DOCKETED	
Docket Number:	26-IEPR-04
Project Title:	Geothermal
TN #:	271330
Document Title:	Technical Challenges to Geothermal Development and New Opportunities With Technology Advancements in California
Description:	Presentation by Eva Schill at the July 9, 2026, IEPR Commissioner Workshop on California's Geothermal Energy Resources
Filer:	Stephanie Bailey
Organization:	Lawrence Berkeley National Lab (LBNL)
Submitter Role:	Other Interested Person
Submission Date:	7/8/2026 2:40:15 PM
Docketed Date:	7/8/2026

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Technical challenges to geothermal development and new opportunities with technology advancements in California

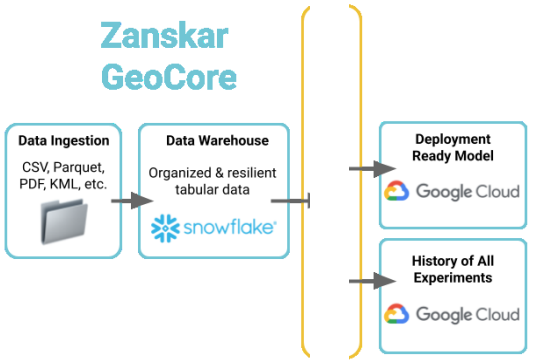
The Next Frontier of California Geothermal Energy

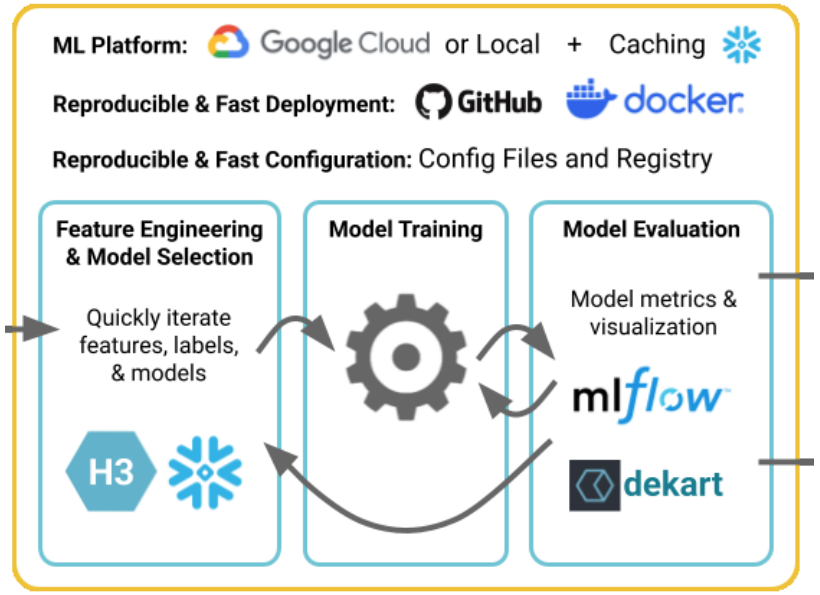
Eva Schill – Geothermal Systems Program Lead

