party investment, ownership, and operations.
 - Involve partners along with value chain, such as co-ops, customers, suppliers, and processors;
 - Work collaboratively with partners on contracting, permitting, energy, design, or operations;
- General types of business model structures:
 - Farmer owned & operated
 - 3rd party owned & operated
 - 3rd party operated
 - Hub & Spoke (see figures)



Project Example: 3rd Party Owned/ Operated

BAR-WAY FARM

Deerfield, MA

7,700 MWh

Annual energy output.

5,500 lbs

Daily offset of CO₂ emissions.



Farm Facts

- 600-acres
- 250 cows milked daily

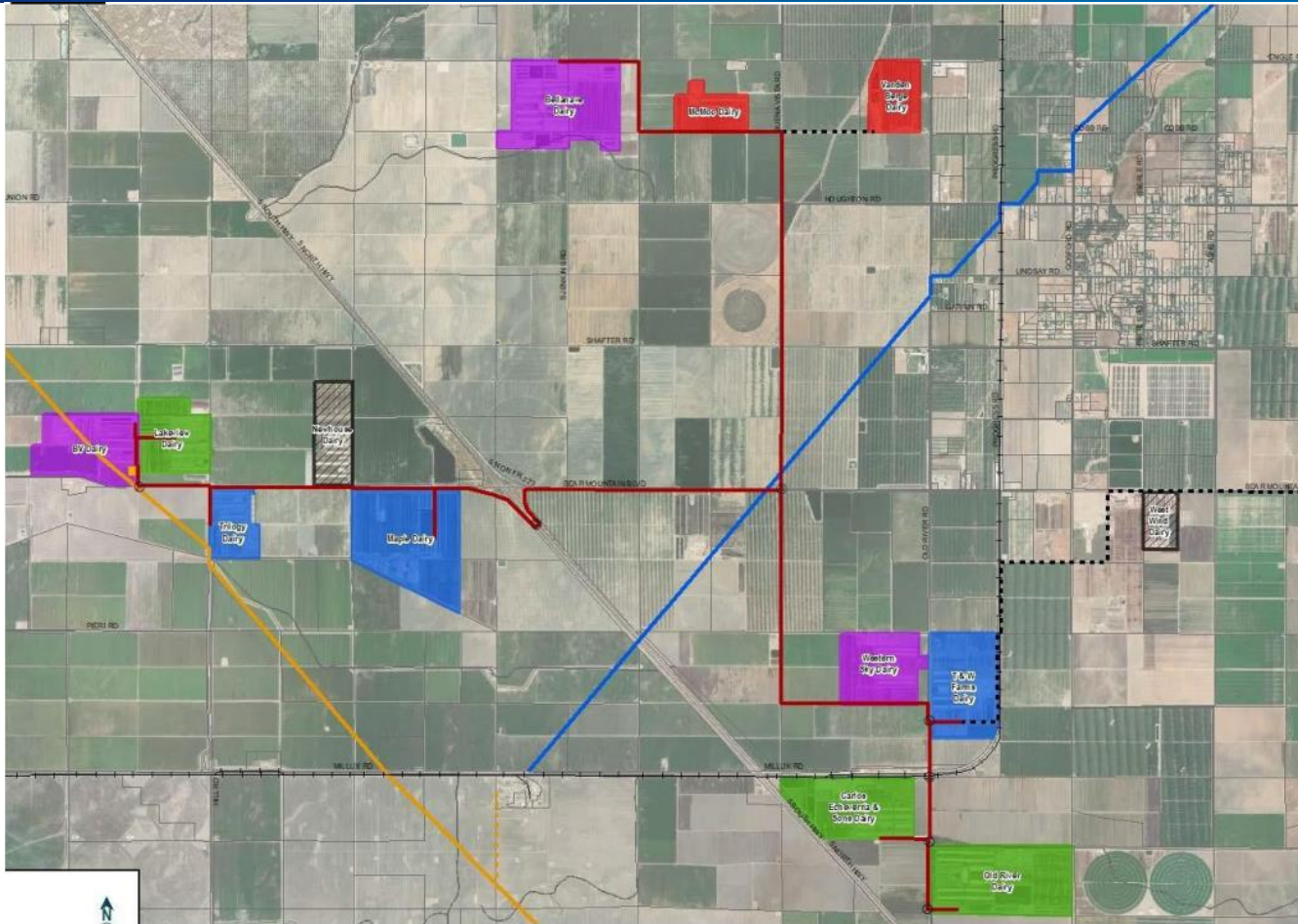
Digester Facts

- Built in 2016
- 660,000-gallon capacity
- Owned, operated and maintained by Vanguard Renewables

