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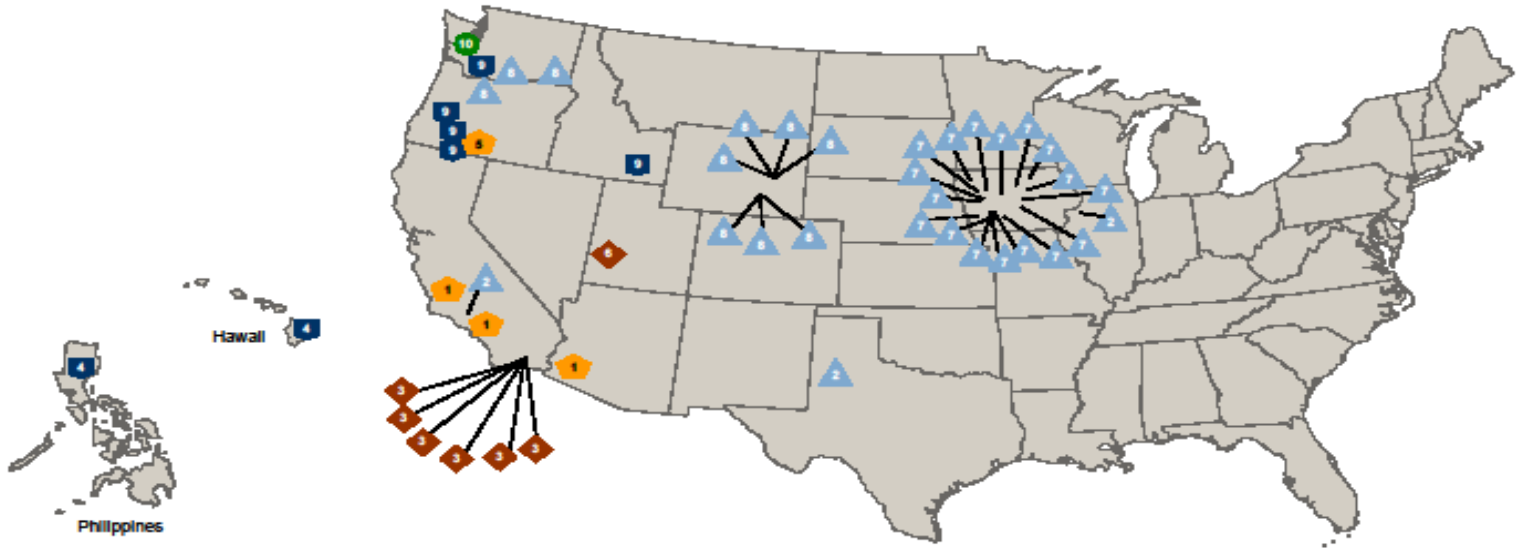
BHE RENEWABLES
A Berkshire Hathaway Energy Business

CALENERGY OPERATING CORPORATION

Berkshire Hathaway Energy's Significant Renewable Energy Experience

Berkshire Hathaway Energy owns one of the largest renewable energy portfolios in the U.S. – with more than 7,500 MW of renewable generating capacity currently in operation or under construction



BHE Renewables	
Solar	1,271 MW
Wind	681 MW
Geothermal	327 MW
Hydro	138 MW

PacifiCorp Solar	2 MW
PacifiCorp Geothermal	34 MW
MidAmerican Energy Wind	3,335 MW
PacifiCorp Wind	1,031 MW
PacifiCorp Hydro	1,013 MW
PacifiCorp Biomass	14 MW