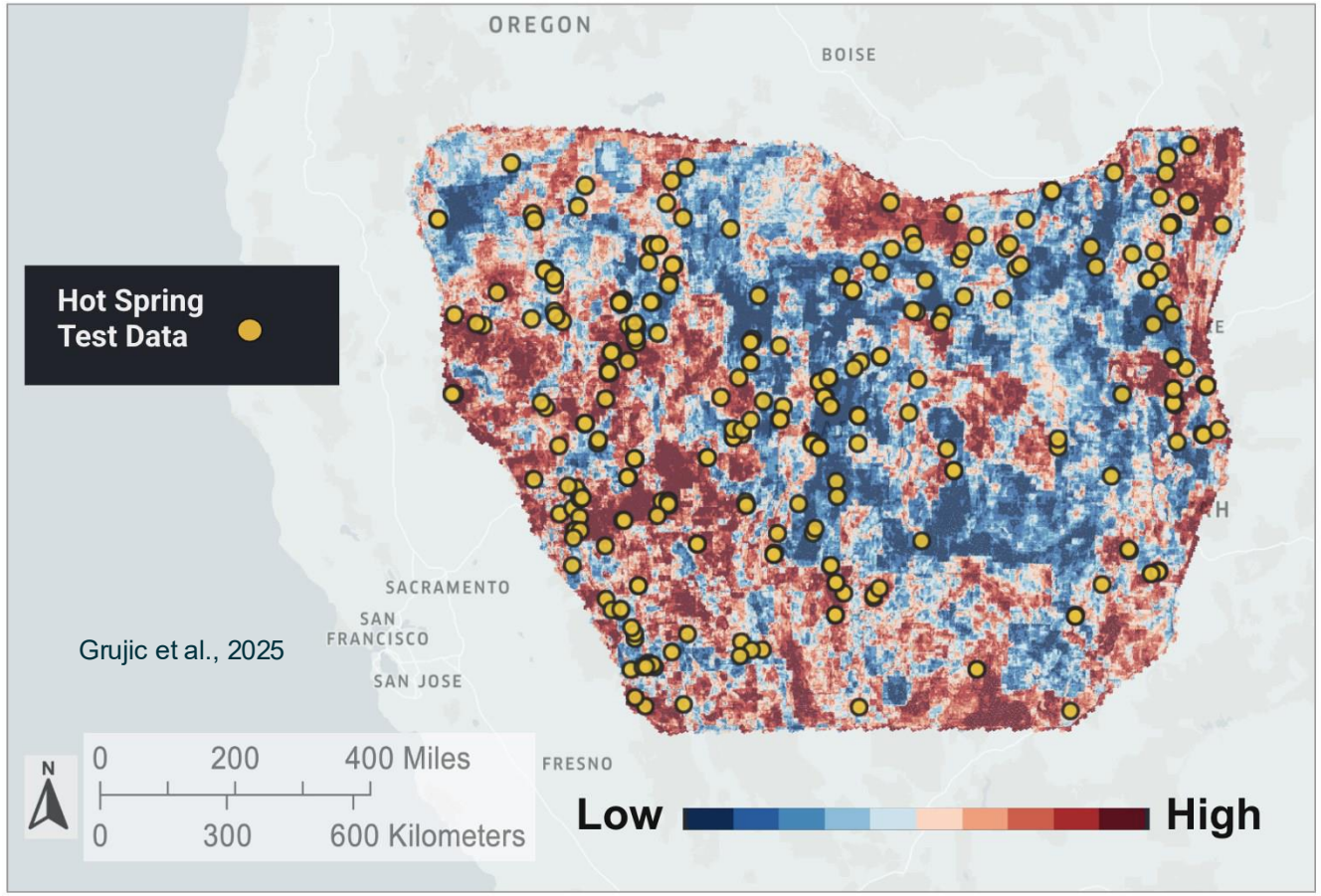


Advances in Conventional Resources
INGENIOUS – Play Fairway Analyses

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