

Geothermal Energy for California's Future

September 27, 2016



McGinness Hills, Nevada, US



Green energy you can rely on

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Ormat: 50 Years in Geothermal

Market leader with proven track record in the geothermal sector

Our mission is to become a leading global renewable energy provider



50
Years of
experience



595
\$million Revenue
in 2015

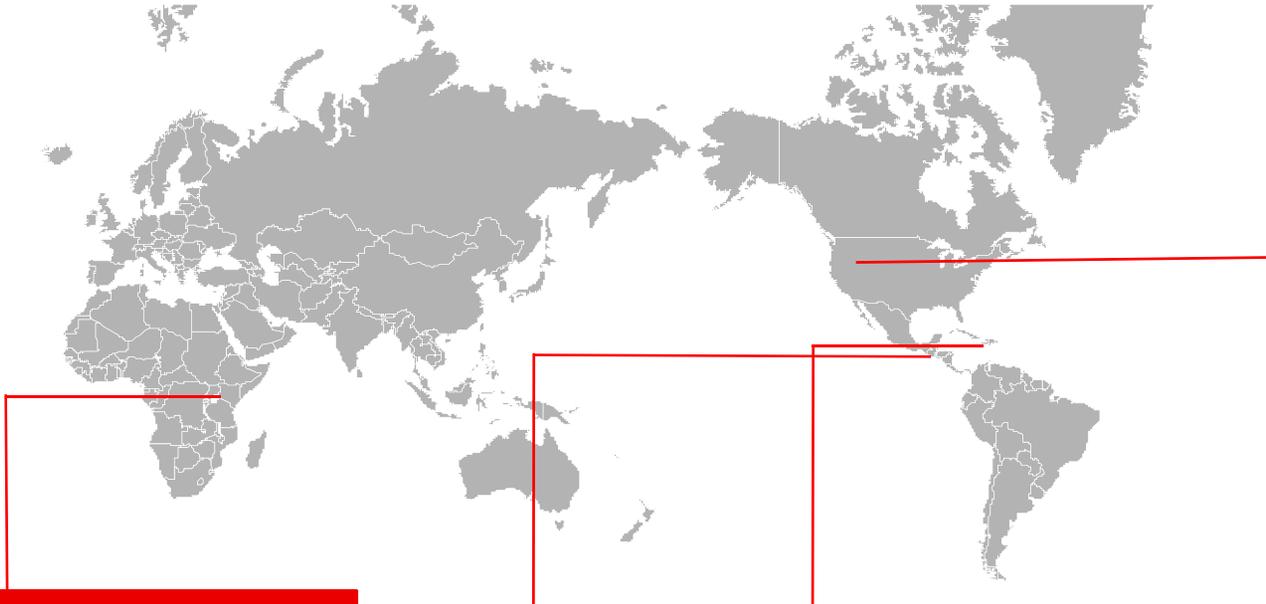
Own &
Operate
707 MW



1,060
Employees



Own and Operate 707 MW in 19 Sites Worldwide



Kenya		139 MW
Olkaria III Plants 1-4	139	

Guadeloupe		10 MW
Bouillante	10	

Guatemala		43 MW
Amatitlan	20	
Zunil	23	

United States		515 MW
Nevada (6 sites)	243	
California (4 sites)	181	
Hawaii	38	
North & South Dakota, Minnesota, Colorado Montana & Colorado (REG) (10 power plants)	53	

Business Segment Overview

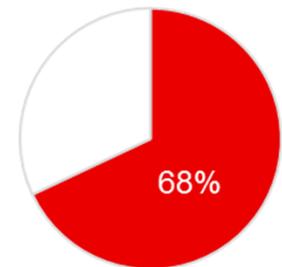
The only vertically integrated player with a balanced business model

Electricity



- Owns & operates 707 MW
- Sells firm & flexible electricity
- Fully contracted

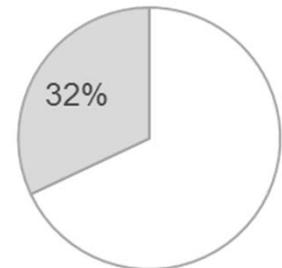
Revenue¹



Products



- Technology leadership
- Supplies power plants of geothermal, REG² and other units to 3rd parties
- Provides EPC services



