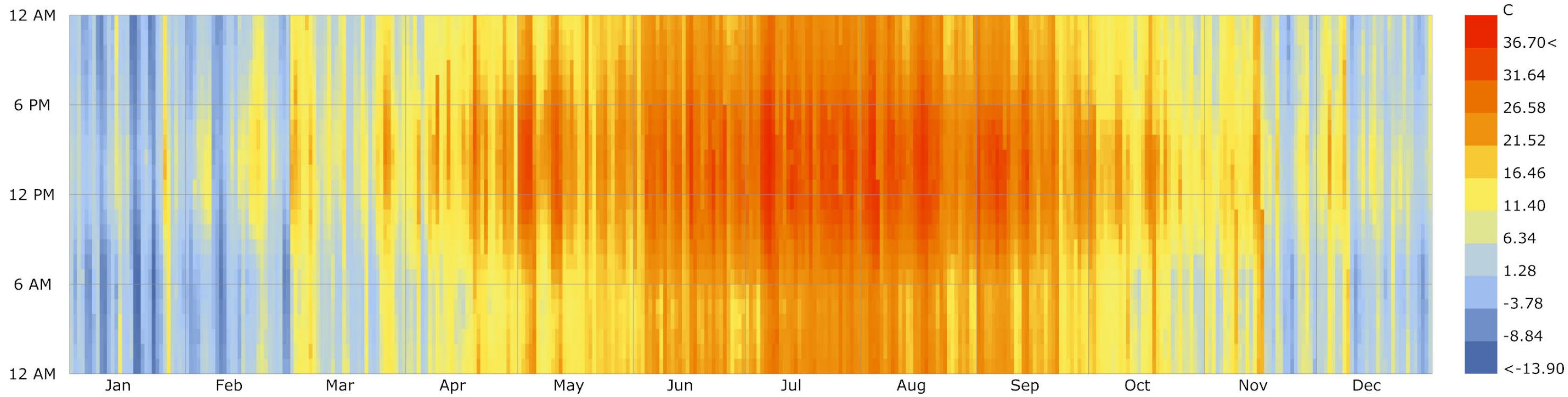
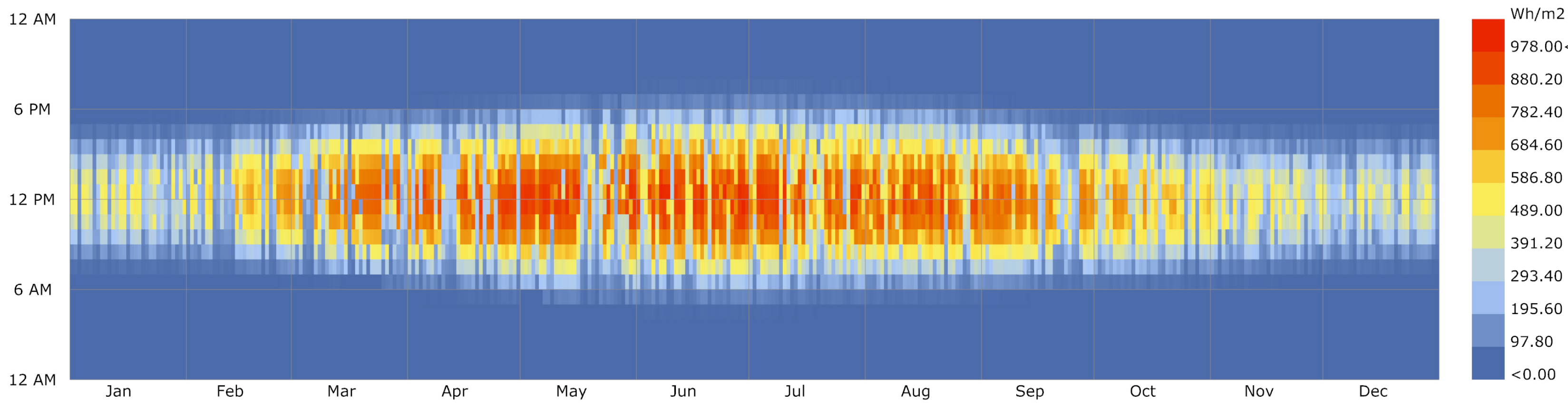
Philadelphia Weather



