TRI-S ENVIRONMENTAL
SENSIBLE STRATEGIES AND SOLUTIONS FOR THE ENVIRONMENT

August 29, 2024

Delivered Via Email

Ms. Victoria Yundt, Attorney
Ms. Rebecca Davis, Attorney
Lozeau Drury
1939 Harrison Street, Suite 150
Oakland, CA 94612

RE: **Environmental Concerns and Comments**
Black Rock Geothermal Project: California Energy Commission Docket 23-AFC-03
Black Rock Geothermal Project Preliminary Staff Assessment and Application
Submitted by Black Rock Geothermal LLC, BHE Renewables
Salton Sea, Imperial County, California

Dear Ms. Yundt and Ms. Davis:

The purpose of this letter is to provide comments and analysis on potential environmental impacts of the subject proposed Black Rock Geothermal Project (BRGP) project by BHE Renewables (BHER) in Imperial County, California. I have reviewed the Preliminary Staff Assessment Report (1,003 pages in length) and Application for Certification files (including the Application for Certification-554 pages in length). I have also reviewed dozens of publications related to geothermal energy and lithium mining that the author will reference as part of the comments provided below. These comments will be broken into two sections. Section One is Comments on the BRGP Preliminary Staff Assessment (PSA) and Section Two is BHER Direct Lithium Extraction History and Environmental Permitting Issues

Section One: Comments on the Preliminary Staff Assessment (PSA)

Part I Potentially Significant Environmental Impacts

There are five production wells and seven injection wells of geothermal brine planned for the operations of the Black Rock Geothermal Plant to a maximum depth of nearly two miles (~3,000 Elmore 14 to ~9,200 feet Elmore 16-see page 201 LBNL) below the ground surface (PSA pages: 5.6-1, 5.12-1, 5.16-1). Note: The number of wells on PSA page 3-19 appears to be in error (9 production wells and 12 injection wells listed and not in proportion to power production capacity). The author has conducted an evaluation of the PSA and there is substantial evidence Potentially Significant Environmental Impacts for three items: *5.7.2 Hazards, Hazardous Materials, and Wildfire sections a. and b.* (pages 5.7-12 and 5.7-13) and *5.16.2 Water Resources section a* (page 5.15-7). The possibility of an accident or upset is real and would create a ***potentially***

2121 Yacht Yankee
Newport Beach, California 92660
www.tri-s.com
Tel: (949) 698-8851

significant impact/hazard to the environment and the public. The author strongly suggests the environmental impacts are modified from less than significant with mitigation to potentially significant impacts. The four comments below address the reasoning behind and the evidence supporting the change of the three aforementioned subsections to **potentially significant environmental impacts**.

1) Geothermal Well Failure a Distinct Possibility: Potential for Hazardous Material Release

Changes in pressure and temperature in geothermal wells can result in mechanical failure of the well and the geological formation near the catastrophic blowout area. Carbon dioxide has resulted in as much as 3 millimeters of corrosion of carbon steel well casing per year in the Imperial Valley which led to well plugging after 10-12 years of operation. Attempts at extending the well life by cementing in smaller production strings failed per the 2012 Sandi National Laboratory Handbook of Best Practices for Geothermal Drilling. The failure or plugging of a well can result in expansion of trapped fluid an in the casing to casing annulus that could result in shallow groundwater contamination or a discharge to the surface (waste or exceedance of water quality standards). There are a number of potential causes of geothermal well casing failure and several failure modes are listed below:

- Strength loss due to temperature elevation
- Mechanical wear of casing inner side
- Buckling due to thermal stress and pure cementing job
- Corrosion (internal and external) and scaling
- Decoupled casing joints due to thermal stress
- Buckling of the casing at some interval in well
- Failure of cement exposed to cyclic loads
- Failure of casing material exposed to cyclic loads

There was also mention of well head damage due to thermal expansion as an issue and poor cementing of the casing as a reason for failure (Allahvirdizadeh, P. *A review on geothermal wells: Well integrity issues*, Journal of Cleaner Production 275 (2020) 124009, pages 1-21). There is an entire journal article devoted to the quantification of accidental risks in geothermal energy systems entitled "Comparative accident risk assessment with focus on deep geothermal energy systems in the Organization for Economic Co-operation and Development (OECD) countries" published in 2021 in Geothermics whereby equations for the evaluation risk factors of accidents during various phases of geothermal work (well drilling, stimulation and operations) and for blowouts is presented. The article discusses the accident risks during the drilling phases as it pertains to caustic soda (additive in the drilling mud) which "is a highly caustic metallic base and alkali salt and is extremely corrosive for humans (as well as for metals)." There are numerous other risk factors for accidents during the operational phase as well as the possibility of a blowout (in the worst-case scenario where an installed blowout prevention device fails or otherwise). The evidence presented in this paragraph is justification for there being a potentially significant environmental impact in case of an accident that is reasonably foreseen.

A California Energy Commission (CEC) report CEC-500-2-23-042 entitled *Modeling Flexible-Mode Geothermal Energy Production in California: Comprehensive Physical-Chemical Modeling to Reduce Risks and Costs of Flexible Geothermal Energy Production* describes mechanical failure of well casings, cement

and rock as a result of stress/strain changes due to changes in fluid pressure/temperature. CEC's own document describes a failure scenario as follows "It was found that the biggest risk of mechanical failure occurs during the initial startup of production because of large and rapid temperature increases from initially cool temperatures near the ground surface." It is reasonable to conclude potentially significant impacts to the environmental could occur in the form of hot geothermal brine releases to the shallow groundwater and/or the land surface. It is also possible that an accident could occur during well installation or start up that may be catastrophic and those impacts should be considered as part of the environmental permitting process, e.g. 2010 Deepwater Horizon disaster.

2) Geothermal Brine Contains several known hazardous chemical constituents in excess of standards: Hazard

The USEPA reported brine from geothermal wells in the Salton Sea contain six constituents that are far in excess of drinking water standards. For example, the drinking water standard for a) Lead is listed as 0.015 mg/L and brine concentration as much as 102 mg/L or 6,800 times greater, b) Manganese is listed as 0.050 mg/L and the brine concentration 1,500 mg/L or 30,000 times greater. c) Cadmium is listed as 0.005 mg/L and brine concentration as much as 2.3 mg/L or 460 times greater, d) Barium is listed as 2 mg/L and brine concentration as much as 353 mg/L or 176 times greater, e) Zinc is listed as 5 mg/L and brine concentration as much as 518 mg/L or 103.6 times greater, and f) TDS -Total Dissolved Solids is listed as 150 mg/L and the brine concentration 260,000 mg/L or 521 times greater. There are also hazardous constituents in the brine that should be determined (in addition to those listed at a. through f.) such as radium, thorium, and radon; antimony, chloride, arsenic, chromium, copper, orpiment, stibnite, antimony, ammonia, mercaptans, sulfides, mercury, iron, selenium, and silver; petroleum hydrocarbons, uranium, methane, nitrate and carbocyclic acids (not a complete list) to assess their environmental impacts should there be a catastrophic well failure or blowout. A hot brine release to the shallow subsurface or surface that could create a hazard that would have a potentially significant environmental impact. All potentially hazardous constituents in the hot geothermal brine should be thoroughly tested/characterized, and their impacts considered, as part of the environmental permitting process.

