Geothermal Energy: The Heat Beneath Our Feet

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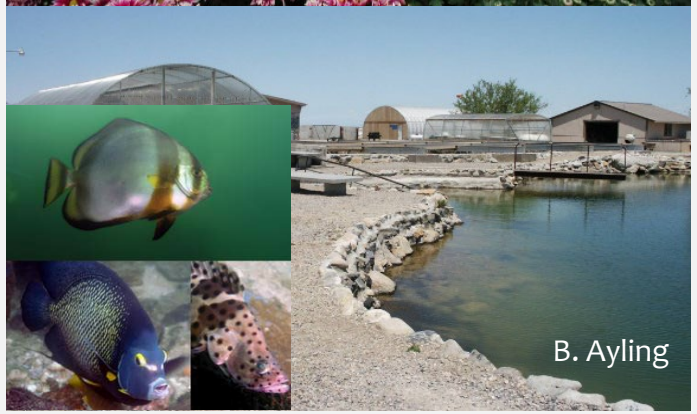
Benefits of Geothermal Energy

- Low emission
- Base load power
- Peaking
- Renewable
- Vast resource
- Environmentally benign
- Low costs once established
- Small geographic footprint
- Secure

Electric Generation

Space Heating



Spas

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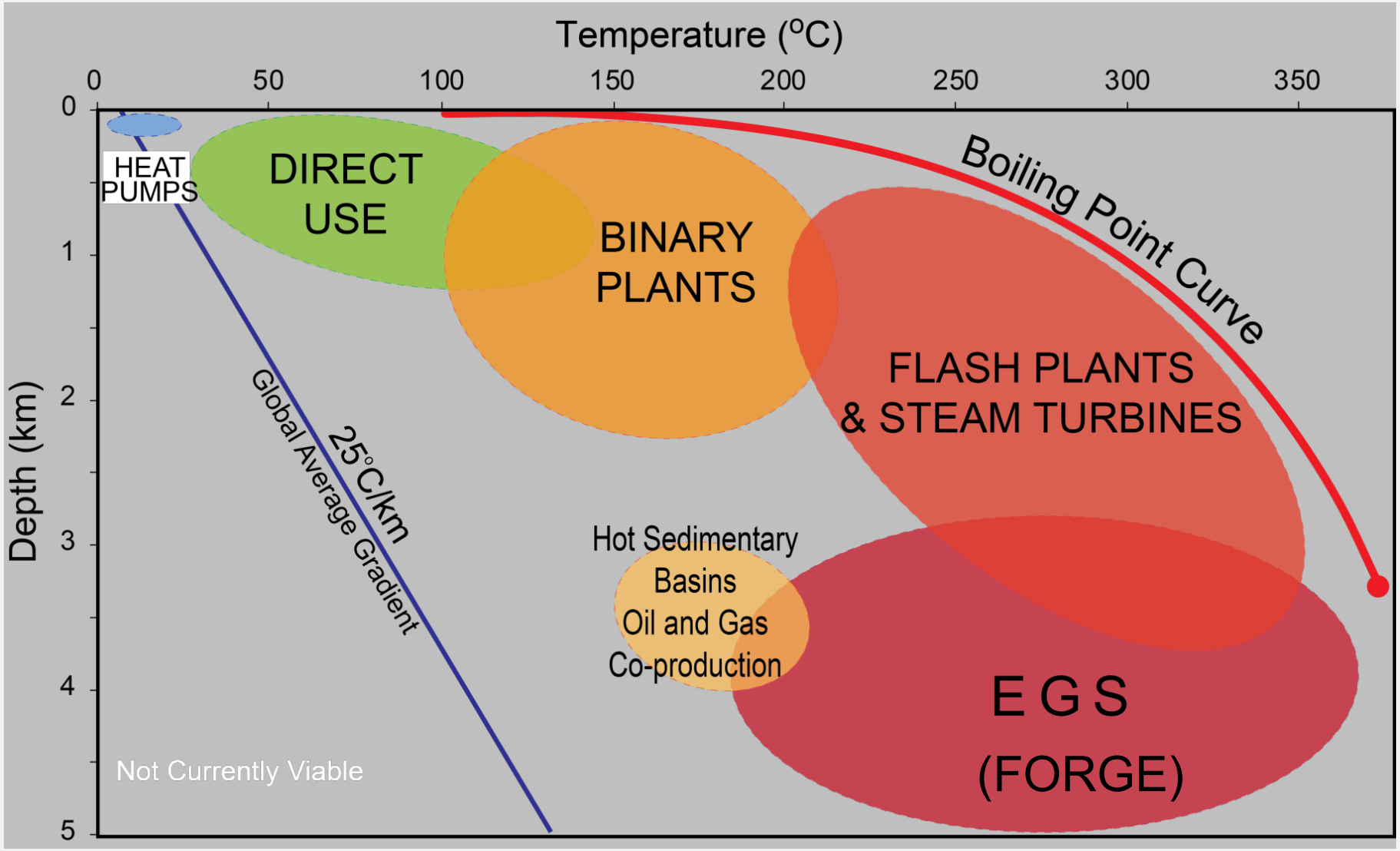
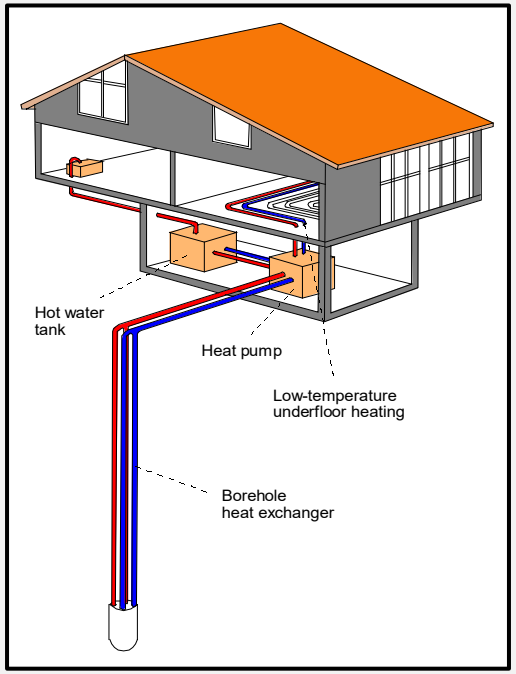
Geothermal Systems



