

**Thesis Project Portfolio**

**Carbon-Neutral Production Of Methanol Via Direct Air Carbon Capture**

(Technical Report)

**The Integration of Direct Air Capture in Modern Society and Industry**

(STS Research Paper)

An Undergraduate Thesis

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

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2022

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## **Sociotechnical Synthesis**

Climate change has been a growing concern over the last few years due to the increase in greenhouse gas emissions and these theses seek to propose a solution to this problem. These emissions are largely the result of industrialization with little technologies implemented to mitigate these emissions. Recently, there are major developments in direct air capture, DAC, technology to help capture the greenhouse gases already in the atmosphere and convert those gases into more useful materials. The following technical thesis will explore designing a DAC facility that seeks to produce methanol from captured greenhouse gases. While the STS thesis will explore the integration of DAC technologies in modern day society.

The technical thesis proposes a design for a direct air capture facility followed by a downstream methanol production plant. The goal of this project was to design a production process for a carbon-neutral fuel, with the process being carbon-negative. The project included design for all the necessary reactors, heat exchangers, and other process units. The DAC process utilized a high-temperature aqueous solution approach, and the methanol synthesis portion followed the CAMERE process. An economic analysis was also performed as part of the paper, this analysis shows that currently the process is too expensive to be practical but shows room for optimization.

The STS thesis examines the integration of direct air capture technology utilizing the multilevel perspective and makes predictions of how the pathway of this technology could develop in the future. Evaluation of both supporting and opposing regimes were performed at the state, national, and international levels. Policies across North America, Europe, and Asia were analyzed in support of DAC technology as well as some expected and unexpected industries. Remarks about how the United States can pave way for this technology internationally were also discussed as well as how other nations may be resilient to this change. Public perception plays a key role in this technology's development, particularly with the idea of 'greenwashing' and how this technology can have impacts on the environment.

The work contained within these theses shows that DAC technology has the potential to make significant impacts on the future of the climate crisis. There is significant room for optimization, particularly as more technology is developed and made more affordable, but the foundation for DAC exists and is practical.