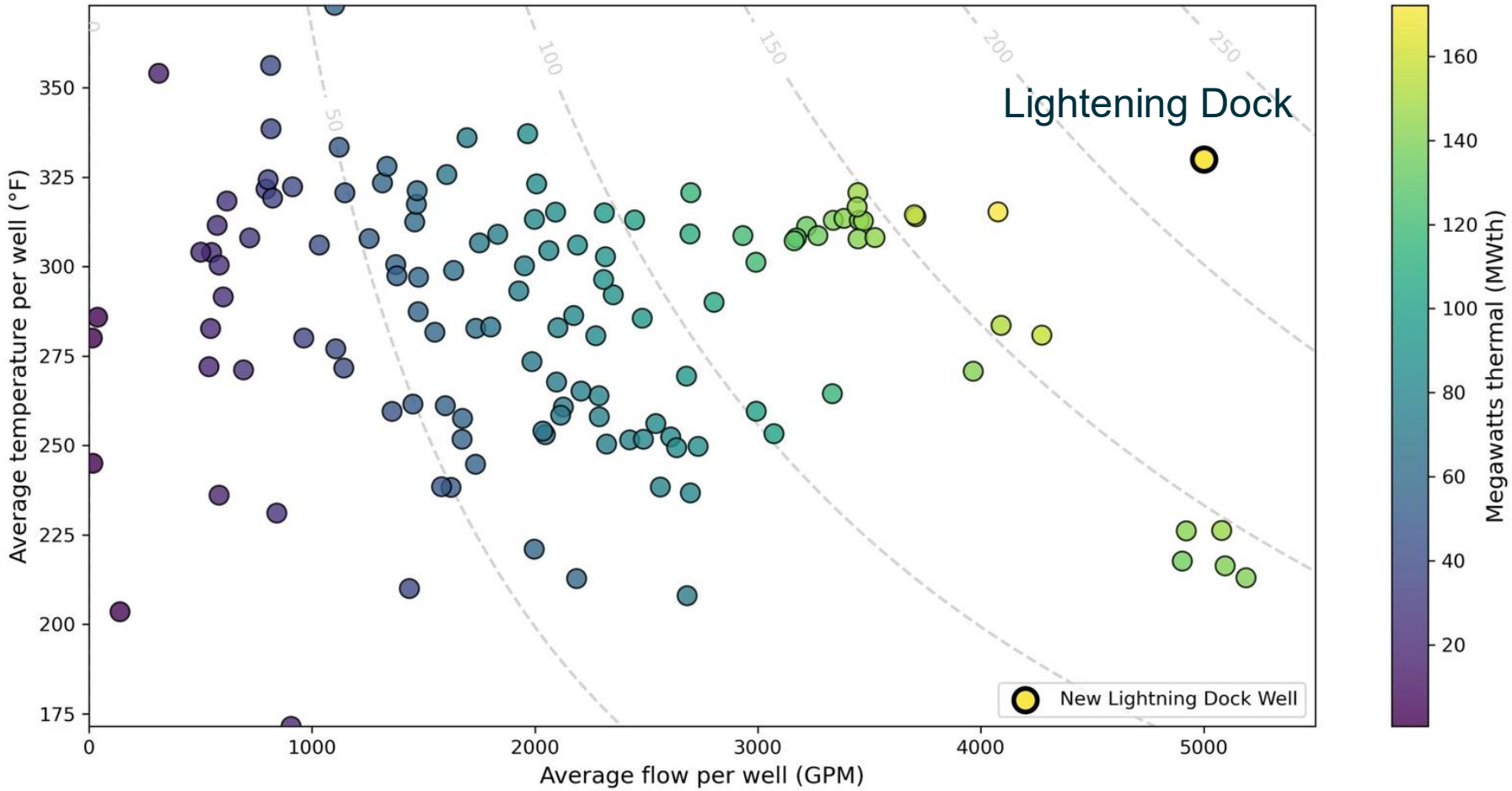






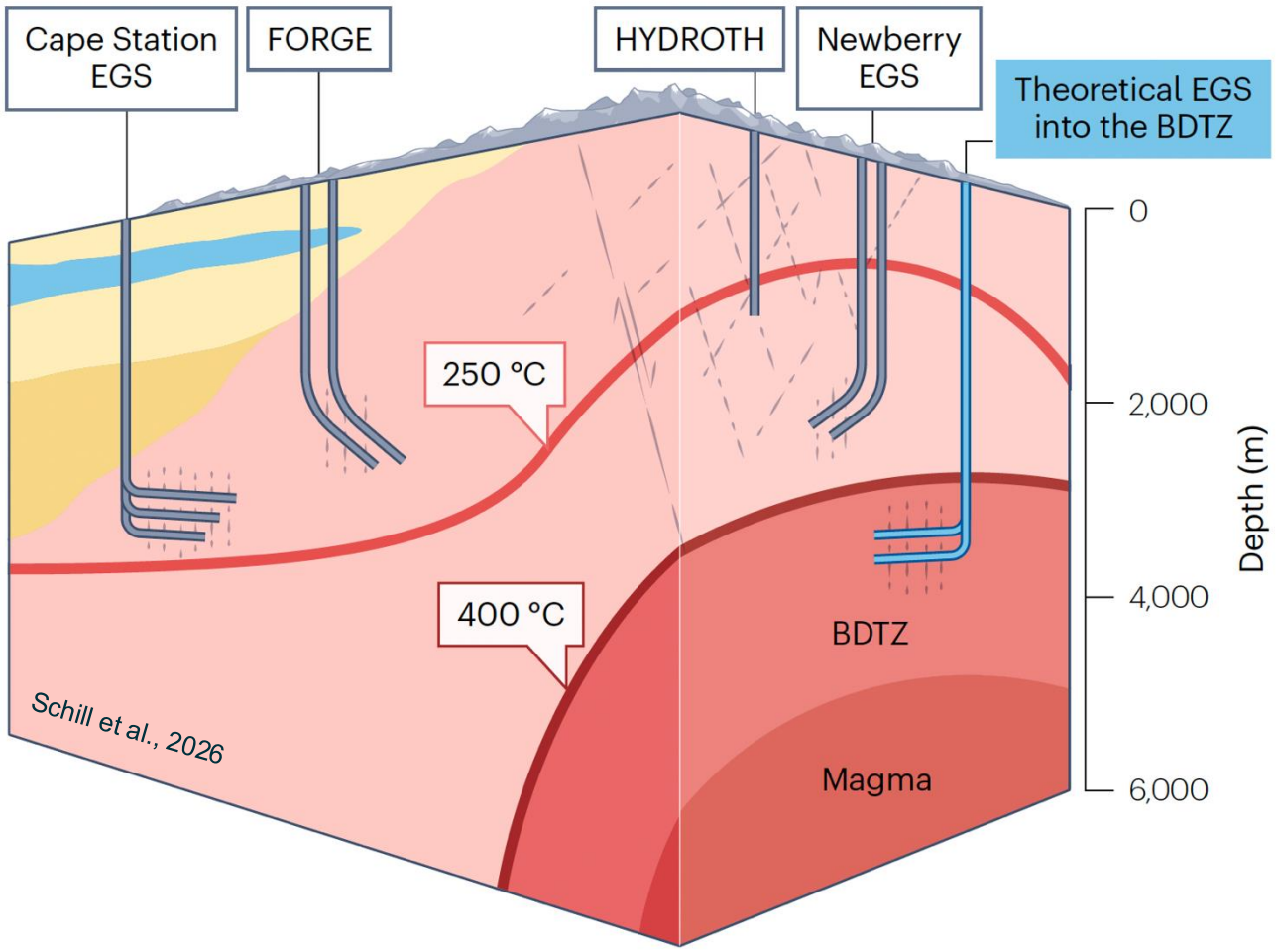
Recent Breakthrough – Enhancement of Productivity using Artificial Intelligence

