Steps in the Anaerobic Digester Series

Understanding Technical Feasibility

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Estimate energy generation potential

Biogas generated by anaerobic digestion typically contains between 60 and 70 percent methane. The predicted energy production for different types of animal wastes is shown in Table 1. To put the energy value of animal waste into perspective, a well-insulated three-bedroom home uses about 32 kilowatt-hours (kWh) per day, or 110,000 Btu, for heating during cold weather. If half of the biogas generated goes back into maintaining the necessary temperature of the digester, it would take the manure from approximately 21 head of cattle to produce enough biogas to heat an average home. This assumes a thermal efficiency of 65 percent for a furnace using biogas.

Table 1. Energy value for various animal wastes based on a 1,000-lb animal.

	Volatile solids (lbs/day/1,000 lbs)	Methane production (ft^3/animal/day)	Energy value (kWh/1,000-lb animal/day)
Dairy cattle	8	17	4.7
Beef cattle	6	13	3.5
Swine	5	18	5.0

Estimating energy generation

Calculate the energy production per day (EPD) in kWh per day:

No. of animals × kWh per 1,000-lb. animal per day × typical animal weight, in lbs.
= EPD, in kWh per day

Note: kWh/1,000-lb. animal/day is the energy value available Table 1's third column.

To estimate savings associated with use of biogas for on-site heating, first determine the available energy after biogas (AEB) is used for heating the digester. At a conservative estimate, 50 percent of the produced biogas is used to meet heating requirements:

EPD × 0.5 = Available energy after biogas, in kWh per day

Calculating cost savings

Determine your on-site natural gas demand (ONGD). Estimate ONGD efficiency by looking at your utility bill over the past year. Most utilities can provide one year of records upon request.

If AEB is not in excess of ONGD, use this equation to estimate cost savings (assuming 65 percent efficiency for use of biogas as a fuel):

Available energy after biogas × 0.65 efficiency × cost of energy per day
= Cost savings, in dollars per day

Note: The cost of energy per day should be in units of dollars per kWh. Gas bills often report energy in Btu. There are 3,412 Btu in 1 kWh. Some newer furnaces may be more efficient than the 65 percent assumed for these calculations, so check with the manufacturer to determine the efficiency of your furnace.

If the EPD is in excess of the on-site natural gas demand, then ONGD should be used in place of EPD:

ONGD × 0.65 efficiency × cost of energy per day = Cost savings, in dollars per day

Note: Cost of energy per day should be in units of dollars per kWh.

If you intend to install a generator for on-site use or to sell electricity to a utility,

determine your on-site electricity demand (OED). Estimate OED by looking at your average electricity use on your utility bills over the past year; most utilities can provide one year of records upon request. Energy in excess of OED can be sold to your utility if they are amenable to such an arrangement. You will need to research this possibility if you are interested in selling generated energy to the utility (see discussion on net metering in the *Economics* guide).

Determine electricity available (EA) from the generator in kWh per day, assuming an efficiency of 35 percent for use of biogas in a generator:

EPD × 0.35 efficiency = EA, in kWh/day

Estimate savings from on-site use of energy. If the EA is lower than OED, then only EA should be used for calculation of cost savings.

OED × cost of energy per day
= Cost savings, in dollars per day

If the EA exceeds OED, then some energy may be sold to the utility and you must determine the price (P) they are willing to pay in dollars per kWh. P is the wholesale rate for purchasing electricity, not the retail rate you are charged by the utility. In Missouri, P is often $0.01 to $0.03 per kWh but can be as high as $0.10 per kWh in other states. You can then estimate revenue from electricity sales:

(EA – OED) × P = Revenue, in dollars per day

Other energy savings from a digester can be attained by recovering heat from the water from the engine generating electricity. This could be particularly important in dairy operations.

References

USDA Natural Resources Conservation Service. (1992). Chapter 4: Agricultural Waste Characteristics. *Agricultural Waste Management Field Handbook*. Washington DC: USDA.

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