

Ground-Source Heat Pump Case Study



MAPC - MassCEC
**Clean Heating and Cooling
Workshop**

April 4, 2017





Geothermal Project Example

- Design
- Installation
- Equivalent Fuel Cost
- Massachusetts Incentives
- Simple Payback



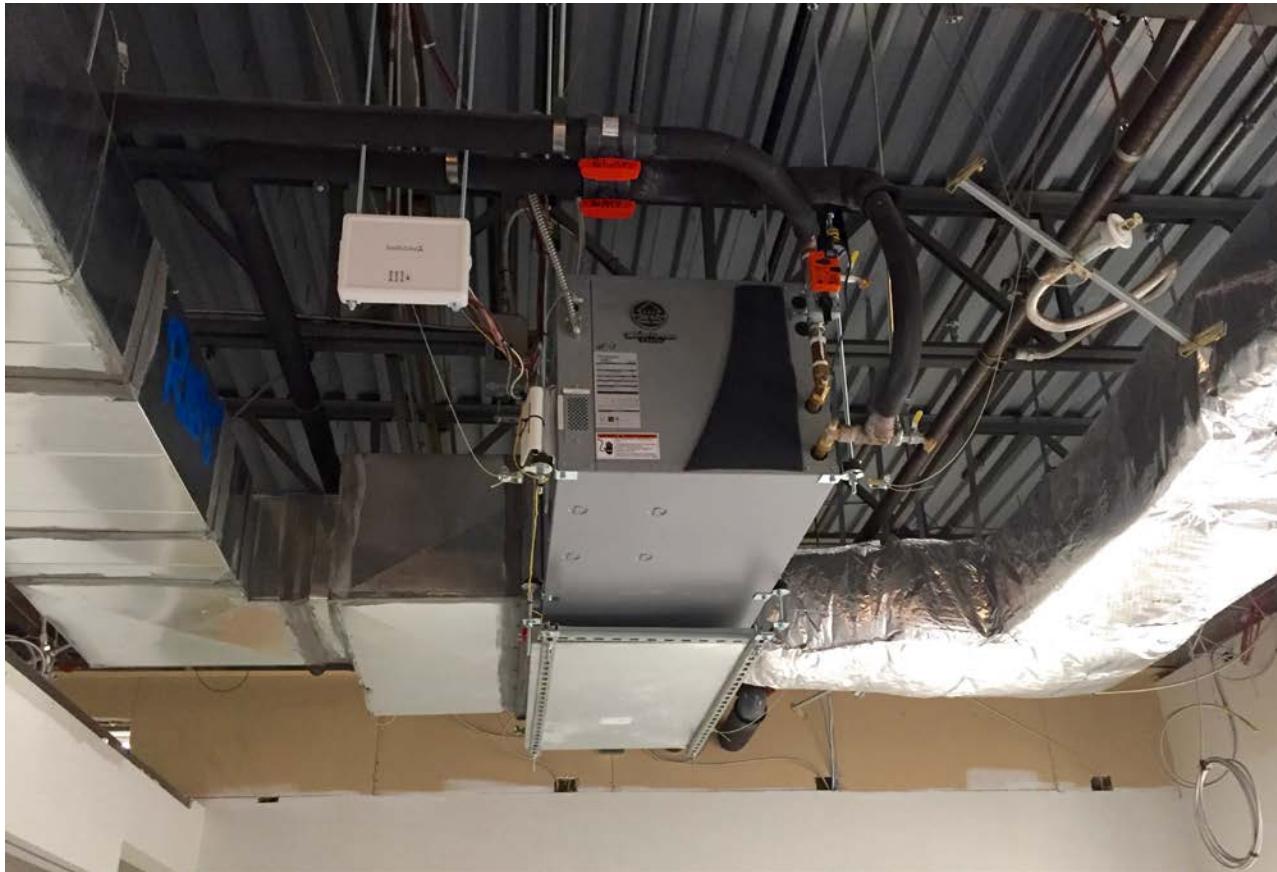
No Volcano Needed



Vertical Closed-Loop



GHSP Installation





Affordable Housing Non-Profit Project Example



Updating a 1980's Affordable Housing Project

- 5-story brick building
- 59 residential units
- Conditioned living space approximately 42,500 sq. ft
- Limited insulation
- Existing heating is via electric baseboard
- Some window-mount air conditioners



Why Geothermal?