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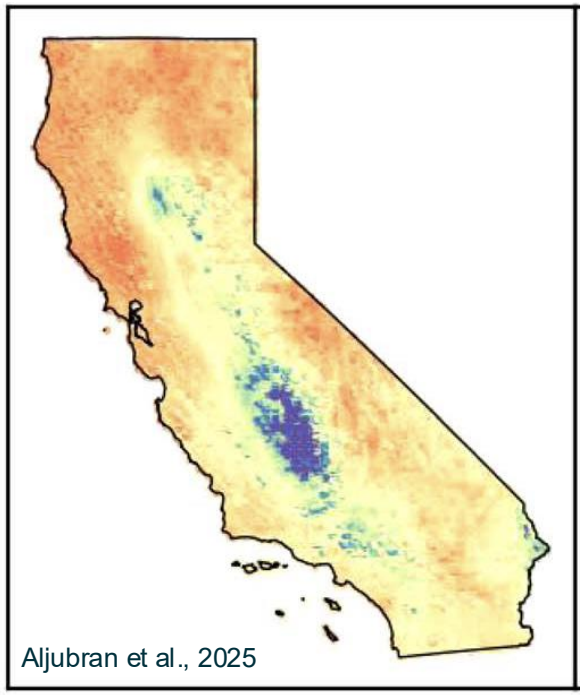


Advances in Enhanced Geothermal Systems (EGS) and Towards Supercritical Condition

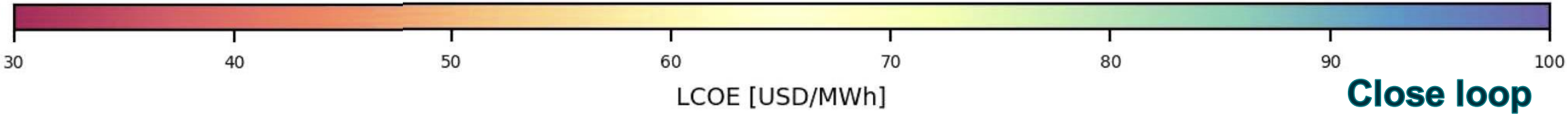
- **2024 Cape Station, UT (FERVO Energy)**
  - Flow test confirms about 100-120 L/s ($10\ MW_{el}$) per doublet
- **2025 Newberry, OR (Mazama Energy)**
  - Successful hydraulic fracturing and circulation test of a 331 °C EGS reservoir at Newberry



Techno-Economic Impacts of Integrating EGS into California's Electricity and Gas End-Use Sectors

