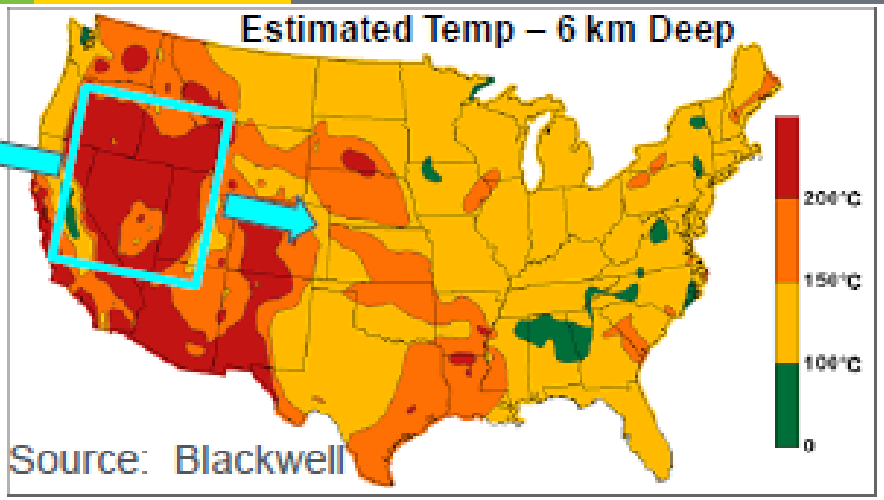
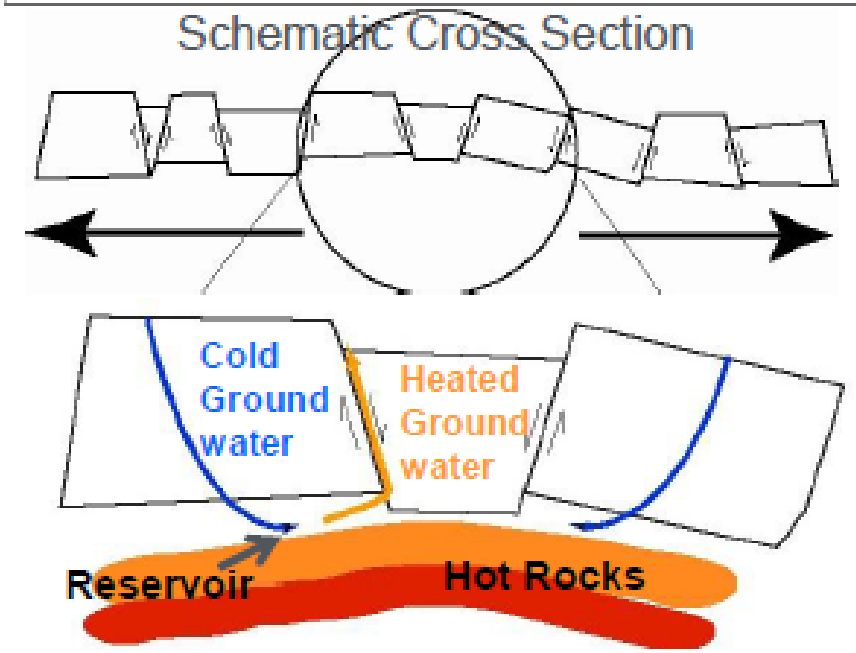
Geothermal Energy in Nevada: Exploration, Development and Production

Rich Perry, Nevada Division of Minerals

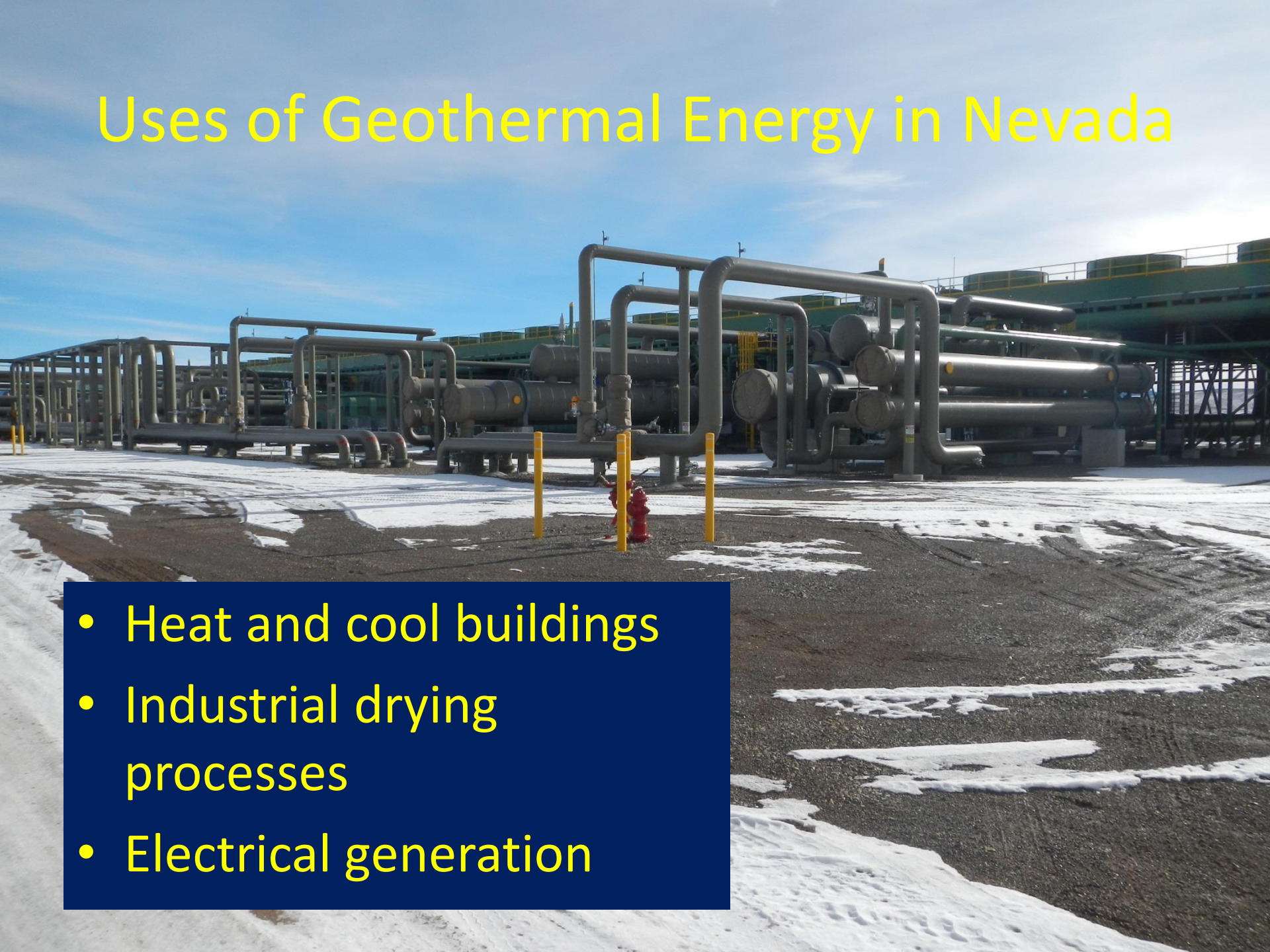
Great Basin Region

- Region of warm crust
- Crust pulling apart or extending
- As crust thins, hot rocks get closer to surface
- Saudi Arabia of geothermal
- Cannot drill 6 km deep (20,000 ft) economically
- Faults allow hot water to reach shallow levels
- Must find hot water pathways using geologic and geophysical techniques





Uses of Geothermal Energy in Nevada



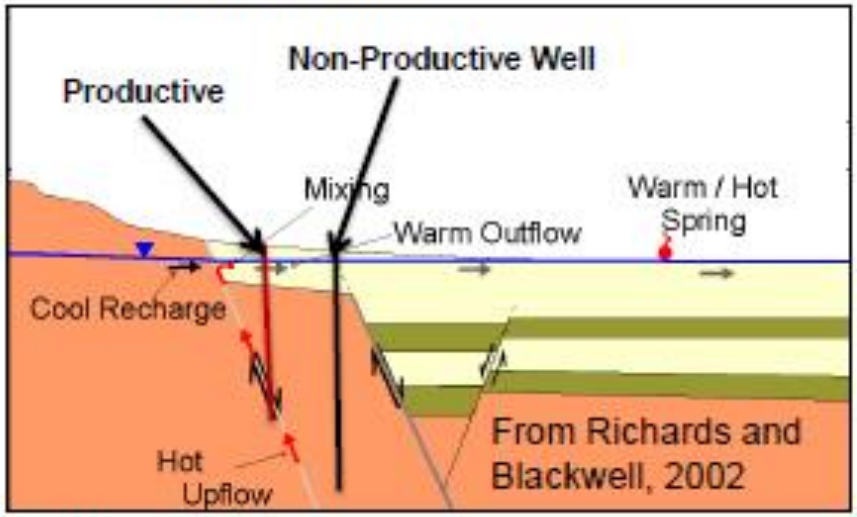
- Heat and cool buildings
- Industrial drying processes
- Electrical generation

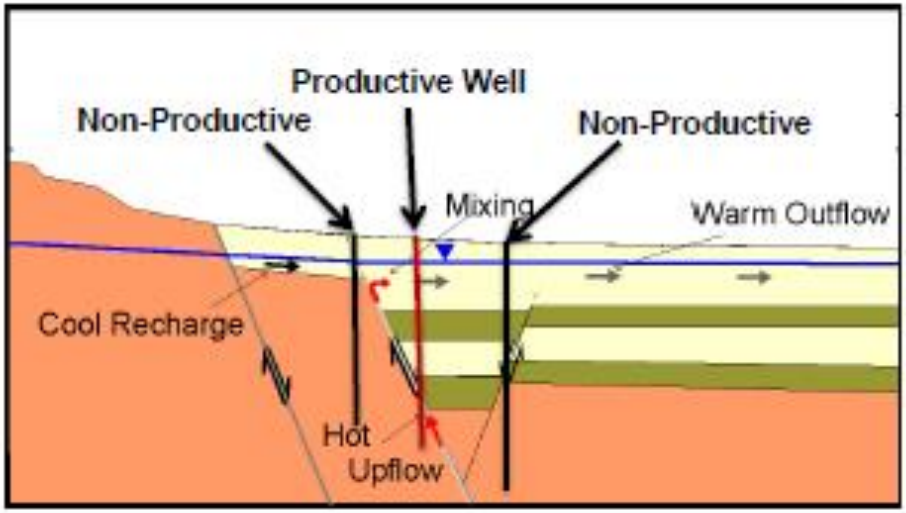
EXPLORATION FOR GEOTHERMAL RESOURCES

- Exploration focused initially on areas of known hot springs
- Exploration is now focused on ‘blind’ geothermal systems using geophysical methods
- Intersection of basin and range faults at depth with no surface expression
- Continued focus on range front faults

Exploration Challenges

- **Exploration Challenges**
  - Spring directly above upflow from deep source (uncommon)
  - Outflow from source (common)
  - Hidden or blind systems (common)
- **Results – significant drilling risk**
  - Hot dry wells
  - Overturn in down-hole temperatures
- **Need better conceptual models to:**
  - Locate areas of upflow
  - Avoid typically less productive outflow zones





Phases of Exploration and Development Drilling

- Initial drilling of temperature gradient holes. Generally 1,000 ft. deep or less
- Drilling of observation wells to deeper depths to test potential reservoir
- Drilling of production wells to test capabilities of the reservoir
- Drilling of injection wells or assigning previously drilled production wells as injection wells

Exploration and Production Drilling

Truck Mounted Exploration Rig

GeoDrill 1 – Diesel Electric Rig

Commercial Uses

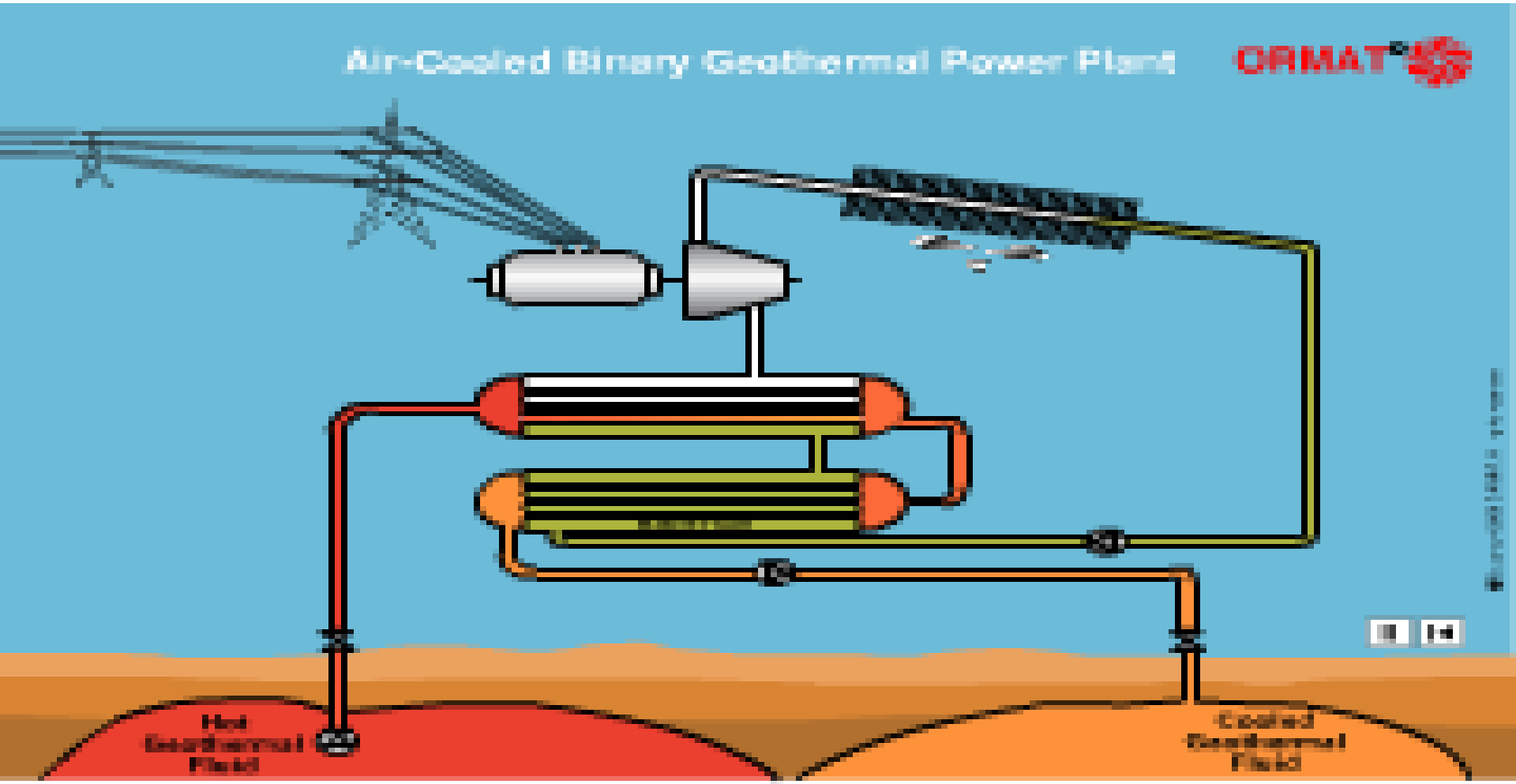
OLAM Onion Dehydration Plant , Brady Hot Springs, approximately 250°

Peppermill Casino, Reno
Approximately 173°

How Geothermal Power is Generated

- Hot water from the Earth is pumped into a heat exchanger where it heats up a refrigerant or Isopentane vaporizing it to gas.
- The pressurized gas then spins a turbine which in turn spins the generator and creates energy.

http://www.tmba.tv/3d-animation/alternative-fuels/

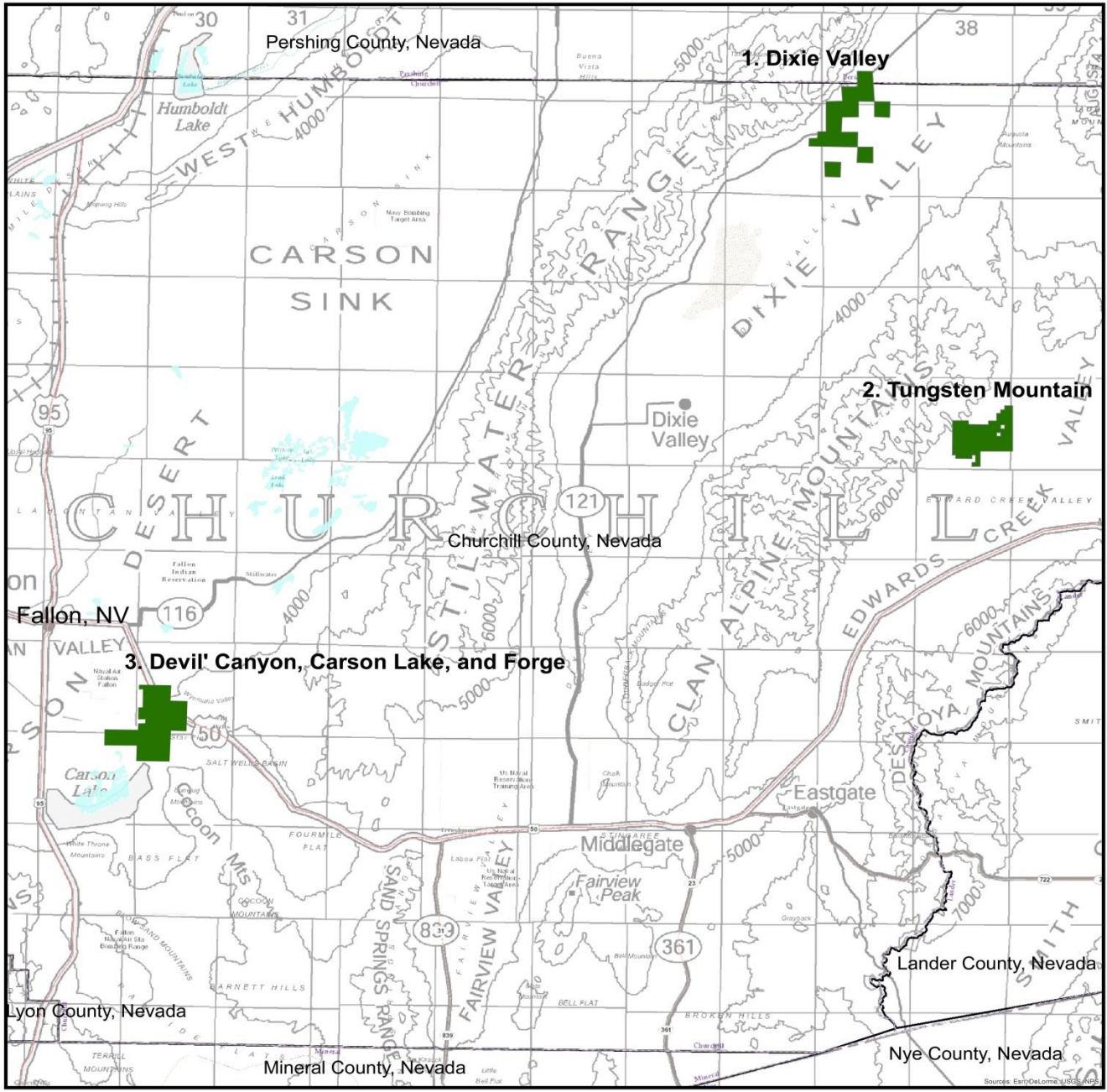

Air-Cooled Binary Geothermal Power Plant
ORMAT
Hot
Geothermal
Fluid
Cooled
Geothermal
Fluid

2016 Areas of Active Geothermal Exploration

Legend

Geothermal Fields

1. Dixie Hope
2. Tungsten Mountain
3. Devil's Canyon, Carson Lake, and FORGE



LOCATION

N

0 5 10

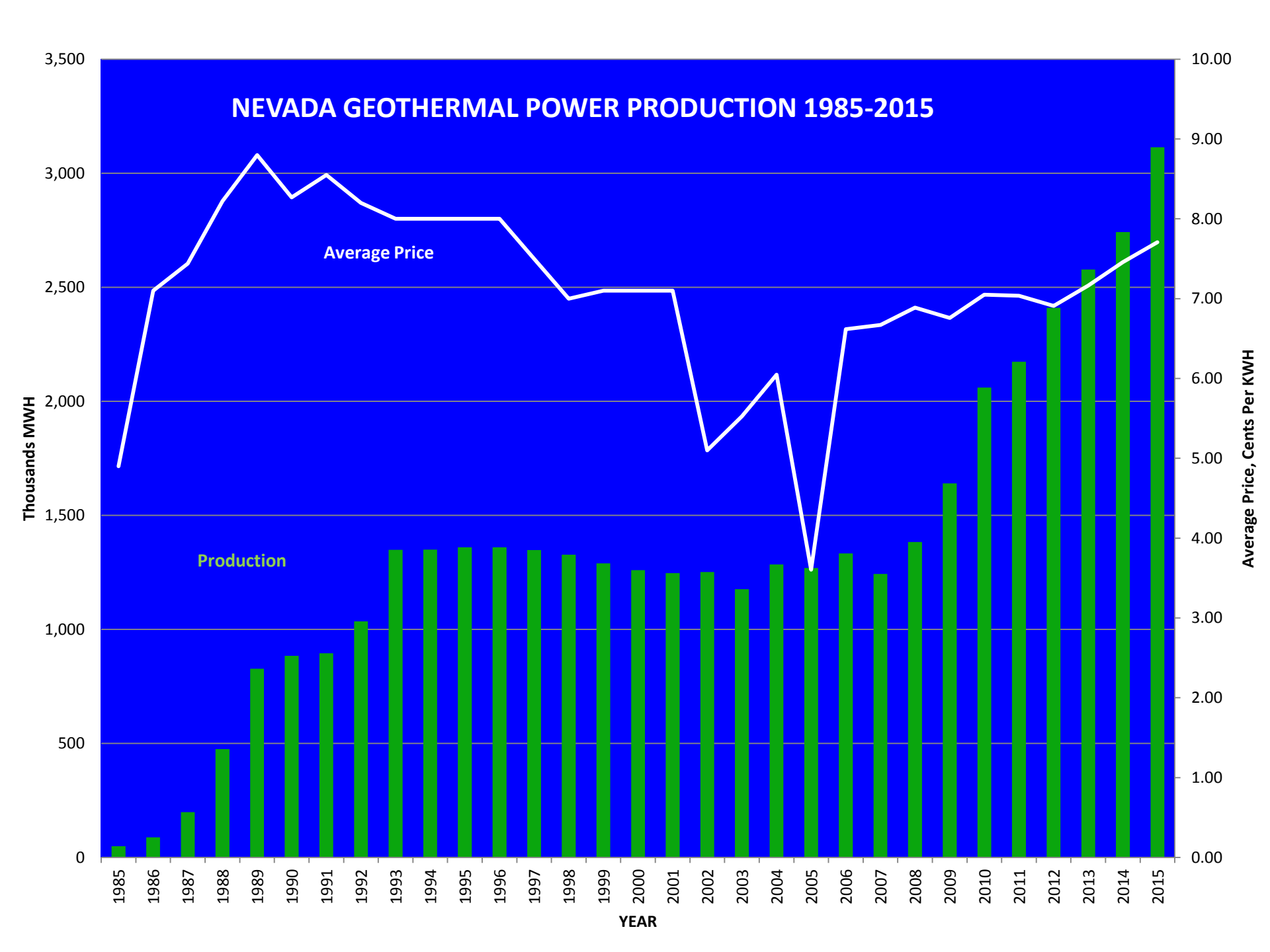
Miles

MAP CREATED BY NEVADA DIVISION OF MINERALS

Tungsten Mountain, Churchill County

- Potential future geothermal reservoir which may have 20-30 MW of continuous power generation.

Enel Solar/Geothermal Stillwater Plant-hybrid facility


NEVADA GEOTHERMAL POWER PRODUCTION 1985-2015
Average Price
Production
Thousands MWH
Average Price, Cents Per KWH
YEAR
3,500
3,000
2,500
2,000
1,500
1,000
500
0
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
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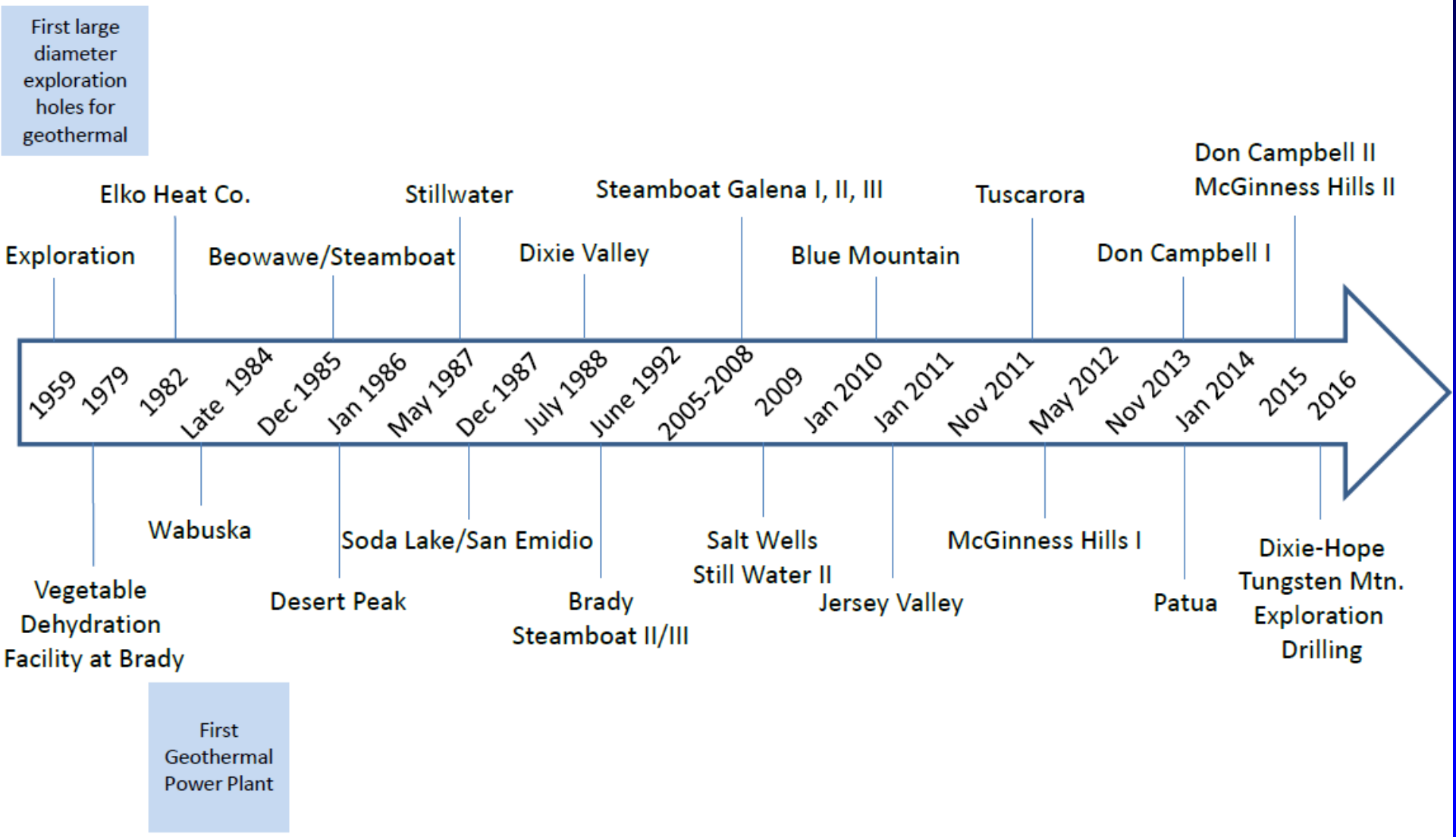
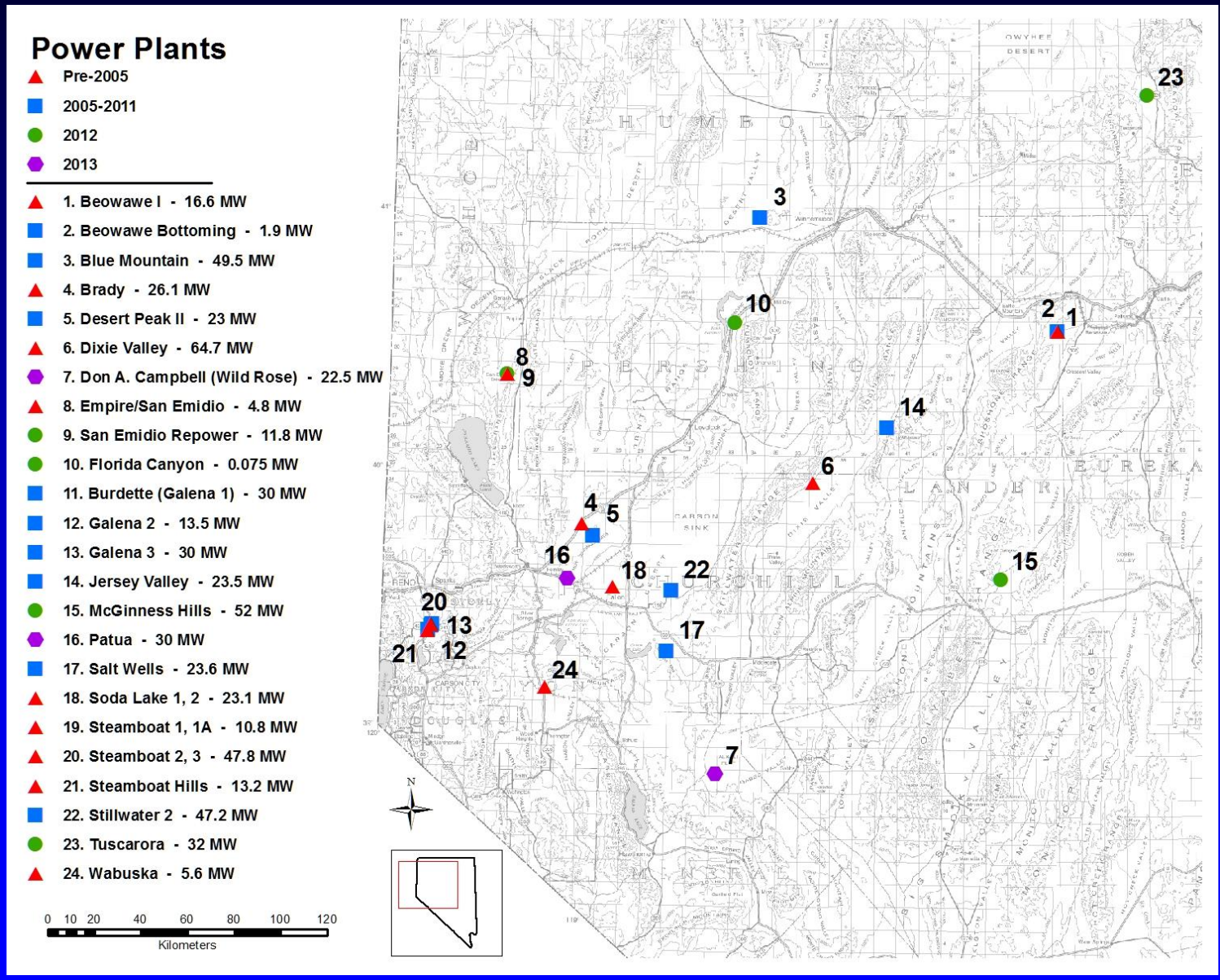
2015

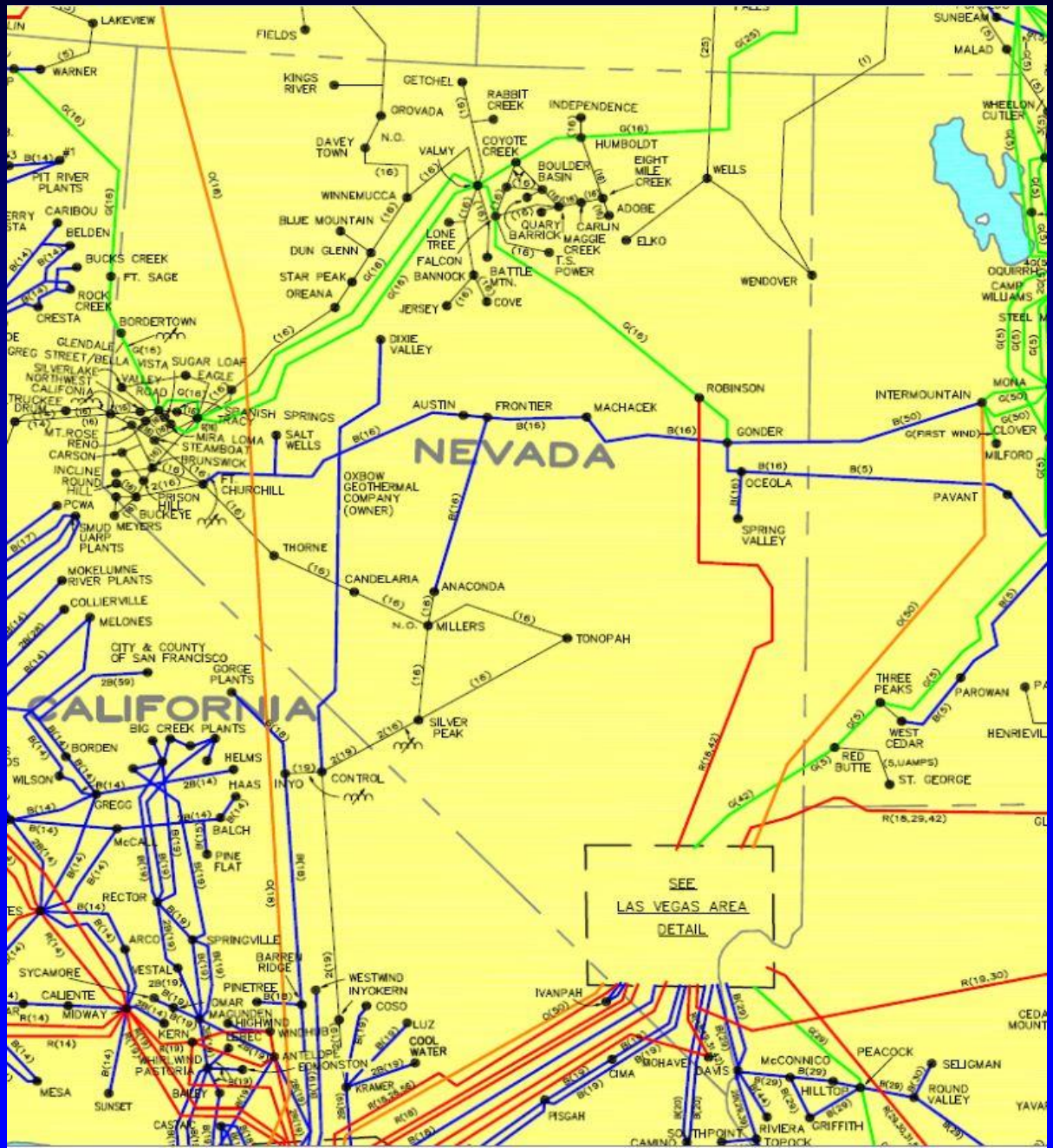
HISTORY OF GEOTHERMAL ACTIVITIES IN NEVADA

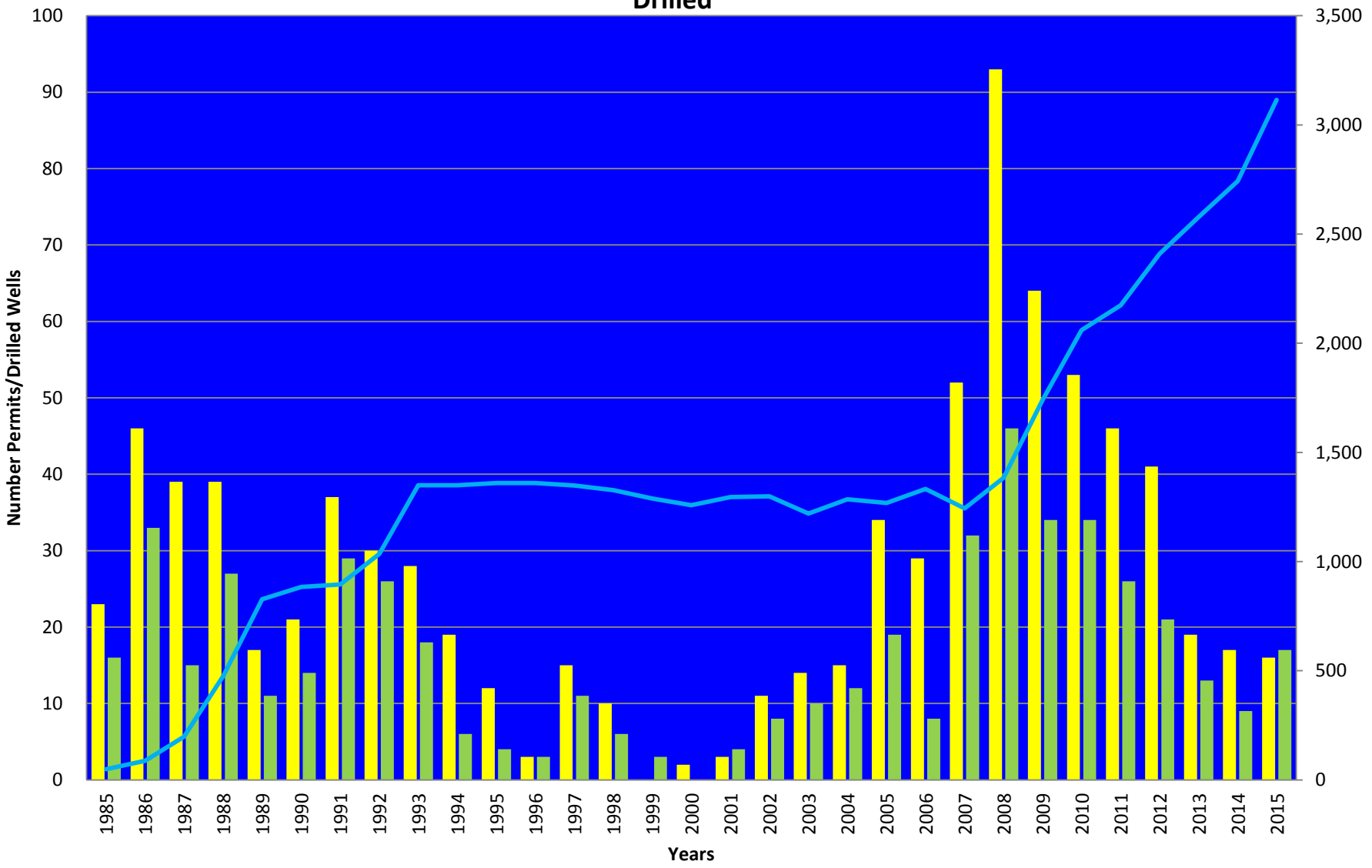




From: Lisa Shevenell, Atlas Geosciences, Inc.

Nevada Power Grid




Nevada Production, Injection, and Observation Wells 1985-2015 Permits Issued vs. Wells Drilled
Number Permits/Drilled Wells
Years
0
10
20
30
40
50
60
70
80
90
100
0
500
1,000
1,500
2,000
2,500
3,000
3,500
1985
1986
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2013
2014
2015

FUTURE TRENDS AND OPPORTUNITIES & CHALLENGES

- Co-Located renewable technologies
  - Solar located at geothermal facilities
- Transmission expansions
- Optimizing reservoirs (phased development)
- R&D: Frontier Observatory for Research in Geothermal Energy (FORGE), Enhanced Geothermal Systems (EGS)
- Public lands permitting
  - Sage Grouse impacts
  - ~60% of NV geothermal wells on private, ~40% on public lands

Programs

- Bond Pool (Reclamation)
- Oil & Gas
- Geothermal
  - Forms and Reports
  - Permits
  - Geo FAQ
  - Renewable Energy
  - Links
- AML
- Education and Outreach
- Mining

GEOTHERMAL

The Nevada Division of Minerals is the state's regulatory authority for all geothermal wells drilled in Nevada. Geothermal wells drilled within Nevada, on either private or federally managed lands, must be permitted by the Nevada Division of Minerals. The associated drilling and completion programs must be approved by the Division before either program is implemented. The Division oversees the drilling and subsequent completion operations through daily reporting to the Division by the operator, as well as inspect the wells after they are completed. The Division must also approve all maintenance and work-over operations during the life of the well, as well as the final plugging and abandonment of a well at the end of its useful life. Geothermal production and injection information is submitted to the Division on a monthly basis, where the information is tabulated both monthly and annually.

- Letter Announcing New Geothermal Regulations (12/22/2015)
- NV Geothermal Power Plants
- Nevada Active Mines and Energy Producers

Nevada Geothermal Resources and Production

Nevada's geothermal resources are utilized in three major ways. The geothermal resources are used to generate electricity, for space heating, and commercial applications.

- NV Geothermal Production Summary - 2015
- NV Geothermal Power Production Graphic 2015
- NV Geothermal Power Production and Price 1985-2015

Electrical Generation

Nevada's geothermal electrical generation plants are located predominantly in the northern portion of the State. Nevada's geothermal plants can theoretically generate up to 673 megawatts of power collectively in any given hour. A megawatt is 1,000 kilowatts, which is enough electrical power to serve over 800 typical households. Nevada has 24 plants in 16 different locations. The 2015 gross electrical output for Nevada's 24 geothermal plants was 4,078,544 MWh, with net output (sales) being

Geothermal Contact

Lowell Price
Oil, Gas, and Geothermal Programs Manager
lprice@minerals.nv.gov

Statute & Regulations

- NRS 534 A
- NAC 534 A

BLM Links

- LR 2000
- BLM Geothermal
- Nevada Geothermal Guidance

Educational Material (K-12)

- Geothermal Resources in Nevada Activity Book

Presentations

- 30 Years of Geothermal Power Production - GRC Conference September 2015