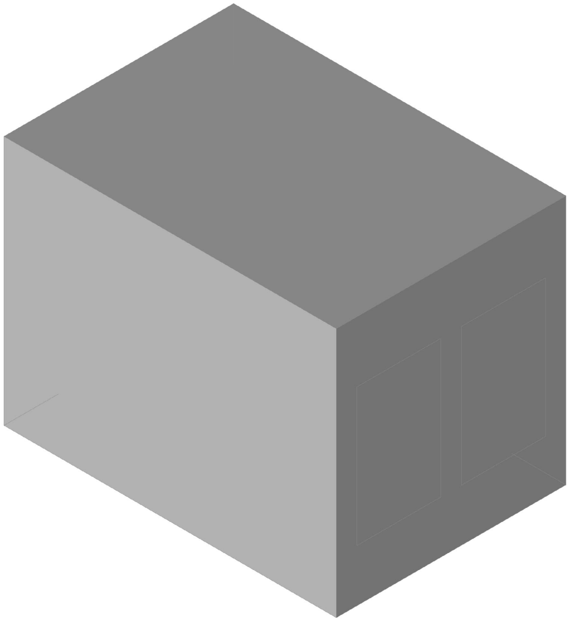
Dry Bulb Temperature (C) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

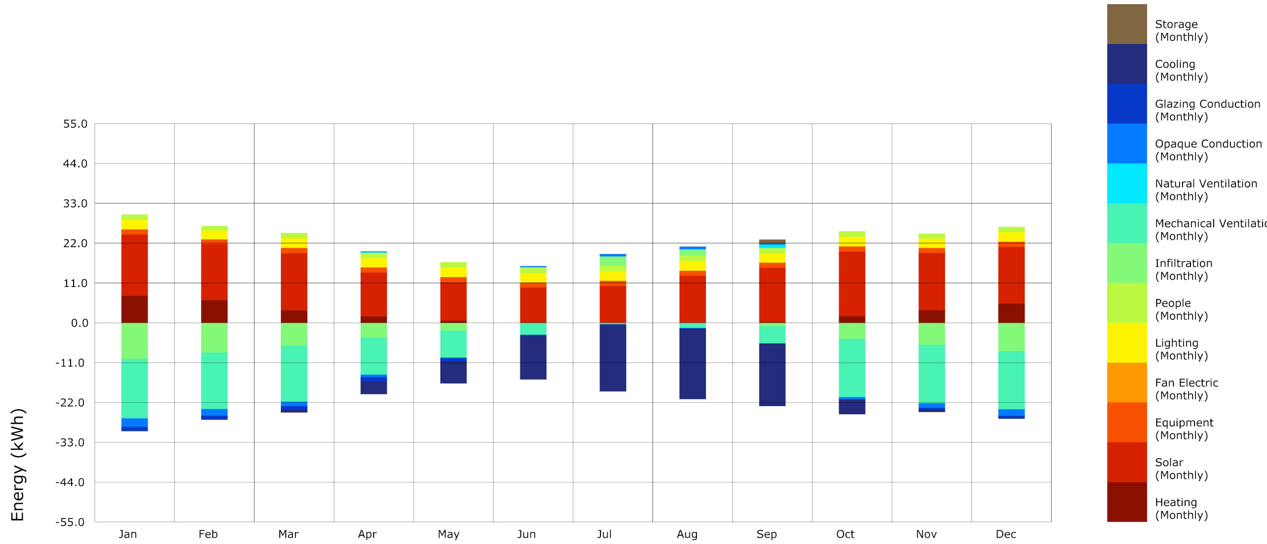


Global Horizontal Radiation (Wh/m2) - Hourly
Philadelphia International Ap_PA_USA
1 JAN 1:00 - 31 DEC 24:00

