

**Production of Biodiesel and Ethanol from Algae**  
(Technical Report)

**Analysis of BP's actions throughout the Deepwater Horizon oil spill using care ethics**  
(STS Research Paper)

An Undergraduate Thesis Portfolio

Presented to the Faculty of the  
School of Engineering and Applied Science  
University of Virginia, Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree  
Bachelor of Science in Chemical Engineering

By

David Vann

May 1, 2020

## **Table of Contents**

Socio-technical Synthesis

Production of Biodiesel and Ethanol from Algae

Analysis of BP's actions throughout the Deepwater Horizon oil spill using care ethics

Prospectus

David Vann

April 24, 2020

STS 4600

### **Socio-technical Synthesis: Algal Biofuels and the Ethics of the BP Oil Spill**

My technical work and STS research are connected, in some sense, by a theme of replacing/reducing usage of fossil fuels in the service of reducing emissions contributing to climate change. By all available evidence, climate change will be one of the most important issues by the end of the century, and each year in which we do not commit to radically alter the ways in which we produce energy and organize society is a delay that will have exponential consequences as time drags on. My work aims to show that there are both alternatives to producing our energy primarily from fossil fuels (albeit, with some hurdles yet to overcome) as well as serious ethical and practical implications of continued extraction of hydrocarbon products from the planet.

In my technical work, my capstone team and I have explored a potential design for a process to cultivate algae and produce both biodiesel from extracted algal lipids as well as ethanol from spent algae biomass, each of which could be used as fuel for transportation. Algae as a source of biofuels has some promising advantages over traditional sources of biofuels (e.g., corn, soybeans) such as higher energy density by land area used for growth, which is why we used it in this project. In this design, a fairly large amount of land would be used to grow algae in raceway ponds. The algae would then go through an acid treatment to aid in lipid recovery and to hydrolyze bonds between glucose monomers in the algae cellulose. Finally, lipids would be extracted using hexane and converted into biodiesel, and the glucose (from the hydrolyzed cellulose) would be fermented and turned into ethanol. Our design hoped to improve the

profitability of algal biodiesel by using wastewater as a nutrient source for algae cultivation and co-producing the ethanol with the spent biomass. Ultimately, though, we found it to not be an exceptionally profitable enterprise at this time and uncompetitive with petroleum fuels at current prices. However, with further optimizations and research into production methods (or increases in petroleum fuel prices by taxes or otherwise), it certainly may be feasible in the future.

My STS research looked at the BP *Deepwater Horizon* oil spill in 2011 through the lens of care ethics, an ethical framework that emphasizes the importance of relationships and values as well as the contexts in which those relationships exist. I primarily examined the ethics of the ways in which BP responded to the spill, looking at its actions regarding the spill's impacts on BP's workers (particularly those working on the rig when it exploded), people living near the Gulf of Mexico, and the environment. I argue that, because of BP's various cases of inaction and misdeeds, it failed to uphold its duty of care to any of these groups and therefore acted unethically throughout the crisis. In doing so, I hope to have covered some of the moral implications of BP's response that seemed to be unaddressed in literature or media in the years since the spill.

I feel that each project has added value to the other. In my technical work, I was able to gain a greater understanding of one fuel which could provide an alternative to fossil fuels in transportation, the technical limitations hindering its adoption, and possible improvements for the future that could make wide-scale adoption a reality. In my STS research, I also looked more deeply into one of the more dire cases of the ethical consequences of drilling for high-pressure hydrocarbons underground, with both human and environmental costs. Overall, working on both of these projects together in the broader context of climate change has provided me both with arguments against current fuels as well as technical understanding of a proposed alternative fuel.