- Offers Greatest Comfort with lowest operation cost
- GSHPs have the lowest Carbon Footprint of any heating and cooling system
- Project Location is in a Flood Plain which restricts some conventional options
- Massachusetts Incentives offset most of the incremental cost of GSHP compared to the original WSHP plan



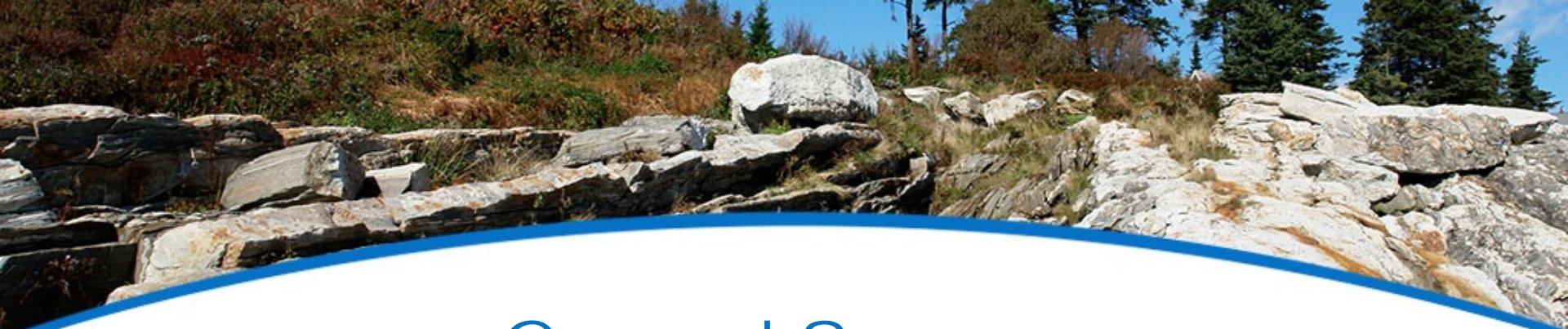
Additional Advantages

- Separate GSHPs allow independent heating and cooling of all spaces
- GSHPs have Zero Carbon Monoxide emissions
- GSHPs have available energy monitoring, remote control and operation telemetry
- Electrical use can be offset by renewable sources



Thermal Loads and Equipment Selection

- Heating and Cooling Loads Calculated by Industry Accepted Methods
 - Peak Heating Load: 551,000 Btu/hr
 - Peak Cooling Load: 487,000 Btu/hr
- Mixed single and dual speed GSHPs
- Total nominal capacity approximately 55-65 tons

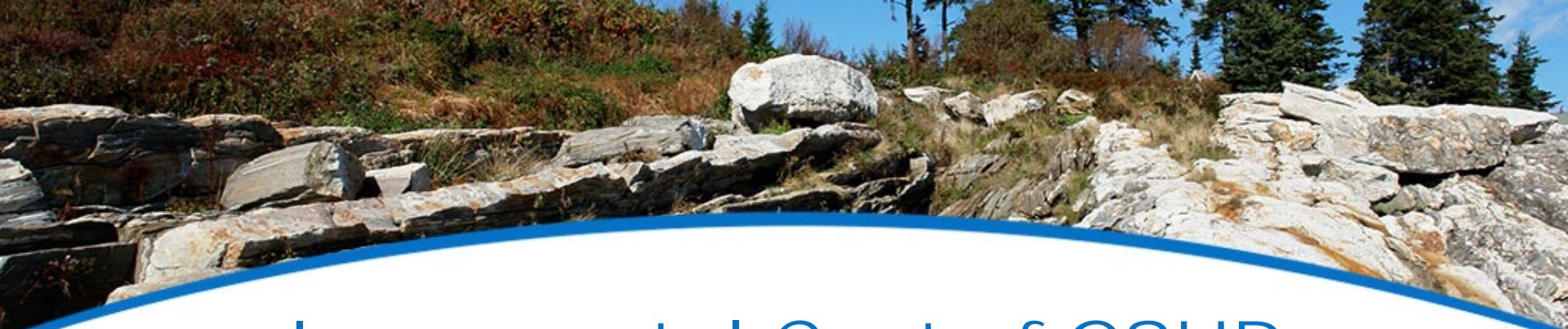


Ground Source

- A series 24 of vertical bores to 450 feet
- Bores constructed with high thermal conductivity grout and HDPE pipe that are geothermal-specific
- A redundant, variable speed, pumping system provides circulation
- Automated valves control flow at each GSHP
- Loop circuit connection and flow balance is via a central vault/manifold