3) Extremely Large Brine Production and Injection Rates are Correlated to Seismic Activity: Hazard Concern

As much as ~13,000 gallons per minutes of geothermal brine production is planned for this project (estimated from a November 2023 LBNL document page 152 at LBNL-2001557). A percentage of that brine will be injected back into the geothermal formation via injection wells. A thirty-year time history of seismic activity near geothermal wells in located in the Imperial Valley was analyzed in the LBNL document and that seismic activity was reported to correlate with the operation of geothermal well system operation. LBNL reports "During the first 14 years of geothermal energy production (1982-1996), background seismicity rates appear to be directly proportional to production and injection rates." from deep geothermal systems located near the Salton Sea. The correlation strength (R^2) varied from 0.71 to 0.85. The authors explained "As geothermal plant activity increased, pore-pressure perturbations propagated away from the injection well flow intervals (i.e., permeable zones in the injection wells between the casing shoe and the bottom of the well), causing many pre-existing faults to become critically stressed and move." It is also reported "During the next 10 years (1996-2006), the correlation can be described as weak to moderate" with correlation strength (R^2) that varied from 0.20 to 0.48. For this analysis of geothermal wells and seismic activity, the authors stated "The seismogenic response of the crust to well activity was strongest early in the history of plant operations." A thorough analysis must be conducted to determine the increased risk of hazards caused by earthquakes, as a

result of operation of the proposed geothermal production and injection wells, so that the hazards related to significant impacts to the environment can be evaluated.

A geothermal energy project that consisted of injection and extraction wells was determined to be the cause of a 5.5 magnitude earthquake in Pohang, Korea in November 2017. Water was injected at pressure in a well which "began to activate an unknown fault" as reported by the StanfordReport in May 2019. The unknown fault intersected the well. It was determined "Pressure migrating into the fault zone reduced the forces that would normally make it difficult for the fault to move. Small earthquakes lingered for weeks after the operators turned the pumps off or backed off the pressure." It is necessary to perform a detailed examination of all known faults, fractures (fracture mapping), shears and other heterogeneities that may result in either seismic activity or catastrophic land subsidence (settlement). There is an entire handbook that should consulted or potentially implemented for further evaluation. The 287-page book is entitled "The analysis of subsidence associated with geothermal development. Volume 1. Handbook" and can be downloaded from the link provided (Atherton, R. W.; Finnemore, E. J. & Gillam, M. L. September 1, 1976.). There are numerous processes that contribute to land subsidence in geothermal areas such as seismic activity, preconsolidation, fracture closing, thermal contraction and a variety of other factors. The book recommends "Tectonic movements may mask induced subsidence and horizontal ground motion associated with production. So that the impacts of production may be identified, it is important to design baseline leveling surveys (Lofgren, 1973) and gravity surveys (Volume 2, Research Report, Chapter 4) before production begins." CALGEM requires an injection plan be submitted as part of the well permitting process, however, potentially significant risks to the environment from well failure or other operational accidents must be addressed as part of the project preliminary staff assessment.

4) The USEPA Safe Drinking Water Act and Underground Injection Program: Threat Assessment

The author would like to provide the USEPA's position on requirements for Class V Injection Wells and how to minimize impacts to shallow groundwater aquifers. The following excerpt is from the USEPA website at Basic Information About Class V Injection Wells | US EPA.

> *Class V wells are a concern because they pose a risk to underground sources of drinking water. Because of this they are regulated by the Underground Injection Control (UIC) program under the Authority of the Safe Drinking Water Act. EPA established minimum requirements to prevent injection wells from contaminating underground sources of drinking water (USDWs). In addition, Class V regulations are linked to EPA's source water assessment program.*

The USEPA Office of Ground Water and Drinking Water published a 69-page document entitled "The Class V Underground Injection Control Study, Volume 17, Electric Power Geothermal Injection Wells" EPA/816-R-99-014q in September 1999. In fact, Figure 2 is a cross-section of the Geothermal System, Imperial County, California (East Mesa Field, Imperial County). Therefore, CalEnergy/BHE/CEC should take note of the USEPA guidance and requirements. The ultra-complex nature of high flow geothermal extraction and reinjection systems can not be engineered, constructed, designed or monitored such that there is no possibility of failure. A failure resulting in a catastrophic release of hot geothermal brine near the surface must be considered and may result in a potentially significant environmental impact. The responsibilities of and procedures to be used by the EPA and DOGGR (now CalGEM) in the administration of the Underground

Injection Control (UIC) program for geothermal energy Class V injection wells are set forth in a six-page 1991 Memorandum of Understanding between the two agencies. The USEPA will be involved with all permitting, compliance and enforcement procedures of geothermal injection wells in California.

Part II Additional Considerations Related to Hazardous Waste Generation and Water Supply

5) The hazardous and nonhazardous waste components were broken into multiple categories and to quantities of each waste estimated on a per metric ton basis (Nov 2023 LBNL document at page 150).

Black Rock Estimated Waste Quantities

Hazardous	**Metric Tons Per Year**
Brine pond solids	6,350
Geothermal Scale	2,722
Geothermal filter cake	726
Cooling tower debris and sludge	181
Petroleum contaminated solids (>51%)	45
Oil, water, sludge	45
Used Oil	18
Laboratory analysis waste	1

Nonhazardous	**Metric Tons Per Year**
Geothermal filter cake	12,701
Commercial Trash	68

The Black Rock Geothermal plant will produce an estimated 726 metric tons of hazardous filter geothermal filter cake with a similar composition of the BHER Geothermal plant located in Calipatria, California. The Filter Cake Safety Data Sheet (BHER- CalEnergy Operating Corp, 7030 Gentry Road, Calipatria, CA 92233) is contained on pages 262-272. Section 2: Hazard Identification lists the classification of the mixture as OSHA HSC 2012: Specific Target Organ Toxicity Repeated Exposure 1-H372. H372 hazard statement identifies causes damage to organs-lungs through prolonged and repeated exposures. The storage and disposal must be in accordance with local, regional, national and/or international regulations (P501). All of the hazardous waste items (with the exception of Used Oil) will be disposed of in a treatment, storage, and disposal facility (TSDF). Please identify which portions of all hazardous wastes will be transported to either Clean Harbors Buttonwillow Class I Landfill or Class II Landfill in Wellton, Arizona? Is there adequate landfill capacity over the course of the projected life of the Black Rock Geothermal Plant?

6) Water Supply Needs and Anticipated Usage

Black Rock Geothermal (87 MW) plans to use 1125 AF per year of freshwater (12.9 AF/MW), meeting 50% of their demand and meeting the other 50% with the steam condenser (Black Rock Geothermal LLC, 2023) per the LBNL document page 90. It is stated that additional water will be required at each of these facilities for startup, fire protection, and maintenance. The BRGP PSA (page 3-12) states an expected average annual use of 1,125 acre-feet per year (afy) of water when operating at full plant load for uses including plant water, dilution water, plant wash down, and cooling tower makeup. Average annual supply requirements will vary, depending on the capacity factor of the overall facility. On page 5.16-7 of the BRGP PSA it is stated:

> *In addition to the proposed BRGP, the applicant is concurrently pursuing certification of two other geothermal projects in the vicinity; Elmore North geothermal (140 MWs) and Morton Bay geothermal (140 MWs). Therefore, the cumulative environmental impact of all three projects needs to be considered. With respect to water supply, the combined estimated water supply for all three geothermal projects proposed by the applicant is 13,165 acre-feet per year (AFY). IID has available for non-agricultural uses up to 25,000 AFY, of which 6,380 AFY has been committed to other customers. (IID 2009). Based on email communication with IID, as of January 2024, a remainder of 18,620 AFY (IID 2024) is available to future uses. The water supply estimated for the three applicant projects constitutes nearly 71 percent of the available supply.*

The author is interested in receiving an explanation as to how the potential water shortfall will be addressed in the event of either drought or additional water demand from other geothermal power plants that may be in the environmental permitting process? Is there a contingency plan? Are there other water supply options available that are not discussed in the BRGP PSA?