Moore and Simmons, 2013

Geothermal Heat Pumps

- Can be used for heating and cooling
- Extract heat from ground in winter; reject heat in summer
- >1,500,00 units worldwide
- Growing at a rate of 25%/yr
- Savings of 30-70% when heating and 20-50% when cooling

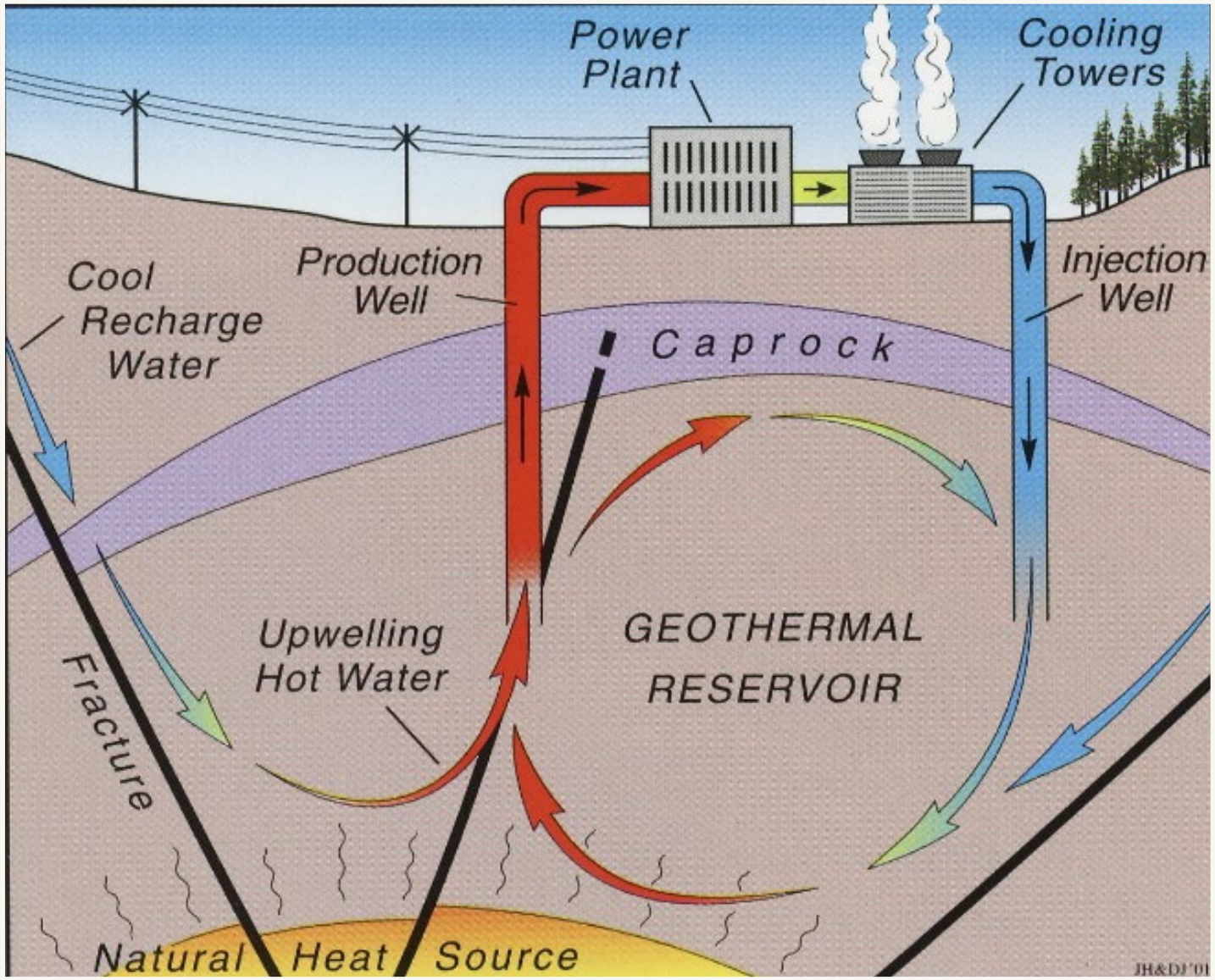


Carolyn and Kem Gardner Building (U of U)

