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Black Rock (23-AFC-03), Elmore North (23-AFC-02) and Morton Bay (23-AFC-01)

Geothermal Resource Evaluation

Testimony

by

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and

Jesus M. Salera Jesus Salera

May 18, 2023

Introduction

Charlene L. Wardlow and Jesus M. Salera, are employed by the California Geologic Energy Management Division (CalGEM) formerly the Division of Oil, Gas, and Geothermal Resources. We are the senior managers in the Geothermal Program. Charlene is the Geothermal Program Manager, and Jesus, the Senior Oil and Gas Engineer (Supervisor). Charlene has 40 years in geothermal energy and Jesus has 26. Our resumes outlining our educational and professional qualifications are attached.

The Geothermal Program oversees drilling, operation, and maintenance, and plugging and abandonment of low and high temperature geothermal wells located on private and state lands throughout California. The Program also oversees the efficient utilization of the geothermal resources as defined by Public Resources Code section 3714. Under the direction of the Geothermal Program Manager, the Senior Oil and Gas Engineer supervises three Associate Oil and Gas Engineers (AOGE) who prepare the drilling, workover, plugging and abandonment, and injection permits for applications submitted by the geothermal operators for such operations. The geothermal team coordinates with the CalGEM districts for well field inspections as required by the permits the Program issues during drilling operations and for compliance with the geothermal statutes and regulations. We also prepare materials for hearings at other regulatory agencies with oversight on geothermal operations such as Regional Water Quality Control Boards.

California Code of Regulations, title 20, section 1809 (c) requires that: "The California Division of Oil and Gas (DOG) shall be requested to review the application and all well records filed with the division concerning wells completed at the site, and shall be requested to present at the hearing its conclusions, based on the professional experience of its personnel, as to whether the site is reasonably capable of providing geothermal resources in commercial quantities." In accordance with this requirement, the California Energy Commission has requested CalGEM evaluate the availability of

commercial geothermal resources in the Salton Sea Geothermal Field (SSGF) to support the proposed geothermal projects called Black Rock, Elmore North, and Morton Bay for their proposed 30-year life.

We have prepared the following testimony to detail our professional opinion, based on the review of production and injection well data, geologic and geophysical studies, and updated reservoir modeling of the SSGF, that there is sufficient commercial resource to support the Black Rock, Elmore North, and Morton Bay geothermal power plant projects.

Salton Sea Geothermal Field Analysis

In the 20 years since the CE Obsidian Energy LLC Salton Sea Unit 6 project (SSU6) (185 MW net) was certified by the California Energy Commission (CEC) in 2003, the understanding of the geology of the Salton Trough that includes the San Andreas fault system has dramatically improved. A US Geological Survey (USGS) seismic refraction survey called the Salton Sea Imaging Project was completed in 2011. It included some of the first surveys under the Salton Sea expanding the understanding of what's known as the Brawley Seismic Zone that creates not only the Salton Sea Geothermal Field (SSGF) but other geothermal fields to the south. In 2016 an updated velocity model was completed which better delineated the Quaternary volcanics that may be aligned with the heat source for the system and a detailed analysis of the faults controlling the geothermal system. This includes both the northwest-southeast faults aligned with the San Andreas and the transverse faults, Riedel shear faults, that run almost perpendicular because the trough is an active transtensional basin. Naod Araya, now with Ormat Technologies, Inc., provides an excellent review of the updated geologic model based on geophysical surveys and other surveys performed in the last 20 years. His paper, based on his master's thesis at the University of Auckland, was presented at the 2022 Geothermal Rising Conference. The understanding of the geology of the system, especially the structure, is critical since heat flow calculations for the SSGF indicate the field could produce thousands of megawatts even with data available to the scientists in the 1970's. However, because the deeper SSGF is primarily fractured sedimentary and metamorphic rocks, drilling a productive well requires an understanding of the fault and fracture system that is controlling the fluid flow in the reservoir. Many dry holes or uncommercial wells have been drilled in the history of geothermal energy development because this information wasn't known.

The reserves for the SSGF for the SSU6 project were determined to be 680 MW proven which included the 350 MW of existing production and 330 MW of undeveloped projects. GeothermEx Inc., who prepared the third-party report for SSU6 concluded that 1200 MW of reserves were available in the SSGF to dedicate to the SSU6 project. Modeling of geothermal systems has also greatly improved in the past 20 years, and they provide input for a much more detailed geologic model and grid layout for the reservoir. The history matching capability includes temperature, pressure, production, injection, enthalpy, and even geochemistry.

