Optimizing A/C Power Usage

Contents

Original Conclusion (6/2022): In my specific example, it does **NOT** make sense to adjust the thermostat cooling level up and down based on outside temperature. However, my circumstances are very specific, and your circumstances may well save you money to do this. I have documented this to hopefully save other people time even though it was not a success case for me.

Updated (7/2023) Conclusion: I made several modifications (like moving the thermostats to proper locations) and have re-run the test with different parameters and it now shows a considerable savings in energy and money. You can see the results of this update test here: Updated Test Results.

Reasons to Optimize A/C power usage

Shifting power usage to "off-peak" hours can save money

As can be seen from the chart below (from Nevada Power Company d/b/a NV Energy Electric Rate Schedules for Residential Customers as of 6/2022) there are different plans that can be used with different rates.

- On the left (variable) are plans that charge different rates in summer based on time of day
- On the right (fixed) is the plan that charges the same amount regardless of time of day

Option A:

Basic Service Charge, per month	$ 70.70
Electric Consumption, per kWh	
Winter	$ 0.06340
Winter REVRR	$ 0.05863
Summer on-peak	$ 0.33287
Summer off-peak	$ 0.06342
Summer REVRR	$ 0.05865
DEAA, all kWh, per kWh	$ 0.00750
TRED, all kWh, per kWh	$ 0.00076
REPR, all kWh, per kWh	$ 0.00043
EE, all kWh, per kWh	$ 0.00075
NDPP, all kWh, per kWh	$ 0.00056

Option B:

Basic Service Charge, per month	$ 181.10
Electric Consumption, per kWh	
Winter	$ 0.06260
Winter REVRR	$ 0.05791
Summer on-peak	$ 0.28753
Summer off-peak	$ 0.08684
Summer REVRR	$ 0.07973
DEAA, all kWh, per kWh	$ 0.00750
TRED, all kWh, per kWh	$ 0.00076
REPR, all kWh, per kWh	$ 0.00043
EE, all kWh, per kWh	$ 0.00075
NDPP, all kWh, per kWh	$ 0.00056

RESIDENTIAL SINGLE–FAMILY (RS)

Available to residential customers who are separately metered in a permanent, single-family dwelling.

Basic Service Charge, per month	$ 12.50
Electric Consumption	
All kWh, per kWh	$ 0.11469
DEAA, all kWh, per kWh	$ 0.00750
TRED, all kWh, per kWh	$ 0.00076
REPR, all kWh, per kWh	$ 0.00043
EE, all kWh, per kWh	$ 0.00124
NDPP, all kWh, per kWh	$ 0.00056

To take advantage of the 'variable' rate plan you are required to pay a higher basic service charge which negates much of the savings.

If you figure out the "best case scenario" (where "all" of your power usage is in 'off-peak' hours the math is as follows:

1. Extra service charge = $70.70 - $12.50 = **$58.20**
2. kWh savings = 0.11469 – 0.06342 = **0.0513 $/kWh**
3. Breakeven point = $58.20 / 0.513 $/kWh = **1135 kWh**

Which means that you have to use at least 1135 kWh of electricity to make it worthwhile switching to the variable plan.

In my particular case, a typical summer electrical bill shows that my house is using around 1863 kWh of electricity per month. This means that my summer electrical savings (using the variable rate) would be as follows:

1. Usage past breakeven point = 1863 kWh – 1135 kWh = **728 kWh**
2. Monthly savings = 728 kWh * 0.0513 $/kWh = **$37.34**

Since my total bill for the summer month in question was $224.54 this would translate to a savings of approximately 17%.

A major drawback to using the 'variable' power company rate (and I have not followed through and checked on this) is that I suspect that you have to sign up for a whole year. In other words, I doubt that you can use this rate schedule during the summer, and then switch back to the 'fixed' rate schedule during the winter. If I am correct, this would make the 'variable' rate plan even worse because you would most likely be paying "more" in the winter due to the higher basic service charge.

Another assumption of this analysis is that 'all' power is billed at the 'off peak' rate which would only be true if you literally turned off your AC during the peak hours. A more realistic scenario would be that it runs for a few minutes here and there to keep you somewhat comfortable.

My conclusion here is that there does not appear to be an adequate cost savings to offset the personal discomfort experienced due to higher household temperatures in the hot months. However, this may be different in your case if your power company offers better power rate options.