Section Two: BHER Direct Lithium Extraction History and Environmental Permitting Issues

Part I Background on Lithium Extraction and Geothermal Brines involving CEC and BHE

Direct Lithium Extraction (DLE) is the process of recovering lithium from geothermal brine using advanced technologies. *Occidental Petroleum is forming a joint venture with Berkshire Hathaway-owned BHE Renewables. The partners aim to extract lithium from brines at a California geothermal power plant that BHE owns. In 2022, Oxy acquired TerraLithium, which is developing technology to chemically extract lithium from brine. Berkshire Hathaway owns a 28% stake in Oxy.* (C&EN June 10/17, 2024 page 12 attached as Exhibit A in an article entitled *Occidental steps up hunt lithium hunt*). In a June 4, 2024 Oxy Press Release, it is stated "Upon successful demonstration, BHE Renewables plans to build, own and operate commercial lithium production facilities in California's Imperial Valley." It is clear that BHER is gearing up to capitalize on the lithium market and the timing of the joint venture with Oxy/TerraLithium occurring nine days prior to the release of the Preliminary Staff Report for the Black Rock Geothermal Project suggests there is an expectation the future brine streams will lead to lithium extraction from those brines. In fact, RIGZONE, in an article dated June 6, 2024 entitled *Occidental, BHE Form JV to Demo Lithium Tech*, reports "*The joint venture has started a project at BHE Renewables' Imperial Valley geothermal facility to demonstrate the feasibility of using TerraLithium DLE technology to produce lithium in an environmentally safe manner."*

The California Energy Commission (CEC) has a history of funding research on lithium extraction from geothermal brines over the past decade. SRI International report dated March 2020 was funded by CEC (Grant Number EPC-16-020 in the amount of $873,387 per the 2015-2017 EPIC Investment Plan) and involved sorbent technologies (hybrid nanocomposite sorbent beads) designed to recover lithium from brines. It is not clear how a nanostructured lithium manganese oxide, manufactured by a technique described as "hydrothermal synthesis" or a "new hybrid sorbent made from nanostructured inorganic ion sieves embedded into a lithium-imprinted polymer" impact water quality or add hazardous chemical constituents to the brine. The sorbent regeneration process may release potentially hazardous components from the sorbent in a pernicious manner. The CEC/ERDD Final Project Report is entitled Selective Recovery of Lithium from

Geothermal Brines and is dated March 2020 (37 pages). Note: ERDD-Energy Research and Development Division.

Part II BHE Renewables Explores Lithium Extraction from Geothermal Brines in 2020

According to a BHE Fact Sheet dated April 2022, "BHE Renewables won a $6 million matching grant award from the California Energy Commission in May 2020 to design and build a demonstration project to recover lithium from geothermal brine to produce lithium chloride." The State of California Grant Form (CGF) is entitled "Salton Sea Geothermal Lithium Recovery Demonstration Project" and the document is 26 pages in length. The CGF indicated CEC's ERDD funded the grant for BHER Minerals, LLC.

The CGF indicates in Section F "Proposed resolution approving agreement EPC-19-020 with BHER Minerals, LLC for a $6,000,000 grant to design, build, and commission an integrated system that includes geothermal brine pre-treatment and lithium recovery processes and adopting staff's determination that this action is exempt from CEQA." Staff determination should be clarified. The 26-page CGF indicates on page 1, Section G) subpart 2: the project is listed as categorical exempt under CEQA per Cal. Code Regs., tit 14, § 15301 and Cal. Code Regs., tit 14, § 15303.

The start date of the lithium extraction demonstration project is listed as June 1, 2020 and the end dated as March 31, 2024. The CEC/ERDD Final Project Report is entitled Pilot Scale Recovery of Lithium from Geothermal Brines and is dated March 2024 which is 54 pages in length. The project succeeded with extracting lithium from a synthetic brine which resulted in the production of lithium carbonate.

In the BRGP PSA (BHER/Jacobs Staff Assessment Report) on Page 5.4-44&45, in a bulleted section entitled "Future Expansion/Related Development", the following appears:

> *"We note that the three projects only propose to build on part of their parcel areas at this time. The remainder of the parcels do not appear subject to any future use restrictions. We are concerned about what future development might occur on these parcels. This is a particular concern as an agent for the applicant stated at the 08/31/23 public hearing that these three plants are being sited where they are because of proximity to existing plants. Also of concern, is Black Rock Geothermal Project the potential to co-locate future lithium extraction activities at these locations causing additional effects to the TCRs."*

There is some ambiguity regarding the plan for lithium production as part of the Black Rock facility and it is important to consider the recent history of this regulatory body, CEC, as it relates to development of harvesting technologies with respect to environmental permitting processes. The history of CEC/ERDD funding lithium extraction technology and pilot testing outlined above demonstrates CEC's interest of moving lithium extraction forward. In fact, on Dec. 9, 2020 the CEC appointed nine members to a Blue Ribbon Commission on Lithium Extraction in California (Lithium Valley Commission) as described in the article entitled "CalEnergy/BHE Get $15M Federal Grant for Lithium Plant" that appeared in the Calexico Chronicle, January 21, 2021.

In summary, CEC has funded at least two projects on lithium extraction. One of the two CEC funded projects was a 2020 pilot project for BHE in the amount of $6,000,000 and that CEC/BHE staff deemed that CEQA

approvals for the were not necessary (exempt from CEQA). Reports suggest BHE received an additional $15 million from the US Department of Energy. It is also reported "The Department of Energy grant was for $14,894,540, which was a one-for-one cost-share match on an overall project cost of $29,789,0981 to turn geothermal brine waste from geothermal-energy operations into battery-grade lithium, according to DOE documents." by the Calexico Chronicle, January 21, 2021 (see prior paragraph for link).

Part III Environmental Permitting Issues: Geothermal Energy and Zinc/Lithium Extraction Facilities-Joint Programmatic EIS/EIR and BHE Enterprises Gain Experience 2000-2024

The background provided thus far outlines the underpinnings behind the purpose of this comment regarding the environmental permitting process. Pacific Northwest National Laboratory (PNNL-32717), under contract with The U.S. Department of Energy Contract DE-AC05-76RL01830, prepared a report entitled "*Salton Sea Geothermal Development: Nontechnical Barriers to Entry-Analysis and Perspectives*". The report was authored by D. Goodman, P. Mirick and K. Wilson and is dated June 2022 (122 pages in length). There is an entire section of this report devoted to Permitting (Section 7.2) with State, Federal and Model for Analysis of Geothermal Economics are addressed. The final portion of the Permitting section, Permitting Issues and Recommendations (7.2.4) contains four parts. Part one of four addresses *An areawide determination about CWA Section 404 jurisdiction by the USACE would provide certainty to developers and the public* (Note: USACE-U.S. Army Corps of Engineers). Part four of four addresses *Development and funding of a state permitting coordination office*. The second and third portions are addressed and discussed below.

It is the intent of the author to bring to the forefront the potential environmental concerns regarding lithium extraction and the permitting challenges related to implementing DLE at a geothermal power production facility. Both BHE and CEC have received tax payer funds to explore the implementation of DLE and have performed on-site pilot testing on extracting lithium from geothermal brines which included waste stream(s)/environmental assessment. The following two subsections from the aforementioned PNNL report provide recommendations are reproduced below and certain portions are emphasized in bold by the author.

