

Developing Geothermal Resources in Utah and the Western Markets

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Daniel J. Fleischmann
Ormat Technologies, Inc.
www.ormat.com
dfleischmann@ormat.com
775-356-9029 ext. 2239

Ormat: Innovative Power Plant Technology

- ❑ Vertically-integrated company active in the design, engineering, supply, installation, support & operation of renewable & sustainable energy products and projects since 1965
- ❑ Four decades of experience developing modular power plants from 0.2 MW to 130 MW for geothermal, recovered energy generation (REG), biomass, solar, and re-powering/rehabilitation of existing plants
- ❑ Supplied over 950 MW of geothermal and REG power generation in 23 countries, about half of the supplied MW are currently owned by Ormat
- ❑ The only pure play geothermal and renewable energy company supplying equipment and technology to utilities and developers as well as owning and operating geothermal projects world wide

Ormat's World Wide Presence

Over 900 MW of Geothermal Power Plants



1987

57 MW Ormesa Binary Geothermal Complex, California



1992

30 MW Puna Combined Cycle Geothermal Power Plant, Hawaii



1996

125 MW Upper Mahiao Combined Geo Power Plant, Philippines



1992

40 MW Heber Geothermal No. 2 Binary Power Plant, California



2005

20 MW Burdette Binary Geothermal Power Plant, Nevada



2000, 2005, 2007

115 MW Mokai Combined Geo Complex, New Zealand

Plug and Play On Site Geothermal Power

Pre-Packaged Equipment Supply for Self Construct

Ormat supplied equipment for remote and rural applications

1984



800 kW Wabuska Geothermal Power Unit, Nevada.

First commercial geothermal application in Nevada. 800 kW OEC, with power supplied to Sierra Pacific Power Co. 24 years of operation.

1989



300 kW Egat Geothermal Power Plant, Thailand

Supplying local electrical power and energy for crop drying and cold storage since 1989. 19 years of operation.

2004



1.8 MW Oserian Geothermal Power Plant in Naivasha, Kenya

Owner installed plant using Ormat supplied equipment, documentation and technical assistance. 4 years of operation.

2001



250 kW Geothermal Power Unit at Rogner Hotel & Spa, Bad Blumau, Austria

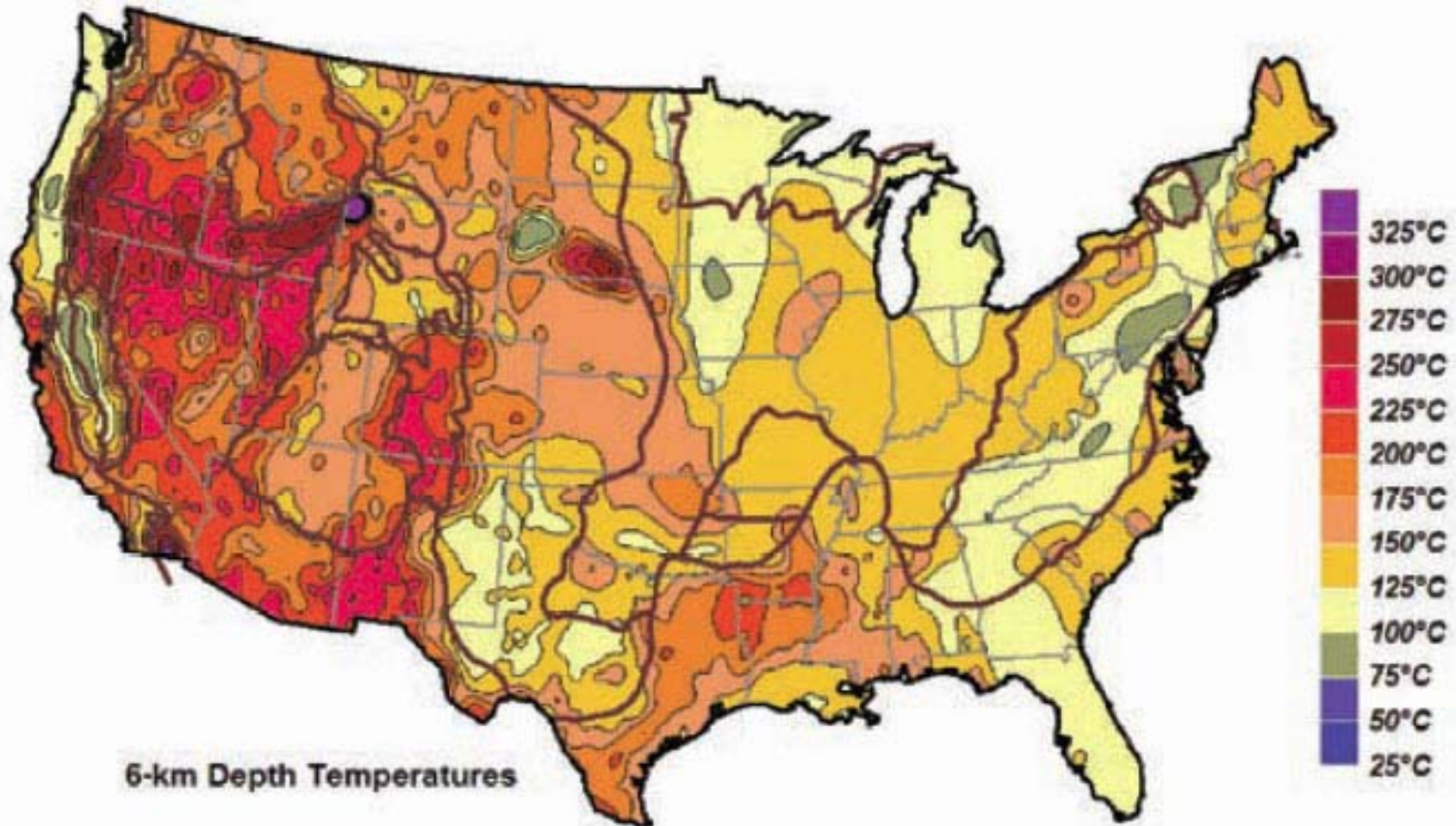
250 kW air-cooled geothermal CHP plant generating electrical power as well as district heating, by utilizing a low temperature geothermal resource. 7 years of operation.