- Save ~$62,000/year vs traditional mechanical system
- Save 1,440,000 gallons of potable water per year
- Eliminate > 4 tonnes CO_2/year released into the air
- 170 wells to depth of 350 ft

Conventional Geothermal Systems

- A heat source
- Water to transport the heat
- Permeable fractures for the water to move through



Direct Uses of Hot Water

- Spas
- Space Heating and Cooling (70 countries)
- Agriculture (greenhouse heating)
- Aquaculture (tilapia, trout, prawns, alligators)
- Industrial Processes (vegetable drying, paper production)

Heating 330,000 sq ft (Utah State Prison)

24 acres of greenhouses (Milgro – Newcastle, Utah)

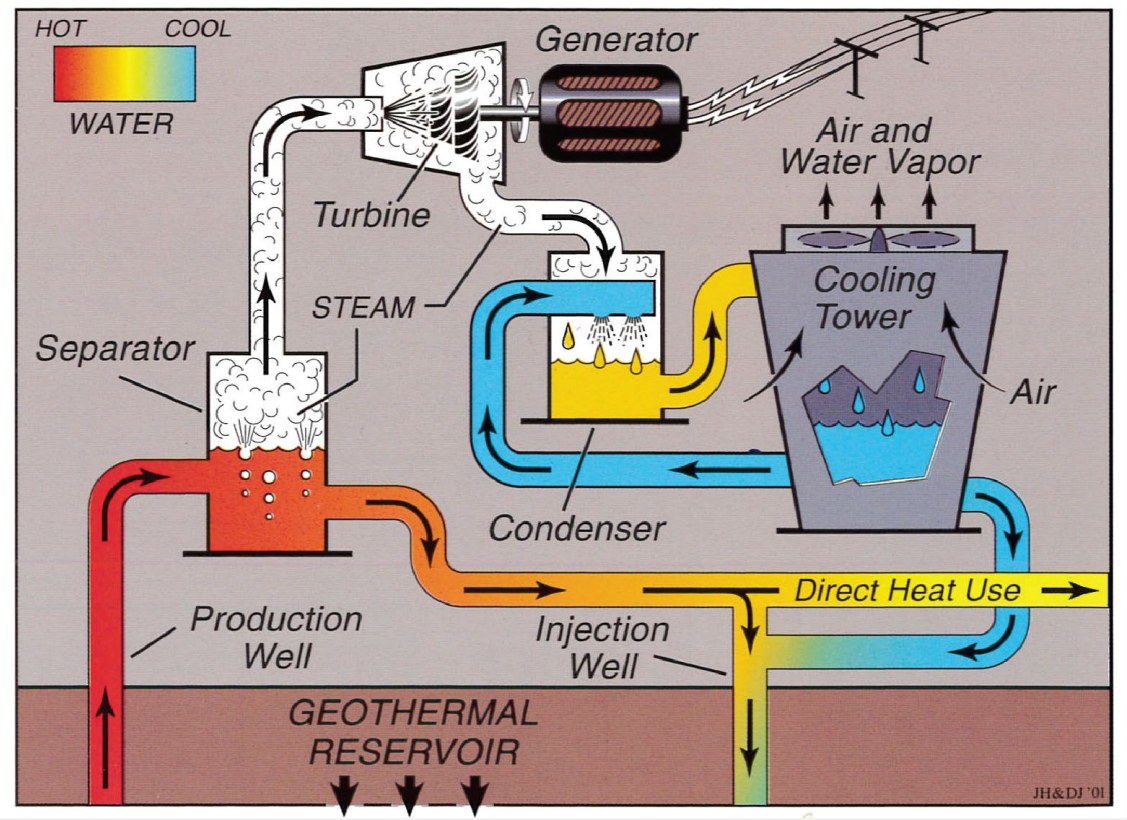
Vegetable drying (Guatemala)