Incremental Cost Operational and Carbon Savings



Incremental Cost of GSHP

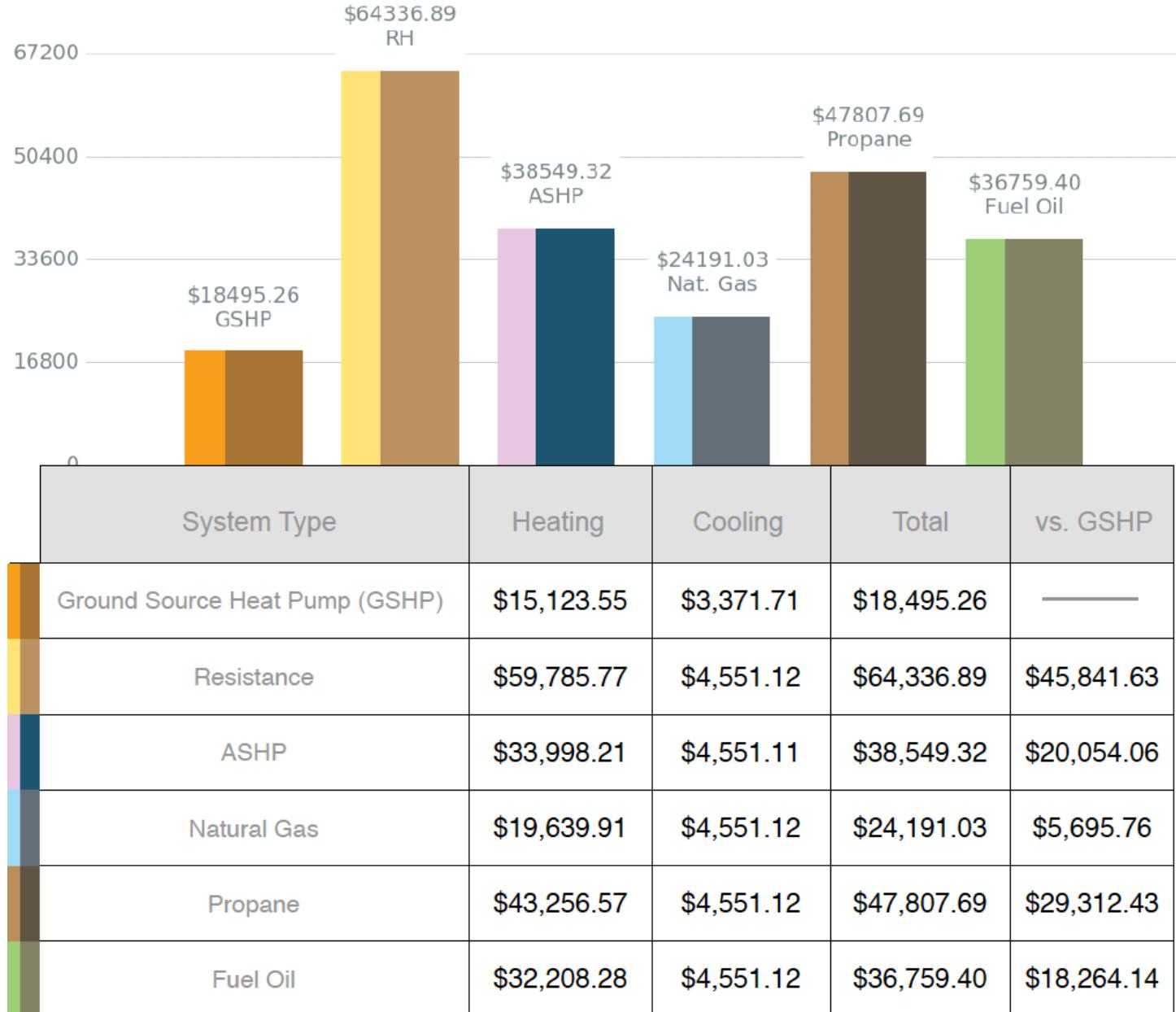
- Existing conditioning is provided by electric baseboard and some window-mount air conditioners
- Renovation plans originally included a conventional system using water-source heat pumps with a boiler and cooling tower
- Estimated incremental cost of GSHP over WSHP is \$348,000 or less