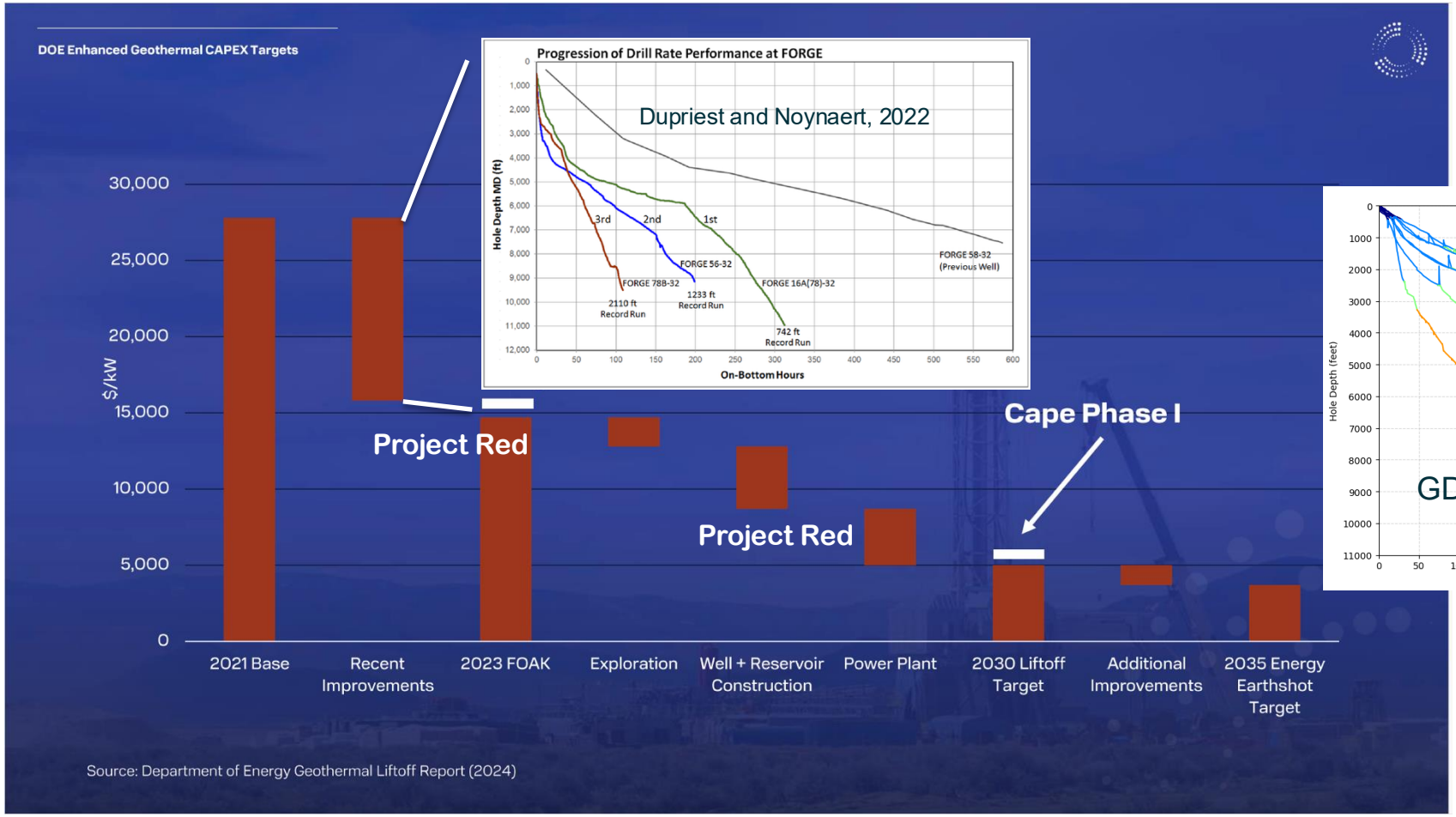


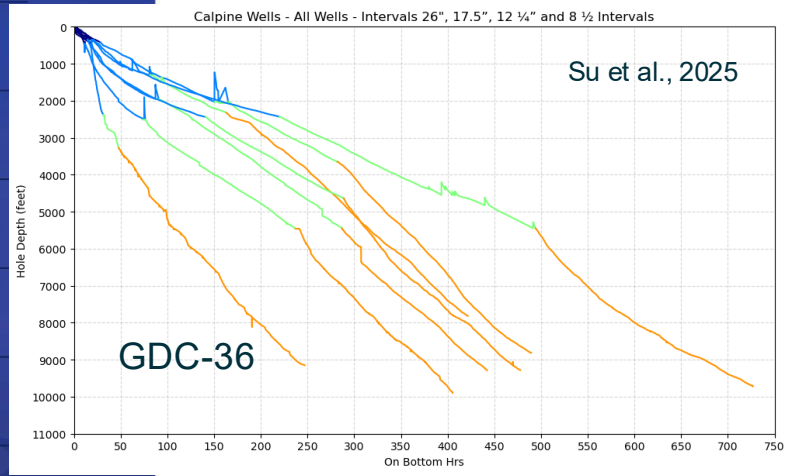
- Use of BRIDGES gas-electric capacity expansion model – a multisector energy model optimizing energy system investment, retirements, and hourly dispatch over multiple time horizons
- EGS supply curves based on recent commercial EGS designs and deployments which involved significant cost reduction in drilling and stimulation.
