Does Night Setback Save Energy?

Dave Moser, 4/19/2024

The question: Does lowering your thermostat's heating temperature setpoint during the evening use less energy than just leaving the setpoint at a constant temperature?

The answer: Yes, for my office at least. About a 30% reduction in heating energy use if the setpoint is reduced from 68 °F to 50 °F at night.

Room Description

I work from home (Viroqua, WI) from a 7' x 10' office with exterior walls on the east, south, and west sides. The east and south sides have a window, and there's a glass door on the west side. See the below photos. Wood frame construction. Batt insulation in the ceiling and roof, rigid insulation in the floor.

The office is heated with a 1,250 watt baseboard heater, controlled by a Mysa programable thermostat.

Test Setup

I placed a 20 amp data logger on the circuit serving the baseboard heater.

Amp draw was logged from 2/7/2024 through 4/4/2024, at a 1-5 minute interval.

Three scenarios were tested:

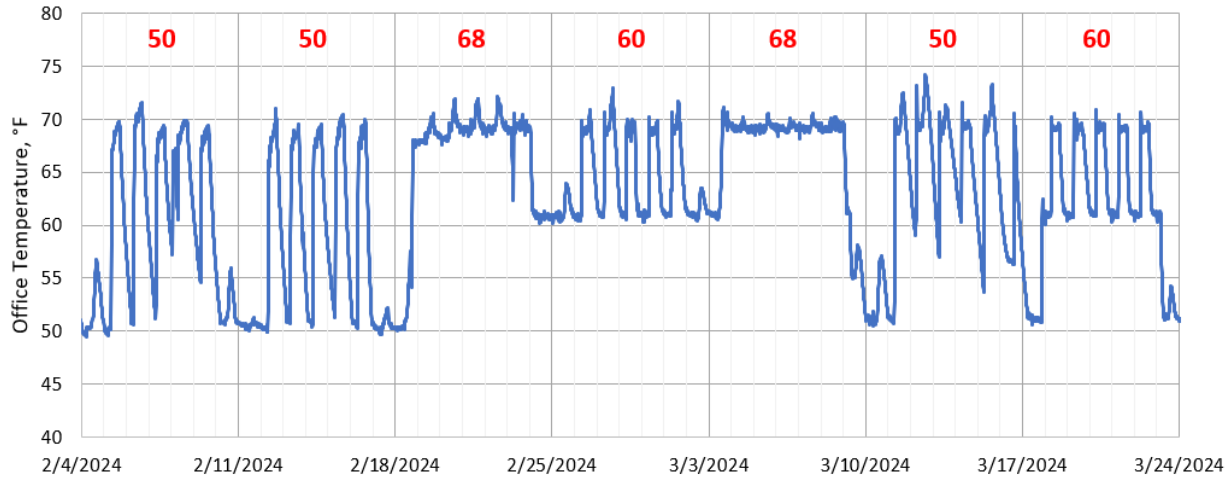
1. "68": 68 °F heating setpoint continuously
2. "60":
    a. 68 °F heating setpoint Mon-Fri 7:40 am – 5 pm
    b. 60 °F setpoint at all other times
3. "50":
    a. 68 °F heating setpoint Mon-Fri 7:40 am – 5 pm
    b. 50 °F setpoint at all other times

Monday through Friday were tested instead of the entire week to allow for temperatures to stabilize over the weekend for the following week's test case.

Each scenario was tested for at least two weeks. The following chart shows office temperatures during the test period.

- There are times when the lower setpoint is not reached during the evening, due to relatively warm outside conditions. E.g., during the week of 3/10/2024, the office temperature never dropped to the 50 °F setpoint at night.

- Sometimes the daytime temperature setpoint is exceeded, when temperatures are warm outside and/or the solar load is high.