Electric Generation

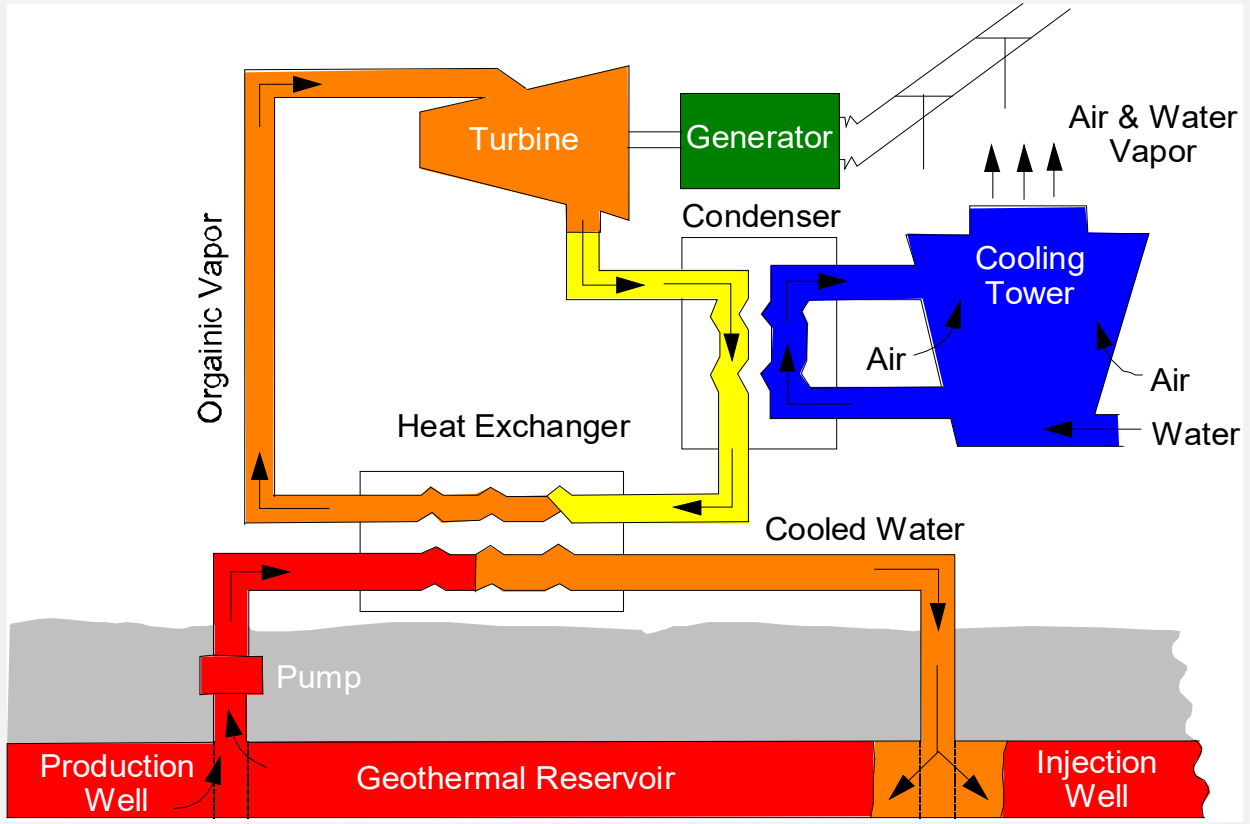
- Electricity can be generated at temperatures >300 F
- PacifiCorp's 36 MWe Blundell Plant
- Compare footprints of geothermal plant and wind farm