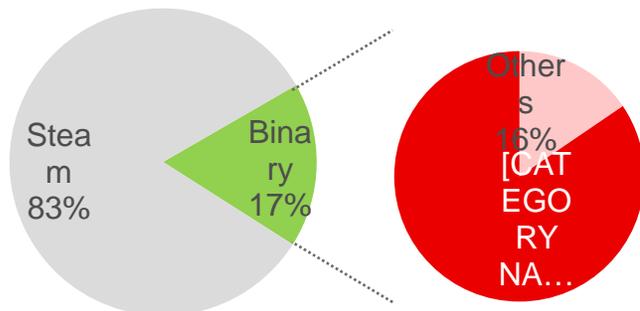
¹ Five years average (2010-2014)

² REG - recovered energy generation

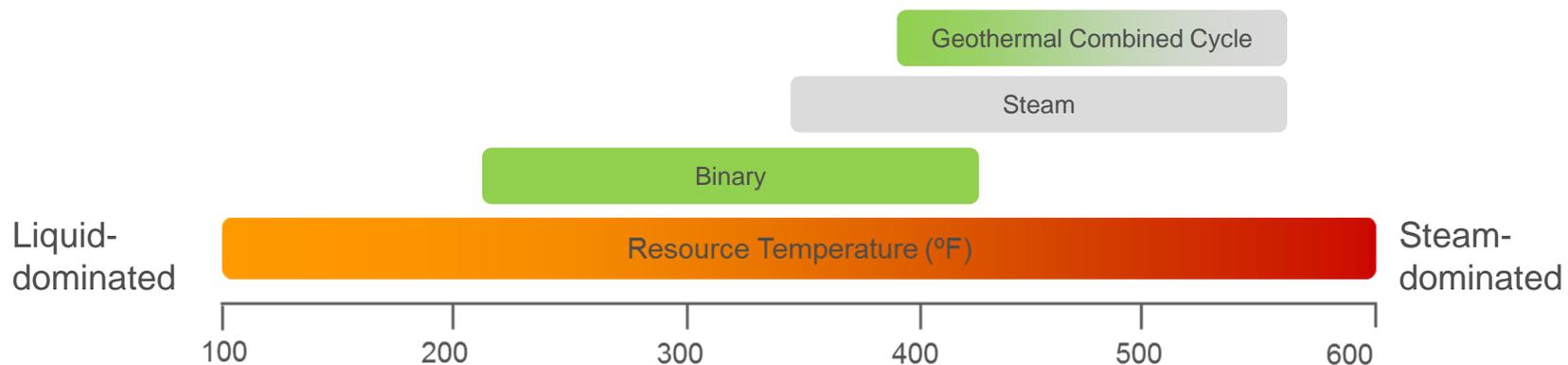
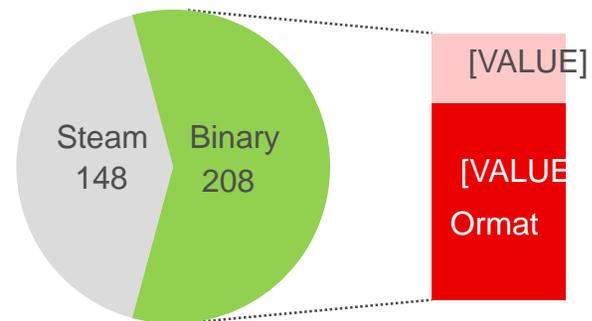
Global Technology Leader

