STEP 2

E3A: Anaerobic Digester Applications for the Farm or Ranch

Steps in the Anaerobic Digester Series

1. Understanding and Technical Feasibility
2. **Estimate Potential**
3. Economics
4. Selection
5. Maintenance

Estimate Energy Generation Potential

Biogas generated by anaerobic digestion typically contains between 60-70 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 takes about 32 kilowatt hours (kWh), or110,000 BTU, per day for heating during cold weather. If 50 percent of the biogas goes back into maintaining the necessary temperature of the digester, it would take the manure from approximately 21 cows to produce enough biogas to heat an average home. This assumes an efficiency of 65 percent for a furnace using biogas.

Table 1. Energy value for various animal wastes based on a 1000 lb animal.

	Volatile Solids (lb/day/1,000 lb)	Methane Production (ft^3/animal/day)	Energy Value (kWh/animal/day)
Dairy cattle	8	17	4.7
Beef cattle	6	13	3.5
Swine	5	18	5.0

The steps to estimate energy generation from animal waste at your facility and associated cost savings are outlined below.

1. Calculate the energy production per day (EPD) in kWh/day

   Number of animals × kWh/(1000 lb animal·day) × Typical weight per animal (lb) = EPD(kWh/day)

   Note: kWh/1,000 lb animal/day is the energy value available in the third column of Table 1.

2. Estimate savings associated with use of biogas for on-site heating.
   - You will first need to determine the available energy after biogas is utilized for heating the digester (AEB). A conservative estimate is that 50 percent of the produced biogas will be used to meet the heating requirement:

     AEB (kWh/day) = EPD×0.50

   - Determine your on-site natural gas demand (ONGD). Efficiency ONGD can be estimated by looking at your utility bill over the last year. Most utilities can provide one year of records upon request.
   - If AEB is not in excess of ONGD, the following equation can be used to estimate cost savings (assuming 65 percent efficiency for use of biogas as a fuel):

     Cost Savings ($/day) = AEB × 0.65 Efficiency × (Cost of Energy)/day

     Note: The cost of energy per day should be in units of dollars per kWh. Gas bills often report energy in BTU. There is are 3412 BTU in 1 kWh.

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

     Cost Savings ($/day) = ONGD × 0.65 Efficiency × (Cost of Energy)/day

     Note: The cost of energy per day should be in units of dollars per kWh

3. If you will be installing a generator for on-site use of electricity and/or selling the electricity to a utility, you will need to determine your on-site electricity demand

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(OED). OED can be estimated by looking at your utility bill over the last year. Most utilities can provide one year of records upon request. Energy in excess of the OED can be sold to the utility if the local utility is amenable to purchasing the electricity. You will need to research this possibility if you are interested in selling generated energy to the utility (see discussion on net metering in Step3: Determine Economic Feasibility).

- Determine electricity available (EA) from the generator kWh/day (assuming and efficiency of 35 percent for use of biogas in a generator):

EA (kWh/day) = EPD × 0.35 Efficiency

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

Cost Savings ($/day) = OED × (Cost of Energy)/day

Note: The cost of energy per day should be in units of dollars per kWh

- If the EA exceeds OED, then some energy may be sold to the utility and you must determine the price they are willing to pay (P) in dollars per kWh. P is the wholesale rate of electricity, not the retail you are charged from the utility to purchase electricity. In Colorado, P is often 0.01-0.03 dollars per kWh (1-3 cents per kWh), but can be as high as 0.10 dollars per kWh (10 cents per kWh) in other states. You can then estimate revenue from electricity sales (RE):

RE ($/day) = (EA - OED) × P

Reference

USDA Soil Conservation Service (1992), Agricultural Waste Management Handbook, Chapter 4: Agricultural Waste Characteristics.

Notes