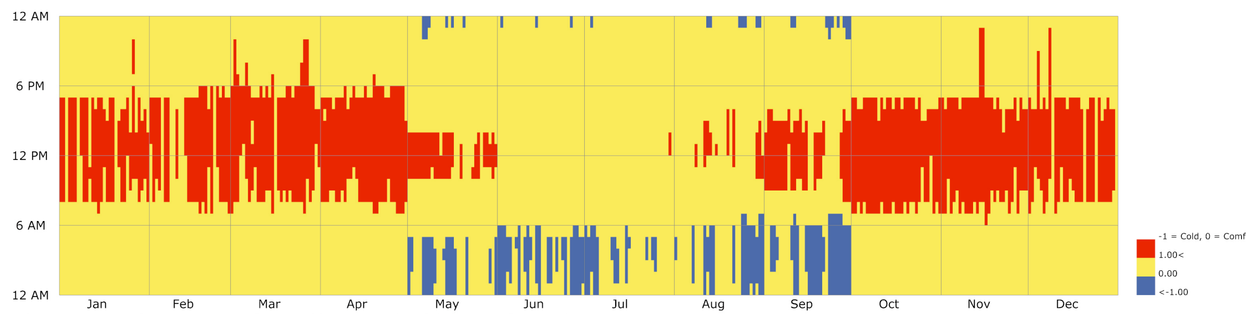
Philadelphia weather is highly variable with hot summers and cold winters. These issues are only exacerbated by the intensity of the sun in the summer and the low angle in the winter. An understanding of these changes are important when designing or looking at the energy balances for any space. With these high variations it is hard to make an truly passively maintained building. However, the following pages represent some of the changes possible to try and reduce the needed mechanical loads as much as possible.

Base Energy Balance and Comfort





Room Energy Balance
Cooling Load:83.544391
Heating Load:81.055217
Total Load:164.599608

