# RESIDENTIAL GROUND SOURCE HEAT PUMPS

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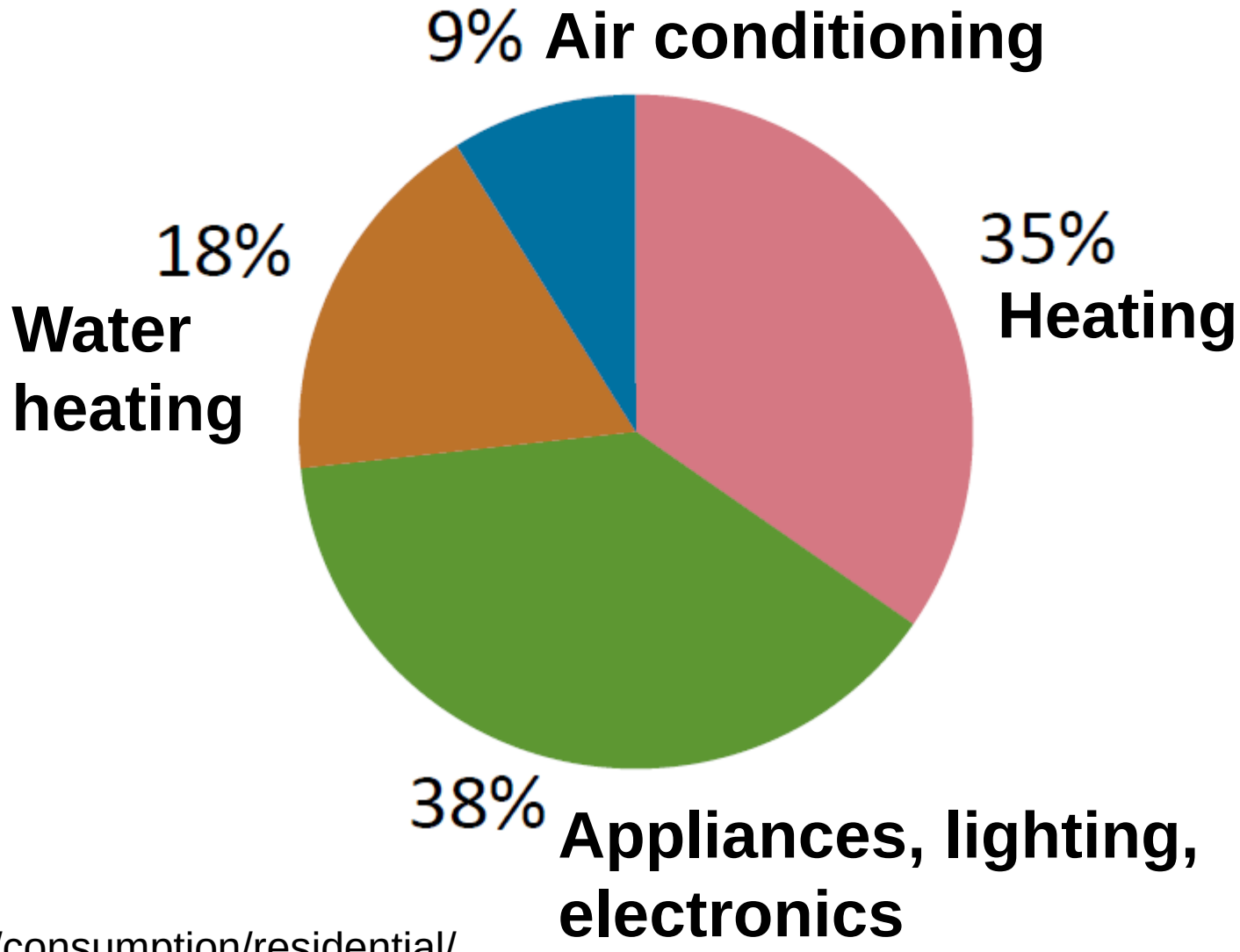
# ENERGY USE IN AVERAGE VIRGINIA HOME (2009)




http://www.eia.gov/consumption/residential/

# ENERGY USE IN AVERAGE HOME

- **Heating and cooling accounts for 40% to 50% of energy use in average U.S. home**
  - Depending on location and heating system selection

- **Compared to the U.S. average, a greater proportion of Virginia households heat with electricity (55%) and a smaller proportion use natural gas (35%) (www.eia.gov, 2013)**

- **Energy efficiency improvements:**
  - ~50,000 geothermal (ground source) heat pumps (GSHP) installed in the United States each year (energy.gov)