GeothermEx was hired again as the third-party consultant to update the reserves for BHE Renewables, LLC (BHER), the applicant for the Black Rock, Elmore North, and Morton Bay projects totaling 357 net MW that would double the current power plant output of the field. Energy Source added the Hudson Ranch Power 1 project in 2012 (now at 55 net MW) bringing the current SSGF output to about 400 net MW. GeothermEx had 20+ years of additional history for the SSGF to estimate reserves for the new projects and even included the proposed Controlled Thermal Resources (CTR) project called Hell's Kitchen (49.9 net MW) that will come on-line about the same time as BHER. CTR completed two exploration wells in early 2022 and are currently performing a long-term flow test. The Draft Environmental Impact Report for the Hell's Kitchen power plant project and well field is due for release this spring from the Imperial County Planning and Development Services Department. The reserves are estimated to support this new generation, doubling the current output of the SSGF to almost 800 net MW through 2065.

Kaspereit et al., 2016, updated work done by Jeff Hulen et al., in 2002, which is an update to a 2D model of the field including a reserve estimate. The 2002 estimate was 2330 net MW for the entire SSGF. However, the Salton Sea has receded since that time, and additional shallow heat flow data has been obtained for areas that are now dry land. Their current estimate is 2950 net MW for the entire area analyzed. The updated study continues to indicate 990 net MW proven for the area that approximates the leasehold of BHER.

Finally, CalGEM has continued to review monthly production and injection data for BHER and other SSGF operators since 2002, and meets annually with them to review overall output, chemistry of injectate, mechanical integrity testing, and field operations. CalGEM also permits new wells, workovers, plugging and abandonment and injection operations. The data suggests a stable resource with very little decline in production, temperatures or pressures as shown by the GeothermEx updated resource model. BHER has continued to evaluate metallurgy for well construction to improve the longevity of the wells which can reduce workovers, and they have developed a well construction design based on what they have learned. Even titanium was found to have a relatively short life if a well's normal life is considered to be 20 to 30 years. New cements have also emerged to prevent degradation from carbon dioxide, which is an issue in the SSGF where a shallow CO_2 field was defined almost 100 years ago.

Conclusion

Based on the current knowledge of the geologic structure of the Salton Trough and the Salton Sea Geothermal Field specifically, the updated reservoir modeling as explained in the resources outlined above, and our knowledge of reservoir modeling and assessment, we agree with the various studies' contention that there is adequate geothermal resource to support the proposed BHER projects totaling 357 net MW for 30 years.

References:

Araya, N., O'Sullivan, J. "A 3D Conceptual and Natural-State Model of the Salton Sea Geothermal Field." GRC Transactions, 46, (2022), 2123-2155

Kaspereit, D., Mann, M., Sanyal S., Rickard, B., Osborn, W., and Hulen, J. "Updated Conceptual Model and Reserve Estimate for the Salton Sea Geothermal Field, Imperial Valley, California." *GRC Transactions*, 40, (2016), 57-66

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EXPERIENCE

California Department of Conservation, Geologic Energy Management Division
Sacramento, CA May 2016 – present

Supervisory Oil and Gas Engineer, Geothermal Program Manager, and former Northern District Deputy
Direct the development, implementation and management of the Northern District and Division's geothermal program that includes the largest gas field in California, 2/3 of the state's underground gas storage facilities and the largest geothermal field in the world. Oversee District operations to ensure permits are issued timely; proposed and existing Underground Injection Control projects are professionally evaluated, and operations are following the Division's regulations. Collaborate with the State Oil and Gas Supervisor in the formulation and dissemination of oil, gas and geothermal regulatory plans, policies, standards, and controls.

Ormat Nevada Inc.
Reno, NV September 2006 - April 2016

Director of Business Development - September 2009 to current
- Spearheaded citing of a new power plant at Mammoth Lakes, CA coordinated with the USFS, BLM and Mono County agencies. Worked cooperatively with the local water district to address their concerns. Supported attorneys in the legal processes to win all appeals on the project;
- Lead successful permitting effort on two new geothermal power plant projects and Ormat's first US solar project in Imperial County, CA as well as expansion projects at existing facilities;
- Permitted Ormat's first exploration project in New Mexico resolving permit conditions that would have caused abandonment of the project before the first well was drilled;
- Collaborated on what would have been the first geothermal project in Indian Country. Developed and implemented multiple presentations for the Tribal Council and the Tribe's legal counsel, staff and cultural committee;

Environmental and Regulatory Affairs Administrator - September 2006 to August 2009
- Played key leadership and liaison role in assisting environmental staff with specific projects such as a settlement agreement with the Regional Water Quality Control Board and setting up compliance letters for new projects;
- Led Ormat's team in permitting and developing new geothermal energy projects in Imperial County and Mammoth Lakes, CA. Developed trusting, working relationships with county and state agencies and officials to bring projects to fruition.

