Appendix A Operating U.S. Farm-Scale Digesters

This section provides information on farm-scale digester systems currently operating at commercial livestock farms in the U.S. Of the 40 operating digester systems, nine are at swine farms, 29 are at dairy farms, one is at a caged layer farm, and one is at a duck farm. Three of these systems are centralized digester operations for dairy farms that receive manure from surrounding dairy farms. Table A-1 provides information about each of these digester systems. The table is organized by animal type and state location.

In the past two years, the number of operating farm-scale digesters has increased by nearly 30 percent. In addition, seven additional systems are currently under construction or in start-up (Table A-2). AgSTAR estimates that in October 2002, at least 40 additional systems were in various stages of planning and should come on line during the next several years.

In 35 of the 40 operational systems, the captured biogas is used to generate electrical power and heat. The systems combined produce the equivalent of approximately 4 MW of energy output per year. The remaining five systems flare the captured gas for odor control. Each year, the 40 operating digesters prevent the emission of nearly 124,000 metric tons of methane, on a carbon dioxide equivalent basis,[1] from entering the atmosphere.

[1]Greenhouse gas emissions are most commonly expressed as metric tons of carbon dioxide equivalents ($MTCO_2E$/year). This measure is used to compare the emissions of different greenhouse gases based on their potential to trap heat in the atmosphere. Methane has 21 times the global warming potential of CO_2. A metric ton is 1.1 tons.

Appendix A Operating U.S. Farm-Scale Digesters

Table A-1. Operating U.S. Digesters, October 2002

Location	Digester Type	Year Operational	Animal Type and Population	Manure Handling Method	Approximate Total Installed Cost	Biogas End-Use	Operational Output (kilowatt)	Methane Reduction ($MTCO_2E$/year)
Dairy Farms								
CA	Mesophilic plug flow, flexible top	1982	Dairy; 400 milkers	Scrape	$200,000	Electricity and hot water	40	1,186
CA	Mesophilic plug flow, flexible top	2002	Dairy; 650 milkers	Solids separator; scrape	$386,000	Electricity and hot water	100	2,965
CA	Unheated partially covered lagoon	1998	Dairy; 200 to 300 cows	Flush	$225,000	Flare	0	800
CA	Thermophilic-mesophilic complete mix tanks	2001	Dairy; 5,000	Vacuum scrape	Not available	Electricity and hot water	200	119
CA	Mesophilic plug flow, fixed top	2002	Dairy; 7,000 milkers, 3,000 other	Vacuum scrape	$1,800,000	Electricity and hot water	500	296
CA	Unheated partially covered lagoon	2000	Dairy; 200 milkers, 50 dry	Flush and scrape	Not available	Electricity and hot water	25	741
CT	Mesophilic complete mix	1997	Dairy; 600 milkers	Scrape	$450,000	Electricity	55	1,631
CT	Mesophilic plug flow, flexible cover	1997	Dairy; 200 milkers	Scrape	$149,000	Hot water and flare	0	1,387

Appendix A Operating U.S. Farm-Scale Digesters

Location	Digester Type	Year Operational	Animal Type and Population	Manure Handling Method	Approximate Total Installed Cost	Biogas End-Use	Operational Output (kilowatt)	Methane Reduction ($MTCO_2E$/year)
FL	Unheated fixed film	2000	Dairy; 500 cows	Hydraulic flush	$150,000	Hot water and flare	0	3,467
IA	Mesophilic plug flow, fixed top	2002	Dairy; 480 cows	Scrape	$348,000	Electricity and heat	80	2,372
IA	Mesophilic plug flow, fixed top	2002	Dairy, 800 cows	Scrape	$450,000	Electricity and hot water	100	2,965
IA	Mesophilic plug flow, fixed top	2002	Dairy; 170 (100 milkers, 20 dry)	Scrape	$200,000	Hot water	0	1,179
IL	Mesophilic plug flow, flexible top		Dairy; 1,400 lactating	Scrape	$1,200,000	Electricity	360	10,673
IL	Mesophilic plug flow, flexible top		Dairy; 2,000 lactating	Scrape	$875,000	Electricity	246	7,293
MD	Mesophilic slurry loop tank	1994	Dairy; 120 lactating, 70 heifers	Scrape	$500,000	Flare	0	1,317
MI	Plug flow	1981	Dairy; 730 milkers	Scrape	$150,000	Electricity	0	5,061
MN	Mesophilic plug flow, flexible top	1999	Dairy; 850 milkers	Scrape	$355,000	Electricity and hot water	130	3,854
NY	Mesophilic plug flow, flexible top	1998	Dairy; 500 to 550	Scrape	$295,700	Electricity and hot water	44	3,640
NY	Mesophilic complete mix tank	1985	Dairy; 295 milkers	Scrape	$500,000	Electricity and hot water	25	2,045

