



Does Night Setback Work with Minisplit Heat Pumps?

Energy Planning Action Team, 4/10/2026

Executive Summary

Vernon County Energy District performed a night setback test on a ductless air-source heat pump (ASHP) HVAC system in a residential home in Viola, WI. The test was conducted from early January to late February 2026, and produced the following main findings:

- Programming the ASHP's thermostat for a night setback of 10 °F resulted in up to 10% heating energy cost savings.
- The ASHP recovered relatively quickly from night setback.
- The ASHP was able to maintain the room temperature setpoint as long as the outside air temperature was above 0 °F.

While this test was only conducted on one ASHP, it helps dispel the myths that ASHPs do not save energy with night setback and they cannot quickly return temperatures to occupied conditions after night setback.

Additional testing on a larger population of in situ ASHPs would allow for the development of more broad guidance and recommendations related to ASHP temperature control.

Introduction

Ductless ASHP (“minisplit”) systems are an efficient method of heating and cooling a space. Many sources recommend operating ASHPs at a constant space heating temperature setpoint, with no night setback¹. But does operating an ASHP at a constant setpoint use more energy than setting back the temperature at night? How fast can an ASHP recover from night setback in the morning? The Vernon County Energy District conducted a test at a local home heated with an ASHP to find out.

Home Description

A Vernon County resident kindly offered their home for the test. The house is a single story single-family detached home located in Viroqua, WI, on Elk Run Road in a rural wooded area. The front door faces primarily east and is set in a hill that rises up from east to west. The main floor is 583 square feet, and there’s a 136 square foot loft. The floor is slab-on-grade, the walls are wood frame insulated, and the roof is wood frame insulated.

The home is heated and cooled with one air-to-air ASHP. The indoor unit is a Fujitsu model ASU18RLF and the outdoor unit is a Fujitsu model AOU18RLXFWH, rated down to -15 °F outside air temperature. The home also has a wood stove, but since the installation of the ASHP in February 2025 the homeowner has not used the wood stove.

The home is served by Vernon Electric Cooperative, and the marginal wintertime electric rate is \$0.11/kWh.

¹ One such source is the U.S. Department of Energy’s Programmable Thermostats webpage. “Programmable thermostats are generally not recommended for heat pumps.” <https://www.energy.gov/energysaver/programmable-thermostats>, accessed 3/11/2026.

Test Procedure

The ASHP's power draw is monitored using an Emporia power monitor. Both the indoor and outdoor sections of the ASHP are monitored with that system. 15-minute interval data from that system was used to calculate the power draw of the system.

Three temporary temperature data loggers were installed, each a HOBO UX-120 with a HOBO TMCx-HD temperature sensor:

- ASHP return air temperature (room temperature). All temperatures noted in this report are dry bulb temperatures.
- ASHP supply air temperature
- Outside air temperature

The loggers were set up with a five minute interval.

The system was tested over an eight week period in January and February of 2026, in four operating modes. Each mode was tested over two non-consecutive weeks, in hopes to capture a representative range of outside air conditions. The specific test period was 1/5/2026 through 2/28/2026.

- Mode "1S" (one setpoint)
 - The baseline condition. 70 °F continuous heating space temperature setpoint.
 - Test periods:
 - Week one: 1/5/2026 – 1/10/2026
 - Week two: 1/26/2026 – 1/31/2026
- Mode "2S" (two setpoints)
 - Heating space temperature setpoint schedule:
 - 10 pm: 60 °F
 - 6 am: 70 °F
 - Test periods:
 - Week one: 1/19/2026 – 1/24/2026
 - Week two: 2/16/2026 – 2/21/2026
- Mode "6S" (six setpoints)
 - Heating space temperature setpoint schedule:
 - 10 pm: 60 °F
 - 4 am: 62 °F
 - 5 am: 64 °F
 - 6 am: 66 °F
 - 7 am: 68 °F

- 8 am: 70 °F
 - Test periods:
 - Week one: 2/2/2026 – 2/7/2026
 - Week two: 2/23/2026 – 2/28/2026
- Mode “10S” (ten setpoints)
 - Heating space temperature setpoint schedule:
 - 6 pm: 70 °F
 - 9 pm: 68 °F
 - 12 am: 66 °F
 - 2 am: 64 °F
 - 4 am: 62 °F
 - 8 am: 64 °F
 - 9 am: 66 °F
 - 10 am: 68 °F
 - 11 am: 70 °F
 - 12 pm: 72 °F
 - Test periods:
 - 1/12/2026 – 1/17/2026
 - 2/9/2026 – 2/14/2026

The modes were changed each week on Sunday mid-day. Only Monday through Saturday data was used for the analysis, since Sunday was a transition day.

Test Results – Power Draw

The power and outside air temperature data was rolled up into daily averages to allow for meaningful comparisons between the four modes. The results are shown in Figure 1. The data shows the expected trend of reduced average power draw with increasing average daily outside air temperature. The baseline case (“1S”) is the blue points and curvefit.

Figure 1 also shows the following:

- The red vertical lines represent the bounds of the coincident data. This is the range of outside air conditions within which all four cases have data that can accurately be used to characterize average power draw. Outside of this period, at least one mode did not have data.
- The number of annual days at each average outside air temperature using typical meteorological year (TMY) data (grey line). It shows that:
 - To the left of the coincident data period, there are not many days in a typical year with those average outside air temperatures.
 - To the right of the coincident data period, the number of days is relatively high, but the average heating power draw is low, trending to zero at approximately 50 °F average outside air temperature.

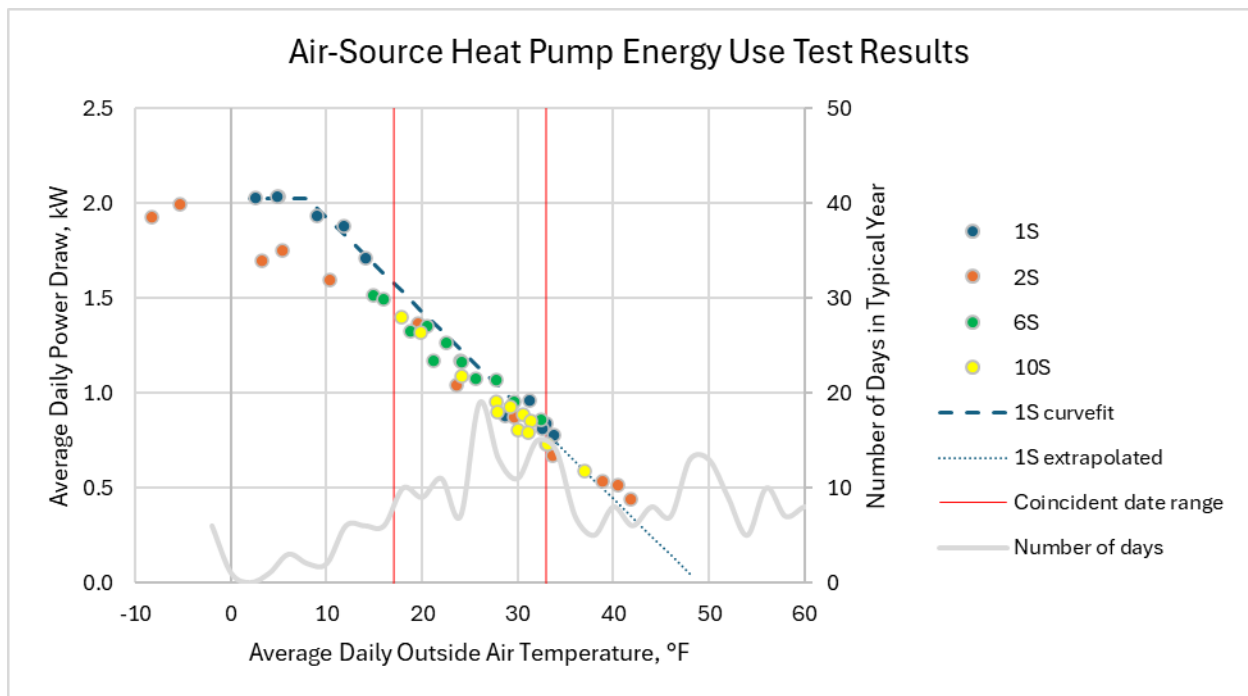


Figure 1: Power Draw Test Results

In the 2S mode, the two data points below 0 °F average daily outside air temperature are 1/23 and 1/24/2026. On those dates, the temperature stayed below 0 °F most of the time, and the heating space temperature setpoint was rarely met, even at the night setpoint of 60 °F. See the “2S, Week One” chart in Appendix B: Temperature Data.

Figure 2 zooms in on the coincident period and includes the curvefit of each of the four modes. It shows that, within the coincident period, the 2S and 10S modes draw less power on average than the baseline (1S) mode. The 6S mode draws less power than the baseline at cooler temperatures, then draws more power at warmer temperatures.

