

Ground-Source Heat Pump Case Study



MAPC - MassCEC Clean Heating and Cooling Workshop

April 4, 2017

A photograph of a rocky, mountainous landscape with sparse vegetation and evergreen trees in the background. A thick blue arc curves across the middle of the image, separating the photo from the text below.

Geothermal Project Example

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

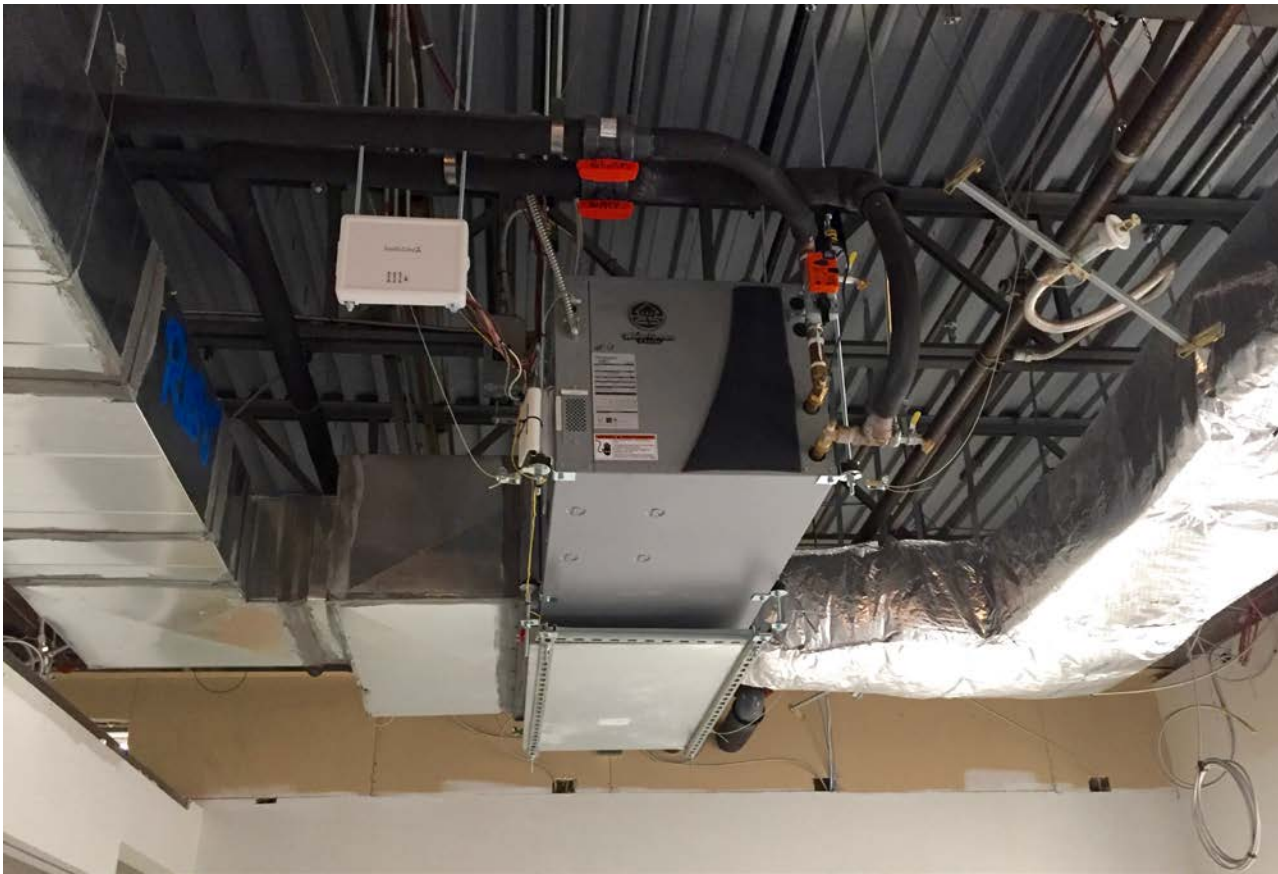
No Volcano Needed



Vertical Closed-Loop



GHSP Installation





Affordable Housing Non-Profit Project Example

A photograph of a rocky hillside with sparse vegetation and evergreen trees in the background under a clear blue sky. A blue curved line separates the image from the text below.