Geothermal Power Plants

Steam Plant



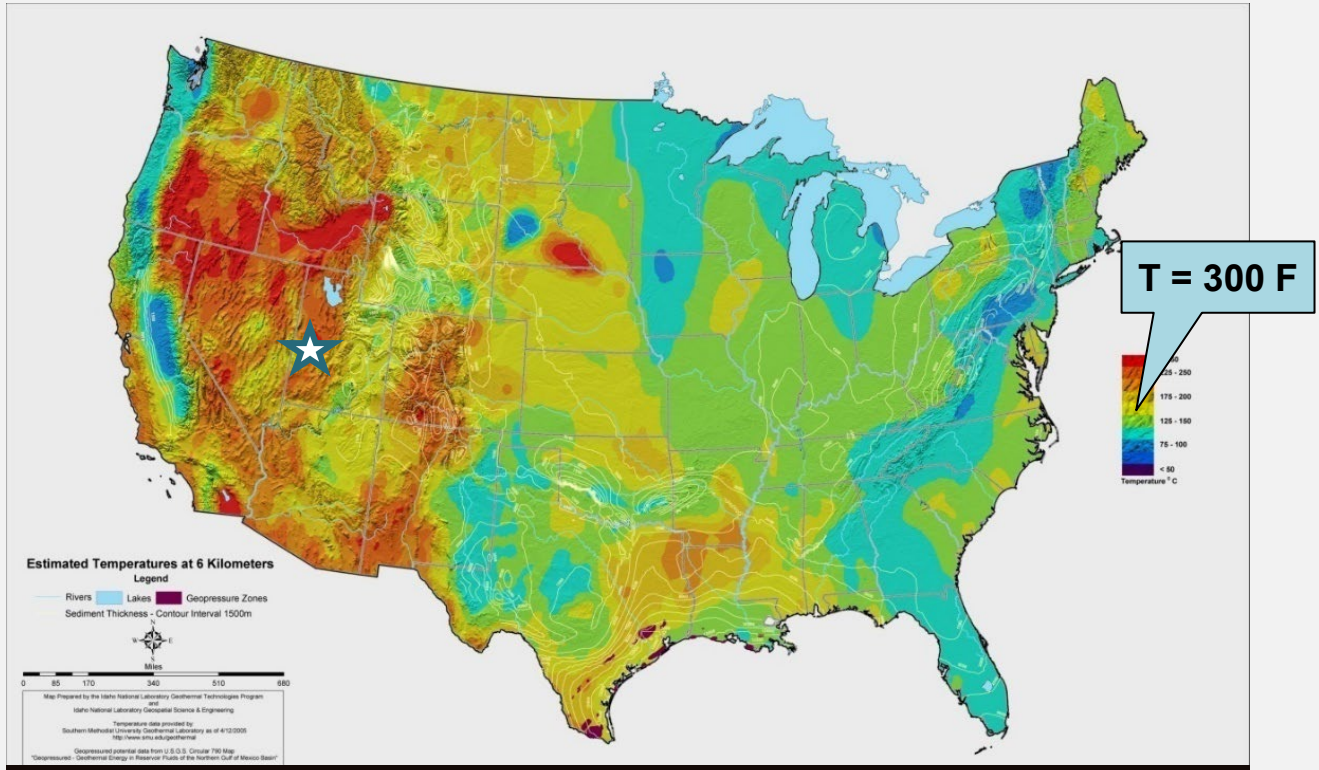
Binary Plant



US Enhanced Geothermal System Resource Base

- The US currently produces ~3700 MWe. Continued development of natural hot spring systems cannot meet DOE's programmatic goals of:
  - 90,000 MWe by 2050
  - Reducing cost of EGS by 90% to $45 per MW hour
- Requires the creation of geothermal reservoirs where none exist naturally.
- **Tapping even 2% of the energy between 2 to 4 miles, would provide more than 2000 times the yearly US energy needs (Tester and others, 2006).**

The heat beneath our feet is inexhaustible



Temperatures at ~4 miles

Data from SMU; from Tester and others (2006)

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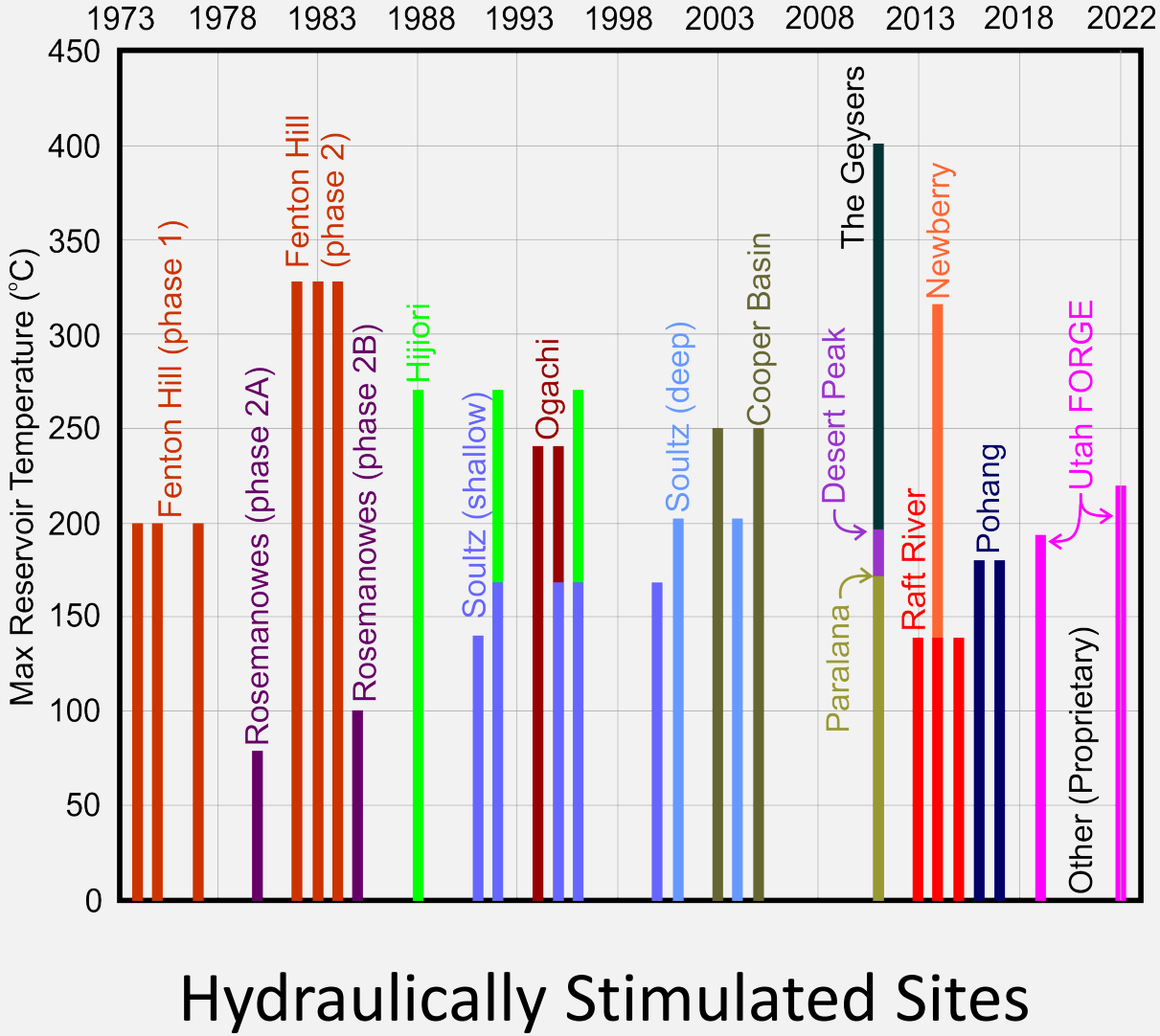
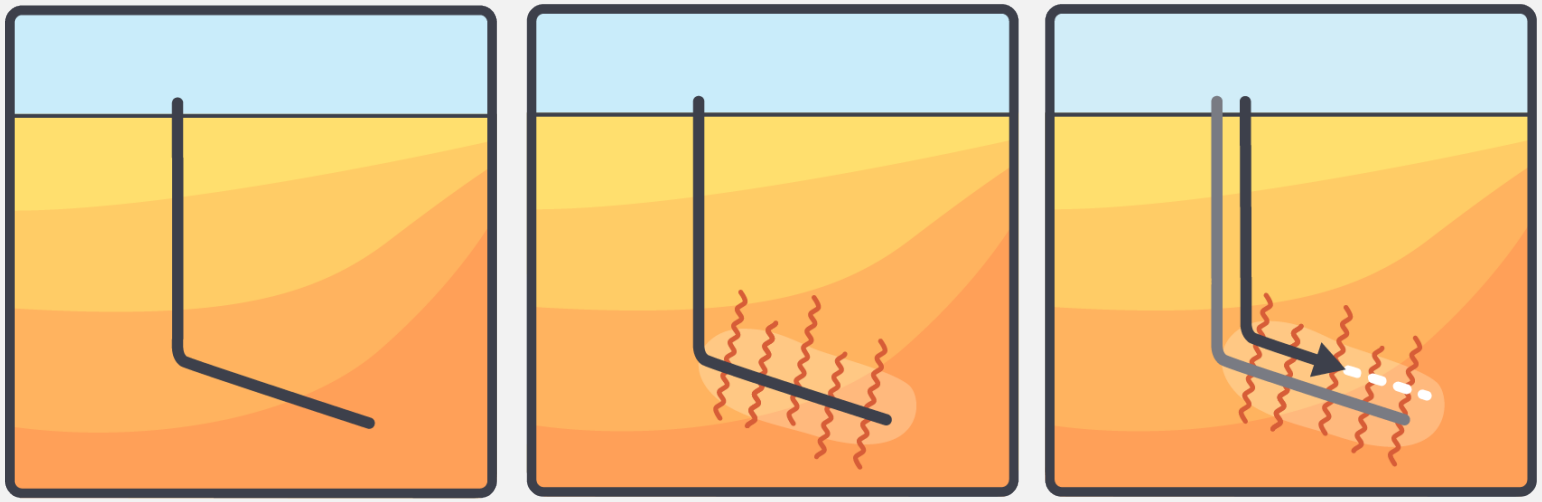
Current State of Enhanced Geothermal System Development