Low-mid temperature geothermal binary market is led by Ormat

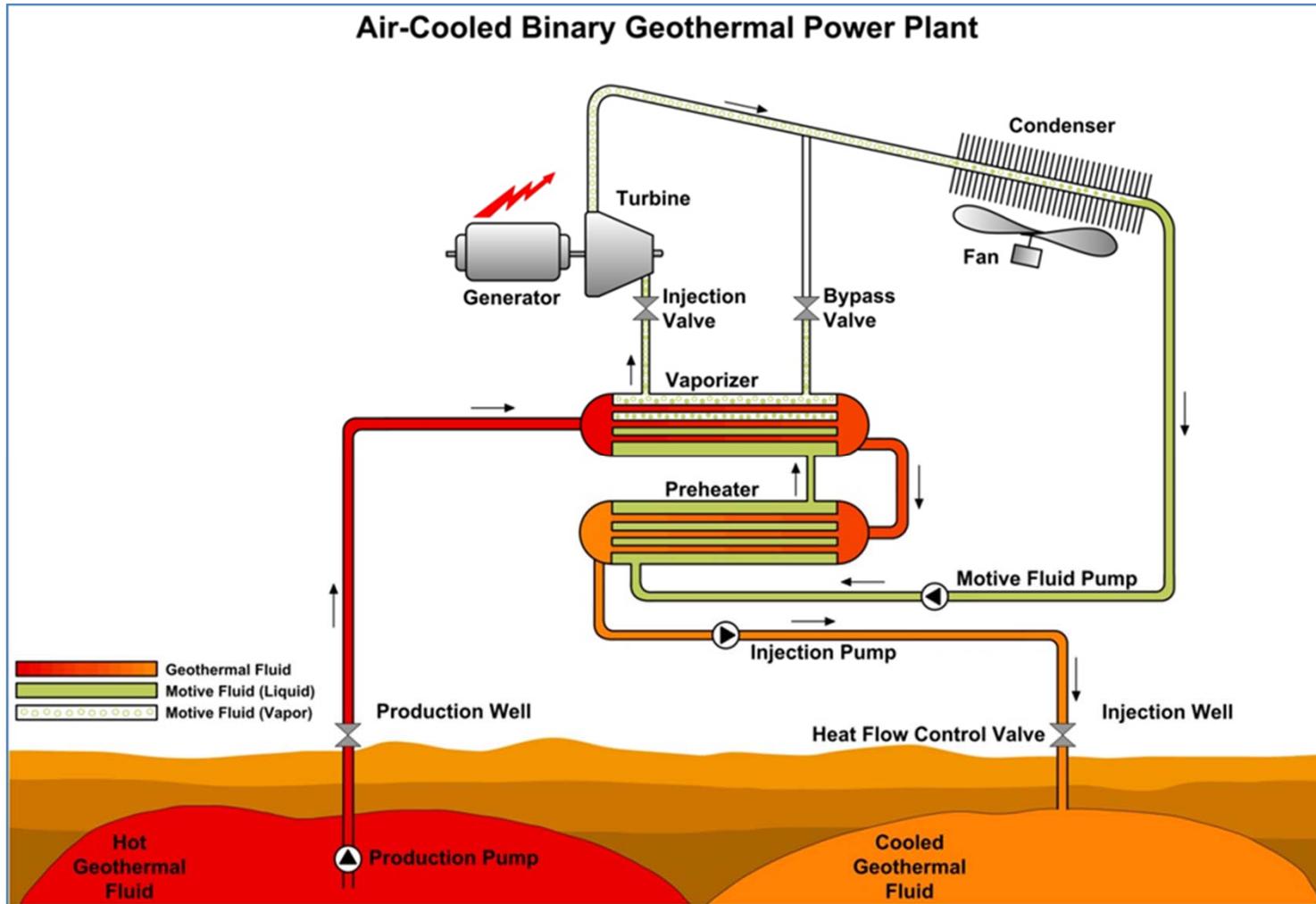
Global Installed Capacity by Technology Type (%)



2015 Actual Installed Capacity by Technology Type (MW)



Geothermal: How it Works



Cost of Geothermal is Going Down

- Cost of new Ormat geothermal projects is \$4,000-\$4,500/kW
- Levelized PPA prices dropped from >\$100/MWh to ~\$80/MWh
- Trend is continuing
 - Cost reduction: exploration, development, power plant CAPEX, O&M
- Provides a range of operational benefits which will be needed in high renewable penetration scenarios

