Geothermal R&D Needs in California

Presented To: California Energy Commission Workshop

Presentation Date: 20 September 2023

Presenter: Jill Robinson Haizlip

GEOLOGICA
Geothermal Resource Solutions

Geothermal Energy-Potential versus Actual

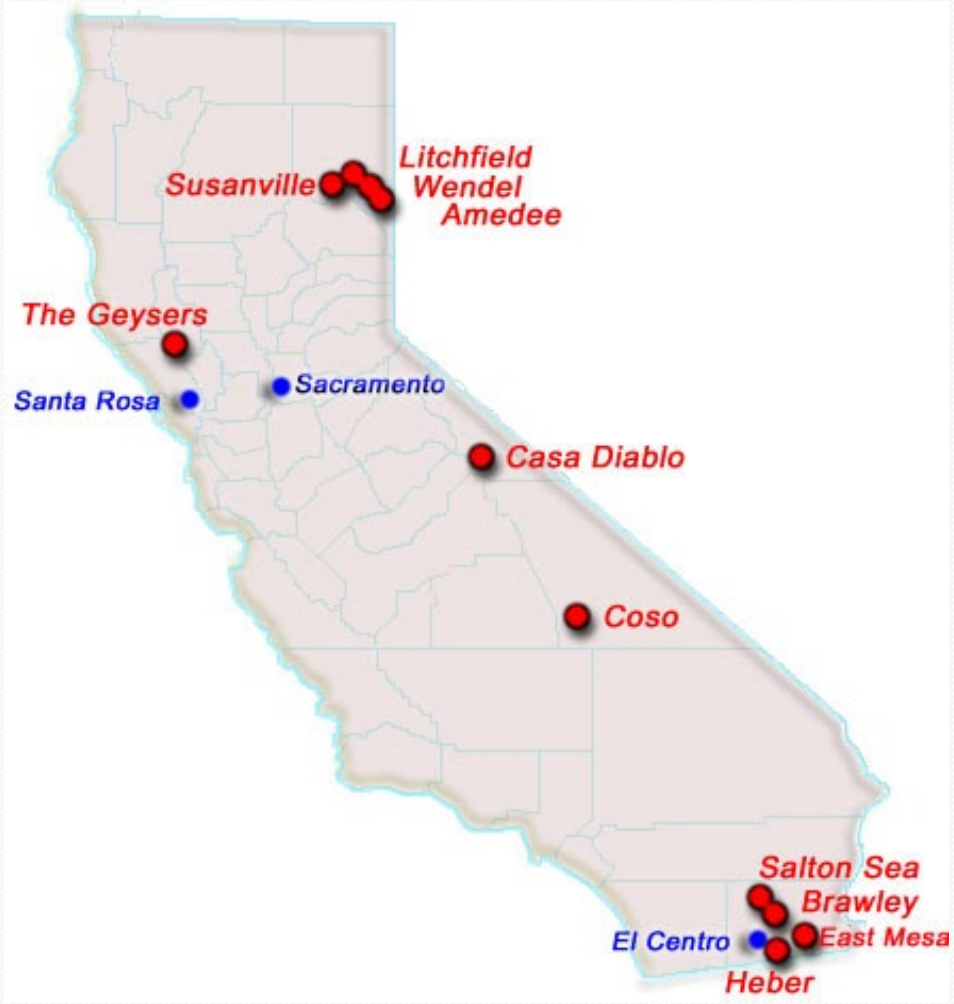
- Geothermal Energy can contribute to low carbon emission power generation, heating and cooling and other direct uses of heat
- Geothermal transforms the natural heat in the ground to energy either as power measured as MegaWatts-electric (MWe) or heat as MegaWatts-thermal (MWth)
- The use of a geothermal resource depends on its nature, size, temperature, transport to the surface and access
- Potential for Geothermal Energy >>>>> Geothermal Power as MWe or MWth
- The current geothermal installed capacity in the USA is 3800 MWe, of which 71% (2800 MWe) is operating in California.