Calpine Corporation
Middletown, CA 1981 – June 2006

Manager of Development Permitting - September 2001 – June 2006
- Lead permitting and environmental review required by federal, state and local agencies for development of power plants, transmission lines and well fields at Glass Mountain and The Geysers in California;
- Managed environmental budget for the Glass Mountain project and managed compliance during construction;
- Coordinated environmental due diligence team on potential acquisitions for geothermal division.
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Environmental, Health and Safety Manager - April 1999 – September 2001

- Managed a staff of 17 environmental, health and safety (EHS) professionals responsible for 19 power plants and their associated well fields and the health and safety of about 400 Calpine employees at The Geysers; responsible for an EHS budget of more than $1 million.

Environmental Manager - 1991 – April 1999

- Oversaw the transfer of more than 400 permits and the regulatory review in concert with legal counsel to perform due diligence documentation for the acquisition of Pacific Gas & Electric's (PG&E) 14 power plants, Florida Power and Light's power plant and steam field and Unocal's well field at The Geysers in 1999, about $400 million in acquisitions.

Assistant Manager Environmental/Legislative Affairs - 1988 - 1991

- Lead environmental permitting effort to license (Sutter Project) the first power plant in California in almost 10-years, a 550-mw combined-cycle natural gas power plant; conducted numerous presentations to local community groups as part of public outreach for the project;
- Directed company efforts for a coal-fired power plant (Navajo South Project) southwest of Farmington, NM; coordinated team efforts for the NEPA review with the Bureau of Indian Affairs (BIA) and to secure other permits for the project. (Calpine's senior management decided to focus on natural gas and this project didn't go forward.)

Petroleum Engineer - 1981 - 1988

- Initiated major project to set up and organize database with data from more than 100 wells for five-year period that became instrumental for reservoir modeling and future projections;
- Worked closely with management in project budgeting, economics, acquisitions and growth planning; made numerous presentations to senior management that generated confidence in budget forecasts and company projections;
- Worked as production engineer responsible for 50 oil wells; performed reservoir engineering in oil field and geothermal and worked in drilling department to support two-rig operation for development of two new power plants.

EDUCATION

Master of Science in Petroleum Engineering
New Mexico Institute of Mining & Technology
Bachelor of Science in Geology
New Mexico Institute of Mining & Technology

Jerry Salera

Resumé - May 15, 2023

SENIOR OIL AND GAS ENGINEER (SUPERVISOR) - <5 years, CalGEM Northern District/Geothermal Program

- Supervise geothermal permitting process of well work and UIC Class V injection
- Supervise geothermal well injection surveillance and field inspections
- Provide technical information and support as District rep to UIC Roundtable and represent District in regular meetings with the EPA and the SWB/RWBs
- Support CalGEM's Geothermal Regulations update process

SENIOR OIL AND GAS ENGINEER (SUPERVISOR) - 7 years, CalGEM HQ UIC Program

- Supervised reviews of District UIC projects and compliance and analyzed statistical data to identify issues on UIC compliance
- Coordinated with the SWB/RWB on the processing of aquifer exemptions and other UIC-related initiatives like Legislature reporting and UIC compliance efforts
- Provided technical support and statistical data in the UIC Regulations update process
- Interfaced with the US EPA (Region 9) on CalGEM's Class II Program reporting requirements and prepared annual documentation for Grant support

ASSOCIATE OIL AND GAS ENGINEER – 6 months, CalGEM HQ UIC Program

- Reviewed UIC projects and MIT compliance

ENERGY AND MINERAL RESOURCES ENGINEER - 5 years, CalGEM District 6 (now Northern District)

- Performed witnessing of BOPE and well MIT testing, zone and well P&As and updated maps, well files and databases
- Conducted and documented well and lease inspections, sent out Notices of Violations (NOVs) and monitored compliance

SENIOR RESOURCE ENGINEER – <1 year, Caithness Energy, Coso Geothermal Field, CA

- Monitored production well performance and effects of injection well utilization
- Coordinated and implemented testing programs of production and injection wells
- Generated statistical data of reservoir performance

RESERVOIR ENGINEERING SUPERVISOR, RESERVOIR ENGINEER, MEASUREMENTS ENGINEER - <21 years, Philippine National Oil Company – Energy Development Corp. Geothermal Division, Makati, Philippines

- Supervised the monitoring of production and injection wells and proposed and coordinated well utilization strategies to optimize steam production for the power plants in 4 geothermal fields.
- Implemented and coordinated well testing programs to determine well and reservoir potential in geothermal exploration areas
- Planned and implemented well discharge stimulation campaigns for hard-to-discharge wells in newly explored areas.
- Participated in multi-disciplinary group studies of exploration areas, helped create and develop conceptual and reservoir models and performed resource assessment studies.

EDUCATION

- **University of Auckland, Geothermal Institute, New Zealand**
  - **Master's in Engineering (Engineering Science), 1987 -** Focus on Geothermal Reservoir Engineering.
  - **Diploma in Energy Technology (Geothermal), 1983**
- **B. S. Industrial Engineering 1981, University of the Philippines, Diliman**