Trends & Resources for U.S. Biogas Projects in the Livestock Sector

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USEPA AgSTAR Program and Global Methane Initiative

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Atlanta, GA – November 1, 2016

My Background

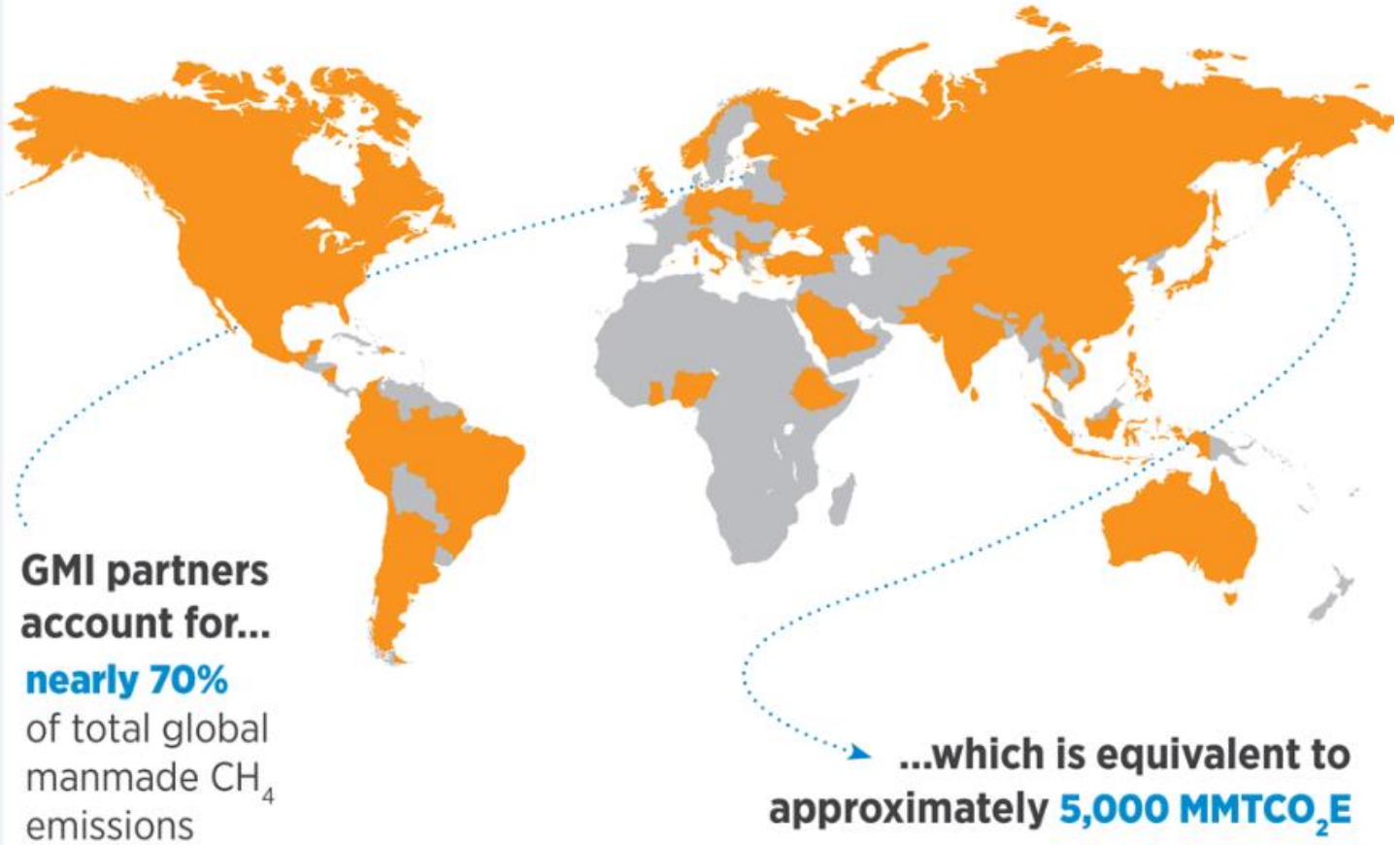
- Currently direct AgSTAR and lead Ag and Wastewater AD efforts for Global Methane Initiative
- 30 years in waste management and biogas energy fields
- Mix of federal government, non-profit, private sector project development and consultancy sectors
- With EPA and Global Methane Initiative previously from 2002-2012; started back in December 2015
- Believe strongly in global networking, outreach and education

USEPA AgSTAR & Global Methane Initiative

- AgSTAR - encourages the use of biogas recovery technologies in the U.S. at livestock operations, reducing methane emissions, achieving environmental benefits, and generating renewable energy.
- Global Methane Initiative (GMI) - a voluntary, multilateral partnership that aims to reduce methane emissions and to advance the abatement, recovery, and use of methane as a clean energy source.

