Control Number 2203-1817

Applicant: University of Michigan (UM), Ann Arbor, MI

Project Title: Integrated biochemical and electrochemical technologies (IBET) to convert organic waste to biopower via North American research and educational partnerships

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Project Objectives: The overall goal of this project is to leverage resources and talents from five North American universities, a national lab, a water resource recovery facility, and two private companies to form a bioenergy technology research and educational consortium. We propose to develop an innovative, integrated biochemical and electrochemical technologies (IBET) system to produce pipeline-ready renewable methane from organic solid waste streams. This research effort will be integrated with an educational program to support next-generation workforce development. The IBET consists of two key modules that work synergistically: (i) a small-footprint, low-maintenance two-phase biogas production module, which enhances the production rate of biogas (60% methane and 40% carbon dioxide) and (ii) a tandem electrochemical and gas-phase bioreactor system to upgrade the biogas to renewable methane by capturing the carbon dioxide electrochemically and convert it to methane biologically. Compared to state-of-the-art technologies, the IBET system can generate high-purity renewable methane, rather than biogas only, increase the methane production rate by at least 40%, and reduce capital and operating costs by at least 20%. The educational platform will (i) provide cross-institutional research exchanges for Ph.D. students, (ii) research and professional internships for undergraduate and master's students; (iii) share knowledge and expand collaborative opportunities through development of a Bioenergy Technology and Sustainability Education Certificate; (iv) broaden participation of underrepresented minorities in STEM; and (v) publicly disseminate consortium research and educational information.

Potential Project Impact: The organic fraction of municipal solid waste comprises more than 50% of the almost 300M tons of municipal solid waste generated in the U.S. per year. This fraction is difficult to recycle and the majority of this waste is landfilled. An additional 55M dry tons of water resource recovery facility residuals and manure slurries are produced per year. These potential energy sources are largely untapped as waste-to-energy technologies are currently expensive to build and demanding to operate and maintain. The increase in efficiency and reduction in cost resulting from the successful development of the IBET system can substantially reduce the gasoline gallon equivalent of renewable methane and propel waste-produced renewable energy to become financially favorable. Students working on this project will be exposed to industry, government, and academic institutions through research exchange and internship programs. A waste-to-energy Undergraduate Symposium for regional minority serving institutions and community colleges will provide opportunities for recruiting into the consortium's student opportunities. Educational content will be organized into three courses, which can be taken together as a certificate program or separately, by students preparing for internships or employment, students completing engineering or scientific coursework, students or faculty developing co-curricular and club projects, and skilled workers planning research or professional projects. Research and educational materials will also be made available on the project website.