Thesis Project Portfolio

Carbon-Negative Production of Methanol via Direct Air Carbon Capture

(Technical Report)

Renewable Energy's Land Demands and Native Peoples in the U.S.: An Analysis of Renewable Energy Infrastructure Development on Native Lands

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Industrial society's dependence on fossil fuels has resulted in concerning concentrations of greenhouse gases in the atmosphere. As a result, rapid climate change places sensitive ecosystems in danger as they are unable to adapt quickly enough. As climate change and rising global tempertaures put human development in danger, climate scientists now emphasize the necessity for societies to reach net-zero emissions, or even net-negative emissions, within decades. To this end, this collection of both technical and social thesises explore the development and implementation of sustainable technologies.

For the technical portion of this project, a Direct Air Capture (DAC) system was designed to extract ambient carbon dioxide and process it into a purified carbon dioxide stream to be sent to a designed methanol synthesis plant. Methanol is an important chemical used as stock in many manufacturing processes, and can be burned as a fuel. However, current methods of making methanol depend on the combustion of fossil fuels. The proposed DAC to methanol synthesis plant seeks to develop a way to form methanol that does not rely on fossil fuels as well as to add to the collection of knowledge about an up-and-coming technology, direct air capture. DAC is achieved via the absorption of ambient carbon dioxide by a potassium hydroxide sorbent and a subsequent calcium caustic loop and recovery system, achieving a purified carbon dioxide stream while regenerating necessary reagents within the system. Methanol synthesis is achieved via a reverse-water-gas-shift reaction and subsequent methanol synthesis reaction utilizing ZnO/Al_2O_3 and $Cu/ZnO/Al_2O_3$ catalysts respectively.

While this technical project could not be recommended under the base scenario studied due to lack of economic viability, there is hope that by selling the produced methanol at a

premium or with plant optimiziation and technological improvements, DAC can be proliferated and processed carbon can be turned into useful materials in a profitable mannor.

Accompanying the technical project, a research report was synthesized to evaluate renewable energy infrastructure proliferation on lands owned by Native Americans. While Native Americans reside on 5% of total U.S soil, it is estimated that due to the geographical location of reservations, approximately 10% of US energy resources are contained within these territories. While starting renewable energy technology projects could improve Native communities by boosting the local economy, a long history of land dispossession and lack of regard for Native peoples rights could mean community members will be placed in a vulnerable position if they allow new developments. The social construction of technology framework was used to understand how proponents of renewable energy infrastructure and defenders of Native land rights will influence installments in and around Native communities. These two projects contribute to an overall goal of gaining a better understanding as to how sustainable technology is developed and placed, and the impacts that arise due to development, both in a technical and social sense.