Geothermal HVAC Metered Comparison for National Chain Quick Service Restaurant

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Key Points:

- How GSHP’s are more efficient and offer the greatest potential for energy savings

- Air Source HVAC efficiency goes down when outdoor temperatures go up

- GSHP’s are environmentally better, why not take advantage of the constant temperature of the earth….

- GSHP’s can be feasible in cooling dominant regions

- Metered Project – Cost, Payback and ROI
The Earth is an Efficient Place to Reject Heat in the Summer... and to Extract Heat in the Winter...

Outdoor air design temperature: 95°F summer, 30°F winter

Delta T = $ to operate!!!
Geothermal Heat Pump Efficiency

1 kWh of energy from the grid

Plus: 3-5 kWh of energy from the earth

Yields: 4-6 kWh of energy for the building

400-600% Efficient (COP of 4-6)

Electric Heat – 1.0 COP
Gas Heat - .8 to .9 COP
Project Details

• Location: Pensacola, FL
• Multi-Geothermal HPs (40 tons @ 15 EER-2 speed cap)
• 1” loops in 4” boreholes with no grout on 30’ centers
• 56 ground loops – 4 x 14 grid
• Single variable speed pump (3 HP w/ redundant
• Ground Properties(average in a 350’ borehole)
  – Temperature: 72 deg F
  – Thermal Conductivity: 1.37 Btu/hr-ft-deg F
## Specific Equipment Metered

<table>
<thead>
<tr>
<th>Conventional Store RTU’s</th>
<th>Ground Source Geothermal HP Test Store</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – 17.5 Ton --11.5 EER</td>
<td>6 – 6 Ton GHP’s --15 EER</td>
</tr>
<tr>
<td>60 kW Heat each unit</td>
<td>5.0 COP</td>
</tr>
<tr>
<td></td>
<td>No kW Supplemental Heat</td>
</tr>
<tr>
<td>1 – 4 Ton Heat Pump</td>
<td>1 – 4 Ton GHP –15.8 EER</td>
</tr>
<tr>
<td>(13.5 SEER, 11.5 EER)</td>
<td>5.1 COP</td>
</tr>
<tr>
<td>7 kW Supplemental Heat</td>
<td>No kW Supplemental Heat</td>
</tr>
<tr>
<td></td>
<td>Total – 39 Tons</td>
</tr>
<tr>
<td></td>
<td>Total – 40 Tons</td>
</tr>
<tr>
<td>Hot Gas Reheat</td>
<td>1- 3HP Loop Pump w/VFD w/redundant spare</td>
</tr>
<tr>
<td></td>
<td>Hot Gas Reheat</td>
</tr>
</tbody>
</table>
HVAC Consumption of Total Bill

Energy Usage
"Geothermal Store"

- HVAC: 16%
- Other: 84%

Energy Usage
"Conventional Store"

- HVAC: 25%
- Other: 75%

Only 1% Heating Load
A better question to ask when comparing HVAC efficiency is:

What’s the efficiency (EER) when it’s 90-95 degrees outside?
What happens to A/C system Efficiency?
Actual Hourly Temperature for August
Averaged 2011/2012

Roof is 5-6 Degrees Hotter than Ambient
HVAC Equipment Efficiency at Peak

**Geothermal A/C**
- 15 EER
- 30% > Efficiency
- 54% > Efficiency

**Roof Top Unit**
- ARI 11.5 EER, 12.3 IPLV
- 16% Efficiency Reduction from hotter ODT

Average Temperature vs. Hour
HVAC Demand for System Peak Day
August 1st, 2012

- RTU HVAC
- GSHP’s
HVAC System Metered Building – 40 Tons

Total AC vs. Roof Temperature by Store
Start Date = 08/21/2011, End Date = 08/27/2011

Peak Load ~35 Kw
Peak Load ~19 Kw

RED -- RTU’s
Blue -- GSHP’s
(.4-.5 Kw/ton less)

.9 Kw/ton
.48 Kw/ton

100-103 Roof Top Temp

Day of Week

Rooftop Temperature (F)
2-Year Average Energy Consumption Comparison

Conventional Rooftop Units

Geothermal Units

Air Source Roof Top Units

Geothermal Heat Pumps

KWH

Jan Feb Mar Apr May June

5,000 7,000 9,000 11,000 13,000 15,000 17,000 19,000
Note: Due to mild winters, 98% of the savings was space cooling.
Geothermal Break Even & 20 Year Cost Benefit Analysis

- Project Cost
- Energy Savings + Replacement costs (Cumulative)

Break Even Point

Equipment Replacement Cost

20% ROI

$407,998

$2500/ton more

2% annual escalation

w/Tax credit & incentives

Years
Geothermal HVAC Cautions

GSHP’s work great when designed and installed correctly!

If you want a successful geothermal project:

- Use experienced design engineers
- Use experienced drillers
- Use experienced installers
- Don’t cut corners and you will get what you expect!