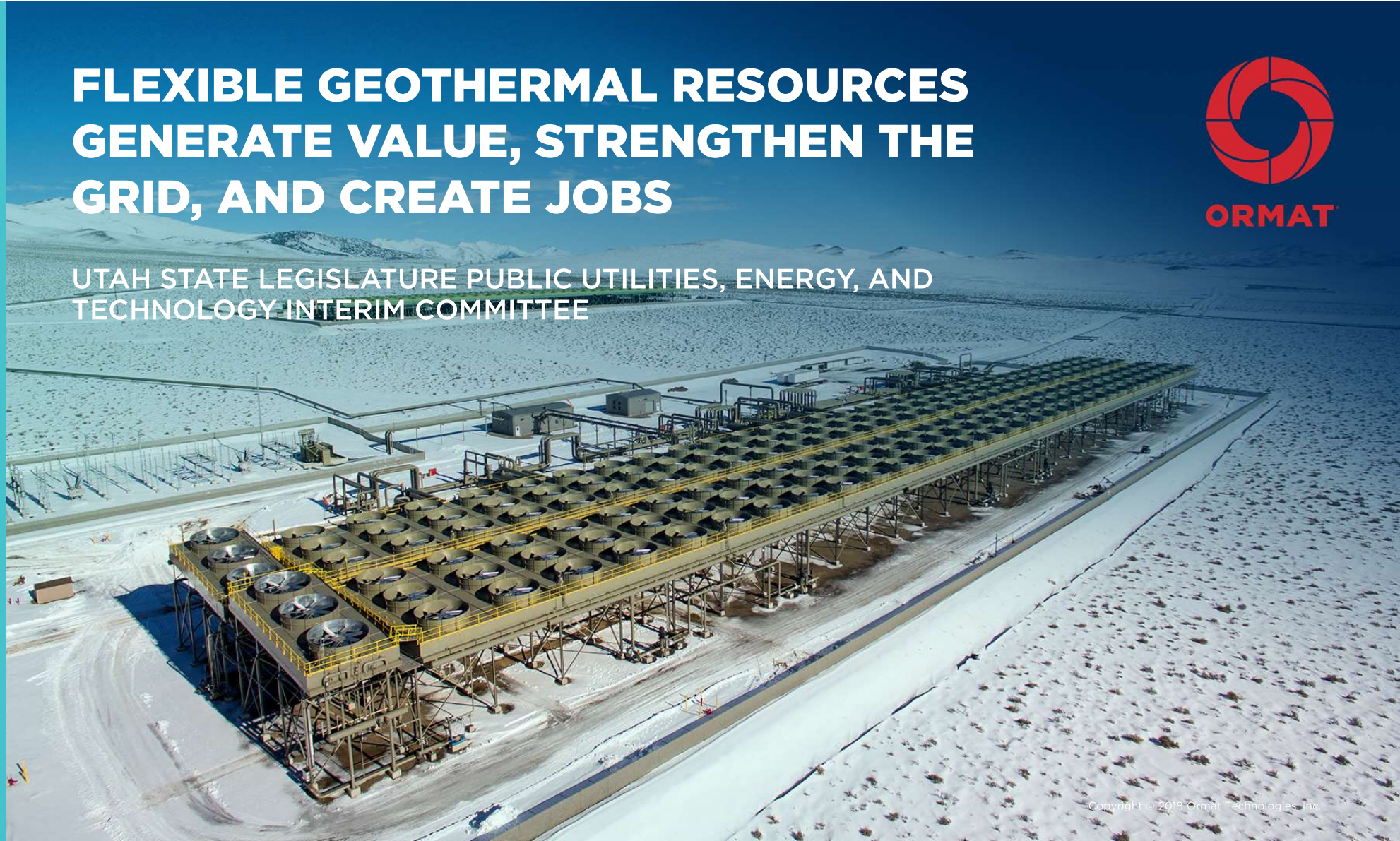


# FLEXIBLE GEOTHERMAL RESOURCES GENERATE VALUE, STRENGTHEN THE GRID, AND CREATE JOBS

UTAH STATE LEGISLATURE PUBLIC UTILITIES, ENERGY, AND  
TECHNOLOGY INTERIM COMMITTEE



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# ORMAT TECHNOLOGIES





# INTRODUCTION TO ORMAT

Market leader with proven track record in the geothermal energy sector

Our mission is to become a leading global renewable energy provider



**53** years Of experience

**4.2** Million

Metric Tons of CO2 avoided per year