The curvefits were developed using a linear regression modeling tool. The statistics are good for each of the curvefits except for 2S, which only has 12 observations instead of the minimum recommended 18 observations for a changepoint model. However, all other statistics for that mode are excellent, so it was used in the analysis. See Appendix A: Temperature Setpoint Mode Curvefits.

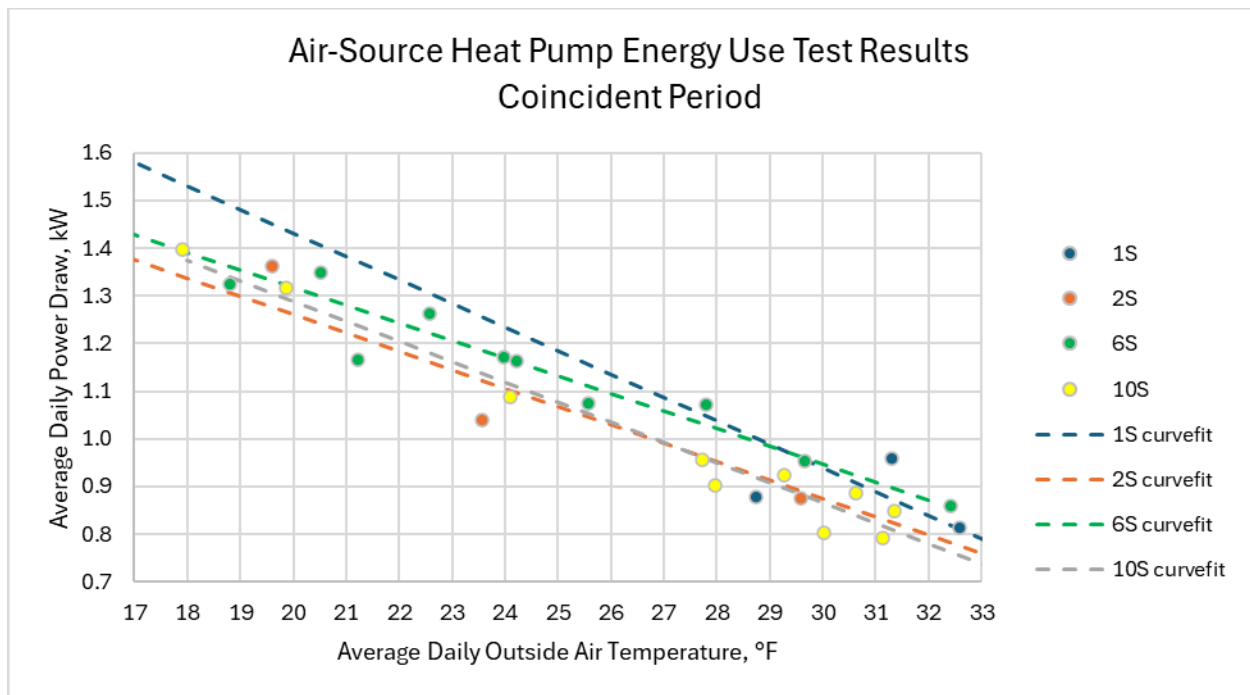


Figure 2: Power Draw Test Results - Coincident Period

Test Results – Temperatures

Appendix B: Temperature Data includes time-series charts of the logged temperature data. The data shows that the system can meet the heating space temperature setpoint in all modes down to approximately 0 °F. Below that temperature, the space temperature is consistently below the setpoint. See Figure 3. This is somewhat surprising, since the ASHP manual shows heating performance data down to -15 °F outside air temperature. This suggests that the heating load due to the cold outside air temperatures was greater than the heating capacity of the unit, causing the indoor temperatures to fall below setpoint.

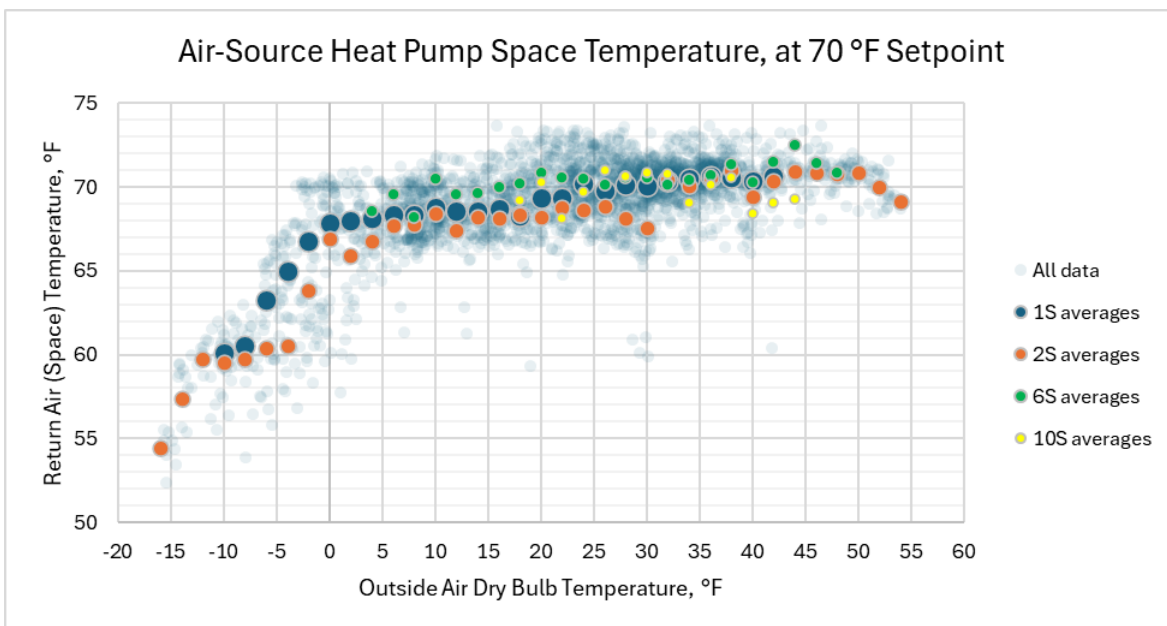


Figure 3: Space Temperatures At 70 °F Setpoint

Figure 3 shows that the 2S space temperatures are below the 1S baseline space temperatures, especially below 5 °F outside air temperature. The data was filtered to show the 2S data after 9 am (three hours after shifting from 60 °F setpoint to 70 °F setpoint), to see if it's due to morning warm-up – see Figure 4 . That chart shows that 2S's space temperatures are more in line with the 1S baseline after 9 am in cold outside air conditions.

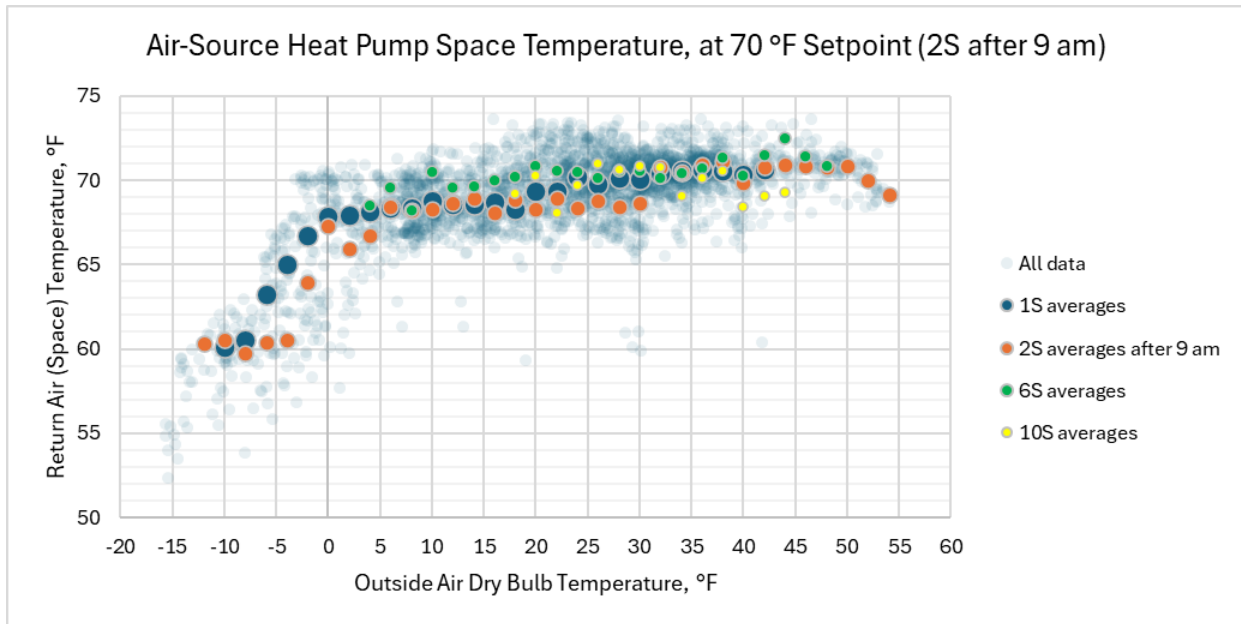


Figure 4: Space Temperatures At 70 °F Setpoint, 2S after 9 am

The data shows that the amount of time it takes for the system to reach 70 °F from 60 °F night setback in mode 2S depends on the outside air temperature at the time of warm-up. See Figure 5. TMY data shows that the average outdoor air temperature at 6 am from November through March is 19 °F. Applying that temperature to the trendline from the logger data, the system would take approximately 1-1/2 hours to warm the space from 60 °F to 70 °F.

