

What's New in Geothermal?

A Quick Survey

A Few Statistics

Share of Total Capacity (nameplate) 0.3%

“Increased **renewable energy** consumption in the electric power sector, excluding hydropower, accounts for **23 percent of the growth** in electricity generation from 2009 to 2035.”

US Energy Information Administration
AEO2011 EARLY RELEASE OVERVIEW
http://www.eia.gov/forecasts/aeo/early_elecgen.cfm

Table 1.2. Existing Capacity by Energy Source, 2009
(Megawatts)

Energy Source	Number of Generators	Generator Nameplate Capacity	Net Summer Capacity	Net Winter Capacity
Coal ¹	1,436	338,723	314,294	316,363
Petroleum ²	3,757	63,254	56,781	60,878
Natural Gas ³	5,470	459,803	401,272	432,309
Other Gases ⁴	98	2,218	1,932	1,899
Nuclear.....	104	106,618	101,004	102,489
Hydroelectric Conventional ⁵	4,005	77,910	78,518	78,127
Wind.....	620	34,683	34,296	34,350
Solar Thermal and Photovoltaic.....	110	640	619	537
Wood and Wood Derived Fuels ⁶	353	7,829	6,939	6,992
Geothermal ^R	222	3,421	2,382	2,561
Other Biomass ⁷	1,502	5,007	4,317	4,382
Pumped Storage.....	151	20,538	22,160	22,063
Other ⁸	48	1,042	888	900
Total.....	17,876	1,121,686	1,025,400	1,063,848

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Geothermal Potential

“The U.S. Geological Survey assessment released today is the first national geothermal resource estimate in more than 30 years.


“The results of this assessment show that the United States has an estimated

- 9,057 Megawatts-electric (MWe) of power generation potential from domestic, conventional, identified geothermal systems,
- 30,033 MWe of power generation potential from conventional, undiscovered geothermal resources, and
- 517,800 MWe of power generation potential from unconventional (high temperature, low permeability) Enhanced Geothermal Systems (EGS) resources.”