**344**\$M

FY 2017 adj. EBITDA



Own & Operate

**862** MW

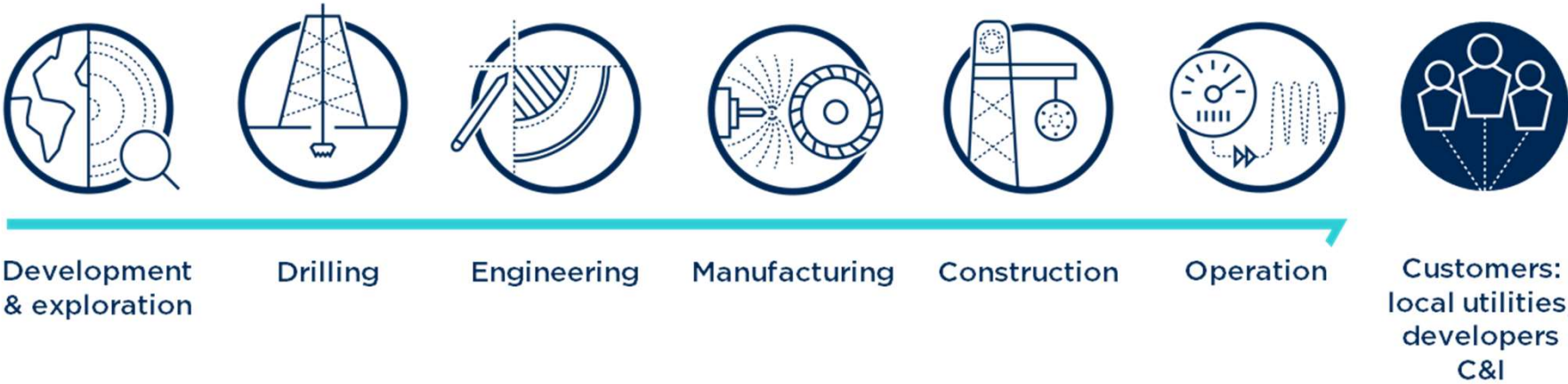


**1,300** Employees



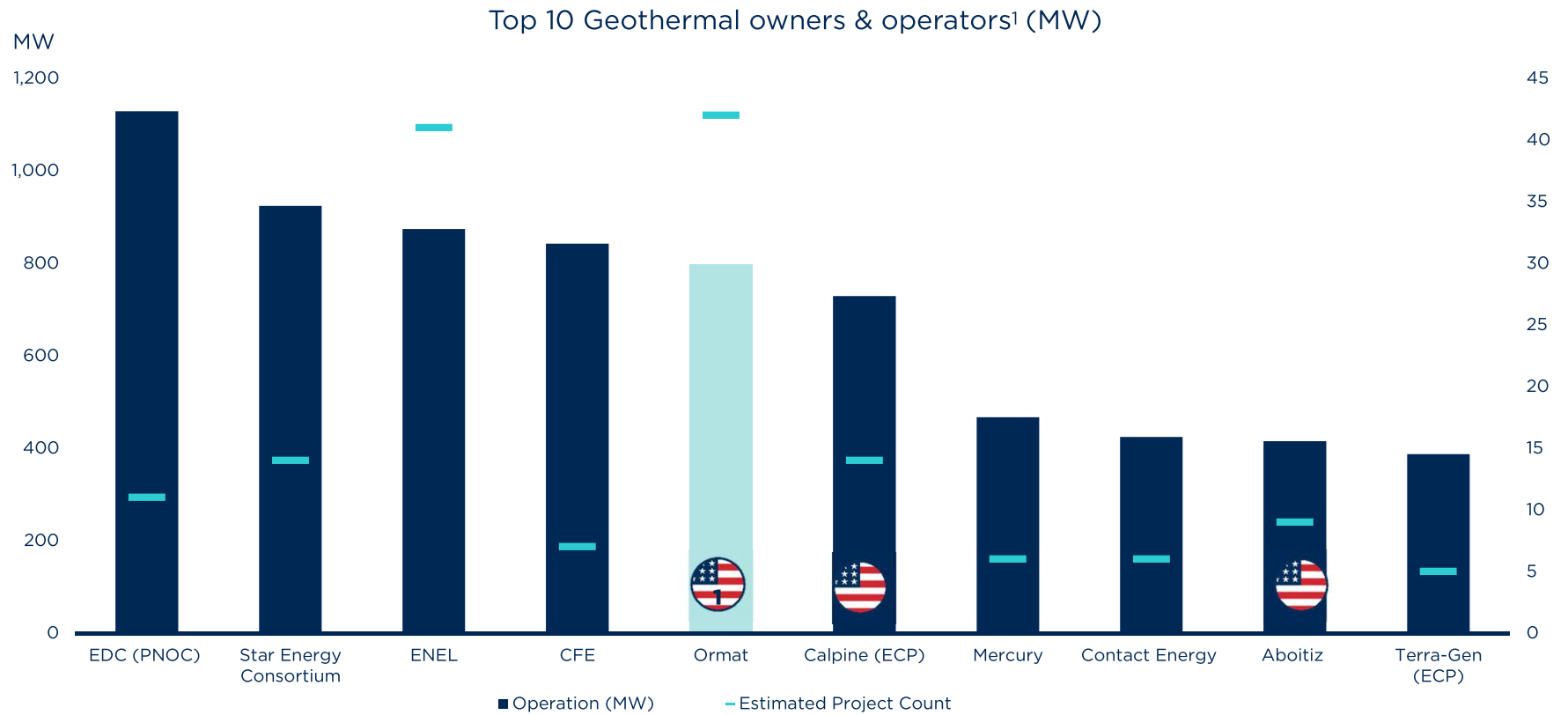
ORMAT

# THE WORLD'S ONLY VERTICALLY INTEGRATED GEOTHERMAL COMPANY



# MARKET SHARE - ELECTRICITY SEGMENT

Most active global developer - with over 450 MW developed in the last decade



(1) Ormat study based on presented public disclosure; Ormat is the largest US-based geothermal operator.



## A DECADE OF EXCELLENCE IN UTAH

- Utah is blessed with natural resources:
  - Geothermal, solar, wind, natural gas and other fossil-fuels, minerals
- Four high-performing Ormat renewable energy plants since 2007:

Power Plant	Tech.	Capacity (MW gross)	Year Commercial	Location	Owner
Blundell Unit 2	Geo.	12 MW	2007	Milford	PacifiCorp Energy
Thermo I	Geo.	10 MW	2013	Minersville	Cyrq Energy, Inc.
Cove Fort	Geo.	25 MW	2013	Cove Fort	ENEL Green Power North America
Veyo	REG	9.8 MW	2016	Veyo	UAMPS

- More to come!