GMI Partner Countries

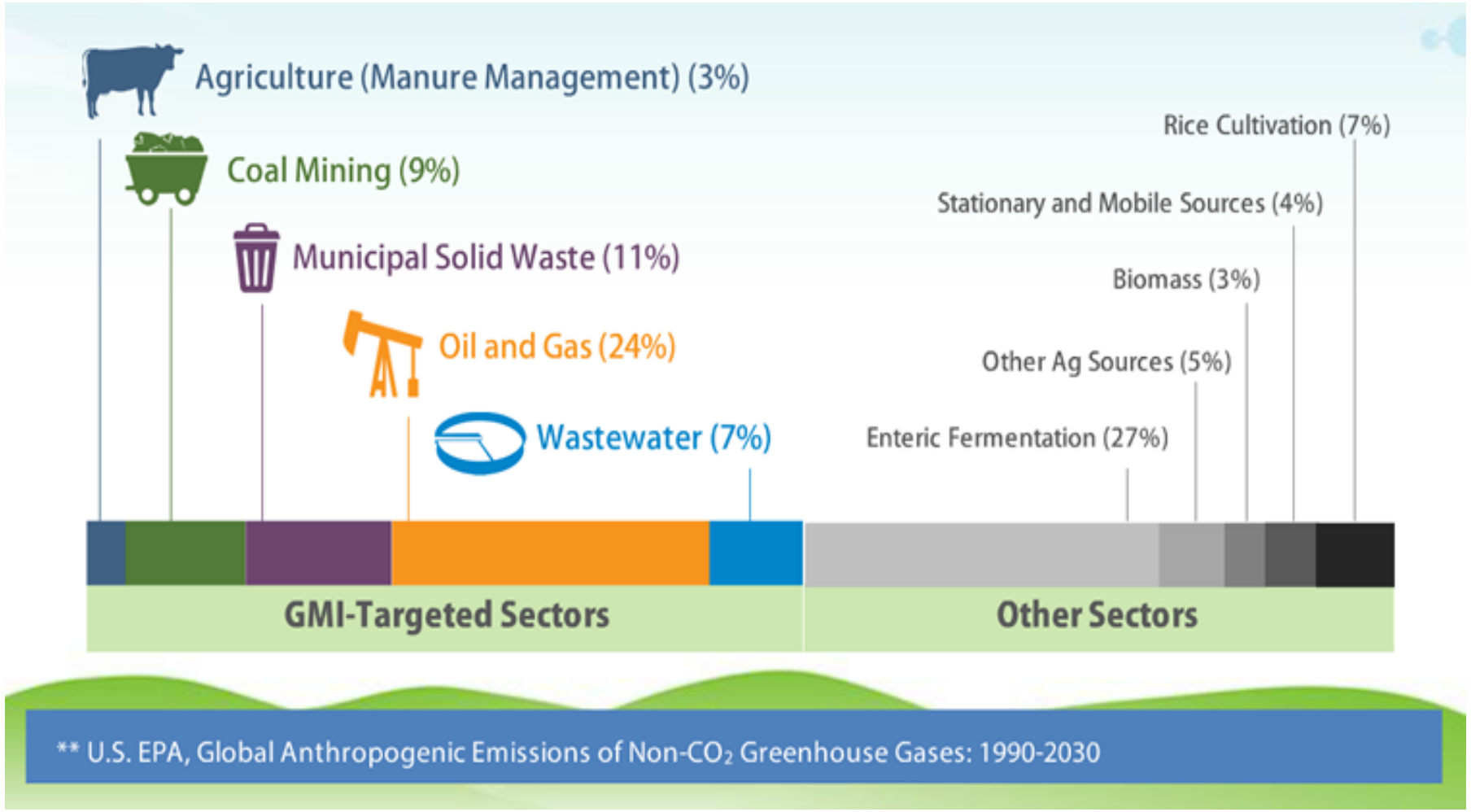
GMI reduces global methane emissions and encourages recovery and use of methane as an energy source.



Albania	Kazakhstan
Argentina	Mexico
Australia	Mongolia
Brazil	Nicaragua
Bulgaria	Nigeria
Canada	Norway
Chile	Pakistan
China	Peru
Colombia	Philippines
Dominican Republic	Poland
Ecuador	Republic of Korea
Ethiopia	Republic of Serbia
European Commission	Russia
Finland	Saudi Arabia
Georgia	Sri Lanka
Germany	Thailand
Ghana	Turkey
India	Ukraine
Indonesia	United Kingdom
Italy	United States
Japan	Vietnam
Jordan	