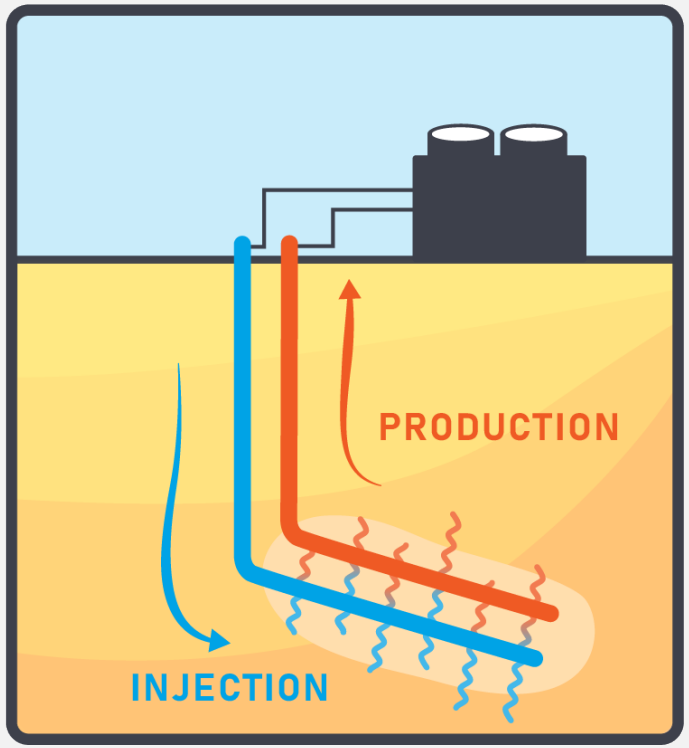
- Over a dozen EGS projects worldwide over past 50 years
- No commercial-scale EGS projects developed from high-T rocks
- Unacceptable levels of induced seismicity have occurred at a few sites
- Flow dominated by a few natural fracture zones in all stimulated systems



