EXECUTIVE SUMMARY

WERF

WATER ENVIRONMENT RESEARCH FOUNDATION | INFRASTRUCTURE MANAGEMENT

An Assessment Tool for Managing Cost-Effective Energy Recovery from Anaerobically Digested Wastewater Solids (LCAMER)

Treatment of wastewater residual solids is one of the most demanding and costly requirements of wastewater treatment. However, wastewater residuals are also a potential source of heat and power. Anaerobic digestion processes convert residuals to biogas and maximize energy production from the solids treatment process while minimizing the overall treatment cost. Techniques for optimizing biogas production have been investigated for years, but only recently have other technologies such as fuel cells been developed to provide viable options to recover heat, power, and electricity from the biogas production.

The LCAMER tool helps managers determine the most cost-effective alternative for recovering digester gas energy.

The rapidly fluctuating energy costs provide an incentive to investigate the use of anaerobic digestion of wastewater solids for on-site energy recovery at municipal wastewater treatment facilities. This study used a life-cycle assessment (LCA) approach to develop a spreadsheet model that enables users to compare the relative economic merits of one energy recovery technology to another over the life of the systems.

To assist municipalities in selecting an energy recovery technology, the project developed a spreadsheet model – The Life Cycle Assessment Manager for Energy Recovery (LCAMER) – that incorporates site-specific information on factors such as energy costs, regulatory conditions, wastewater plant capacity and operations, and social values to identify the most feasible alternatives.

LCAMER Helps Users Compare Returns on Investment

LCAMER is a unique spreadsheet-based tool that helps wastewater treatment plant owners and LCAMER engineers with their decisions about recovering energy from anaerobic digestion of wastewater solids. Using a life cycle assessment approach, which incorporates factors such as equipment lifetime and the cost of borrowed money, users can compare the payback periods or internal rates of return for a variety of processes:

- **anaerobic digestion** – mesophilic, thermophilic, and temperature-phased
- **gas pretreatment** – hydrogen sulfide, siloxanes, and carbon dioxide
- **energy recovery** – boilers, engine-generators, turbines, heat exchangers, fuel cells, and direct drive engines

LCAMER users can use the spreadsheet model to evaluate benefits and costs of upgrading their existing energy recovery technologies. For example, municipalities that already operate mesophilic digesters with a boiler for heat recovery can evaluate use of alternate recovery technologies, such as engines, turbines, or fuel cells. Based on an analysis of the digester gas for contaminants such as hydrogen sulfide or siloxanes, gas pretreatment costs can also be included. Others may wish to use the anaerobic digester process configurations to determine the costs of upgrading from mesophilic to thermophilic digestion with their current energy recovery technology.

BENEFITS

- Enables WWTP managers to use site-specific plant inputs to assess the most cost-effective alternative for recovering digester gas energy.
- Helps WWTP managers determine the price for purchased energy at which a recovery technology would become cost effective.
- Provides a tool – LCAMER – that will help tap green energy and reduce green house gas (GHG) emissions.
- Provides a tool that policymakers can use in their analyses for reducing emissions and establishing GHG credits.

RELATED PRODUCTS

State of Science Report: Energy and Resource Recovery from Sludge (OWSO3R07)

RELATED ONGOING RESEARCH

Co-Digestion of Organic Wastes and Wastewater Solids (OWSO5R07)

Life-Cycle Tool for Green Energy Options (OWSO6R07TO2)

AVAILABLE FORMAT

Online PDF, User's Guide, and Database.

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A detailed user's manual accompanies the model, including four model-use scenarios describing potential applications. These applications include:

- baseline comparison of payback periods for different energy recover processes;
- payback periods for the baseline with conversion form mesophilic to thermophilic digestion;
- payback periods for the baseline with advanced sludge treatment processes for higher volatile solids reduction and greater gas production; and
- payback periods for the baseline and considering of peak electricity price shifting.

LCAMER Anticipates Climate Change Programs

The benefits of fully recovering digester gas energy go beyond just dollars and cents. Onsite production of energy from digester gas reduces the need to purchase offsite electricity, thus reducing emissions of greenhouse gases and other pollutants, such as NOx, CO, SOx and particulates. The LCAMER model makes provisions for claiming credits for carbon dioxide reductions in the cost analysis, if allowable. The LCAMER model also includes criteria air pollutant emission factors for the various energy recovery processes, so that it is possible to determine if certain processes might be better than others for use in regions of impaired air quality. The emission factors have been incorporated into the LCAMER spreadsheet so that emission rates of air pollutants can be calculated for all technologies evaluated.

Researchers Used Wastewater Treatment Plant Data to Ensure Accuracy

Through the course of this project, the researchers evaluated boilers, engine generators, turbines, microturbines, direct drive engines, and fuel cells (phosphoric acid and molten carbonate). They acquired the data from surveys of treatment plants, from site visits to selected facilities, from equipment suppliers, and from the published technical literature.

The spreadsheet combines all available options for recovering the energy value of digester gas. Many of the economic functions for capital and operating and maintenance costs were developed based on actual treatment plant data acquired from over 40 wastewater treatment plants in North America. These data are supplemented by information from equipment suppliers. The final report also includes a comprehensive literature reference database that is a valuable reference source for agencies interested in energy recovery from the anaerobic digestion process and energy recovery facilities, such as gas engine generators or fuel cells.

This tool is available on the WERF website and is free to subscribers. Non-subscribers can purchase the LCAMER tool for a fee. Version 2.0 is planned for a 2010 release. For more information, contact WERF Program Director Lauren Fillmore at 703-684-2470, ext. 7153, Lfillmore@werf.org.

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