Data Results

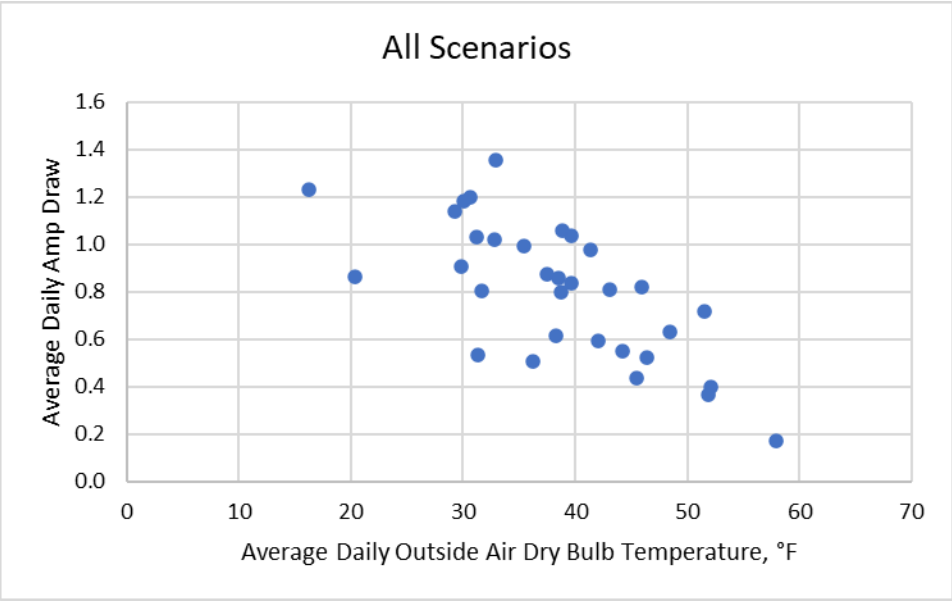
The table on the following page shows the logged average daily amp draw values, and other relevant values (outside air temperature, solar load, wind speed).

Average daily outside air dry bulb temperatures during the logger period ranged from 16 °F to 58 °F, with a 38 °F average. These values fall within the historic average daily temperatures for Viroqua during heating season:

- October: 50 °F
- November: 37 °F
- December: 24 °F
- January: 18 °F
- February: 21 °F
- March: 34 °F
- April: 47 °F

			From Wunderground, for Viroqua, WI	*From data logger*	*From home solar panels*	*From Wunderground, for Viroqua, WI*
Date	Day of Week	Mode	Average Outside Air Dry Bulb Temperature, °F	Average Amp Draw	Solar Production, kWh	Average Wind Speed, mph
2/9/2024	Fri	50	38.3	0.61	5.2	15.1
2/12/2024	Mon	50	35.4	0.99	52.4	8.5
2/13/2024	Tue	50	31.7	0.80	26.1	2.7
2/14/2024	Wed	50	37.5	0.87	23.9	7.3
2/15/2024	Thu	50	31.3	0.53	44	12.2
2/19/2024	Mon	68	32.9	1.36	43.3	4.9
2/20/2024	Tue	68	39.7	1.04	46.8	7.8
2/21/2024	Wed	68	38.8	0.80	41.7	2.8
2/22/2024	Thu	68	42	0.59	52.3	7.6
2/23/2024	Fri	68	31.2	1.03	5.6	8.9
2/26/2024	Mon	60	46.4	0.52	45.8	8.3
2/27/2024	Tue	60	36.2	0.51	49.2	16.0
2/29/2024	Thu	60	32.8	1.02	55.3	12.7
3/1/2024	Fri	60	44.2	0.55	56	15.3
3/4/2024	Mon	68	38.9	1.06	4.1	7.1
3/5/2024	Tue	68	38.5	0.86	56.9	6.8
3/6/2024	Wed	68	41.4	0.98	57.7	5.9
3/7/2024	Thu	68	45.9	0.82	53.6	4.8
3/8/2024	Fri	68	39.7	0.83	6.4	12.1
3/15/2024	Fri	50	45.5	0.43	55.7	7.0
3/18/2024	Mon	60	30.6	1.20	47.6	11.6
3/19/2024	Tue	60	43.1	0.81	54.4	15.5
3/20/2024	Wed	60	29.8	0.90	61.7	13.4
3/21/2024	Thu	60	30.1	1.18	29.2	4.3
3/22/2024	Fri	60	29.3	1.14	13.4	6.0

The amp draw data shows a strong correlation with outside air temperature, as shown in this chart:



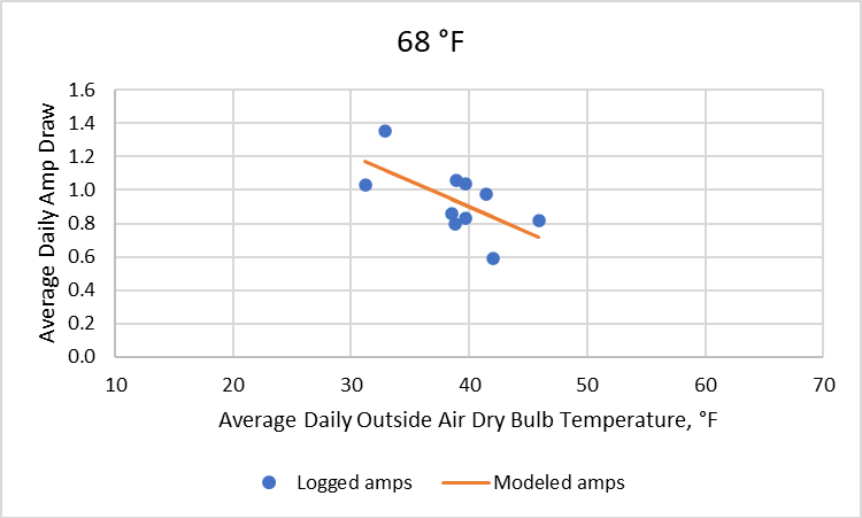
Analysis

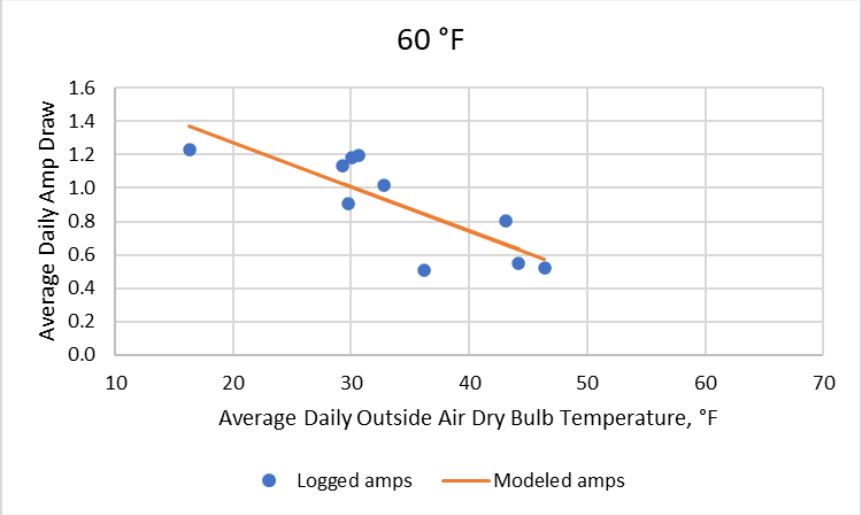
For each of the three scenarios, a regression model was developed to correlate average daily amp draw with influencing variables. The following variables were tested:

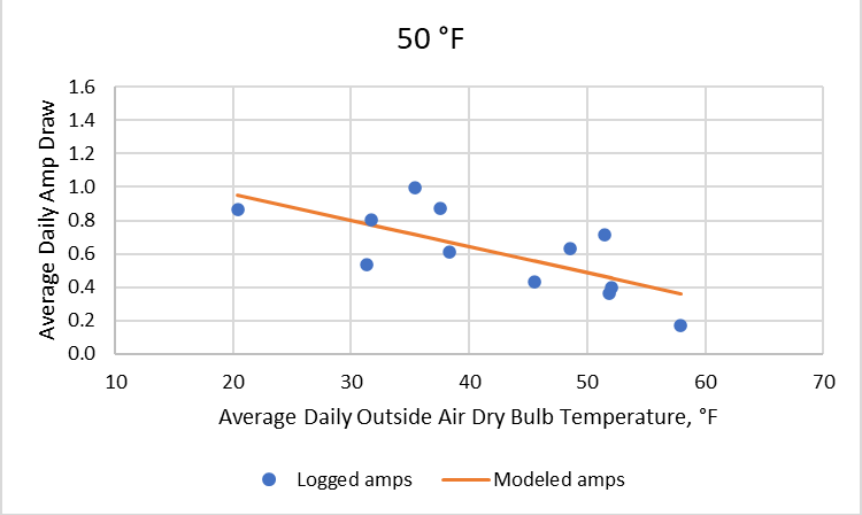
- Average daily outside air dry bulb temperature
- Daily solar panel production (proxy for solar load / cloud cover)
- Average daily wind speed

Of those three, only temperature had a significant impact. The other two (solar load and wind speed) each had absolute t-stat values less than 2, meaning that those two variables do not have a statistically significant impact on average daily amp draw.