> *2. Development of a **programmatic EIS/EIR** for the Salton Sea that analyzes the environmental impacts of geothermal development, from exploration to production, encompassing both geothermal and lithium.*
>
> *The 2015 Renewable Energy and Transmission Element from the County of Imperial General Plan is a good starting place for such a review, describing the history of renewable energy generation in the county, describing existing conditions and resource concerns, and including a series of specific goals that "support development of renewable energy resources that will contribute to the restoration efforts of the Salton Sea" (ICPDSD 2015). A comprehensive CEQA/NEPA document could provide greater certainty for geothermal development permitting and approval. **The resource issues and environmental impacts of geothermal development at the Salton Sea are well known and well understood. However, the environmental impacts and considerations for a co-located lithium plant have not been analyzed on a comprehensive scale.** Sponsoring such a **programmatic review** could be a form of a subsidy undertaken by either the federal government, the state of California or Imperial County, or could be issued by a geothermal developer interested in subsequent future developments in the area.*

3. Issuance of a geothermal/lithium MOU between CEC and CalGEM

> *Regardless of whether a comprehensive EIS/EIR is developed for geothermal development at the Salton Sea, it would* ***be beneficial for CEC and CalGEM to issue an agreement, likely in the form of an MOU, making the roles and responsibilities for a co-located geothermal and lithium extraction plant clear****. This would provide greater certainty to developers in obtaining approval through the CEQA process, particularly because of the limited history of such co-located development. Alternately, CalGEM could potentially delegate authority for permitting lithium production to Imperial County for projects below a certain size threshold, as has already been done for conventional geothermal development.*
>
> Note: CalGEM-California Geologic Energy Management Division

A July 25, 2023 letter of support from the Imperial County Board of Supervisors states that Imperial County is actively working on a programmatic environmental impact report "that would result in geothermal and lithium recovery facilities being exempt from mitigation prime and statewide importance agricultural lands.' The subject of the letter is *Black Rock, Black Rock and Black Rock Geothermal Projects in Imperial County, CA*. The letter of support emphasizes "significant economic benefit and jobs to benefit Imperial County and California." and the County expressed an interest to "assist in permitting these projects."

The Lithium Valley Specific Plan, Final Baseline Report, created for Imperial Valley, California dated February 2024 (668 pages and prepared by Rick Engineering Company) gives an update on that includes plans for a Programmatic EIR (PEIR) on page 5:

> *Senate Bill (SB) 125 On June 30, 2022, Governor Gavin Newsom signed into law Senate Bill (SB) 125 authorizing the state to assist in the development of Imperial County's lithium resource in an area that is a part of the Salton Sea Known Geothermal Resource Area, known as Lithium Valley. Among other provisions of SB 125, the bill appropriated $5,000,000 from the State General Fund to the County of Imperial (County) for various lithium related activities, including, but not limited to, funding to develop a Programmatic Environmental Impact Report (PEIR) and to distribute grants to local community-based organizations to conduct engagement on the PEIR.*

The Final Programmatic Environmental Impact Report (PEIR), Imperial County Renewable Energy and Transmission Element Update, Imperial County, California review process. More specifically, Black Rock Geothermal LLC-BRGP (with assistance from Jacobs) in their Data Response Set 2 dated October 27, 2023 writes the CEC as follows:

> *In contrast, the BRGP is a renewable energy project located in the geothermal and renewable energy overlay that is subject to the more specific provisions set forth in the Renewable Energy and Transmission Element, Renewable Energy Overlay Zone, and, where applicable depending on the potential impacts of a renewable energy project, the mitigation measures described in the Programmatic Environmental Impact Report for the Imperial County Renewable Energy and Transmission Element Update ("RE PEIR"). This reading is*

> *consistent with the February 23, 2010 resolution of the Board of Supervisors to not accept any new Williamson Act contracts or renew existing contracts, and the July 25, 2023 letter from the Imperial County Board of Supervisors (TN#251675) stating that the County is developing a programmatic Environmental Impact Report (EIR) for geothermal and lithium recovery development that will identify geothermal and lithium facilities as being exempt from mitigation requirements resulting from significant agricultural impacts to both Prime Farmland and Farmland of Statewide Importance.*

The author researched the July 2015 Final Programmatic Environmental Impact Report, Imperial County Renewable Energy and Transmission Element Update, Imperial County, California ("2015 ProgEIR Update") and was unable to find the document on the internet or on the Imperial County website. The document link was sent to the author by Ms. Diana Robinson on the morning of August 20, 2024 and after telephonic and email requests. The document is 1674 pages in length and ~110 megabytes in size (shared via a Ms. Valerie Grijalva).

CalEnergy comments (Begins with letter dated Feb 23, 2015) starts at page 3-269 (pdf 355) and continue through page 3-296 (pdf 382). Comment 22-45 Page 3-280, reads:

> *CalEnergy asks that the reference to our zinc extraction plant be reworded as follows to more accurately reflect the facts: "CalEnergy owned and operated a zinc extraction plant at their existing geothermal plants before closing due to production and market declines."*

CalEnergy (a subsidiary of BHER) once operated a zinc extraction plant from brines at an existing geothermal plant and have recently tested Direct Lithium Extraction (DLE) on-site to be, undoubtedly, used on brines from existing and future on brines from operating geothermal plants. According to the Calexico Chronicle article entitled "To Get 'White Gold,' We Need More Geothermal- CPUC Ruling for 1,000 Megawatts of New Earthen Energy Opens Door for "Lithium Valley." dated July 2, 2021, the zinc extraction plant started in the early 2000s. There is an interest in moving forward with lithium extraction at new geothermal plants as laid out in the article as four excerpts from the article confirm.

> *That liquid has traditionally been reinjected into the earth around the Salton Sea, or any geothermal plant where energy production occurs, but in the commercial-grade process that brine would run through a second facility to recover the various minerals that have worth and use. Imperial County had two mineral recovery developments in the past, according to county officials. In the early 2000s, CalEnergy developed and operated a zinc-extraction facility. That project was successful but closed after five years.*
>
> *"This is a tremendous win for Imperial, but also for this (Lithium Valley) Commission. We now have a path for putting new geothermal online, and the accompanying brine that will allow us to recover lithium," texted Imperial County Supervisor Ryan Kelley just hours after the decision came down on June 24.*
>
> *"Now the hard work: permitting and financial incentives to make the Lithium Valley a reality," continued Kelley, who represents District 4, which includes the Salton Sea.*

> *CPUC's order does bring up a double-edged sword of trying to get the geothermal plants in Imperial County's queue streamlined and permitted before the 2026 deadline.*
>
> *There are presently 10 geothermal-energy facilities operated by CalEnergy in what is referred to as the Salton Sea Known Geothermal Resource Area, and those plants are generating around 327 net megawatts, according to the U.S. Department of Energy.*

The public in Imperial County is aware of the push for lithium extraction yet BHER chose not to address the permitting of DLE as part of the permitting of new geothermal plants. BHER appears to have a track record influencing environmental regulations and a knack for having things done their way (See comments starting at page 3-269 @pdf 355 and continuing through page 3-296 @ pdf 382 in the 2015 ProgEIR Update referenced above. BHER has business and operational experience of extracting zinc from brine and some additional details from that zinc operation were found in 2006, six-page paper entitled "Economic Benefits of Mineral Extraction From Geothermal Brines" and two paragraphs on the CalEnergy Zinc operation are shown below. The paper was written by Dr. R. Gordon Bloomquist, Ph. D., Washington State University Extension Energy Program, Center for Distributed Generation and Thermal Distribution.