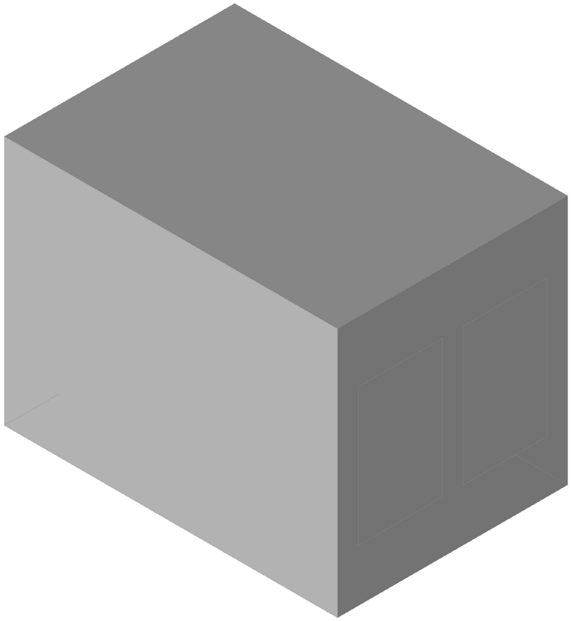


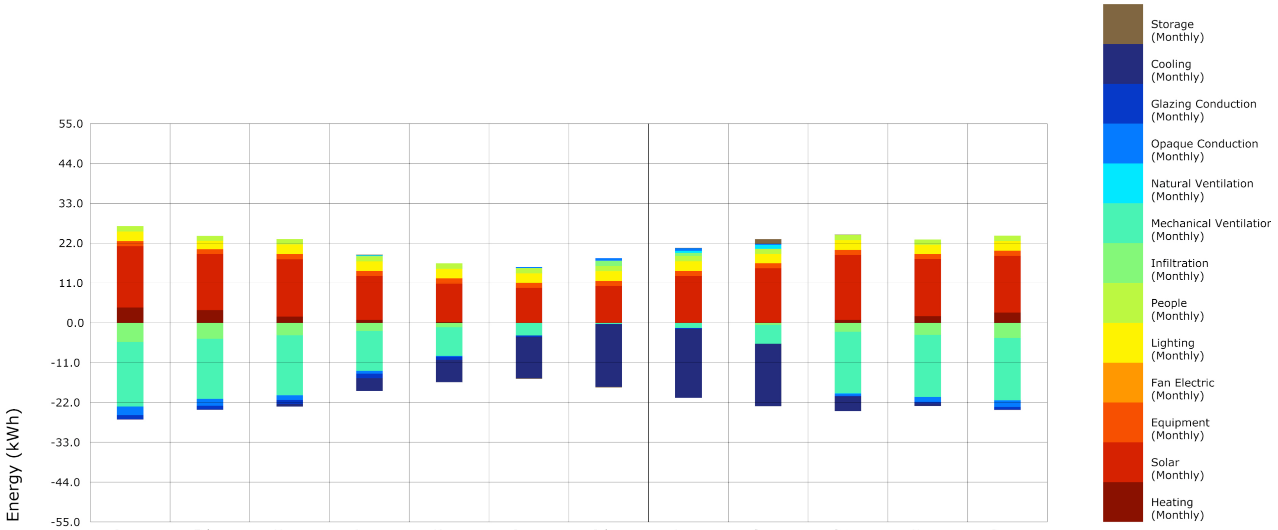
Adaptive Comfort for TEST_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

The Graphs to the right represent the baseline for Energy in this room. Overall this building is not at a bad starting point. However, this is also largely due to it being a part of a townhouse and only having the south side exposed to exterior elements. Still, there is a large opportunity for growth.

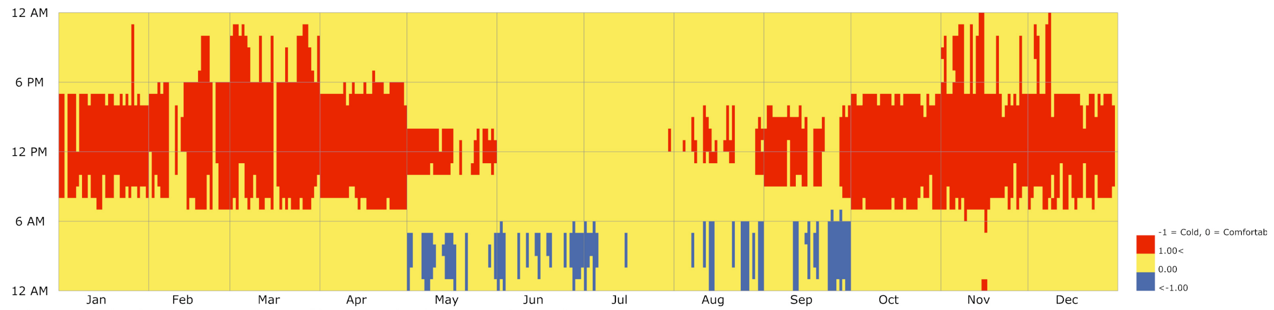
The interior loads for this room are not large as it is only partially used, with few electronics and sometimes insufficiently penetrating light. These along with the outdated construction has been taken into account.

Energy Balance and Comfort with Tighter Build





Room Energy Balance
Cooling Load:79.940187
Heating Load:81.057973
Total Load:160.99816