GMI - Targeted Sectors

These 5 sectors contribute ~54% of total global methane emissions

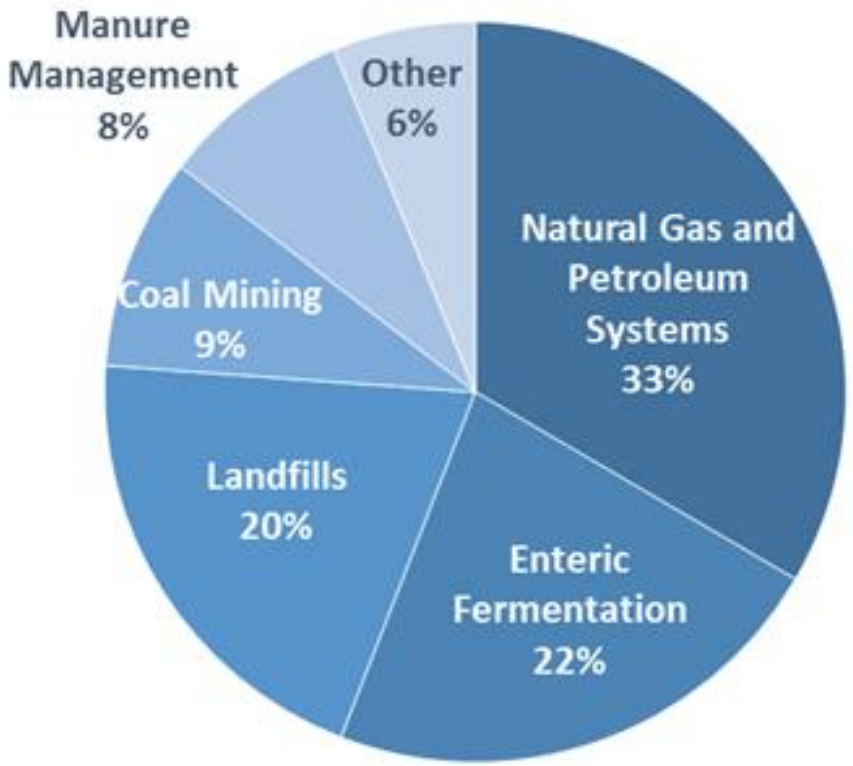


U.S. Livestock Sector Overview

- 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

USDA 2012 Census of Agriculture, https://www.agcensus.usda.gov/Publications/2012/#highlights

U.S. 2014 Methane Emissions, By Source



- Total U.S. methane emissions in 2014 = 730.8 $MMTCO_2e$
- Portion from waste sector (landfills; wastewater; composting) = 164.7 $MMTCO_2e$
- Portion from agriculture sector (manure management) = 61.2 $MMTCO_2e$

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

U.S. Climate Action Plan: Methane

- Four sources of methane emissions:
  - Landfills (EPA)
  - Agriculture (EPA, U.S. Department of Agriculture, Department of Energy)
  - Coal Mines (Department of Interior, EPA)
  - Oil & Gas (EPA, Department of Energy, Department of Interior)
- Reducing Methane Emissions**:** Builds on best practices and activities to reduce methane emissions
  - Combination of regulatory and voluntary domestic activities, depending on sector

Mission - The Biogas Roadmap

- This Biogas Opportunities Roadmap builds on progress made to date to identify voluntary actions that can be taken to reduce methane emissions through the use of biogas systems and outlines strategies to overcome barriers to a robust biogas industry in the United States.
- It supports the U.S. dairy industry's voluntary 2008 goal to reduce its greenhouse gas emissions by 25% by 2020.

