U.S. Anaerobic Digester Status: A 2011 Snapshot

Digester Systems Continue to Show Steady Growth

An estimated 176 anaerobic digestion systems for livestock manure were operating in the United States by the end of 2011. Farms are installing digesters to help meet their waste storage and energy needs as well as for the systems' benefits, such as greenhouse gas reductions, odor control, and creation of valuable byproducts (e.g., fibers for bedding). The total number of systems operating has grown steadily for more than a decade, with an average of 16 new digesters coming on line each year (see Figure 1). However, there is much potential for growth as this comprises less than two percent of the potential in the livestock sector alone.

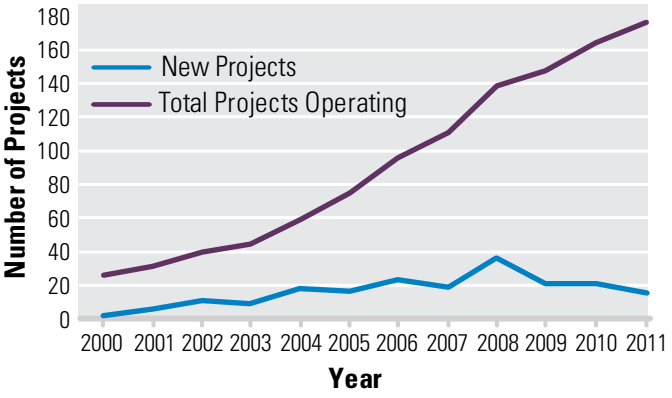

Figure 1. Annual Counts of Anaerobic Digester Projects

Digesters Generate 541 Million kWh of Energy

In 2011, digesters produced the equivalent of approximately 541 million kilowatt-hours (kWh) of useable energy (see Figure 2), enough to supply more than 36,000 average American homes for a year.[i] The majority of the energy is in the form of electricity (489 million kWh); however, some operations use the gas as a boiler fuel while others upgrade it for injection into natural gas pipelines or flare it for odor control.

More than half of the operating projects are combined heat and power systems. These projects not only generate electricity, but also capture heat, which can be used to warm farm buildings, provide hot water, or heat the digester.

2011 by the Numbers

- **176** digesters in operation
- **15** new digesters brought on line
- **541 million** kWh of energy generated
- **1.2 million** metric tons of CO_2e destroyed
- **301,000** metric tons of CO_2e avoided

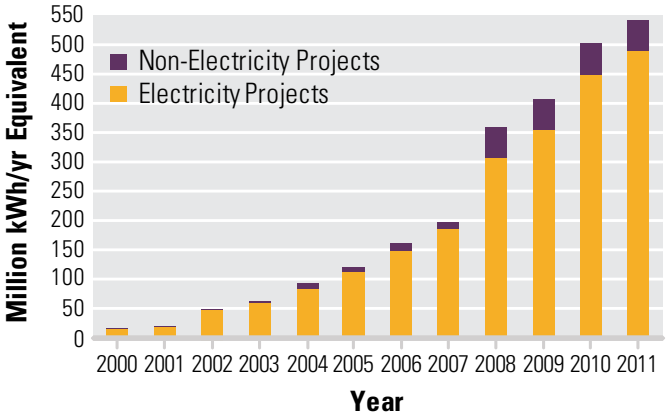

Figure 2. Trends in Energy Production by Anaerobic Digesters[ii]

Digesters Reduce Over 1 Million Metric Tons of CO_2e

Anaerobic digesters help to reduce greenhouse gas emissions both directly and indirectly (see Figure 3). Digesters capture and destroy methane, a potent greenhouse gas, that would otherwise be released directly to the atmosphere. The biogas captured by digesters can also be used as an energy source, which typically offsets fossil fuels use.

In 2011, digester systems directly reduced methane emissions by 55,000 metric tons, or 1.2 million metric tons carbon dioxide equivalent (CO_2e), and avoided 301,000 metric tons of CO_2e by displacing fossil fuels with captured methane. These reductions are equivalent to:

- Removing about 294,000 passenger vehicles from the road, or
- Reducing oil consumption by almost 3.5 million barrels, or
- Reducing gasoline consumption by over 168 million gallons.[iii]

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[i] Energy equivalency was estimated using U.S. EPA's 2011 LFGE Benefits Calculator, available at www.epa.gov/lmop/projects-candidates/lfge-calculator.html.

[ii] Output estimated includes a calculated equivalent kWh/yr output for the energy generation of direct thermal, pipeline injection, or other non-electricity-producing projects.

[iii] Emission reduction equivalencies were estimated using U.S. EPA's Greenhouse Gas Equivalencies Caluculator (May 2011 version), available at www.epa.gov/cleanenergy/energy-resources/calculator.html.

