Bioenergy Production from MSW by Solids State Anaerobic Digestion

August 2015

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Report # 4

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Abbreviations, Acronyms, and Units of Measurement

BMP – Biochemical Methane Potential
EU – European Union
IWA – International Water Association
L-AD – Liquid Anaerobic Digestion
MS-OFMSW – Mechanically-Separated Organic Fraction of Municipal Solid Waste
MSW – Municipal Solid Waste
NSF – National Science Foundation
OFMSW – Organic Fraction of Municipal Solid Waste
OWS – Organic Waste Systems
P&P – Pulp and Paper Mill
PFRP – Process to Further Reduce Pathogens
RET – Research Experience for Teachers
REU – Research Experience for Undergraduates
SGEF – Student Green Energy Fund
SS-AD – Solids-State Anaerobic Digestion
SS-OFMSW – Source-Separated Organic Fraction of Municipal Solid Waste
STP – Standard Temperature and Pressure
TIER – Tampa Interdisciplinary Environmental Research
TPY – Tons per Year (processing capacity)
TS – Total Solids
UF – University of Florida
US – United States
VS – Volatile Solids
WAS – Waste Activated Sludge
WtE – Waste-to-Energy
WW-AD – Wastewater Anaerobic Sludge
ZWE – Zero Waste Energy, LLC.

QUARTERLY PROGRESS REPORT

May 17, 2015 - August 17, 2015

PROJECT TITLE: Bioenergy Production from MSW by Solid-State Anaerobic Digestion

PRINCIPAL INVESTIGATOR(S): Dr. Sarina Ergas and Dr. Daniel Yeh

AFFILIATION: University of South Florida

COMPLETION DATE: January 1, 2016 **PHONE NUMBER:** 813-974-1119

PROJECT WEB SITE: http://mbr.eng.usf.edu/yardwaste/

Work accomplished during this reporting period:

During the fourth quarter of this Hinkley Center Project, the following tasks were accomplished: (i) additional data pertaining to the assessment of the potential for SS-AD implementation in Florida was collected, organized and analyzed to identify suitable SS-AD technologies for Florida, regions where SS-AD may be promising, and critical economic/legislative factors required for success; (ii) bench-scale and pilot scale experiments were completed, results were analyzed, a manuscript for publication of the results is in preparation, and additional experiments were designed; (iii) potential sites for a full-scale demonstration project were identified, permitting requirements were explored, a preliminary economic analysis was initiated, and industry professionals were engaged to further develop plans for potential demonstration; and (iv) dissemination activities were continued. In the fourth quarter of this Hinkley Center project, the information gained from fundamental research, literature reviews, and industry surveys was tied together to significantly progress the assessment of the outlook for SS-AD in Florida and substantial progress was made toward publishing the critical findings emerging from this research.

Objective 1: SS-AD Potential in Florida

Trends in AD technology selection in Europe were identified and a detailed chronological database of SS-AD projects in the US was developed. Trends in AD development in the EU indicate that: 1) SS-AD systems are economically and environmentally advantageous over L-AD systems for processing OFMSW; 2) thermophilic systems are becoming more economical than mesophilic systems (although mesophilic systems have traditionally been more common); 3) single-stage systems are more common and more mature technologies than multi-stage systems; 4) continuous systems are more common in general than batch systems; however, batch systems have become much more common in the past 5-6 years, especially for processing lignocellulosic wastes, such as yard waste and agricultural residues, and are expected to become increasingly prevalent because of their low cost and simplicity. The state of the art of AD of OFMSW in Europe (by design parameter), past trends in development, and expected future trends are shown in Table 1.

Table 1: Characterization of AD of OFMSW in Europe (De Baere and Mattheeuws, 2014)