September, 2008

http://www.usgs.gov/newsroom/article.asp?ID=2027&from=rss_home

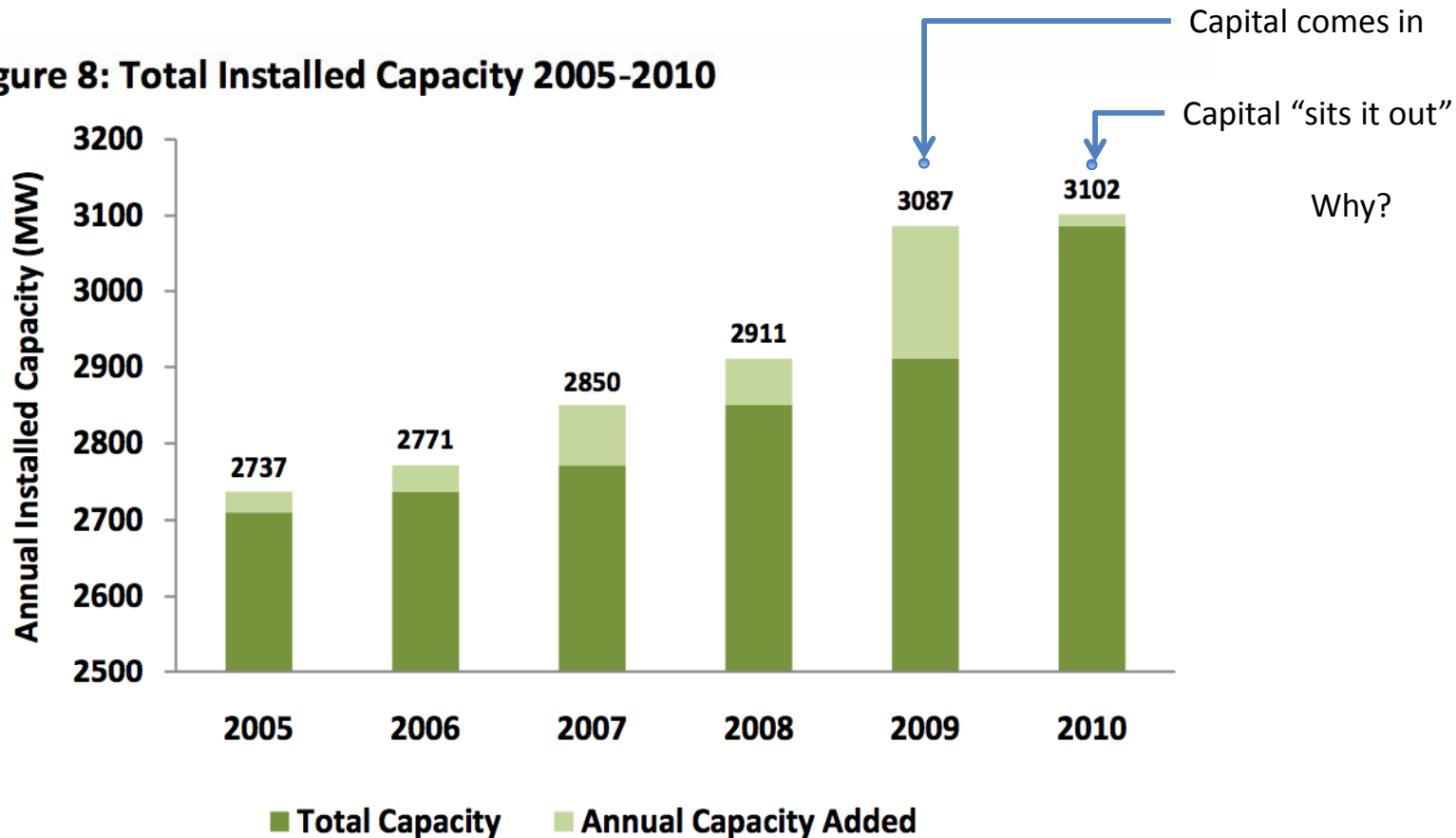
Emphasis added



3x Current Install; 1% Total Need (2009)
10x Current Install; 3% Total Need (2009)
150x Current Install; 46% Total Need (2009)

Pace of Progress in Geothermal

Figure 8: Total Installed Capacity 2005-2010



Source: GEA

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Institutional Capital wants to fund.

Requires:

No Unpleasant Surprises

Takes:

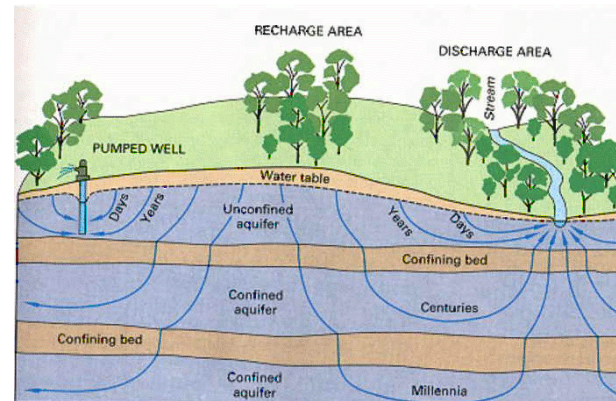
Plan for Managing Downside

Five Steps to Doing a Deal

1. Resource
2. Technology
3. Services
4. Revenues
5. Capital

- Rethinking Resource Definition?
 - Old methods from Oil & Gas = “Target Fixation”
 - New methods build on Geothermal Experience
 - Hydrothermal System Dynamics
 - Heat and heat recharge
 - Water and water recharge