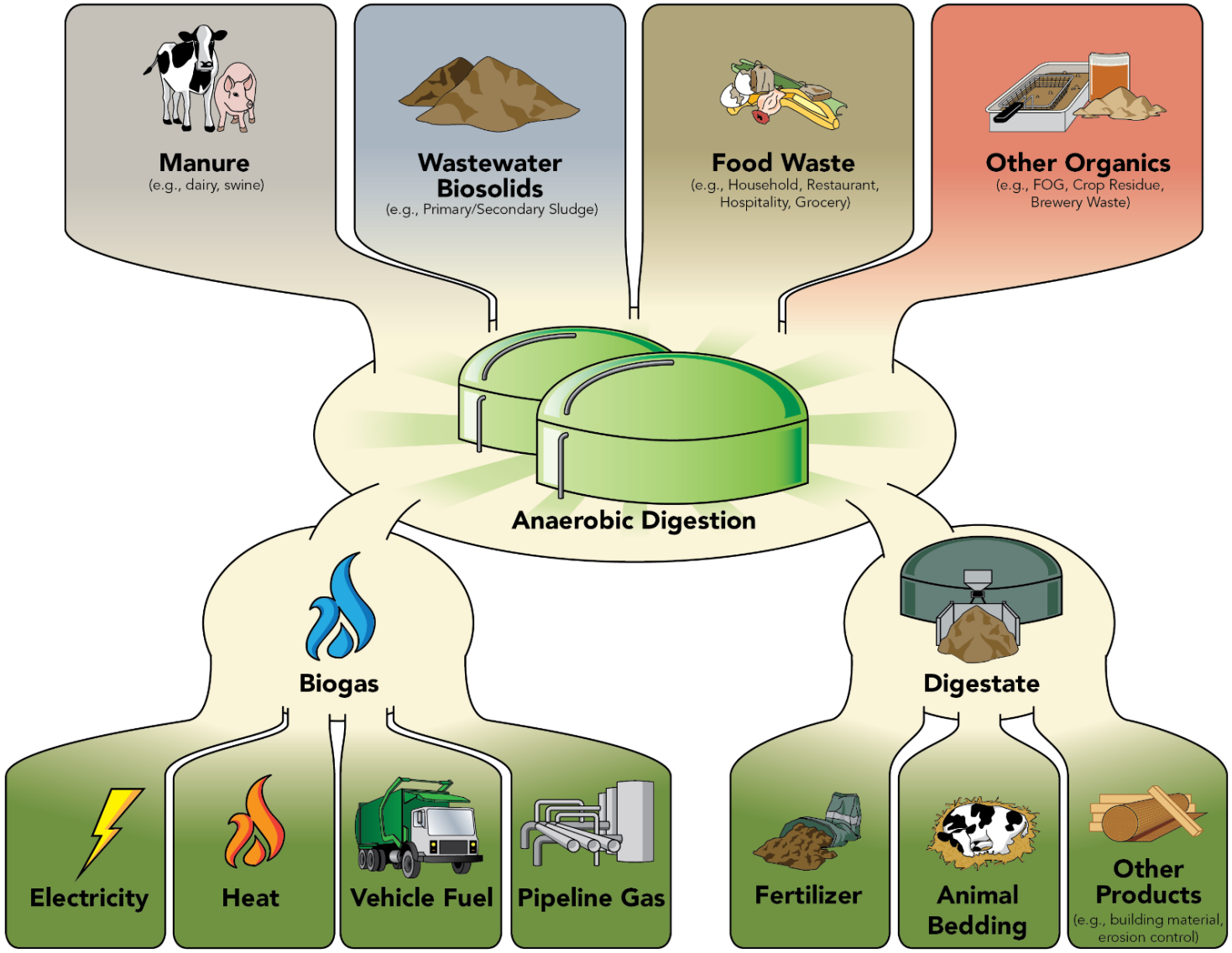
U.S. Market for Biogas

Estimated Energy Potential from Biogas Sources in the United States (Livestock Manure, Landfill Gas, Water Resource Recovery Facilities)	
Currently Operational Biogas Systems	2,116
Potential Number of Biogas Systems	13,008
Biogas Production Potential	654 billion cubic feet/year
Potential Vehicle Fuel Displaced	2.5 billion gasoline gallon equivalents/year

Biogas Opportunities Roadmap: Voluntary Actions to Reduce Methane Emissions and Increase Energy Independence, U.S. Department of Agriculture, U.S. Environmental Protection Agency, U.S. Department of Energy, August 2014

Currently Operational and Potential Biogas Systems in the United States				
	Livestock Manure	Landfill Gas	Water Resource Recovery Facilities	Total
Currently Operational Biogas Systems	239[xi]	636[xii]	1,241[xiii]	2,116
Total Potential Number of Biogas Systems	8,241[xiv]	1,086[xv]	3,681[xvi]	13,008

Livestock Manure Opportunities



Current AD Projects on U.S. Livestock Farms

- 242 operational projects in the U.S. (May 2016)
  - 196 Dairy
  - 39 Hog
  - 7 Poultry
  - 7 Beef
  - 7 Mixed
- *Note: Totals sum to more than 242 because some projects accept manure from more than one animal type.*

Source: USEPA AgSTAR

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%

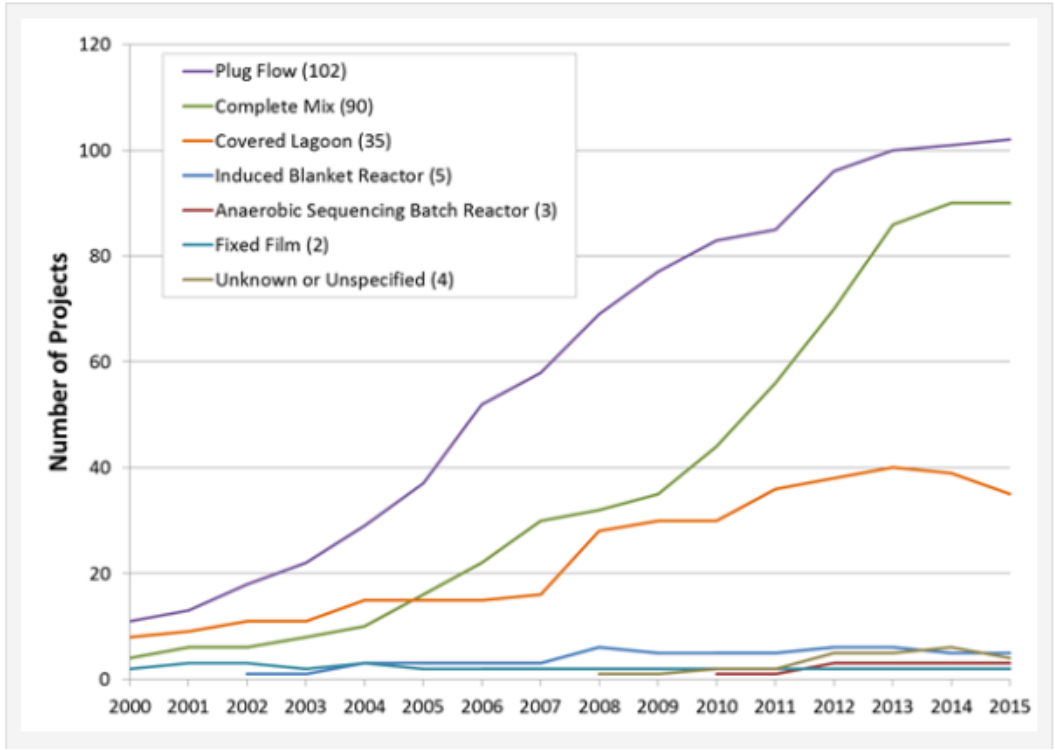
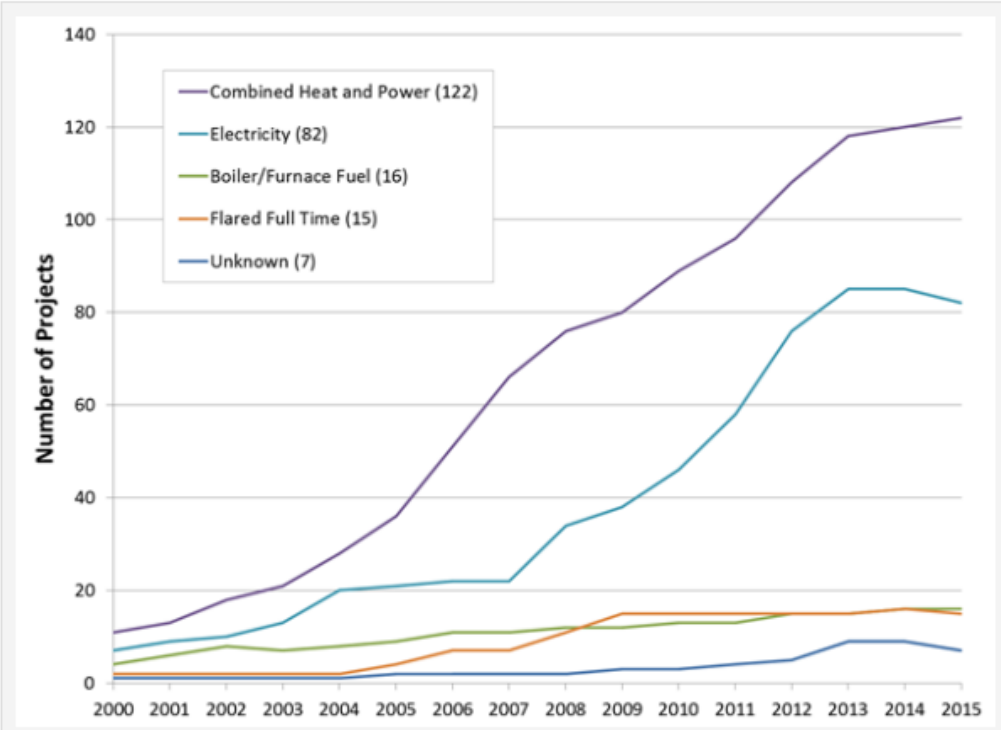


