

**Thesis Project Portfolio**

**Design of a Processing Plant for Direct Lithium Extraction from Geothermal Brine in the Salton Sea Region**

(Technical Report)

**A Virtue Ethics Analysis of Evo Morales's Push for Domestic Lithium Extraction in the Salar de Uyuni**

(STS Research Paper)

An Undergraduate Thesis

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

**Sunya Qamar**

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Department of Chemical Engineering

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## **Sociotechnical Synthesis**

### **The Ethics of Lithium Mining and its Proposed Alternatives**

As the world shifts to adopting renewable alternatives to energy and transportation, the demand for lithium, a key component in lithium-ion batteries, continues to rise. My technical work and STS research are connected by the concept of lithium extraction and production; specifically, the ethics of traditional extraction methods and a proposed sustainable alternative. My STS research focuses on the ethics surrounding lithium mining in Bolivia, highlighting the key social and environmental issues that have risen since the start of the operations in the late 2000s. To mitigate the social and environmental issues associated with foreign operations in general, my technical work proposes a direct lithium extraction plant in the Salton Sea region of California. Both projects, in turn, emphasize the need for a more sustainable method of lithium extraction as demand increases.

Building upon research done by Team TELEPORT at the University of Virginia, my technical work proposes a large-scale direct lithium extraction (DLE) plant. DLE is a new method of lithium extraction that is being researched as a sustainable alternative to traditional extraction methods. Designed to retrofit pre-existing geothermal power plants, DLE selectively extracts lithium from liquid geothermal brine that is not used for energy production. After the lithium is extracted, the depleted brine is sent back into the ground, thereby greatly reducing the land and water requirements traditional extraction methods have. Using the data collected by Team TELEPORT, in addition to our own calculations and modeling (primarily done via Aspen Plus V14), my team and I successfully designed a DLE plant that produces over 10,000 US tons of lithium hydroxide monohydrate per year at 99.6% purity. Our process specifically was

designed to be used in the Salton Sea region of California, thus proving that domestic production of lithium to meet demand is possible.

My STS research also emphasizes the need for a sustainable alternative to traditional lithium extraction, but from the ethical perspective. The Salar de Uyuni in Bolivia contains over 50% of the world's lithium supply. To tap into the ever-growing market, Bolivian President Evo Morales began mining operations in the late 2000s, resulting in environmental damage and civil unrest, which ultimately led to his forced resignation in 2018. I analyze this case through the lens of virtue ethics, and more specifically, the cardinal virtue of justice, to assess the morality of President Morales's actions. My work claims that President Morales did not act as a moral leader during his presidency because he failed to act with justice towards his citizens. The importance of my research, outside of judging the morality of President Morales's actions, was to highlight the common ethical issues that have risen since lithium extraction operations have begun in South America.

Working on both projects concurrently greatly added value to both. My STS research highlighted the concerns surrounding lithium extraction operations in South America, providing context as to why a more sustainable and ethical alternative is needed. My technical project proposed a new alternative method of lithium extraction that would allow for domestic production of battery-grade lithium, providing a starting point for the design to be improved as more data is collected in forthcoming years. My technical project served as a proof-of-concept that the domestic production of lithium is not only possible but also highly economical, while my STS research emphasized that domestic production is also the morally correct option to meet lithium demands.