# ENERGY EFFICIENCY: GEOTHERMAL

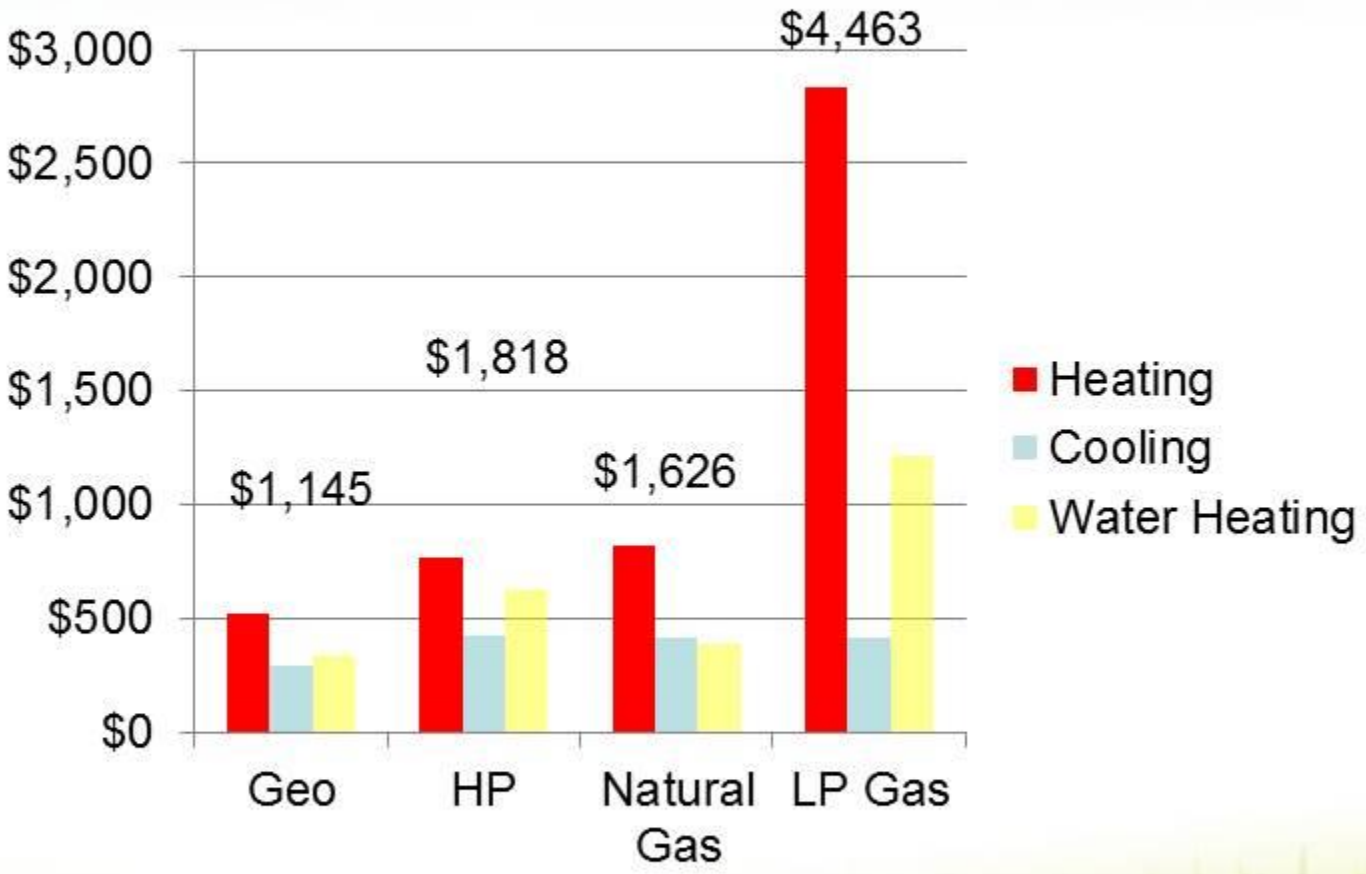
- Environmentally friendly, renewable capture of solar energy striking land/water
- Soil/water temperatures moderate but steady year round
- Uses 25% to 50% less electricity than conventional home heating and cooling system
- Can reduce energy consumption, and corresponding $CO_2$ emissions, up to 44% compared to air source HP and 72% compared to electric heat and standard A/C