CalEnergy Existing Geothermal Operations Salton Sea, California

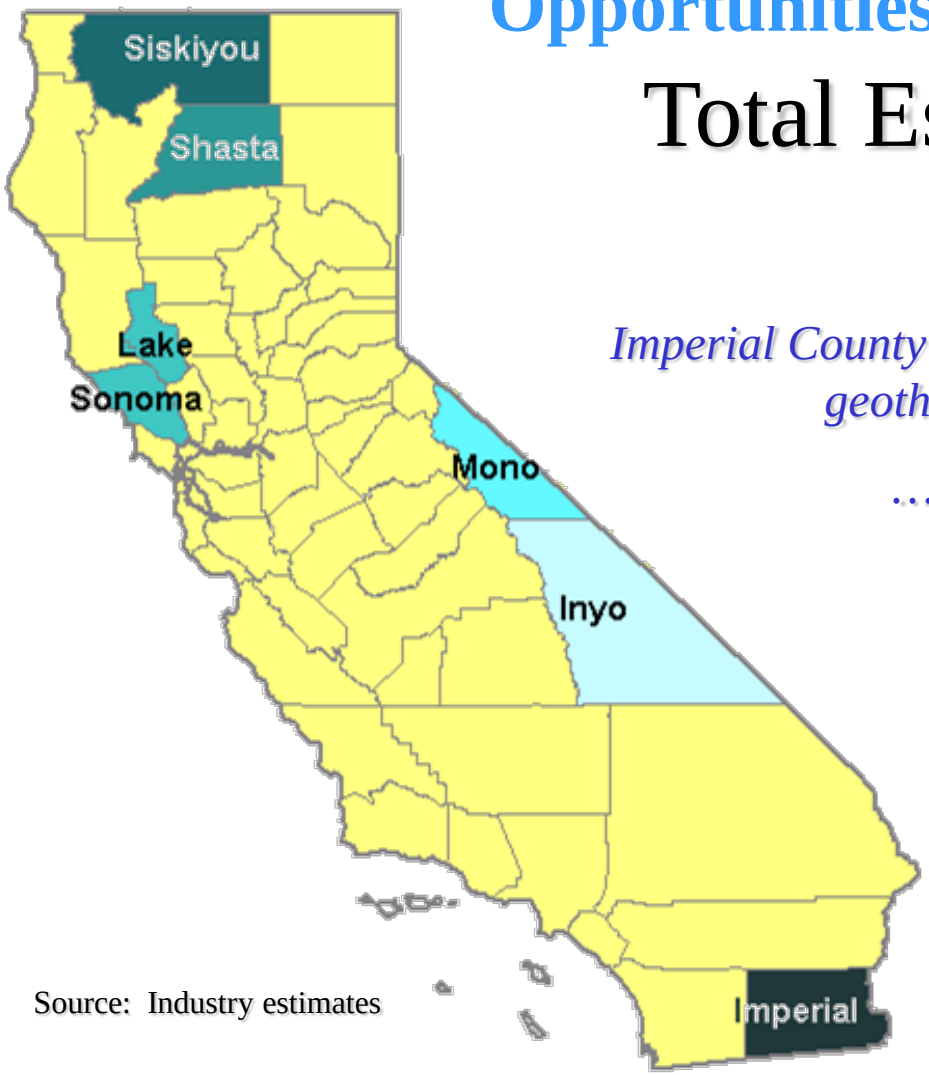
Plant	(MW)	In Service	Available
Vulcan	38	1986	Feb 2016
Unit 1	10	1982	Jul 2017
	48		
Del Ranch	42	1989	Jan 2019
Elmore	42	1989	Jan 2019
Unit 3	50	1989	Mar 2019
	134		
Leathers	42	1990	Jan 2020
Unit 2	17	1990	May 2020
Unit 5	46	2000	Jun 2020
	105		
Unit 4	42	1996	Jun 2026
CE Turbo	11	2000	Jan 2030
	53		

- CalEnergy currently operates 10 of the 11 geothermal facilities at the Salton Sea Resource in Imperial Valley with a combined installed capacity of 342 MW of the total 392 MW
- Fleet capacity factor > 90%
- Existing facilities have all been recontracted except for 46 MW and much later expiring contracts

Southern end of Salton Sea

…and Salton Sea Geothermal Field – one of the world's largest fields.

New Geothermal Development Opportunities in California



Total Est. Future Potential: 3,465 MW

Imperial County contains the largest known undeveloped geothermal resource in California,

……and possibly the world.