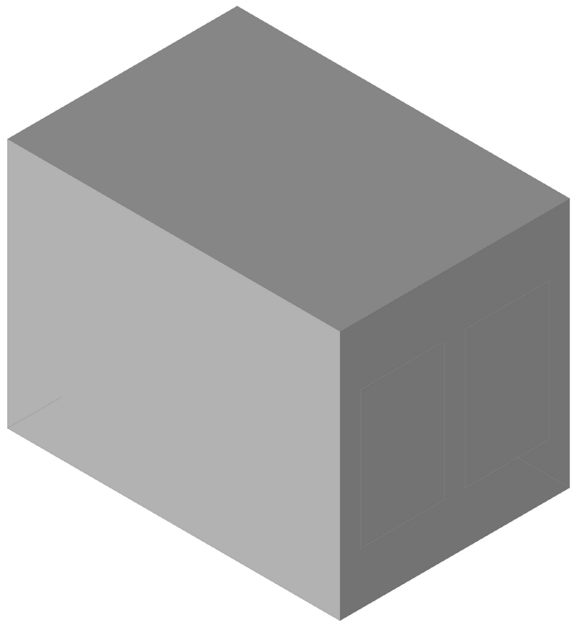


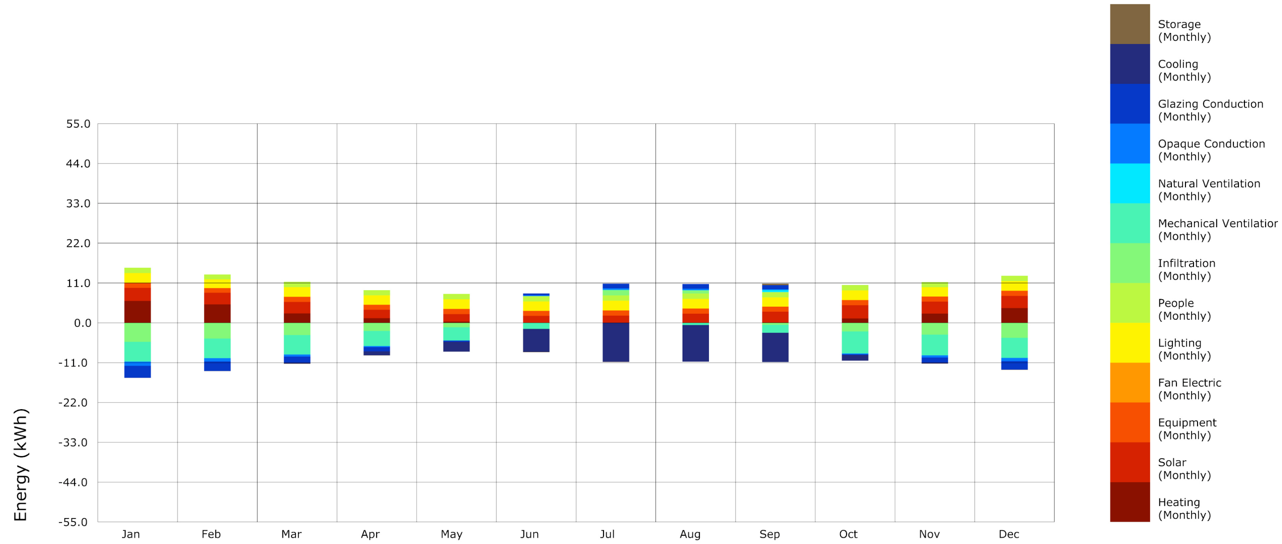
Adaptive Comfort for TEST_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

Hours Hot:2309 Hours Comfortable:6185 Hours Cold:266

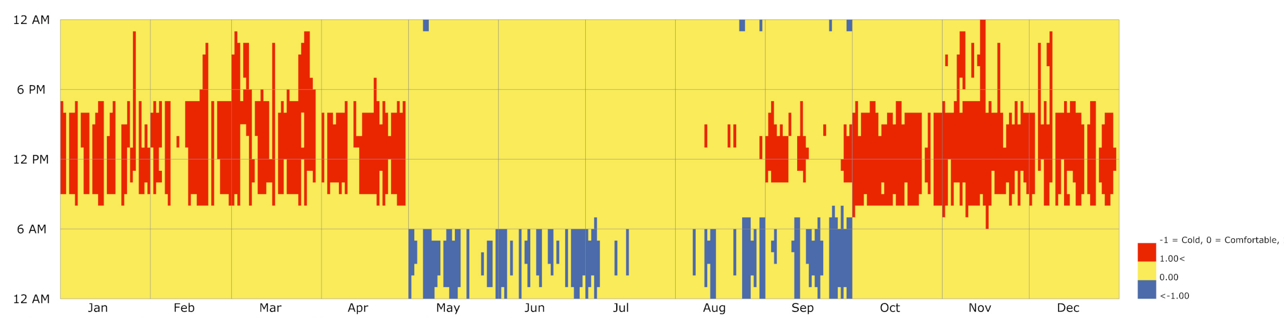
This first step was simply done to show what a tighter build would do for the space. It is clear on the previous page that infiltration was an issue. This room and its construction is over 100 years old and has not been particularly well maintained. The decrease in infiltration did not end up making a large difference to the energy needed to keep the space comfortable.