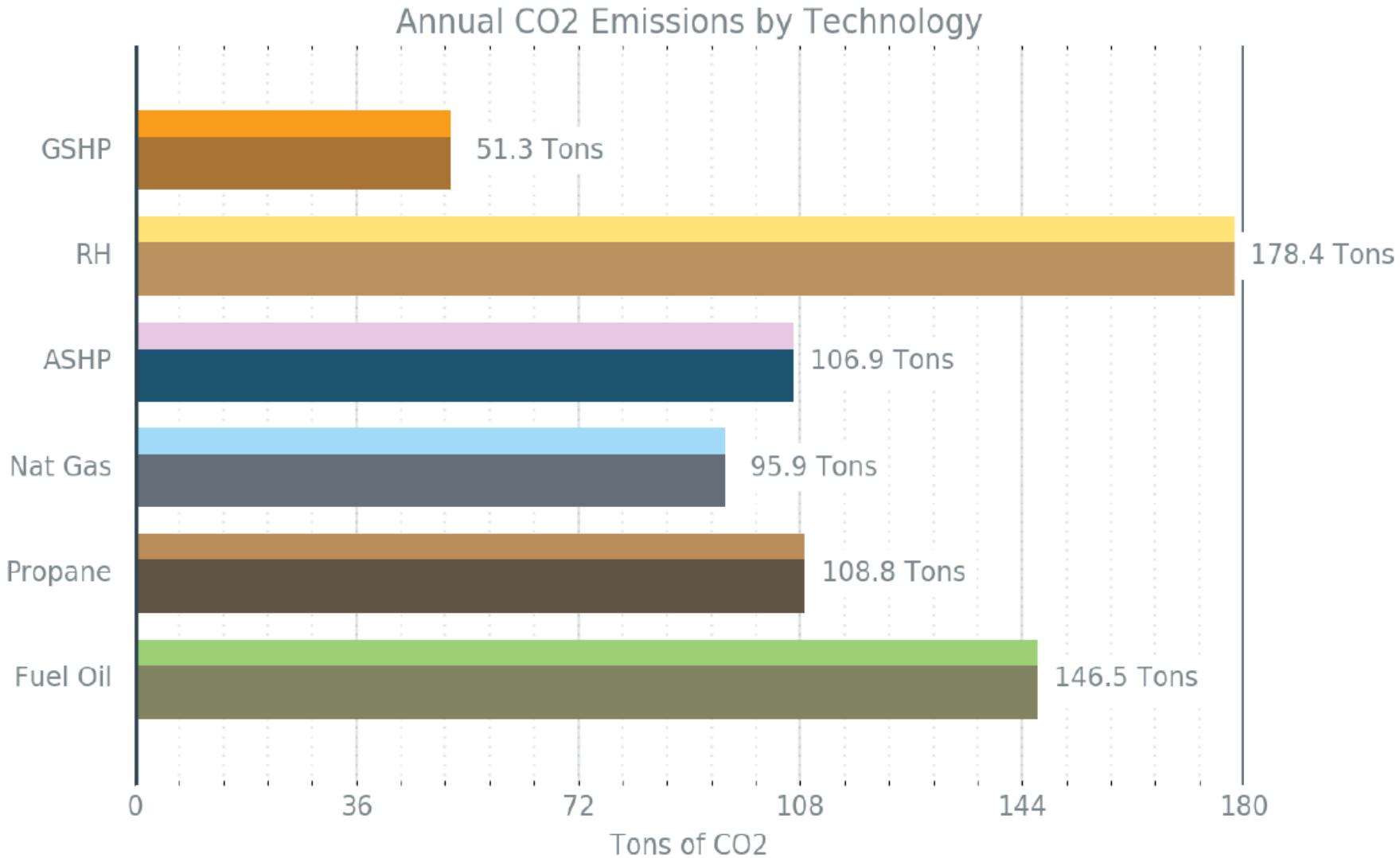
Fuel Cost and Carbon Footprint

- GSHPs have much lower ‘fuel’ cost than alternatives
- GSHPs have the lowest carbon footprint of the available options
- System will harvest 928,000,000 Btu of renewable thermal energy annually
- GSHPs have lower maintenance cost and longer service life than conventional alternatives further reducing operating cost

Reduction in 'Fuel' Cost



Reduction in Carbon Footprint





Financial Incentives Simple Payback



Applicable Incentives

- Federal Investment Tax Credit
- Accelerated Depreciation
- Energy Efficient Building Deduction
- MassCEC Base Grant
 - High Efficiency GSHP Adder
 - Municipal/Non-Profit Adder
 - Affordable Housing Adder
- AEC Program
- MassSave Incentives (in service area)



Post-Incentive Net Project Cost

Pre-Incentive Incremental Cost	\$348,000
MassCEC Grant (assumes 60% of Efficiency plus Non-profit and Affordable Housing adders)	(\$136,000)