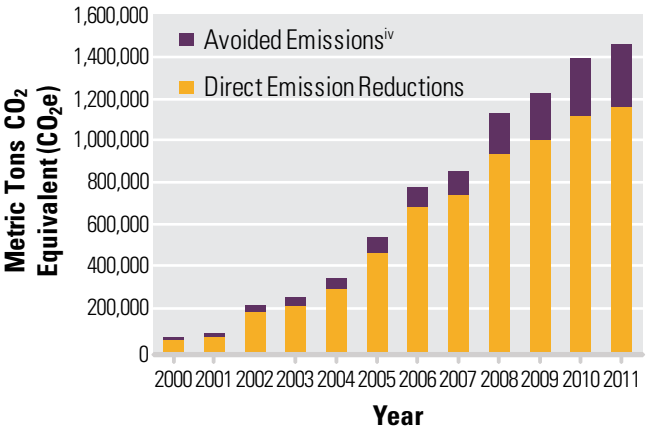

Figure 3. Trends in Greenhouse Gas Emission Reductions by Anaerobic Digesters

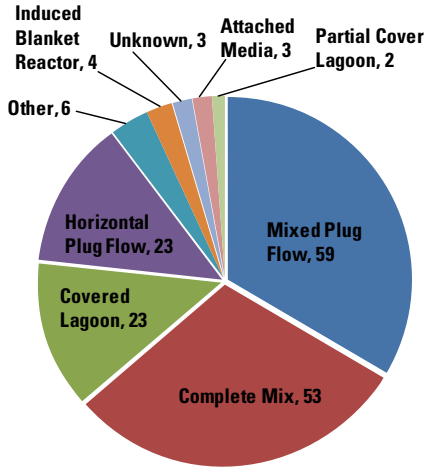

Figure 4. Number of Currently Operating U.S. Digesters by Technology (Dec 2011)

2011 Trends

Almost half of the new projects that became operational in 2011 were complete mix designs, with mixed plug flow designs composing another 40 percent. These two mesophilic temperature systems continue to be the dominant technology designs in relation to all operating digester systems in the U.S. as seen in Figure 4. The remainder of the systems include covered lagoons operating at ambient temperature, as well as attached growth and induced blanket reactors. Although the majority of systems use only livestock manure and are farm-owned and operated, other approaches are emerging. For example, approximately 30 percent of project operators reported co-digesting high-strength organic wastes (e.g., food waste, agriculture waste, cheese whey). There is also significant growth in third-party owned and operated systems.

Most digestion systems operate at dairy farms in the Midwest, West, and Northeast (see Figure 5). Of the new systems that came on line in 2011, three were installed at swine farms (Indiana, Pennsylvania, and North Carolina), while the rest were located at dairy farms in Pennsylvania (four projects), Vermont (three projects), Massachusetts (two projects), Ohio (one project), Wisconsin (one project), and Virginia (one project). Farms in 34 states now have anaerobic digestion systems.

Since 2003 the average project electric generating capacity has increased from 125 kilowatts (kW) to 454 kW. This increase is due not only to strong growth in the small-medium sized farm projects and increasing co-digestion, but the emergence of larger farm and centralized systems as well. Since 2006, ten 1+ megawatt (MW) and seven 2+ MW projects have been built. Also, the digester system with the largest electric generating capacity (4.5 MW) in the U.S., based solely on dairy manure, became operational in 2011.

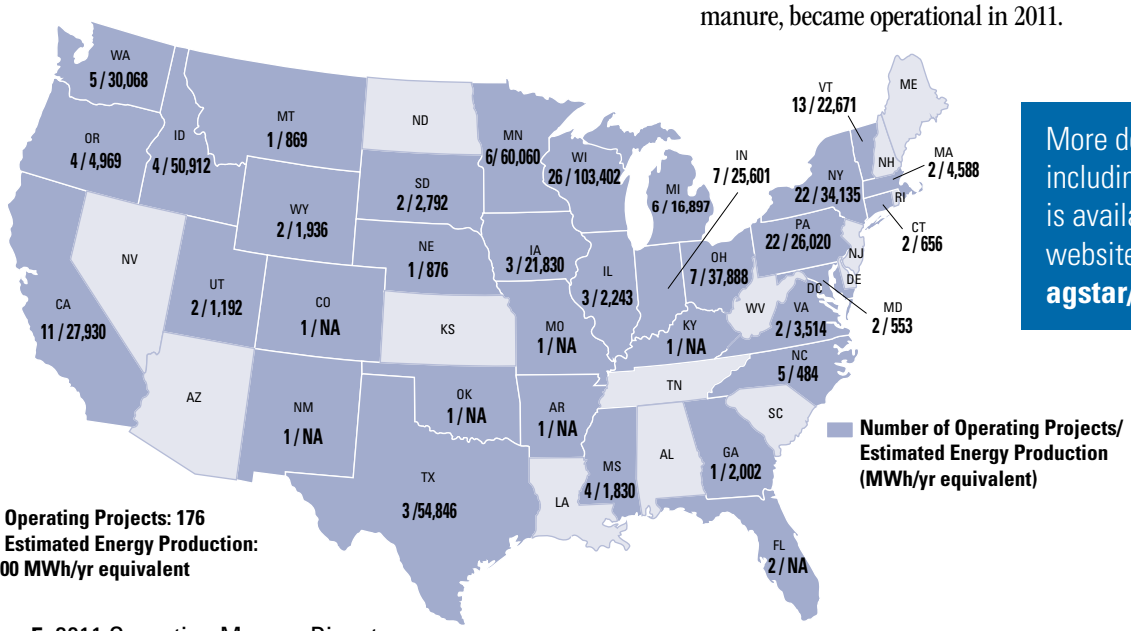

Figure 5. 2011 Operating Manure Digesters

More detailed information, including project profiles, is available on the AgSTAR website: **www.epa.gov/agstar/projects.**

[iv] Avoided emissions calculated based on EPA eGRID national average emission rates for electricity projects and EPA's "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006" for non-electricity projects. EPA eGRID data unavailable for 2001, 2002, 2003, and 2006 so values were extrapolated based on a linear decrease from 2000 to 2004 and from 2005 to 2007. EPA eGRID data for 2007 and EPA greenhouse gas inventory data for 2006 were assumed for subsequent years.