- Supply curves were associated with noticeably lower costs compared to other estimates, such as the 2024 NREL Annual Technology Baseline (ATB)



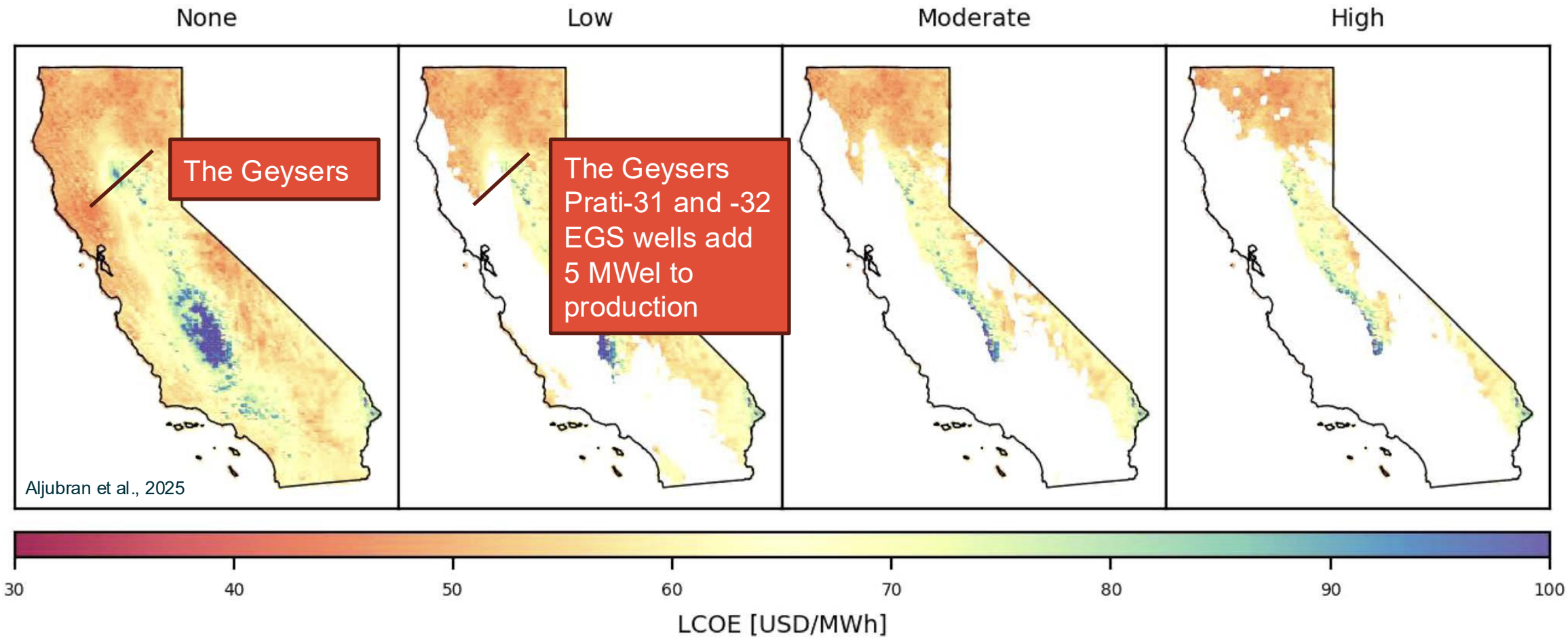
Close loop $136/MWh

Recent Breakthrough – Development of EGS CAPEX California specific opportunities: Well GDC-36





Land exclusion scenarios based on the chance of any level of damaging natural earthquake in 100 years