Value of Geothermal Technology is Going Up

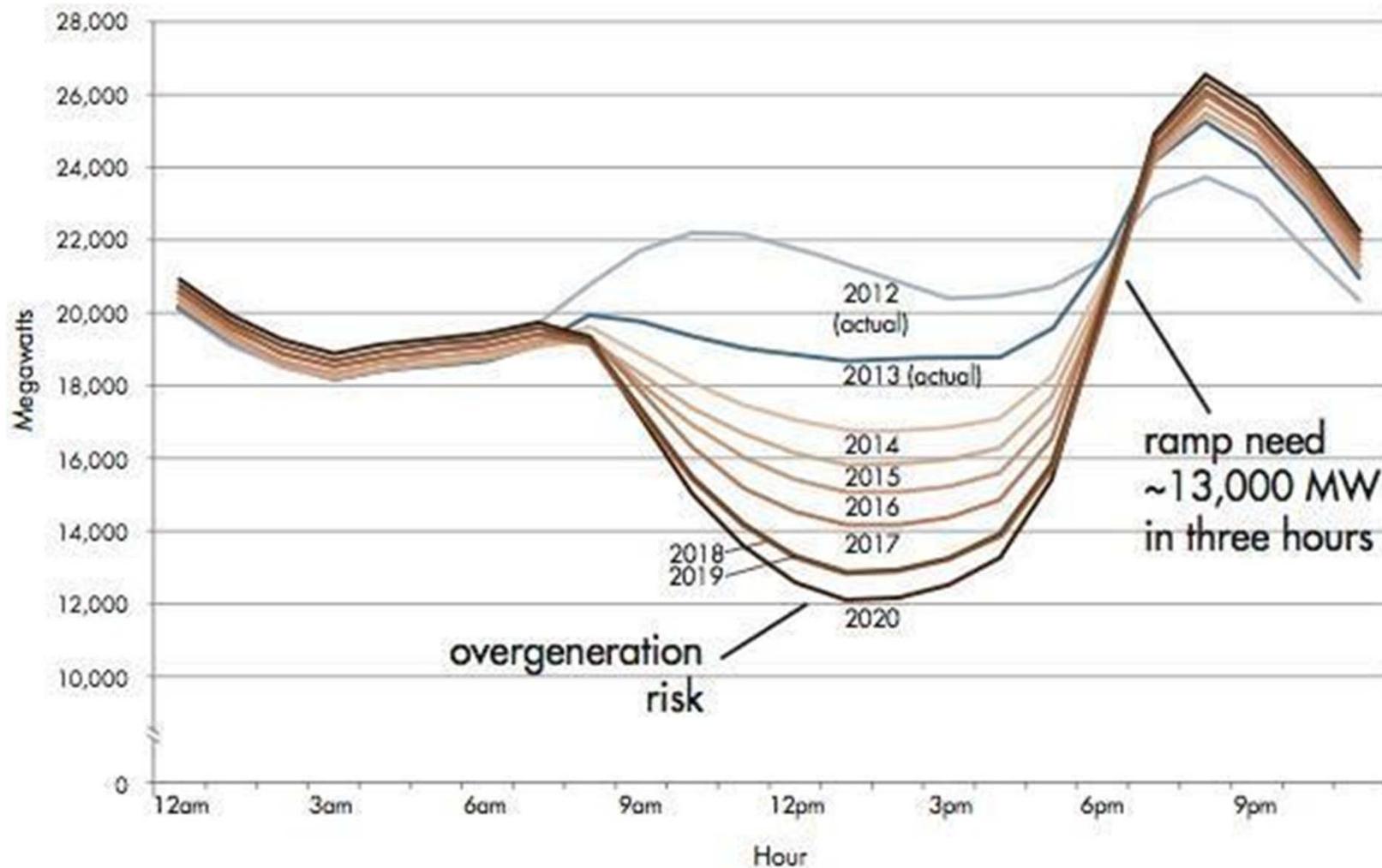
- Provides resource diversity
- Ancillary benefits:
 - Real-time economic dispatch and flexible ramping reserves
 - Regulation up and down within a wide range
 - Spinning reserve and frequency response reserve
 - Voltage regulation
- Highest economic benefits
 - Typical 30 MW geothermal project:
 - 29 full time O&M jobs
 - \$5 million / year to local economy



How Geothermal Energy Can Help California

- Geothermal provides firm, reliable energy around the clock
 - Availability is 95% or higher
- Geothermal plants are flexible
 - Can be dispatched based on a customer's needs
 - Provides energy when it's needed the most
- Contributes to lower emissions
 - Geothermal is emissions free
 - Retire older baseload plants that burn fossil fuels
- Geothermal is cost effective
 - Less curtailment costs
 - Less integration costs
 - Less transmission costs