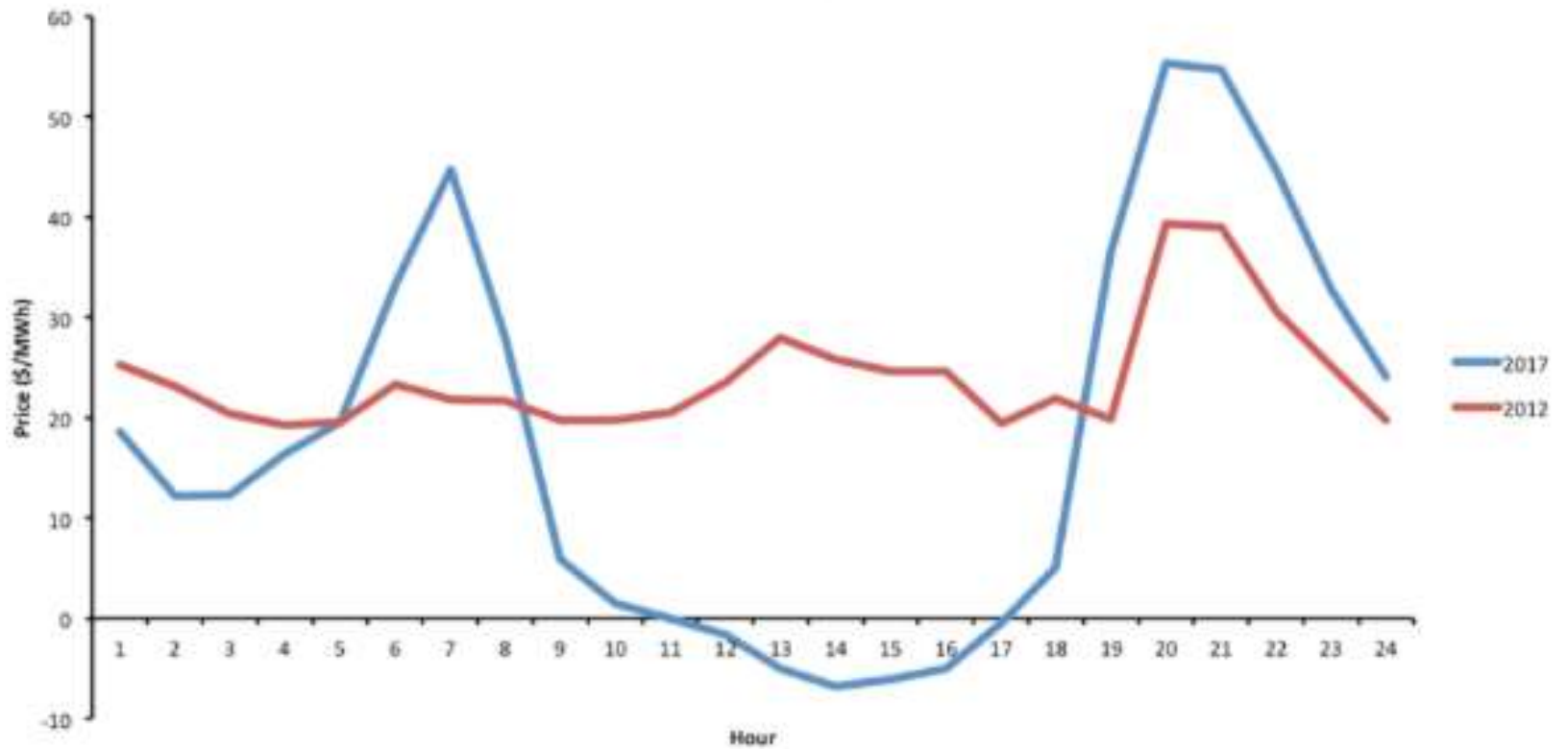
# FLEXIBLE GEOTHERMAL RESOURCES GENERATE VALUE





# MASSIVE INTERMITTENT RENEWABLE PENETRATION IMPACTS VALUES

SP15 Day-Ahead Prices  
Second Sunday in April



Source: California ISO OASIS



## **GEOTHERMAL'S INCREASING VALUE**

- Today in California geothermal is worth as much as \$32/MWh more than solar PV on a combined energy and capacity basis\*
- In the next 5-10 years geothermal will have a combined energy and capacity value as high as \$37/MWh higher than solar PV
- Add in Geothermal's ancillary services and operational flexibility and you see combined values of \$40/MWh higher than solar PV
- The time is now to procure and develop flexible renewable resources such as geothermal to mitigate impact high penetrations of variable energy resources

\*Orenstein, R., and P. Thomsen, The Increasing Comparative Value of Geothermal – New Market Findings and Research Needs, GRC Transactions, Vol. 41, 2017.