Presentation Purpose

- This presentation will examine the power market in Utah and general issues related to how geothermal fits into power markets in the Western U.S.
- The presentation will focus on:
 - Utah's power market
 - Utah's geothermal potential
 - Utah's needs in order to facilitate geothermal development
 - Key issues for geothermal throughout the West
 - General power market trends throughout the West

How Extensive is the U.S Geothermal Resource?

Estimated Earth temperature at 6-km (3.7-mile) depth. Southern Methodist University (SMU) Geothermal Laboratory. Source – National Renewable Energy Lab (NREL)



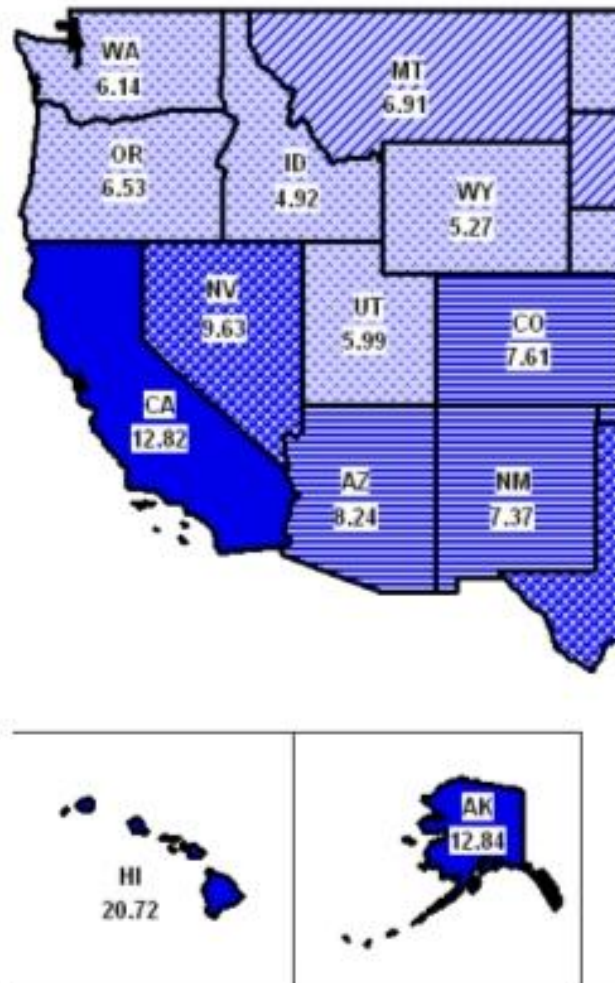
Status of the U.S. Geothermal Power Market



