Thesis Project Portfolio

Production of Biodiesel from Algae

(Technical Report)

The Impacts of Crop-based Biofuels on Food Insecurity in the United States

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

The problem that the technical report and STS research paper attempt to address is the use of biofuels. The two papers go hand-in-hand, as the STS research paper discusses the effect of crop-based biofuels on food insecurity and the technical paper attempts to design algae farm and biodiesel refinery. The motivation of the STS research paper was to explore how food insecurity and crop-based biofuels are related, and it seeks to highlight the impact that corn-based ethanol has on food insecurity in America. The motivations behind the technical report's algae farm and biodiesel plant are the possible environmental benefits associated with them. This plant would provide a means of obtaining a green fuel source through the production of biodiesel, and the farm's use of poultry litter as the algae's nutrient source will help prevent nutrients from entering natural waterways and causing damage. The technical project was an attempt to address some of the issues surrounding the use of crop-based biofuels highlighted in the STS research paper, such as land usage. However, in the end, the use of algae in the designed plant seems to have a set of challenges that make it a difficult implementation.

The STS research paper will use the Social Construction of Technology and Co-production frameworks to help evaluate how different groups in the United States perceive corn-based ethanol, how these different perceptions mold ethanol into what we know it as today, and how these groups might be affected by the development of ethanol. The STS research paper shows that society's interpretation and opinions regarding corn-based ethanol determine how it is used and that corn-based ethanol affects the society return. Research into a more effective structure of resource allocation to help decrease the number of people experiencing food insecurity, while honoring the technology that is corn-based ethanol, is a next step that could be taken.

The methods and tools used to design the technical report's algae farm and biodiesel plant were kinetic data, Aspen Plus modeling, and other key chemical engineering principles and considerations. An economic analysis, which involved the equipment cost, labor and benefits costs, utility costs, raw material costs, and taxes, was performed in order to determine the plant's economic potential. In a year of production, 4.5 million gallons of biodiesel and 970,000 kg of glycerol will be produced, which brings in a yearly product revenue of $12 million. As designed, the plant costs $297 million in capital, has $22 million in yearly operating cost, and $6.2 million in labor cost. These factors result in a loss of $15.9 million per year. Assuming a plant life of 20 years, the design's internal rate of return would be -10.3%. As a result, the current design does not make the algae farm and biodiesel plant an economically viable project. The only scenario where this project may be economically feasible is when diesel prices are sold at $14.25/gallon, which leads the investment to break even at the end of the plant's lifespan. Research into a way to produce larger amounts of algae without the need for an extensive amount of resources could further the progress of biofuels significantly.