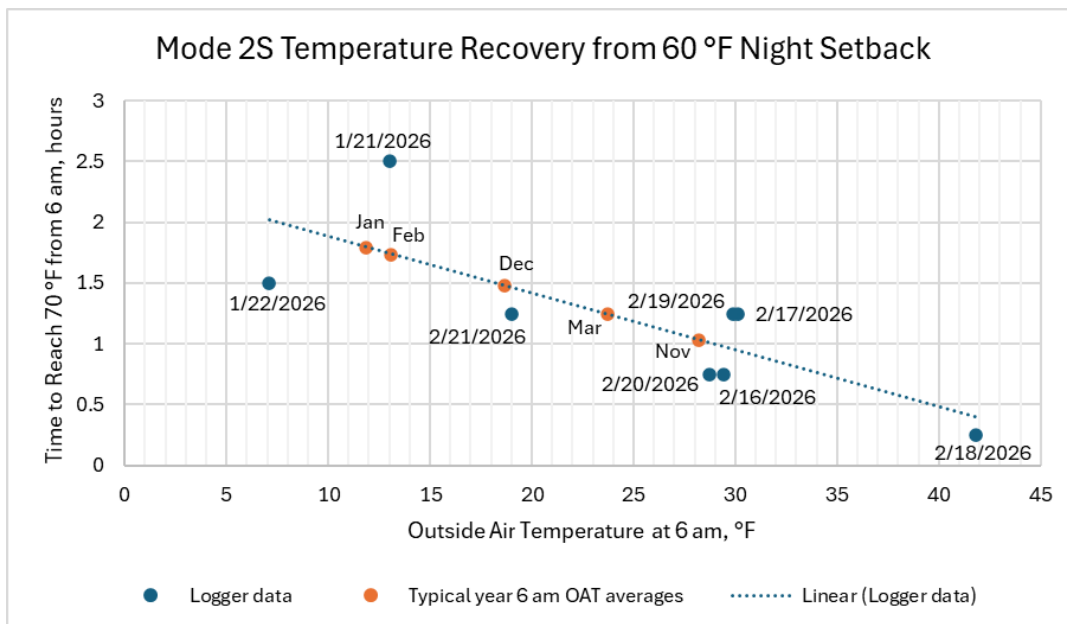


Figure 5: Temperature Recovery Time from Night Setback in Mode 2S

Energy Use Analysis

Applying the average number of days in each outside air temperature bin to the curvefits results in the energy use values shown in Table 1 for the coincident data period of 18 to 32 °F average daily temperature (95 days per year according to TMY data). The energy use calculations are shown in Appendix C: Energy Use Calculations.

Table 1: Energy Use and Cost Values in Coincident Data Period

Mode	Energy Use, kWh/yr	Percent Energy Savings (compared to baseline)	Energy Cost, \$/yr
1S (baseline)	2,627	n/a	\$289
2S	2,376	9.6%	\$261
6S	2,525	3.9%	\$278
10S	2,393	8.9%	\$263

Extrapolating the baseline (mode 1S) curvefit to all outside air temperatures results in 4,743 kWh/yr energy use². The 2,627 kWh/yr shown in Table 1 is 55% of that value, implying that the coincident data period is representative of the entire heating season (the energy use is at least half of the total heating season energy use).

For the 2S scenario, savings would be greater than that shown in Table 1 if the occupied period start time were delayed from 6 am, since the system would operate longer in night setback mode and the outside air temperature is higher after 6 am on average (more efficient ASHP operation). See the last chart in Appendix B: Temperature Data.

If a home has photovoltaic solar panels and the electric utility's net metering arrangement is structured to motivate homeowners to use more electricity when the sun is shining, it might be more cost-effective to use a strategy like 10S, where the space temperature setpoint is highest during midday hours.

² The home used approximately 6,800 kWh from March 2025 through February 2026. Therefore, the ASHP uses $4,743 / 6,800 = 70\%$ of the home's electric consumption, which falls in the expected range.

The outside air temperature data was investigated to find a day in each of the four scenarios that had a similar outside air temperature profile. While not an exact match, the following dates have the most similar profile (see Figure 6):

- Scenario 1S: 1/31/2026
- Scenario 2S: 1/21/2026
- Scenario 6S: 2/23/2026
- Scenario 10S: 1/17/2026

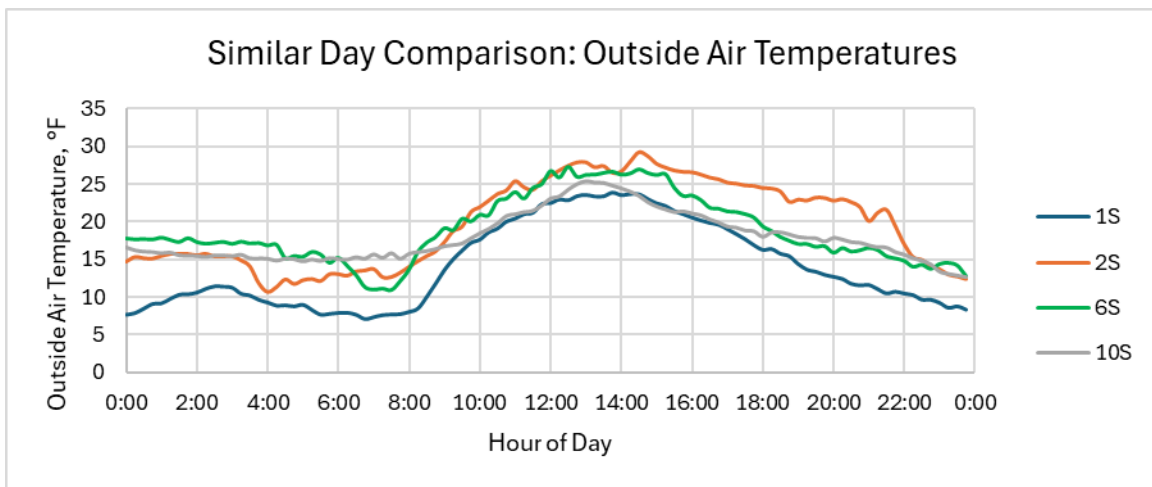


Figure 6: Outside Air Temperature Profile for Similar Dates Comparison

Figure 7 shows the average hourly power draw for each scenario on those dates. The data shows that:

- Scenario 1S power draw is relatively steady as expected, dropping midday when the heating load is lower and the ASHP efficiency is higher due to higher outside air temperatures.
- Scenario 2S power draw at 6 am is high as expected, when the setpoint increases from 60 °F to 70 °F.
- All scenarios have approximately the same power draw from 10 am to 6 pm except scenario 10S, which has a slightly higher space temperature setpoint than the other scenarios (72 °F vs 70 °F).
- The power draw for scenarios 2S and 6S drops significantly at 10 pm as expected, when the setpoint is lowered to 60 °F.

