Tuesday Oct 30, 2012

Geothermal ...Chapter 8

http://geothermal.marin.org/video/vid_page.html
Geothermal Energy

Geothermal Education Office
1-800-866-4436
http://geothermal.marin.org
Temperatures in the Earth

Temperatures in Fahrenheit

Depth in miles

9,000°

7,200°

1,250

2,500

4,000
Temperatures in the Earth

Temperatures in Celsius

Depth in kilometers

4,000°

5,000°

2,000

4,000

6,000
Plate Boundaries

“Ring of Fire”
Hottest Known Geothermal Regions
Temperature Gradient Data

Depth in Ft

°C  50°  100°  150°  200°  250°

- Typical gradient
- Example of core hole gradient in geothermal area

Bottom hole temperature 265°C (509°F)
Easy on the Environment

Geothermal power plants have been built:

- In the middle of crops
- In forested recreation areas
- In fragile deserts
- In tropical forests
Dry Steam Power Plant

Turbine

Generator

Electricity

Steam

Condensed Steam (Water)
Flash Steam Power Plant

- Flash Tank
- Steam
- Turbine
- Generator
- Electricity
- Hot Water
- Separated Water
- Condensed Steam (Water)
Binary Power Plant Heat Exchanger

Binary vapor out to turbine

Binary liquid in from condenser

Heat transfer

Hot geothermal water in from production well

Geothermal water out to injection well
## Countries Generating Electricity with Geothermal Resources

<table>
<thead>
<tr>
<th>Australia</th>
<th>Indonesia</th>
<th>Portugal (Azores)</th>
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</thead>
<tbody>
<tr>
<td>China</td>
<td>Italy</td>
<td>Russia (Kamchatka)</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>Japan</td>
<td>Taiwan</td>
</tr>
<tr>
<td>El Salvador</td>
<td>Kenya</td>
<td>Thailand</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Mexico</td>
<td>Tibet</td>
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<tr>
<td>France (Guadeloupe)</td>
<td>New Zealand</td>
<td>Turkey</td>
</tr>
<tr>
<td>Guatemala</td>
<td>Nicaragua</td>
<td>United States</td>
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<tr>
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<td>Philippines</td>
<td>Zambia</td>
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...and geothermal power plants are planned in several other countries
Direct Uses

• Balneology (hot spring and spa bathing)
• Agriculture (greenhouse and soil warming)
• Aquaculture (fish, prawn, and alligator farming)
• Industrial Uses (product drying and warming)
• Residential and District Heating
District Heating in Western U.S.

- There are 18 district heating systems operating in the western United States.
- Over 270 cities in the western U.S. are close enough to geothermal reservoirs to use district heating.
Geothermal Heat Pumps
(GeoExchange Systems)

Residential and commercial heating and cooling
. . . without a geothermal reservoir
Impact of Energy Use

“Energy production and energy consumption cause more environmental damage than any other peacetime activity on earth.”

Christine Ervin, U.S. DOE, 1996
CO₂ Emissions Comparison (lbs/MW-hr)

Source: EIA 1998; Bloomfield and Moore 1999