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| **Docket Number:** | 20-LITHIUM-01 |
| **Project Title:** | Lithium Valley Commission |
| **TN #:** | 242533 |
| **Document Title:** | Initial Response from California Energy Commission |
| **Description:** | Initial step in responding to the Leadership Counsel for Justice and Accountability (Leadership Counsel) questions submitted to the Lithium Valley Commission. The Lithium Valley Commission asked the CEC to prepare a written response to the questions submitted by Leadership Counsel in October 2021. This letter provides background information about the local geothermal resources, geothermal power plants, lithium, and lithium extraction from geothermal brine. |
| **Filer:** | Erica Loza |
| **Organization:** | California Energy Commission |
| **Submitter Role:** | Commission Staff |
| **Submission Date:** | 4/4/2022 8:09:07 AM |
| **Docketed Date:** | 4/4/2022 |

CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

April 1, 2022

Mariela Loera
Policy Advocate
Leadership Counsel for Justice and Accountability

RE: Public Engagement and Outreach Related to the Lithium Valley Commission – Initial Response from California Energy Commission

Dear Mariela Loera,

Thank you for your correspondence and other communications on behalf of Leadership Counsel for Justice and Accountability (Leadership Counsel) and community residents, seeking clarity on proposed geothermal and lithium extraction projects in the Salton Sea region and related topics including potential benefits and impacts being considered by the Lithium Valley Commission. During the January 27, 2022 public Lithium Valley Commission meeting and via a letter submitted to the Lithium Valley Commission docket, the Lithium Valley Commission's Chair Silvia Paz asked the California Energy Commission (CEC) to prepare a written response to the questions submitted by Leadership Counsel in October 2021.

As an initial step in responding to the questions, this letter provides background information about the local geothermal resources, geothermal power plants, lithium, and lithium extraction from geothermal brine. CEC staff will provide additional information and responses to questions in subsequent correspondence.

## Background

**Geothermal energy and power plants.** Geothermal energy is heat from the earth, that is constantly generated underground. It is a renewable energy, like wind and solar since the energy is not depleted when used. Geothermal reservoirs are hydrothermal resources, where deep underground the heat from the earth comes close enough to underground water to raise the temperature of that water, effectively storing the heat as energy. Each geothermal reservoir will have different characteristics depending on the depth, size, and temperature and the water, generally referred to as geothermal brine, will contain different minerals, salts, and metals largely due to the surrounding rock that

the heated water flows through. The Department of Energy defines a Known Geothermal Resource Area (KGRA) as a region identified by the U.S. Geological Survey as containing geothermal resources. KGRAs are typically given a specific name and the CEC has identified 20 KGRAs in California with seven in the Imperial Valley region. Four of the region's KGRAs have been identified as having significant amounts of geothermal energy: Salton Sea, Heber, East Mesa, and South Brawley.

Geothermal energy can rise to the surface naturally through hot springs or geysers and can also be drawn up to the surface for direct heating or to be used to create electricity in geothermal power plants. Not all geothermal reservoirs are at a proper depth or have the right temperature or composition to support the development of power plants. Geothermal power plants use a multi-step process that begins with drilling wells deep into an underground geothermal reservoir to pump either a mixture of steam and hot brine or hot brine alone to the surface. When the brine reaches the surface, it produces steam that spins a machine called a turbine, which is connected to a generator that produces electricity. The steam and brine are then cooled and pumped back into the geothermal reservoir where it is naturally reheated. Currently, there are 17 existing geothermal power plants in the Imperial Valley, with 11 of these existing plants using energy from the Salton Sea KGRA. These facilities utilize geothermal brine from wells that are between roughly 3,000 feet and 8,000 feet underground.

**Lithium in Geothermal Brine at the Salton Sea.** As noted, each KGRA has a unique depth, temperature and composition. As the heated, geothermal brine flows through the rock underground, minerals, salts and metals dissolve from the rock and are transported by the brine through the geothermal wells, bringing the dissolved minerals and other compounds to the surface. In the Salton Sea geothermal reservoir, the brine is rich in many minerals including manganese, zinc, and lithium. Lithium is a naturally occurring mineral often identified as "Li," that is found in hard rocks and some geothermal brine.

Lithium is a key component of batteries due to its ability to store and discharge high amounts of energy. Many consumer products use lithium-ion batteries as do most electric vehicles (EVs) and energy storage technologies. Both EVs and energy storage are important to achieving California's air quality and climate change targets. EVs offer a transportation option that does not emit air pollutants or greenhouse gas emissions from their tailpipes and energy storage supports additional use of renewable energy technologies like wind, solar and geothermal power. Due to the high demand for and reliance on lithium-ion batteries in the United States (US) and the world, lithium is seen as a critical mineral important to national security and economic prosperity for which the United States must enhance its extraction and processing capacity for the protection of domestic supply chains.

**Recovery of Lithium from Geothermal Brine.** To ensure a domestic supply of lithium, efforts are being taken throughout the US, to identify sources and develop processes to produce significant amounts of lithium to meet US demand. In the Salton Sea KGRA,

three companies – Controlled Thermal Resources, BHE Renewables, LLC, and EnergySource Minerals – are developing technologies to extract lithium from the geothermal brine used in geothermal power plants. These technologies, referred to as direct lithium extraction, use a closed system to pull lithium and other minerals from the brine and then return the brine back to the geothermal reservoir. Each company's technology is unique but generally speaking use a combination of chemicals and materials to extract the lithium.