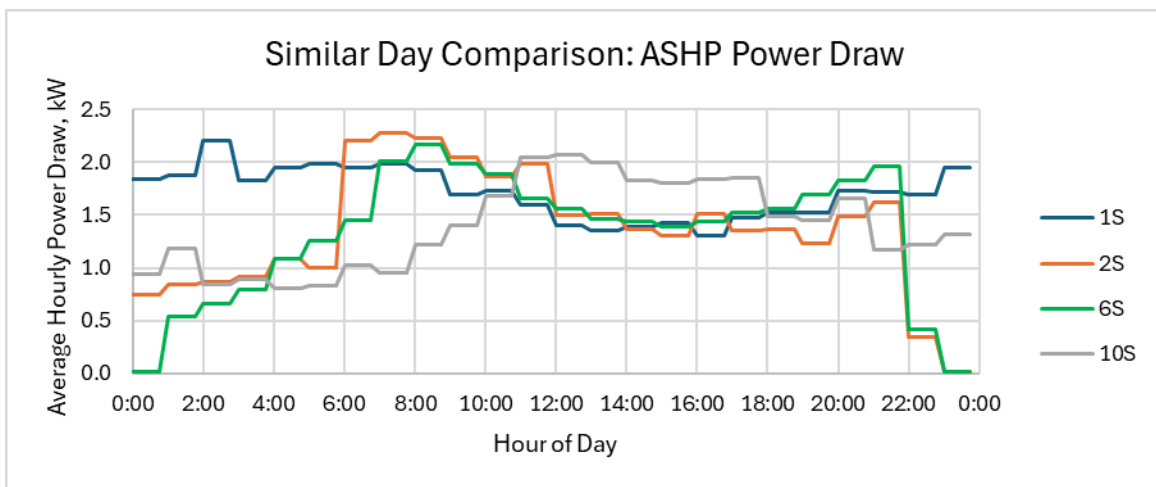


Figure 7: Power Draw Profile for Similar Dates Comparison

Appendix A: Temperature Setpoint Mode Curvefits

Table 2: Mode 1S Curvefit and Related Statistics

Baseline Model		
kW / Day =	2.023448	x days in period
+	-0.049321 x MAX(0, DB - 8.00) [°F]	

Statistical Summary	Suggested Range
Number of Observations = 12	>= 12
R-squared = 99.1%	> 75%
Adjusted R-squared = 99.0%	> 75%
Standard Error = 0.1	NA
Coeff. of Variation (RMSE) = 4.2%	< 20%
F Statistic = 1,114.3	NA
Autocorrelation Coefficient = 34.2%	NA
Durbin Watson = 1.19	~2
Fractional Savings Uncertainty (68% Conf., 5.0% sav., 365 smpls.) = 12.0%	< 50%
Net Determination Bias = -1.80E-16	< 0.00005
Overall P-Value = 1.02E-14	< 0.1
Baseline Period =	1/5/2026 to 1/31/2026

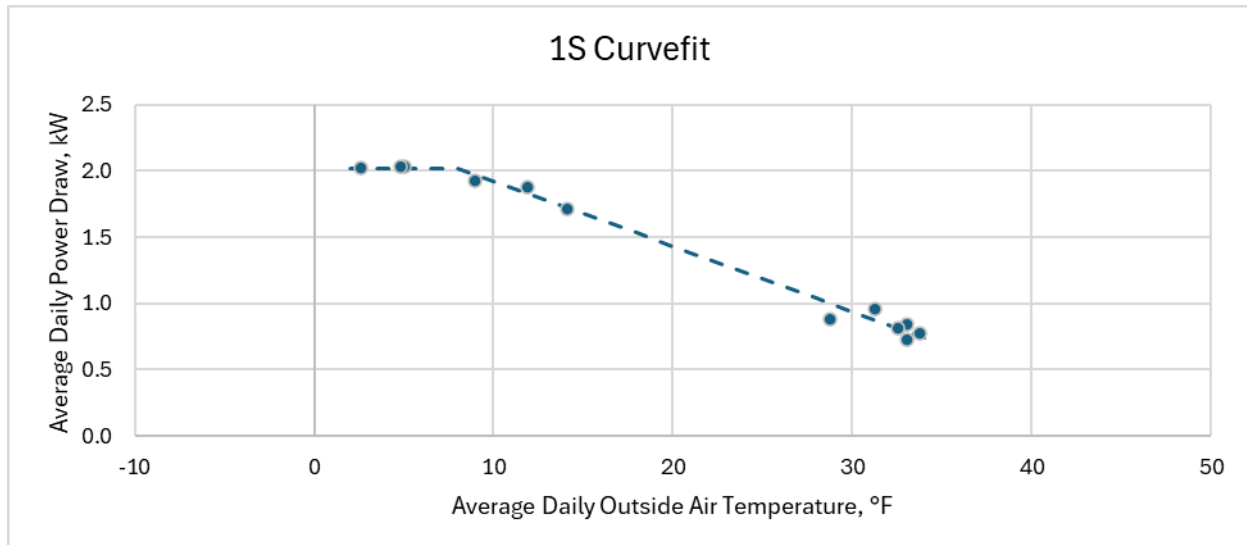


Figure 8: Mode 1S Curvefit Chart

Table 3: Mode 2S Curvefit and Related Statistics

Baseline Model		
kW / Day =	1.568755	x days in period
+	-0.038561 x MAX(0, DB - 12.00) [°F]	
+	0.020427 x MAX(0, 12.00 - DB) [°F]	
	0.000000	#N/A

Statistical Summary	Suggested Range
Number of Observations = 12	>= 18
R-squared = 99.1%	> 75%
Adjusted R-squared = 98.9%	> 75%
Standard Error = 0.1	NA
Coeff. of Variation (RMSE) = 5.2%	< 20%
F Statistic = 482.6	NA
Autocorrelation Coefficient = -1.5%	NA
Durbin Watson = 1.73	~2
Fractional Savings Uncertainty (68% Conf., 5.0% sav., 365 smpls.) = 8.1%	< 50%
Net Determination Bias = 3.35E-16	< 0.00005
Overall P-Value = 2.17E-13	< 0.1
Baseline Period =	1/19/2026 to 2/21/2026

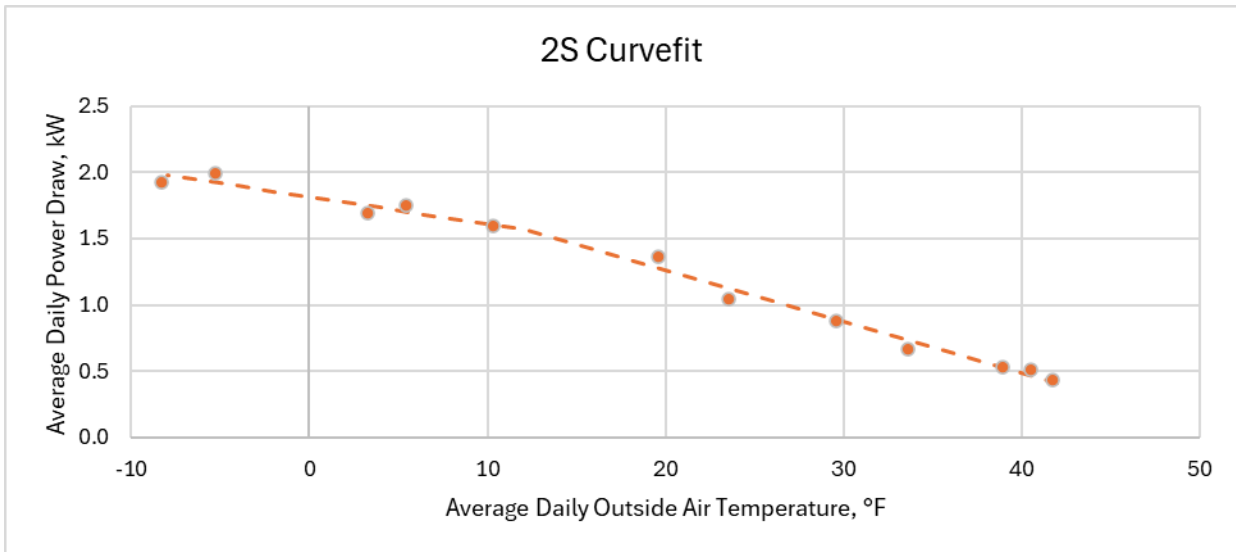


Figure 9: Mode 2S Curvefit Chart

Table 4: Mode 6S Curvefit and Related Statistics

Baseline Model		
kW / Day =	2.056775	x days in period
+	-0.036999 x Dry Bulb Temperature [°F]	
	0.000000	#N/A
	0.000000	#N/A

Statistical Summary	Suggested Range
Number of Observations = 12	>= 12
R-squared = 95.2%	> 75%
Adjusted R-squared = 94.8%	> 75%
Standard Error = 0.0	NA
Coeff. of Variation (RMSE) = 3.8%	< 20%
F Statistic = 200.3	NA
Autocorrelation Coefficient = -5.4%	NA
Durbin Watson = 1.97	~2
Fractional Savings Uncertainty (68% Conf., 5.0% sav., 365 smpls.) = 6.1%	< 50%
Net Determination Bias = 4.39E-16	< 0.00005
Overall P-Value = 5.48E-10	< 0.1
Baseline Period =	2/2/2026 to 2/28/2026