Parameter	% of Installed Capacity	Trends	Expected Future Trends
Total Solids Content	62% SS-AD, 38% L-AD	SS-AD systems have been consistently preferred over L-AD systems for processing OFMSW for more than 20 years, over 70% installed since 2009 has been SS-AD.	SS-AD will continue to increase in prevalence due to the economic and environmental advantages it offers compared to L-AD.
Loading Conditions	> 50% Continuous	Continuous systems have traditionally dominated the industry; batch systems have been catching on quickly since 2009.	Batch systems are expected to continue to increase in popularity due to their simplicity and low cost.
Number of Stages	93% Single-Stage, 7% Two-Stage	Multi-stage systems have been continuously in decline since the 1990's.	No immediate changes in this trend are expected due to the higher investment and operating costs that accompany multi-stage systems.
Operating Temperature	67% Mesophilic, 33% Thermophilic	Thermophilic digestion has been becoming increasingly common in the last decade.	Thermophilic capacity is expected to surpass mesophilic capacity because thermophilic systems are now well-proven and yield net economic benefits in most cases.
Codigestion	89% Single-Substrate, 11% Codigestion	The trend has been almost unanimously from codigestion to single substrate digestion, as "dedicated" systems tailored for OFMSW processing have been designed and implemented; however, in recent years there has been a slight rise in codigestion.	Laboratory research and the agro-industrial sector have demonstrated the potential economic advantages of codigestion and thus, it may become increasingly common.
Feedstock	55% Source-Separated, 45% Mixed MSW	Increases in capacity for processing source separated waste have been in direct proportion to increases in legislation regulating the source separation of OFMSW.	It is expected that source separation regulations will continue to increase and therefore, digestion of source separated OFMSW will continue to increase.

The database of SS-AD projects in the US shows an overwhelming preference for simple technologies over more sophisticated systems and for thermophilic operation of mesophilic operation. Single-stage, batch-type thermophilic digesters constitute more than half of the systems operating in the US today. These systems are capable of processing source separated OFMSW (SS-OFMSW), mechanically separated OFMSW (MS-OFSW), or comingled MSW. The digestate is free of pathogens and is considered compost per the EPA's *Process to Further Reduce Pathogens* (PFRP) program, but requires post-processing to remove contaminants (e.g. by using a trammel screen). As the most proven form of SS-AD in the US, these systems are considered the most suitable for SS-AD in Florida. Specifically, SmartFerm systems marketed by Zero Waste Energy, LLC (ZWE) are the most widely implemented systems in the US. The trends observed in the beginning of SS-AD implementation in the US (since 2012) align relatively closely with trends in industry in Europe. Single substrate is more common than codigestion, source separated digestion is more common than mixed, and source separation regulations are becoming increasingly common in states and municipalities across the country.

Through the review of SS-AD in Europe and the US, multiple factors have been identified as critical for the economic sustainability of SS-AD, including:

- High local electricity costs, high onsite or nearby electricity demand and/or economic incentives for utility companies to purchase the renewable bioenergy;
- Significant centralized sources of source-separated organic wastes, such as from food processing/packaging plants, hospitals, schools, jails, or other institutional facilities with large cafeterias, or from large agricultural operations with crop residues;
- Limited land suitable for composting and/or landfilling and/or lack of conventional WtE facilities;
- Markets for the residual compost;
- Public/private partnerships, for example: between municipalities, waste management companies and haulers, utility companies, and community organizations;
- Grants for funding renewable energy projects and/or recycling projects;
- Regulatory drivers, such as a bans on organics disposal in landfills, regulated source-separation of OFMSW, renewable energy incentives, air quality regulations increasing the costs of composting and/or WtE operations, and incentives for nutrient recovery.

Lastly, preliminary efforts aiming to identify regions of Florida where SS-AD are the most promising are underway. The primary focus of these efforts is to document regional OFMSW generation, recycling, and disposal rates, existing MSW management infrastructure and processing capacity, trends in OFMSW separation and management, and local markets (e.g. energy, compost) and legislation. Further analysis of this data will highlight locations where OFMSW technologies are in demand (where landfilling of OFMSW is predominant) and where SS-AD is the most promising (community/regulatory drive to increase recycling rates, high generation of OFMSW, low recycling, high costs of electricity, market for the sale of compost).

Objective 2: Fundamental Science

Bench Scale Round 2a:

Preliminary results from the second round of bench scale experiments were described in the third quarterly report. Since then, the experiment been completed and the results have been analyzed. A draft manuscript is in preparation, which is expected to be submitted for publication within the upcoming quarter. The goal of this experiment was to investigate the potential to enhance methane production from yard waste via inoculation with pulp and paper mill anaerobic sludge (P&P) as an alternative to wastewater anaerobic sludge (WW-AD; a conventional inoculum). Yard waste constitutes a significant fraction of OFMSW; however, the biodegradability of yard waste in SS-AD is low. Pretreatment has been shown to enhance biodegradability but incurs additional economic and environmental costs. In bench-scale studies, methane production from yard waste inoculated with P&P sludge reached 100.2 ± 2.4 L CH_4/kg VS over 106 days of digestion (Figure 1). This yield was 73 % greater than that achieved through inoculation with WW-AD sludge (58.1 ± 1.2 L CH_4/kg VS). The enhancement achieved through this bioaugmentation strategy (Figure 2 blue diamonds), was similar to values achieved through chemical or thermal pretreatment, suggesting that this strategy could serve as an alternative to pretreatment and improve the sustainability of SS-AD.