Over 60 Geothermal power plants in 6 U.S. states: (AK, CA, HI, ID, NV, UT)

- Geothermal electricity has been produced in 9 states: (NM, OR, TX)
- At least 9 states expect to have plants by 2010
- Ormat owns and operates plants in 3 U.S. states, and Ormat has installed plants in 5 U.S. states that currently operate
- There is potential for geothermal power development in all 13 Western States

Average Retail Electricity in the Western U.S. in 2006



Source: Energy Information Agency

Summary of Development Issues in Utah



Great Salt Lake, Utah. Photo by Daniel Fleischmann

Utah's Energy Market

Fossil Fuel production

Source: Energy Information Agency

- 12th in domestic crude oil production in 2006 (well below 1980s and 1990s averages)
- 12th in domestic coal production in 2006
- Produced approximately 1.87% of domestic marketed natural gas in 2006 (natural gas production at all time highs during this decade)

Energy Generation

Source: Southwest Energy Efficiency Project (SWEET)

- 72.9% of Utah's electricity generated from coal in 2006
- 21.9% of Utah's electricity generated from natural gas in 2006
- The rest comes primarily from hydro-electric
- Less than 40 MW of wind, solar, and geothermal power installed by year-end 2007
- Net exporter of energy

Electric Utilities

- PacifiCorp (Rocky Mountain Power) accounted for just over 80% of state retail power sales in 2006.
- Numerous small rural cooperatives and municipal utilities in Utah (the largest four of them produced 8% of Utah's energy in 2006)

Power prices

- 5th lowest average power prices in the United States in 2006

Population Growth

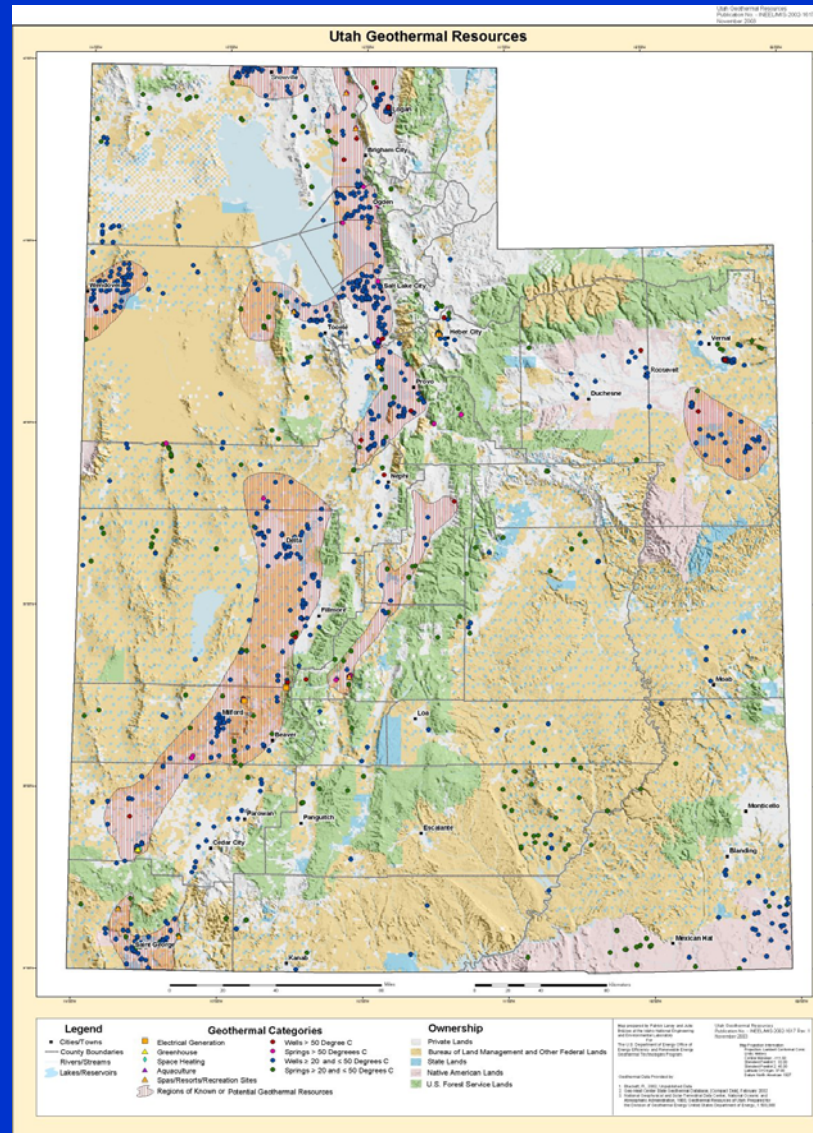
- Grown by more than double the U.S. average since 2000
- Almost a half-million more people living in Utah in 2008 than 2000

