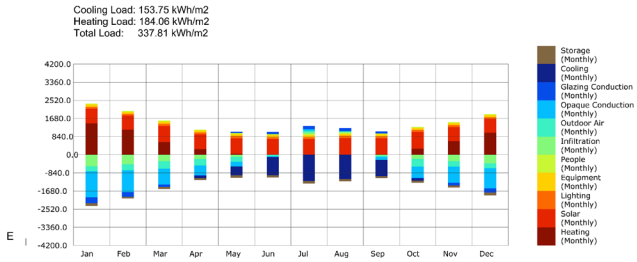
Ellison Turpin
Assignment 10 - Energy Balance

ARCH 631
Environmental Systems I

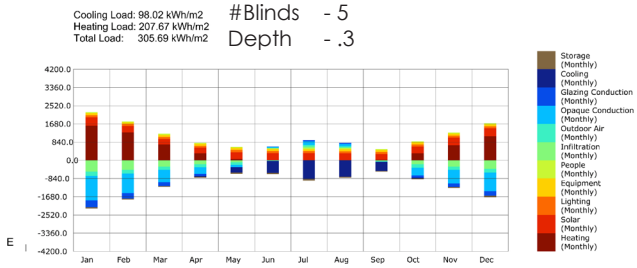
No modifications



Without altering any of the sliders, the base case had:

Cooling Load 153.75 kWh/m2
Heating Load 184.06 kWh/m2
Total Load 337.81 kWh/m2

Adding Blinds



I began by addressing the cooling load by adding blinds at different depths and numbers. I found that any amount of blinds no matter the depth always reduced the cooling load but increased the heating load. After several trials, 5 blinds at a depth of .3m reduced the total load without raising the heating load significantly.

Cooling Load 98.02 kWh/m2
Heating Load 207.67 kWh/m2
Total Load 305.69 kWh/m2

#Blinds - 3
Depth - .2m
Cooling Load: 121.49 kWh/m2
Heating Load: 192.31 kWh/m2
Total Load: 313.80 kWh/m2

#Blinds - 5
Depth - .2m
Cooling Load: 107.77 kWh/m2
Heating Load: 199.00 kWh/m2
Total Load: 306.77 kWh/m2

#Blinds - 10
Depth - .2m
Cooling Load: 90.96 kWh/m2
Heating Load: 216.76 kWh/m2
Total Load: 307.72 kWh/m2

#Blinds - 3
Depth - .3m
Cooling Load: 110.85 kWh/m2
Heating Load: 197.06 kWh/m2
Total Load: 307.91 kWh/m2

#Blinds - 5
Depth - .3m
Cooling Load: 98.02 kWh/m2
Heating Load: 207.67 kWh/m2
Total Load: 305.69 kWh/m2

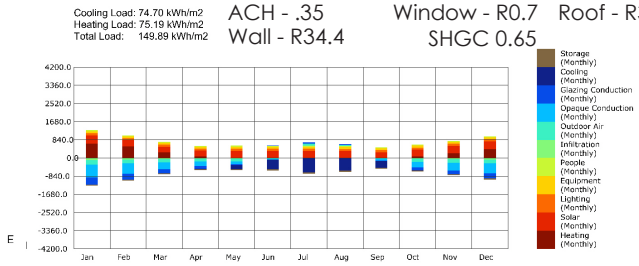
#Blinds - 10
Depth - .3m
Cooling Load: 84.16 kWh/m2
Heating Load: 229.38 kWh/m2
Total Load: 313.53 kWh/m2

#Blinds - 3
Depth - .5m
Cooling Load: 99.90 kWh/m2
Heating Load: 206.50 kWh/m2
Total Load: 306.40 kWh/m2

#Blinds - 5
Depth - .5m
Cooling Load: 86.32 kWh/m2
Heating Load: 223.39 kWh/m2
Total Load: 309.71 kWh/m2

#Blinds - 3
Depth - 1m
Cooling Load: 87.66 kWh/m2
Heating Load: 225.64 kWh/m2
Total Load: 313.29 kWh/m2

Construction



Assuming the most tightly sealed envelope without needing a mechanical ventilation system, I adjusted the Air Change Hours from 2 to .35, which mainly reduced the heating loads. Higher R-value Roof and Wall systems reduce the the overall cooling and heating loads, but are probably unneccesarily thick for this area. The windows had the opposite effect as I expected. The more "efficient" the window the more heating load is required, due to the reduction of radiation from the sun.

