Thesis Project Portfolio

Production of Sustainable Butanol Biofuel from Corn Stover

(Technical Report)

How Biofuel Legislation and The Subsidization of Corn for Ethanol Product Impacted Agricultural Communities

(STS Research Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

My technical and STS projects both focus on the use of corn-derived biofuels to solve domestic and worldwide issues. However, each project approaches this motivation from opposite sides. My technical project designs a facility that utilizes corn waste to create a biofuel called butanol. This project has two main primary design goals: producing a higher quality biofuel substitute in place of ethanol, and helping to eliminate the food versus fuel debate caused by more than half of total domestic corn production needed to produce traditional biofuels. Current United States government policy encourages the production of such biofuels by putting money and resources behind the production facilities themselves, but also behind the products required to produce such biofuels- namely, corn. My STS project focuses on the corn feedstock side of the biofuel issue. This project investigates how biofuel policy and subsidization of corn for biofuel product was intended to fund farmers, allowing for increased corn production and maintenance of the farming sector.

Technical Project

According to the EPA, over a quarter of all greenhouse gas emissions produced by the United States can be attributed to the burning of fossil fuel based gasoline from internal combustion engines (ICEs) (Sources of Greenhouse Gas Emissions). To reduce ICE emissions and their subsequent effect on the world's climate, extensive research has been devoted to creating new alcohol-derived fuels called "biofuels." Ethanol has been the biofuel of choice, blended into gasoline for minor emissions savings since the 1970s. However, butanol has

recently appeared as a higher quality substitute, given that its lower volatility, increased ignition performance, and higher energy density than ethanol (Trindade & Santos 2017). This technical project includes the design of a large-scale solids-liquids processing plant, producing over 57 million kilograms of butanol per year from corn stover, a second-generation feedstock. Currently, ethanol in the United States is made from the fermentation of corn, with more than half of total domestic corn going towards ethanol production (Feed Grains Sector at a Glance). This technical project uses the leftover corn stalks, leaves, and cobs from regular corn production, alleviating the food versus fuel debate caused by traditional ethanol product. Corn stover is broken into usable sugars via the Weizmann process, a fermentation technique using Clostridium bacteria to create acetone, butanol, and ethanol (Nguyen et al., 2018). Leftover corn waste and nutrients will be mixed with calcium monohydrogen phosphate and sold as an animal feed supplement. Although the economics for this process initially indicate a monetarily successful investment, several technical and agricultural uncertainties around the butanol and animal feed supplement products raise caution about the process' economic viability.

STS Project

The aim of this research is to explore how biofuel policy and the subsidization of corn for ethanol product facilitated an infrastructural paradigm shift in agricultural communities from the 1970s to today. Specifically, I investigate how the response to government policy was to transition the type and total number of crops grown, and deviate from traditional farming technologies, ultimately leading to the changing of the makeup, size, and number of farmers within these agricultural communities. I argue that policy initiatives initially created to artificially sustain the farming sector potentially caused irreversible damage to farming

communities. To bolster my argument, I performed a policy analysis primarily using secondary source data from the USDA Economic Research Service, along with overviews of legislation from the Department of Energy and the Environmental Protection Energy. Throughout this analysis, I utilize the STS analytical framework of the "sociotechnical imaginary" in the reading "Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power" by Sheila Jasonoff & Sang-Hyun Kim (2015), to better understand the government's purpose behind biofuel policy and the legislative implications on the farming industry. Using Jasonoff's & Kim's (2015) definition of sociotechincal imaginaries, I argue that the government's perception of the agricultural sociotechnical imaginary is misconceived. The government's imaginary understands the effects of the farming industry, but not the cause, or the being of it. The basic relationships that farming has with the soil has spider-webbed effects on the respective technologies, culture, and sociological makeup of the farming industry, far before the industry begins to impact the U.S. economy or national security.

Conclusion

My two projects, technical and STS, focused on the US biofuel issue in different capacities. By investigating both the technical side of how corn is used in biofuel production, and the STS side of how to get that corn to biofuel facilities, I was able to get a comprehensive, complimentary understanding of this biofuel issue in the United States. I would not have been able to fully grasp the vast implications of implementing biofuel policy in a variety of sectors without the research done in both my technical and STS projects. The technical design requiring corn waste for butanol production instead of corn cobs mitigates the STS issue of inflated corn prices, potentially helping cool the artificially boosted agricultural sector. By investigating

infrastructural changes in my STS project like shifting planting preferences from non-corn crops to corn, my technical project can project how much corn stover we can buy, and at what price we can sell our animal feed supplement. Overall, I learned through the combination of these two projects that biofuel policy has long reaching implications for both farmers, green fuel production, and future government policy.

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