- 60 MW
- 185 MW
- 200 MW
- 220 MW
- 500 MW
- 2300 MW

Source: Industry estimates

Salton Sea Known Geothermal Resource Area (SSKGRA)

- Everything we do is with precipitating brines as our primary focus
  - *Or cause to happen suddenly or unexpectedly a change from a liquid to a solid*

– *And a picture is worth …….*

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Flexibility or Load Following Geothermal Generation

- Operational Challenges at the SSKGRA
  - Each time you change the temperature or flow of the brine you create scale or something falls out of solution
    - To combat, we use alloy piping in all conduit that has any possibility of contacting the brine. Approx. 35 miles at CalEnergy
    - 10 times the cost of traditional carbon steel
  - Each production well has the life expectancy of 25 thermal cycling events, whether one week or 20 years
    - Cost of new production well, approx. $12 to $16m

Flexibility or Load Following Geothermal Generation (cont.)

- Even a partial thermal cycle or restricting the flow of brine from a “steady state” will stress the entire well integrity
  - The reservoir is under-pressured and the wells are not flowing artisan. The wells have to be induced to flow but once flowing, the production wells are free flowing. If the wells are shut in for a significant period of time, they lose the ability to flow. Starting a well to flow again requires days to reach temperatures.
  - Not keeping stable flow in injection and production pipelines casing static brine to sit in place. This leads to precipitation of scale in the pipelines

Flexibility or Load Following Geothermal Generation (cont.)

- Operational Challenges at the SSKGRA (cont.)
  - Uninterrupted brine flow and temperature incorporating a "by passing" approach would create a negative environmental impact
    - To circumvent the production process and vent to atmosphere or "flow thru" in lieu of abatement of H2S, CO2,benzene, and noise, would significantly violate permits.
  - Geothermal brines contain significant concentrations of non-condensable gases, such as hydrogen sulfide, carbon dioxide, and the like. Such gases, particularly hydrogen sulfide must be abated to comply with environmental restrictions. Abatement methods are very expensive.
    - *Of course if an environmental "hall pass" could be obtained….*

Cost Drivers for SSKGRA

- Substantial reduction in market pricing for critical alloys would greatly reduce production well costs
- Cheaper and more effective chemicals for geothermal scaling control that targets lower O&M costs.

Research & Development needed to address Limiting operational issues

- It may be possible for new development of load following plants in the SSKGRA, only after significant research and development are preformed in brines like the SSKGRA
- When speaking of flexibility or load following the next word should be economic
  - To develop a load following geothermal product, cost drivers and adders, absent baseload efficiencies will greatly effect the ability to remain economic in a Renewable Portfolio Standard

Main barriers preventing more geothermal generation

- Material Integration with other renewable technologies that recognize
  - Property tax exemption status
  - Federal incentives or subsidizes
  - Time of use pricing
  - Appropriate adder valuation of non renewable backstopping of intermittent resources
    - Including an adder caused by an increase of carbon

Main barriers preventing more geothermal generation (cont.)

- Ancillary Values Integration Recognition
  - Geothermal plants provide the counties that they are sited in, generally with the highest revenue streams in the county
  - Geothermal plants require between 5 and 19 time as many employees to operate compared to other intermittent resources
  - Importing out-of-state generation provides zero benefit to the schools and communities of Californians

Main barriers preventing more geothermal generation (cont.)

- SB350 - 50% Renewable Portfolio Standard
  - Main barrier is the culture at the state agencies that believe that a reliable grid without a balanced portfolio can be achieved, i.e. “least cost – least cost”
  - In a 50% RPS California, a true mix of renewable technologies is required to meet carbon reduction goals economically, as revealed in the “Low Carbon Grid Study” recently released.
  - Specifically points to the procurement of renewables from disadvantaged communities of California
    - Imperial County the most disadvantaged county in California and home to the SSKGRA is anxious to partake.

Current potential for geothermal expansion from CalEnergy

- CalEnergy's Black Rock 1-3 project is immediate or "shovel ready" for construction
  - 159 MW project currently licensed by the CEC
  - Resource and site control is achieved
  - Construction financing completely attained
  - Valid generator interconnection agreement
  - Existing transmission capacity available
  - Could be commercial in 30 to 36 months
  - Black Rock 4-6 lags 24 months from go
  - *Lacks a market to deliver geothermal power*