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Resources on Lithium Extraction Methods for the July 29, 2021 Lithium Valley Commission Meeting

This document provides a list of selected resources to inform discussion of lithium extraction methods during the July 29, 2021 Lithium Valley Commission meeting.

Warren, Ian. 2021. Techno-Economic Analysis of Lithium Extraction from Geothermal Brines. NREL/TP-5700-79178

This report includes an overview of methods used to extract lithium from geothermal brines around the world, including evaporative brine processing, hardrock mining, and direct lithium extraction (adsorption, ion exchange, and solvent extraction). This NREL report was published in May 2021 and is available online (https://www.nrel.gov/docs/fy21osti/79178.pdf).

Related CEC-Funded Active Research Projects

Improved Silica Removal for Enhanced Geothermal Plant Performance

Agreement EPC-19-029 (https://www.energy.ca.gov/filebrowser/download/1799) with Hell's Kitchen Geothermal, LLC is a $2,999,599 grant with $45,000 in match funding to develop and demonstrate a fundamentally new and innovative method for managing silica in geothermal operations; silica removal is a key step in brine pre-treatment for lithium recovery. The new technology, Geothermal Micropillar Enabled Particle Separator, systematically separates silica particles from the geothermal brine based on their size as they flow through a series of carefully positioned staggered/offset posts. This technology has the potential to lower both the capital and operational costs of brine management at geothermal plants.

Salton Sea Geothermal Lithium Recovery Demonstration Project

Agreement EPC-19-020 (https://www.energy.ca.gov/filebrowser/download/293) with BHER Minerals, LLC for a $6,000,000 grant and more than $4 million in match funding to design, build, and commission an integrated system that includes geothermal brine pre-treatment and lithium recovery processes. The demonstration project will deploy an innovative technology at an existing geothermal power facility in Calipatria, California to cost-effectively process at least 100 gallons of geothermal brine per minute and produce a battery-grade lithium carbonate equivalent at a production cost of approximately $4,000 per tonne.

Hell's Kitchen Geothermal Lithium Extraction Pilot

Agreement EPC-19-018 (https://www.energy.ca.gov/filebrowser/download/1599) with Hell's Kitchen Geothermal, LLC, for a $1,460,735 grant and $480,000 in match funding. This project will design a pre-treatment process based on the chemical composition of the geothermal fluids at the project site and demonstrate its technical performance on a pilot-scale. The process will remove silica and heavy metals and prepare the brine ready for subsequent extraction of lithium. The developed process will be demonstrated on flowing geothermal brine at 5 gal/min and will provide a path to a technically feasible lithium extraction process with favorable commercial scale economics.

Pilot Scale Recovery of Lithium from Geothermal Brines

Agreement EPC-19-017 (https://www.energy.ca.gov/filebrowser/download/296) with Materials Research LLC for a $1,878,634 grant is demonstrating a pilot scale process for the recovery of lithium from geothermal brines. The agreement is based on a newly developed sorbent material for the extraction of lithium and a carbon-negative sorbent regeneration process for the direct formation of high-purity lithium carbonate. The co-production of this valuable metal adds revenue and improves the economics of geothermal energy generation.

Related CEC-Funded Completed Research Projects

Recovery of Lithium from Geothermal Brines

This project EPC-16-020 for $873,387 has been completed; the final report is available online (https://www.energy.ca.gov/publications/2020/selective-recovery-lithium-geothermal-brines). The project demonstrated a cost-effective integrated process for the recovery of lithium from geothermal brines based on: (1) new high-capacity selective composite sorbents comprised of inorganic lithium-ion sieves and lithium-ion-imprinted polymers; and (2) a new sorbent regeneration process using eco-friendly carbon dioxide/carbonic acid that leads to the direct formation of high-purity lithium carbonate (Li2CO3). Compared to traditional methods of Li recovery from brines, the high-capacity selective sorbents and their regeneration process are expected to lower the cost of Li production by enabling online separation with higher recovery efficiency, using smaller volumes of sorbents, and minimizing processing time. The project demonstrated a laboratory-scale integrated separation process for the production of high-purity Li2CO3 from geothermal brines.

Technologies for Extracting Valuable Metals and Compounds from Geothermal Fluids

This project PIR-10-059 for a $380,000 grant with more than $6 million in match funding was completed in 2014. Methods for extraction were developed in laboratory tests and the viable methods were then tested at pilot scale. A lithium extraction pilot plant was constructed adjacent to a geothermal power plant in Calipatria, California, to test processes on geothermal brine. Two other pilots were constructed in Brawley, California for production of lithium products from lithium chloride extracted from geothermal brine. These plants demonstrated the key steps to produce lithium products, mainly: silica management, lithium extraction, purification, concentration, and conversion into lithium hydroxide and lithium carbonate products. In particular, the research team demonstrated that battery-grade lithium carbonate could be produced from lithium chloride extracted from geothermal brine. The final report is available online at https://wayback.archive-it.org/5763/20171222133218/http:/www.energy.ca.gov/2015publications/CEC-500-2015-023/CEC-500-2015-023.pdf.

Well to Wheels Lithium Design

Agreement GEO-16-006 (https://wayback.archive-it.org/5763/20200831110334/https://www.energy.ca.gov/filebrowser/download/1411) with EnergySource Minerals, LLC for a $2,500,000 grant with more than $2.5 million in match funding developed a robust engineering package and accurate capital budget for a facility to extract lithium and mineral co-products from geothermal brines using processes and equipment from the water treatment, metal processing, and chemical processing industries. An existing pilot facility was used for a small-scale demonstration of the extraction process and extracted lithium product. The project was completed in 2020.