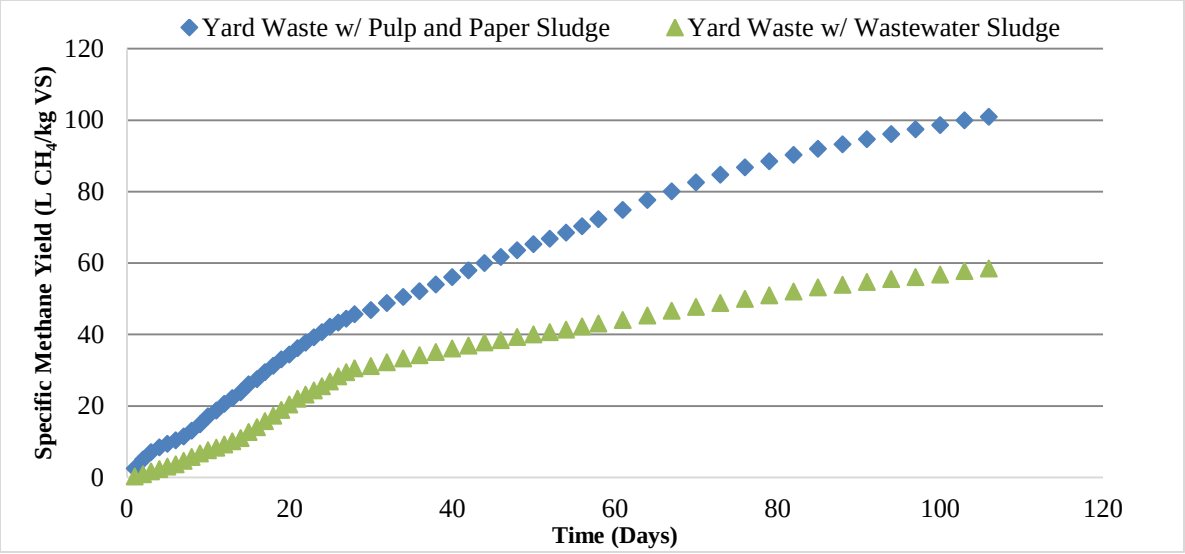

Figure 1: Specific methane yields (adjusted to STP) of yard waste inoculated with P&P sludge and WW-AD sludge over 106 days of SS-AD.

