DOCKETED	
Docket Number:	23-SB-100
Project Title:	SB 100 Joint Agency Report
TN #:	252186
Document Title:	Geothermal Rising Comments - 2025 SB100 Joint Agency Report Comments from Geothermal Rising
Description:	N/A
Filer:	System
Organization:	Geothermal Rising
Submitter Role:	Public
Submission Date:	9/8/2023 12:51:36 PM
Docketed Date:	9/8/2023

Comment Received From: Geothermal Rising
Submitted On: 9/8/2023
Docket Number: 23-SB-100

2025 SB100 Joint Agency Report Comments from Geothermal Rising

Additional submitted attachment is included below.

GEOTHERMAL RISING POLICY
POWERING OUR RENEWABLE FUTURE.

SB 100 Comments Draft

Summary

California's adoption of SB100 and the thoughtful planning underpinning the 2021 Joint Agency Report, 2022 Scoping Plan, and CPUC Integrated Resource Plan process are critically important to mitigating the impacts of climate change. California is not only making meaningful emissions reductions and air quality improvements through these endeavors, but also providing leadership for the rest of the world on how to successfully deploy a reliable and highly decarbonized energy system in a time of oil and gas volatility. The 2025 SB100 Joint Agency Report provides a great opportunity to build on this leadership by technological progress, market conditions, stakeholder values, and other dynamics in the energy transition to build a more robust pathway to achieving SB 100 targets. As with the 2021 report, the results of the 2025 update will be critical in shaping state policy discussions—including prioritization of infrastructure investments, research dollars, permitting reform, and guiding resource procurement.

As part of the early 2025 report development **Geothermal Rising implores that the joint agencies take a comprehensive look at the role all geothermal technologies could play in increasing the affordability, non-energy benefits, and reliability of a SB100 grid**. The geothermal industry continues making significant technological advances, ideally positing it to provide a robust supply of clean firm power. The proven technology has begun the process of scaling following a successful commercial-scale demonstration of an Enhanced Geothermal System (EGS) in Spring 2023, ramping-up geothermal development to fulfill the California Public Utility Commission's (CPUC) 1 GW baseload tranche of Mid-term Reliability procurement, spudding the first commercial-scale Advanced Geothermal System (AGS) in Germany, and supporting Department of Energy's adoption of a $45/MWh EarthShot target for EGS by 2035. These advances put geothermal power on a trajectory to serve more of California's load than it has historically and provide needed reliability. The advances in technology and methods of harnessing resources vastly increase the scale of developable resources—with some studies suggesting with cost declines and increased geothermal operational flexibility, there could be as much as 115 GW of geothermal capacity in an optimal expansion of the Western Interconnection[i]. **Geothermal Rising would appreciate the opportunity to convene experts to directly share these advances in clean firm technology with SB 100 stakeholders and technical modeling staff—ideally in a workshop this year**.

Geothermal Power Aligns with California Values

A common theme in the August 22nd SB100 Kickoff Workshop was that the joint agencies need to recommend a core carbon free pathway that includes significant gas generation retirements but did not fully address the overall need for grid reliability.

Geothermal Rising is confident that updates to the SB100 modeling assumptions that align with the trajectory of cost reductions, increasing flexibility, and scalability of geothermal will reveal that geothermal resources can play a key role in providing California the clean firm capacity needed to achieve a carbon free grid and deliver the non-energy benefits demanded by stakeholders. Those benefits include minimizing local air pollution, much more efficient land use (5x greater than solar PV and 10x greater than wind per MWh[ii]), and economic impacts that increase local skilled workforces. In contrast, many competing clean firm technologies involve combustion that does not reduce emissions other than GHGs (e.g., hydrogen repowering or direct air capture) or rely on foreign supply chains or modular installations that do not create opportunities for the local workforce (e.g., fuel cells, battery storage).