Annual Digester Input

- 9,200 tons of manure
- 30,000 tons of food waste

Project Example: Cluster Project, RNG to Vehicle Fuel



Map of dairies connected in red (as of 2019)
Source: CalBio

Kern Cluster Project: CalBio

- Connects 11 digesters from dairy farms
- Sends biogas to upgrading facility then injection into RNG pipeline
- Benefits from economies of scale: farms share RNG upgrading facility
- 339,000 metric tons of CO₂e reduced per year; equivalent to removing 75,000 passenger cars from the road each year

Project Example: Creating Value from Coproducts

FREUND FARM

East Canaan, Connecticut

- ★ Small Family-owned farm
- ★ Horizontal plug flow digester
- ★ 300 dairy cows feeding digester



Displace unsustainable peat moss and plastic planters.

Biodegradable planter pots made from digested manure solids.



Policies and Incentives for Anaerobic Digester Systems

Federal Financial Programs for Agricultural Methane Mitigation

- **EPA:**
 - Climate Pollution Reduction Grants: \$5 billion in grants to states, local governments, tribes, and territories for plans to reduce GHG emissions; plans can include AD projects/programs
 - Greenhouse Gas Reduction Fund: \$27 billion investment for financing three grant competitions; project specifications TBA
 - Renewable Fuel Standard: The RFS program is a national policy that requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil or jet fuel. Offers incentive for production of bio-based fuel, including biogas.
- **USDA:**
 - Rural Energy for America Program (REAP):
 - Grants up to \$1 million
 - Loans for up to 80% of project cost
 - Environmental Quality Incentives Program (EQIP):
 - Grants for conservation and energy efficiency, Varies by state
- **Tax Credits:**
 - Federal Renewable Electricity Production Tax Credit
 - 1.3 - 5 cents/kWh for 10 years based on system size
 - Federal Business Energy Investment Tax Credit
 - 30% tax credit; 10% bonus for projects in communities with high unemployment rates and fossil fuel production



State and Local Policy Mechanisms to Support AD Adoption

Grants and Loans

- Grant and loan programs can be funded through various state agencies, including environmental, economic development, and rural development/agriculture
- States can also encourage AD adoption through utility rebate programs

Program Examples

- The Pennsylvania [Alternative and Clean Energy Program](#) (ACE) provides loans and grants for clean energy generation projects
 - Project grants cover up to \$2 million or 30% of project cost
 - Feasibility and planning grants cover up to \$175,000 or 50% of cost
- Since 2014, Wisconsin [Focus on Energy](#) (FOE) has provided up to \$15,000 of cost for feasibility studies for biogas projects

State and Local Policy Mechanisms to Support AD Adoption

Performance-Based Incentives

- States with performance-based incentives typically offer \$0.015 to \$0.1 per kWh produced
- Performance-based incentives can be made available to a wide range of capacities so that farms of different sizes can participate

Program Example

- In 2014, Rhode Island passed a bill to create the [Renewable Energy Growth](#) (REG) program
 - Tariff-based incentive program designed to finance development, construction, and operation of renewable energy projects to achieve specified megawatt (MW) targets
- In 2023, AD systems can receive up to \$0.19/kWh for 20 years

State and Local Policy Mechanisms to Support AD Adoption

- **Low Carbon Fuel Standard (LCFS)**
 - State-level initiative to reduce carbon intensity of transportation fuels
 - Biogas processed into compressed renewable natural gas for use as vehicle fuel qualifies as a "low-carbon fuel"
 - Biogas projects generate credits which can be sold or traded in the carbon market
 - California and Oregon have implemented LCFS programs

State and Local Policy Mechanisms to Support AD Adoption

Renewable Portfolio Standard (RPS)

- Renewable Portfolio Standards (RPS) are policies that set requirements to increase the use of renewable energy sources for state electricity generation
- Majority of states have enforceable or voluntary RPS
 - **not all RPS allow energy generation from AD systems**
- RPS do not directly provide financial incentives to AD system operators
 - To meet RPS requirements, utilities may develop rebate programs for AD systems

