



Energy Opportunities Anaerobic Digestion: Supermarkets

Fresh fruit and vegetable waste from supermarkets can be an energy source. An anaerobic digester will partially convert the fresh fruit and vegetables to energy in the form of biogas which contains methane (CH₄).

Samples of fresh fruit and vegetables were collected in Alberta and analyzed to determine their potential energy production. The average potential energy used (see referenced map) was 1173 MJ/T of feedstock and was calculated from these sources

and combined with values from referenced literature. Fresh fruit and vegetable waste varies throughout regions and seasons. Samples collected contained portions of fruit and vegetables that were representative of what is disposed of normally, for example, samples were not collected during December due to higher than normal quantities of oranges in the waste. The range of characteristics, methane yield and energy production is shown in Table 1.

Table 1. Potential energy from supermarket fresh fruit and vegetables

| Source | Description | Total Solids (%) | Volatile Solids (%) | Accumulated CH ₄ (NL/kg VS) | Energy (MJ/T _{feedstock}) |
|--------------------------------|-------------|------------------|---------------------|--|-------------------------------------|
| Supermarket ^{a, b, c} | Fresh waste | 5 – 25 | 75 – 90 | 163 – 400 | 311 – 2916 |

Background for Methane Yields

Volatile Solids (VS) analysis determines the total amount of organic matter (OM) in a feedstock. It is a definitive measure of OM on a mass basis. Feedstocks containing more than 60 or 70% VS on a dry matter basis are good candidates for anaerobic digestion. The non-volatile solids, or ash content, of a feedstock takes up valuable digester volume and will not contribute to biogas production (Hamilton, 2012).

The methane yield is determined by taking a sample of feedstock, seeding it with anaerobic microorganisms, mixing with a nutrient medium, and incubating it. The volume of CH₄ produced during the incubation period is measured and interpreted as specific methane yield or the volume of CH₄ produced per mass of VS added (Hamilton, 2012). The methane yield is reported as normalized litres per kilogram VS added (NL/kg VS).

To convert from methane yield to Energy (Vik, 2003):

- Convert the VS (%TS) to kg of VS/T of feedstock
- Use VS (kg) to convert methane yield from NL/kg VS to m³/T of feedstock
- Apply a 90% efficiency rate to represent commercial operations
- Use the lower heating value for CH₄, 36 MJ/m³, to determine MJ/T of feedstock
- To determine the potential MW the overall supply of the feedstock available must be determined. This is the power output from the feedstock that went into the digester.

NOTE: The energy potential displayed on the map is the pure energy calculated above. The CH₄ can be used by a combined heat and power (CHP) unit to transfer the pure energy into electrical output and heat. On average, units produce 40% electricity (Clarke Energy, 2013).

A CHP unit is typically a reciprocating gas engine that uses the gas, CH₄, to drive a crank shaft. The crank shaft turns an alternator to produce electricity. Heat is released during the gas combustion process (Clarke Energy, 2013). This heat can be recovered during cogeneration in order to maximize the heating value of the system.

References

- Clarke Energy. 2013. CHP efficiency for biogas. www.clarke-energy.com/2013/chp-cogen-efficiency-biogas/. (Accessed: 2013).
- ^a Danner, W. Unknown. Energy through waste management, a UNIDO initiative. http://www.unidorc.org/pdf/UNIDO_%20Kerala_WM_Seminar.pdf (Accessed: June 2013).
- Hamilton, D.W. 2012. Anaerobic digestion of animal manures: methane production potential of waste materials. BAE-1762. Oklahoma: Oklahoma Cooperative Extension Service.
- ^b Morar, M.V., H. Oechsner, Z. Dancea, and S. Kusch. 2009. The anaerobic digestion as process step for hygienisation of liquid manure and agro-industrial waste. *Bulletin UASVM, Agriculture* 66(2): 149-154.
- ^c Steffan, R., O. Szolar and R. Braun. 1998. Feedstocks for anaerobic digestion. Vienna: University of Agricultural Sciences Vienna.
- Vik, T.E. 2003. Anaerobic digester methane to energy a statewide assessment. MCM. No. W0937-920459. Neenah, Wisconsin: McMahon Associates, Inc.

