Project Title: An Advanced Pretreatment/Anaerobic digestion (APAD) Technology for Increased conversion of Sewage sludge to Bio-natural gas in small-scale wastewater plants of less than five dry ton sewage sludge/day Control Number: 2029-1520
Topic Area (AOI 9): Rethinking Anaerobic Digestion
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Summary

The problem today of energy production from sewage sludge at small-scale is that the benefits of the treatment used today do not warrant the extra cost of current available technologies due to low carbon conversion. We propose to develop a new concept, which will overcome this obvious problem and produce significant more energy product in the form of bio-natural gas (methane) from sewage sludge while further reducing the final disposal cost. Most (88%) of the ca. 15000 wastewater treatment facilities in USA is small meaning less than 5 dry ton sludge per day. Even that these plant treats far lower flows than the large treatment plants, they will still represent a major unused biomass resource, which can be valorized for production of biofuels and/or bio-products.

Conventional Anaerobic Digestion (AD) is used today at 1233 wastewater treatment plants in the US converting sludge from 53% of the total wastewater treated in total. Overall, only 40-45% of the carbon in sewage sludge will be converted into biogas (ca. 60% methane/40% carbon dioxide) leaving 7.3 Mill ton/year of dry solids behind from conventional AD plants, which will need further disposal (land application, incineration or landfilling). **Our goal for the project is to improve the carbon conversion efficiency of sewage sludge during AD by at least 65% resulting in a total conversion of ca. 70% of sewage sludge.** To achieve this goal, we will develop a new concept for Anaerobic Digestion (AD): the **Advanced Pretreatment/Anaerobic Digestion Process-APAD**. This technology includes a Pretreatment step (Advanced Wet oxidation/Steam explosion-AWOEx) treating the recalcitrant part of the material not converted during the first AD step. For existing plants with AD, the can substitute the first part of the APAD process and the rest can be directly bolted on as an extra addition. The pretreated material is then converted in the second AD step. The resulting biogas from these two AD steps is upgraded/CO2 is removed with added hydrogen producing bio-natural gas. Hydrogen will come from electrolysis of renewable electricity coupling Power production to Gas production. With a 97% conversion of CO_2 produced in the APAD process, we will produce ca. 25% more methane compared to a process with AWOEx pretreatment, but no biogas upgradation. Producing bio-natural gas will result in a higher value energy product that can be supplied directly to the natural gas grid or used locally as a transportation fuel. *This means that the APAD process is producing far more useful energy product and will further have a lower carbon footprint through the sequestration of CO_2 into methane.*

Our main hypothesis is that a viable solution for validating sewage sludge even at small wastewater treatment facilities can be developed by adding AWOEx pretreatment to selectively handle the recalcitrant part of the raw material and by upgrading the biogas into methane, which can be added to the gas grid or used locally as a transportation fuel.