Geothermal Provides Energy When its Needed the Most

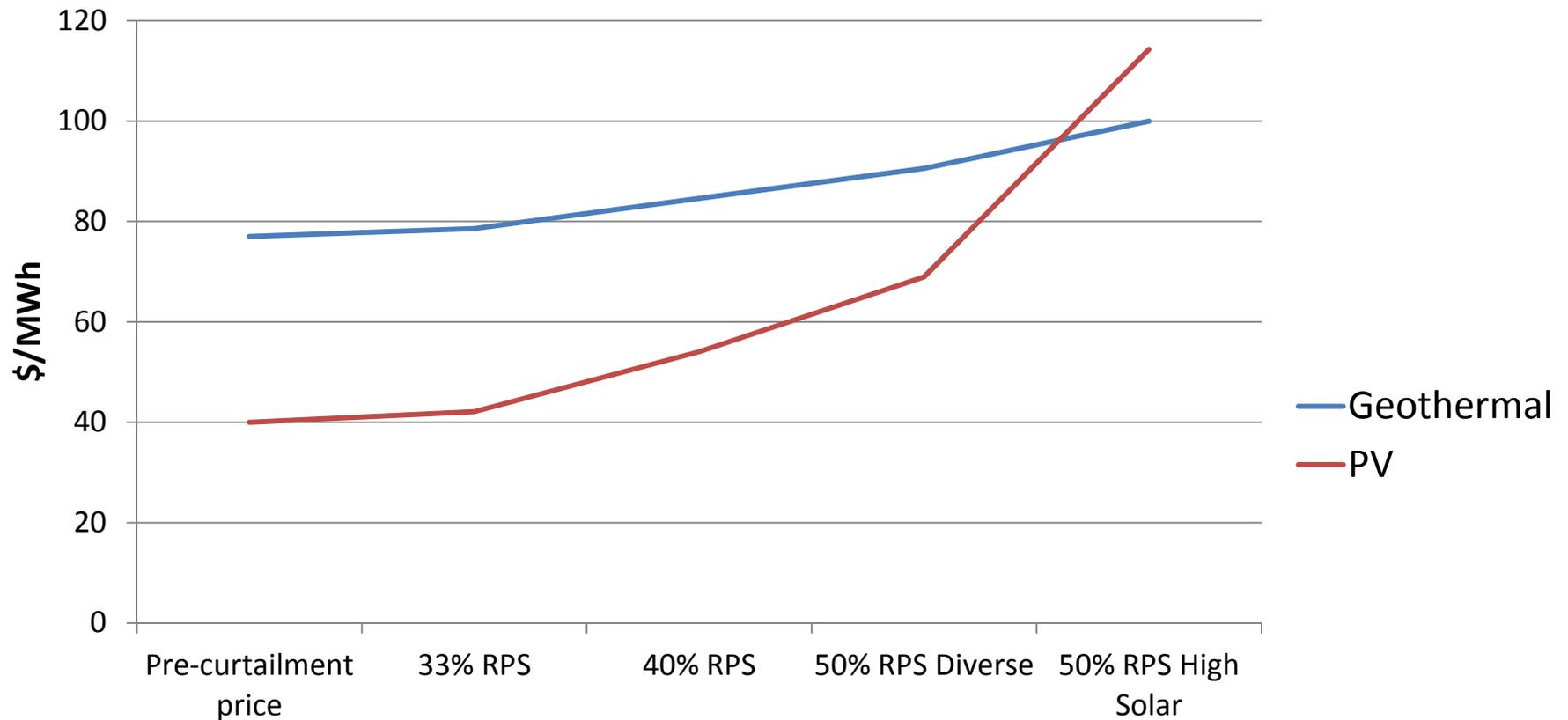


Source: CAISO

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Curtailment Costs Current PPA Prices Adjusted by E3 Utility Study Curtailment Rates

- Cost of a \$77/MWh geothermal PPA is actually lower than a \$40/MWh solar PPA, when adjusted for curtailment

