Project No: P12-052

Cuku's Nest Enterprises (CNE)
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Spruce Grove, AB
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June 13, 2013

ATTENTION: Dennis Cuku

REGARDING: Mosaic Center – Concept #3 Preliminary Optimization Report

Dear Dennis,

Having received the updated 'C3' conceptual design from Manasc Isaac, we have investigated the effect of glazing size/performance, and envelope thermal resistance on overall performance. As well, we have updated the Net Zero Design calculations, and produced an approximate range in annual energy budget for the team to target as the design becomes more refined.

To begin, we created the glazing design scenarios shown in Table 1. The visual representation of these is shown in Figures 1-9.

Table 1: Description of Mosaic Center glazing performance scenarios under analysis. Constant: glazing is vertically centered between 1m above the floor and 0.5m below the ceiling. Incremental change highlighted in Orange.

Glazing Design #	Size Description			Performance Description
	6m Storeys	5m Storeys	4m Storeys	
1	100% width 4.5m tall	100% width 3.5m tall	100% width 2.5m tall	Duxton R16, SHGC-0.37, Vt=0.54
2	100% width 4.5m tall	100% width 3.5m tall	100% width 2.5m tall	Duxton R20, SHGC-0.15, Vt=0.34
3	100% width 4.0m tall	100% width 3.0m tall	100% width 2.0m tall	Duxton R20, SHGC-0.15, Vt=0.34
4	100% width 3.5m tall	100% width 2.5m tall	100% width 1.5m tall	Duxton R20, SHGC-0.15, Vt=0.34
5	100% width 2.5m tall	100% width 1.5m tall	100% width 1.0m tall	Duxton R20, SHGC-0.15, Vt=0.34
6	100% width 2.5m tall	100% width 1.5m tall	100% width 1.0m tall	Duxton R16, SHGC-0.37, Vt=0.54
7	66% width 2.5m tall	66% width 1.5m tall	66% width 1.0m tall	Duxton R16, SHGC-0.37, Vt=0.54
8	100% width 2.5m tall	100% width 1.5m tall	100% width 1.0m tall	Duxton R8.3, SHGC-0.53, Vt=0.68
9	66% width 2.5m tall	66% width 1.5m tall	66% width 1.0m tall	Duxton R8.3, SHGC-0.53, Vt=0.68

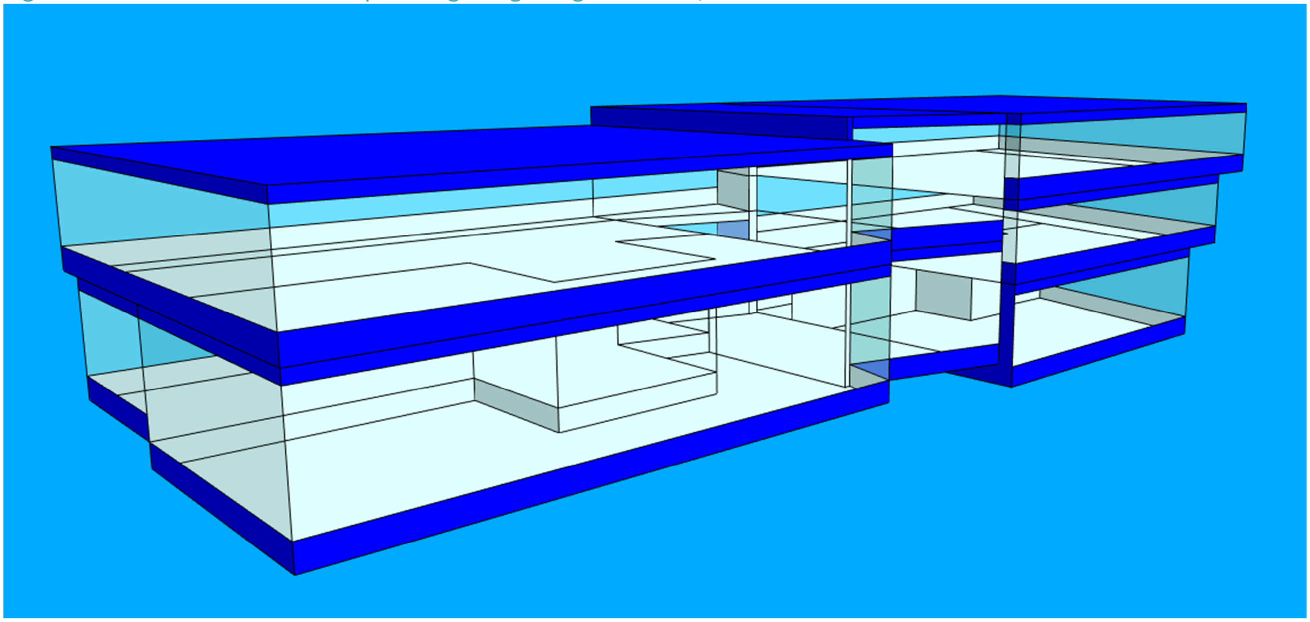


Figure 1: Mosaic Center C3 concept with glazing designs #1 & #2, as viewed from the Southwest.

