Evaluation of low-volume anaerobic digestion (LVAD) for on-site food waste conversion

This study evaluates the feasibility of LVAD using RIT as an institutional food waste generator case study.

Background

Anaerobic digestion (AD) technology is well-suited for converting food waste into value-added products such as biogas and fertilizer. There are a significant number of multi-million-dollar AD facilities operating world-wide, mostly converting livestock wastes for electricity production in industrialized countries. At the same time, there are millions of much smaller household-scale anaerobic digesters deployed in developing countries, to provide biogas resources for heating and cooking.

As food waste disposal in landfills is expected to be increasingly constrained in the future, it is important to consider alternative conversion pathways such as AD. However, it is not immediately apparent what deployment strategy should be followed as huge volumes of food waste come onto the market. While most commercial AD facilities are centralized operations on large dairy farms, other options include centralized systems at waste water treatment plants or landfills, or low volume anaerobic digestion (LVAD) systems deployed at individual waste generation sites. The latter option offers some notable advantages in that the generator of the waste can benefit from the AD co-products while avoiding disposal fees. Moreover, there may be opportunities to directly utilize biogas for heating or steam production instead of producing electricity.

Research Overview

In this research, an assessment of the economic feasibility LVAD systems at institutional food waste generators was investigated. Rochester Institute of Technology (RIT) was chosen as a case study to assess the possibilities of implementing an anaerobic digester utilizing the campus organic waste resources. The RIT population consists of approximately 15,400 undergraduates, 3,200 graduate students and 3,854 faculty and staff.

The campus generates approximately 917,000 pounds (416 metric tons) of food waste per year.

Our initial study indicates that an AD system at RIT would produce 43,000 m^3 of methane per year, with solid digestate of 21 metric tons and liquid digestate of 85,000 gallons (Figure 1).

In the economic model, two types of AD systems were considered to utilize biogas for different applications: Scenario 1. direct utilization of biogas through boiler system (AD+BG), and Scenario 2. electricity and waste heat generation through CHP system (AD+EG). The estimated capital cost of AD system was assumed to be $400,000 ($960/MT) for Scenario 1 and $500,000 ($1,200/MT) for Scenario 2.

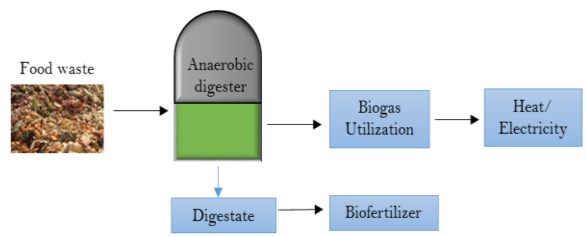

Figure 1 - Representative illustration of a LVAD system at RIT

Outcomes

A model of the RIT LVAD system showed positive net present value only after 15 years without incentives under direct combustion of biogas and the current volume of food waste available on campus. However, this study further showed that adopting on-site LVAD systems at food waste generation sites can be economically viable if 1. capital costs of AD systems are significantly reduced, and 2. additional sources of revenue such as accepting food waste outside of campus are implemented to generate income by receiving tipping fees and to produce more energy output and monetize the liquid or solid bio-fertilizer from byproduct (digestate) produced from the anaerobic digestion of food waste. Developing new markets for digestate products are critical to encourage deployment of pure food waste digesters in non-farm locations where field spreading is not a viable option.

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