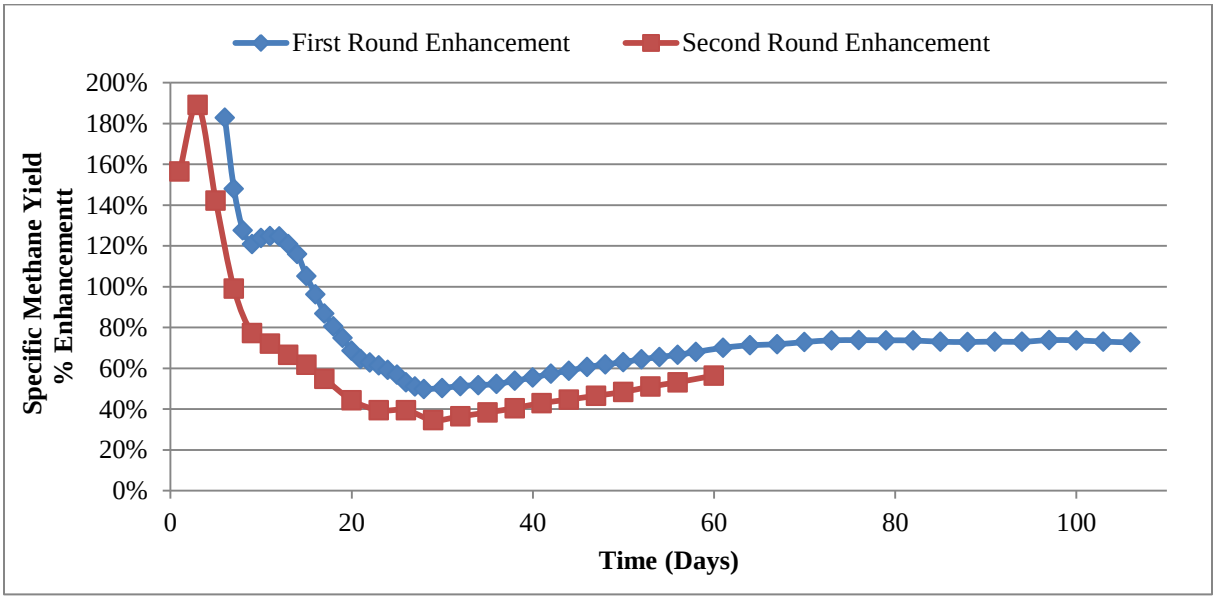

Figure 2: Percent enhancement of specific methane yields of yard waste achieved in SS-AD in the first round of digestion (using fresh P&P sludge as an inoculum) and in the second round of digestion (using digestate from digesters inoculated with P&P sludge).

Bench Scale Round 2b:

Digestate from the first round of experiments was used to inoculate yard waste in a second round of bench-scale studies. The results suggested that the beneficial effects of using P&P sludge as an alternative inoculum can be sustained from one batch of digestion to a subsequent batch, as shown in Figures 2 and 3. The results further support the potential to improve the sustainability of SS-AD via the proposed bioaugmentation strategy. This aspect is critical to the overall viability of this method, because in full-scale systems, digestate is often used as an inoculum source in SS-AD after initial inoculation with seed-sludge upon process startup. In Dranco

continuous SS-AD systems, for example, up to six parts recycled digestate are blended with one part of fresh feedstock before being loaded to the system.

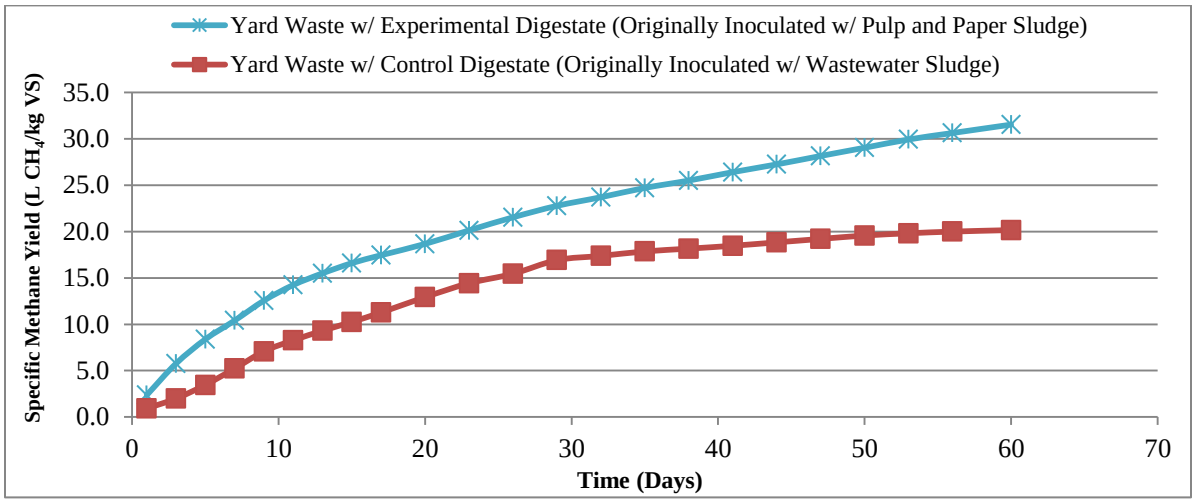

Figure 3: Specific methane yields of yard waste inoculated with digestate from the first round of BMP assays over 60 days of SS-AD.

Bench Scale Round 3:

In this experiment, we attempt to achieve higher rates of methane production via co-digestion of yard waste with food waste and biosolids (undigested dewatered waste activated sludge [WAS]). We were able to demonstrate that inoculation with P&P sludge yielded a 95% increase in methane production and incorporating biosolids yielded a 56% increase over the first 21 days (Figure 4). However, the data was skewed by inhibition resulting from rapid hydrolysis of the food waste fraction. After six days, digesters with no P&P sludge or biosolids showed severe inhibition and digesters with no P&P sludge were showing signs of inhibition, thus an alkalinity source was added to each digester. The alkalinity source that was selected was crushed oyster shells. This is a common waste product in Florida and has been shown to be a good alkalinity source in prior research in our laboratory because the oyster shells break down slowly providing a prolonged alkalinity supplement. Overall, the digesters inoculated with P&P sludge had higher alkalinity than those inoculated with wastewater anaerobic sludge and therefore were more resistant to acidification. Likewise, the reactors with biosolids had slightly higher alkalinity than those without and displayed a slightly higher tolerance to rapid acid production. This experiment will be repeated with oyster shells added at the beginning of the assay. Microaeration will also be explored as a potential method for upgrading biogas quality in solid-state codigestion of yard waste, food waste, and biosolids.