- ~50,000 geothermal (ground source) heat pumps (GSHP) installed in the United States each year

http://energy.gov/energysaver/articles/heat-pump-systems

# Energy Star Rated Systems
# Geothermal VS. Conventional

5 Ton Home in Charlottesville Annual Dollars




Virginia State Average Utility Rates
Source www.eia.gov

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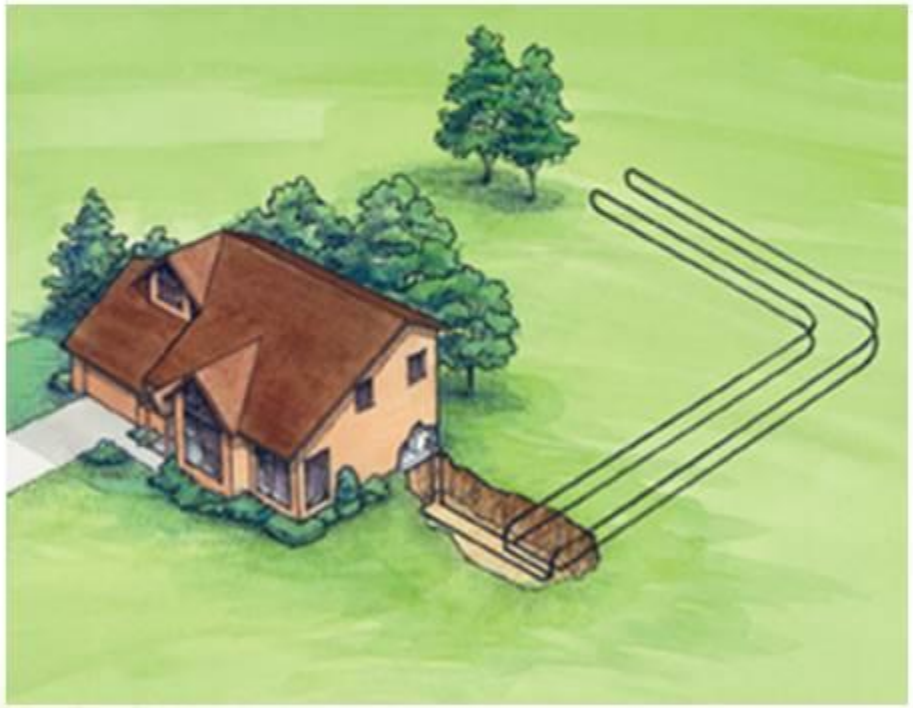
# RESIDENTIAL INSTALLATIONS

- **Closed loop systems**
  - Plastic loop filled with environmentally safe antifreeze solution
  - Horizontal
  - Vertical
  - Pond/lake
- **Open loop systems**
  - Well or surface water pumped through system and discharge back to ground water
  - Requires good supply of clean water and fit with local ground water codes
- **Choice depends on your specific site**

# Typical Earth Loops in our Area

## Horizontal

- 5’ deep 2” wide
- 150’ long per ton



## Vertical

- 6” bores
- 175’ to 200’ deep per ton
- 1 hole per ton 15’ apart

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# Pond Loops

- Pond size about ½ acre and 8-10 feet deep (during dry conditions)
- Actual area needs is about 3,000 SF
- Typical installations have one 300’ ¾” coil per ton

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# The Geothermal Unit Inside

- Water is circulated between the loop field and the unit through a pump station.
- The refrigerant is circulated through the indoor coil by a compressor.
- A fan pulls air from the home's duct system to either cool or heat the air.


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# COST COMPARISON WITH GEOTHERMAL UPGRADE

