DEPARTMENT OF
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Biogas Production From Anaerobic Digestion of Algae

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Background

The Port of Baltimore is exploring Algal Turf Scrubber (ATS) technology as a method of removing nutrients from runoff that would otherwise pollute the Chesapeake Bay. Before scaling up the ATS, the Port needs an alternative disposal method for the harvested algae that is more economically viable than the tipping fee for landfilling.

Objectives

This study will assess the biomethane potential (BMP) of the algae from the ATS system. The purpose is to determine the feasibility of implementing an Anaerobic Digestion (AD) system to process the algae for renewable energy production. We will investigate different ratios of algae to inoculum and the volume and composition of methane will be analyzed.

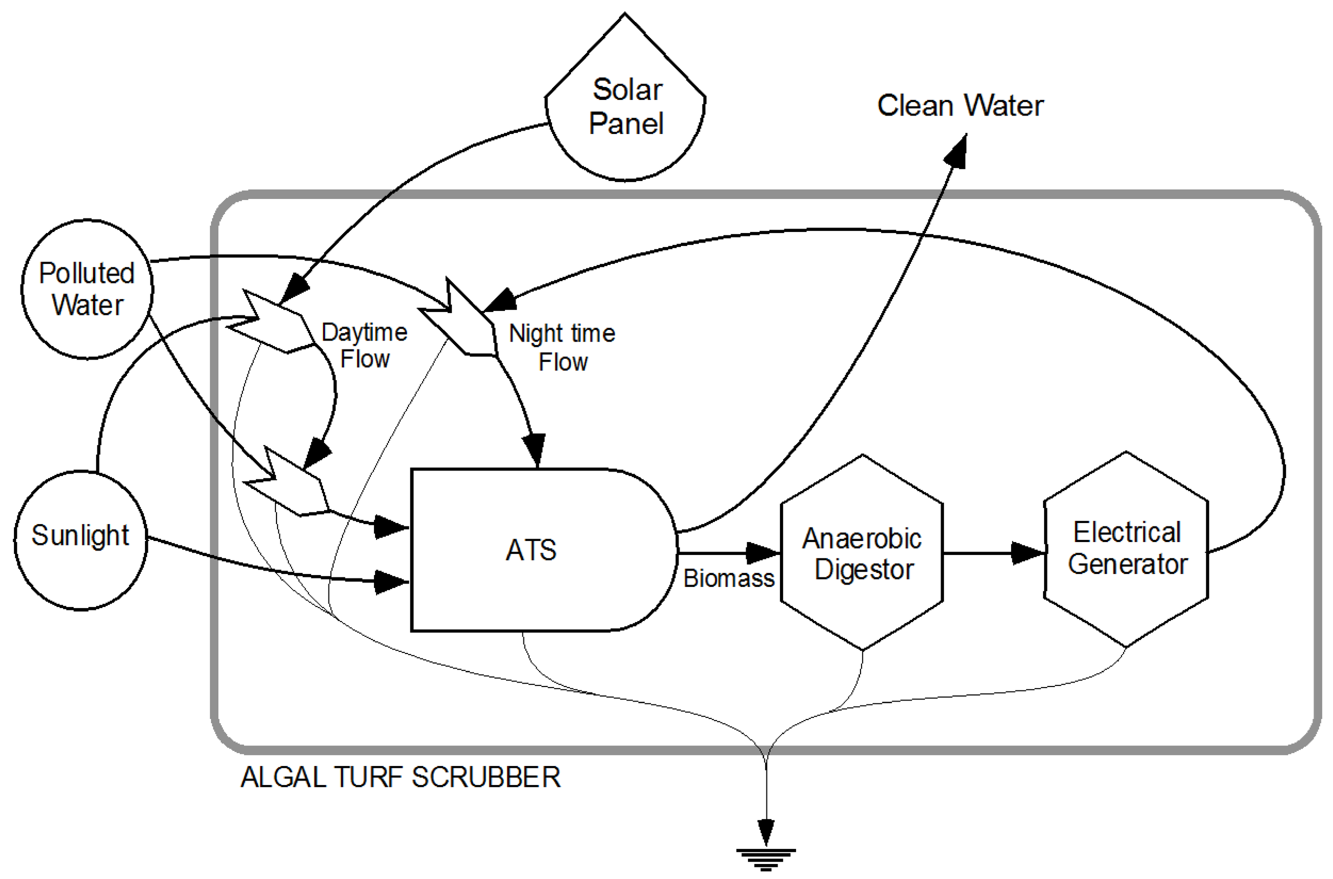
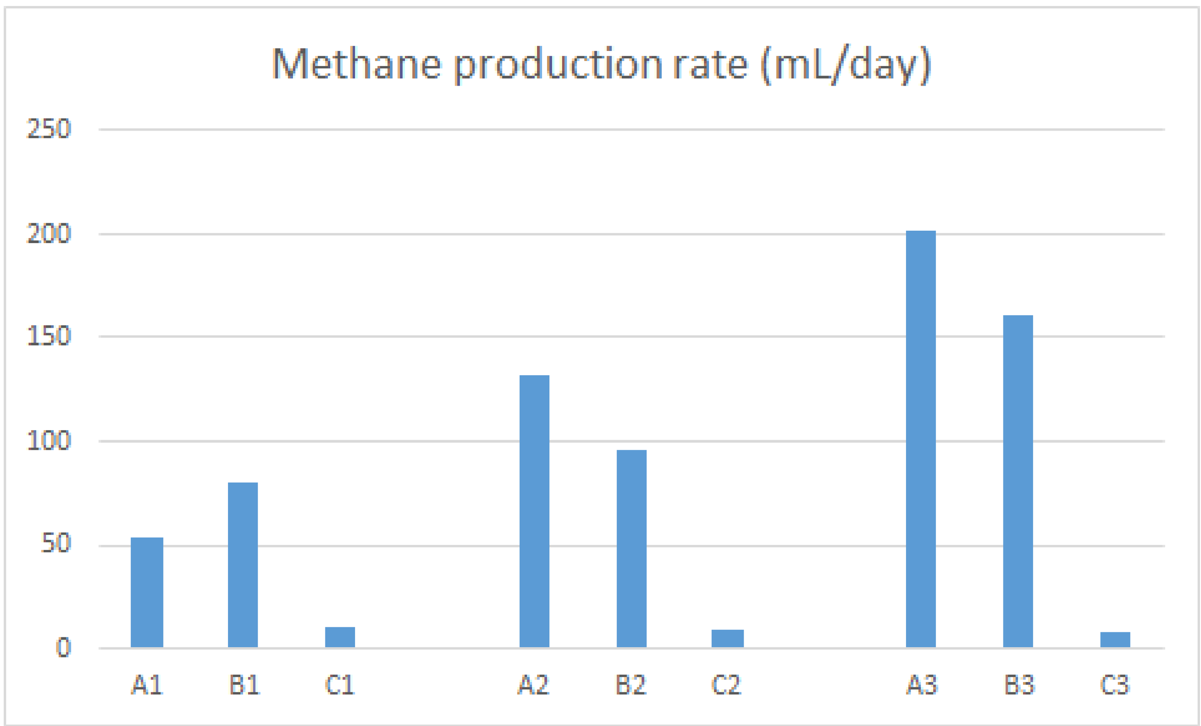