Energy Balance and Comfort with New materials





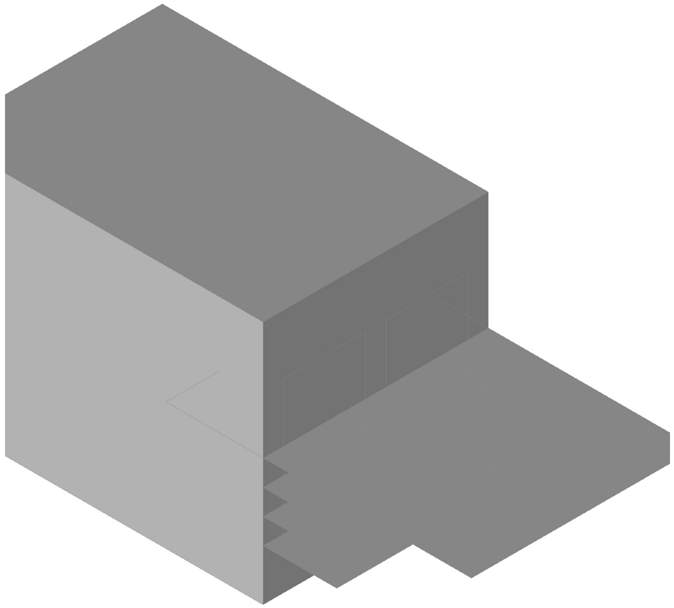
Room Energy Balance
Cooling Load:40.090688
Heating Load:42.33992
Total Load:82.430608

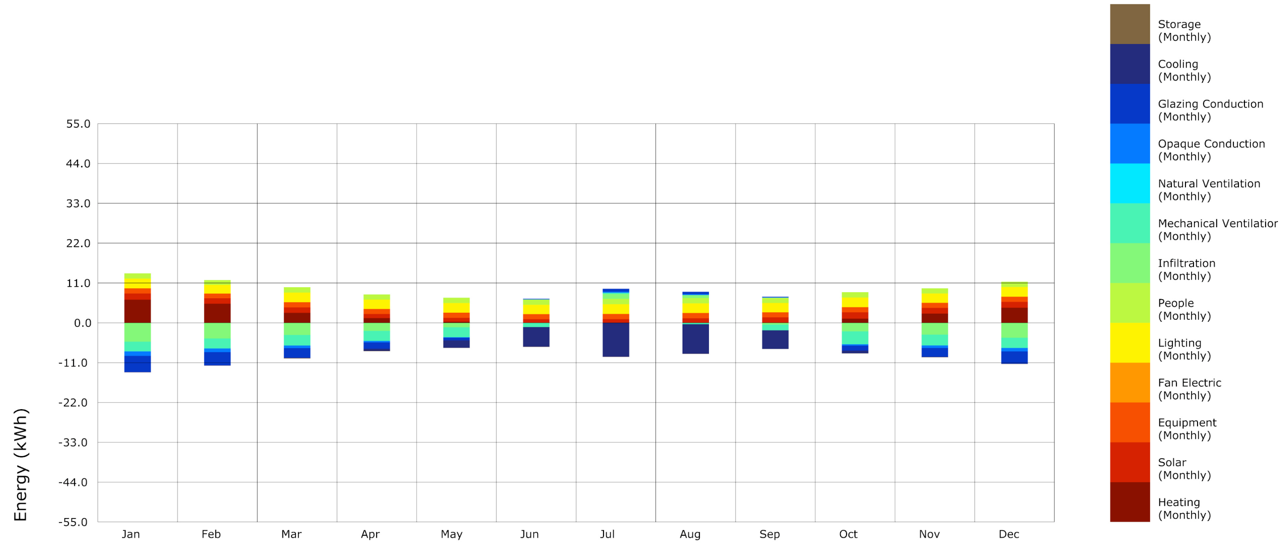


Adaptive Comfort for TEST_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00
Hours Hot:1469 Hours Comfortable:6905 Hours Cold:386

These graphs show a large difference in the energy needed for the space. In this case two main elements were changed: the exterior wall and the window since these are the two exposed to the environment. The wall is improved by adding a second layer of intensive insulation raising the r-value to 26. Secondly the single pane of glass is replaced with a double paned, low-e, argon filled window unit. Additionally the reduced transmittance of the window reduces some of the solar gain which was previously highly detrimental. These two changes together have the ability to vastly improve the energy needs for the room, almost halving it.