Utah's Policies

- Renewables Portfolio Standard
 - Target of 20% by 2025 (2008)
- Tax credits
 - State renewable energy production tax credit of 0.35¢/kWh for 4 years (2007)
 - Sales tax exemption for the purchase or lease of equipment used to generate electricity from renewable resources (2004)

Utah Geothermal Resource Map

Source: Idaho National Laboratory



Utah's Geothermal Potential

- **WGA estimate of 230 MW economical potential (by 2015)**
- **WGA estimate of 630 MW longer-term potential (by 2025)**
- **Utah has geothermal potential within the Basin and Range province of western Utah, the Transition Zone of central Utah, and the Wasatch fault zone**
- **High temperatures have been measured in exploration wells in several areas in the state, although only two geothermal fields have been developed for electric generation**
- **Much of the geothermal exploration that took place was during the 1970s and early 1980s before binary technology was commercially available**

Utah's Needs (based on what has worked in other States)

- **Transmission**
 - Examine transmission-related challenges to developing resource targets in remote areas
- **Lease sales**
 - June 2007 BLM geothermal lease sale generated over \$3.6 million; which should encourage future sales
- **Resource characterization**
 - University of Nevada efforts to apply exploration techniques to geothermal have led to new resource discoveries
 - These efforts could be applied in Utah to survey broader regions for potential new targets
- **Utilize US DOE support for Industry Coupled Drilling – similar to GRED**
 - Geothermal Resource Exploration and Development (GRED) program initiated by USDOE in 1999
 - GRED provided funding support and technical assistance for exploration and development efforts at 22 sites in 7 states (Alaska, Arizona, California, Idaho, Nevada, New Mexico, and Utah)
 - Budget of \$12.5 million from 1999 through 2005
 - Resulted in 2 completed power plants
 - Expansion of U.S. geothermal facilities from 4 states to 6 states
 - 12 projects under development
- **Leasing and permitting**
 - Critical to identify relevant state and federal agencies involved with leasing and permitting of geothermal projects.
 - Interagency coordination will be imperative to enable projects to move forward
 - Follow the example of Nevada and its efforts to streamline the leasing and permitting process
- **Outreach to the public**
 - Critical to bring relevant civic and environmental groups into the discussion of how to design projects that reduce impact on the local environment
 - Critical to educate the public on the environmental benefits of geothermal power, and the environmental impacts they offset

Key Issues Throughout the West

- Federal policies
- State policies
- Resource characterization
- Leasing and permitting
 - Streamlining
 - PEIS progress
 - Federal lease sales
- Transmission planning
 - to incorporate more renewable power into the grid

Other Applications that may Expand Geothermal to Other Markets

- **Co-production from oil wells and geopressured gas wells**
 - California, Gulf Coast, Rocky Mountains, Northern Great Plains
- **Engineered Geothermal Systems (EGS)**
 - Expand existing geothermal fields.
 - Hot rocks and deep geothermal resources across the U.S.
- **Off-Grid applications***
 - Aluminum Smelting
 - Alternative fuels
 - Hydrogen Production
 - Industrial drying
 - Local power use
 - Desalinization

**Generally applicable in hydrothermally active areas*

Looking Ahead to the Future



Three “P’s” and an “R”

Renewable energy markets are being driven by:

- Population
- Power Prices
- Pollution
- Reliance on Energy Imports

All 4 of these affect California. Hawaii and Nevada are particularly reliant on energy imports.

What about Utah? - Let's discuss