Modeling Modern Geothermal Technology

In the 2021 SB 100 report, the joint agencies signaled geothermal might play an expanded role in future studies given cost reductions reflected in the 2020 NREL Advanced Technology Baseline (ATB) released after the report's publication[iii]. Since then, ATB staff at NREL have collaborated closely with geothermal industry leaders to incorporate advances into the technology readiness metrics. To align with advancements in recent years, updating the cost assumptions and technological advances for conventional geothermal is needed for California to adequately model future grid needs.

The currently operating geothermal capacity serving California uses conventional technology. Conventional geothermal resources require a confluence of unique geologic conditions: a heat source, reservoir permeability, and geothermal fluid/steam. These conditions are present in places like the Geysers, Imperial Valley, and parts of Nevada. The input assumptions for the total developable geothermal capacity in RESOLVE modeling derive from a 2010 report that only considers known resources developable with conventional technology[iv]. The assumptions yielded 2.4

GW of potential incremental capacity in California and 1.8 GW in Nevada yet understate the impact of new exploration techniques for discovering new resources or the ability of enhanced and advanced geothermal technologies to target resources that do not have reservoir permeability or geothermal fluid/steam.

EGS is one of the technologies that could greatly expand the envelope of developable geothermal resources, and is demonstrating significant progress. EGS should be incorporated in modeling for the 2025 SB 100 report. EGS allows resources without permeability to be developed by stimulating the subsurface to create interconnectivity between production and injection wells. The technology has benefitted from recent advancements in the oil and gas industry that improve the modeling and execution of well stimulation, particularly from horizontal wells—allowing operators to create fractures that are dispersed and provide efficient subsurface heat transfer. For example in Spring 2023, a geothermal company focused on developing EGS successfully tested an EGS well pair in an impermeable target with sufficient flow and temperature that the company states has the potential to generate a level of megawatts aligned with the "Advanced Scenario" in the performance criteria for the 2023 NREL ATB's EGS cost estimate[v].

The ability of EGS to harness resources beyond what is developable with conventional technology is impactful—a 2023 NREL report estimates that California could see 18.2 GW of EGS capacity deployed by 2035 and 27.9 GW by 2050 if EGS continues its trajectory of innovation[vi]. As such, cost projections for EGS can be largely standardized and benefit from the types of cost curve declines experienced by more mature modularized technologies like solar, wind, and battery storage. Although EGS could unlock *geothermal anywhere*, costs will vary based on location and resources near thermal anomalies—which are pervasive in California and Nevada—will be more cost-effective to develop first.

AGS is a parallel technology that unlocks significant scale-up of geothermal potential. AGS, also known as Advanced Closed-Loop (ACL), does not require the working fluid to flow through the reservoir and instead uses a closed-loop wellbore as a subsurface heat exchanger. Similar to EGS, AGS has benefitted from technological advancements in the oil and gas industry that are greatly improving costs and drilling efficiency, and allow for execution of much more complicated wellbore geometries that can facilitate significant rates of heat transfer. For example, in 2019, a geothermal company focused on closed-loop technologies successfully tested a 2.4-km deep AGS system in Alberta, Canada that validated the thermodynamic modeling of an

AGS system. This same company has designed a commercial-scale AGS system consisting of 12 multilateral wells 7.5-km deep that could generate megawatts and in favorable geologic conditions (which are present in California)[vii]. As important stepping stones, this AGS company successfully drilled the world's deepest and hottest directional geothermal well in New Mexico in 2022 and just started drilling for a commercial AGS deployment in Bavaria, Germany. As with EGS, AGS is expected to benefit from modularity and scalability. Studies of optimal capacity expansion modeling in the Western Interconnection suggest AGS could provide 90 GW of capacity and 40% of energy needs[viii].

In addition to scalability, both EGS and AGS provide another important capability not reflected in the last SB 100 modeling: flexibility. EGS and AGS are dispatchable and dynamic systems, and shutting generation in allows for temperature and or pressure to build-up—storing energy that can be used for generation later. This capability has been demonstrated in the field for both AGS and EGS and given most of the cost for geothermal power is related to subsurface equipment, the upsized surface facility costs to enable increased levels of dispatch are very cost-effective.