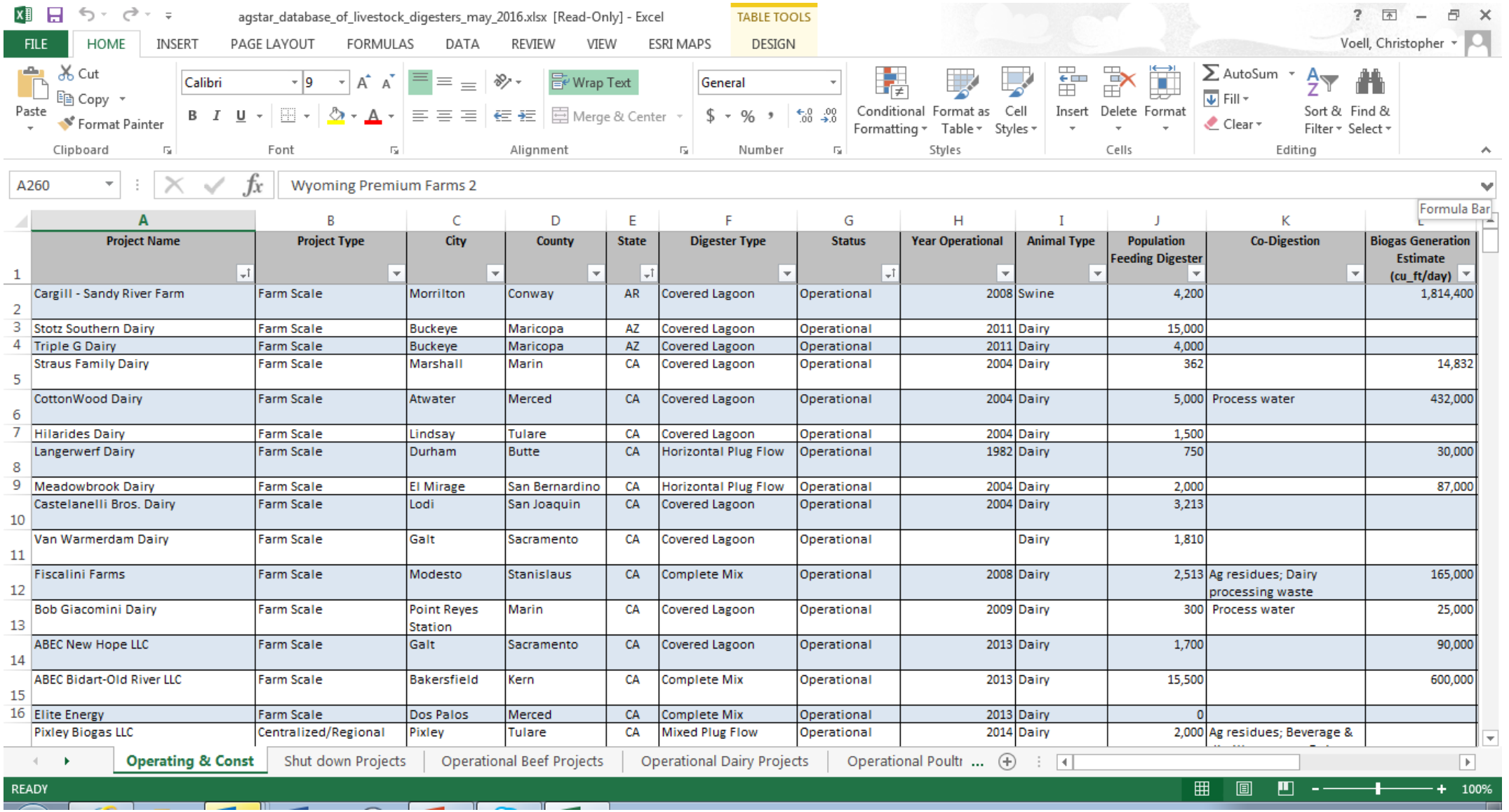
Table 2: End Uses of Biogas in 2015

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%



Line chart showing trends in the end uses of biogas from 2000 through 2015. Combined heat and power is the most common end use, followed by electricity. Since 2003, combined heat and power and electricity have steadily increased each year. Boiler and furnace fuel has also increased, but at a much slower rate. Projects that flare the biogas full time make up approximately 6 percent of all projects in 2015.