> *Zinc is another metal found in highly concentrated amounts in Salton Sea brines. In the late 1990s, Cal Energy entered into a contract for the construction of a zinc recovery facility that was designed to produce 30,000 metric tons of 99.99 percent pure zinc per year to be sold to Cominco, Ltd. for a value of some $40 million per year. The zinc plant went on line in 2002 and at that time Cal Energy anticipated that the 177-million-dollar facility would generate as much revenue as they were then recovering from energy sales.*
>
> *Unfortunately, by mid-2003, it became common knowledge that the Cal Energy zinc plant was experiencing operational difficulties and on September 10, 2004, the operating company decided to cease operation and liquidate the assets.*

The author expects the CEC will investigate the zinc mining operations conducted by CalEnergy (BHER) to ensure the wastes generated were handled properly, there were no impacts to the environment during the operational period of 2001-2002 and that the zinc recovery plant was properly permitted by Department of Conservation, Division of Oil, Gas, and Geothermal Resources-DOGGR which became CalGEM in 2020 prior to any zinc recovery plant operations. Further, the author is curious, as will readers of these comments, what were the "operational difficulties" encountered and what was the composition of the wastes generated from the zinc extraction plant? Surely BHER gained extensive experience on the pitfalls of the mining process.

The author also supports consideration of a geothermal/lithium Memorandum of Understanding that addresses environmental (water quality, water supply, hazards, toxic and hazardous waste impacts) in addition to clarifying roles and responsibilities. CalGEM *prioritizes protecting public health, safety, and the environment* by using *science and sound engineering practices to regulate the drilling, operation, and permanent closure of energy resource wells* (https://www.conservation.ca.gov/calgem). It is clear the environmental permitting process should include all facets of a co-located geothermal power plant and a lithium production facility, as opposed to independently evaluated and/or permitted piecemeal approach. A complete analysis of waste composition, water quality, water supply, toxicity, pre-treated brine prior to

lithium extraction, post-lithium extracted brine (filtrate), and an evaluation of cross-contamination injection/extraction risks must be conducted. It is vital these unknowns be quantified, evaluated and analyzed prior to permit approval.

Part IV Direct Lithium Extraction: A potential game changing technology-Goldman Sachs April 2023

The Global Metals & Mining Division of Goldman Sachs published a 29-page Equity Research Note whereby 27 global lithium projects "that are using or plan to implement DLE." The table of DLE implementors and technology developers on page 5 includes a Berkshire Hathaway project in the Salton Sea with the following items associated with the project:

Company:	Berkshire Hathaway
Project:	Salton Sea
County:	USA
DLE Project Stage:	Pilot
DLE Technology Provider:	Proprietary
Lithium extraction technology:	Sorption
Tech Origin:	USA
Geothermal:	Yes
Resource (Mt LCE):	-
Start Date:	-
Capacity (ktpa LCE):	90 (Note: Second highest capacity of the 19 projects listed)

LCE- lithium carbonate equivalent
Mt-Million tons
ktpa-Kilotons per acre

It is apparent that Berkshire Hathaway is ramping up their research and business efforts toward lithium extraction of geothermal brines at a rapid pace. The obvious question is why not combine the permitting of the DLE production facility with the geothermal energy project now as opposed to later? The State of California and Federal Government are best served to address water, environmental, waste and hazardous waste issues now for the incorporation of DLE at a later date will, in all likelihood, will be complicated by the potential for unforeseen regulatory and/or economic obstacles.

The author just discovered that the CEC's Notice of Proposed Award (NOPA) was released on August 1, 2024 "GFO-23-304 - Geothermal Energy Operations and Lithium Innovation (GEO/LI)" with the purpose listed as "*The purpose of this solicitation is to fund projects that develop and demonstrate technologies to reduce impacts from scaling and corrosion at geothermal power plants in California or advance processes to enhance the recovery of lithium and other valuable minerals from geothermal brine at the Salton Sea geothermal field."* can be found at this link.

Part V TerraLithium (Oxy/BHE) Patents Related to Lithium Extraction: 2020-2024

The following is a list of patents assigned to TerraLithium obtained from Justia Patents. There is a clear link between patent development for lithium extraction from geothermal brines by an entity owned in part by the permit applicant.

1) Forward osmosis composite membranes for concentration of lithium containing solutions
Patent number: 12030017
Type: Grant
Filed: August 8, 2019
Date of Patent: July 9, 2024
Assignees: UT-Battelle, LLC, TERRALITHIUM LLC

2) Preparation of lithium carbonate from lithium chloride containing brines
Patent number: 11649170
Type: Grant
Filed: August 7, 2020
Date of Patent: May 16, 2023
Assignee: Terralithium LLC

3) Treated geothermal brine compositions with reduced concentration of silica, iron and lithium
Patent number: 11466191
Type: Grant
Filed: October 1, 2020
Date of Patent: October 11, 2022
Assignee: Terralithium LLC

4) Processes for producing lithium compounds using forward osmosis
Patent number: 11235282
Type: Grant
Filed: November 19, 2019
Date of Patent: February 1, 2022
Assignee: Terralithium LLC

5) Preparation of lithium carbonate from lithium chloride containing brines
Patent number: 10773970
Type: Grant
Filed: November 2, 2017
Date of Patent: September 15, 2020
Assignee: TERRALITHIUM LLC

The evaluation and analysis of water quality, water usage, hazardous waste and toxic composition of solids from the pretreatment of brine prior to lithium extraction plus post lithium extraction processes is necessary as part of the permitting process. Further, as a professional environmental expert with over thirty years' experience, it is the author's judgment that BHER is duty-bound to share all data, analysis, reports, waste

manifests, processes descriptions, mass balance calculations, water budgets, analytical results for water/solids analyses, chain of custodies, toxicity characteristic leaching testing results, sorbent media composition, groundwater/brine composition testing results, isotope testing results, flow studies, mass flux estimates, loading calculations, sensitivity analyses, settlement analysis, detailed process flow diagrams and life-cycle assessment results as they relate to lithium extraction from geothermal brine. There is no question the plan is to incorporate direct lithium extraction as part of the geothermal power plant operations as can be from the excerpt below.

Excerpt from the Executive Summary from CEC report dated March 2024 | CEC-500-2024-020

> *The creation of an additional value stream generated from the recovery of useful metals, such as lithium, from geothermal fluids will lead to an expansion of geothermal energy production. Lithium production in the Salton Sea geothermal resource area has the potential to become an important source of lithium for the United States*.

Part VI National Laboratory Estimates Additional Wastes Created from Lithium Production: Nov 2023

A 371-page report prepared by Lawrence Berkeley National Laboratory (LBNL) entitled *Characterizing the Geothermal Lithium Resource at the Salton Sea* (A Project Report to the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, Geothermal Technologies Office) discussed the Black Rock project at length and numerous times throughout. The report was completed on November 11, 2023.

On page 22 there were calculations presented on the quantity of lithium contained in the brine-in-place. Table 2.2 lists 760 ktons of proven, 2,600 ktons accessible and 3,400 ktons of probable lithium in the Salton Sea Geothermal Reservoir. Note: kton-kiloton and 2,600 metric kilotons is 5.732 Billion US Pounds.

