Carbon Capture, Utilization and Storage

(Technical Report)

Analysis of the Effect of Climate Change on Cultivation of Arabica Coffee (*Coffea arabica*)

(STS Research Paper)

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Sociotechnical Synthesis

The technical design project, Carbon Capture, Utilization and Storage, explores the feasibility of converting carbon dioxide captured from stack gas from a natural gas power plant, Pastoria Energy Facility, into diesel. The plant is retrofitted with an amine scrubbing system to remove and isolate the carbon dioxide (CO_2) gas from the power plant exhaust using monoethanolamine (MEA). The CO_2 is then fed into a reverse water-gas shift reactor followed by a Fischer-Tropsch reactor, which converts the CO_2 into carbon monoxide (CO) and a variety of hydrocarbons, respectively.

The final recommended solution from mainly an economic standpoint is to sequester captured CO_2 as opposed to pursuing synthetic fuel generation. The overall capital cost for the recommended option is $56,805,108 with utility costs of $26,392,029 per year, labor costs of $1,664,600 per year, and CO_2 transportation and storage costs of $6,411,006 per year. Overall, this project would remove 56,000 kg/hr of CO_2 from the atmosphere, a 27% reduction from the total plant emissions, at a process cost of $34,804,505 per year. This cost for carbon removal can be offset by earned carbon credits of $6,740,000 per year and a price increase of 3.6% for 10 years and 3.0% after in electricity sold by the plant.

Climate change brought on by the excessive release of greenhouse gases, namely CO_2, is negatively impacting agriculture on a global scale. The Science, Technology, and Society analysis of this thesis explores specifically the cultivation and harvest of Arabica coffee, which is under great duress due to a perfect storm of shifting climate conditions and poor harvest techniques. Carbon capture, utilization and storage (CCUS) technologies have the potential to mediate a portion of greenhouse gas (GHG) emissions

by capturing point source CO2 emissions, but even with the implementation of these technologies, farmers must still consider adaptation techniques to reduce the potential for extinction of *Coffea arabica*.

China and the United States are the source of nearly 50% of global greenhouse gas emissions (U.S. EPA, 2014). The top 10 coffee consuming countries per capita all have a human development index (HDI) greater than 0.90, which reflects a very developed nation (World Atlas, 2018). That being said, Greater than 90% of coffee production is located in developing countries (Ponte, 2002), and the residents of these areas are found to be extremely vulnerable to climate change. These communities feel the effect on their livelihood through reduction of suitable locations for coffee cultivation brought on by greenhouse gas emissions.

Technological determinism is a theory of STS that applies to the analysis of the effect of climate change on the cultivation of Arabica coffee. This framework emphasizes the deterministic effect of technology on societal norms and cultures of affected areas based upon its interaction with situational circumstance and ideology of localities impacted. In this specific case of arabica coffee harvesting in developing nations, farmers are left with virtually no option but to adapt according to the effects of climate change that they experience.

Personal opinions from local Charlottesville coffee shop personnel that source coffee beans through the use of a short survey was gathered to support the analysis. Primary data was also gathered through the use of published academic journals that include interviews from rural farmers located in the geographical areas of interest themselves. It was found that climate change is projected to have an overwhelming

negative effect on the cultivation of Arabica coffee over the next few decades. Farmers are unlikely to have a full grasp of the changes brought on their livelihood caused by climate change, since they are mostly located very far from the epicenter of greenhouse gas emissions and lack the education necessary for a depth of understanding of climate change science.

No single technology has the ability to save Arabica coffee from the effects of climate change. The coffee industry will not prevail due to simply the implementation of CCUS technologies at certain power producing facilities. That being said, these technologies implemented in concert with more sustainable agricultural practices and increased education of farmers has the potential to prolong the lifespan the coffee industry.

References

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