ACH - .5
Cooling Load: 93.99 kWh/m2
Heating Load: 155.05 kWh/m2
Total Load: 249.04 kWh/m2

ACH - .35
Cooling Load: 93.55 kWh/m2
Heating Load: 149.84 kWh/m2
Total Load: 243.39 kWh/m2

Wall - R5.5
Cooling Load: 93.55 kWh/m2
Heating Load: 149.84 kWh/m2
Total Load: 243.39 kWh/m2

Wall - R8.7
Cooling Load: 87.04 kWh/m2
Heating Load: 111.89 kWh/m2
Total Load: 198.93 kWh/m2

Wall - R14.8
Cooling Load: 85.46 kWh/m2
Heating Load: 109.47 kWh/m2
Total Load: 194.93 kWh/m2

Wall - R34.4
Cooling Load: 81.51 kWh/m2
Heating Load: 94.60 kWh/m2
Total Load: 176.12 kWh/m2

Window - R0.7
SHGC 0.65
Cooling Load: 81.51 kWh/m2
Heating Load: 94.60 kWh/m2
Total Load: 176.12 kWh/m2

Window - R1.9
SHGC 0.39
Cooling Load: 63.01 kWh/m2
Heating Load: 153.97 kWh/m2
Total Load: 216.98 kWh/m2

Window - R1.7
SHGC 0.39
Cooling Load: 62.97 kWh/m2
Heating Load: 160.28 kWh/m2
Total Load: 223.25 kWh/m2

Window - R1.0
SHGC 0.70
Cooling Load: 80.68 kWh/m2
Heating Load: 182.30 kWh/m2
Total Load: 262.98 kWh/m2

Roof - R9.2
Cooling Load: 81.51 kWh/m2
Heating Load: 94.60 kWh/m2
Total Load: 176.12 kWh/m2

Roof - R14.8
Cooling Load: 77.89 kWh/m2
Heating Load: 84.14 kWh/m2
Total Load: 162.02 kWh/m2

Roof - R34.4
Cooling Load: 74.70 kWh/m2
Heating Load: 75.19 kWh/m2
Total Load: 149.89 kWh/m2

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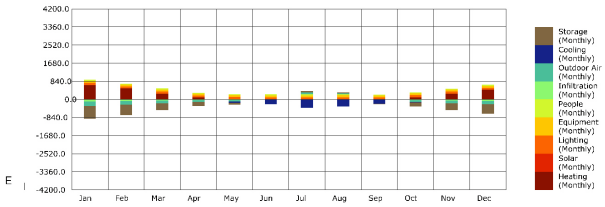
Window to Wall Ratio

Cooling Load: 40.33 kWh/m2
Heating Load: 78.64 kWh/m2
Total Load: 118.97 kWh/m2

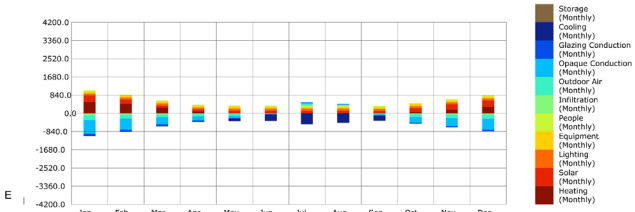
All - 0.0



Completely closing off the buidling with no windows, but maintaining a mechanical system, reduces the cooling load dramatically but leaves the heating load virtually the same. Having no windows reduces infiltration, but eliminates any solar gain in the winter. Increasing the southern glazing helped reduce the heating load to a threshold. Once the glazing grew too large the less efficient glazing caused higher infiltration.

Cooling Load: 54.75 kWh/m2
Heating Load: 61.55 kWh/m2
Total Load: 116.29 kWh/m2

South - 0.3
N/E/W - 0.0



All - 0.3
Cooling Load: 74.70 kWh/m2
Heating Load: 75.19 kWh/m2
Total Load: 149.89 kWh/m2

South - 0.5
N/E/W - 0.3
Cooling Load: 86.60 kWh/m2
Heating Load: 69.84 kWh/m2
Total Load: 156.44 kWh/m2

South - 0.7
N/E/W - 0.3
Cooling Load: 96.06 kWh/m2
Heating Load: 69.67 kWh/m2
Total Load: 165.73 kWh/m2

South - 0.9
N/E/W - 0.3
Cooling Load: 107.93 kWh/m2
Heating Load: 71.68 kWh/m2
Total Load: 179.61 kWh/m2

S - 0.5
N - 0.5
E/W - 0.3
Cooling Load: 94.67 kWh/m2
Heating Load: 78.55 kWh/m2
Total Load: 173.22 kWh/m2