Hydraulically Stimulated Sites

Engineering the Geothermal Reservoir





January 2021 **April 2022** **April 2023**

2023-2024

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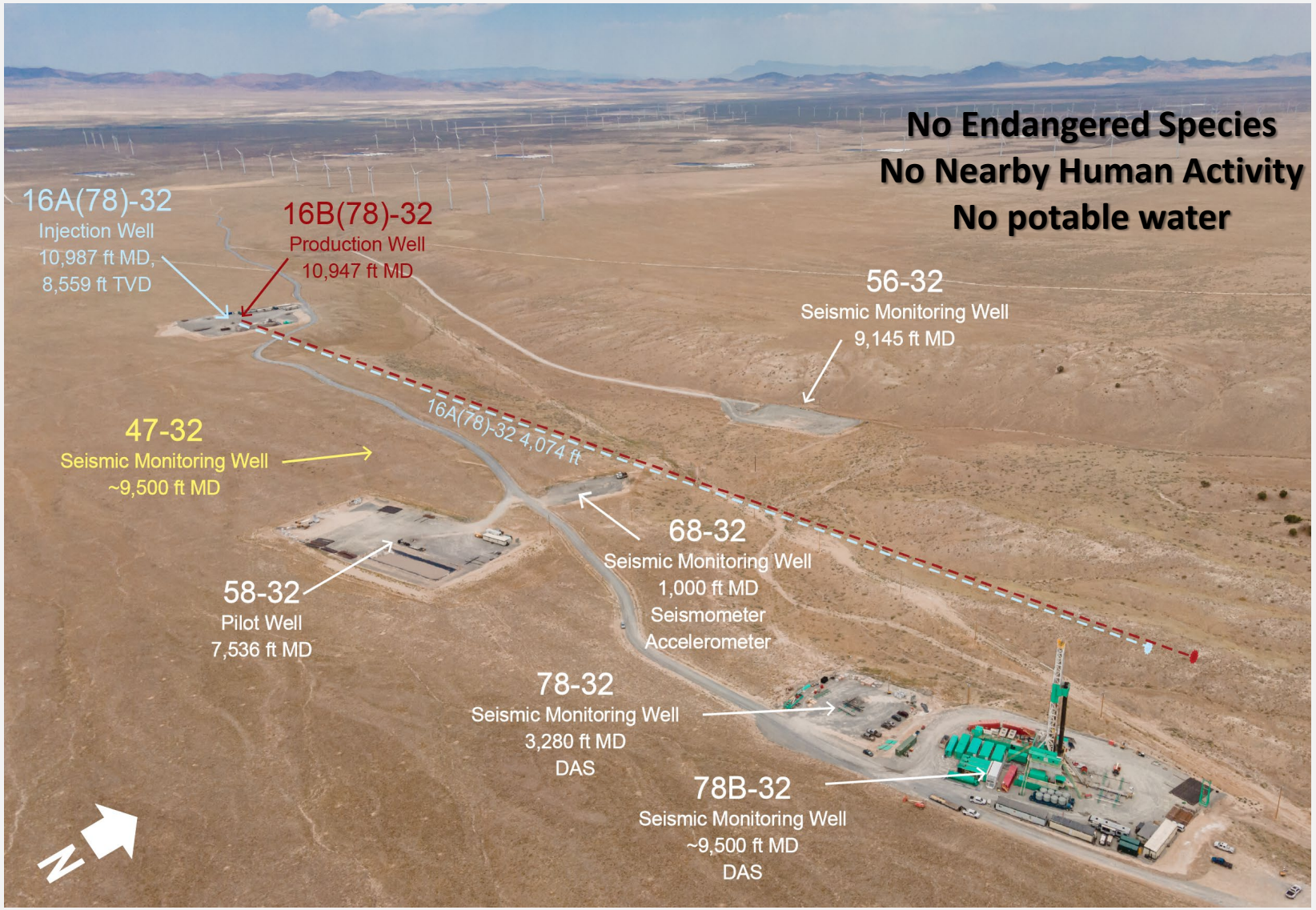
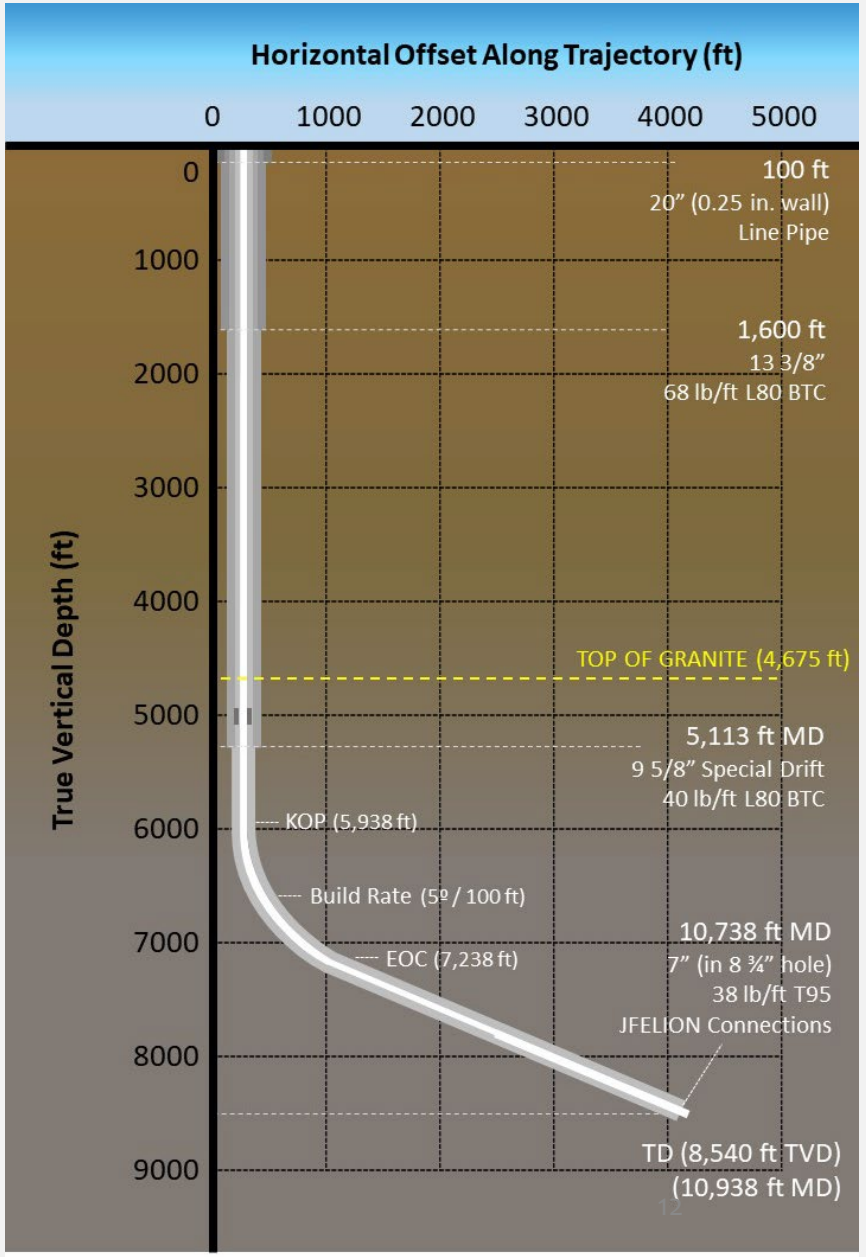
Utah FORGE Wells