| Month | KW used | KW per day | Would have used with old HP | Bill would have been with old HP | Bill Was, With GEO and TOU | TOU savings | Geothermal savings | Total savings | % savings |
|---|---|---|---|---|---|---|---|---|---|
| Jun-10 | 1050 | 36.21 | 1609 | $162.87 | $102.66 | $8.82 | $51.39 | $60.21 | 36.97% |
| Jul-10 | 1083 | 31.85 | 1927 | $193.02 | $105.44 | $8.56 | $79.02 | $87.58 | 45.37% |
| Aug-10 | 982 | 36.37 | 1566 | $158.79 | $84.13 | $19.16 | $55.50 | $74.66 | 47.02% |
| Sep-10 | 897 | 30.93 | 1381 | $141.14 | $76.92 | $19.90 | $44.32 | $64.22 | 45.50% |
| Oct-10 | 848 | 29.24 | 1269 | $130.54 | $76.59 | $13.93 | $40.02 | $53.95 | 41.33% |
| Nov-10 | 1206 | 35.47 | 1966 | $196.76 | $99.01 | $25.59 | $72.16 | $97.75 | 49.68% |
| Dec-10 | 1256 | 41.87 | 2421 | $240.08 | $105.48 | $23.87 | $110.73 | $134.60 | 56.06% |
| Jan-11 | 1508 | 47.13 | 2498 | $229.15 | $118.93 | $23.73 | $86.49 | $110.22 | 48.10% |
| Feb-11 | 1209 | 41.69 | 1962 | $182.15 | $96.34 | $19.77 | $66.04 | $85.81 | 47.11% |
| Mar-11 | 1102 | 38.00 | 1730 | $161.78 | $83.73 | $22.96 | $55.09 | $78.05 | 48.24% |
| Apr-11 | 912 | 30.40 | 1442 | $136.42 | $68.49 | $21.51 | $46.42 | $67.93 | 49.80% |
| May-11 | 1144 | 34.67 | 1443 | $136.52 | $78.66 | $31.71 | $26.16 | $57.86 | 42.38% |
| Jun-11 | | | | | | | | | |
| Jul-11 | | | | | | | | | |
| Aug-11 | | | | | | | | | |
| | 13197 | 36.15 | 21215 | $2,069.22 | $1,096.38 | $239.50 | $733.34 | | |
| | | | | | | | | Total $972.84 | |

# COST SAVINGS WITH GEOTHERMAL UPGRADE

- 1500 sq.ft. home
- Savings compared to air-to-air heat pump

| Month | KW used | Geothermal savings |
|---|---|---|
| Jun-10 | 1050 | $51.39 |
| Jul-10 | 1083 | $79.02 |
| Aug-10 | 982 | $55.50 |
| Sep-10 | 897 | $44.32 |
| Oct-10 | 848 | $40.02 |
| Nov-10 | 1206 | $72.16 |
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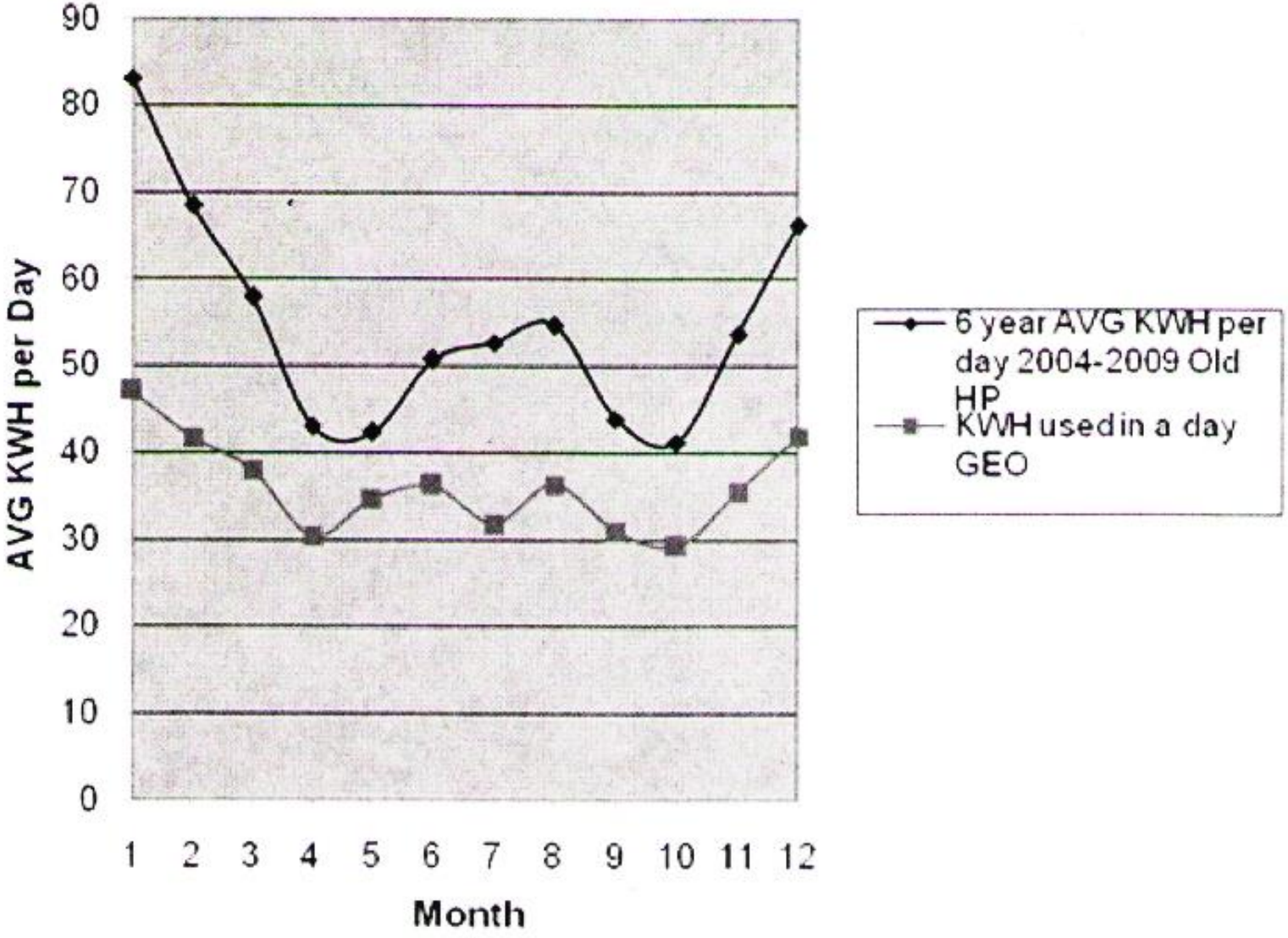
| Mar-11 | 1102 | $55.09 |
| Apr-11 | 912 | $46.42 |
| May-11 | 1144 | $26.16 |
| Jun-11 | | |
| Jul-11 | | |
| Aug-11 | | |
| | 13197 | $733.34 |