AEC Income (PV of 10 years less brokerage fee)	(\$112,000)
MassSave Incentives	(\$TBD)
Post-Incentive Cost	\$100,000



Simple Payback

Post-Incentive Incremental Cost	\$100,000
Annual Fuel Savings v. Existing Electric RH	\$45,800
Simple Payback v. Existing	2.2 Years
Annual Fuel Savings v. WSHP-Boiler-Cooling Tower	\$18,300
Simple Payback v. WSHP	5.5 Years



Questions?

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Go Sox!





Telemetry Example

CURRENT STATUS:

1:25 PM Fri 9/9 Eastern



Cooling Speed 1

EQUIPMENT SUMMARY

Series: 7 Series

Model: NVV060A101CTL0KN

Serial #: 151002335

Supply Air: 54.5°F



THERMOSTAT SUMMARY



ARLINGTON, MA



Current Temp: 88°

Saturday 80° 67°

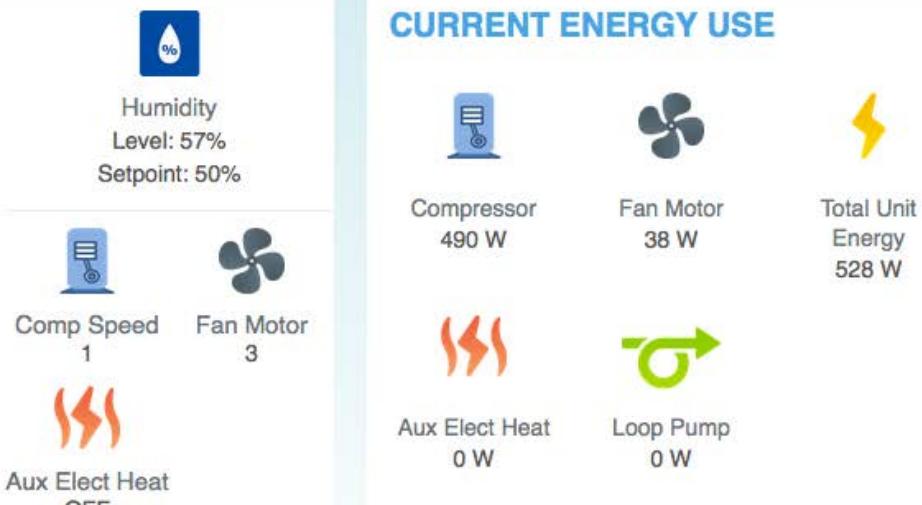
Sunday 80° 63°

Monday 74° 54°

Tuesday 83° 53°

Wednesday 79° 58°

CURRENT ENERGY USE



MY ENERGY USE

Power Dollars

Rate per kWh (in dollars)