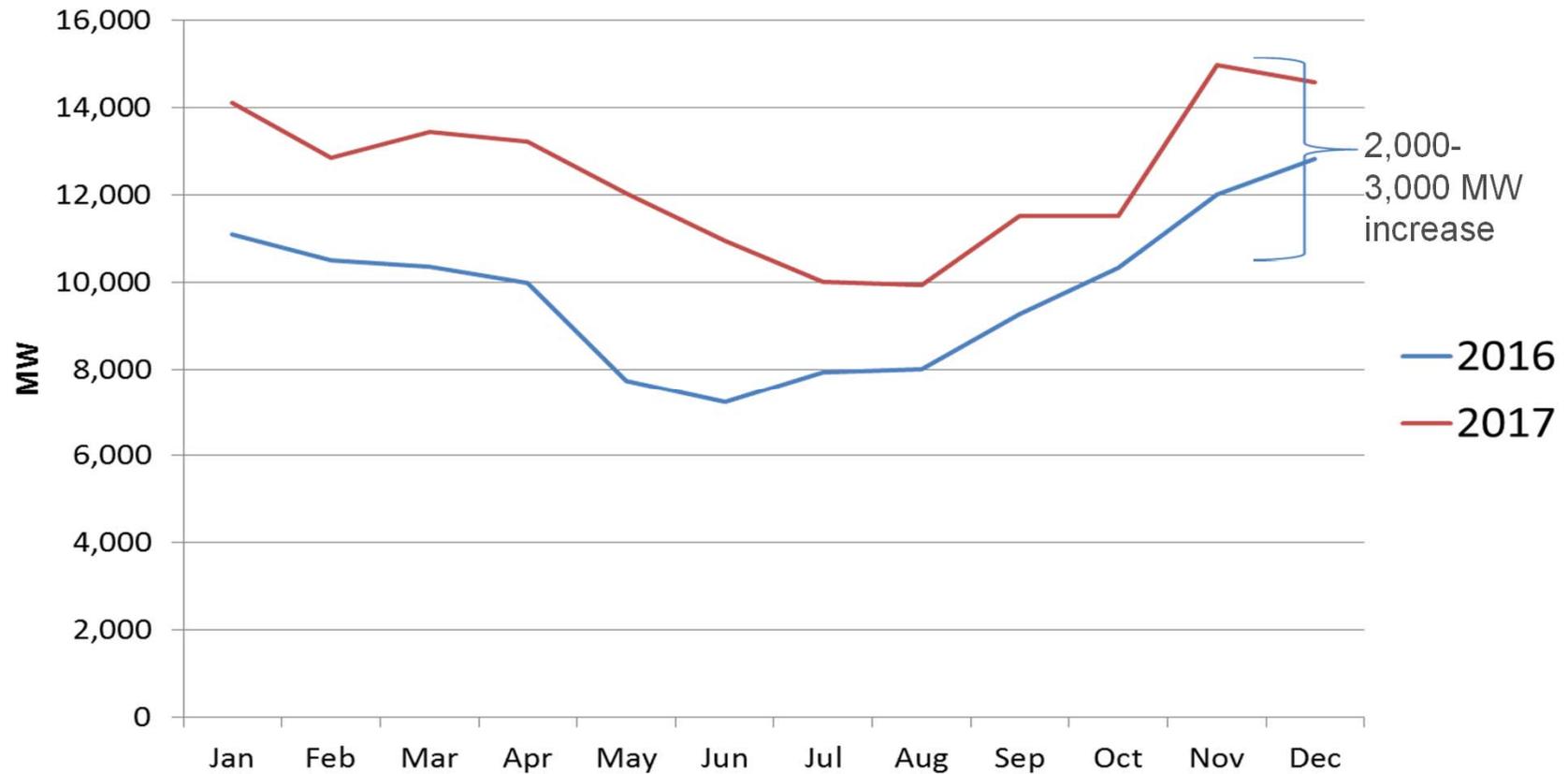


Source: E3, Utility Study Curtailment Rates

Binary Geothermal Technology is Flexible

- Dispatchable resource provides a range of operational benefits:
 - Fast ramping for a range of services:
 - Multiple cycles / day
 - 30% of nameplate / minute
- Most current and future operational services could be supplied with precise operational control:
 - Real-time economic dispatch and flexible ramping reserves
 - Regulation up and down within a wide range
 - Spinning reserve and frequency response reserve
 - Voltage regulation
 - Qualifies as flexible capacity under current CPUC rules