Policy Examples

- In 2008, Michigan enacted the [Clean, Renewable, and Efficiency Energy Act](#), which requires all state electricity providers to meet tiered RPS requirements with 60% renewables by 2035
- In 2021, the Illinois [Climate and Equitable Jobs Act](#), increased state RPS requirements to 50% renewable energy by 2040

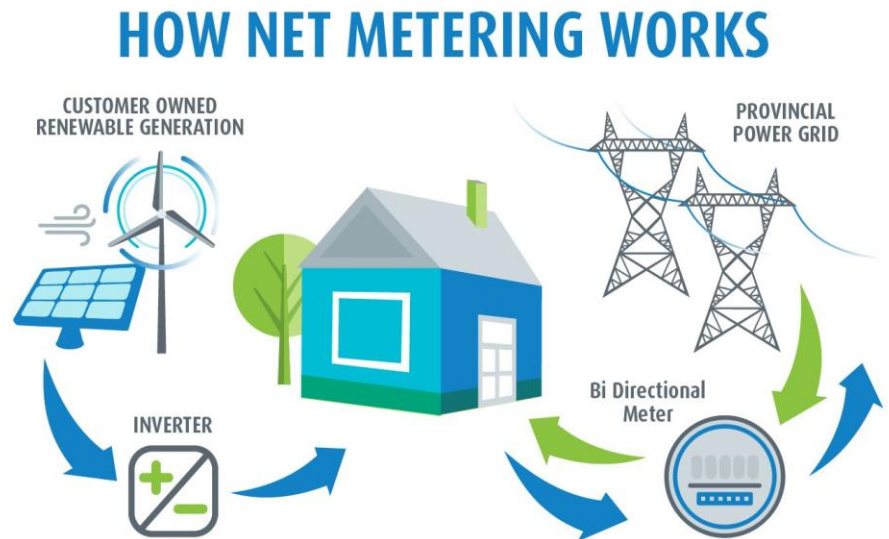
State and Local Policy Mechanisms to Support AD Adoption

Net Metering and Feed-in-Tariffs

- Allow electricity producers to sell excess electricity to the grid at a fixed or variable price
- As of 2021, 41 states and Washington, D.C. have adopted net metering policies
- Feed-in-Tariffs with fixed terms allow farms to have consistent revenue stream over project lifetime
 - Very useful for project planning and feasibility

Program Example

- Northern Indiana Public Service Company customers can sell electricity generated by AD back to utility for \$0.092/kWh over a 15-year term



State and Local Policy Mechanisms to Support AD Adoption

Tax Credits and Incentives

- Corporate, personal, sales, and property tax incentives can be used to directly reduce an individual biogas producer's tax bill
- Options vary by state but include allocating tax credits based on kilowatts per hour (kWh) produced, allocating tax credits worth a percentage of the property constructed, or offering reduced tax liability

Program Examples

- The Utah State Energy Program provides tax credits for both residential and commercial renewable energy systems
 - For commercial AD systems, the tax credit is \$0.0035/kWh for a 4-year term
- The Michigan Department of Agriculture provides 100% exemption from real and personal property taxes for qualifying farm AD systems



State and Local Policy Mechanisms to Support AD Adoption

Organics Diversion Policies

- States implement organic waste diversion policies to reduce food and yard waste from going to landfills
- These policies provide a reliable source of waste that can be added to farm AD systems (known as co-digestion) to increase biogas production and revenue

Program Examples

- Massachusetts regulations ban disposal of food and other organic wastes from businesses and institutions that generate more than one-half ton of these materials per week
- From 2012 to 2020, the [Commonwealth Organics-to-Energy Program](#) helped prepare the state for the impending ban by providing grant funding for feasibility studies and construction of AD systems that combine food waste and manure
 - 12 facilities were constructed or upgraded for a 500,000-tons-per-year increase in state organics processing capacity
 - The program established a business model of economically viable co-digestion AD systems on modestly-sized farms

Technical Assistance to Support Anaerobic Digestion

▪ Anaerobic Digester Ombudsman

- A third-party individual that helps livestock facilities develop and maintain anaerobic digester projects.
- In New York and Vermont, AD ombudsman programs supported development of over 40 anaerobic digestion projects.

“I cannot overstate the fact that without [the ombudsman] I wouldn’t have my anaerobic digester. I would have been too overwhelmed with the process. [The ombudsman] provided guidance that was vital to getting my anaerobic digester.”