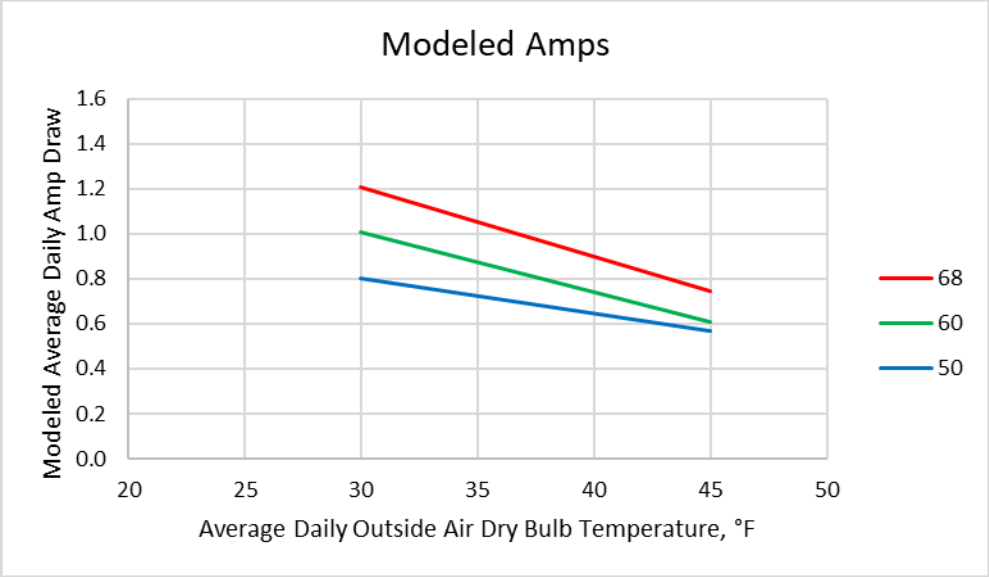
The following charts show the data and modeled curvefit for each scenario:


68 °F
Average Daily Amp Draw
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
Average Daily Outside Air Dry Bulb Temperature, °F
Logged amps
Modeled amps


60 °F
Average Daily Amp Draw
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
Average Daily Outside Air Dry Bulb Temperature, °F
Logged amps
Modeled amps


50 °F
Average Daily Amp Draw
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
Average Daily Outside Air Dry Bulb Temperature, °F
Logged amps
Modeled amps

Overlaying all three, it's clear that the 68 °F scenario uses more energy than 60 °F, and 60 °F uses more than 50 °F:



The following table shows the energy savings suggested by the logged data:

	Average Daily Amp Draw				
Average Daily Outside Air Dry Bulb Temperature, °F	**50**	**60**	**68**	**Energy reduction going from 68 °F to 50 °F night setback**	**Energy reduction going from 68 °F to 60 °F night setback**
30	0.80	1.01	1.21	34%	17%
45	0.57	0.61	0.75	24%	18%

This test and analysis was conducted with a limited data set, and only for my office. So the percent reductions in the above table should not be assumed to be applicable to all homes and offices. However, the data shows a clear trend: setting back the temperature setpoint at night saves energy, on the order of 15% going from 68 °F to 60 °F, and 30% going from 68 °F to 50 °F.

Zoom In On Three Days

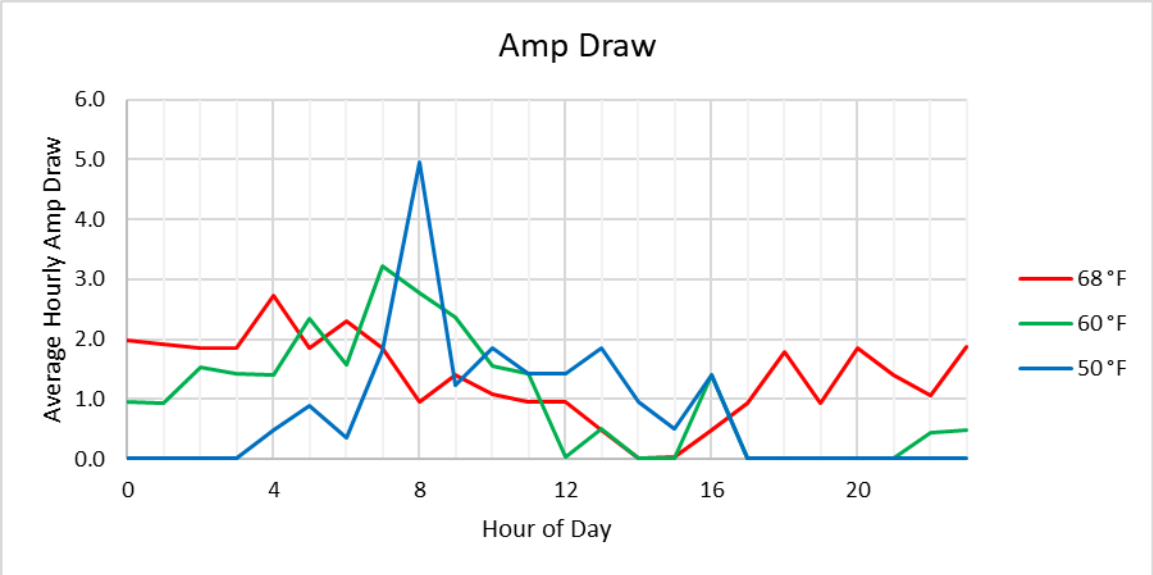
These three days, one for each scenario, were selected for a more detailed comparison since the average daily outside air temperature on each of these days was similar:

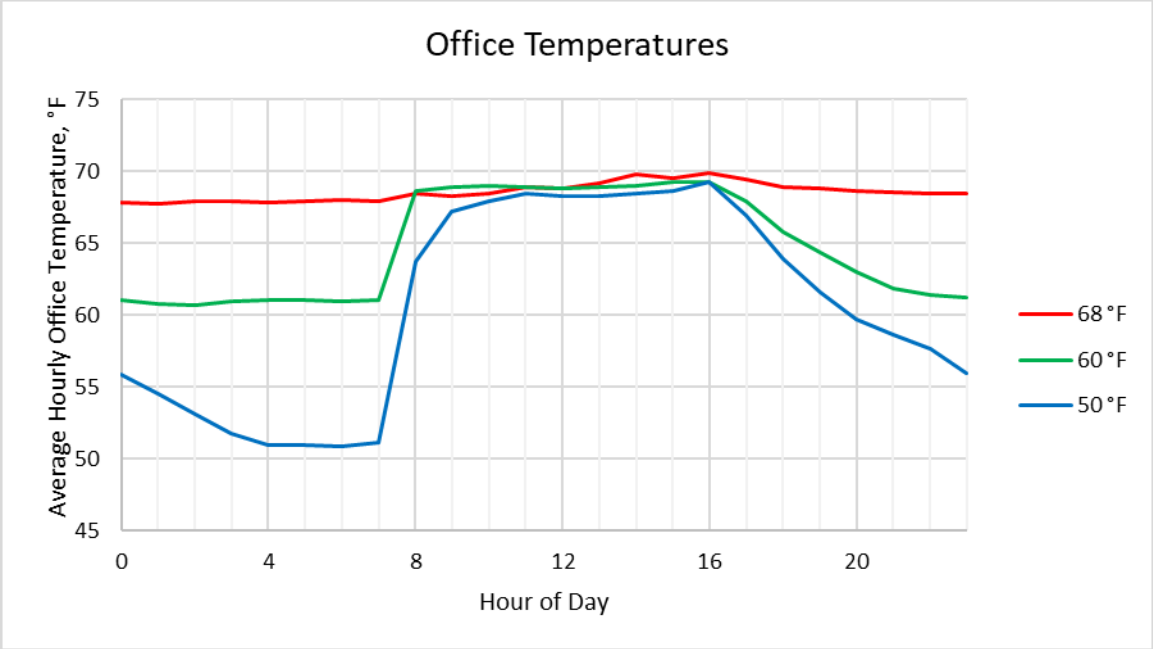
			From Wunderground, for Viroqua, WI	*From data logger*
Date	**Day of Week**	**Mode**	**Average Outside Air Dry Bulb Temperature, °F**	**Average Amp Draw**
2/13/2024	Tue	50	31.7	0.80
2/19/2024	Mon	68	32.9	1.36
2/29/2024	Thu	60	32.8	1.02

The average hourly amp draw and office temperature for those three days are shown in the following charts. Those charts show:

- Nighttime amp draw and office temperatures for the 50 °F and 60 °F scenarios are lower than the 68 °F scenario

- The 8 am amp draw for the 50 °F and 60 °F scenarios is higher than the 68 °F scenario, since the heat starts to operate more often when the office temperature setpoint increases to 68 °F at 7:40 am. The maximum amp draw seen in the data is 5.7 amps, so the heat was on close to continuously from 8-9 am for the 50 °F scenario. The reduction in nighttime amp draw is greater than this increase, though, resulting in reduced average daily amp draw.





Another Example of Night Setback Energy Savings

From late 2010 to early 2011, my wife and I went on a trip and rented out our Portland, OR house for those 4-5 months. We were paying our house's utility bills online during the trip, and I noticed our monthly natural gas bill was significantly higher than usual (the house used a natural gas-fired forced air furnace). We asked the tenant about this, and they said they were keeping the heating setpoint at 68 °F continuously. This was the likely reason for the higher-than-expected gas use, since in years past we would lower the heating setpoint to 50 °F at night.