# COMPARISON OF KWH USAGE: AIR-TO-AIR HP VS. GSHP



# POND LOOPS IN SMITH MOUNTAIN LAKE

- New construction – installed Aug. 2003
- ~200 ft from house to lake
- Altered existing ditch for lines to house
- Four coils in lake ~18 ft deep
- No longer permitted at SML

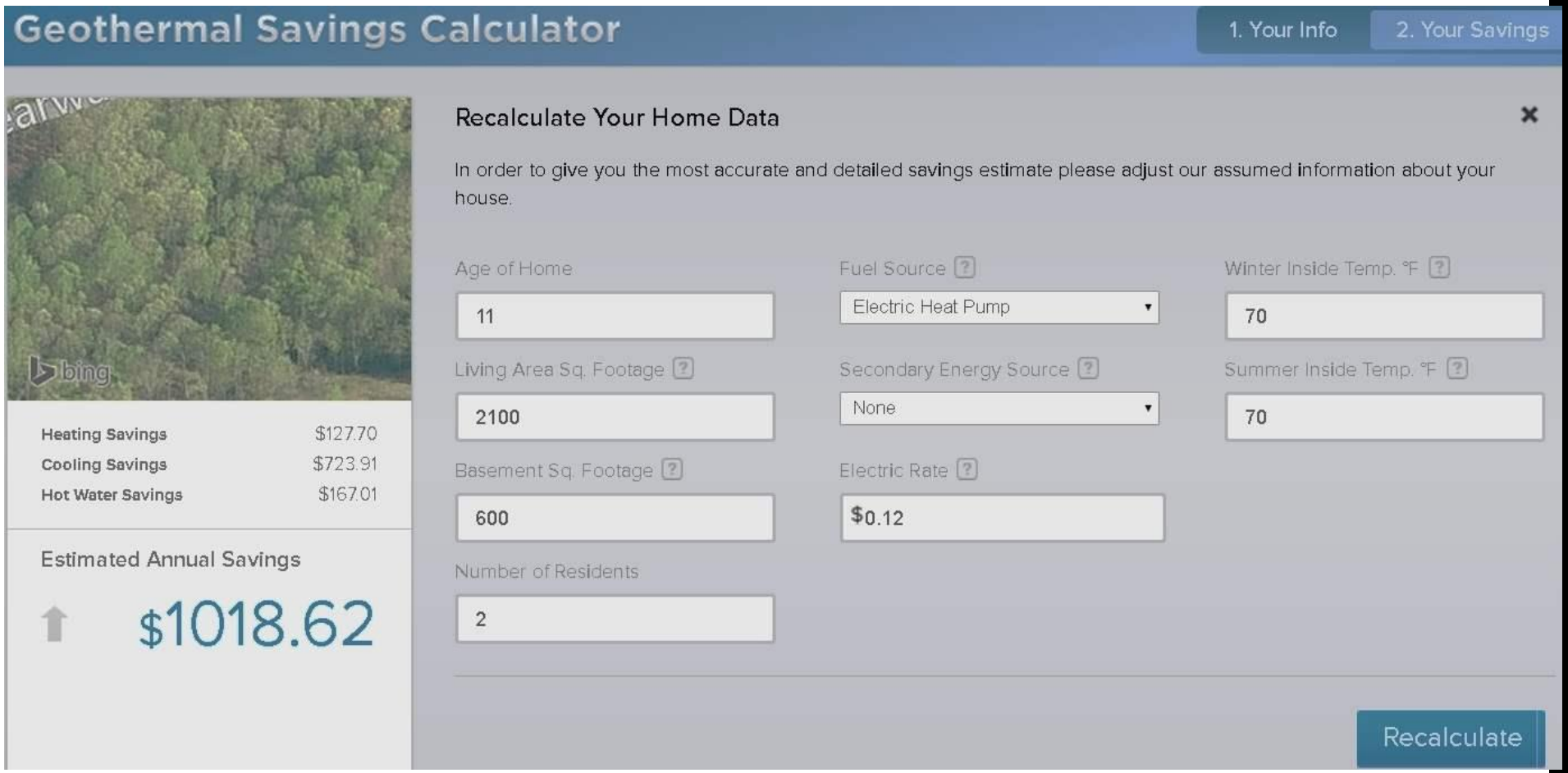
# GSHP: MY HOME

- **2100 sq.ft. with 600 sq.ft. basement**
- **GSHP:**
  - WaterFurnace E Series, 4-Ton
  - 2-stage compressor
  - 3-zone system