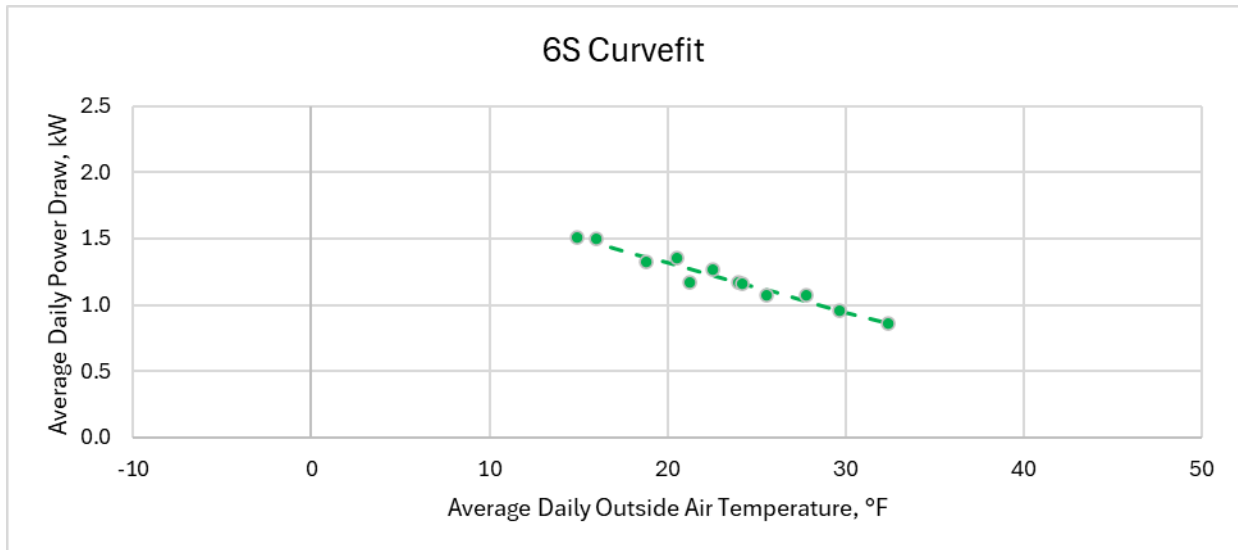


Figure 10: Mode 6S Curvefit Chart

Table 5: Mode 10S Curvefit and Related Statistics

Baseline Model		
kW / Day =	2.137083	× days in period
+	-0.042378 x Dry Bulb Temperature [°F]	
	0.000000	#N/A
	0.000000	#N/A

Statistical Summary	Suggested Range
Number of Observations = 12	>= 12
R-squared = 97.7%	> 75%
Adjusted R-squared = 97.5%	> 75%
Standard Error = 0.0	NA
Coeff. of Variation (RMSE) = 3.9%	< 20%
F Statistic = 431.1	NA
Autocorrelation Coefficient = -54.1%	NA
Durbin Watson = 2.62	~2
Fractional Savings Uncertainty (68% Conf., 5.0% sav., 365 smpls.) = 21.5%	< 50%
Net Determination Bias = -2.77E-16	< 0.00005
Overall P-Value = 4.45E-12	< 0.1
Baseline Period =	1/12/2026 to 2/14/2026

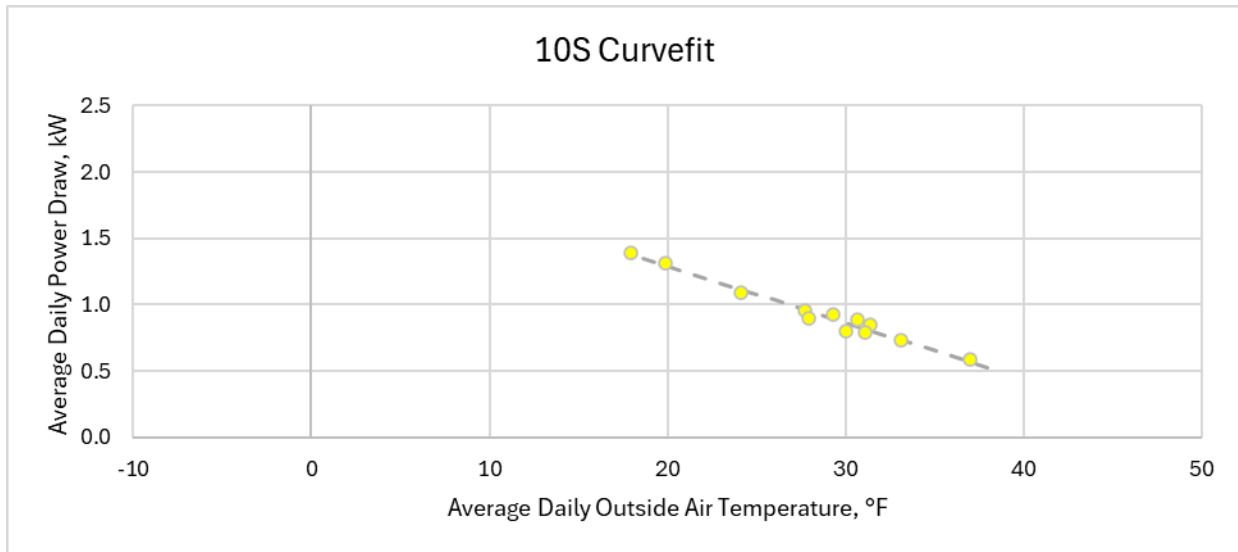
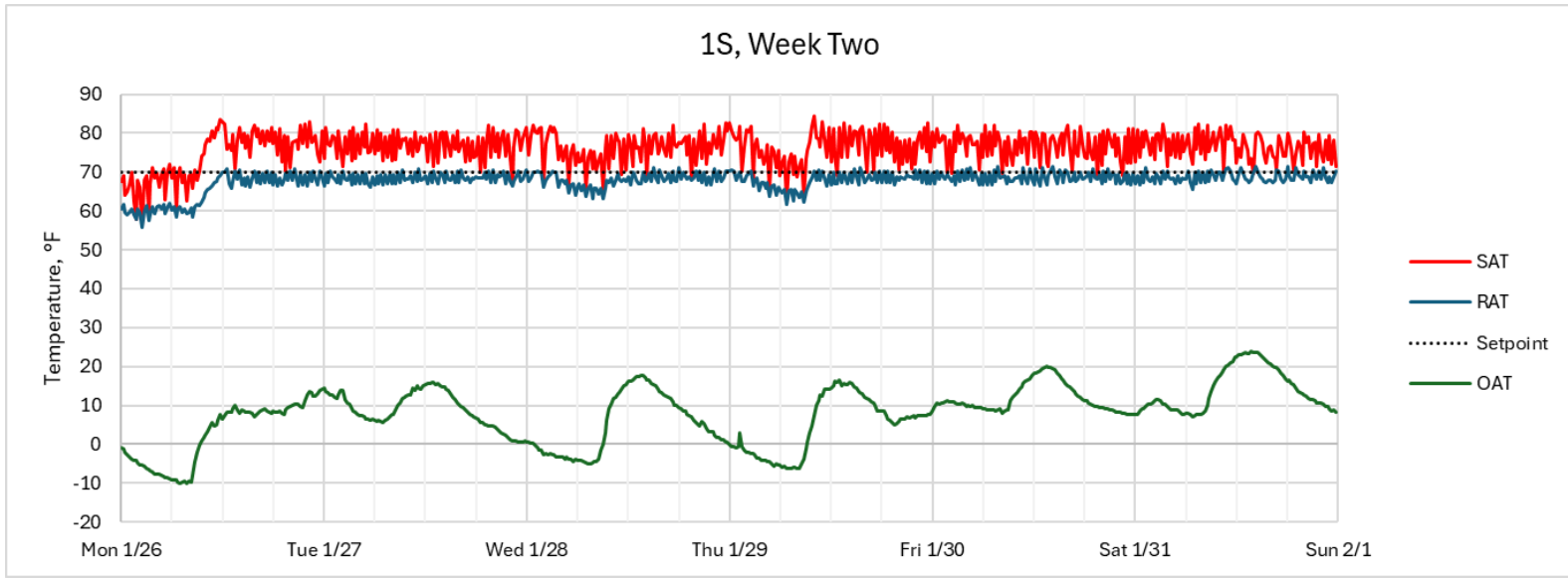
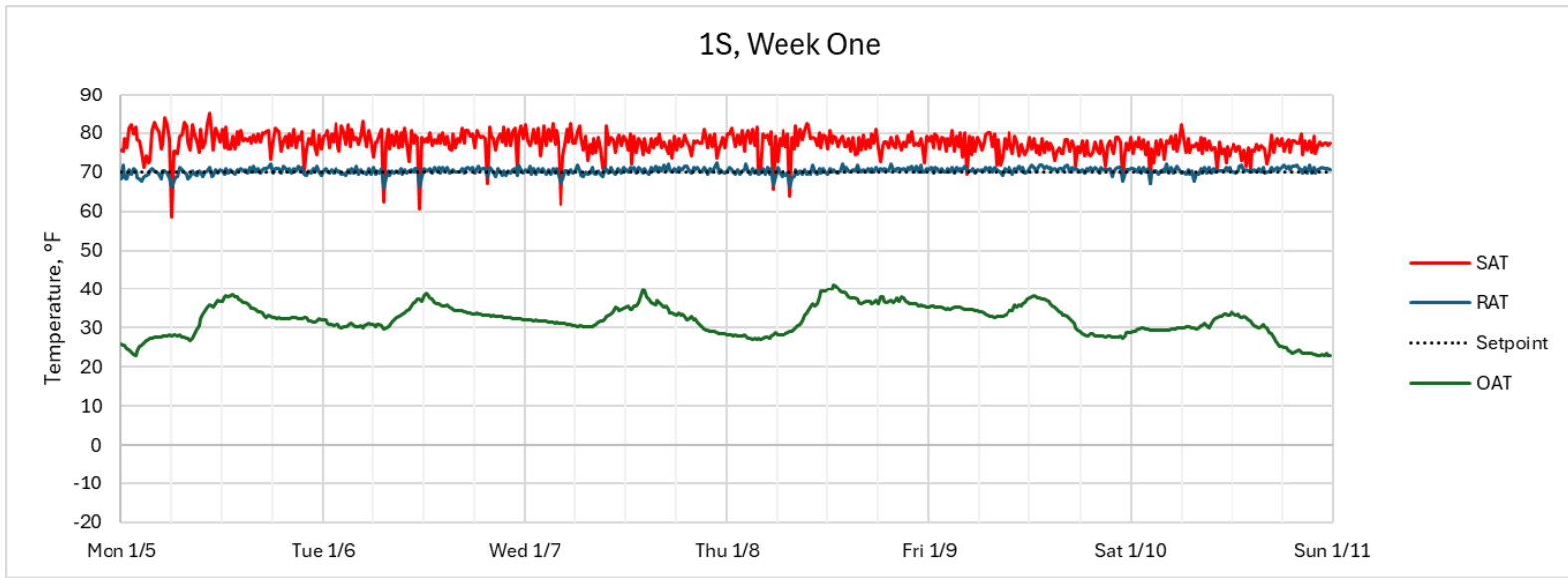