AgSTAR AD Database



	A	B	C	D	E	F	G	H	I	J	K	L
1	Project Name	Project Type	City	County	State	Digester Type	Status	Year Operational	Animal Type	Population Feeding Digester	Co-Digestion	Biogas Generation Estimate (cu_ft/day)
2	Cargill - Sandy River Farm	Farm Scale	Morrilton	Conway	AR	Covered Lagoon	Operational	2008	Swine	4,200		1,814,400
3	Stotz Southern Dairy	Farm Scale	Buckeye	Maricopa	AZ	Covered Lagoon	Operational	2011	Dairy	15,000		
4	Triple G Dairy	Farm Scale	Buckeye	Maricopa	AZ	Covered Lagoon	Operational	2011	Dairy	4,000		
5	Straus Family Dairy	Farm Scale	Marshall	Marin	CA	Covered Lagoon	Operational	2004	Dairy	362		14,832
6	CottonWood Dairy	Farm Scale	Atwater	Merced	CA	Covered Lagoon	Operational	2004	Dairy	5,000	Process water	432,000
7	Hilarides Dairy	Farm Scale	Lindsay	Tulare	CA	Covered Lagoon	Operational	2004	Dairy	1,500		
8	Langerwerf Dairy	Farm Scale	Durham	Butte	CA	Horizontal Plug Flow	Operational	1982	Dairy	750		30,000
9	Meadowbrook Dairy	Farm Scale	El Mirage	San Bernardino	CA	Horizontal Plug Flow	Operational	2004	Dairy	2,000		87,000
10	Castelanelli Bros. Dairy	Farm Scale	Lodi	San Joaquin	CA	Covered Lagoon	Operational	2004	Dairy	3,213		
11	Van Warmerdam Dairy	Farm Scale	Galt	Sacramento	CA	Covered Lagoon	Operational		Dairy	1,810		
12	Fiscalini Farms	Farm Scale	Modesto	Stanislaus	CA	Complete Mix	Operational	2008	Dairy	2,513	Ag residues; Dairy processing waste	165,000
13	Bob Giacomini Dairy	Farm Scale	Point Reyes Station	Marin	CA	Covered Lagoon	Operational	2009	Dairy	300	Process water	25,000
14	ABEC New Hope LLC	Farm Scale	Galt	Sacramento	CA	Covered Lagoon	Operational	2013	Dairy	1,700		90,000
15	ABEC Bidart-Old River LLC	Farm Scale	Bakersfield	Kern	CA	Complete Mix	Operational	2013	Dairy	15,500		600,000
16	Elite Energy	Farm Scale	Dos Palos	Merced	CA	Complete Mix	Operational	2013	Dairy	0		
	Pixley Biogas LLC	Centralized/Regional	Pixley	Tulare	CA	Mixed Plug Flow	Operational	2014	Dairy	2,000	Ag residues; Beverage &	

Increasing Scrutiny of Livestock Practices

STATE POLITICS

EPA, DNR asked to investigate large farm in Kewaunee County

April 08, 2015

0 Comments

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Inquiry into farm urged

Environmental groups want state and federal regulators to investigate manure handling practices of Kinnard Farms in Kewaunee County, and the effect it could have on water resources.

Journal Sentinel

By Lee Bergquist of the Journal Sentinel

Environmentalists and others in northeastern Wisconsin launched their latest attack Wednesday on large dairy farms, which they say are responsible for polluting ground and surface water.

Environmental groups asked the U.S. Environmental Protection Agency and the state Department of Natural Resources to investigate what the groups found:

Large quantities of manure from a single farm, Kinnard Farms of Casco in Kewaunee County, is the likely source of polluting drinking water and streams in the Town of Lincoln.

David A. Crass, a Madison-based lawyer for the farm, hadn't yet reviewed the request but rejected the premise that the farm is responsible for such problems.

The actions come after the groups in October 2014 asked the EPA to exercise emergency powers under the Safe Drinking Water Act to investigate groundwater contamination across the county.

Last year's request occurred two weeks before Republican Gov. Scott Walker's victory over Democrat Mary Burke.

Factory farming practices are under scrutiny again in N.C. after disastrous hurricane floods

By Arelis R. Hernández, Angela Fritz and Chris Mooney October 16

In North Carolina, massive flooding in the wake of Hurricane Matthew isolated or swamped these and other hog farms and their waste lagoons, raising fears of environmental contamination. (Arelis Hernández/The Washington Post)

Most Read

1 'Sorry I was being stupid,' he said in a farewell video after crashing. Then came his 'miracle.'

What’s Happening in U.S. Market?

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FARM POWERED

Barstow's Longview Farm

Barstow's Longview Farm in Hadley, Massachusetts is a seventh-generation family farm, founded in the early 1800s. The farm is a member of the the Cabot Creamery/Agri-Mark Cooperative. To sustain the farm for future generations, the Barstow family pursued an opportunity to house one of the first anaerobic digesters in New England on the farm.