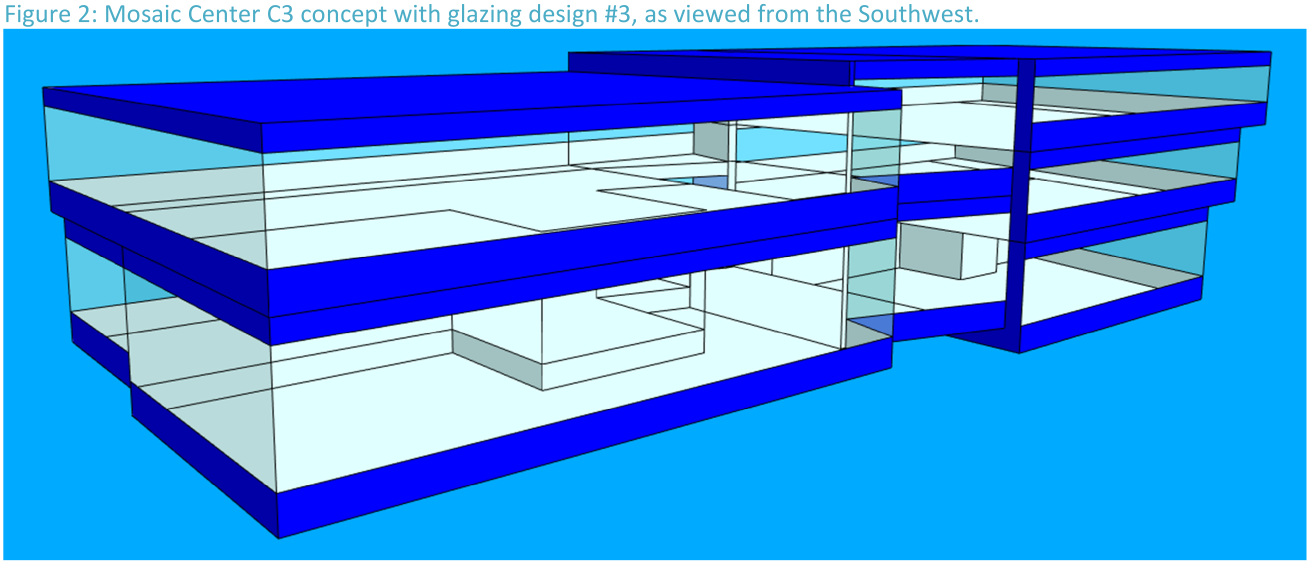


Figure 2: Mosaic Center C3 concept with glazing design #3, as viewed from the Southwest.

Figure 3: Mosaic Center C3 concept with glazing design #4, as viewed from the Southwest.