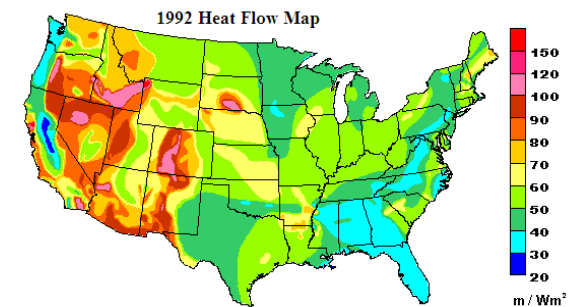
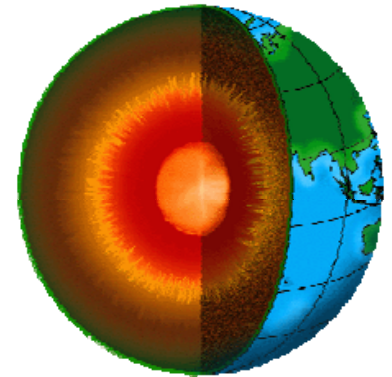
“Flawed Conceptual Model”?



Where does the Heat come from?

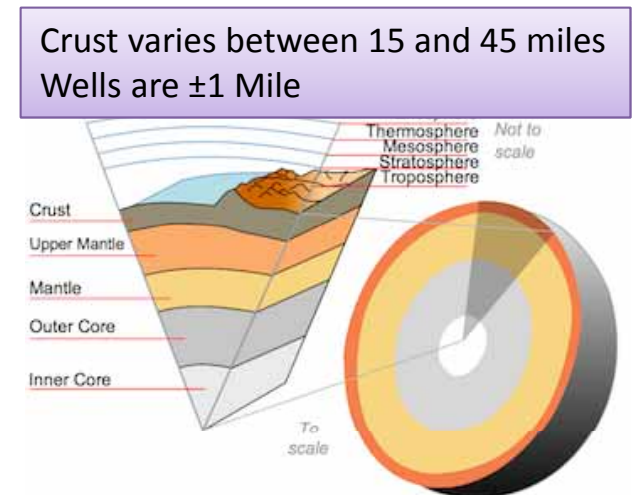
Science tells us:

- Earth is hot at its core
- Core heat is constantly escaping into Space
- Geothermal captures heat “on its way out”
- Heat flow patterns are not uniform
 - Some places “young and hot”
 - E.g. Utah
 - Other places, “old and cold”
 - E.g. New England
- Site-Specific Uncertainties
 - Why is heat flow hotter at shallower depths here?
 - How will heat extraction affect normal heat flow patterns?



A Side Note: Will We Cool the Earth?

- Not likely
 - 9,800° F at its core
 - Constantly losing heat into Space by natural processes
 - Geothermal wells are pinpricks in the Earth's crust





