Ground Source Efficiency

It’s Better Than You Think!

Keith Swilley
Energy Sales and Efficiency Manager
Efficiency – What’s really happening?

Space Cooling*

Space Heating

Heating Cost/Carbon
GSHP Metered Operating Costs

Heat & Cool
2000 Square Feet
$381/year
HRU saved 33% WH
Water-to-Water saved 54% WH

Heat & Cool
2500 Square Feet
$344/year
How are GSHP’s More Efficient?
Underground Temperatures

* At well depths of 30 to 60 ft
70-75 degrees NWFL

"70-76 in homes"

30 – 95 degrees ambient

Heat transfer Refrigerant/Water/Ground

Sustainable – Ground loop 50+ years
-- ground loop will multiple unit replacements

HRU -- 30- 50% FREE Hot Water! 50% reduction on demand (W-W)

Earth Loop: Horizontal, Vertical, Pond (or Well Water)
Annual Operating Costs Comparison

- Arnold High - Closed Loop Geothermal System (completed Aug, 2000)
- School A - Gas Boiler/Chiller System (Updated w/ new equipment 1996)
- Bay Haven Charter School – Closed Geo System
- School B - Air to Air Heat Pumps in classrooms; Gas/chiller in common areas (completed 1996)
- School C - All Electric-Gulf Coast Coop
- Washington Co. – Includes Rouhlac Middle School & Chipley High School – Open Geo System

Note: 12 month average

Average savings for Geothermal Schools 54%
Geothermal Heating & Cooling

Hurricane Proof

Hurricane Ivan 2005
How are GSHP’s More Efficient?

“Space Cooling”
HVAC Efficiency

✓ Know what your buying!
✓ Verify the efficiency rating by each unit! “every unit is different”
✓ Know the difference between air source and ground source efficiency!
Efficiency

✓ Know what your buying!

Air Source
~~ up to 19 SEER  ??
~~ up to 20 SEER  ??

Ground Source - Geothermal
~~ up to 27 EER  ??
~~ up to 30 EER  ??
A/C Efficiency

Seasonal Energy Efficiency Ratio (SEER)

Energy Efficiency Ratio (EER)

• SEER – the total cooling output provided by the unit during its normal annual usage period divided by its total energy input during the same period.

• EER for Air Source Systems – Efficiency/Capacity at 95 degree ODT

• EER for GSHP’s – Efficiency/Capacity determined by entering water temperature.

✓ Don’t be confused, SEER IS NOT EER!
Energy Efficiency Ratio (EER)

EER = btu capacity/system watts

Example – 3 ton unit

36000 btu/10 EER = 3600 watts
36000 btu/15 EER = 2400 watts

15 EER is 33% more efficient or lower to operate!!!
Air Conditioning Refrigeration Institute “ARI”

**ARI – Tests all A/C Equipment for SEER/EER**

- ARI Test Conditions – 95 ODT, 80 IDT/67 WBT
- Manual J Load Conditions – 95 ODT, 75 IDT/63 WBT
- Not tested at “real world” space cooling conditions
- Air Source System Capacity/Efficiency vary by Indoor/Outdoor Conditions
Efficiency Comparison

Space Cooling Efficiency

3 Ton Single Speed Air Source Systems
13 SEER -- 11 EER
14 SEER -- 12 EER
15 SEER -- 13 EER

When Do I have the SEER efficiency?

2-Speed High SEER Air Source Systems
2 ton - 19 SEER -- 14 EER
3 ton - 18.6 SEER -- 13 EER
4 ton - 17.5 SEER -- 12 EER
5 ton - 17 SEER -- 11 EER

Ground Source HP’s -- 16-21 EER
HP-A/C Efficiency Analysis

SEER - Single Speed Air Source Compressors
Air Source to Ground Source Efficiency

Energy Efficiency EER

11-13 EER

Outdoor Temperature

17-19 EER

ARI

13 SEER

14 SEER

15 SEER

16 SEER
Outdoor Ambient Temperature Affect on Home Btuh Requirements

Example - 2255 SF Home – Code Construction

Btuh Heat Gain to maintain 75 indoors

Outdoor Temperature

<table>
<thead>
<tr>
<th>Outdoor Temperature</th>
<th>Btuh Heat Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>10000</td>
</tr>
<tr>
<td>85</td>
<td>20000</td>
</tr>
<tr>
<td>95</td>
<td>30000</td>
</tr>
</tbody>
</table>

11-13 EER

12-14 EER

Air Source Efficiency

“The best efficiency is when the A/C unit runs the least!”

75% More

138% More

“The best efficiency is when the A/C unit runs the least!”
HP-A/C Efficiency Analysis

High SEER Air Source Units

SEER – 2--Speed Compressors
Best Air Source vs Best Ground Source Efficiency

2 – Speed Systems
"High" - Capacity Mode

Energy Efficiency Rating (EER)

19 SEER Air Source High Speed
Ground Source High Speed

Outdoor Temperature

- 19 SEER Air Source High Speed
- Ground Source High Speed
Best Air Source vs Ground Source Efficiency

2 – Speed Systems
“LOW”- Capacity Mode

Energy Efficiency Rating (EER)

- 19 SEER
  - Air Source Low Speed
  - Ground Source Low Speed

Outdoor Temperature

- 75
  - 27 EER
  - 70 EWT

- 85
  - 23.5 EER
  - 21 EER

- 95
  - 17 EER
  - 90 EWT

- 12.6 EER
HVAC Efficiency

What about Commercial?