Appendix A Operating U.S. Farm-Scale Digesters

Location	Digester Type	Year Operational	Animal Type and Population	Manure Handling Method	Approximate Total Installed Cost	Biogas End-Use	Operational Output (kilowatt)	Methane Reduction ($MTCO_2E$/year)
NY	Mesophilic complete mix, flexible top	2001	Dairy; 560 milkers, 40 dry	Scrape and gravity flow	$350,000	Electricity and hot water	130	3,854
NY	Mesophilic plug flow, flexible top	2001	Dairy; 850 milkers, 100 dry	Continuous scrape	$400,000	Hot water	0	1,779
NY	Mesophilic, fixed film tank	2001	Dairy; 100 milkers	Gutter flush with liquid solids separation	Not available	Hot water	0	693
PA	Mesophilic slurry loop, fixed top	1983	Dairy; 250 milkers	Scrape	$80,000	Electricity and hot water	45	1,334
PA	Mesophilic slurry loop, fixed top	1979, 1981, 1984	Dairy; 2,300 milkers	Scrape	$225,000 each	Electricity and hot water	350	10,376
VT	Mesophilic plug flow, flexible top	1982	Dairy; 340 milkers	Scrape	$300,000	Electricity and hot water (steam)	28	2,357
WI	Mesophilic plug flow, flexible top	2002	Dairy; 900 cows	Scrape	$425,000	Electricity and hot water	125	3,706
WI	Mesophilic two-stage mixed, fixed top	2002	Dairy; 600 milkers	Scrape	$550,000	Digester and dairy heat, electricity, and hot water	135	4,002

Appendix A Operating U.S. Farm-Scale Digesters

Location	Digester Type	Year Operational	Animal Type and Population	Manure Handling Method	Approximate Total Installed Cost	Biogas End-Use	Operational Output (kilowatt)	Methane Reduction ($MTCO_2E$/year)
WI	Mesophilic two-stage mixed, fixed top	2002	Dairy; 750 cows	Recycle flush	$487,500	Electricity, heat, and hot water	160	4,743
WI	Mesophilic two-stage mixed, fixed top	2002	Dairy; 2,800 milkers	Scrape	$1,400,000	Digester heat, dairy heat, solids drying, electricity, hot water, and flare	425	12,600
Swine Farms								
CA	Unheated covered lagoon	1982	Swine; 300 sows farrow-to-finish	Flush	$220,000	Electricity and hot air	25	741
CO	Mesophilic complete mix, flexible top	1999	Swine; 5,000 sow farrow-to-wean and 1,200 growing pigs	Pull plug	$368,000	Electricity	50	1,482
IA	Unheated bank-to-bank covered lagoon	1998	Swine; 3,000 nursery pigs	Pull plug	$15,000	Flare	0	1,738
IA	Mesophilic complete mix, flexible top	1996	Swine; 5,000 sows farrow-to-wean	Pull plug	$500,000	Electricity	50	1,482

Appendix A Operating U.S. Farm-Scale Digesters

Location	Digester Type	Year Operational	Animal Type and Population	Manure Handling Method	Approximate Total Installed Cost	Biogas End-Use	Operational Output (kilowatt)	Methane Reduction ($MTCO_2E$/year)
IL	Mesophilic bank-to-bank covered lagoon	1998	Swine; 8,300 finishing hogs	Pull plug	$140,000	Hot water and flare	0	2,380
MS	Unheated bank-to-bank covered lagoon	1998	Swine; 145 pigs	Recycle flush	$27,000	Flare	0	84
NC	Unheated bank-to-bank covered lagoon	1997	Swine; 4,000 sows farrow-to-wean	Pull plug and gravity flow	$290,000	Electricity and hot water	41	2,317
PA	Mesophilic plug flow, flexible top	1985	Swine; 4,000	Scrape	$225,000	Electricity and hot water; flare	130	3,854
PA	Mesophilic complete mix	1985	Swine; 1,000 sows farrow-to-finish	Scrape	$325,000	Electricity and hot water	33	1,666

Appendix A Operating U.S. Farm-Scale Digesters

Location	Digester Type	Year Operational	Animal Type and Population	Manure Handling Method	Approximate Total Installed Cost	Biogas End-Use	Operational Output (kilowatt)	Methane Reduction ($MTCO_2E$/year)
Other Animal Operations								
PA	Mesophilic plug flow, slurry loop, fixed top	1983	Chicken; 350,000 caged layers	Scrape	$125,000	Electricity and hot water	150	4,447
WI	Mesophilic complete mix, fixed top	1988	Ducks; 300,000	Scrape	$500,000	Digester heat and electricity	180	5,336

Reprinted from U.S. EPA, "Current Status of Farm-Scale Digesters," *AgSTAR Digest,* Winter 2003, available online at www.epa.gov/agstar/library/digest.htm

Appendix A Operating U.S. Farm-Scale Digesters

Table A-2. U.S. Digesters Under Construction and in Start-Up, October 2002

Location	Digester Type	Animal Type and Population	Manure Handling Method	Estimated Total Installed Cost	Biogas End-Use
IN	Mesophilic two-stage mixed, fixed top	Dairy; 3,500 cows	Scrape	$1,750,000	Digester heat, solids drying, dairy heat, electricity, hot water, and flare
MN	Mesophilic plug flow, flexible top	Dairy; 3,000 milkers	Scrape	Not available	Electricity
NY	Mesophilic plug flow, fixed top	Dairy; 1,100 cows	Scrape	$650,000	Electricity and hot water
NY	Mesophilic plug flow, fixed top	Dairy; 1,000 milkers, 200 dry	Scrape	$900,000	Electricity, hot air, and hot water
OR	Mesophilic complete mix, fixed top	Dairy; 325 milkers	Scrape	Not available	Electricity
OR	Mesophilic plug flow, flexible top	Dairy; 4,000 cows	Scrape	Not available	Electricity
WI	Thermophilic complete mix, fixed top	Dairy; 1,425 milkers	Scrape	Not available	Electricity

Reprinted from U.S. EPA, "Current Status of Farm-Scale Digesters," *AgSTAR Digest*, Winter 2003, available online at www.epa.gov/agstar/library/digest.htm