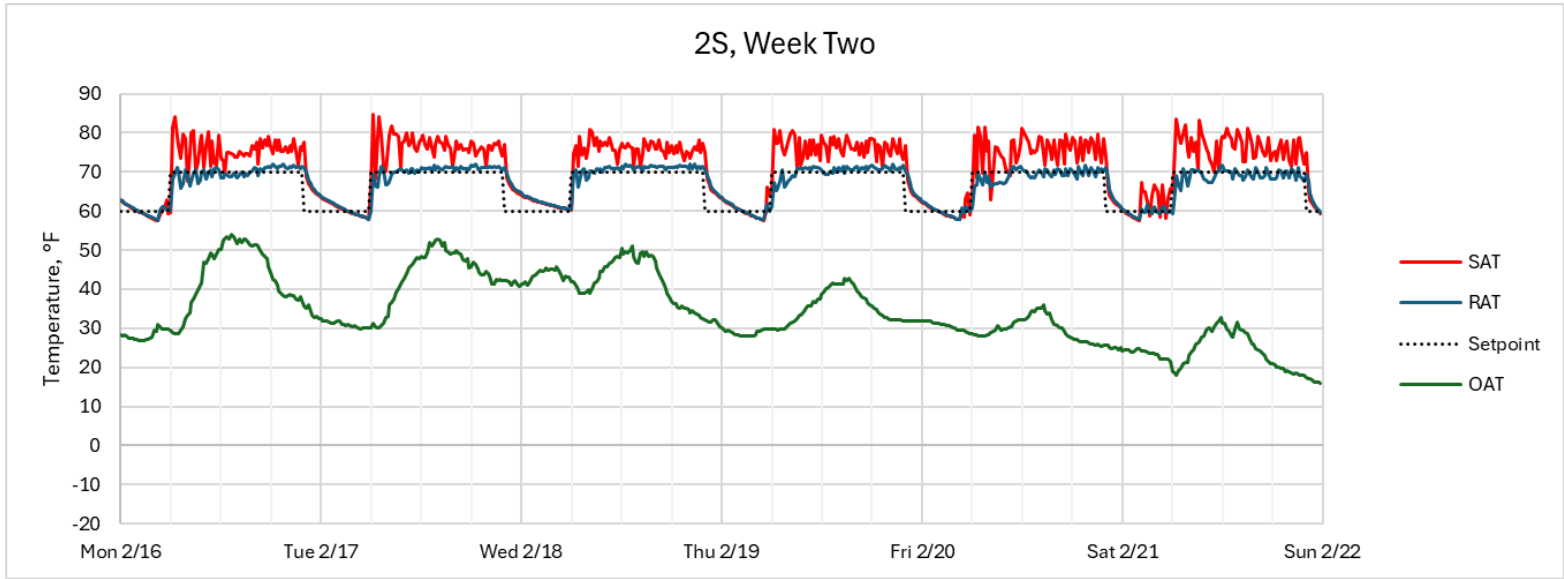
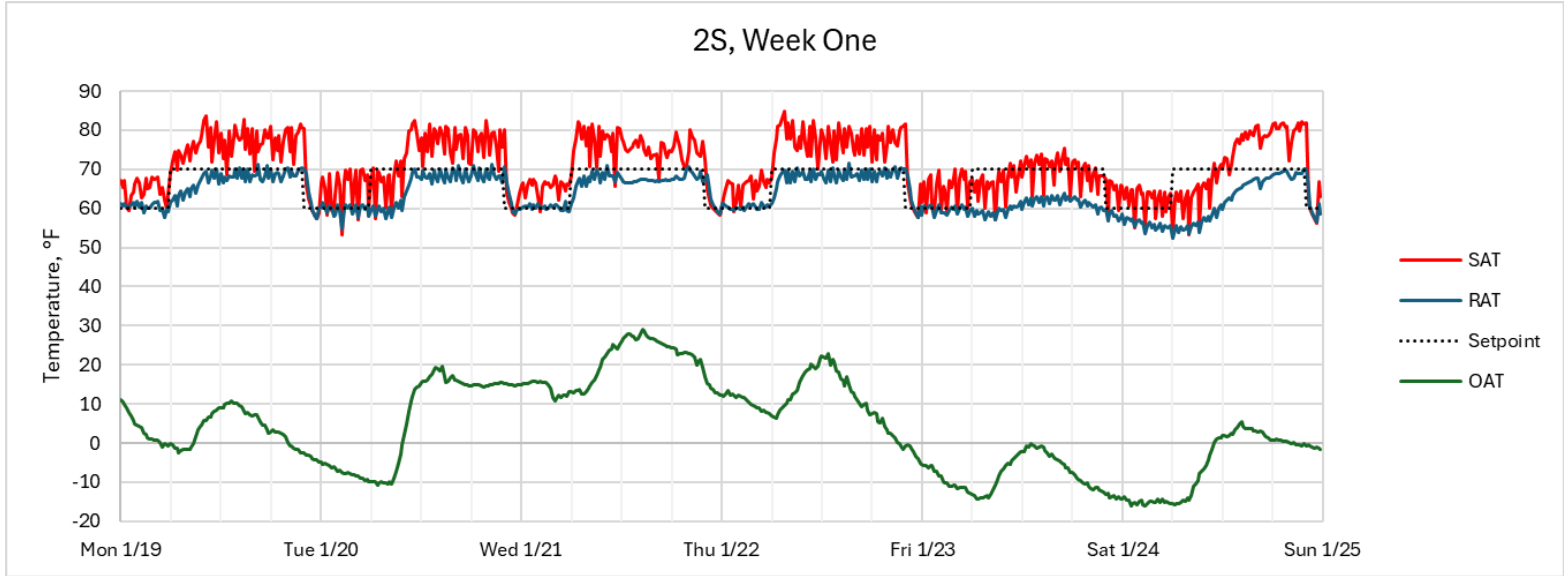
Figure 11: Mode 10S Curvefit Chart