# **FLEXIBLE GEOTHERMAL RESOURCES STRENGTHEN THE ELECTRIC GRID**



**ORMAT**

# GEOHERMAL 2.0 FLEXIBILITY SOLVES HIGH RENEWABLE PENETRATION PROBLEMS

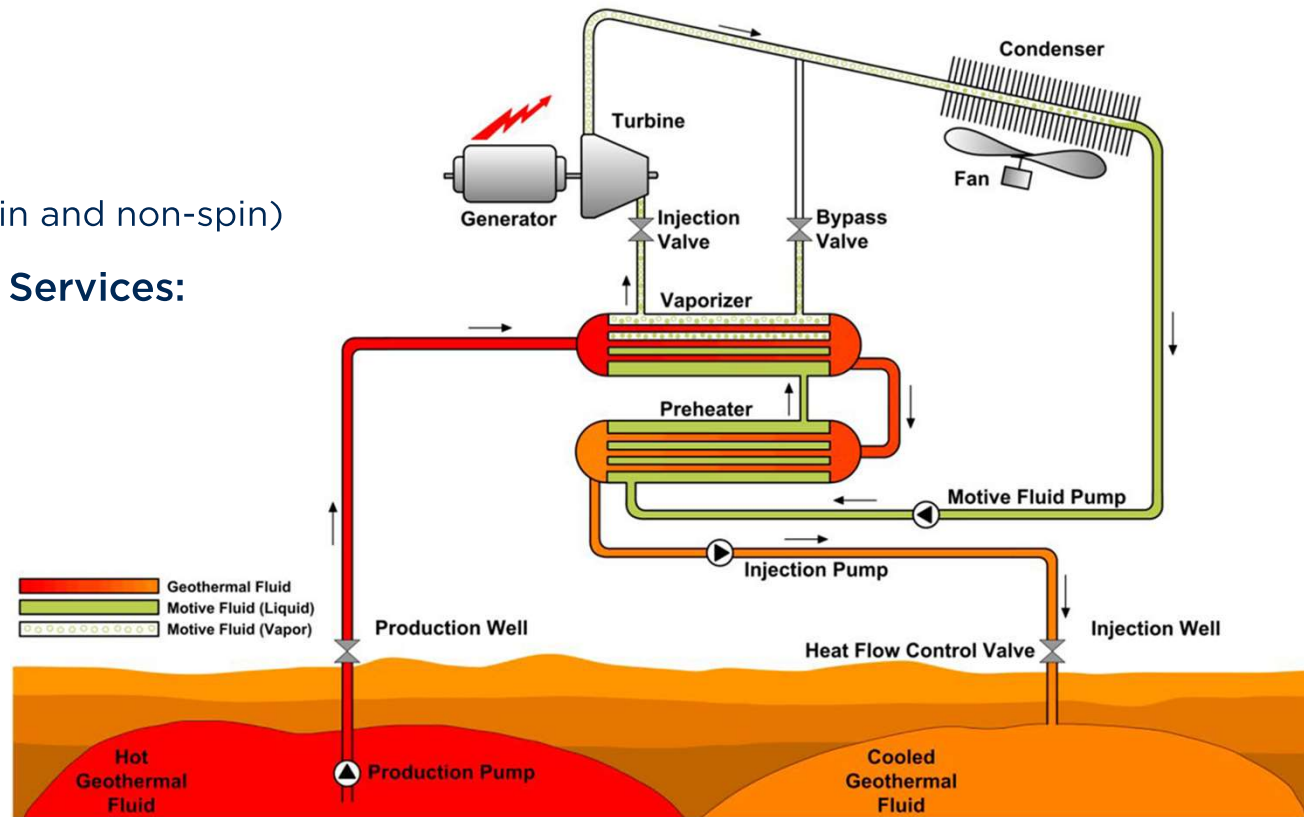
- **Traditional Services:**

- Flexible Capacity
- Regulation
- Frequency Response
- Contingency Reserves (spin and non-spin)

