PROJECT SUMMARY/ABSTRACT

Applicant: Lehigh University

Principal Investigators: Carlos Romero (PI), Liang Cheng, Zheng Yao, Dustin Mcintyre, Daniel Hartzler, Robert De Saro, Ravi Chandran, Dave Newport, Shang-Hsiu Lee and Stephen Goff

Project Title: **Integrated LIBS-Raman-AI System for Real-Time, In-Situ Chemical Analysis of MSW Streams**

Project Objectives - This project will develop a novel optical technique for rapid detection and analysis of MSW streams, and capable of improving MSW characterization throughput over baseline methods by 25%. To achieve this goal, the research team will focus on the following primary objectives: (1) Research optical techniques for on-line MSW detection and quantification; (2) Develop Artificial Intelligence (AI) algorithms for system data processing; (3) Design an integrated prototype and associated AI software; (4) Install and demonstrate prototype at a MSW plant with an industrial environment typical of MSW processing facilities; (5) Evaluate prototype performance in terms of meeting Department of Energy's (DOE's) project metrics.

Project Description - Municipal Solid Waste (MSW) is a very heterogeneous material, with large variability in its physical, chemical and biological characteristics. This poses significant challenges in utilizing it as a feedstock for producing biofuels and bioproducts. Conventional MSW laboratory analyses lack the time resolution required to effect efficient feedstock preprocessing or biofuel production process control. This project is for the development of an advanced technique for rapid detection and analysis of MSW streams. The system will be based on Laser Induced Breakdown Spectroscopy (LIBS) and Raman Spectroscopy - operating simultaneously-, to provide real-time, in-situ spectra for further analysis by AI. LIBS and Raman subsystems will be engineered, assembled and calibrated in the laboratory for accurate analysis of representative non-recycled MSW samples. AI algorithms will be developed for processing of the combined LIBS/Raman spectra, and validated with standardized methods. A system prototype will then be engineered and fabricated for in-situ demonstration at a MSW-biofuels pilot plant for feed-forward control development, and to enhance the conversion of MSW to biofuels or biofuel intermediates. Tests will be conducted over a transport screw at varying speeds. Prototype performance will be evaluated using standardized guidelines, together with a cost analysis and standard protocols for operation of the system at a commercial-scale. The project will additionally produce/provide replicate samples, and associated data and publications to the Bioenergy Feedstock Library and the Bioenergy Knowledge Discovery Framework.

The assembled team is composed of academia, advanced instrumentation and MSW industry researchers uniquely qualified in the chosen novel methods, and achieving the project objectives, and in developing advanced technologies, and managing large sponsored projects.

Potential Impact - The proposed project supports DOE's Bioenergy Technologies Office's (BETO's) goal of innovation to accelerate feedstock technologies and propel a bio economy. The proposed technology will allow rapid, in-situ characterization of an MSW feedstock, providing critical characterization data in minutes for feed-forward process control of downstream biofuel production processes.

Major Participants – Lehigh University, Covanta Energy, Energy Research Company, Department of Energy-National Energy Technology Laboratory, SpG Consulting, ThermoChem Recovery International.