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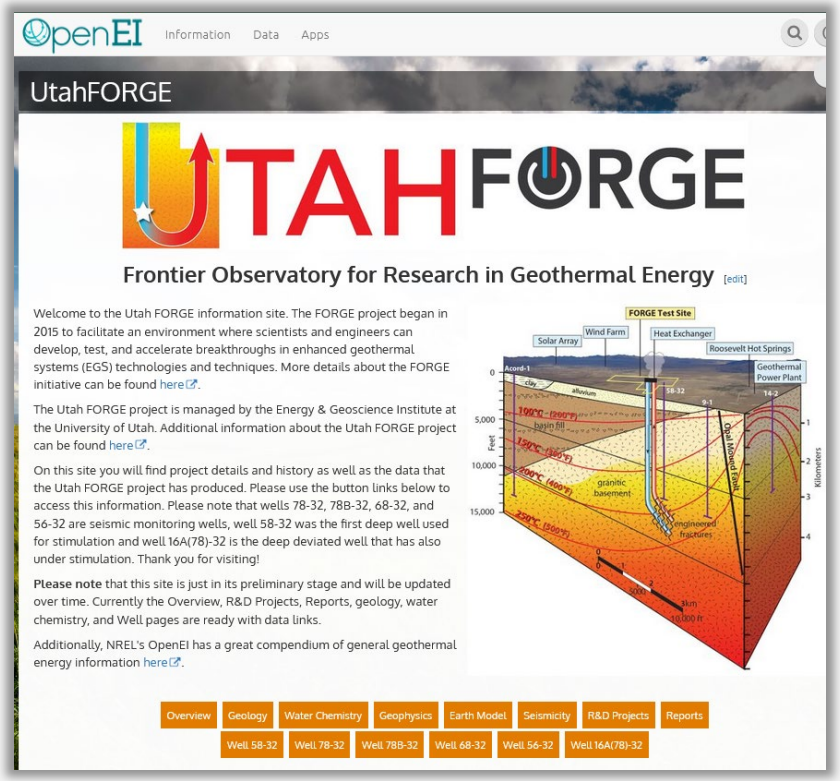
The Impact of Utah FORGE

- ✓ **World's only field laboratory designed** for testing tools/technologies. **Essential stepping-stone** to commercial large-scale geothermal development throughout the US.
- ✓ **New technologies developed at Utah FORGE** significantly reduced the cost of drilling.
- ✓ **Providing economic benefits to several rural economically depressed communities** by using local services.
- ✓ **Educating the public, regulators and elected officials via** website, social media platforms, YouTube channel, classroom lectures and presentations, K-12 contests, STEM activities and participation at local events.
- ✓ **All data collected is publicly available without cost.**



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