Chillers
Roof-Top Units/Air Cooled HVAC
GSHP’s
Chiller Efficiency Example

- Chiller VAV System - 0.5 kw/ton – 24 EER

- Adding the auxiliary components:
  - Air Handler Fans
  - Chilled Water Pump
  - Condenser Pump
  - Cooling Tower Fan
  - Zone or VAV Fans

- Overall System Efficiency Result ---- 7-8 EER

Chiller Efficiency Example

(Actual New Commercial Building 120 Tons)

Air Cooled Chiller – (condenser fan & compressor)  9.3 EER -- 155 Kw

Adding the Auxiliary Components:

Chilled Water Pump  -- 11 kw
AHU Motors  -- 61 kw

Total Auxiliary  -- 72 kw

Overall System Kw  --- 72 + 155 = 227 kw

Overall Full Load System Efficiency

-- 120 tons x 12,000/227,000 watts = 6.3 EER -- 1.89 Kw/ton
Geothermal Efficiency Example

(Actual New Commercial Building – Closed~Loop – 116 Tons)

Water Source Heat Pumps – 116 tons - 13.5 EER – 103 Kw

Adding the Auxiliary Components:
Circulation Pump -- 7.46 kw

Overall System Kw --- 7.46 + 103 = 110.46 kw

Overall System Efficiency
116 tons x 12,000/110,460 watts = 12.6 EER -- .95 Kw/ton
Geothermal Efficiency Example

*(Actual New Commercial Building – Closed~Loop – 19 Tons)*

Water Source Heat Pumps – (6 units) 15.5 EER – 14.7 Kw

Adding the Auxiliary Components:

Circulation Pump -- 1.7 kw

Total Auxiliary -- 1.7 kw

Overall System Kw --- 1.7 + 14.7 = 16.4 kw

Overall System Efficiency

19 tons x 12,000/16,400 watts = **13.9 EER** -- **.86 Kw/ton**
Commercial Air Source A/C vs Ground Source Efficiency

Energy Efficiency
EER

Outdoor Temperature

Ground Source – 14-15 EER

Air Source

- 7.5 Ton 11 EER
- 10 Ton 11 EER
- 15 Ton 10.6 EER
- 20 Ton 10 EER

Air Source – 10-11 EER

Air Source – 9-10 EER

Air Source 8-9 EER
Air Source vs Ground Source Efficiency

**Conclusion**

At Typical Summer Outdoor Temps – 85-95 degrees:

The SEER Rating Efficiency is realized at very low outdoor ambient temps (~75 degrees) -- when there are less run operating hours

**Residential 2-Speed System Efficiency**

- Ground Source Exceeds Air Source Efficiency – 26% for high speed A/C operation
- Ground Source Exceeds Air Source Efficiency – 33% on low speed A/C operation

**Single-Speed System Efficiency**

- Ground Source Exceeds Air Source 13 SEER Unit Efficiency – 40% on A/C Operation
## “Conclusion”

### Commercial HVAC System Efficiency

<table>
<thead>
<tr>
<th>System</th>
<th>Efficiency (Kw/ton)</th>
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<tbody>
<tr>
<td>Chillers</td>
<td>1.8</td>
</tr>
<tr>
<td>Roof-Top Units</td>
<td>1.2</td>
</tr>
<tr>
<td>GSHP’s</td>
<td>0.9</td>
</tr>
</tbody>
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### GSHP’s vs Air Source System Efficiency

- 25% more efficient than packaged equipment
- 50% more efficient than air cooled chillers
How are GSHP’s More Efficient?

“Space Heating”
### Heating Cost Comparison

<table>
<thead>
<tr>
<th>Method</th>
<th>BTUs</th>
<th>COP/AFUE</th>
<th>Kwh</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Heat</td>
<td>1,000,000/3413</td>
<td>1.0</td>
<td>293</td>
<td>$35</td>
</tr>
<tr>
<td>ASHP</td>
<td>1,000,000/3413</td>
<td>3.0 COP</td>
<td>97.7</td>
<td>$12</td>
</tr>
<tr>
<td>Gas Heat</td>
<td>1,000,000/100,000</td>
<td>0.80 AFUE</td>
<td>12.5</td>
<td>$25</td>
</tr>
<tr>
<td>Gas Heat</td>
<td>1,000,000/100,000</td>
<td>0.90 AFUE</td>
<td>11.1</td>
<td>$22</td>
</tr>
<tr>
<td>Geo GSHP</td>
<td>1,000,000/3413</td>
<td>4.5 COP</td>
<td>65</td>
<td>$8</td>
</tr>
</tbody>
</table>

Kwh – 12cents (Gulf Power)
Therm - $2.00 (NW Fl Avg)
Conventional Gas Furnace 80% AFUE
Conventional Gas Furnace 90% AFUE
Air Source Heat Pump
Geothermal "Ground Source" Heat Pump

Heating Cost Per Millions BTU’s
Operating Cost and Carbon Foot Print

Cost($)

Heating Cost Per Millions BTU’s
Operating Cost and Carbon Foot Print

60% less heating cost
40% less carbon

Operating Cost
Carbon Foot Print (lbs)
Extreme Makeover Show Home

ABC – December 2010
Questions