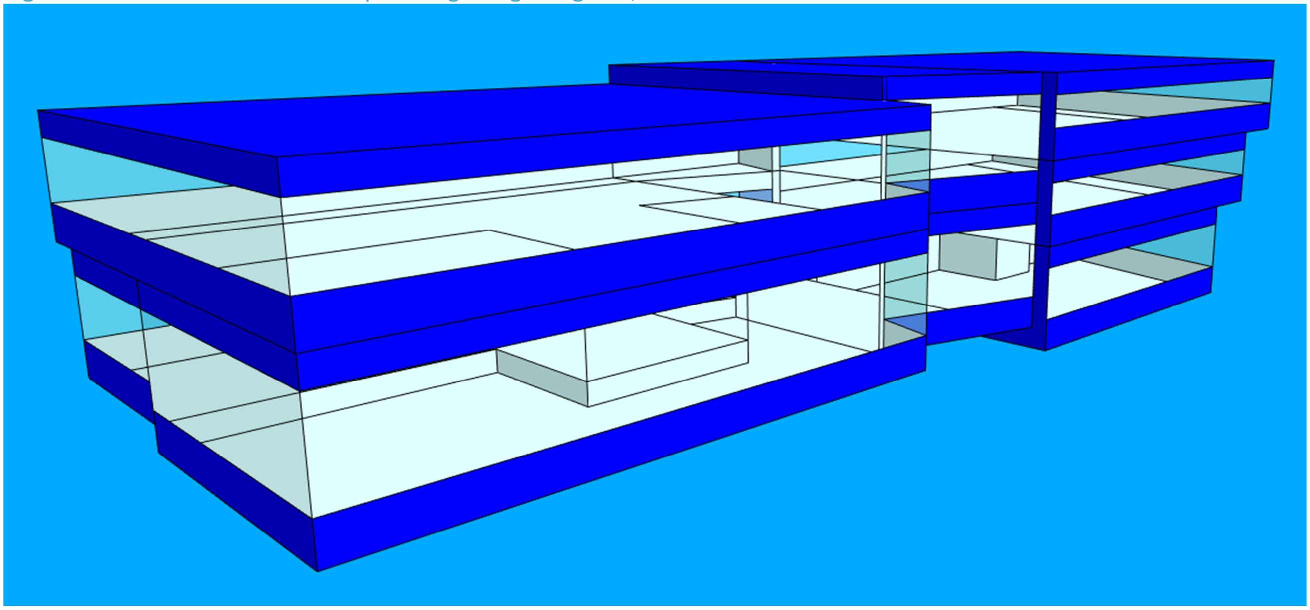


Figure 4: Mosaic Center C3 concept with glazing designs #5, #6, & #8 as viewed from the Southwest.

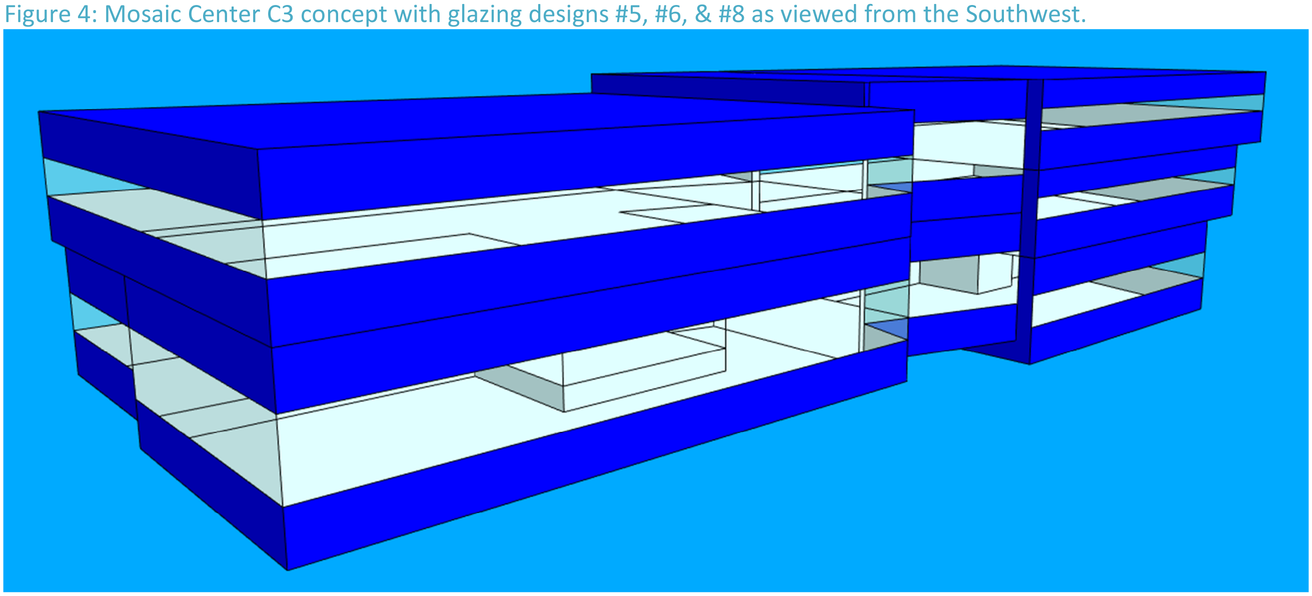
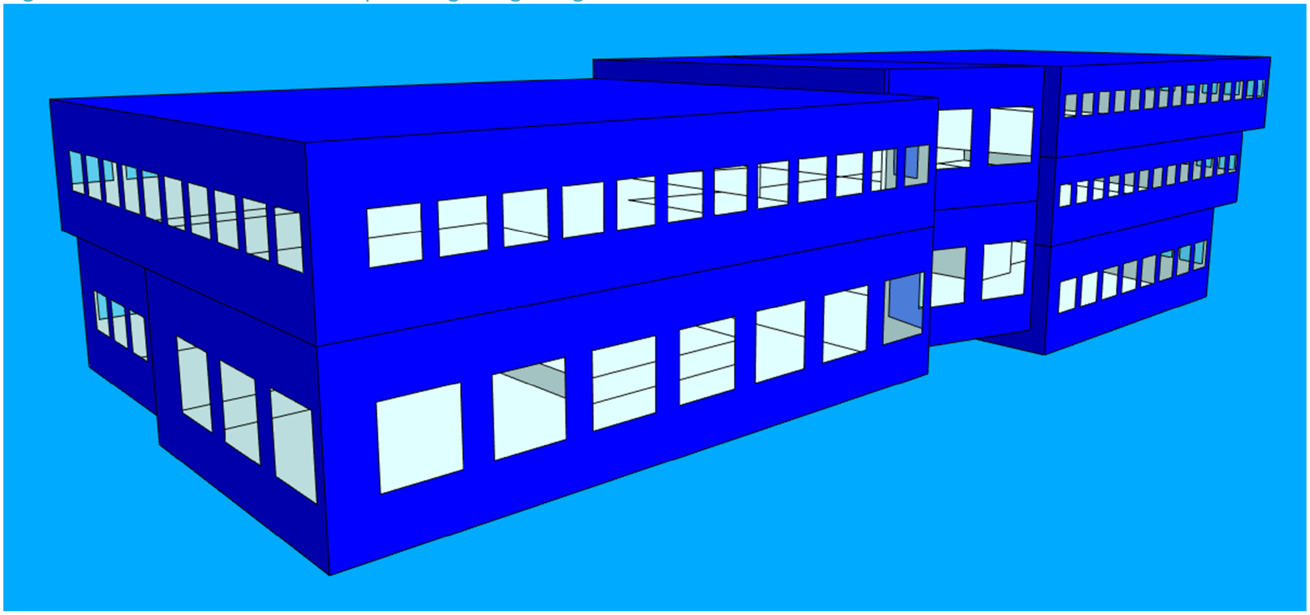