There is an entire chapter (Chapter 9: Evaluation of Potential Chemical Use and Solid Waste) devoted to landfill capacity, solid waste generation and pretreatment of the geothermal brine prior to Direct Lithium Extraction (DLE). One of the key takeaways from the chapter is reproduced below:

> *To produce lithium chloride from geothermal brine, the brine will be treated to remove silica and metals to produce "clean brine" prior to the direct lithium extraction (DLE) process step, creating a solid byproduct. More silica and metals will need to be removed to prepare the brine for lithium extraction will be more significant than what is currently needed to reinject the spent brine back into the formation.*

With respect to additional waste generation for pretreatment of the brine (based on data from the Elmore Power Plant) prior to DLE, a summary is provided on page 155 as follows:

> *The crystallizer-clarifier is optimized for operation of the power plant, and it is expected that the brine from the power plant will need to be further treated to produce a "clean" brine suitable for the DLE technology step. Based on published requirements for mineral content*

> *of brines suitable for DLE sorbents, it is likely that over 90% of the silica, iron, manganese, and zinc in the geothermal brine will need to be removed prior to DLE.*

Additional language on waste generation for DLE continues on page 158:

> *The amount of solid waste that will be produced during the process for lithium extraction and purification is dependent on the exact process applied and whether the solids produced during pretreatment can be monetized; some solids produced during pretreatment contain manganese and other potentially valuable metals. However, the extraction and purification of lithium will produce iron-silicate solids and possibly solids containing calcium and other elements (e.g., magnesium) that are unlikely to have value, and must be landfilled.*

Portions of the Acknowledgment section on page ii demonstrate BHER's involvement for the authors of the report as shown below:

> *We thank Berkshire Hathaway Energy Renewables (BHER)/CalEnergy and Controlled Thermal Resources for kindly providing access to the brine and some of the rock samples that were analyzed in this study. We also thank Michael Krahmer from BHER for assistance in sampling drill cuttings;*
>
> *We also appreciate Jon Trujillo, Billy Thomas, and Jonathan Weisgall from BHER/CalEnergy for providing critical data and responding to our many queries.*

BHER was involved with the preparation of this report and is gearing up to implement a DLE and, as such, should be compelled to supply all available information related to their on-site pilot studies so that environmental and water supply/quality concerns can be evaluated as part of the permitting process.

<u>Part VII Hazardous Waste Generated as part of Lithium Extraction from Geothermal Brine (CEC 3/2024)</u>

The CEC report entitled "Pilot Scale Recovery of Lithium from Geothermal Brines" dated March 2024 revealed heavy metals were present in the filtered material generated as part of the treatment process. Key portions of the report are presented below and reveal the plan is to use geothermal brine for a new revenue stream plus to generate hazardous wastes including heavy metals.

> *Page 1. The creation of an additional value stream generated from the recovery of useful metals, such as lithium, from geothermal fluids will lead to an expansion of geothermal energy production. Lithium production in the Salton Sea geothermal resource area has the potential to become an important source of lithium for the United States.*
>
> *Page 1. The efficient direct extraction of lithium from geothermal brines promises to make geothermal power generation in the Salton Sea geothermal resource area economically favorable and will secure lithium production in the United States in support of a carbon-free economy.*

> *Page 7. The basic process consisted of four unit-operations: Absorption, Polishing, Concentration and Crystallization. Additional operations included pre-processing brine, water recycling, product washing and drying, return of lithium-depleted brine and waste management.*
>
> *Page 25. Frequent sorbent replacement not only takes plants out of operation, but also creates waste in the form of spent sorbent.*
>
> *Page 29. Solids were disposed of as hazardous waste. An analysis of the filtrate showed the presence of various heavy metals, including iron.*

The author was unable to locate the analytical results for the heavy metals or the hazardous waste manifest/composition in the report. There is no mention of hazardous waste generation, heavy metal presence, geothermal brine pre-treatment processes, water usage or water quality in the Conclusions section.

Part VIII Hell's Kitchen Powerco 1& Lithiumco December 2023 EIR and March 2024 Lawsuit

The Final Environmental Impact Report for The Hell's Kitchen Powerco 1 and Lithiumco 1 Project Imperial County, California dated December 2023 is 200 pages in length and was prepared by Chambers Group, Inc., Costa Mesa, California, The EIR was prepared in accordance with CEQA and examined the potential environmental impacts from a lithium hydroxide plant. The report was submitted to County of Imperial Planning and Development Services Department. The EIR addresses environmental impacts of a co-located geothermal energy plant (to produce as much as 49.9 megawatts) and an "*mineral extraction and processing facilities capable of producing lithium hydroxide, silica and polymetallic products, and possibly boron compounds, for commercial sale*." The EIR demonstrates the importance of considering the joint environmental concerns of connected actions of geothermal brine generated for power production to be used for the production of lithium. The cumulative effects of the combined operations are difficult to assess for the wastes generated from pretreatment of the brine for mineral extraction and the composition of the post-treated brine, that will be injected into the subsurface brine reservoir, will be process dependent.

On March 13, 2024 a legal complaint (CEQA action) was filed in the Superior Court of California, County of Imperial by Comite Civico Del Valle and Earthworks against County of Imperial, Controlled Thermal Resources, Hell's Kitchen PowerCo and Hell's Kitchen LithiumCO. The complaint alleges "*that the Project Approvals violated the California Environmental Quality Act, Pub. Res. Code § 21000 et seq., ("CEQA") and 14 Cal. Code Regs. § 15000 et seq. ("CEQA Guidelines") by relying on a fatally flawed EIR*." There are a multitude of environmental raised in the Complaint such as water supply shortfalls, air quality, hazardous materials, tribal cultural resources and cumulative impacts. On page 13 of the Complaint, it is stated "*Nor did the EIR adequately assess the cumulative impacts of the Project in the context of the three related geothermal projects (i.e., BHE Renewables) and the County's Specific Plan calling for the use of an additional 100,000 AF of water*."

Part IX Geothermal Energy and Lithium Extraction Environmental Permitting Must Be Addressed Together

The author spoke with Mr. Dave Goodman of Pacific Northwest National Laboratory the morning of August 5, 2024 regarding his recommendations in the aforementioned June 2022 *Salton Sea Geothermal*

Development: Nontechnical Barriers to Entry-Analysis and Perspectives report. The author has included 7.2.4 Permitting Issues and Recommendations as Exhibit B (pages 57-59) attached hereto. We discussed the Hell's Kitchen EIR and several aspects of the material presented above as they relate to the possible environmental permitting agencies who could become involved with aspects of combined operation of geothermal energy/lithium production. The author believes the EPA UIC program regulations for Class V injection wells may apply for possible contaminants emanate from the pre- and post-treatment processes that alter the native brine composition. The contaminated brine might impact the geothermal reservoir or shallow groundwater. Mr. Goodman stated that he believes the "best example" of connected actions that requires a robust analysis is the combination of brine produced from geothermal energy production that is then used for lithium production.

Very truly yours,

Joseph E. Odencrantz, Ph.D., P.E., BCEE, PH
California Registered Professional Civil Engineer C 61137 (expiration 12/31/2024)
Board Certified Environmental Engineer 23-E0041 (expiration 12/31/2024)
Professional Hydrologist 24-HGW-05002 (expiration 1/15/2029)

Enclosures

Exhibit A	Occidental steps up hunt lithium hunt. C&EN. June 10/17, 2024 (1 page)
Exhibit B	Section 7.2.4 Permitting Issues and Recommendations *Salton Sea Geothermal Development:* *Nontechnical Barriers to Entry-Analysis and Perspectives* Report from Pacific Northwest National Laboratory for the US Department of Energy dated June 2022 (7 pages)

Exhibit A

Occidental steps up hunt lithium hunt. C&EN.
June 10/17, 2024 (1 page)

ENERGY STORAGE

Occidental steps up hunt lithium hunt

Occidental Petroleum is forming a joint venture with Berkshire Hathaway–owned BHE Renewables. The partners aim to extract lithium from brines at a California geothermal power plant that BHE owns. In 2022, Oxy acquired TerraLithium, which is developing technology to chemically extract lithium from brine. Berkshire Hathaway owns a 28% stake in Oxy. Two other oil companies, ExxonMobil and Equinor, also have plans to extract lithium using similar techniques.—MATT BLOIS

HYDROGEN POWER

Yara starts producing green hydrogen

Yara International has opened its renewable hydrogen plant in Herøya, Norway. The company claims that the unit is Europe's largest electrolysis plant, with

Yara has completed its water electrolysis installation in Norway.