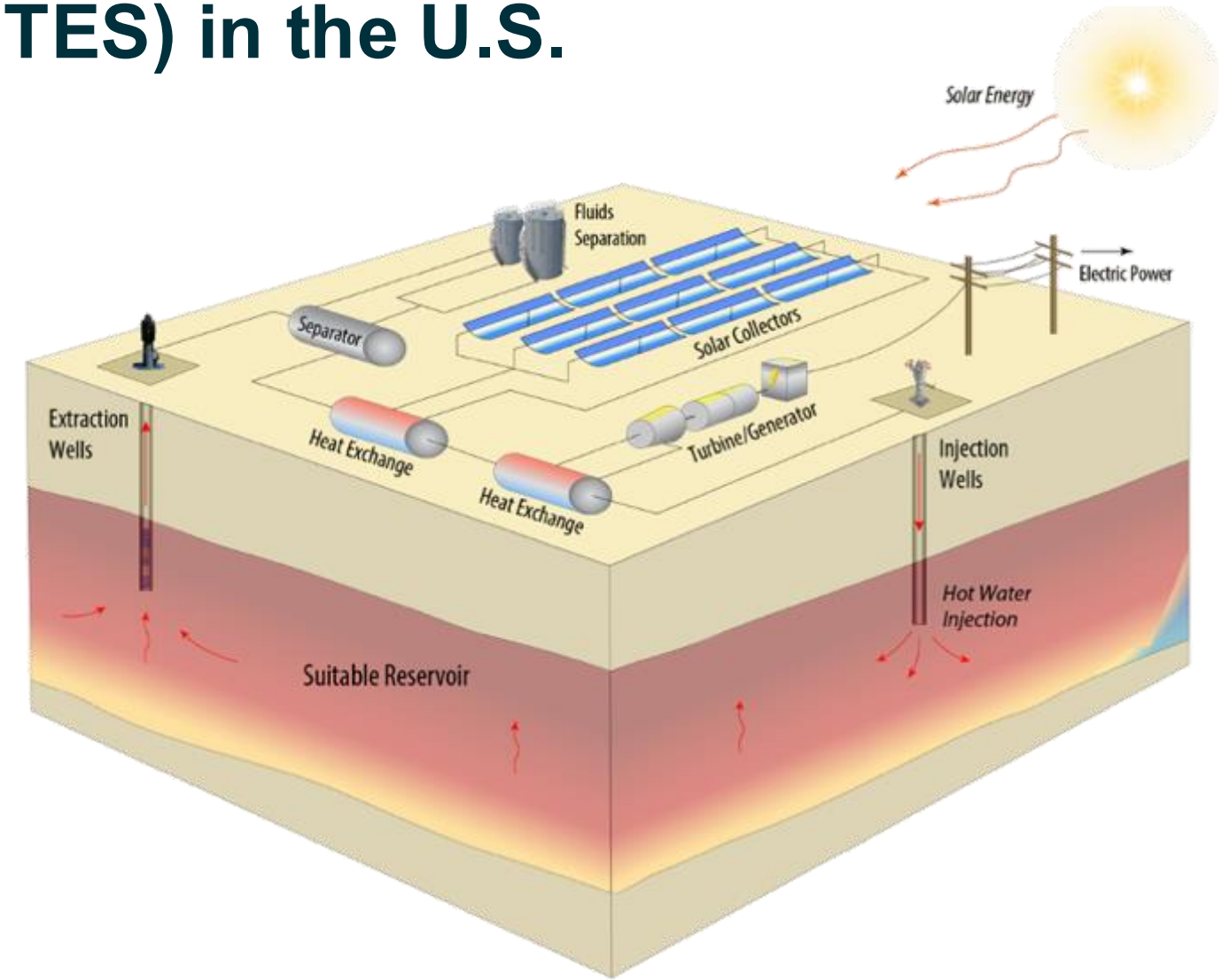
California specific challenges and opportunities