Figure 5: Mosaic Center C3 concept with glazing designs #7 & #9 as viewed from the Southwest.



The performance of these nine glazing scenarios was simulated and the results are summarized in Figures 6-8. You'll note that the equipment demand is dominating the annual performance; while heating, cooling, & lighting energy demand vary quite significantly as glazing performance varies, these changes seem somewhat insignificant in relation.

Figure 6: Simulated performance range caused by varied glazing designs 1 through 9, with NO mechanical COP's.

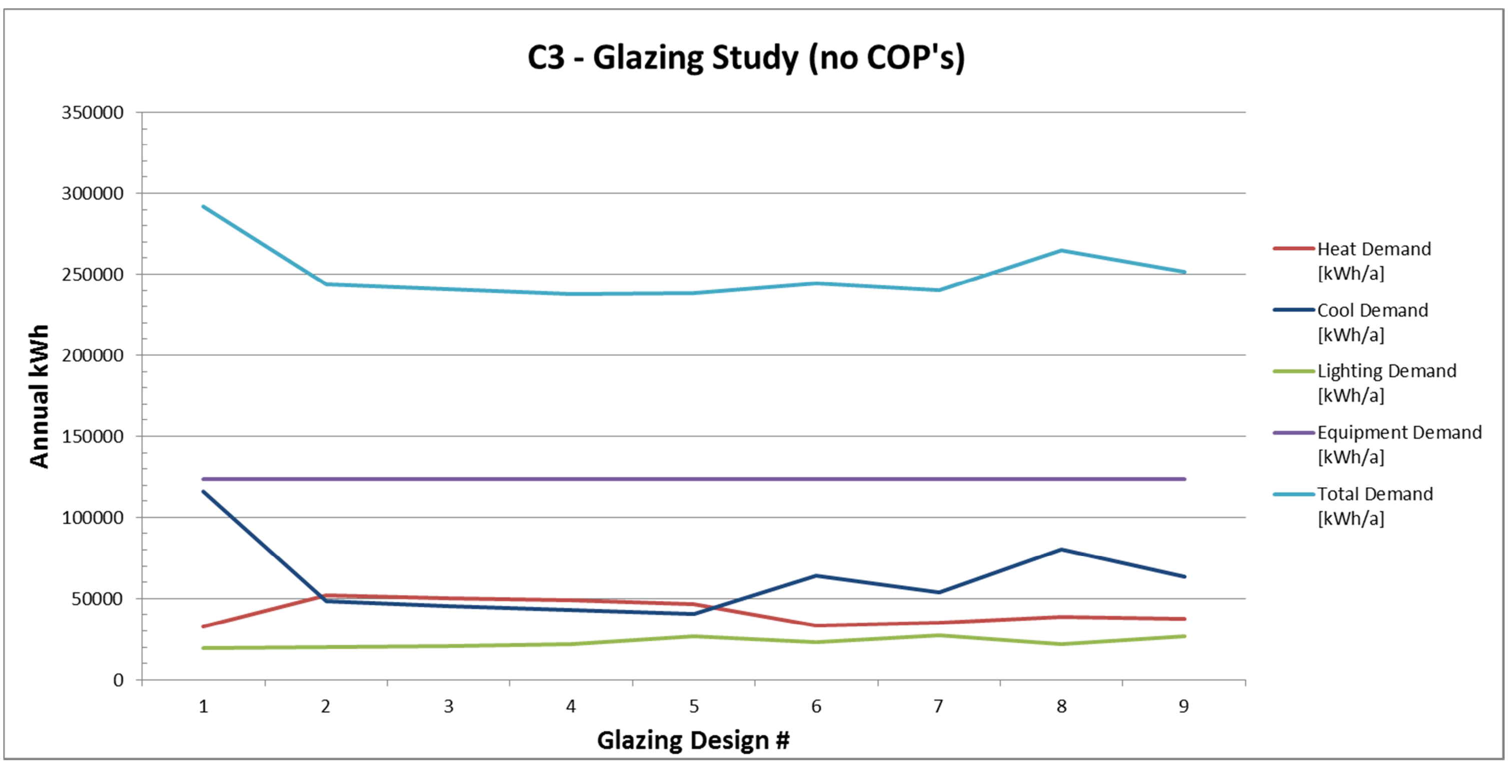
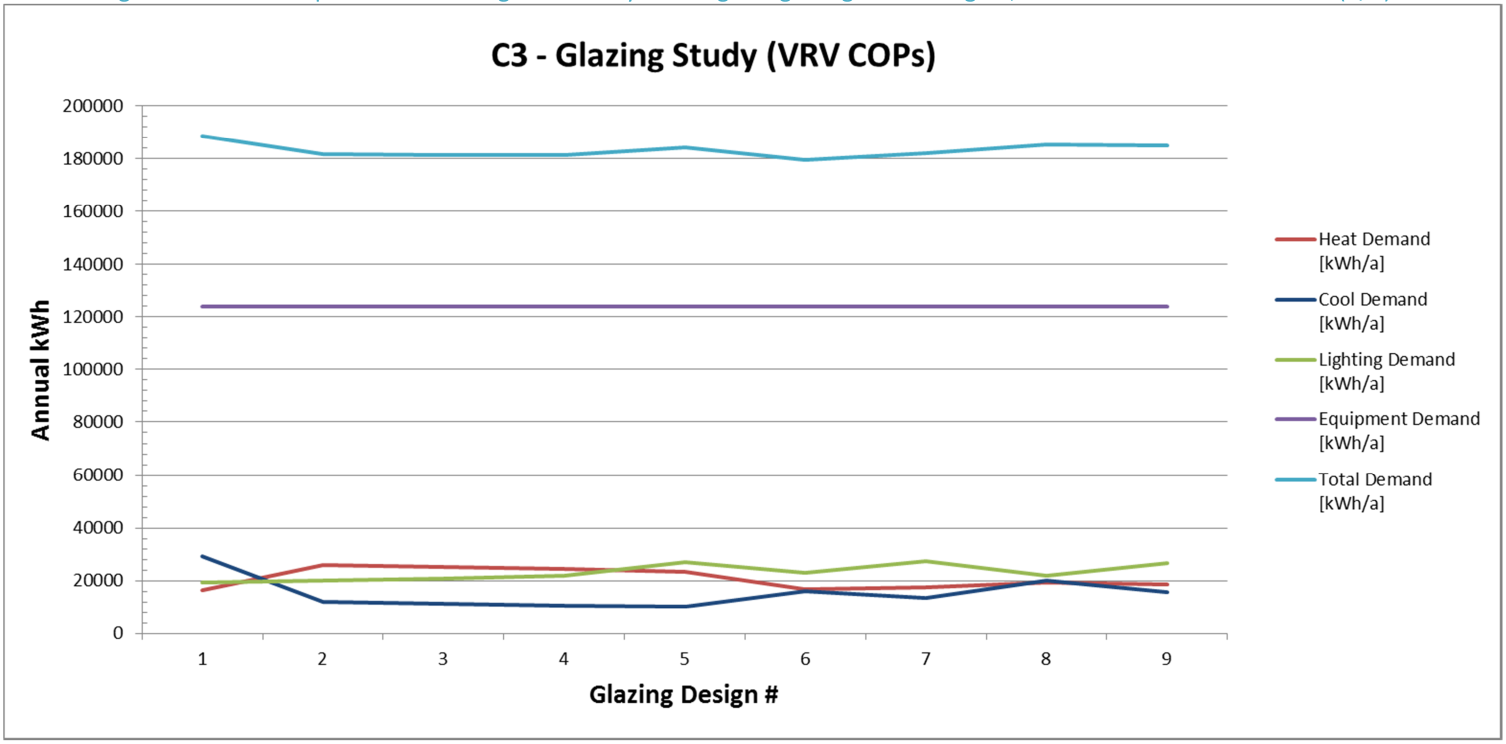
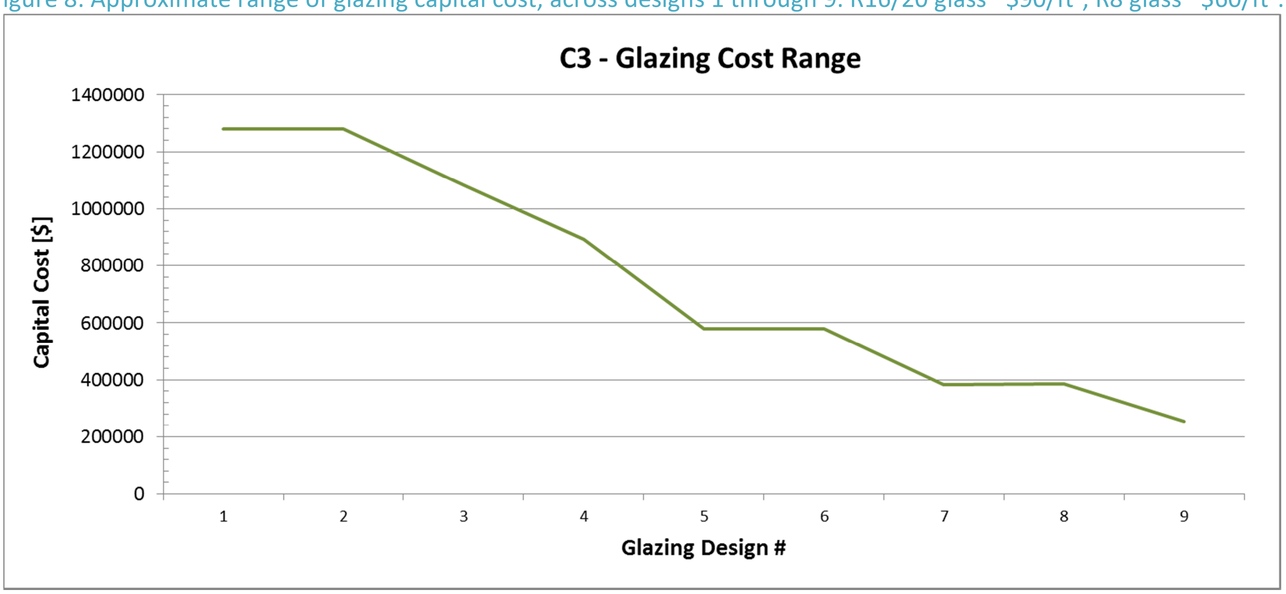