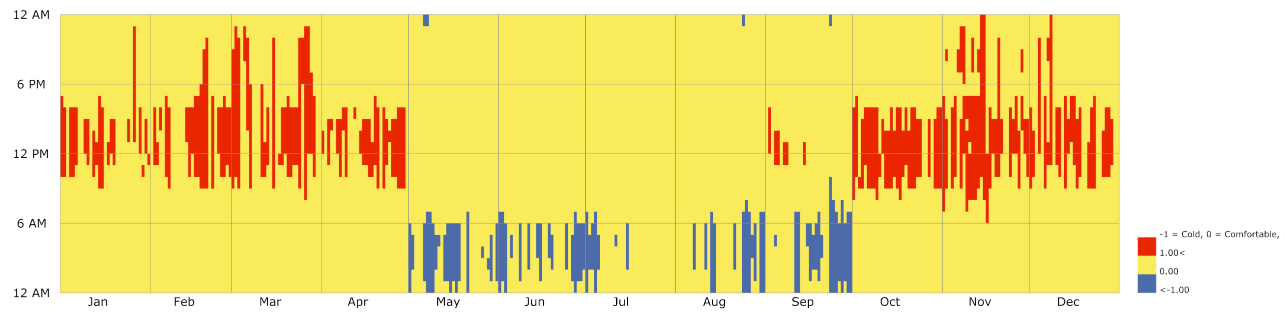
Energy Balance and Comfort with Light Shelf and Shading





Room Energy Balance
Cooling Load:30.484181
Heating Load:32.802801
Total Load:63.286983

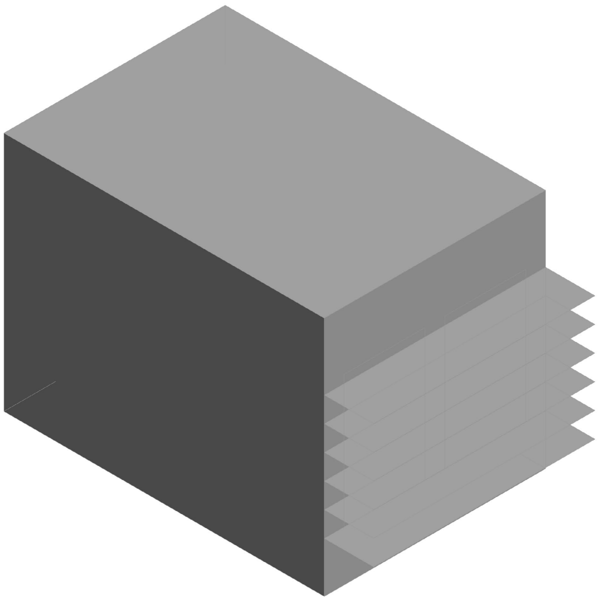
This proposal for shading represents that which was found to be highly successful in bringing light into the space in earlier studies. These shading devices do reduce some of the summer solar load reducing needs for cooling and bring the overall need for energy down. However, some summer solar gain is still occurring.