0.18

Update

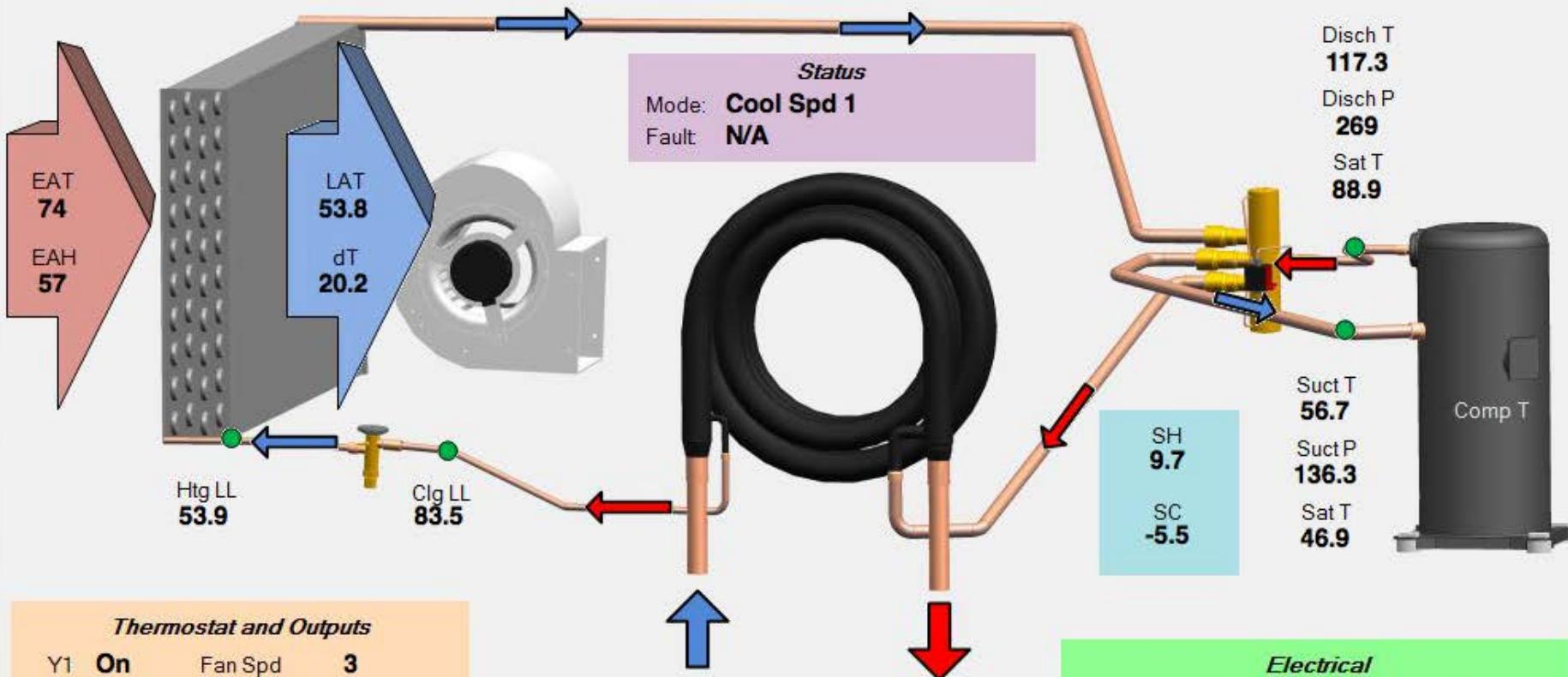
● Heating (Part) ● Heating (Full) ● Cooling (Part) ● Cooling (Full) ● Aux Heat ● Fan

Compare Day Week Year



*Note: Average and total includes previous 7 months (excluding current month).

Heat Pump Troubleshooting

**Thermostat and Outputs**

Y1	On	Fan Spd	3
Y2	Off	Comp Spd	1
O	On	Pump	1
G	On	Pump PWM	50
W	Off	AUX	Off

EWT **78.6** dT **-7.3** LWT **85.9**
 Flow **4.8** HE/HR **16.994**

Electrical

Fan A	0.3	Fan W	37
Comp1 A	0	Comp W	494
Comp2 A	0	Aux W	0
Aux A	0	Pump W	0



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