Figure 7: Simulated performance range caused by varied glazing designs 1 through 9, WITH VRV mechanical COP's (2/4).



After VRV mechanical system COPs of 2 & 4 for heating & cooling are added, as shown in Figure 7, the equipment energy consumption is even more dominant. This isn't to say that glazing design isn't important, but it highlights how critical any equipment reductions are to the Net Zero Energy picture. With respect to glazing, the most interesting impact of design changes is on cost, as shown in Figure 8.

Figure 8: Approximate range of glazing capital cost, across designs 1 through 9. R16/20 glass ~$90/ft^2, R8 glass ~$60/ft^2.



In addition to glazing, we've investigated the effect of varied thermal insulation values, using seven scenarios as listed in Table 2. The resulting simulated performance is shown in Figures 9 & 10.

Table 2: Description of Mosaic Center glazing performance scenarios under analysis. Constant: glazing is vertically centered between 1m above the floor and 0.5m below the ceiling. Incremental change highlighted in Orange.

Rvalue Design #	Performance Description
1	R30/R50/R70, R16Duxt, 0.6ACH, 93%HRV
2	R25/R45/R65, R16Duxt, 0.6ACH, 93%HRV
3	R20/R40/R60, R16Duxt, 0.6ACH, 93%HRV
4	R15/R35/R55, R16Duxt, 0.6ACH, 93%HRV
5	R10/R30/R50, R16Duxt, 0.6ACH, 93%HRV
6	R5/R25/R45, R16Duxt, 0.6ACH, 93%HRV
7	R1/R20/R40, R16Duxt, 0.6ACH, 93%HRV

Figure 9: Simulated performance range caused by varied insulation designs 1 through 7. NO mechanical COPs.

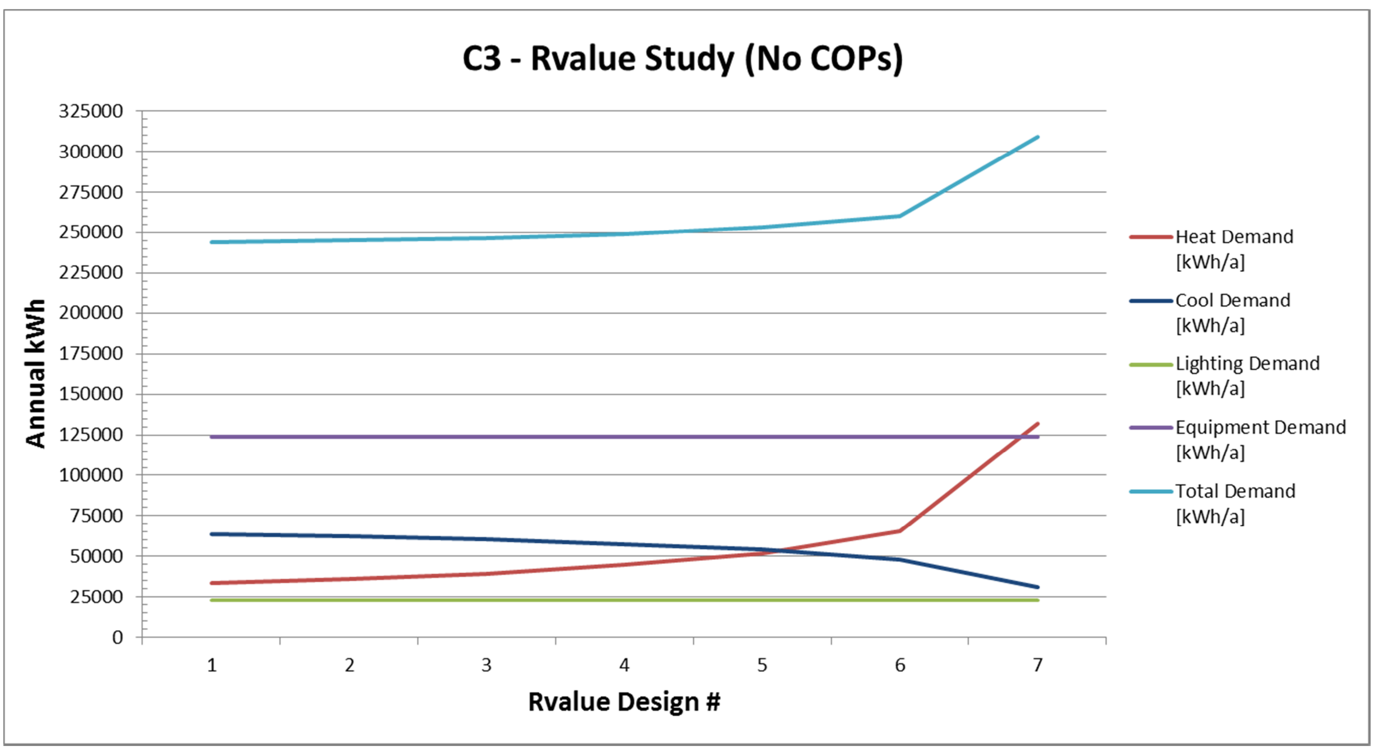
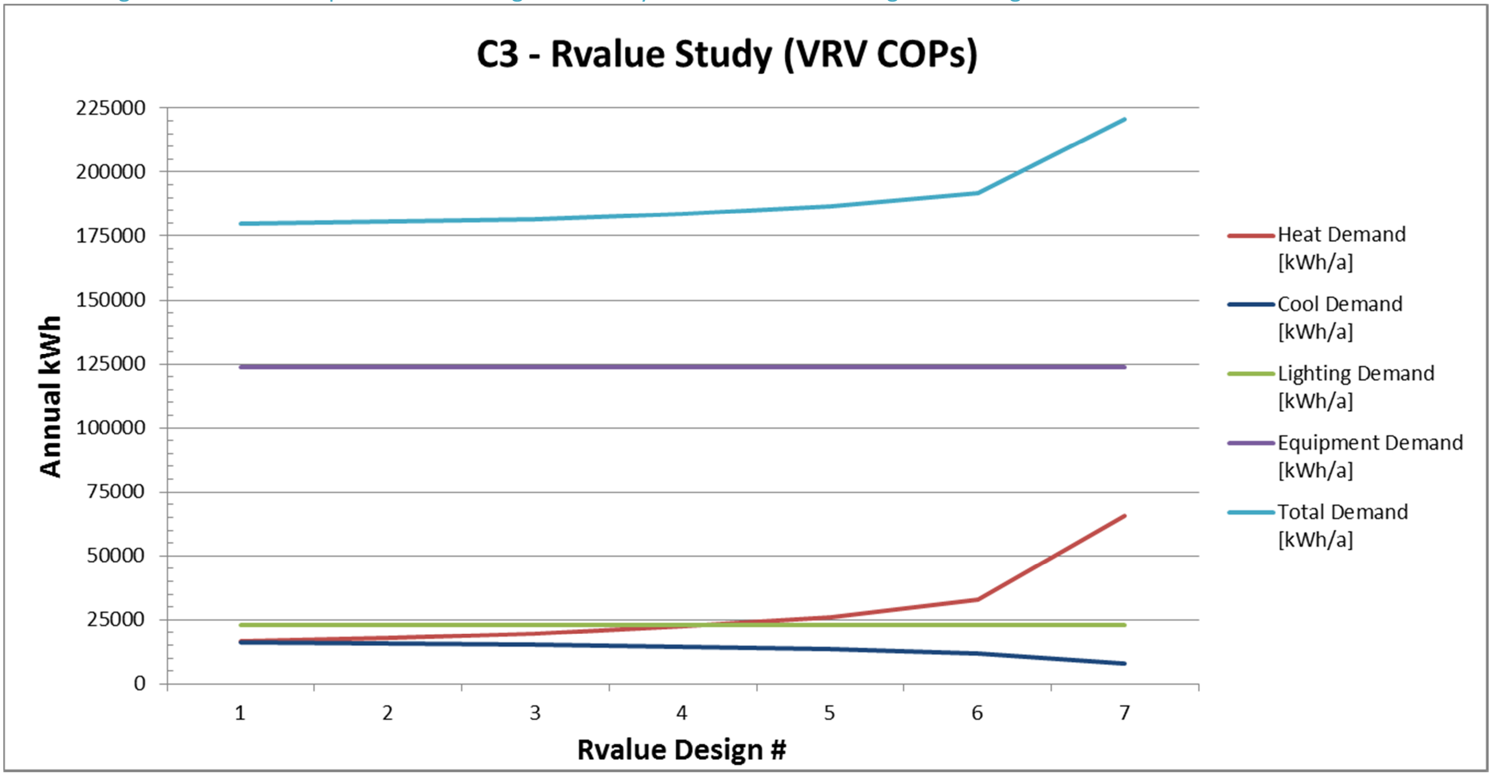