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

A photograph of a rocky mountain slope with sparse vegetation and evergreen trees in the background under a clear blue sky. A blue curved line separates the image from the text below.

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

A photograph of a rocky mountain landscape with a blue sky and some trees in the background. The image is partially obscured by a white curved banner that contains the title and list.

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

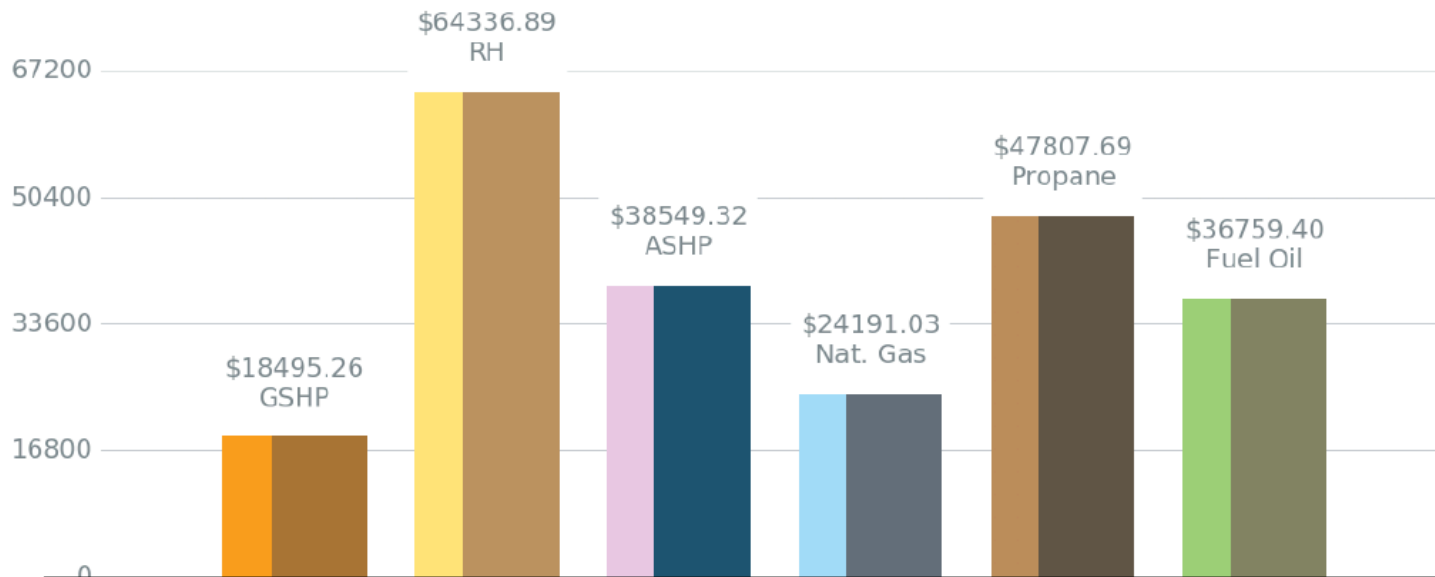
- Existing conditioning is provided by electric baseboard and some window-mount air conditioners
- Renovation plans originally included a conventional system using water-source heat pumps with a boiler and cooling tower
- Estimated incremental cost of GSHP over WSHP is \$348,000 or less

A photograph of a rocky mountain slope with sparse vegetation and evergreen trees in the background under a clear blue sky. A blue curved line separates the image from the text below.