Geothermal Rising strongly recommends that the joint agencies convene industry, governmental, and third-party experts to adequately capture the advances of the geothermal industry in the 2025 SB 100 report. A workshop that tackles how advances in clean firm power would allow these technological advances to be socialized broadly across stakeholders so that we may optimally plan for Califonia's energy future.

Geothermal in SB 100 Pathways and State Policy Implications

The proposed pathways for the 2025 SB 100 report does not adequately represent the scenario in which geothermal power currently is poised in playing a major role in California's decarbonized grid—which is unfortunate given the continued technological progress in the geothermal industry and the potential for geothermal scale-up and delivery of non-energy benefits to Californians. Geothermal energy also represents a near-term proven technology that is primed to be scaled while the complexities of various other renewable energy technologies are sorted out, potentially providing California with much-needed reliability services. Although the proposed combustion retirement pathway adjusts assumptions on increased technology innovations that may include geothermal, limiting geothermal advancements to one pathway and embedding it within a technological

advancement scenario limits the visibility of state policy opportunities that support geothermal development and de-risk SB 100 compliance.

Geothermal Rising asks the joint agencies to include geothermal assumptions as a discrete assumption in the sensitivity analysis for SB 100 pathways—on a level playing field with other clean, firm and long-duration storage resources. In line with developments in other clean firm power such as offshore wind, hydrogen, and long-duration storage, geothermal energy assumptions should be evaluated in par with the current industry's aggressive growth in the proposed "Resource Diversification" and "Combustion Retirement" pathways.

In line with these steps to adequately represent geothermal energy advancements in California, Geothermal Rising also requests that the 2025 SB 100 report identify additional state policy opportunities that support geothermal development and deployment of advanced technologies. To optimize its value in the California grid, the geothermal industry must navigate unique hurdles: exploration risk, federal well permitting, a comparatively high property tax burden, low federal research and development funding, and moderate to long project development cycles. There are opportunities to directly alleviate these burdens with supportive state policy—and accelerate deployment of a scalable clean firm resource that could provide the foundation for meeting SB 100 targets.

Thank you for the consideration of these comments from Geothermal Rising and the geothermal community.

Sincerely,

Bryant Jones, PhD
Executive Director
Geothermal Rising
Use the Earth to Save the Earth
www.geothermal.org
+1 (530) 758-2360

[i] Ricks, et. al (2022). The Role of Flexible Geothermal Power in Decarbonized Electricity Systems. https://zenodo.org/record/7093330/files/Working%20Paper.pdf?download=1
[ii] McDonald RI, Fargione J, Kiesecker J, Miller WM, Powell J (2009) Energy Sprawl or Energy Efficiency: Climate Policy Impacts on Natural Habitat for the United States of America. PLoS ONE 4(8): e6802. https://doi.org/10.1371/journal.pone.0006802
[iii] "The Evolving Role of Geothermal" page 92, 2021 SB 100 Joint Agency Report
[iv] Lovekin J, and Pletka R (2010). Geothermal Assessment as Part of California's Renewable Energy Transmission Initiative (RETI). https://www.geothermal-energy.org/pdf/IGAstandard/WGC/2010/0318.pdf
[v] Norbeck J, and Latimer T (2023). Commercial-Scale Demonstration of a First-of-a-Kind Enhanced Geothermal System. https://eartharxiv.org/repository/view/5704/
[vi] Augustine, et. al (2023). Enhanced Geothermal Shot Analysis for the Geothermal Technologies Office. https://www.nrel.gov/docs/fy23osti/84822.pdf.
[vii] Beckers K, and Johnston H (2022). Techno-Economic Performance of Eavor-Loop 2.0. https://pangea.stanford.edu/ERE/db/GeoConf/papers/SGW/2022/Beckers.pdf.
[viii] Holmes M, et al (2021). Multilateral Closed-Loop Geothermal Systems as a Zero-Emission Load-Following Resource. https://publications.mygeoenergynow.org/grc/1034365.pdf.