CAISO flexible capacity requirements for IOU RA procurement, 2016-2017



Sources: CAISO flexible resource adequacy assessments, 2016 and 2017; www.caiso.com

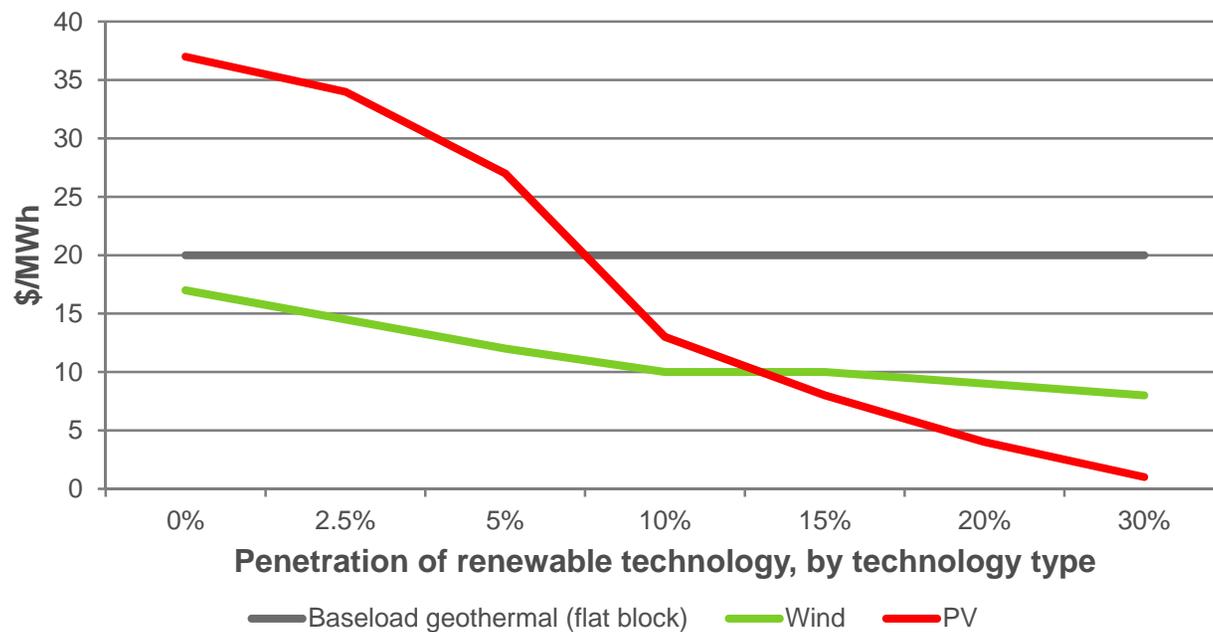
Dispatchable Geothermal Case Study: 38 MW Puna Geothermal Venture

- Big Island, Hawaii
- 6 energy converters
- Automatic Generator Control (AGC) remotely and automatically controlled by HELCO System Operator
- Dispatch: 22 MW ~ 38 MW
- Ramp rate up or down: 2 MW/min.
- Spinning reserve at all times: 3 MW