DOE GeoVision Study of the US geothermal industry (2019) indicated that with existing technology, geothermal power could increase 26x to 60 GigaWatts (GWe) and direct use of heat though heat pumps or district heating similarly

By 2023, an update indicates that with technological advances, the potential is closer to 90 GWe

California has >25% of the world's geothermal capacity

- California hosts 11 operating geothermal fields ranging from <1 MW (Wendel/Amedee) to 820 MW (The Geysers).
- Largest known steam-dominated (The Geysers) and liquid-dominated (Salton Sea) resources in the world.
- High level of geothermal expertise and experience in exploration, field development, and operations in a variety of geothermal systems.
- Extensive R&D at US government facilities (national laboratories) and universities with close ties to the industry



What are the barriers?

- Site Specific: **Geothermal resources must be used at the site where they are located-electricity can be transported on the electrical grid, but the resource must be converted to electricity and heat must be used at the site.**
- Technology: **While power plant technology has expanded use of a wider range of temperatures, and drilling and well completion technology have greatly advanced, but exploration remains high risk and enhanced geothermal systems (EGS) power conversion technologies remains unproven.**
- Capital Cost: **Initial costs are high mostly due to drilling, but satisfactory long term returns and sLCOE can be achieved with carefully planned exploration, short permitting, and risk-adjusted planning and applied experience**
- Permitting: **Local and state regulations vary (CEQA, NEPA, etc.), timelines are unpredictable and delays costly**

Solutions: Invest in Barriers-DOE's Roadmap

Action Area 1:	**Research Related to Resource Assessments, Improved Site Characterization, and Key Technology Advancements**
Key Action 1.1 – Conduct national- and local-scale resolution resource assessments across the geothermal resource spectrum	
Key Action 1.2 – Improve detection of subsurface signals	
Key Action 1.3 – Improve geothermal drilling and wellbore integrity	
Key Action 1.4 – Improve geothermal energy resource recovery	
Key Action 1.5 – Improve geothermal resource and asset monitoring, modeling, and management	
Action Area 2:	**Regulatory Process Optimization**
Key Action 2.1 – Improve land access	
Key Action 2.2 – Improve the ability to develop geothermal energy in accessible lands	
Key Action 2.3 – Evaluate geothermal heat-pump regulatory processes	
Action Area 3:	**Maximizing the Full Value of Geothermal Energy**
Key Action 3.1 – Improve valuation of and compensation for geothermal energy	
Key Action 3.2 – Investigate geothermal hybrid opportunities	
Key Action 3.3 – Quantify additional geothermal value streams	
Key Action 3.4 – Assess the economic barriers and solutions pertaining to direct-use applications and geothermal heat pumps	
Key Action 3.5 – Identify opportunities to improve standards, business models, and economics for direct-use applications and geothermal heat pumps	
Action Area 4:	**Improved Stakeholder Collaboration**
Key Action 4.1 – Maintain the Roadmap as a vibrant, active process	
Key Action 4.2 – Improve public education and outreach about geothermal energy	
Key Action 4.3 – Increase awareness of employment and training opportunities across all geothermal energy technologies	

1. Technical: Increase the number of known geothermal resources across regions (geographic and geologic) and improve the technology to explore, assess, produce and manage geothermal resources.

2. Address permitting and regulatory barriers and timeline for power and heat projects. In California, where NEPA and CEQA local permits can be required taking several years if full EIR/EIS are needed and no significant complications occur.

3. Improve collaboration, maximize value both in economic models, PPAs and multiple uses of a single resource stream, e.g., thermal desalination, mineral recovery, food processing, district heating, "Blue Lagoons" (cascading uses)

4. Update the roadmap, increase public awareness

Apply to California

- California has an installed capacity of ~2800 MWe, 6% of state power comes from geothermal more MW than any country in the world.
- California geothermal potential is greater. State's Geothermal resources reviewed and documented in California in the early 2000s--based on remote GIS analysis, Williams et al., 2008, USGS, calculated that about 40% of the geothermal resources in California have yet to be identified. Technological advances will allow a wider range of resources to be used and therefore an updated and more detailed review of California geothermal resources could increase development by reducing the cost of exploration and resource characterization.
- #1 Non-technical barrier in California: extending project timelines with permitting and regulatory delays projects and increases costs (Levine et al., NREL, 2022, Neupane et al., 2022), especially in California where the NEPA/CEQA process and local permits are unpredictable. Delays up to several years and increases costs increasing LCOE by 4-11%.
- Collaboration and public awareness could reduce permitting delays that are due to lack of understanding of geothermal.
- Higher power prices, which include payments for flexible power (not just baseload) or avoided carbon emissions or other incentives could help.