

Thesis Project Portfolio:

**Optimization of Carbon-Neutral Production of Methanol Via Direct Air Carbon Capture**

(Technical Report)

**Occidental Petroleum's Carbon-Neutral Oil: Leading the Transition to Cleaner Energy**

(STS Research Paper)

A Thesis Prospectus submitted to the Department of Engineering and Society

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By

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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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## **Executive Summary**

Global carbon emissions continue to rise rapidly and catastrophic changes to the environment are already being realized, whether it is the widespread loss of biodiversity hotspots like coral reefs or unprecedented weather events. Emissions of gases like CO<sub>2</sub> are driving climate change and hundreds of gigatons are still to be produced from existing fossil fuel infrastructure. Since almost every model used by the Intergovernmental Panel on Climate Change (IPCC) describing a safe climate trajectory necessitates “negative emissions technologies,” technologies like carbon capture and storage have been the subject of intensive research. This technical capstone project addresses the design and economic viability of a plant which turns CO<sub>2</sub> captured directly from the air into methanol, a widely used solvent. The plant operates 6000 hours per year, capturing 0.98 Mt CO<sub>2</sub> per year which is then converted to methanol at 99% purity at a rate of 0.62 Mt per year. It is important to consider the human and social actors of this technology through Actor-Network Theory: the position of fossil fuel companies in carbon capture technologies, the role the government plays in subsidizing carbon capture, negative environmental risks and impact on vulnerable communities near new large scale construction, and the unintended effect deployment of carbon capture may have on prolonging the shift to renewable energy. When evaluating the potential for direct air carbon capture to be a climate solution, it is necessary to weigh the human and social dimensions to better understand how the technology will impact society beyond the technical components. The sociotechnical research paper will address the questions associated with the promise of carbon-neutral oil by performing an in-depth literature review of a case study: Occidental Petroleum’s proposed direct air capture facility and enhanced oil recovery operation which will utilize and sequester the captured CO<sub>2</sub> to extract more oil from existing oil fields. Occidental aims to have their plant in operation by 2025, so the sociotechnical research paper aims to discover whether Occidental should be a role model for other fossil fuel companies searching for sustainable production methods, or if the detrimental social and environmental effects of their proposed operation outweigh any potential reduction in emissions. Both this capstone project and this sociotechnical research paper evaluate direct air carbon capture from different points of view and in different technical applications. The analyses work in concert to demonstrate both the technical and economic feasibility of direct air carbon capture technology and how human, social, and environmental actors weigh against the

technical and economic when a fossil fuel giant applies direct air carbon capture to manufacture carbon-neutral oil.