Figure 1: *Polluted water is pumped into the ATS, which is powered by solar PV during the day. At night the pump will run off of biogas produced through the anaerobic digestion of the algae. The system is designed to be self-sustainable and will produce clean water as an output.*

Methods

Nine digesters were constructed using 3" PVC and fitted to collect gas. The digesters were split into three groups, each of which was heated with re-wired pipe heating tape. One reactor in each group was loaded with inoculum only, one was loaded with dry algae and inoculum at a 1:1 (gVS:gVS), and the last was loaded with algae and inoculum at a 2:1 volatile solid (VS) ratio. Biogas production was checked on days 7, 21, and 28, using a gas chromatograph to determine methane content and a volumetric syringe to determine biogas volume. TS/VS tests were performed on each mixture, before and after digestion to determine volatile solid to biogas conversion rates.

Results



Data Analysis

Table 1. Current Algal Turf Scrubber biomass production to electricity conversion.

Average Algae Production	20 g(dry)/m/d
Algal Turf Scrubber Area	186 m^2
Algae produced	3720 g/d
Conversion Rate (A)	1.94 mL CH_4/g algae
Methane Production	7.2 L/CH_4/d
Energy Production- 100% efficiency	258 Btu/d
	0.076 kWh/d
Energy Production- 50% efficiency	129 Btu/d
	0.038 kWh/d

Table 2. Proposed half acre Algal Turf Scrubber biomass production to electricity conversion.

Average Algae Production	20 g(dry)/m/d
Algal Turf Scrubber Area	2025 m^2
Algae produced	40,469 g/d
Conversion Rate (A)	1.94 mL CH_4/g algae
Methane Production	78 L/CH_4/d
Energy Production- 100% efficiency	2808 Btu/d
	0.8 kWh/d
Energy Production- 50% efficiency	1404 Btu/d
	0.41 **kWh/d**

Discussion & Conclusion

Currently, the ATS at the Port has the theoretical capacity to produce 7.2 L CH4/day. If the project were scaled to a half acre, methane production would increase by more than 10 times providing 111 kWh per year. Although this is not enough energy to power the ATS pump, it could be directly combusted for heating purposes which is a more efficient process. This experiment had inherent limitations due to the lab-scale, but greater methane conversion rates would be expected for a full-scale digester. The reactors in this experiment were only heated to the lower mesophillic temperature range, inhibiting methanogenic activity. Furthermore, in a full-scale continuous-feed system, methanogenic bacterial communities would have time to adapt to the algal feedstock, thus boosting biogas production.