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

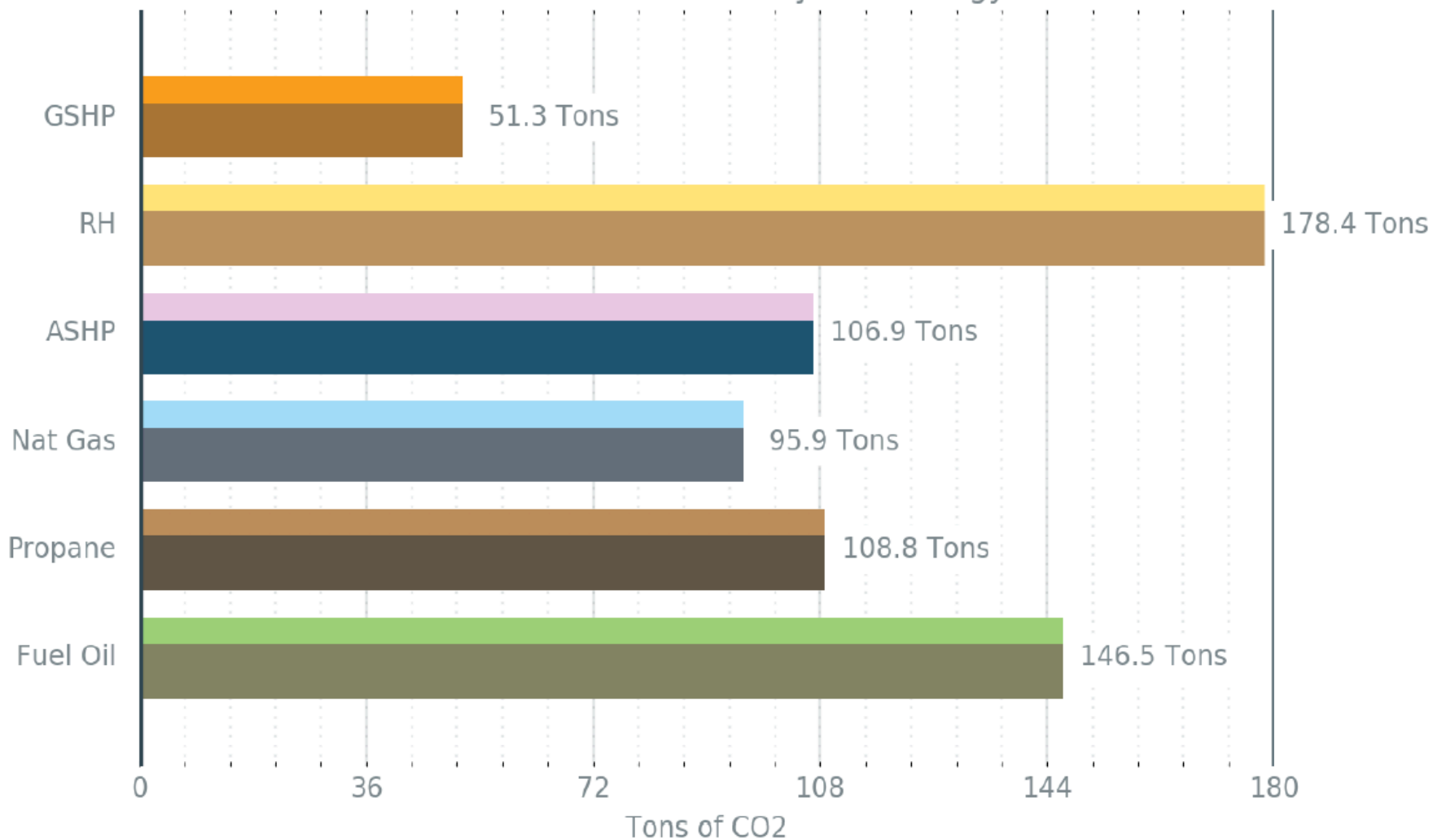
Reduction in 'Fuel' Cost



System Type	Heating	Cooling	Total	vs. GSHP
Ground Source Heat Pump (GSHP)	\$15,123.55	\$3,371.71	\$18,495.26	—
Resistance	\$59,785.77	\$4,551.12	\$64,336.89	\$45,841.63
ASHP	\$33,998.21	\$4,551.11	\$38,549.32	\$20,054.06
Natural Gas	\$19,639.91	\$4,551.12	\$24,191.03	\$5,695.76
Propane	\$43,256.57	\$4,551.12	\$47,807.69	\$29,312.43
Fuel Oil	\$32,208.28	\$4,551.12	\$36,759.40	\$18,264.14