– Reg Chaput, Chaput Family Farms

Evaluating State Policy & Incentives Impact on AD Adoption

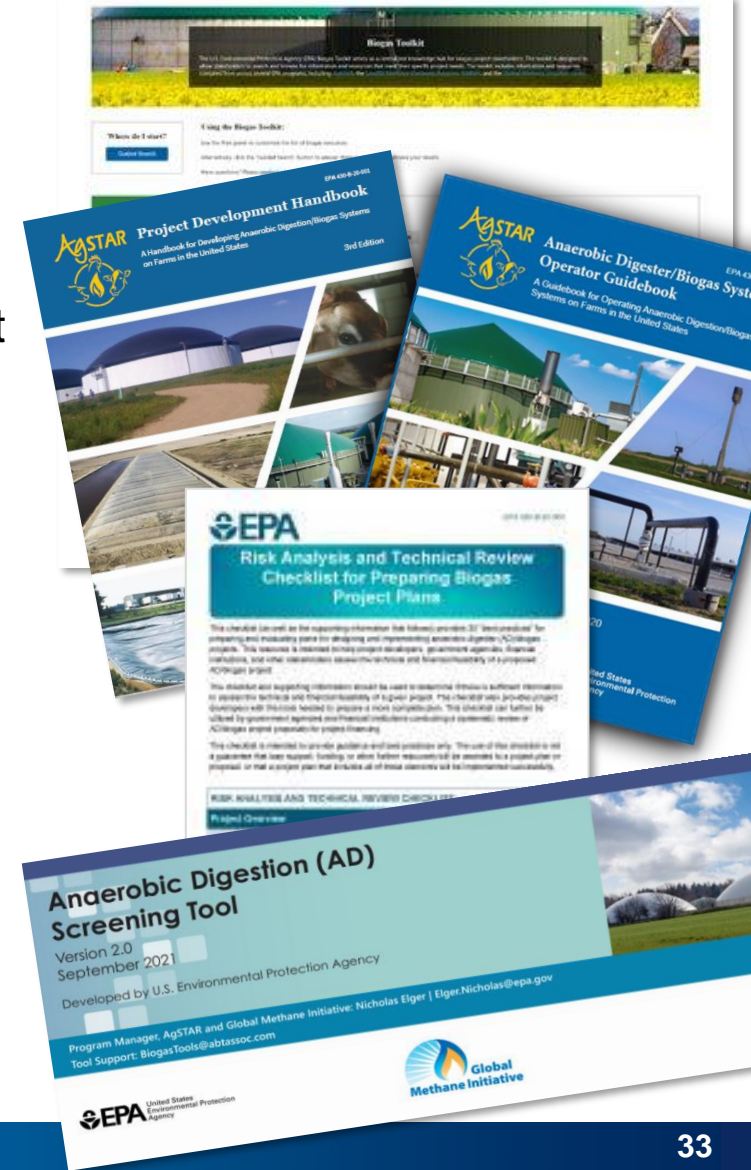
- **Several studies have evaluated the influence of state policies and programs on AD adoption**
 - **Most effective:** RPS, performance-based incentives, and other state mandates to increase consumption and purchase of renewable energy
 - Performance-based incentives especially critical for AD; Fixed rate, fixed term provides certainty
 - **Most effective for smaller farms:** grants and loans to subsidize development costs; lack of access to capital is major barrier
 - **Most effective for GHG reductions:** carbon pricing policy not tied to energy production provides the greatest social benefits
 - **Less effective:** net metering and interconnection

Sources: [University of Florida](#) (2017); [USDA](#) (2012)



Foundational Resources for AD/ Biogas Systems

- **Biogas Toolkit:**
 - A web-based toolkit with 38 tools and resources to facilitate biogas project development.
- **Project Development Handbook (3rd Edition):**
 - A comprehensive compilation of the latest knowledge in the industry on best practices for anaerobic digestion (AD)/ biogas systems.
- **Operator Guidebook (1st Edition):**
 - A guide for AD/ biogas systems operators to ensure safe and efficient operations of the systems they manage.
- **AD Risk Analysis Checklist:**
 - A checklist of best practices to help users determine technical & financial feasibility of AD/ biogas projects.
- **AD Screening Tool:**
 - A Microsoft Excel-based screening tool to assess the potential feasibility of AD projects in the U.S. and globally.



Question and Answer



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