  - Included AprilAire humidifier and electronic air cleaner
  - Hot water assist included
- **Typical set points**
  - Heating 70/64F
  - Cooling 70/68F
- **Total cost: $21,215**

# ELECTRICITY COSTS AND MAINTENANCE

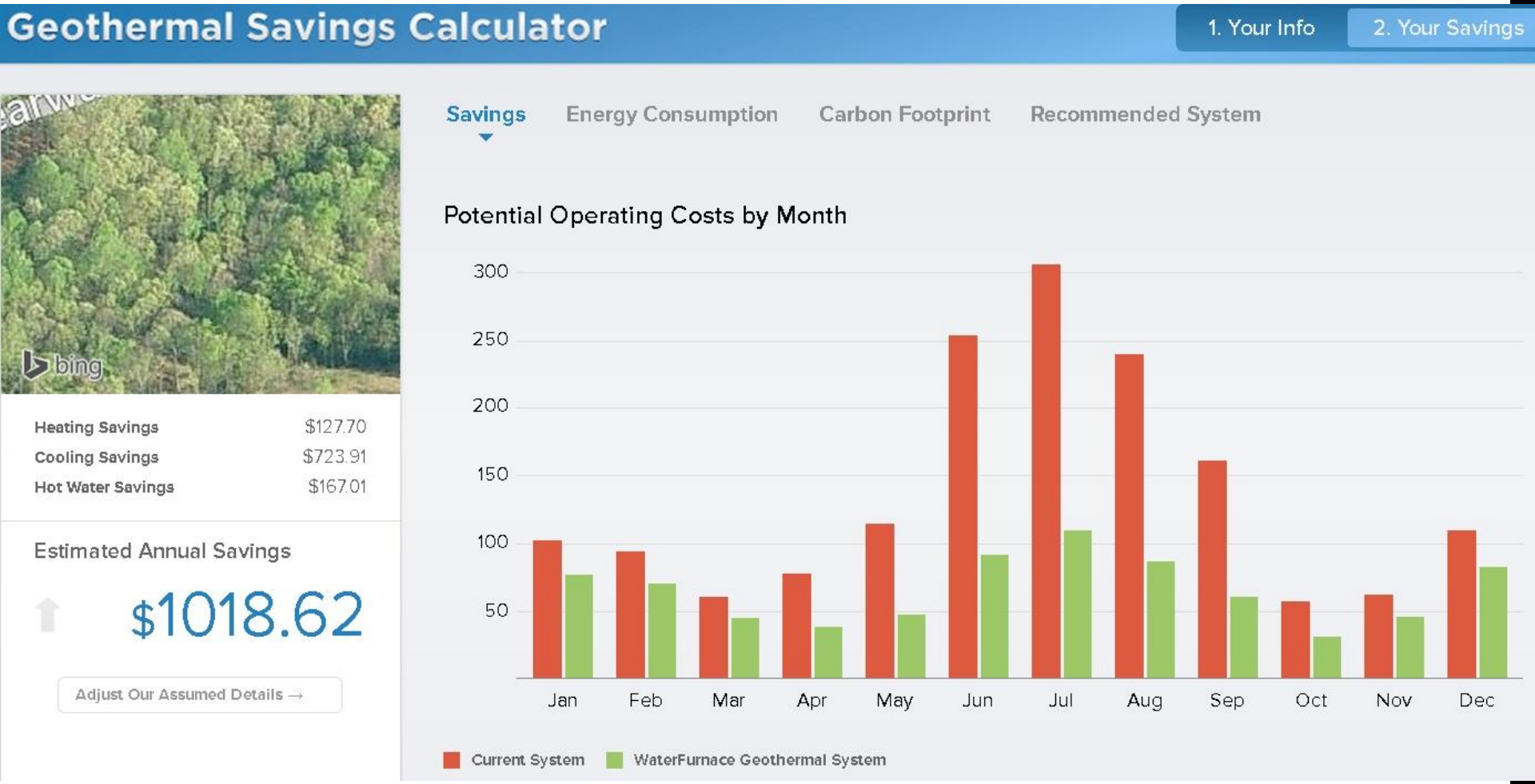
- **Average electric bill (last 6 yr)**
  - $2298/yr; $192/mo
- **Maintenance**
  - To date, thermostats, air handling controller, filters, AprilAire hoses
  - Annual service contract $175