S - 0.5
N - 0.0
E/W - 0.3
Cooling Load: 74.56 kWh/m2
Heating Load: 56.12 kWh/m2
Total Load: 130.67 kWh/m2

South - 0.3
N/E/W - 0.0
Cooling Load: 54.75 kWh/m2
Heating Load: 61.55 kWh/m2
Total Load: 116.29 kWh/m2

South - 0.5
N/E/W - 0.0
Cooling Load: 65.44 kWh/m2
Heating Load: 53.67 kWh/m2
Total Load: 119.12 kWh/m2

South - 0.7
N/E/W - 0.0
Cooling Load: 78.58 kWh/m2
Heating Load: 52.47 kWh/m2
Total Load: 131.04 kWh/m2

Most Optimal Energy Balance
Still using Mechanical Systems

Cooling Load: 54.75 kWh/m2
Heating Load: 61.55 kWh/m2
Total Load: 116.29 kWh/m2

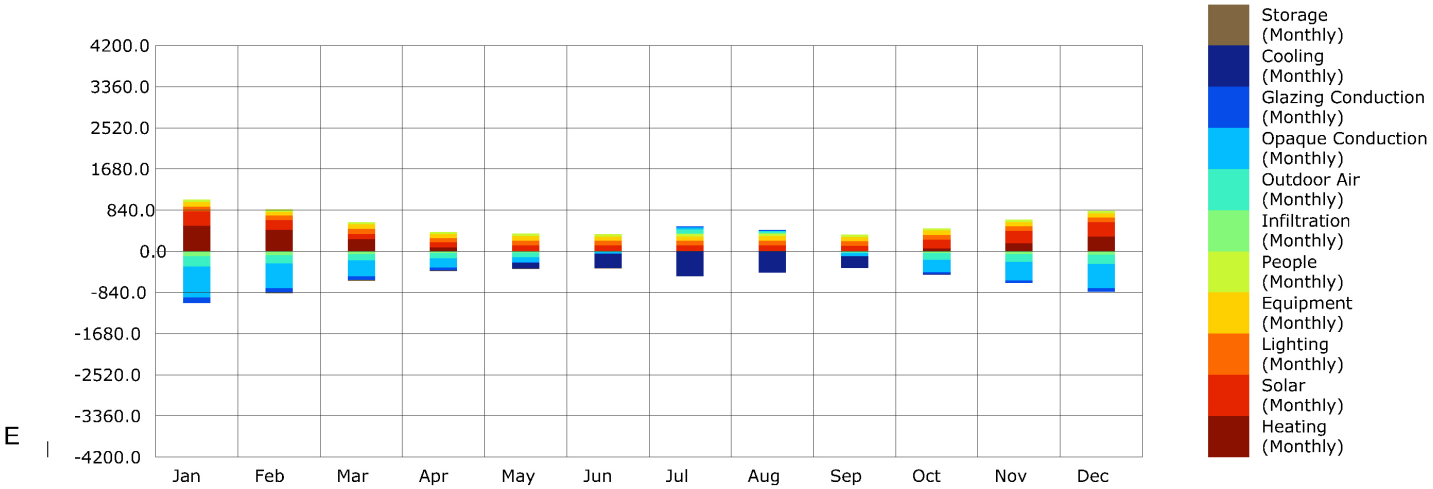
South - 0.3
N/E/W - 0.0

#Blinds - 5
Depth - .3

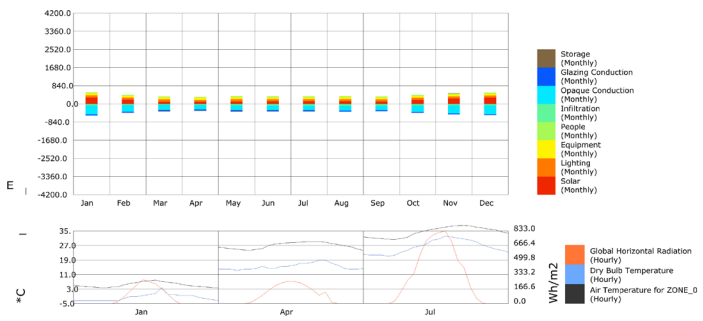
ACH - .35
Wall - R34.4

Window - R0.7
SHGC 0.65

Roof - R34.4



Free Running Building



Average Temperatures for Zone 0 (C)

January	11.756804
February	11.763189
March	16.004855
April	20.653668
May	26.543336
June | 31.034809
July | 33.758979
August | 32.582475
September | 29.228654
October | 22.672801
November | 19.521131
December | 16.095185