Running the A/C at night is more efficient

All A/C units have a practical limit on how much they can cool that is based upon the temperature of the outside air. In other words, if it is 150 degrees outside, your A/C unit is not going to be able to cool your house down to 50 degrees – no matter how long you let it run.

Typical A/C units have the ability to cool the air down by about 20-25 degrees F. Your particular unit may be able to do more if it is new, and older units may only be able to do less – but in general 20-25 degrees is a good average.

So, if you set your thermostat to 75 degrees F and it is 90 degrees outside, the delta is 15 degrees and everything works fine. However, if you set your thermostat to 75 degrees and it is 110 degrees outside, the delta is 35 degrees and your A/C may be incapable of cooling this low – resulting in your A/C unit running constantly.

With a home control system (or a really smart thermostat) you can program the thermostat setting to slowly move "up" as the outside temperature gets hotter. In this example, if you initially set it to 75 degrees, your system would start moving it by one degree (for every degree it got hotter outside) after the outside temperature exceeded 95 degrees (75 degrees + the A/C delta of 20.) This would prevent your unit from running endlessly and wasting electricity.

The drawback of course is that your house would gradually get hotter during the day. This of course is a personal preference and you will need to determine if you are OK with it.

In my case, I put a cap on how high the thermostat could creep up at 78 (and my ideal temperature is 74) and it is still very comfortable. I live in Las Vegas and the outside temperature regularly exceeds 110 F.

Cooling Extra Low at Night to Super Cool the House

An extra step to optimize A/C usage is to cool your house extra low at night. Even a few degrees cooler eliminates much of the time the A/C needs to run during the day. In my case I cool to 68 F at night and 74 F during the day, and this has moved over 50% of my A/C cooling power usage to the night time.

This provides a big benefit because it super cools everything in your house (not just the air.) If your house is well insulated, it will take many hours before the A/C will need to kick in during the day. In my case it doesn't even turn on until around 4pm or so – there is no A/C usage almost all day long!

Running the A/C at Night makes it Last Longer

It's just common sense that if the mechanical components are under less thermal stress for briefer periods of time, they will last longer before requiring maintenance or replacement.

Polisy Logic to Optimize A/C usage

The following Polisy logic is all that is needed to optimize A/C usage. Note that the "Cap Max Temperature" is optional, and only needed if you object to the temperature going too high.

Program Content for 'Adjust Temperature'

```
If
        'Climacell Weather' Temperature >= '$ACMaxOutsideTemperature Fahrenheit'

Then
        $ACSetTemperature  = 'Climacell Weather' Temperature °F
        $ACSetTemperature -= $AC_MAX_DELTA
        Run Program 'Cap Max Temperature' (If)
        Wait  2 seconds
        Set 'Thermostat Bedrooms' Cool Setpoint '$ACSetTemperature Fahrenheit'
        Set 'Thermostat Main Area' Cool Setpoint '$ACSetTemperature Fahrenheit'

Else
        $ACSetTemperature  = $ACIdealTemperature
        Set 'Thermostat Bedrooms' Cool Setpoint '$ACSetTemperature Fahrenheit'
        Set 'Thermostat Main Area' Cool Setpoint '$ACSetTemperature Fahrenheit'
```

Program Content for 'Cap Max Temperature'

```
If
        $ACSetTemperature > $AC_MAX_TEMPERATURE

Then
        $ACSetTemperature  = $AC_MAX_TEMPERATURE

Else
   - No Actions - (To add one, press 'Action')
```

Program Content for 'Set Day Cooling Point'

```
If
        Time is Sunrise

Then
        $ACIdealTemperature  = $IDEAL_DAY_TEMPERATURE
        $ACMaxOutsideTemperature  = $ACIdealTemperature
        $ACMaxOutsideTemperature += $AC_MAX_DELTA

Else
   - No Actions - (To add one, press 'Action')
```

Program Content for 'Set Night Cooling Point'