- **Non-Traditional Ancillary Services:**

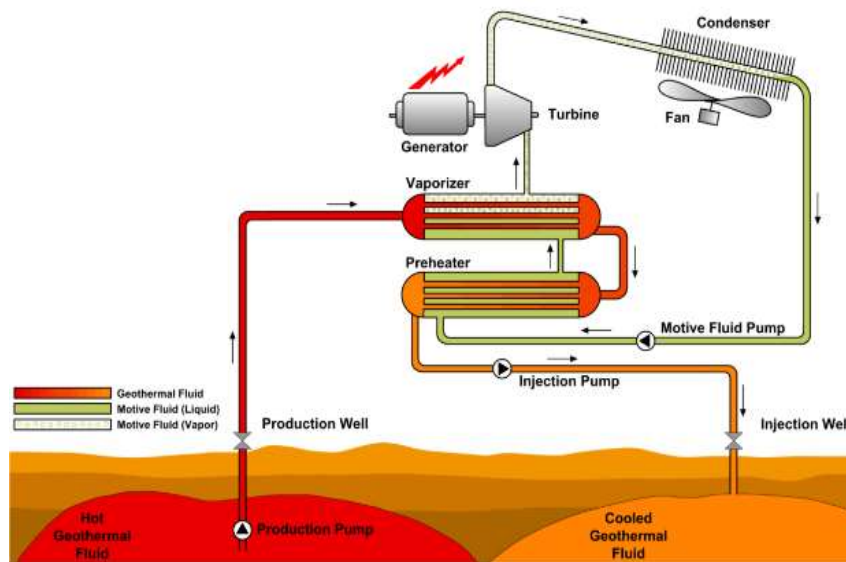
- Voltage control
- Inertia

Air-Cooled Binary Geothermal Power Plant

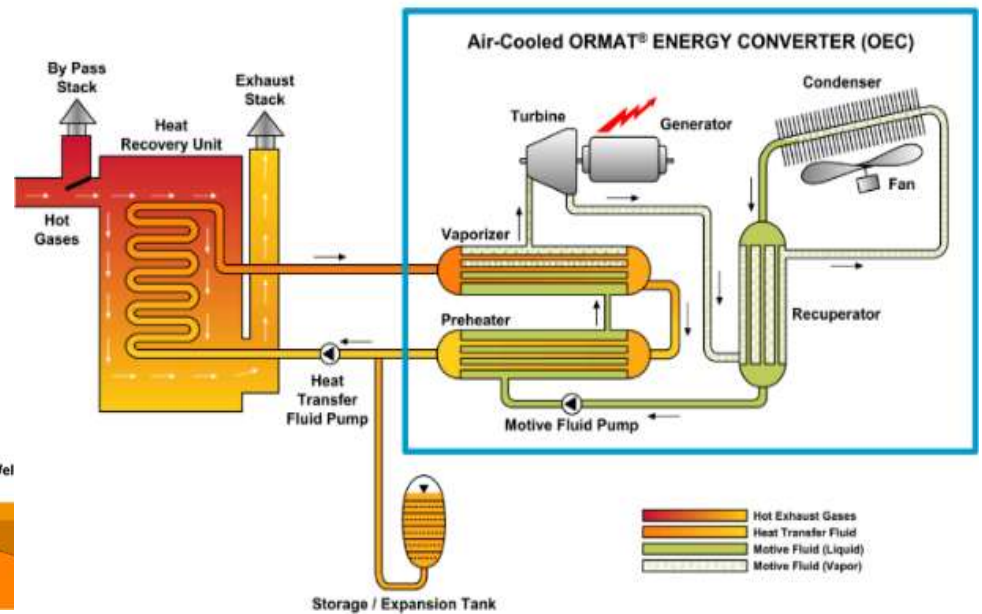


# GEOHERMAL & REG: SAME PROVEN TECHNOLOGY, DIFFERENT APPLICATIONS

## Air-Cooled Binary Geothermal Power Plant



## Air-Cooled Recovered Energy Generation (REG) System





## **GEOHERMAL 2.0 FLEXIBILITY RESOLVES PROBLEMS IN INTEGRATED RESOURCE PLANNING**

- The CPUC RESOLVE model with updated load forecasts now selects 1,700 MW of new geothermal in the 42 MMT scenario when costs are in the \$88.56 - \$91.63/MWh range\*
- Under recently executed geothermal PPA prices, the model yields 2.5 GW to 3 GW of new geothermal when the resource area is expanded to the western region - and not just in-state resources- very important

\*All model versions and supporting documentation can be found at <http://www.cpuc.ca.gov/General.aspx?id=6442451195>.