Utah

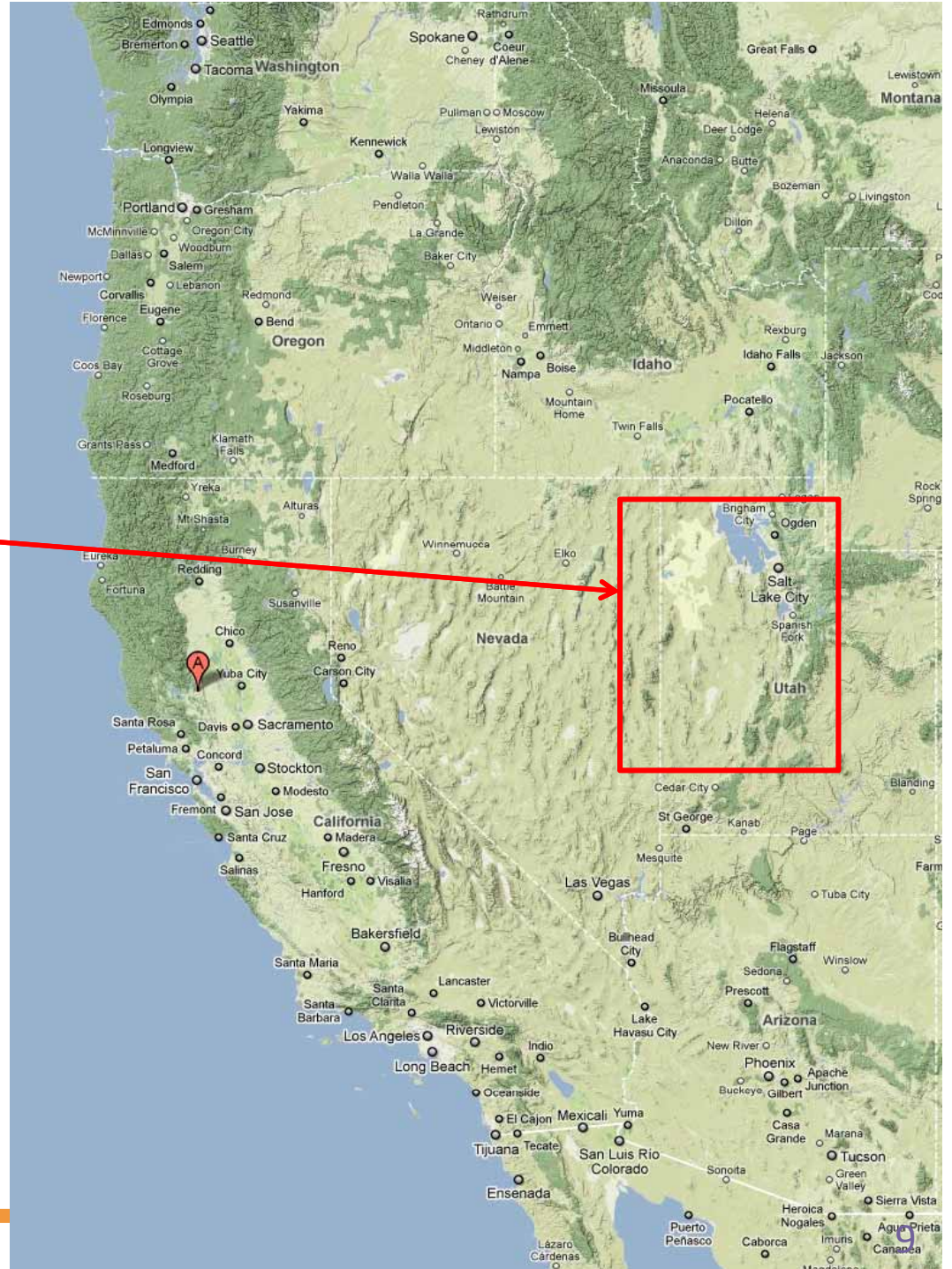
Major Geomorphic Provinces Western U.S.

Coastal Range	Great Valley	Sierra Nevada	Basin and Range
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Central Utah is on the Eastern end of the Basin and Range