capacity of 24 MW. It will use the hydrogen to produce up to 20,000 metric tons of ammonia annually. Making hydrogen from renewable electricity rather than natural gas will cut emissions by 41,000 metric tons per year, the company says.—ALEX TULLO

RECYCLING

Firms partner on tires to polycarbonate

The Finnish refiner Neste, the Austrian petrochemical maker Borealis, and the German specialty materials firm Covestro are teaming up to recycle tires into plastics that could be used in automotive parts like headlamps and radiator grilles. Neste will upgrade pyrolysis oil made from discarded tires into a feedstock suitable for petrochemicals. Borealis will take this raw material and transform it into phenol and acetone, and Covestro will transform those chemicals into polycarbonate resins. The partners are considering expanding the program into polyurethanes.—ALEX TULLO

INVESTMENT

Air Liquide to supply new chip fab

The industrial gas firm Air Liquide has signed a deal to supply a Micron memory chip fabrication plant under construction in Idaho. As part of the deal, Air Liquide will spend $250 million to build a plant on Micron's site that will make ultrapure nitrogen and other gases. The firm says it will implement a range of advanced plant features that will make the plant 5% more energy efficient than conventional designs. The plant is scheduled to open in 2025.—CRAIG BETTENHAUSEN

BIOBASED CHEMICALS

Trillium and Ineos to partner on acrylonitrile

Trillium Renewable Chemicals, one of C&EN's 10 Start-Ups to Watch in 2023, will scale up its biobased acrylonitrile process by building a demonstration plant at an Ineos Nitriles plant in Port Lavaca, Texas. Trillium's thermochemical technology converts glycerin, a by-product of biodiesel and soap production, into acrylonitrile. Ineos says the deal fits well with its sustainability strategy and Trillium says working with the world's largest acrylonitrile maker underscores its ambitions to bring its biobased technology to commercial scale.—CRAIG BETTENHAUSEN

OUTSOURCING

Siegfried will buy US API facility

The Swiss drug services firm Siegfried has agreed to buy an active pharmaceutical ingredient (API) facility in Grafton, Wisconsin, from Curia Global, another services firm, for an undisclosed sum. The facility, which has more than 80 employees, specializes in the synthesis of small-molecule drug candidates in the early phases of clinical development. Siegfried says the site will feed into its commercial-scale facilities in Europe. Cedarburg Pharmaceuticals opened the Grafton plant in 1997; Curia's predecessor, Albany Molecular Research, acquired it in 2014 for $41 million.—MICHAEL MCCOY

VACCINES

Wacker adds mRNA capacity in Germany

Wacker Chemie, the German specialty chemicals firm, has opened a new facility

PETROCHEMICALS

Styrolution to shutter Sarnia plant

Ineos's Styrolution styrenic resins business says it will permanently close its Sarnia, Ontario, styrene plant by June 2026. "The long-term prospects for the Sarnia site have worsened to the point that it is no longer an economically viable operating asset," Styrolution CEO Steve Harrington says in a press release. The plant has been under scrutiny. The Aamjiwnaang First Nation recently reported spiking air pollution that forced it to shut down community buildings. The Canadian government responded by imposing strict limits on emissions of benzene, the key precursor for styrene. Styrolution shut down the plant temporarily It estimates that it would cost about $50 million to comply with the new regulations and reopen the plant, a plan the company will evaluate over the next 6 months. Beyond that expense, the plant would require outlays to stay open permanently, the company says. These investments are "economically impractical given today's challenging industry environment." The plant has styrene capacity of 430,000 metric tons per year.—ALEX TULLO

CREDIT: YARA INTERNATIONAL

Exhibit B

Section 7.2.4 Permitting Issues and Recommendations
Salton Sea Geothermal Development: Nontechnical Barriers to Entry-Analysis and Perspectives
Report from Pacific Northwest National Laboratory for the US Department of Energy dated June 2022
(7 pages)

Pacific Northwest
NATIONAL LABORATORY

PNNL-32717

Salton Sea Geothermal Development

Nontechnical Barriers to Entry – Analysis and Perspectives

June 2022

Dave Goodman
Patrick Mirick
Kyle Wilson

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Salton Sea Geothermal Development

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Dave Goodman
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Pacific Northwest National Laboratory
Richland, Washington 99354

Abstract

Geothermal energy offers an opportunity to generate baseload, renewable energy that can help support the transition to an energy economy with reduced impacts on climate change and replace older, more expensive, nonrenewable, and more resource-impacting energy-generation facilities. The United States has the largest known geothermal resource in the world, with over 31 GW of conventional geothermal potential. However, due to market conditions, an inability to properly quantify both electrical grid benefits and resource stability, and the difficulty of exploring and developing the geothermal resource, few new geothermal projects have come online over the past three decades.

The Salton Sea, in Imperial County, California, provides a prime location and opportunity to develop new geothermal resources. The Salton Sea contains a robust, well-mapped, geothermal resource, with opportunities for concurrent development of lithium and other mineral resources. This report describes the history of geothermal development at the Salton Sea and compares geothermal to other renewable energy sources in the area. The report then uses a techno-economic analysis (TEA) model referred to as MAGE (Model for Analysis of Geothermal Economics) to analyze the relative benefits and costs of various challenges and opportunities and provides recommendations for streamlining geothermal development at the Salton Sea and elsewhere. The challenges and opportunities analyzed in MAGE were informed by stakeholder interviews and literature reviews.

Based upon the identified challenges and opportunities and the results of MAGE, primary findings are that certain nontechnical barriers such as permitting costs play only a minor role in determining the viability of development of the geothermal resource at the Salton Sea. Other barriers such as permitting timelines, government/agency coordination, and the potential co-location of lithium extraction with a geothermal plant may result in much larger impacts on project viability.

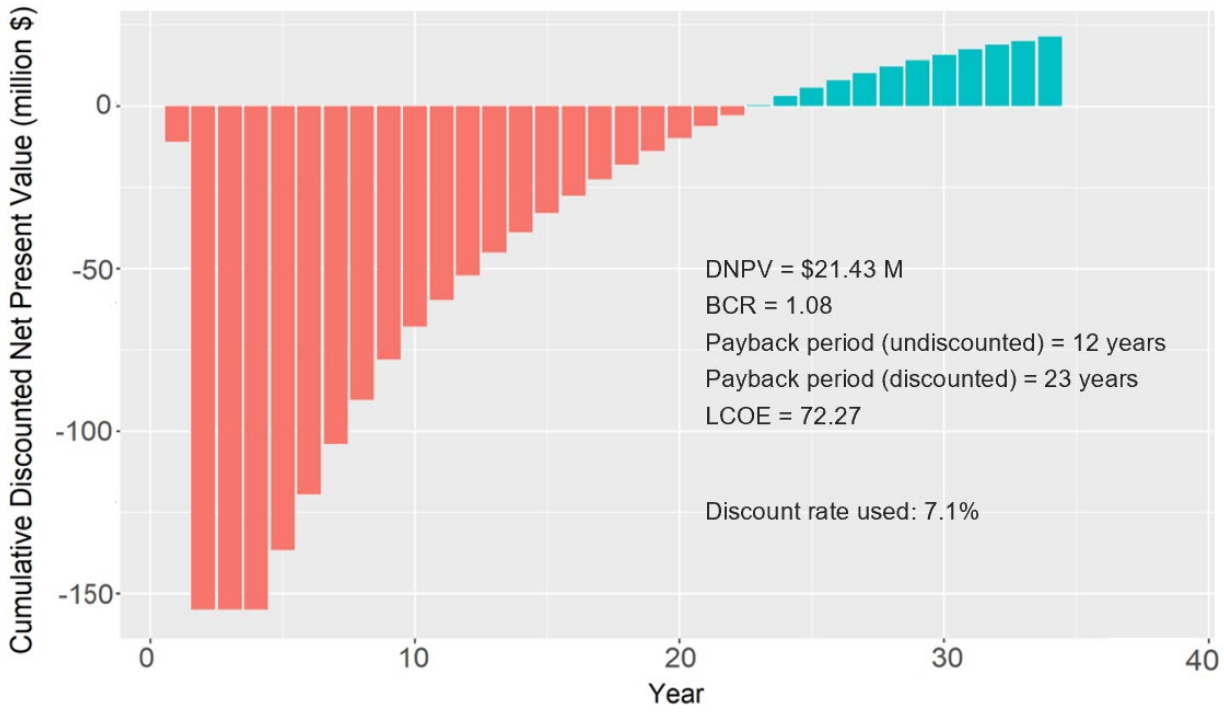

Figure 7-15. Power plant with 3-year reduced permitting time and 1-year reduced construction time.