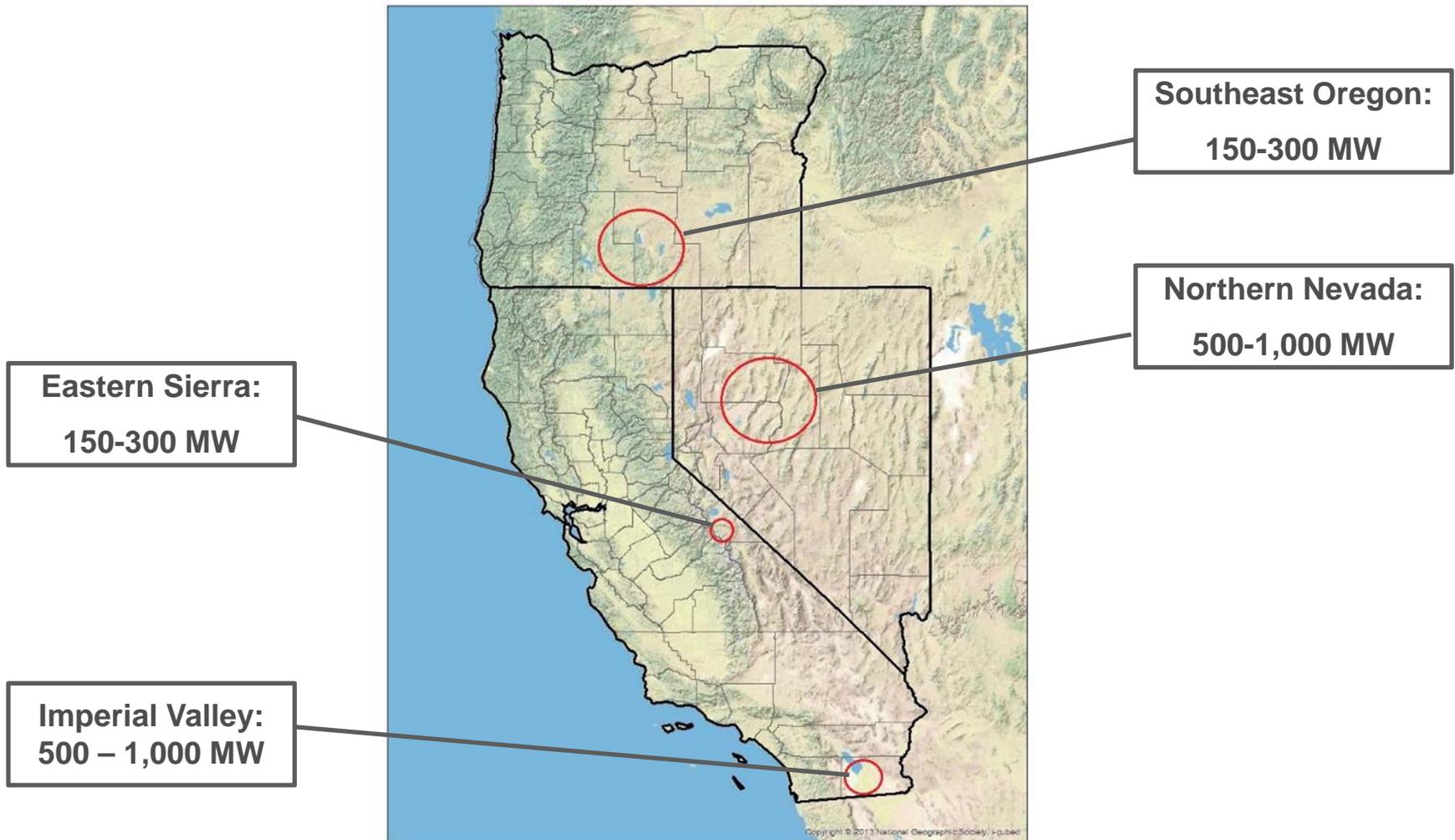
Baseload Geothermal Provides Sustained Capacity Value

- As solar PV penetration increases, incremental solar capacity ratings and value decline (in the absence of mitigating measures); geothermal ratings remain stable



Source: illustration based on results in Mills and Wisser, *Changes in the Economic Value of Variable Generation at High Penetration Levels*, LBNL, 2012; value shown is based on avoided CT in long-term supply equilibrium

Where are Geothermal Resources Located?



Source: GeothermEx – *Geothermal Inventory* 2004; GEA – 2014 Annual US & Global Geothermal Power Production Report, Ormat estimates

Importing Geothermal to California



Don A. Campbell, Mineral County, NV

- 20.5 MW since Dec 2013
- Serves Los Angeles (12 MW) and Burbank (4 MW)
- First IPP to use NV Energy's new One Nevada Transmission Line



Don A. Campbell 2, Mineral County, NV

- 20.5 MW since October 2015
- 100% LADWP

Resource Diversity is Key to California's Energy Future

- Multiple independent studies show the benefit of a diverse portfolio with a meaningful geothermal component, e.g.
 - E3, *Investigating a Higher Renewables Portfolio Standard in California*, 2014
 - NREL, JBS Energy, GE Energy Consulting, *Low Carbon Grid Study 2030*, 2016
- These studies have not examined additional benefits of flexible geothermal operation
- A balanced energy portfolio will contain solar, wind, and geothermal resources

Thank You



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