Direct lithium extraction from geothermal brine has been in the research and development phase for more than a decade but has not yet been done at commercial scale. EnergySource Minerals' Project ATLiS, "a development initiative to extract and produce battery-spec lithium products" and co-located at the existing **John L. Featherstone Geothermal Power Plant**, is the farthest along in the development cycle and has received a permit from Imperial County. Energy Source anticipates start of construction in the second quarter of 2022 and a full operation lithium facility in 2024, with a production of 17,600 metric tons per year of lithium carbonate equivalent (LCE) by 2024. Since lithium can be contained in a number of forms, including lithium carbonate and lithium hydroxide, LCE is the industry standard used for comparison of quantities.

The direct extraction technologies planned for use in the Salton Sea region are significantly different from the two forms of commercial scale lithium extraction that currently dominate the global lithium market: hard rock mining and evaporation ponds. Over half of all lithium produced comes from hard rock mining, most of which occurs in Western Australia and China. Almost all other lithium is produced from evaporating geothermal brine in ponds to recover a lithium concentrate, mainly in Argentina, Chile and again China. These methods of lithium recovery have significant environmental impacts. In comparison, the impacts associated with direct lithium extraction from geothermal brine are generally considered to be less significant.

**Additional Resources**. Controlled Thermal Resources, BHE Renewables, LLC, and EnergySource Minerals have made information available on their company websites and Controlled Thermal Resources has provided additional information explaining the direct lithium extraction process through a document posted to the Lithium Valley Commission Docket, TN number 241468 (English version), TN 241536 (Spanish version), TN 242305 (English version) and 242436 (Spanish version). In addition, the materials referenced in the resource list for July 2021 Lithium Valley Commission meeting, TN 239033 in the Lithium Valley Commission Docket, include additional background on lithium extraction technologies.

To respond to the specific questions related to environmental and public health impacts, CEC staff will work with other agencies to provide additional information on the impacts associated with increased geothermal development and related direct lithium extraction from geothermal brine, including how those impacts compare with those from hard rock

mining and evaporation pond extraction of lithium. CEC also notes that the Lithium Valley Commission continued the discussion of environmental impacts at its March 24, 2022 public meeting and plans to continue the discussion in future meetings.

## Response to Questions

### Why is there lithium in this region?

Lithium is a metal that occurs naturally in certain locations around the world, including deep underground in the Imperial Valley area. In the Imperial Valley, lithium has been identified in samples of geothermal brine with high concentrations found in the Salton Sea KGRA and the South Brawley KGRA. In these geothermal reservoirs, 3,000 to 8,000 feet below the surface, the hot brine circulate through rock formations where minerals, metals and other compounds, including lithium, are dissolved into the geothermal brine.

### How is the quantity of lithium affected by the process of brine extraction and reinjection?

There have been many surveys of the lithium quantity in the Salton Sea KGRA, primarily using samples of brine taken from wells and analyzing how much lithium is present and calculating an estimate of the total amount based on the current understanding of the size and composition of the geothermal reservoir deep underground. For example, a study by the University of California, Riverside Salton Sea Task Force, provides conservative estimates that 2 million metric tons of lithium are available for recovery, which equates to approximately 10.6 metric tons of LCE.[1]

Based on projections from current project developers, production of lithium from the Salton Sea KGRA could reach annual volumes of 35,200 metric tons LCE during 2024 from the EnergySource Minerals and Controlled Thermal Resources facilities. BHE Renewables estimates an additional annual production potential of 90,000 metric tons LCE from lithium extraction facilities co-located at existing geothermal power plants operated by CalEnergy Operating Corporation. BHE Renewables is currently developing two demonstration facilities and with successful completion of these projects, could begin construction of the first commercial plant by 2024.

While these planned facilities will extract lithium and other metals and minerals from the brine that are brought to the surface at geothermal power plants, the hot geothermal brine underground will continue to dissolve minerals from the surrounding rock. Based on the current understanding of the planned amount of lithium to be extracted and the size and composition of the geothermal reservoir, and the estimated rate that lithium will

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[1] (McKibben et al. 2020, https://www.researchgate.net/publication/346088705_Lithium_and_other_geothermal_mineral_and_energy_resources_beneath_the_Salton_Sea)

be recharged into the brine, the anticipated rate of depletion is less than one percent per year, meaning that the process of extracting lithium could be sustained for decades without having significant impact on the overall reservoir.

A current planned study[2] to be conducted with funding from the Department of Energy and led by the Lawrence Berkeley National Laboratory, will seek to better characterize the Salton Sea geothermal reservoir, update estimates of lithium quantities and analyze the rate of lithium recharge in the brine.

CEC staff hope this initial information is helpful for Leadership Counsel and members of the community and as noted above will provide additional information and responses to the specific questions presented by Leadership Council in subsequent communications.

Sincerely,

*Deana Carrillo*

Deana Carrillo
Deputy Director, Renewable Energy Division
California Energy Commission

CC: Assemblymember Eduardo Garcia
Noemi Gallardo, California Energy Commission Public Advisor

[2] https://newscenter.lbl.gov/2022/02/16/quantifying-californias-lithium-valley-can-it-power-our-ev-revolution/