Pilot Scale:

Pilot-scale experiments were conducted using only yard waste and WW-AD sludge to explore the significance of scaling factors in methane yields. Additional experiments will be conducted to verify preliminary results and to scale up other bench-scale experiments.

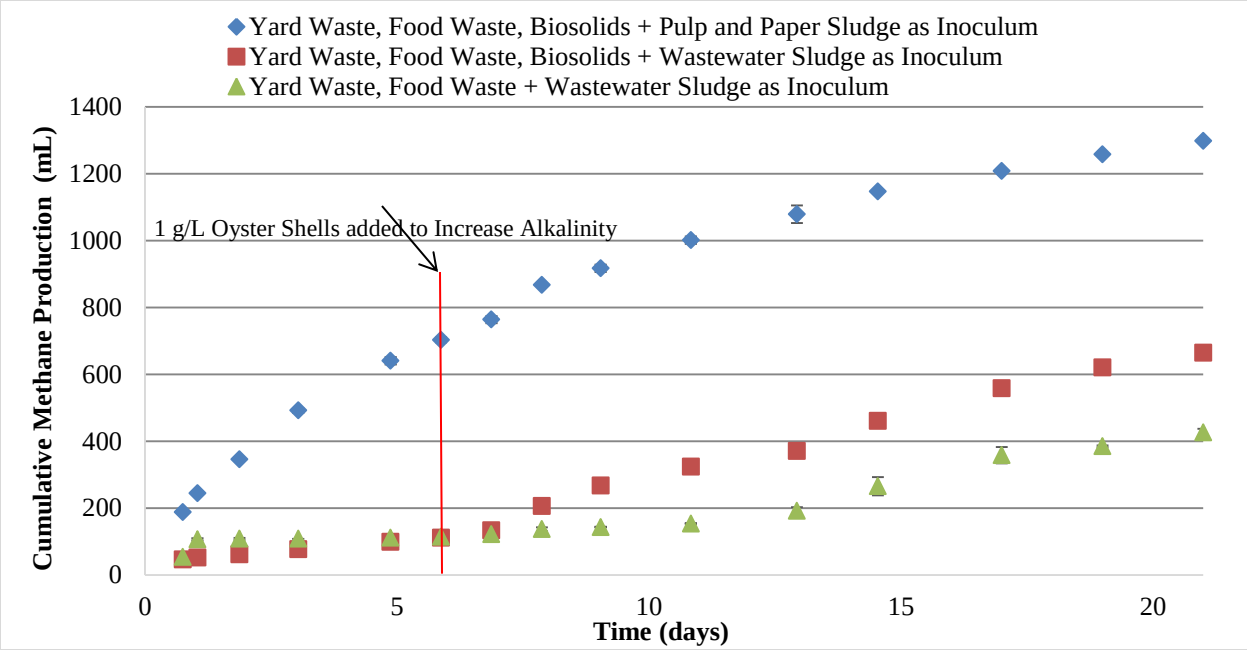

Figure 4: Cumulative methane yields observed in the first 21 days of codigestion investigating the effects of P&P sludge and biosolids addition on SS-AD codigestion process efficiency.

Objective 3: Engineering and Outreach

Potential Demonstration Sites, Collaborators, and Funding Sources:
SS-AD only becomes economically feasible on a relatively large-scale (> 5,000 tons per year). Therefore, availability of high quantities of OFMSW within close proximity is a limiting factor when evaluating potential locations for implementation of a demonstration SS-AD system. Universities were identified as potentially promising demonstrations sites, not only because of the high quantities of OFMSW generation in and near several Florida Universities, but also because of their centralized locations and well-established roles educators of future MSW professionals and pioneers of sustainable technologies. The University of South Florida (USF), for example, is a very large institution generating several tons of OFMSW per day, is surrounded by hospitals, public-schools, and supermarkets, and is very close to Busch Gardens. Other potentially promising locations for a demonstration project include existing waste management facilities such as landfills, waste-to-energy facilities, or landfills. Currently, the vast majority of OFMSW is transported to these facilities (excluding the small fraction that is composted). Implementing an SS-AD demonstration project at one of these sites would not require major changes in waste collection regimes. Furthermore, landfills with energy recovery already have biogas generators installed onsite, which an SS-AD system could easily be tied into, reducing the costs of a demonstration project by eliminating the need to purchase biogas conversion units.