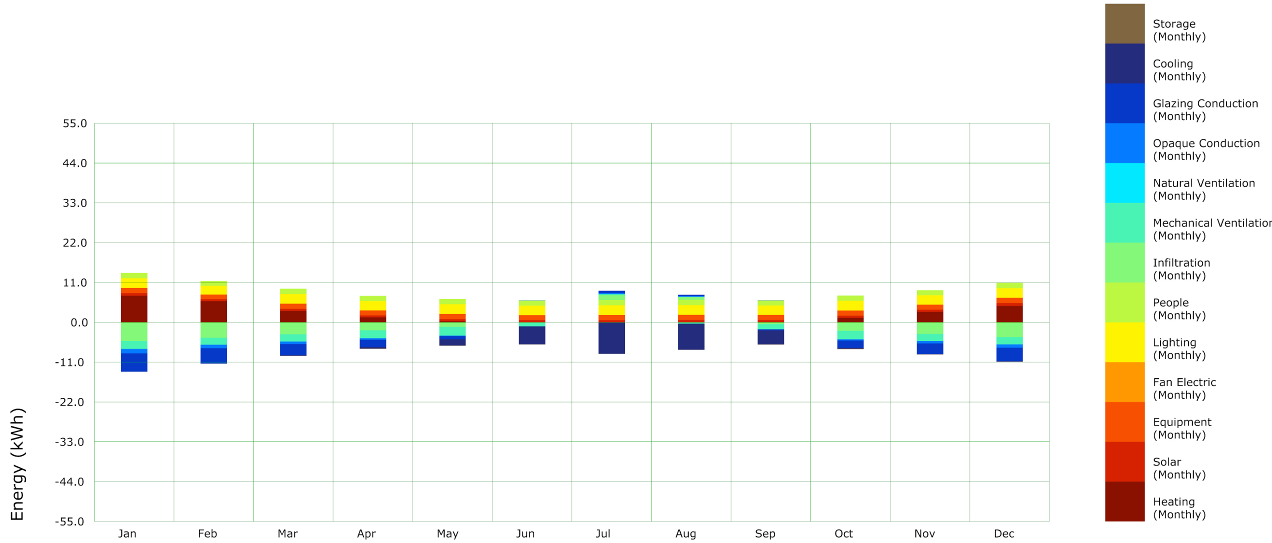


Adaptive Comfort for TEST_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
Philadelphia International Ap PA USA TMY3
1 JAN 1:00 - 31 DEC 24:00

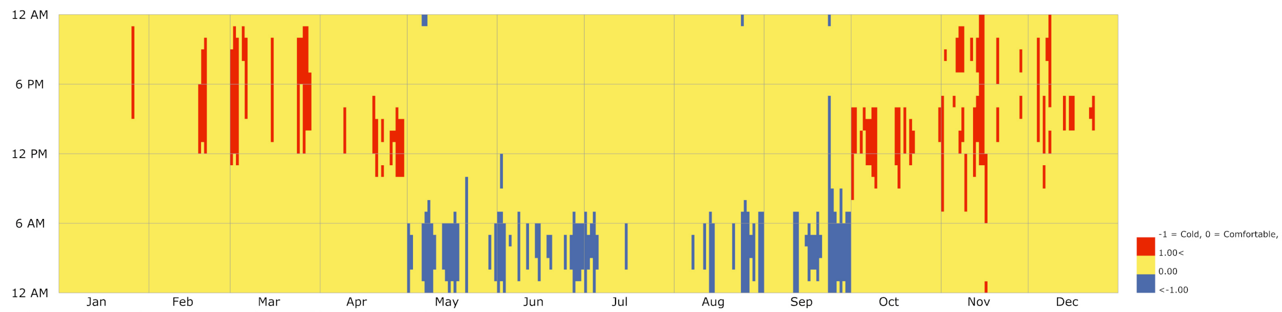
Hours Hot:987 Hours Comfortable:7418 Hours Cold:355

Energy Balance and Comfort with Shading





Room Energy Balance
Cooling Load:26.020347
Heating Load:28.204717
Total Load:54.225064



Adaptive Comfort for TEST_ROOM (-1 = Cold, 0 = Comfortable, 1 = Hot) - Hourly
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This second attempt at the shading devices do allow for the need for energy to be reduced a bit more. These leave the final need for energy for the year around 54 kWh. This is a reduction of about 77%.

However, I believe the previous option would be more successful for the overall comfort of the room. The benefits of the useful natural lighting with the light shelf outweighs the reduction of 9 kWh.