Geothermal Heat for Greenhouses, Can it Pay?

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What is Geothermal?

Definition:
- Having to do with the heat of the earth’s interior
Types of Geothermal Heat

- **Low Temperature** (50 deg F)
  - Direct use
  - Heat pumps

- **Medium Temperature** (140 – 300 deg F)
  - Hot water or steam - Direct use

- **High Temperature** – (>300 deg F)
  - Power generation
Current status of the industry

● 600,000 to 800,000 systems in use in U.S.
● 100 greenhouses heated with geothermal
● About one dozen geothermal power plants
### Average soil temperature (10’ depth)

<table>
<thead>
<tr>
<th>Date</th>
<th>Soil temperature</th>
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<tbody>
<tr>
<td>Sept. 1</td>
<td>58 deg. F</td>
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<tr>
<td>Oct. 1</td>
<td>59</td>
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<td>Nov. 1</td>
<td>59</td>
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<td>Dec. 1</td>
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<td>Mar. 1</td>
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<tr>
<td>Apr. 1</td>
<td>47</td>
</tr>
<tr>
<td>May 1</td>
<td>47</td>
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</tbody>
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Soil temperature
Geothermal system in Japan
Water Systems

Horizontal Loops

Pond Loops
Polyethylene Pipe
Increase temperature with a heat pump
Heat Pump

- 1 ton = 12,000 Btu/hr
- 1 ton will heat about 200 sq ft of greenhouse
- Cost - $800 to $1200/ton
- Typical heat savings – 30 to 50%
Multiple heat pump installation
Heat Distribution
Air Systems

Lateral Earth Tube

Radial Earth Tubes
Example System

Earth Tube
Warm air heat collection system
System Specifications

- 25’ x 100’ exterior section of gutter-connected greenhouse
- Heat needs - 60°F inside, 25°F outside – 140,000 Btu/hr
- Supplies about 80% of heat
- Rest from fossil fuels
System Design

- 8” diameter tubes
- Trench width – 30’
- Stacked system – 3’ between tubes
- Tube length – 100’
- Temperature rise – 12 - 14°F
- Heat collected – 72,000 Btu/hr
Economics

- Two 30’ x 100’ systems: $20,000
- Connection to greenhouse: 5,000
- Heat pump: 10,000
- Total cost: $35,000
Payback

- Assume: fossil fuel cost - $2.50/gal.
- 2000 hours of operation/year
- Electricity cost - $500/yr
  - System cost = $35,000

\[
\text{Payback} = \frac{\text{System cost}}{\text{Savings}} = \frac{35,000}{3,000} = 11.7 \text{ years}
\]
Example: Pond system
Potential for geothermal installation
Applications for Geothermal

● Without heat pump
  – Nursery stock overwintering
  – Perennial and herb production
  – Lettuce and greens production

● With a heat pump
  – Production of annuals
  – Tomato production
Use ground for cooling in summer

- Heat transfer from greenhouse to the soil
- Same system – hot air or water
- Reduce ventilation needs
- Increase time CO₂ is effective
Consider: Energy Conservation First

- Infiltration
- Energy blankets
- Insulation
- Good space utilization
- Electronic controls
- Natural ventilation
- Furnace maintenance