Potential collaborators for a demonstration project include the University of South Florida, the University of Florida, Waste Management, Inc., Zero Waste Energy, LLC., Organic Waste Systems (OWS), LLC., Harvest Power, LLC., SCS Engineers, the Florida Department of Environmental Protection, the Florida Organics Recycling Center for Excellence, Hillsborough County, Orange County, Okeechobee County, Polk County, and Sarasota County. Potential

funding sources include the FDEP's *Innovative Recycling/Waste Reduction Grants, Section 1603* federal grants (of the 2009 American Recovery and Reinvestment Act), *Clean Renewable Energy Bonds* (federal), and other federal grants from agencies such as the EPA, DOE, and USDA. For example, the USDA and DOE reauthorized the Biomass Research and Development Initiative financial assistance program in 2014 that offered (ended July, 2015) grants totaling $8.6 million for bioenergy projects, 50% of which were dedicated to technology demonstration. Additionally, renewable energy projects such as large AD project have successfully employed Investment Tax Credits and Production Tax Credits to attract tax equity investors. In the case of a demonstration project at the University of South Florida, the Student Green Energy Fund (SGEF) could potentially be leveraged to provide additional funding (up to $100,000) for project design, planning, permitting, and construction.

Permitting requirements identified thus far include FDEP's *Permit to Construct/Operate a Solid Waste Facility*, *Bioenergy Air Quality Permit*, *Source-Separated Organics Processing Facility Permit*, and others defined by *Chapter 62-709, Administrative Code*. However, if the project qualifies as a pilot-project, permitting requirements would be significantly decreased.

Information Dissemination Activities:
Activities associated with information dissemination completed in this quarter include:

- Abstract submission to the 2016 Global Waste Management Symposium (accepted for a platform presentation);
- Poster presentation by Lensey Casimir at the University of South Florida NSF Research Experience for Undergraduates Research Symposium (2nd place poster competition winner);
- Poster presentation by Matthew Dawley at the University of South Florida NSF Research Experience for Teachers Research Symposium (2nd place poster competition winner);
- Publication of an article summarizing laboratory research achievements in the Florida chapter of SWANA summer newsletter, *Talking Trash*.
- Publication of an article in the International Water Association (IWA) Specialist Group on Anaerobic Digestion Newsletter.

Metrics:

1. List graduate student or postdoctoral researchers **funded** by **THIS** Hinkley Center project

The graduate and postdoctoral researchers funded by the Hinkley Center project are displayed in Table 2 below.

Table 2: Graduate and postdoctoral researchers funded by the Hinkley Center project.

Last name, First name	Rank	Department	Professor	Institution
Hinds, Gregory	Masters Student	Civil/ Environmental Engineering	Dr. Sarina Ergas	University of South Florida
Dick, George	Masters Student	Civil/ Environmental Engineering	Dr. Daniel Yeh	University of South Florida
Meng Wang	Postdoctoral Researcher	Civil/ Environmental Engineering	Dr. Sarina Ergas	University of South Florida

2. List undergraduate researchers working on **THIS** Hinkley Center project

Ariane Rosario
Department: Civil and Environmental Engineering University of South Florida
Professor: Dr, Sarina Ergas
Institution: University of South Florida

Lensey Casimir
Department: Civil and Environmental Engineering University of South Florida
Professor: Dr, Sarina Ergas
Institution: University of South Florida

3. List research publications resulting from **THIS** Hinkley Center project (use format for publications as outlined in Section 1.13 of this Report Guide).

Two articles were published in *Talking Trash*, the Florida section of SWANA newsletter, one in the spring 2015 release and one in the summer 2015 release. They can be seen here: http://www.swanafl.org/page-1130432?. One article was published in the International Water Association Anaerobic Digestion Specialist Group newsletter and was sent to the SG members.

Hinds, G. R., Dick, G., Yeh, D.H., Ergas, S.J. (2015) Enhanced Methane Production from Yard Waste in Solid-State Anaerobic Digestion, International Water Association (IWA) Specialist Group on Anaerobic Digestion Newsletter, June 2015.