Reduction in Carbon Footprint

Annual CO2 Emissions by Technology





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

THERMOSTAT SUMMARY



ARLINGTON, MA



Current Temp: 88°

EQUIPMENT SUMMARY

Series: 7 Series
Model: NVV060A101CTL0KN
Serial #: 151002335

Supply Air: 54.5°F



Humidity
Level: 57%
Setpoint: 50%

Comp Speed
1Fan Motor
3Aux Elect Heat
OFF

CURRENT ENERGY USE

Compressor
490 WFan Motor
38 WTotal Unit
Energy
528 WAux Elect Heat
0 WLoop Pump
0 W

Saturday



80° 67°

Sunday



80° 63°

Monday



74° 54°

Tuesday



83° 53°

Wednesday



79° 58°

MY ENERGY USE

Power

Dollars

Rate per kWh (in dollars)

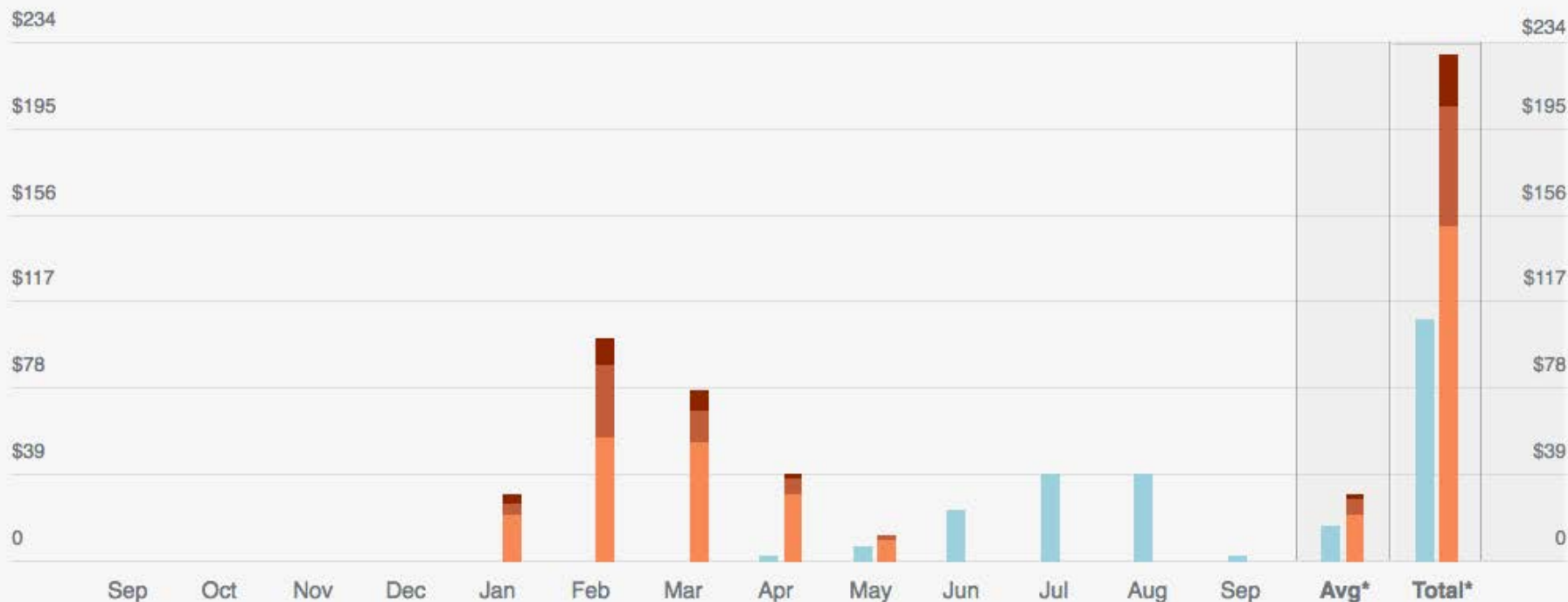
0.18

Update

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

Compare | Day Week Year

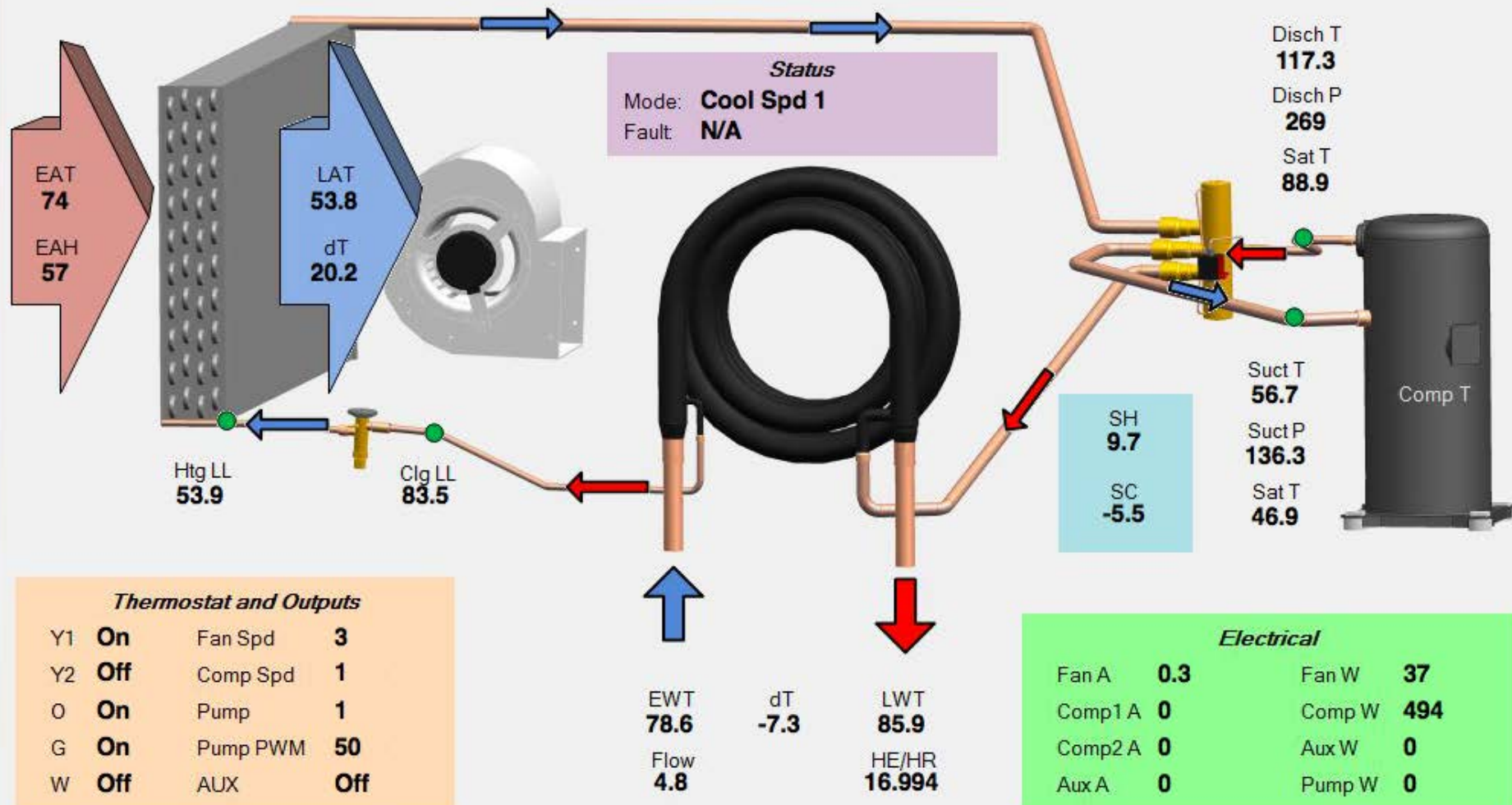
Dollars



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



Heat Pump Troubleshooting





Questions?

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