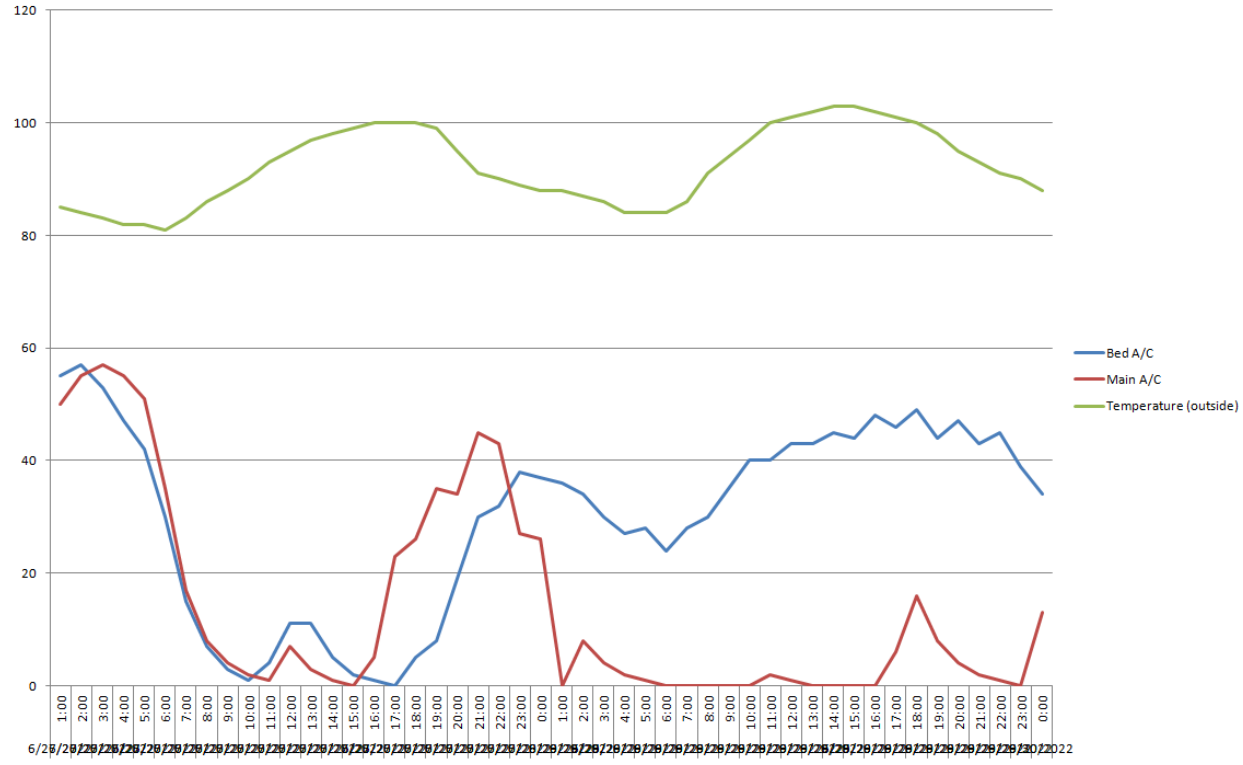
```
If
        Time is 12:00:00AM

Then
        $ACIdealTemperature  = $IDEAL_NIGHT_TEMPERATURE
        $ACMaxOutsideTemperature  = $ACIdealTemperature
        $ACMaxOutsideTemperature += $AC_MAX_DELTA

Else
   - No Actions - (To add one, press 'Action')
```

Actual Charted Power Usage

The following chart shows power usage (in minutes) for two days in June that have relatively close outside temperature ranges. Each block on the x-axis is one hour. There are 48 blocks showing two days usage. The y-axis shows both AC usage (in minutes) and outside temperature (in degrees F.)



The left half of the chart shows the home controller adjusting the thermostats as described in the preceding pages, and the right half of the chart shows the thermostats both set to 74 F all day long.

If you total the AC minutes used for each day (combining both ACs into one number) you get 1111 minutes for the left day, and 1027 minutes for the right day. In other words the left day used 84 MORE minutes of AC usage than the right day. This is, in spite of, the fact that you can see the right day is slightly hotter outside. I have not dug into the laws of physics that might explain this – I simply admit that it is a fact that these are the numbers that were recorded in spite of my expectations.

The clear conclusion to this is that leaving the thermostat setting at a constant temperature uses less power.

As a side note, it can clearly be seen that the right day has an imbalance in run time between the two AC units. This is due to one of my thermostats being poorly positioned in the house – something that I plan to address, but does not directly affect overall usage.