Hinds, G. R., Dick, G., Yeh, D.H., Ergas, S.J. (2015) Resource Recovery from Organic Solid Waste through Solid-State Anaerobic Digestion, *Talking Trash*, March, 2015.

Hinds, G. R., Casimir, L., Dawley, M., Yeh, D.H., Ergas, S.J. Solid-State Anaerobic Digestion: An environmentally and economically favorable approach to OFMSW management? *Talking Trash*, Summer, 2015.

4. List research presentations (as outlined in 1.13.6 of this Report Guide) resulting from **THIS** Hinkley Center project.

Hinds, Gregory. "Bioenergy Production from Municipal Solid Waste through Solid-State Anaerobic Digestion." University of South Florida, College of Engineering Research Day. Tampa, Florida. 19 Nov. 2014.

Hinds, Gregory. "Bioenergy Production from Municipal Solid Waste through Solid-State Anaerobic Digestion." University of Central Florida, AEESP Lecture. Orlando, Florida. 27 Feb. 2015.

Hinds, Gregory. "Enhanced Methane Production from Lignocellulosic Waste in Solid-State Anaerobic Digestion through Bioaugmentation" University of South Florida, Graduate Student Research Symposium. Tampa, Florida. 10 Mar. 2015.

Rosario, Ariane. "Enhanced Methane Production from Lignocellulosic Waste in Solid-State Anaerobic Digestion through Bioaugmentation" University of South Florida, Undergraduate Research and Arts Colloquium. Tampa, Florida. 9 Apr. 2015.

Casimir, Lensey. "Solid-State Anaerobic Digestion for the Recovery of Energy and Nutrients from Organic Solid Waste" University of South Florida, NSF Research Experience for Undergraduates Research Symposium. Tampa, Florida. 29 Jul. 2015.

Dawley, Matthew. "Methane Production by Solid-State Anaerobic Codigestion of the Organic Fraction of Municipal Solid Waste" University of South Florida, NSF Research Experience for Teachers Research Symposium. Tampa, Florida. 29 Jul. 2015.

NOTE: Ariane Rosario won the award for Best Poster Presentation at the 2015 USF Undergraduate Research and Arts Colloquium, Lensey Casimir won 2nd Place at the NFS Research Experience for Undergraduates 2015 Research Symposium (REU) at USF with his poster presentation, and Matthew Dawley won 2nd Place at the NFS Research Experience for Teachers (RET) 2015 Research Symposium at USF with his poster presentation.

5. List who has referenced or cited your publications from this project?

To the knowledge of the PIs, the results from this research study have not been referenced by any others as of the end of this quarter.

6. How have the research results from **THIS** Hinkley Center project been leveraged to secure additional research funding?

- Greg Hinds was partially supported by an NSF funded S-STEM Scholarship during the 2014-2015 academic year.
- Greg Hinds will be partially supported by a USF Foundation Stessel Fellowship in fall 2015. The fellowship gives priority to graduate students in Environmental Engineering with GPA > 3.5 working in the MSW management field.
- Ariane Rosario was partially supported (40%) by funds from the College of Engineering Research Experience for Undergraduates (REU) program.
- Lensey Casimir was fully supported (100%) by funds from the NSF Tampa Interdisciplinary Environmental Research (TIER) REU program.
- A science teacher from Plant City High School, Matthew Dawley, was an intern on this project during the summer. Mr. Dawley was funded through an NSF Research Experience for Teachers (RET) program.
- An interdisciplinary team of students prepared and submitted a proposal to the USF Student Green Energy Fund (SGEF) to conduct a feasibility study on implementing SS-AD on the USF campus to improve the sustainability of organic waste management at the university. This proposal was not selected for funding; however, a new interdisciplinary team of graduate and undergraduate students are working on a proposal for the next solicitation.

- A proposal was submitted to the Environmental Research and Education Foundation (EREF) on the topic of "Sustainable Bioenergy Production from MSW by Solid State Anaerobic Digestion."
- A team of eight graduate and undergraduate students conducted a design feasibility study for a 5,000 ton per year SS-AD facility on the USF campus for processing OFMSW generated on campus and in nearby institutions as Green Engineering class project. The study included a preliminary design, preliminary cost analysis, and a simply life cycle assessment comparing the environmental impacts of onsite OFMSW management via SS-AD compared to the current OFMSW practice at USF – transport and incineration of the waste – and showed that substantial environmental benefits could be incurred through SS-AD implementation. The findings from this project will be incorporated in the next SGEF proposal.
- Natalia Anferova, a doctoral student from the University of Chemistry and Technology in Prague, Czech Republic, is funded by the EU as part of the Biological Waste to Energy Technologies (BioWET) grant. She arrived at USF in July, 2015 and will be working through January conducting bench- and pilot-scale experiments exploring the potential to improve biogas quality by integrating microaeration techniques into SS-AD of yard waste, food waste, and biosolids.

