Renewable Power Generation from Alternative Feedstock Fuels

Anaerobic Digestion of Multiple Feedstocks for Biogas Production, Combined Heat and Power (CHP) Generation

Figure 1. One of two state-of-the-art anaerobic digester tanks where the biogas will be produced. Each tank has an 850,000 gallon capacity and will produce enough biogas to operate a 710 kW engine to generate renewable electrical power.

Photo courtesy of John Fiscalini, Fiscalini Farms.

Introduction

Tens of thousands of dairy and swine farms operate throughout the United States, generating hundreds of millions of tons of manure. From this manure, millions of tons of methane (CH_4) are emitted into the atmosphere. Methane, according to the Intergovernmental Panel on Climate Change, is a greenhouse gas 72 times more potent than carbon dioxide (CO_2) over a 20-year period. Thus, the emitted methane presents a major challenge, but also an opportunity, for the implementation of a sustainable combined heat and power (CHP) generation system that is based on non-fossil fuels. However, given the uncertainties of government regulatory agencies and concerns of the dairy industry, anaerobic digestion renewable power and heat generation systems are not being adopted at the rate required for commercial viability of the industry.

This project aims to address this barrier through the demonstration of an anaerobic digestion power generation system that can operate efficiently, effectively, and within the boundaries of California environmental regulations. The system will generate biogas using multiple fuel feedstock sources, including cow manure, sudan grass green chop silage, and whey from on-site industrial food production. Furthermore, by using multiple feedstocks, the developed system will increase the amount of power generated from the dairy anaerobic digestion power generation system and will offer an economic return on the investment. Lastly, the project will provide the necessary technical data for regulatory agencies and lawmakers to develop and refine public policy to facilitate permitting and the economic return of anaerobic digesters, thus allowing more dairy operations to consider the installation of this type of system.

Benefits for Our Industry and Our Nation

The utilization of an anaerobic digestion system for a biogas-designed CHP generator increases the power-production efficiencies to the 70%–80% range, while also providing surplus heat for general use. The potential energy production from California dairy farms is approximately 5.22 trillion Btu of energy available per year (equivalent to the annual energy consumption of about 30,000 households). Farm operations will be able to feed power to the grid as local distributed small generators, incurring few or also be able to sell excess power to local consumers and communities (acting effectively as "farmers of energy"). Anaerobic digestion also reduces greenhouse gas emissions by capturing the methane that is otherwise emitted in conventional manure processing and by replacing power generation from conventional fossil fuel-based power plants.

Applications in Our Nation's Industry

The primary application of this project will be in the U.S. agricultural and dairy farm industries, estimated in 2004 to include over 180,640 dairy farms nationwide. The initial target application in California includes over 2,000 dairy farms, 75% of which are large enough to benefit from the installation of a similar anaerobic digestion renewable energy power system.

Project Description

The goal of this project is to provide valid and objective third-party-evaluated data showing that European technology for anaerobic digestion and power generation will operate effectively, efficiently, and economically in meeting strict U.S. and California environmental regulations.

Barriers

- Meeting existing California environmental regulations
- Lowering the initial financial capital outlay required for system installation

Pathways

This project will complete the installation of an anaerobic digestion power generation system within the first two to three months of the project start. Biogas and water samples will then be collected on a monthly basis to analyze for quality and quantity. Further project work will include weekly and monthly monitoring of electrical generation and use, monitoring of the operational time of the CHP system, monthly monitoring of the influent and effluent of the digester tanks, monthly monitoring of the effluent of the storage lagoon, monthly monitoring of the solids from the effluent of the digester, quarterly groundwater sampling, and an annual assessment of the greenhouse gas emissions from the project footprint. This data will be evaluated by experts at the University of the Pacific, and a final report will be completed.

Milestones

This project started in 2009.

- Year 1: Completion of installation of renewable energy power generation (REPG) facility, including installation of gas metering device, liquid flow metering device, and all remaining anaerobic digestion system equipment
- Year 1: Initiation of the start-up, sampling, and operation of the REPG system, including starting biogas flow to the CHP unit and moving digester effluent first to a solid separation system and then to a storage lagoon
- Years 1–2: Collection of biogas samples from the pipeline and collection of digester influent, effluent, and storage lagoon liquid for analysis
- Years 1–2: Training and operation of the REPG system and testing equipment
- Years 1–2: Completion of technical and economic analyses of the project, including laboratory analyses of water and biogas samples and a cost-benefit analysis of the project

Commercialization

The project technologies that will be commercialized include the anaerobic digestion technology, the designed lean-burn biogas engine, and the measuring technology utilized to collect accurate and useful data. The ability for the dairy digestion system to utilize more than one feedstock will be critical to the economic viability and commercialization of this system. The cost-benefit analysis, to be performed in the last quarter of the project timeline, is expected to verify that this system can operate successfully with an acceptable economic investment and time frame. The commercial viability of this project is enhanced by the fact that the proposed system has been successfully implemented in Europe and other countries. Thus, meeting existing environmental regulations is the major barrier to be overcome to ensure commercialization in California and the rest of the United States.

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