High Heat Flow
Subsurface Rock Fractures
Lots of Ground Water

Good Geothermal Potential – esp Binary

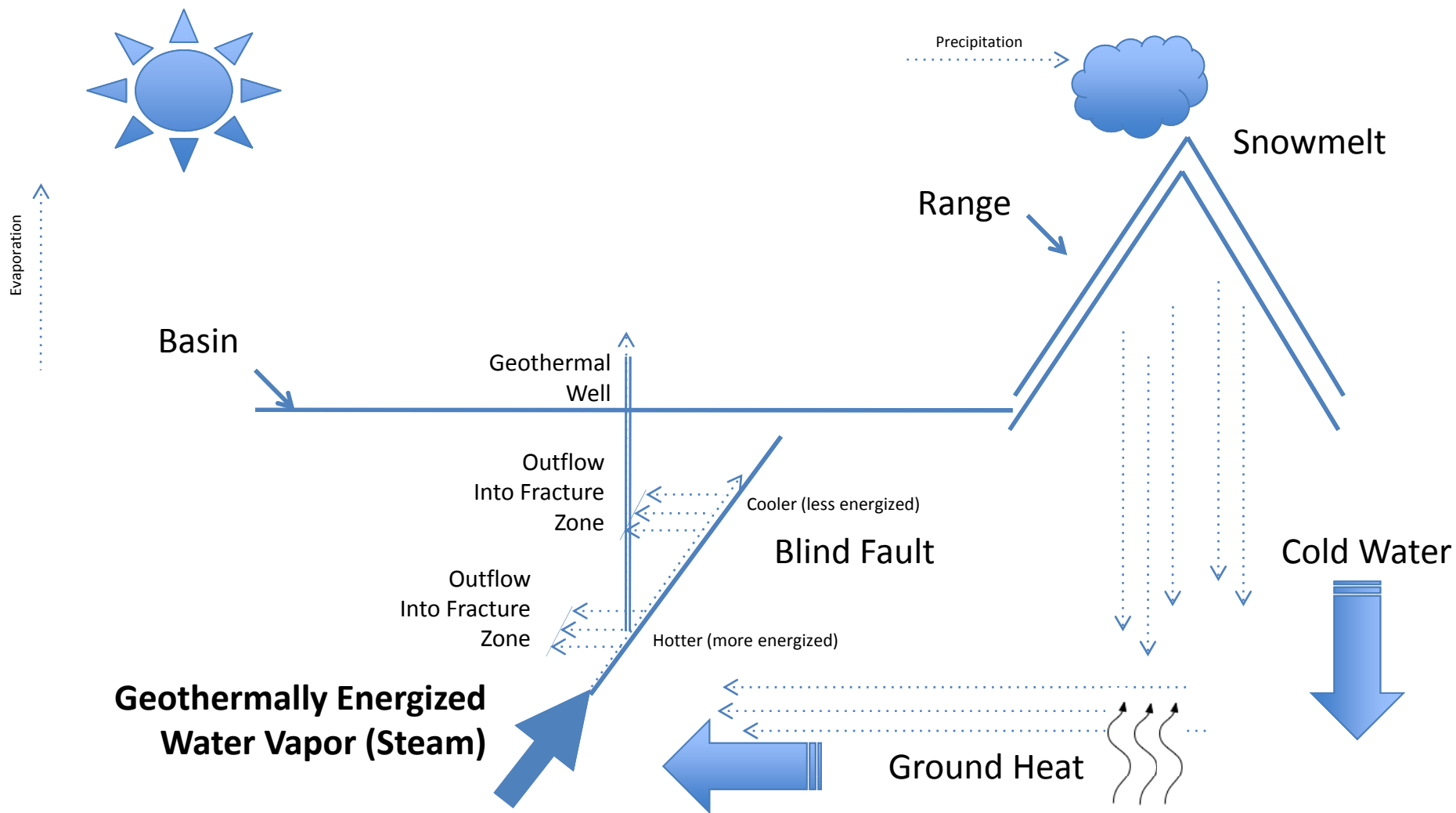


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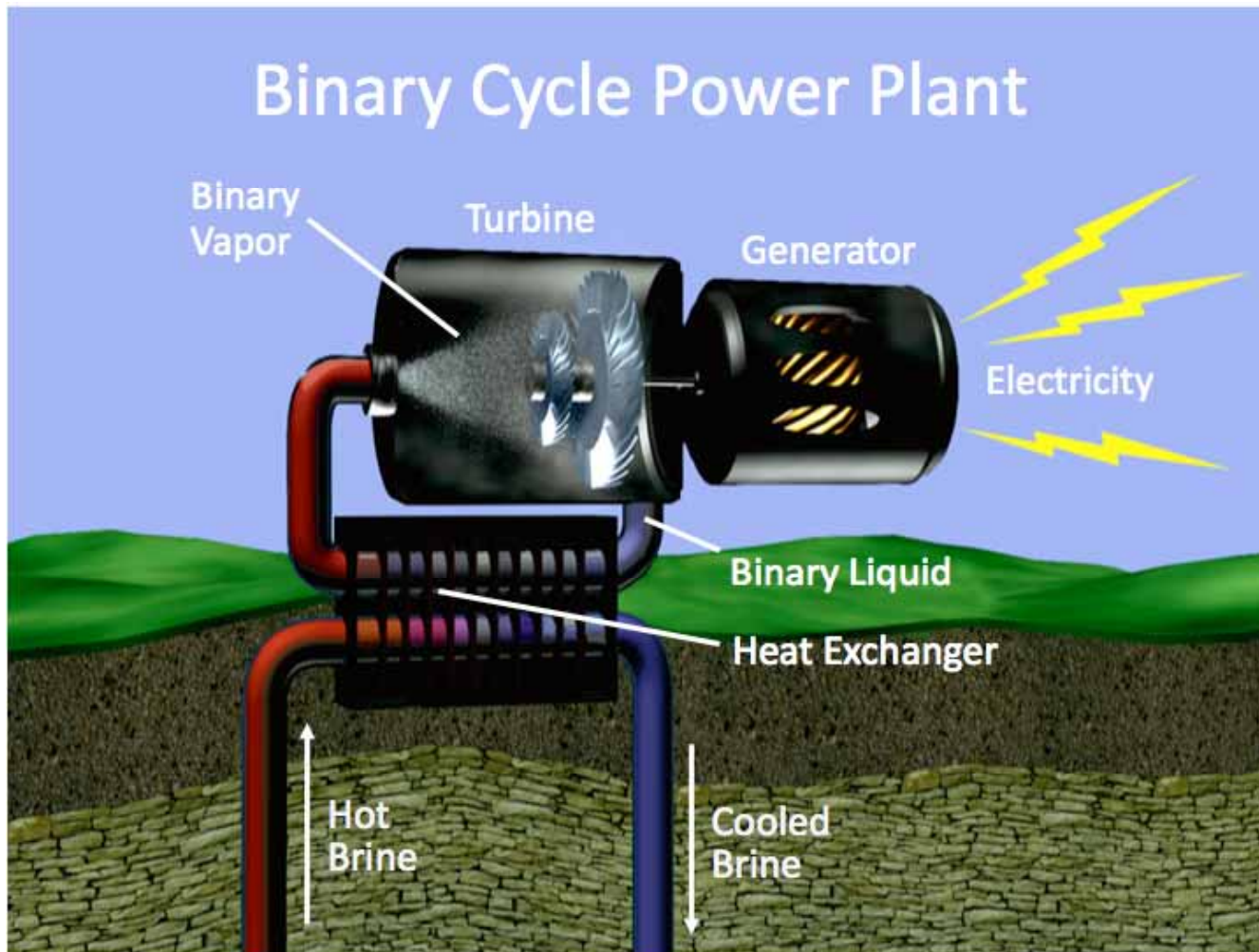
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Basin-and-Range Hydrothermal System



- Surface surveys
 - Seismic
 - Magnetic
 - Geochemical
 - Gas detection
 - Data Integration
- Well drilling
 - Drilling methods
 - Casing and cementing
 - Data logging
- Power generation
 - Flash or Binary?
 - Custom engineered
 - Modular
 - UTC/Turbonden
 - TAS
 - Factory-built to spec
 - Ormat
- Engineered Systems
 - Project life extension
 - New project creation

Technology - Binary Cycle



Works with lower temperature water vapors (“wet steam”)

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A Commercial for LotusWorks

- Partnership Organization
 - To fund Build-Out and Take-Out
- Construction Management
 - To achieve Revenue Services
- Performance Management
 - To deliver expected performance

- Paying for Public Quality of Life
 - Carbon-balanced Power Portfolios
 - Asia is learning the lesson
- Not Market-Driven
 - Renewable Energy Mandates (State-by-State)
- Geothermal is Baseload Renewable
 - Most like coal/gas
 - Complements wind, solar and thermal

- US Government
 - DOE loans and grants
 - IRS tax credits and deductions
- Private Sources
 - Private wealth – identify and define
 - Private equity - develop
 - Project finance - construct
 - Tax equity – subsidize operations
 - Individuals – e.g. micro-cap: TSX

- Much Potential
 - Baseload Renewable most like coal
 - Portfolio approach to carbon-balanced Power Grid
- Capital wants to fund
 - Requires better downside risk management
- Challenge of the Moment: Systems Based Model for Resource Definition
 - Open the flood gates of capital?



Thank You!

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