# ESTIMATED SAVINGS: MY HOME




http://www.waterfurnace.com

# COMPARISON: AIR-TO-AIR HEAT PUMP VS. GSHP

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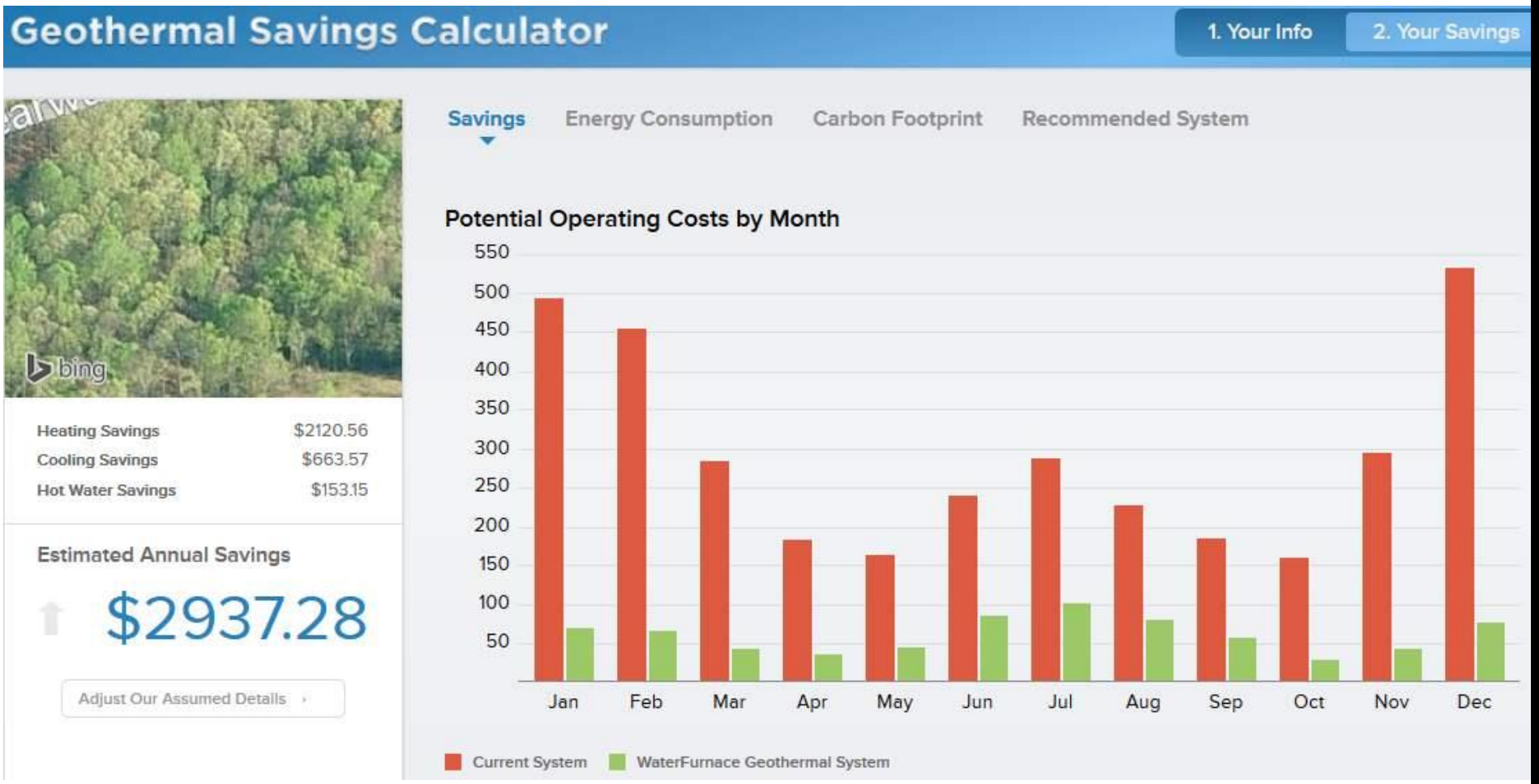
# ENERGY CONSUMPTION COMPARISON