U.S. Dairy Sustainability Awards

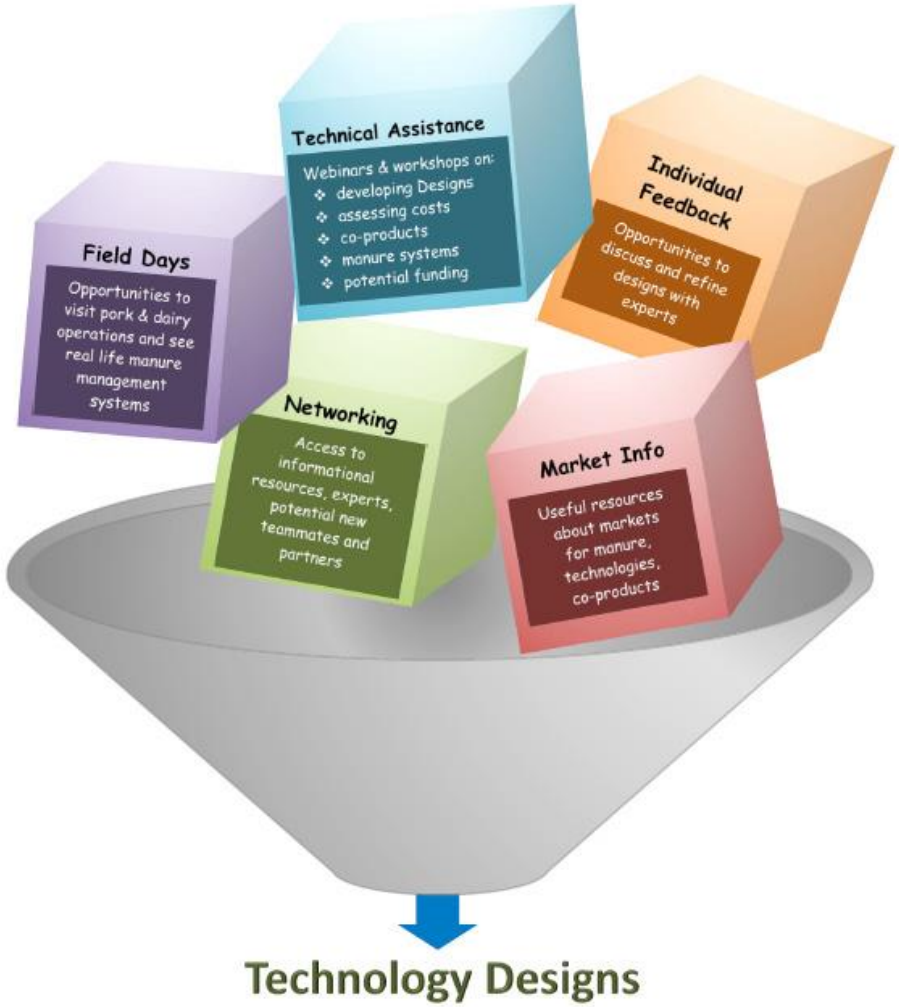
Cabot Creamery Cooperative awarded US Dairy Sustainability Award for organics waste recycling and renewable energy partnership with Barstow's Longview Farm and Vanguard Renewables