# FLEXIBLE GEOTHERMAL RESOURCES CREATE RURAL JOBS



## **GEOHERMAL 2.0 ECONOMIC AND SOCIAL IMPACT**

- **A 30 MW geothermal development has a economic impact to the local community\***
  - Drilling: \$21.4 Million
  - Construction: \$33.7 million
  - Operations: \$5.2 million
  - Taxes: \$500,000 annually
  - CAPEX: \$4 Million to \$4.5 Million per MW
- **A 30 MW geothermal development has direct employment impact to the local community**
  - Drilling: 100 jobs
  - Construction: 400 jobs/280 local workers\*
  - Operations: 20 jobs
- **A 30 MW geothermal development has a direct environmental impact to the local community**
  - 140,000 Metric Tons of CO<sub>2</sub> avoided annually

Wahlstrom & Associates. 2011 "Economic benefits of proposed Dixie Meadows Geothermal power plant, Churchill County, Nevada." Reno, NV: Prepared for Ormat Technologies



# ORMAT'S GEOTHERMAL FOOTPRINT



## Operation

- 1 **Ormesa Complex**  
California, 40 MW
- 2 **Heber Complex**  
California, 89 MW
- 3 **Brawley Complex**  
California, 13 MW
- 4 **Mammoth Complex**  
California, 29 MW
- 9 **Puna Complex**  
Hawaii, 38 MW
- 10 **Neal Hot Springs**  
Oregon, 21 MW
- 14 **Raft River**  
Idaho, 9 MW
- 15 **San Emidio**  
Nevada, 8 MW
- 16 **Steamboat Complex**  
Nevada, 70 MW
- 17 **Brady Complex**  
Nevada, 22 MW
- 18 **Tungsten Mountain**  
Nevada, 26 MW
- 19 **Don Campbell 1,2**  
Nevada, 41 MW
- 20 **McGinness 1,2**  
Nevada, 90 MW
- 21 **Jersey Valley**  
Nevada, 10 MW
- 22 **Tuscarora**  
Nevada, 18 MW



## Exploration/Development

- 5 **Truckhaven**  
California
- 6 **Rhyolite Plateau**  
California
- 7 **WGP Geysers**  
California
- 8 **Glamis**  
California
- 11 **Crump Geyser**  
Oregon
- 12 **Lakeview/Goose Lake**  
Oregon
- 13 **Vale**  
Oregon
- 23 **North Valley**  
Nevada
- 24 **South Brady**  
Nevada
- 25 **Horsehaven**  
Nevada
- 26 **Alum**  
Nevada
- 27 **Tungsten Mountain 2**  
Nevada
- 28 **Dixie Meadows**  
Nevada
- 29 **Dixie Comstock**  
Nevada
- 30 **New York Canyon**  
Nevada
- 31 **Ruby Valley**  
Nevada
- 32 **Baltazor**  
Nevada
- 33 **Colado**  
Nevada
- 34 **Pearl Hot Springs**  
Nevada
- 35 **Rhodes Marsh**  
Nevada
- 36 **Edwards Creek**  
Nevada
- 37 **Trinity**  
Nevada
- 38 **Twin Buttes**  
Nevada
- 39 **San Emidio II**  
Nevada
- 40 **Crescent Valley**  
Nevada
- 41 **Lee Hot Springs**  
Nevada
- 42 **Gerlach**  
Nevada
- 44 **Rincon**  
New Mexico
- 45 **Pavant**  
Utah
- 46 **Roosevelt Hot Springs**  
Utah
- 47 **Puna enhancement \*\***  
Hawaii
- 48 **Steamboat Solar**  
Nevada



## Under Construction \*

- 43 **McGinness Hills 3**  
Nevada, 48 MW
- 49 **Carson Lake**  
Nevada
- 50 **Mammoth CD4,**  
California
- 51 **Tungsten Mountain Solar**  
Nevada

\* McGinness Hills is in advanced construction while Carson Lake, Tungsten Mountain Solar and Mammoth CD4 are under initial construction

\*\* As of May 2018 the project is on hold