http://www.waterfurnace.com

# COMPARISON: LP GAS FURNACE W/ CENTRAL A/C VS. GSHP

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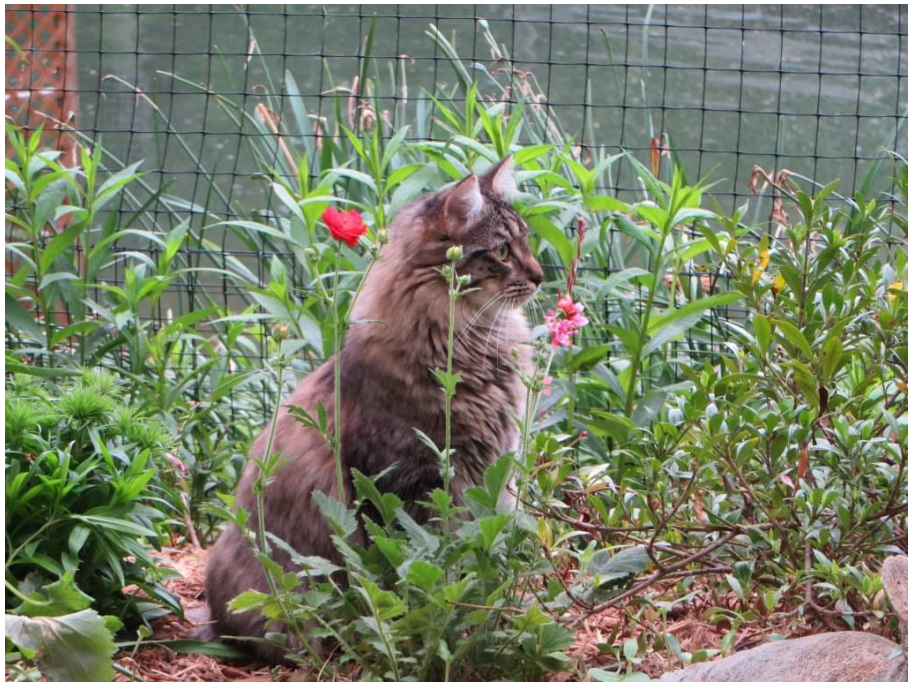
# RETURN ON INVESTMENT

- **Cost to purchase and install GSHP system: $21,215**
- **Other options:**
  - Traditional heat pump est. ~$3,000 per ton: $12,000
  - What my contractor had specified: Lennox LP gas furnace and central A/C: $8,200 (May 2002)
- **Return on investment**
  - Vs. Air-to-air HP additional cost = ~$9,215
    - Savings = $1018/yr
    - Payback period = 9 years
  - Vs. LP gas furnace additional cost = ~$13,015
    - Savings = $2937/yr
    - Payback period = 4.4 yr

# BENEFITS GSHP



- **Energy efficiency**
  - Environmentally friendly – reducing the carbon footprint
  - Saving money – 25% to 50% less electricity
  - ROI 2 to 10 years
- **Durable and reliable**
  - 20 yr heat pumps and 25 to 50 piping
  - Fewer moving parts – less maintenance – 30% to 50% less than traditional heat pump
- **Comfortable heat**
  - Register discharge temp ~90F
- **QUIET – no outdoor condensing unit**

# NEED MORE INFORMATION?

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