Search

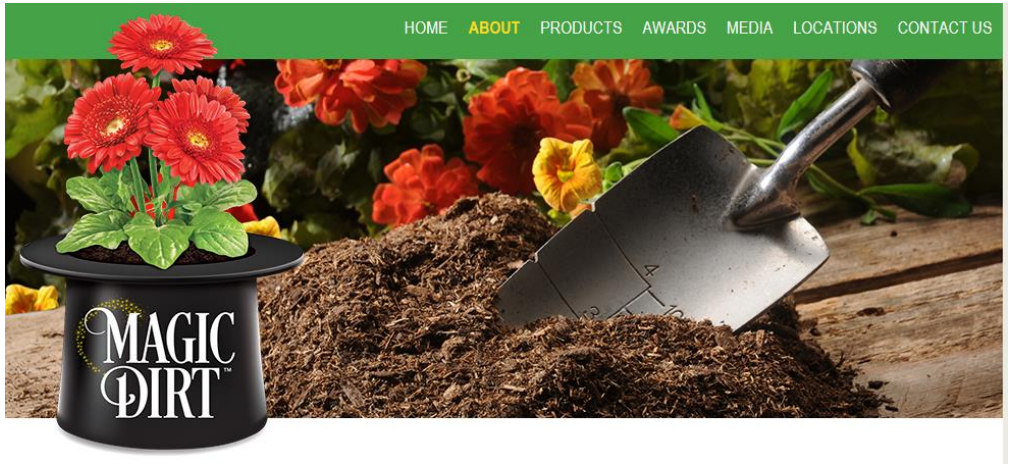
- Increased corn and hay crop

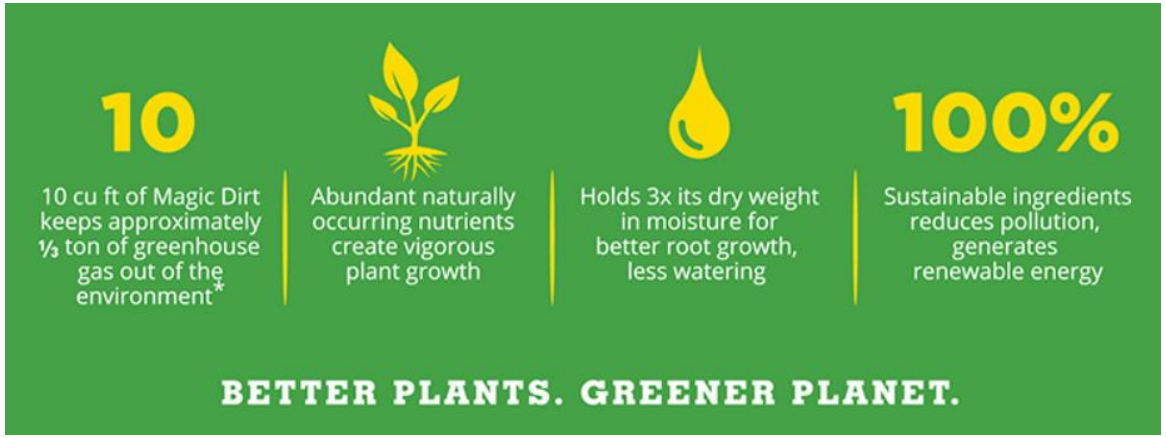
Hog Manure Biogas to Renewable Natural Gas (Roeslein Energy, Missouri, USA)

EPA Nutrient Recycling Challenge – Phase II



Digestate Solids Market





Garden Soil

Plant Food

Potting Soil

Raised Bed Soil

Soil Conditioner

RNG PRODUCTION FOR TRANSPORTATION FUEL

GREW BY 5X
BETWEEN 2013 AND 2015

25.9 M EGE — VS — 139.8 M EGE

IS ON PACE TO **TRIPLE** IN VOLUME
BY 2018

VS — **481.5 M EGE PROJECTED**

THE COALITION FOR
RENEWABLE NATURAL GAS

State Regulatory Action

GOVERNOR BROWN SIGNS NATION'S TOUGHEST SUPER POLLUTANT RESTRICTIONS INTO LAW

9-19-2016

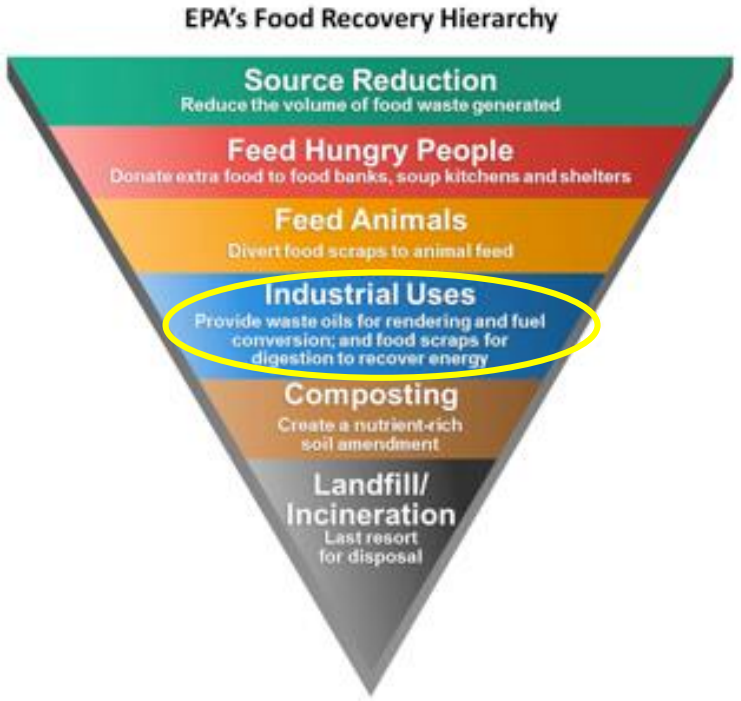

LONG BEACH - Governor Edmund G. Brown Jr. today signed SB 1383 by Senator Ricardo Lara (D-Bell Gardens), which establishes the nation's toughest restrictions on destructive super pollutants including black carbon, fluorinated gases and methane. If followed worldwide, these acts would help cut the projected rate of global warming in half by 2050.

"Cutting black carbon and other super pollutants is the critical next step in our program to combat climate change," said Governor Brown at a signing ceremony near a Long Beach playground bordered by oil refinery smokestacks. "This bill curbs these dangerous pollutants and thereby protects public health and slows climate change."

SB 1383 reduces the emission of super pollutants (also known as short-lived climate pollutants) and promotes renewable gas by requiring a 50 percent reduction in black carbon and 40 percent reduction in methane and hydrofluorocarbon from 2013 levels by 2030. Sources of these super pollutants include petroleum-based transportation fuels, agriculture, waste disposal and synthetic gases used in refrigeration, air conditioning and aerosol products.

On-Site Organics and Food Waste Recovery Addition to Farm AD

Growing Interest in Organics Diversion



Summary

- Biogas feedstock is there – livestock manure, ag residues, food processing and post-consumer food waste, source separated organics
- Low energy prices and competition from dropping solar/wind costs challenging to AD development
- High Renewable Fuel Standard and Low Carbon Fuel Standard credit prices are driving investment and interest in new RNG project development
- Broader ‘environmental market’ view of AD necessary for scaled growth

Thank You!

Websites

www.epa.gov/agstar

www.globalmethane.org

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