7. What new collaborations were initiated based on **THIS** Hinkley Center project?

- A team of interdisciplinary students prepared and submitted a proposal to the USF SGEF in the fall, another team of eight students from multiple fields of engineering conducted a design feasibility study for onsite SS-AD at USF, and a third team of students (with some overlap in participants) are beginning to prepare a second SGEF proposal for the fall solicitation.
- Research collaborations with undergraduates Ariane Rosario and Lensey Casimir, teacher Matthew Dawley, and visiting doctoral student, Natalia Anferova have been initiated.
- Bruce Clark, Chris Bolyard, Ramin Yazdari, and Coby Skye have joined the TAG and collaborations with them have provided valuable insight into various aspects of the project.
- Collaboration and regular communication between the research team and other industrial professionals (Chris Axton, Zero Waste Energy; Norma McDonald, Organic Waste Systems; Whitney Beedle, BioFerm Energy Systems, and more) has become increasingly abundant.
- Facility visits in California in May, 2015 by Greg Hinds resulted in several new collaborations (Table 3).
- Collaboration between Marie Steinwachs, the Technical Manager for Waste Diversion at the University of Florida Physical Plant Division, and the research team has been initiated for the development of onsite organic waste management plans involving SS-AD at both UF and USF.

Table 3: New collaborations formed from California SS-AD facility visits.

Facilities Visited	Date	Professional Contact	Affiliation	Title
ZWE, San Jose, CA, 90,000 TPY Batch SS-AD Facility	May 5th, 2015	John Pena	Zero Waste Energy Development Company	Operations Manager
ZWE, Monterey, CA, 50,000 TPY Batch SS-AD Facility	May 5th, 2015	Chris Axton	Zero Waste Energy, LLC.	Facility Manager
CleanWorld, Davis, CA, 20,000 TPY Continuous SS-AD Facility	May 7th, 2015	Brad Jacobson	CleanWorld Corporation	Business Development
Yolo County Central Landfill, Experimental Pilot-Scale Batch SS-AD	May 7th, 2015	Ramin Yazdari	University of California, Davis	Assistant Professional Researcher

8. How have the results from **THIS** Hinkley Center funded project been used (**not** will be used) by FDEP or other stakeholders? (1 paragraph maximum).

At this time, the research has not been used by FDEP and other stakeholders.

TAG members:

Table 4: TAG Members

TAG Member	Affiliation	Title
Steven G. Morgan	Florida Department of Environmental Protection	Waste Permitting, Environmental Services Section, SW District
Wendy Mussoline	UF, Dept. of Soil & Water Science	Postdoc, Environmental Biotechnology Lab
Juan R. Oquendo	Gresham, Smith, & Partners	Sr. Environmental Engineer & Waste to Energy Leader
Debra R. Reinhart	UCF, Dept. Civil, Environmental & Construction Eng.	Professor & Assistant Vice President
Larry Ruiz	Hillsborough County	Landfill Operations Section Manager
Adrie Veeken	Attero, the Netherlands	Bio-based Products Business Developer
Shawn Veltman	CHA Consultants	Director of Technical Services, Water & Wastewater
Bruce Clark	SCS Engineers	Senior Engineer
Chris Bolyard	Waste Management, Inc	Manager
Ramin Yazdani	Yolo County California	Senior Civil Engineer
Coby Skye	Las Angeles County California	Environmental Programs

TAG meetings:

The first TAG meeting was held on November 6, 2014. After the discussion, TAG members that attended in person were given a tour of the lab facilities in which the initial bench-scale experiments were set up. The second TAG meeting was held on March 11, 2015. TAG members also were able to view lab studies in progress and give feedback on the pilot system before final construction was complete. Larry Ruiz and Bruce Clark came to view the experiments in May and give feedback at a later date. No subsequent TAG meetings have been held to date.

References

De Baere, L., Mattheeuws, B. 2014. Anaerobic digestion of the organic fraction of municipal solid waste in Europe - Status, experience and prospects in: Waste Management, Vol 3: Recycling and Recovery, Vol. 3, TK, pp. 517-526.