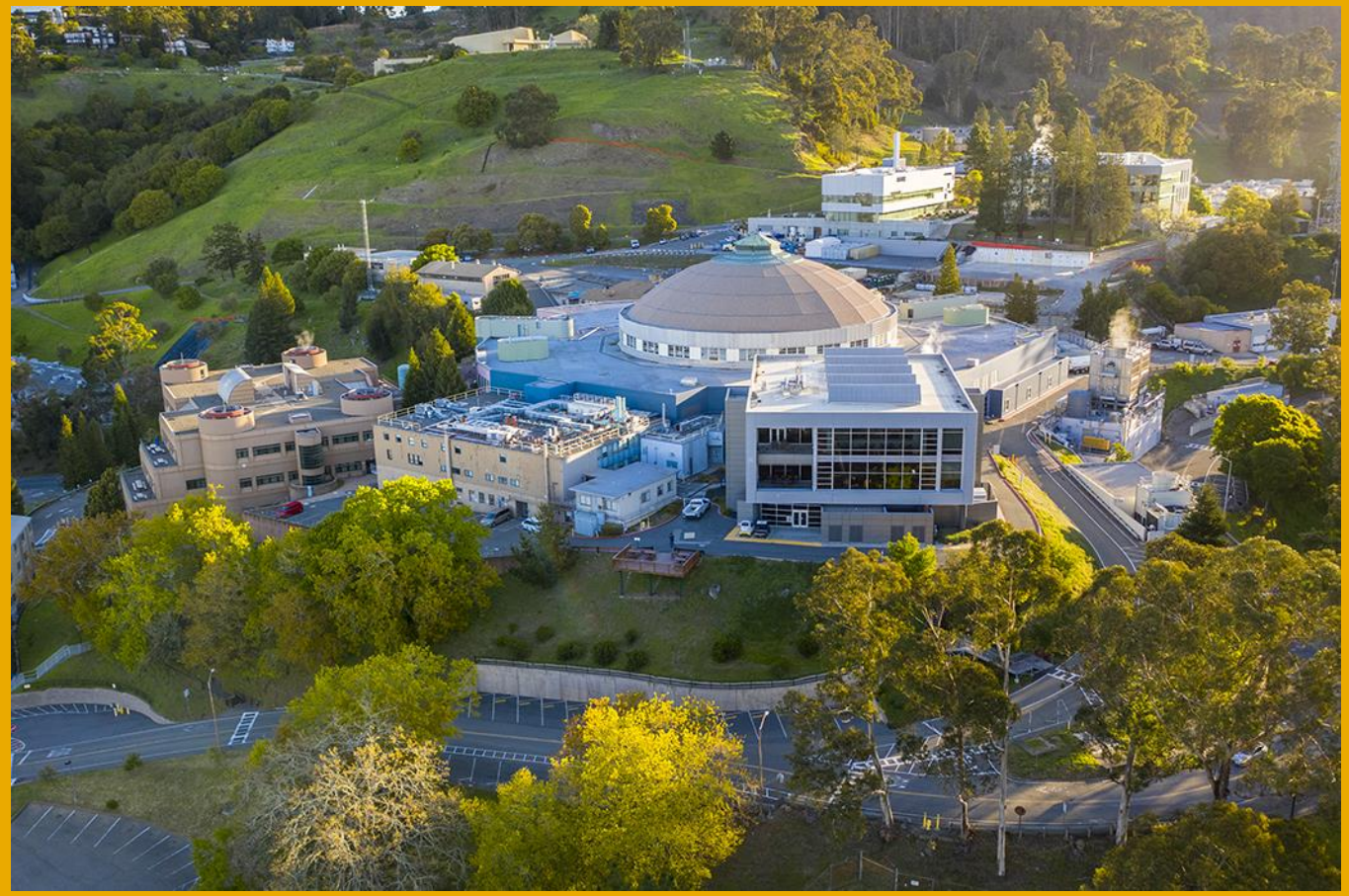
	Conventional	EGS	Supercritical
Technical barriers/opportunities for conventional hydrothermal vs. next-generation geothermal (EGS, superhot rock, closed-loop) in California's specific geological settings	Larger magnitude induced seismicity Co-production of critical minerals or hydrogen	Reactivation of natural faults – Induced seismicity	Deeper-seated resources due to high salinity (Salton Sea) and low pressure (The Geysers)
Different technical requirements and cost profiles through specific subsurface conditions in California	Corrosion and scaling resistance (Salton Sea)		

- What opportunities could future research and technology advancements help unlock around geothermal applications?
  - California resource management plan
  - Management of induced seismicity
  - Storage capacity

Development of High-Temperature Underground Thermal Storage (UTES) in the U.S.

- **Bakersfield, CA (Premier Resource Management, PRM)**
  - Concept 1000+h storage
  - 250ºC water into sandstone reservoir





We acknowledge the support by the U.S. Department of Energy, Office of Hydrocarbon and Geothermal Energy (HGEO), Geothermal Technologies Office, under Award Number DE-AC02–05CH11231 with Lawrence Berkeley National Laboratory.

eschill@lbl.gov

Thank You