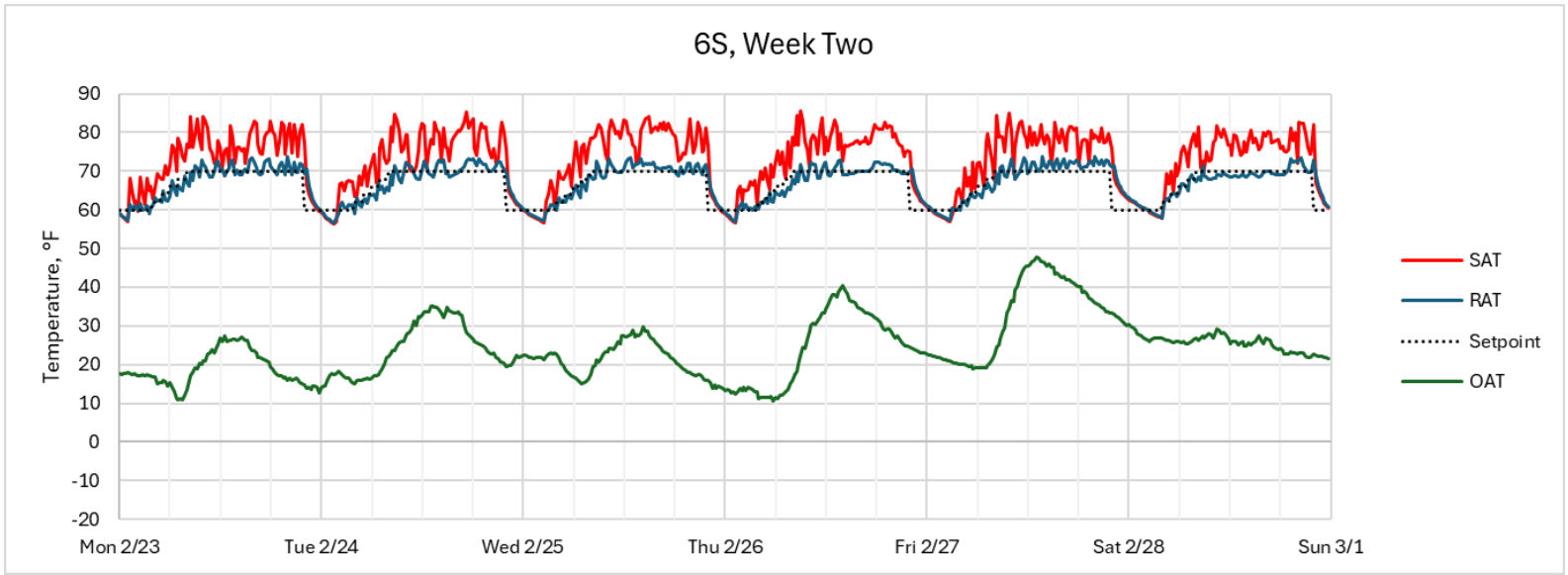
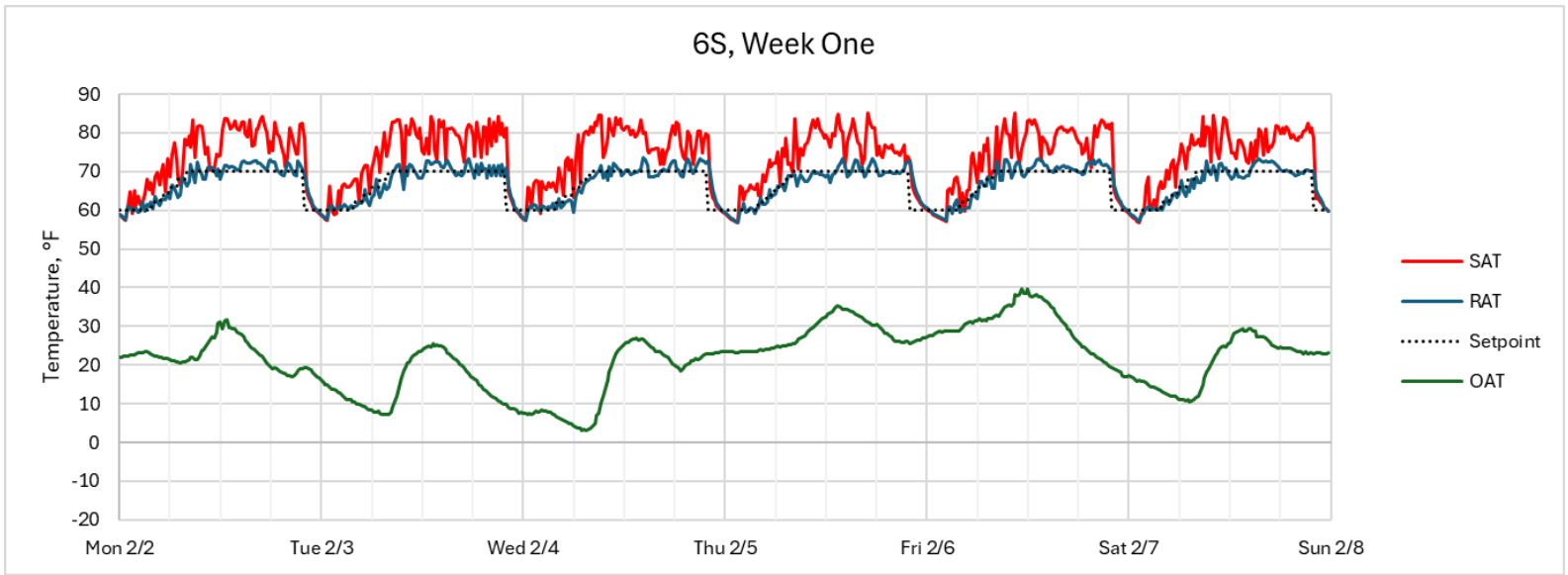
Appendix B: Temperature Data

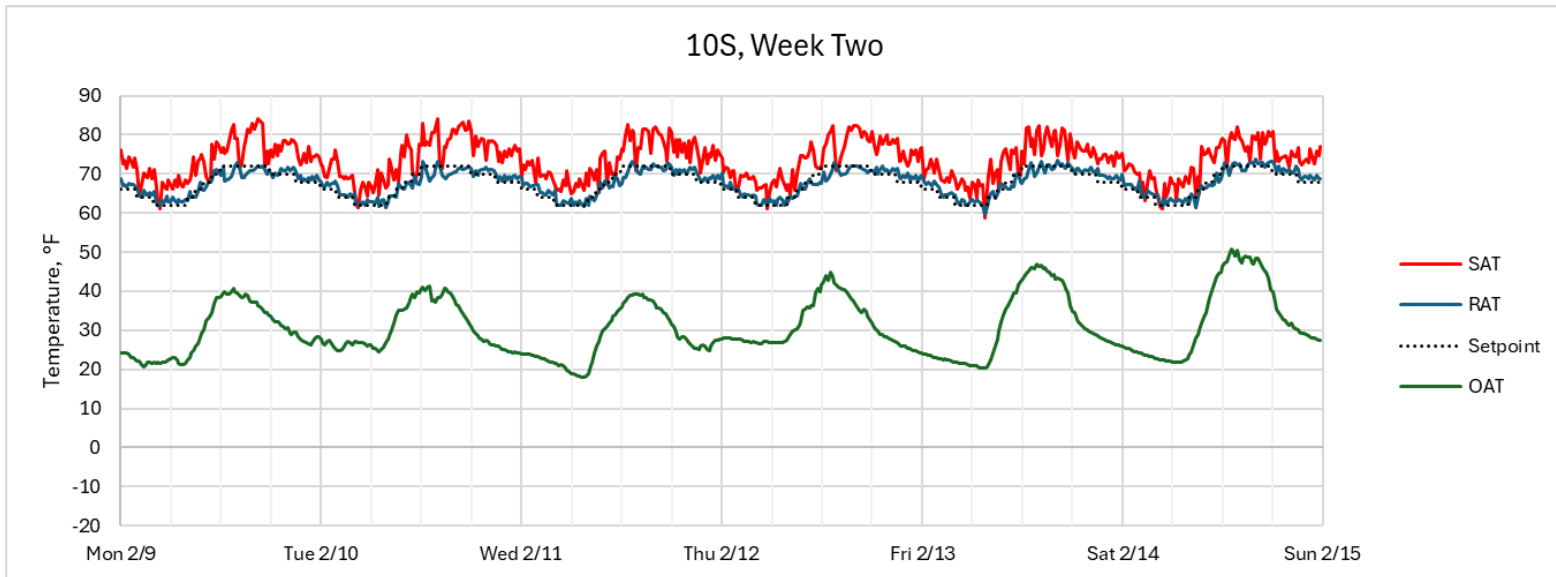
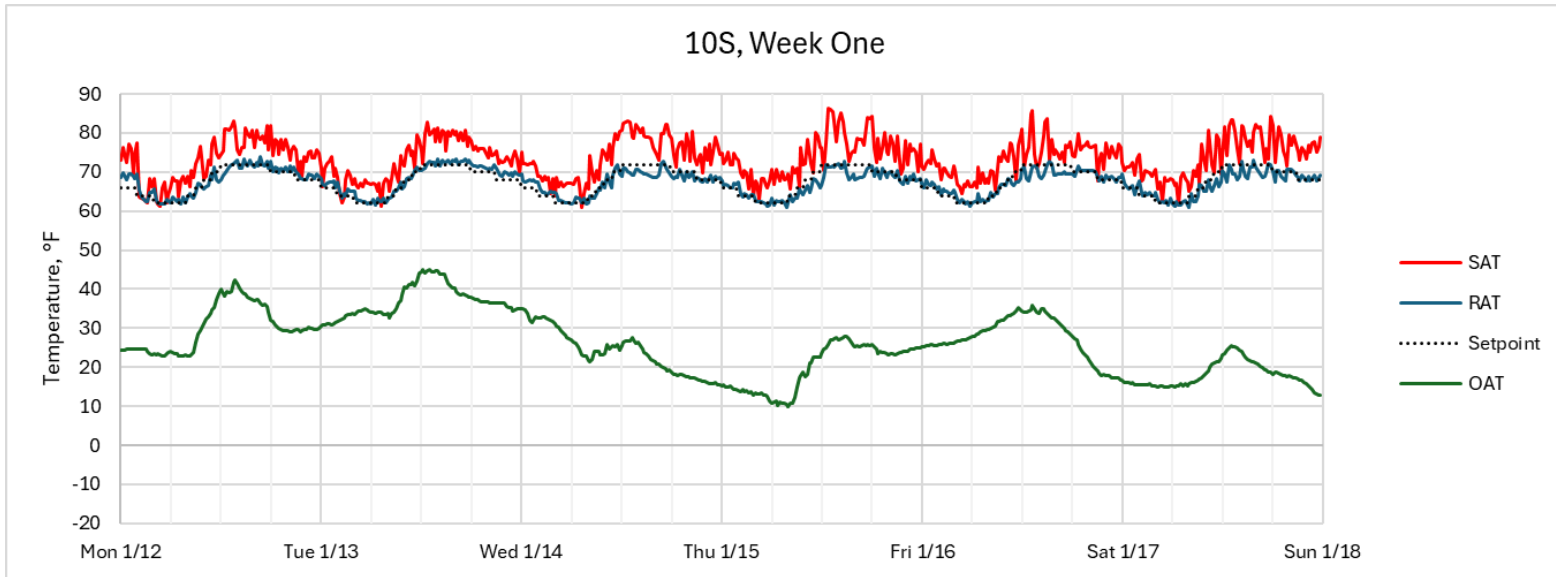
Time-series charts of the heating space temperature setpoint and the logged temperature data are shown on the next four pages. In these charts:

- "SAT" is the ASHP supply air temperature
- "RAT" is the ASHP return air temperature
- "Setpoint" is the heating space temperature setpoint
- "OAT" is the outside air temperature

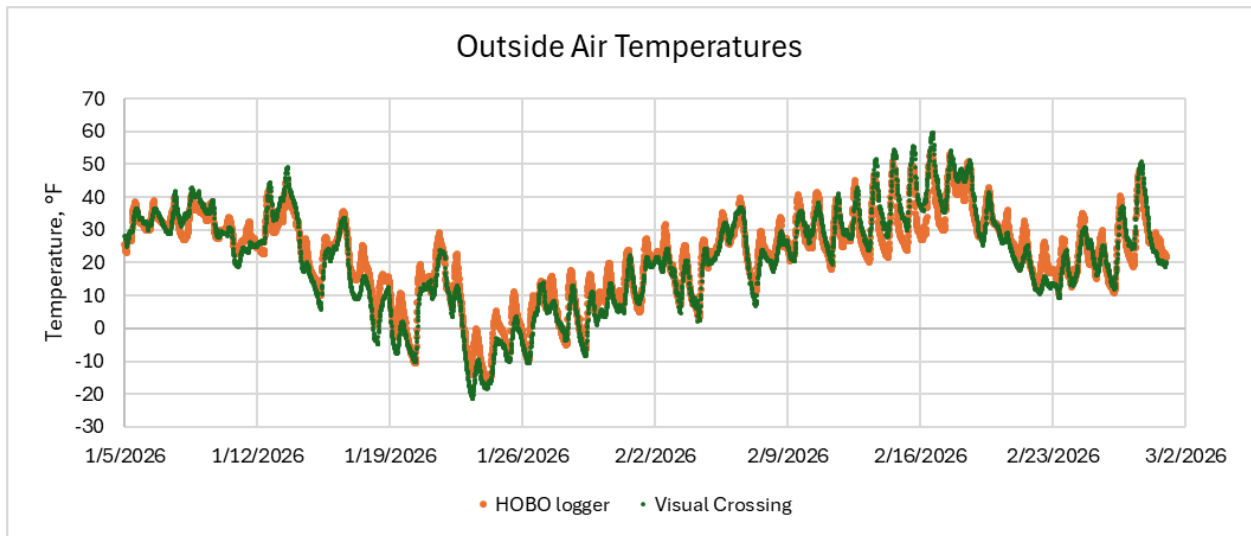




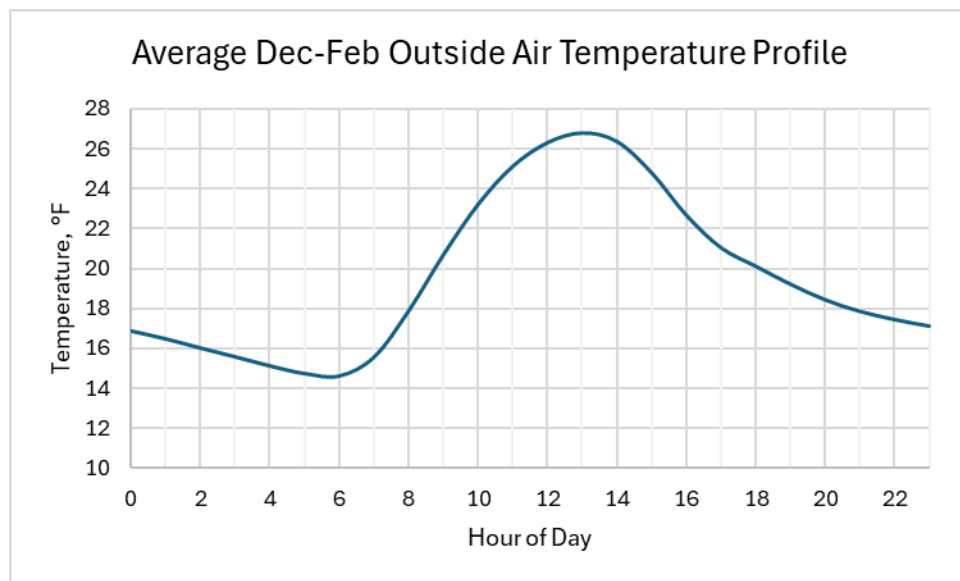




The following chart compares the outside air temperature data from the data logger with that obtained from the Visual Crossing Weather Data Service for Viola, WI (zip code 54664). It shows that the two sources are in close agreement, validating the accuracy of the data logger.



The following chart shows the average December through February hourly outside air temperature (from the TMY data).



Appendix C: Energy Use Calculations

Sum of coincident, kWh/yr ->		2,627		2,376		2,525		2,393
Previous row * \$0.11/kWh ->		\$289		\$261		\$278		\$263
% Savings ->				9.6%		3.9%		8.9%
Savings, kWh/yr ->				252		103		234
Baseline sum, all temps ->	365	4,743						
Percent of coincident ->		55.4%						

TMY data.

Green is Coincident data period. Blue is Extrapolated.

Curvefit values to left

Curvefit values to left

Curvefit values to left

Curvefit values to left

Curvefit values to left

Avg Daily OA DB, °F	# of Days in Year	1S kW	1S kWh/yr	2S kW	2S kWh/yr	6S kW	6S kWh/yr	10S kW	10S kWh/yr
80	1								
78	3								
76	6								
74	12								
72	21								
70	27								
68	10								
66	17								
64	12								
62	8								
60	8								
58	7								
56	10								
54	5								
52	9								
50	13								
48	13	0.05	16						
46	7	0.15	25						
44	8	0.25	48						
42	6	0.35	50	0.41	59				
40	8	0.45	85	0.49	94				
38	5	0.54	65	0.57	68			0.53	63
36	7	0.64	108	0.64	108			0.61	103
34	14	0.74	249	0.72	242			0.70	234
32	15	0.84	302	0.80	287	0.87	314	0.78	281
30	11	0.94	248	0.87	231	0.95	250	0.87	229
28	13	1.04	324	0.95	297	1.02	318	0.95	297
26	19	1.14	518	1.03	469	1.09	499	1.04	472
24	7	1.23	207	1.11	186	1.17	196	1.12	188
22	11	1.33	352	1.18	312	1.24	328	1.20	318
20	9	1.43	309	1.26	272	1.32	284	1.29	279
18	10	1.53	367	1.34	321	1.39	334	1.37	330
16	6	1.63	235	1.41	204	1.46	211		
14	6	1.73	249	1.49	215				
12	6	1.83	263	1.57	226				
10	2	1.92	92	1.61	77				
8	2	2.02	97	1.65	79				
6	3	2.02	146	1.69	122				
4	1	2.02	49	1.73	42				
2	0	2.02	0	1.77	0				
0	1	2.02	49	1.81	44				
-2	6	2.02	291	1.85	267				
-4	0			1.90					
-6	0			1.94					
-8	0			1.98					
-10	0			2.02					