One aspect of exploration and permitting that is not covered in this section is the risk of failure in exploration. Such failure may occur due to unsatisfactory drilling results or an inability to obtain necessary permits. In those situations, the costs incurred are typically sunk, and cannot be recouped and do not provide a return to investors. A potential benefit of streamlining the permitting process could be to reduce the risk of failure, which would yield a reduction in the discount rate. The benefits of reducing the discount rate are discussed in Section 7.1.1.

7.2.4 Permitting Issues and Recommendations

Overall, the state and local permitting process for geothermal projects at the Salton Sea is well understood. Historically, applicants appeared to prefer the Imperial County CEQA review and permitting process, because many projects, such as the Hudson Ranch I (Power Technology 2013) and Hudson Ranch II (OPR 2022) projects, were sized at 49.9 MW, or just below the 50 MW threshold at which point CEC would be the responsible agency. However, many interviewees mentioned that this no longer appears to be a substantial barrier, and that the CEC process has become better understood and streamlined over time and does not necessarily take longer to complete than the Imperial County process.

Stakeholders and developers have expressed a desire to both speed up and reduce costs associated with the permitting process. While NEPA compliance is generally not required for geothermal projects at the Salton Sea, the federal permitting process under the CWA and ESA is opaque and has created confusion. While reduction of costs is a worthy goal, shortening the timeframe from initiating exploration to bringing a project online has a much larger impact on the profitability of the project.

Below are four concepts which, if implemented, could result in a shorter and less expensive geothermal permitting process.

1. An areawide determination about CWA Section 404 jurisdiction by the USACE would provide certainty to developers and the public.

   Nationwide Permits are issued by the USACE to "help protect the aquatic environment and the public interest by providing incentives to reduce impacts on jurisdictional waters and wetlands while effectively authorizing activities that have no more than minimal individual and cumulative adverse environmental effects." Nationwide Permit 51 authorizes

   > [d]ischarges of dredged or fill material into non-tidal waters of the United States for the construction, expansion, or modification of land-based renewable energy production facilities, including attendant features. Such facilities include infrastructure to collect solar (concentrating solar power and photovoltaic), wind, biomass, or geothermal energy.

   Furthermore, "[t]he discharge must not cause the loss of greater than 1/2-acre of non-tidal waters of the United States" (Corps 2021).

   For geothermal development at the Salton Sea, the determination about whether the irrigation ditches, drainages, and associated wetlands on the playa constitute waters of the United States remains unclear, and thus whether Nationwide Permit 51 applies. USACE determination about CWA Section 404 jurisdiction thus remains a primary barrier and source of frustration to the development community. Identification of locations of suitable geothermal development and certainty about the mitigation that should be applied for the Salton Sea playa would provide a substantial incentive for future development.

2. Development of a programmatic EIS/EIR for the Salton Sea that analyzes the environmental impacts of geothermal development, from exploration to production, encompassing both geothermal and lithium.

   The 2015 Renewable Energy and Transmission Element from the County of Imperial General Plan is a good starting place for such a review, describing the history of renewable energy generation in the county, describing existing conditions and resource concerns, and including a series of specific goals that "support development of renewable energy resources that will contribute to the restoration efforts of the Salton Sea" (ICPDSD 2015). A comprehensive CEQA/NEPA document could provide greater certainty for geothermal development permitting and approval. The resource issues and environmental impacts of geothermal development at the Salton Sea are well known and well understood. However, the environmental impacts and considerations for a co-located lithium plant have not been analyzed on a comprehensive scale. Sponsoring such a programmatic review could be a form of a subsidy undertaken by either the federal government, the state of California or Imperial County, or could be issued by a geothermal developer interested in subsequent future developments in the area.

3. Issuance of a geothermal/lithium MOU between CEC and CalGEM.

   Regardless of whether a comprehensive EIS/EIR is developed for geothermal development at the Salton Sea, it would be beneficial for CEC and CalGEM to issue an agreement, likely in the form of an MOU, making the roles and responsibilities for a co-located geothermal and lithium extraction plant clear. This would provide greater certainty to developers in obtaining approval through the CEQA process, particularly because of the limited history of such co-located development. Alternately, CalGEM could potentially delegate authority for

permitting lithium production to Imperial County for projects below a certain size threshold, as has already been done for conventional geothermal development.

4. Development and funding of a state permitting coordination office.

   While geothermal development at the Salton Sea does not require preparation of a federal NEPA document, the concepts included in the *Federal Consolidated Appropriations Act* of 2021 could be extrapolated to streamline local and state permitting. Dedicated geothermal staff either funded by the state, the development community, or through a general fund can conduct more efficient reviews and coordinate necessary approvals more effectively than staff that currently handle geothermal permitting as an extension of other work.

7.3 Government Intervention

Federal, state, and local governments have all expressed interest in increased renewable energy development at the Salton Sea, including a desire for increased geothermal exploration and production. In some cases, these expressions have led toward financial incentives specific to geothermal. New or increased subsidization or incentivization would render new geothermal development more economically competitive.

Exploration and development incentives provide assurance and reduce risk to geothermal developers, while production tax credits, property tax waivers, and other incentivization of producing and transmitting the geothermal energy can help to reduce the effective LCOE and lower the prices associated with PPAs to be more on par with other energy resources. However, the structure and duration of federal incentives compared to long geothermal development timelines make it difficult for developers to rely on such incentives (Young et al. 2019). For example, the Production Tax Credit has rarely been guaranteed to be in effect for longer than 5 years, and geothermal exploration and development timelines are typically longer than this (DOE 2019).

As an example of how government intervention can lead to development, PURPA (discussed in Section 2.3) required that utilities purchase power at the avoided cost of power, which led to the purchase of geothermal energy at above market rates. The Energy Tax Act of 1978 incentivized geothermal development in the 1980s through various tax incentives, including investment tax and income tax credits. The Economic Recovery Act of 1981 allows for depreciation of geothermal equipment. All of these helped to lead to a boom in geothermal development, including at the Salton Sea, in the 1980s (Owens 2002).

New geothermal development at the Salton Sea could promote various other federal, state, and local goals, including Salton Sea habitat restoration, meeting CA RPS standards, meeting federal renewable energy goals, improving US air quality and reducing CO_2 emissions, and promoting high-paying jobs and economic benefits in Imperial County.

Furthermore, as discussed in Section 5.3.3, geothermal energy contains benefits to the power grid that are not necessarily reflected in the LCOE or PPAs associated with a specific project. To the extent that government incentives exist, they are generally not specific to incentivizing geothermal development, and in some cases, greater incentives exist for solar and wind than for geothermal development.

If the ancillary benefits of geothermal power generation can be better understood and quantified, applicable federal and state governments would have a better reason to incentivize