CLIMATE CHANGE INNOVATION AND TECHNOLOGY FRAMEWORK

Awardee Summary

CCITF PROGRAM	Clean Technology Development
PROJECT TITLE	Advancing High Solids Anaerobic Digestion of Organic Waste
SECTOR	Methane Emissions Reduction, Waste to Value-Added
ORGANIZATION	University of Alberta
PROJECT LEAD	Bipro Dhar
AI PROJECT ADVISOR	Xiaomei Li
GRANT AMOUNT	$96,000
START DATE	2018-11-01
END DATE	2021-10-31

PROJECT OBJECTIVE: To enhance the economic and environmental sustainability of the high-solid anaerobic digestion process by providing (1) shortened digestion time, (2) improved process stability, (3) an increased biogas yield and rate, and (4) a lower volume of residuals.

PROJECT PROFILE: The overall goal of this project is to develop new engineering strategies for high-solids anaerobic digestion (HSAD) process that will provide enhanced methane recovery from organic waste through improved process kinetics and stability. This proposal broadly addresses the existing challenges faced by waste service providers across the Province of Alberta, and actively supports Alberta's avid vision in becoming "landfill-free". Anaerobic digestion (AD), which represents an attractive option for diversion of organic waste from landfill, produces methane-rich biogas that can be used to meet on-site heat or electricity needs. However, inferior process kinetics and stability issues remain an ongoing challenge faced by AD facilities, and economic benefits (energy recovery) from traditional HSAD facilities are sometimes not adequate to ensure a positive cash-flow. Hence, the adoption of HSAD is still limited to large-scale facilities. Thus, further advancements in the HSAD regarding process performance and robustness is a critical industry need. In particular, due to the imbalance within anaerobic microbiome, intermediates (mainly organic acids and alcohols) from biodegradation of organics can accumulate within the digester and lead to process instability. Under these conditions, sometimes digesters can run without complete failure but with significantly lower methane productivity. To overcome these challenges, we have been investigating advanced strategies to develop a resilient and kinetically efficient microbiome for HSAD. These methods were developed based on a recently discovered microbial interactions within digesters, called direct interspecies electron transfer (DIET). The DIET-active microbiome can be established via the addition of conductive materials in the digester. Our recent bench-scale research showed that the addition of conductive materials could substantially improve methane productivity up to 2.5-fold as compared to the conventional anaerobic digester. Moreover, we demonstrated "proof-of-concept" of multiple approaches to retrofit these materials in HSAD. However, further refinement of developed ideas in lab-scale followed by a pilot-scale demonstration is required for establishing and maintaining DIET-active microbial communities to realize enhanced biogas production rates at full-scale. The proposed 3-years project will be accomplished in following four phases:

1. Evaluation of various process conditions on the DIET-active microbiome and methane recovery.
2. Optimization of operational approaches to sustain DIET communities during long-term operation.
3. Pilot-scale validation of optimized strategy for promoting DIET in HSAD.
4. Techno-economic assessment to evaluate the feasibility of the developed approaches.

In long-term term (4-6 years), our goal is to demonstrate developed strategies in full-scale, which will ultimately stimulate adoption of HSAD across

the province. Overall, the proposed research will enhance the economic and environmental sustainability of the HSAD by providing (1) shortened

digestion time, (2) improved process stability, (3) an increased biogas yield and rate, (4) a lower volume of residuals.

GHG EMISSION REDUCTION SUMMARY: