GeoPowering the West

Oregon Department of Energy

GEOTHERMAL ENERGY:

What It Is

&

How We Use It

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EARTH HEAT

- Geo = Earth
- Thermal = Heat

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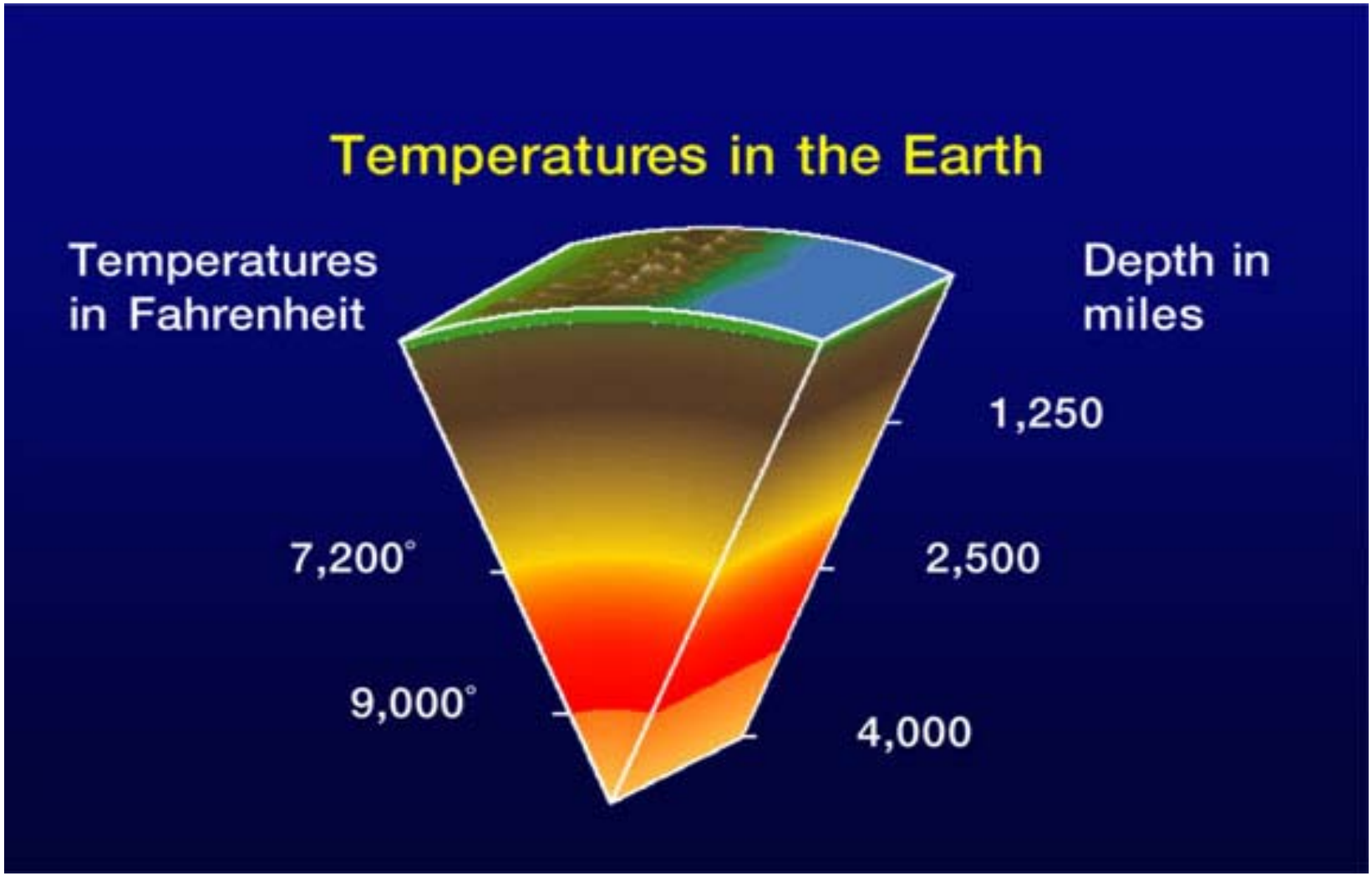

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Kilauea, Hawaii

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Three Sisters, OR

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Surface Manifestations

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RESOURCE USE

- Vertical aquifers allow access at shallow - economically drillable - depths.

- Not all hot water from a geothermal system discharges at the surface as hot springs

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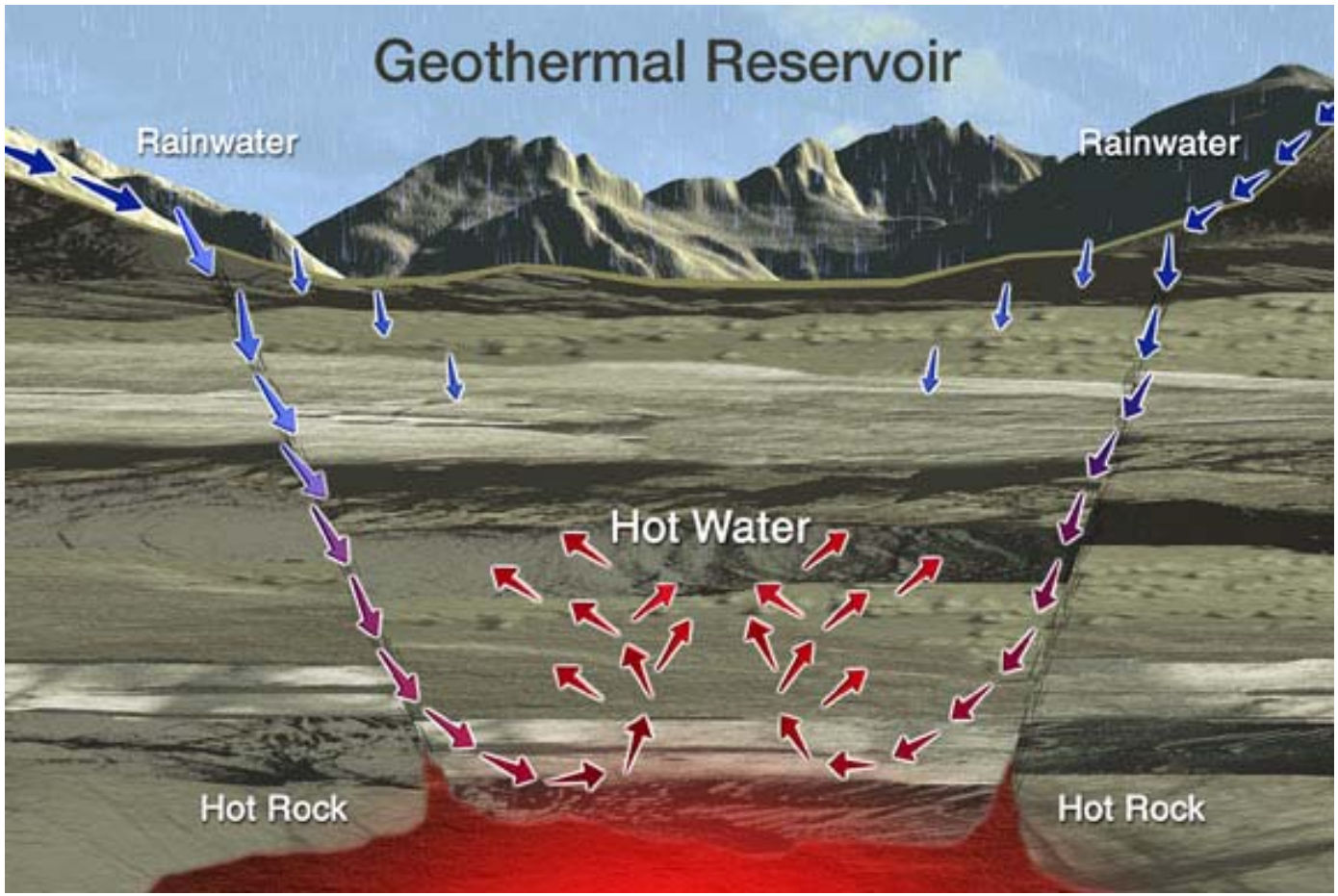

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GEOTHERMAL RESOURCES

- Water & Petroleum terms i.e. aquifers, reservoirs, reserves
- Geothermal water has been used directly in Oregon for many years.
- Geothermal steam has generating power in Italy for >100 years and California for >45 years.

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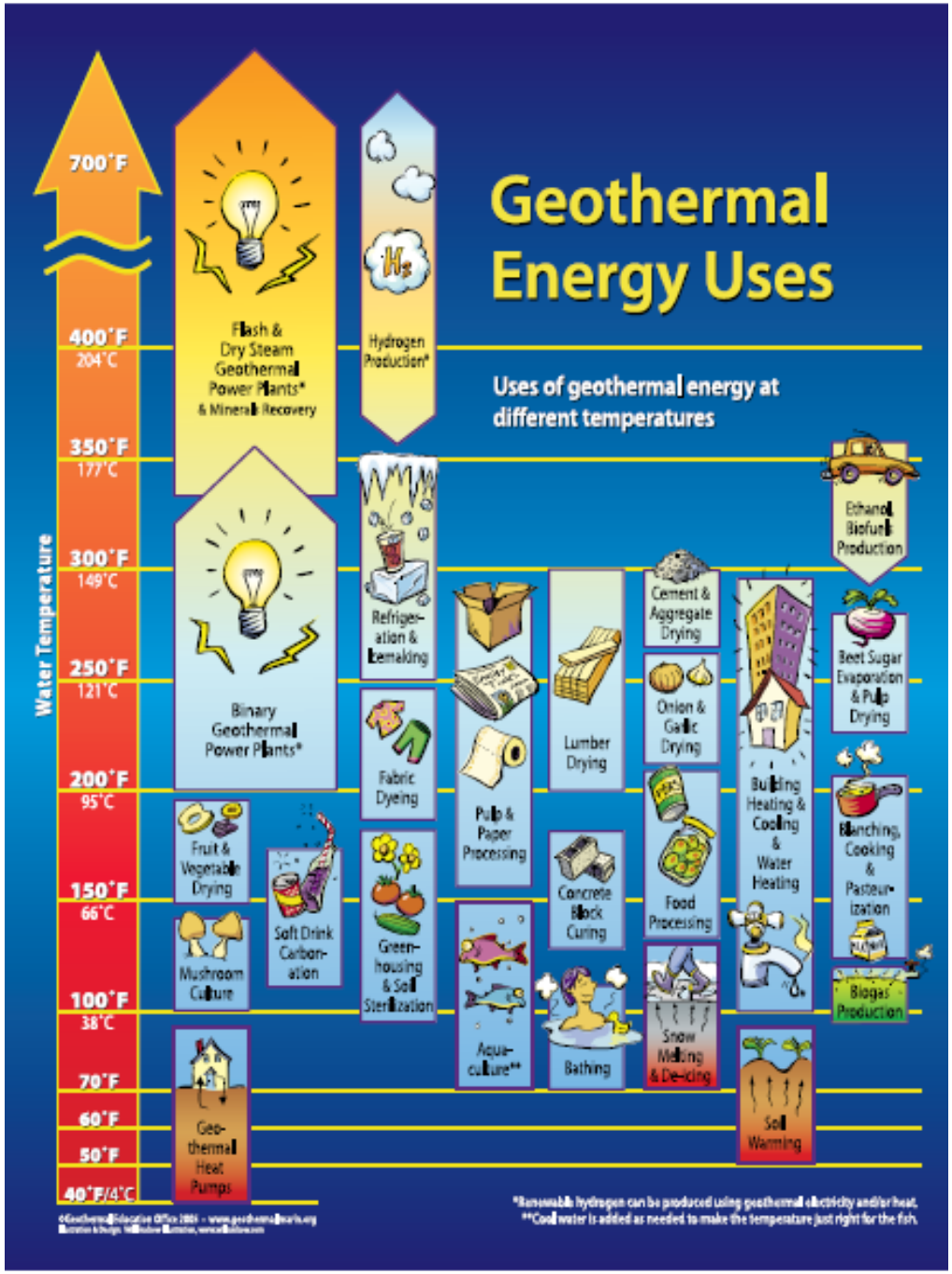

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DIRECT USE

- Hot spring water piped to
  - pools, buildings, greenhouses.

- Wells in Oregon supply downtown Klamath Falls, hospital, schools, OIT, brewpub, and funeral parlor.

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DIRECT USE

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DIRECT USE

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DIRECT USE

- Extension of groundwater use
- Check local well logs
- Local geology esp. faulting
- Well drillers experienced in local area

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DRILLING

"Classic" drill rig in Klamath Falls. Very much a water well rig.

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BASIC EQUIPMENT

Here is a gas furnace retrofitted with pipes running geothermally heated city water instead. Same end result of air heating across the coil.

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Harvesting tropical fish

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AQUACULTURE

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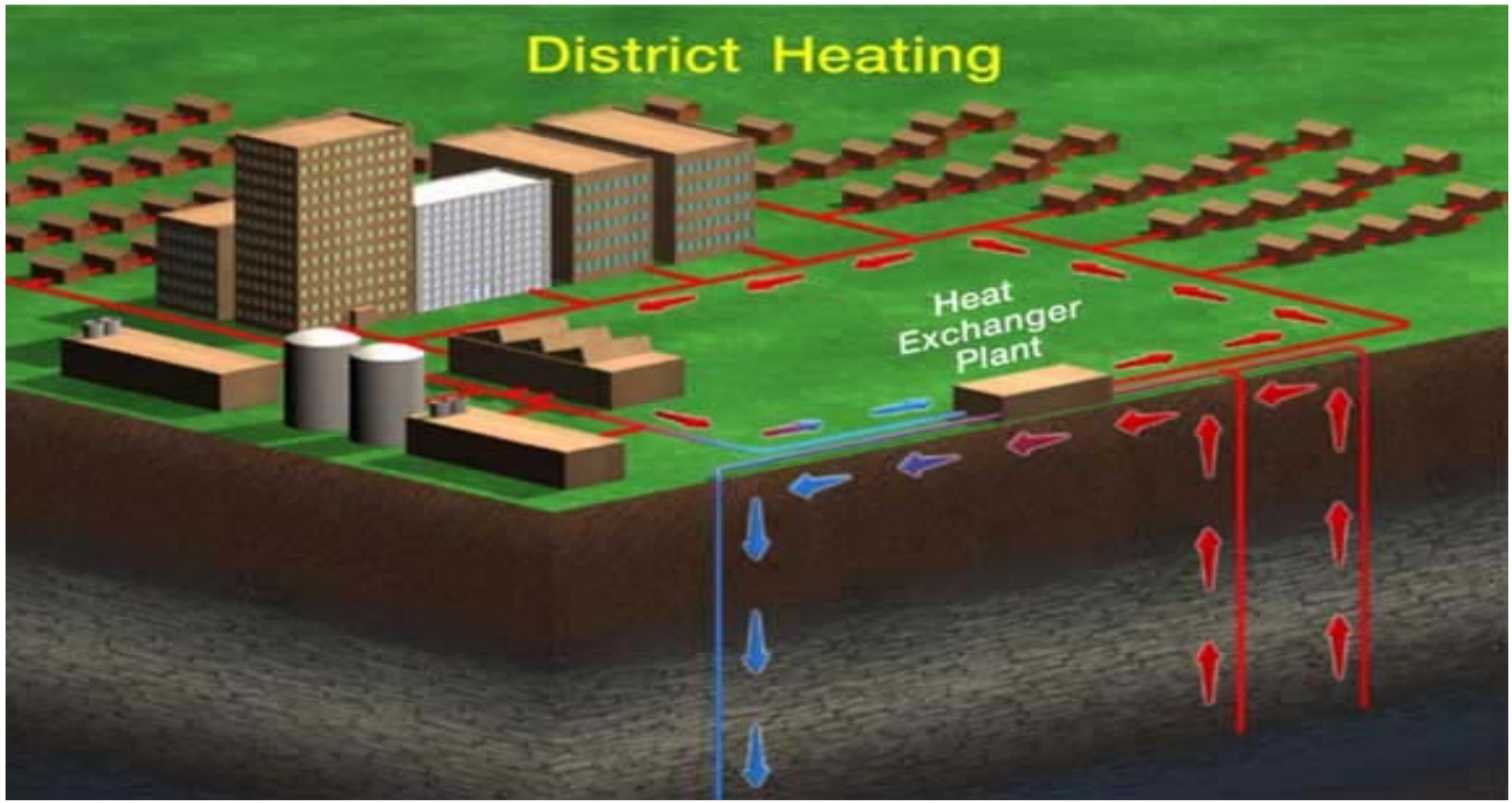
Direct Use



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Klamath Falls – Oregon Institute of Technology

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DIRECT USE COSTS

FOSSIL/ELECTRIC

- Boiler or Furnace
- Distribution system
- Radiators
- FUEL bills for everything
- Power bills for everything

GEOTHERMAL

- Wells
- Heat Exchanger
- Distribution system
- Radiators
- FUEL bill for peaking
- Power bills for pumping

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ECONOMICS

- GOAL of saving energy costs enough to make the operation profitable
- Life cycle costing =
  - Pay now to reduce & control later costs
  - Wells bought now for fuel later

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ECONOMICS

- What you save by using “free” hot water has to be less that same operation using oil, gas or power.
- Savings then pays for amortizing well costs, heat exchange equipment, and operating costs (pumping & maintenance).

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Geothermal Power

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Worldwide Use

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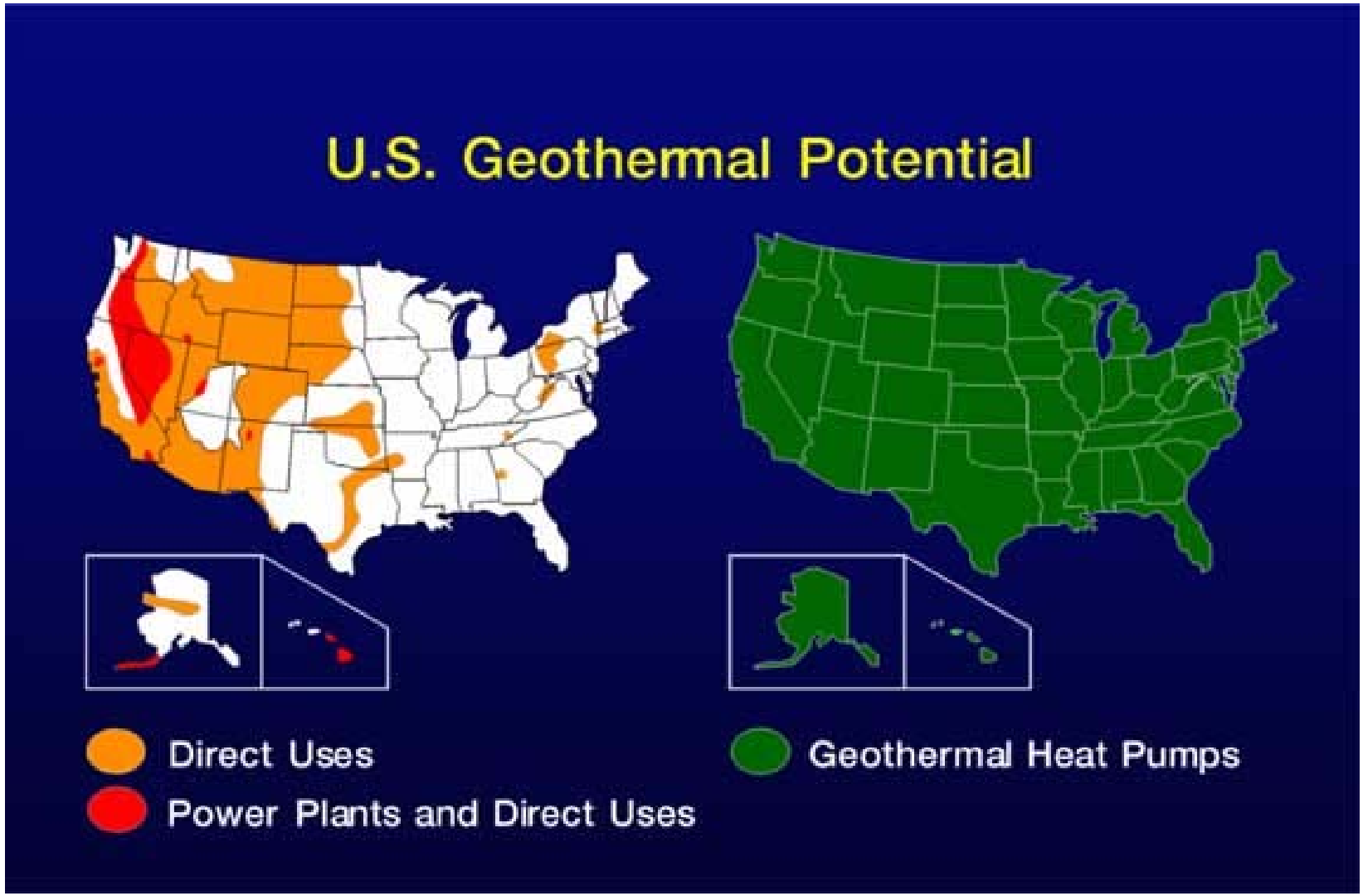

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POWER GENERATION

- Water > 300°F then 212°F now 165 °F
- Rare => High risk e.g. 1 in 11 wells
- Sequence of
  - Lease
  - Explore
  - Drill wells

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POWER ECONOMICS

- Contract to sell power to regional utility
- Price must compete with other utility options
- Price must cover Costs of wells (fuel), pipelines, power plant, operation & maintenance, and profit.

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LEASING

- The right to explore is typically obtained by either Permit or Lease
- Private land leases in SE Oregon
  - Terms
    - Rate
    - Length
    - Restoration

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LEASING

- Federal land leasing in law(s)
- Federal lands in Oregon are leased through the USDI – Bureau of Land Management
  - Plans & Permits
- Land manager may be the USDA – Forest Service i.e. Deschutes NF
  - Lease conditions

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EXPLORATION

- **Passive** – Literature review e.g., well logs, geologic mapping, research
- **Active** – sampling, geophysics, magnetics
- **Drilling** – shallow slim holes

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Surface Manifestations

Sampling

Composition

Age

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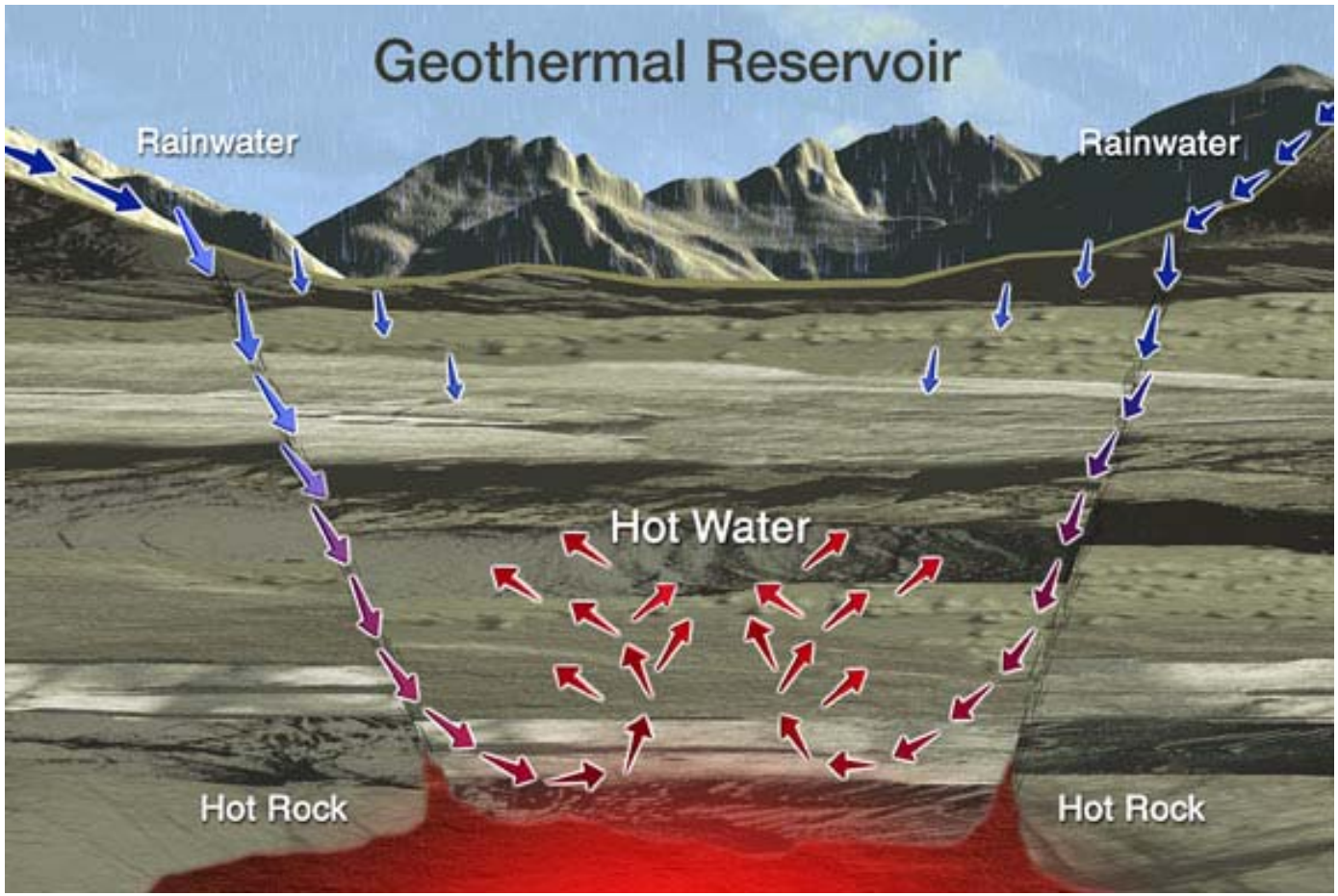

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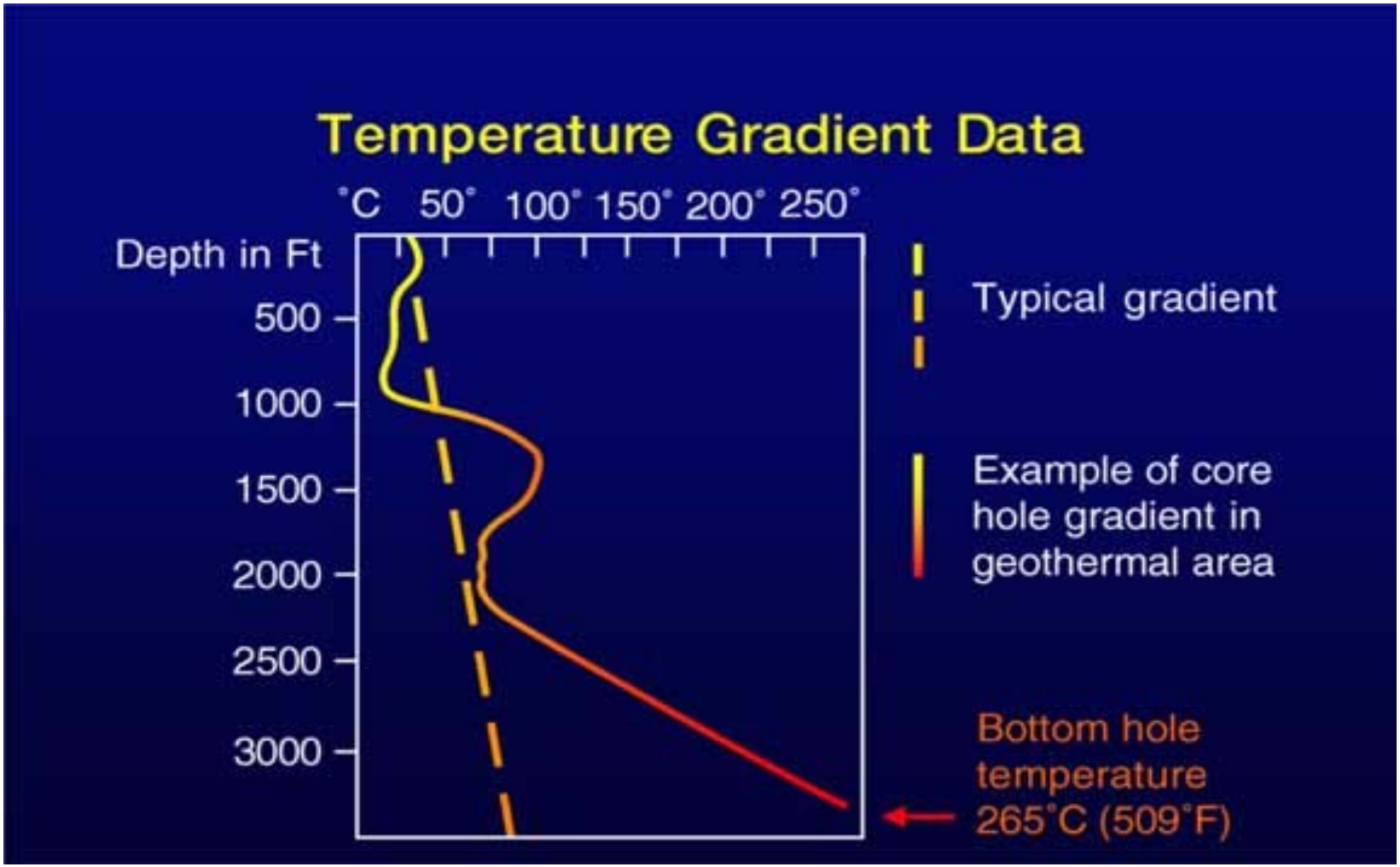

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ENVIRONMENT

- Public lands follow National Environmental Policy Act = Environmental Assessment, EIS

- Private lands follow county building permits, DOGAMI drilling permits, DEQ air & water permits and EFSC Power Plant license.

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DRILLING

Modern truck-mounted drilling rig capable of going to significant depth e.g., 3000 feet.

Cost of $50 - $80 per foot drilled

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DRILLING

Rig used to look for steam, drawn directly from the oil & gas industry.

Blow-out prevention equipment is a critical part of this operation.

20 truckloads of equipment alone

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Well Testing

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WELLS

- Production wells intersect vertical hot aquifers directly or intersect hot lateral aquifers near the up-flow zone.

- Rock permeability critical

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Well Testing

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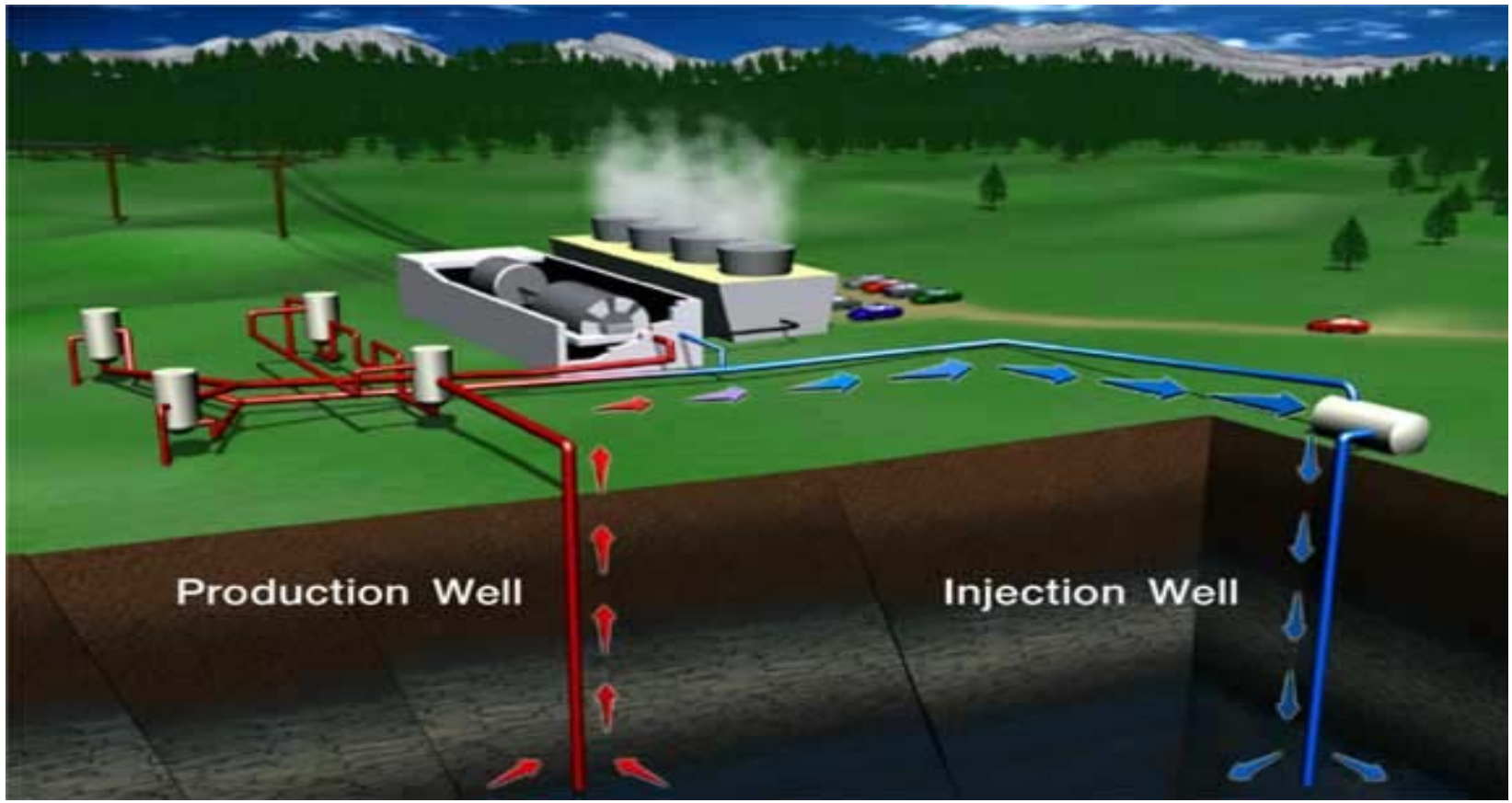
Geothermal Power



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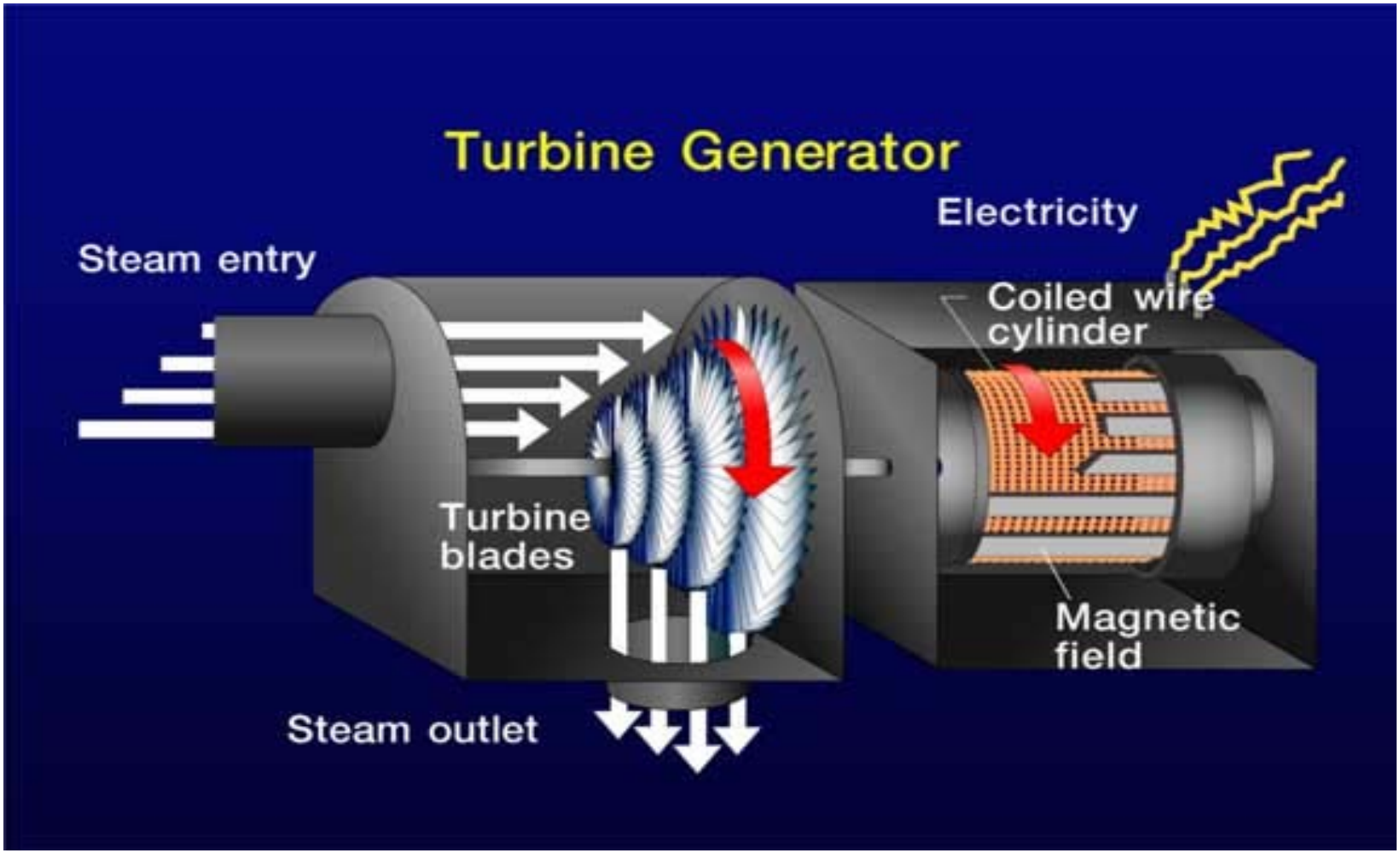

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TURBINE

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Larderello, Italy

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The Geysers, California

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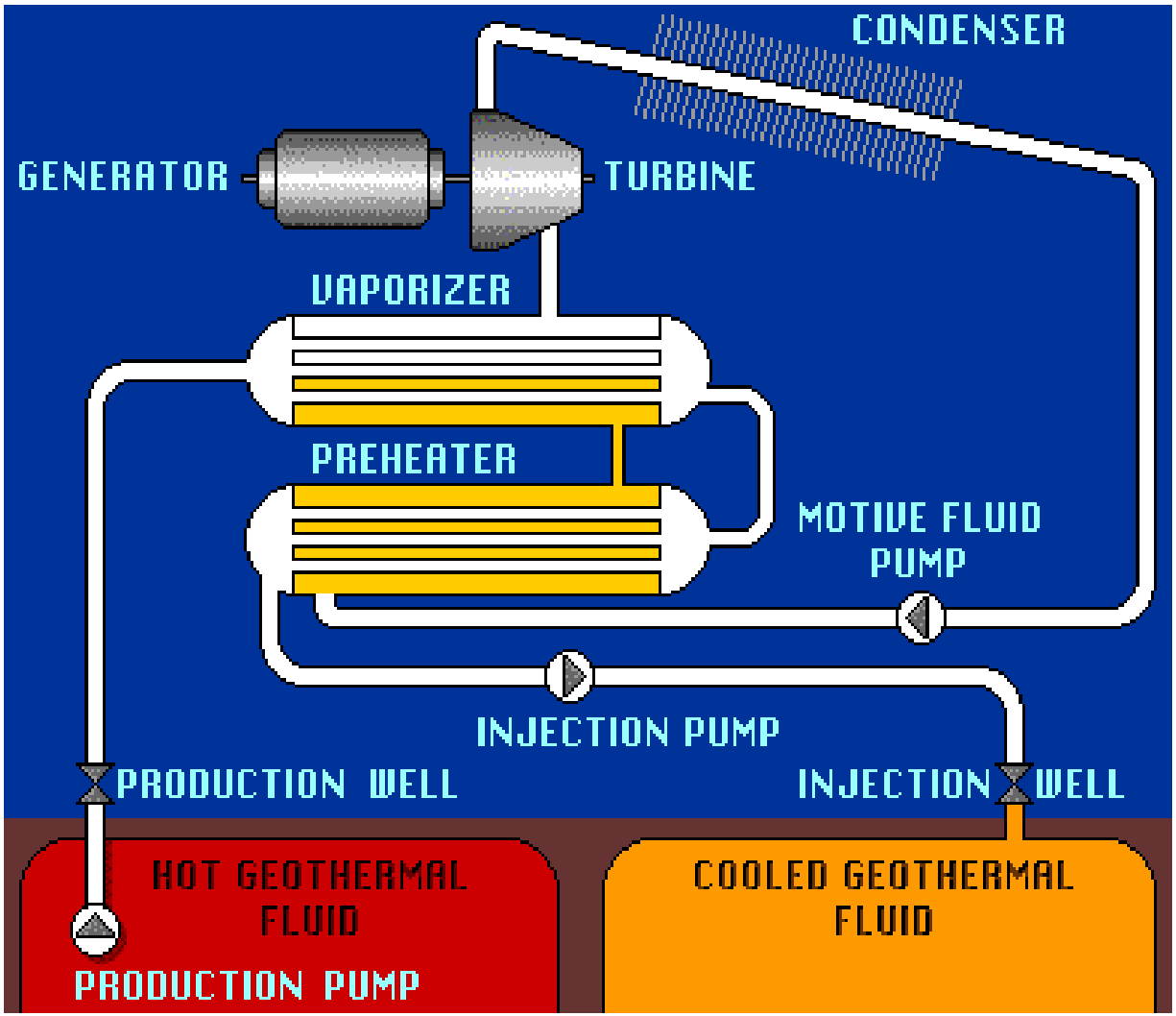
BINARY POWER



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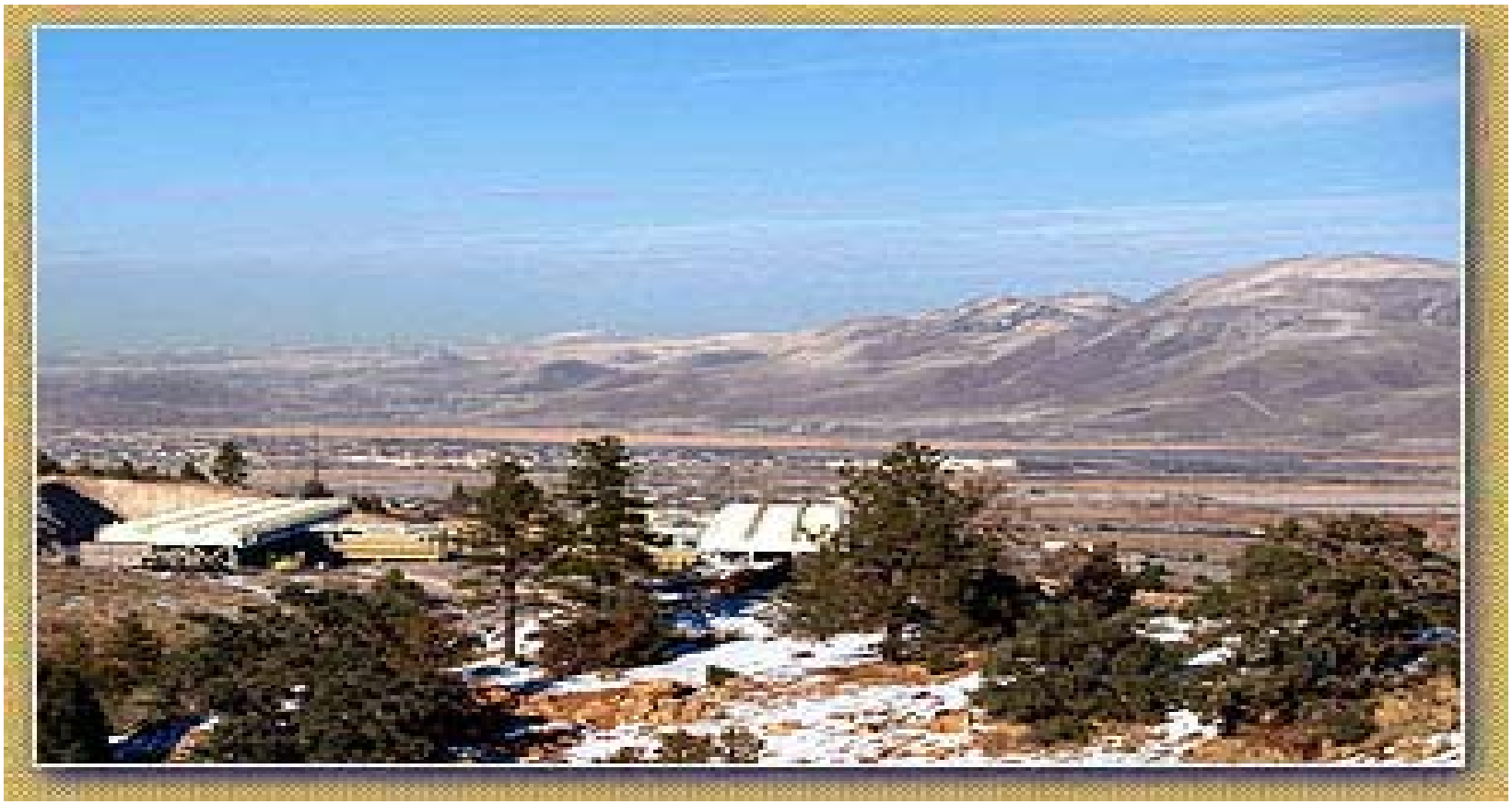
Reno, Nevada



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Mammoth Lakes, Calif.

Environmentally acceptable design

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Use of Geothermal Energy in the U.S.

- 2,800 megawatts of **electricity** supplying 4 million people in western U.S. and Hawaii
- 500 thermal megawatts of **direct uses**
- 400,000 **heat pumps** nationwide, providing 1,500 thermal megawatts of heating and cooling

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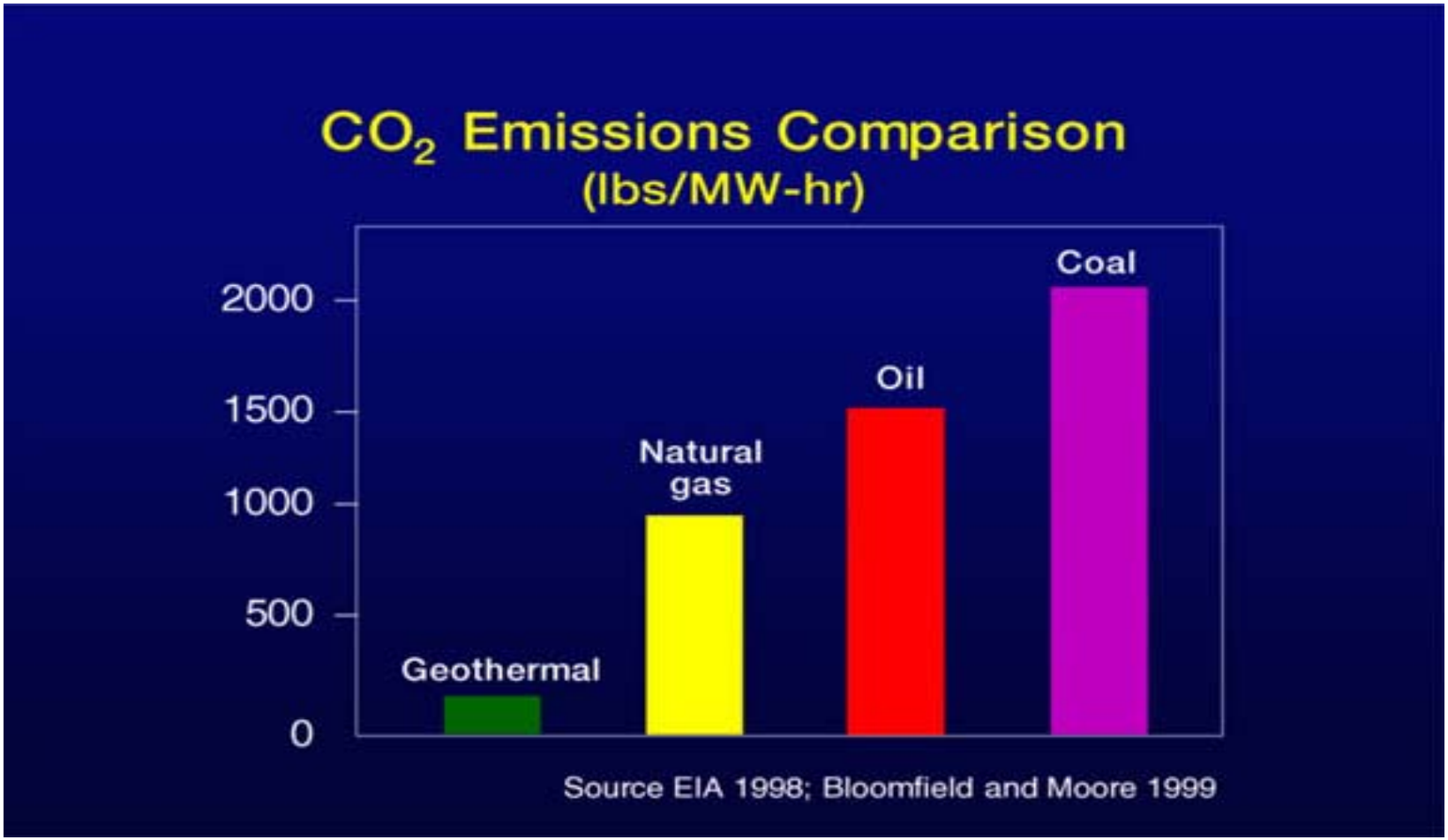
ENVIRONMENT



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Thank you

Slide credits to OIT Geo-Heat Center and the Geothermal Education Office