Poster Title
Local and Sustainable Energy Production and Waste Treatment Using Co-digestion of Organic Solid Waste and Wastewater Solids in Yosemite National Park, USA

Authors
Julia Burmistrova[1]
Advisors: Dr. Marc Beutel[1], Stephen J. Shackelton[1,2], Dr. Jodi Bailey[2]
[1] University of California, Merced
[2] Yosemite National Park, National Park Service

Yosemite National Park (YNP) currently has a Zero Landfill Initiative goal to completely divert their solid waste away from landfills. Landfills are not sustainable because they take up large areas of land and, once they are closed, are banned from having any built structures on top, thus making the land unusable. Current regulation requires landfills to harvest and flare methane gas produced, but this is inefficient, and gas losses are common [4]. More sustainable and local ways of dealing with waste are necessary in order to preserve and to reduce emissions from waste transportation and waste decomposition, while at the same time harnessing biogas for energy production.

YNP receives 4 to 5 million visitors each year that produce 650 annual tons of organic waste and 1.5 tons of wastewater solids, which could be diverted using a proposed co-digestion system. Solid waste includes organic waste, predominantly in the form of food waste, which is the easiest waste stream to divert from landfill because there are many beneficial uses for organic waste that are cost effective and easy to implement, such as compost and anaerobic digestion. Co-digestion is a form of anaerobic digestion in which organic waste, such as food waste, is combined with wastewater solids and treated in large, sealed tanks [1-3, 5]. The byproduct of co-digestion, biogas (60-70% methane and 30-40% carbon dioxide), is collected and combusted to produce energy [3]. Anaerobic digesters are preferred as a treatment method for many sources of waste as they are cost effective, efficient, reduce odors, and produces biogas as a possible source

of energy [1-3, 5]. Biogas production can be used as a source of income or could be used onsite to power the water treatment facility, further increasing environmental efficiency of the facility. Thus, they are compelling solution for the El Portal Wastewater Treatment facility and for YNP's organic waste collection and treatment.

A new $80 million wastewater treatment plant is currently being planned for YNP in El Portal, California. This gives YNP a unique window to evaluate the feasibility of coupling organic solid waste and wastewater solids to enhance methane gas and energy production while substantially lowering the amount of solid waste going to landfills. YNP is the most popular National Park in the United States, and its actions and policies influence the other 58 National Parks in the National Parks Service.

In order to better help YNP assess the treatment efficiency and economic feasibility of using co-digestion to treat food waste and wastewater solids, a laboratory "proof of concept" study of co-digestion for organic solids and wastewater solids specifically from YNP. The effectiveness of co-digestion is highly site specific and varies based on the source and quality of waste feeds [1-3, 5]. Thus, it is important to conduct pilot studies with site specific waste.

A biochemical methane potential (BMP) experiment will be conducted in October 2018, with initial biogas results available in November 2018. Food waste and wastewater solids will be combined at various ratios in 250mL glass bottles and sealed with stoppers. The bottles will be stored in an incubator at 35^{o}C and continuously stirred using an orbital shaker. Measurements will focus on pH before and after digestion and biogas production over a 30-60 day period. The various ratios will determine the upper and lower limits on food waste to wastewater solids, in addition to finding the optimal ratio for biogas production. Results of the BMP will be used for

sizing the digesters for biogas production and a generator for biogas combustion at El Portal, and overall determine the feasibility for combining food waste and wastewater solids for YNP.

[1] C. M. Braguglia, A. Gallipoli, A. Gianico, and P. Pagliaccia, "Anaerobic bioconversion of food waste into energy: A critical review," *Bioresource Technology*, vol. 248, pp. 37–56, 2018.

[2] J. C. Gaby, M. Zamanzadeh, and S. J. Horn, "The effect of temperature and retention time on methane production and microbial community composition in staged anaerobic digesters fed with food waste," *Biotechnology for Biofuels*, vol. 10, no. 1, 2017.

[3] M. S. Lisboa and S. Lansing, "Characterizing food waste substrates for co-digestion through biochemical methane potential (BMP) experiments," *Waste Management*, vol. 33, no. 12, pp. 2664–2669, 2013.

[4] J. T. Powell, T. G. Townsend, and J. B. Zimmerman, "Estimates of solid waste disposal rates and reduction targets for landfill gas emissions," *Nature Climate Change*, vol. 6, no. 2, pp. 162–165, 2015.

[5] Y. Ren, M. Yu, C. Wu, Q. Wang, M. Gao, Q. Huang, and Y. Liu, "A comprehensive review on food waste anaerobic digestion: Research updates and tendencies," *Bioresource Technology*, vol. 247, pp. 1069–1076, 2018.