Production of Biodiesel and Ethanol from Algae
(Technical Report)

Flint Water Crisis: Failure to Provide Care
(STS Research Paper)

An Undergraduate Thesis Portfolio

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Sociotechnical Synthesis: Algal Biofuels and Ethics of the Flint Water Crisis

For my technical capstone, I designed an algal biofuel refinery and for my STS project, I examined the actions of the government throughout the Flint Water Crisis using Care Ethics. Although my technical and STS projects pertain to different technologies, working on both projects at the same time has allowed me to recognize how important both the societal and technical aspects of any successful or failed engineering project are. Technical and societal actors both play a vital role in determining the result of any endeavor that involves engineering.

For my technical capstone, I worked on designing an algal biorefinery that produced biodiesel from algal lipids and ethanol from spent algal biomass. Algae was chosen as the feedstock for production of these biofuels because algae is a carbon neutral crop and has higher land productivities than other food sources used for biofuels. The design utilizes wastewater as a source of nutrients, primarily nitrogen and phosphorous, that are needed for algae growth. Algae cultivation is done in batch processes, taking up a significant amount of land. The cultivated algae is then treated with acid to break down the cellulose and allow the lipids to be extracted. These lipids are extracted with hexane and converted into biodiesel via transesterification. The algal biomass from the acid hydrolysis is neutralized and fermented to produce ethanol. Both biofuels are purified through a series of processes. We had hoped that this design would make the production of these biofuels more economically feasible, as we would be utilizing the spent algal biomass that is traditionally be discarded as waste, as a feedstock for ethanol. Unfortunately, due to the high costs of concentrating the algae and large amounts of water present, this design was not economically feasible. However, the plant could potentially be made

feasible with incentives such as a carbon tax and higher fuel prices. Further design optimizations and research in better growing and genetically engineered algae could also make this plant feasible in the future.

For my STS project, I argued that the local, state and federal government all failed to provide the proper care needed to Flint residents during the Flint Water Crisis. I examined government response towards the crisis using Carol Gilligan's framework of Care Ethics, looking closely at the government's attentiveness, responsibility, competence, and responsiveness. Overall, I determined that all levels of government had been negligent towards testing procedures and inattentive to the complaints of Flint residents, partly due to their racial and socioeconomic status. All levels of government were unethical as they failed to fulfill their responsibility of care towards vulnerable citizens who relied on them for safe drinking water.

Overall, working on these two projects together has helped me appreciate and understand the ways in which social and technical aspects of projects compliment each other. For example, while working on my technical capstone and doing the technical work required to make the plant feasible, I was faced with questions about the safety and environmental aspects of the design. I had to consider what chemicals I used for flocculation, knowing that I would be sending back the wastewater to wastewater treatment facilities. In thinking about ways to make the plant successful, we also thought of a potential carbon tax and government initiatives that would help push society and the energy industry into more sustainable practices. Similarly, while working on the STS project and examining the negligence of the government, I was able to see all the technical fallacies and mistakes that were made along the way. This knowledge helped me understand the competence piece of care at a deeper level. Overall, I have developed a deeper appreciation for both the technical and social aspects of engineering.