Figure 10: Simulated performance range caused by varied insulation designs 1 through 7. WITH VRV mechanical COPs.



As expected, Figures 9 & 10 show the diminishing return on increasing levels of insulation. For example, the highest level of insulation design #1, R30/R40/R50, only saves approximately 4000kWh over the #4 design, R15/R35/R55. The optimal insulation level can be found by bringing in another balancing cost, such as the incremental cost to generate XXXXkWh's with PV, or a site imposed limit on overall production ability.

Lastly, the capacity to generate electricity through a Photovoltaic system on the roof has been estimated, as shown in Table 3. The current generation capacity is roughly between 170 000kWh – 215 000kWh, depending on level of roof coverage, shading, losses, and snow maintenance.

Table 3: Estimated range of annual generation capacity of current C3 design, depending on coverage & maintenance. Assumes 10% misc losses and 95% invertor efficiency. *MUST have no shading, as current roof design does.

Roof Area		PV Capacity	Output (cleared snow)	Output (snow loss)
%	m2			
100%	1300 m2	199 kW	215000 kWh	186682 kWh
80%	1100 m2	168 kW	195000 kWh	169681 kWh

In summary, our analysis has shown that the glazing budget may range between $1 250 000 and $250 000 with little impact on energy efficiency, but significant impact on aesthetics. The costs of PV and thermal insulation must be brought into the analysis to help select the envelope design moving forward.

Yours truly,

Stuart Fix, P.Eng.