

Analysis of energy performance of selected fenestration systems in commercial buildings

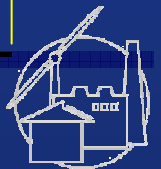
Dr Charlie Curcija

Dr Mahabir Bhandari

University of Massachusetts, Amherst

Glazing systems considered

S. No.	Glazing system	Fill gas	U (Btu/hr-ft ² -F)	SHGC	Initial cost (1997) \$/sf		
					Alum w/o bk	Alum w/ bk	Renf'd vinyl
1	Double clear	Air	0.48	0.76	3.93	5.88	9.13
2	Double Green	Air	0.48	0.57	4.43	6.38	9.63
3	Double lowE Pye (e2=0.1)	Arg	0.27	0.54	5.23	7.18	10.43
4	Double lowE Spe (e2=0.04)	Arg	0.25	0.39	5.88	7.83	11.08
5	Triple lowE (film)	Air	0.22	0.51			15.17



Cases considered

Climates:

- 1. Miami
- 2. Anchorage
- 3. Atlanta
-

■ Building Types

- | | | | |
|------|---------------------------|-------------------------|---------|
| ■ 1. | Office Building, highrise | 250,000 ft ² | 8 story |
| ■ 2. | High-rise residential | 72,000 ft ² | 8 story |
| ■ 3. | School, College/univ | 50,000ft ² | 4 story |

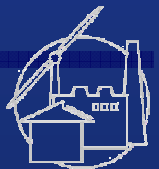
- WWR = 20% in each facade



Annual total energy consumption (kWh)

Total energy (in 1000 kWh)

	Miami			Anchorage			Atlanta		
	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl
Office									
Double Clr	3,186.49	3,185.68	3,184.77	4,912.73	4,906.67	4,894.65	3,305.17	3,298.61	3,293.06
Double Green	3,166.00	3,164.83	3,164.21	4,946.06	4,940.10	4,931.31	3,331.43	3,325.42	3,319.54
Double lowE.1	3,165.43	3,164.91	3,164.01	4,867.45	4,861.49	4,858.56	3,255.20	3,248.63	3,244.06
Double lowE.04	3,143.69	3,142.79	3,142.08	4,977.26	4,974.53	4,968.67	3,360.29	3,354.42	3,348.57
Triple lowE (film)			3,161.90			4,858.56			3,243.68
University									
Double Clr	3,419.22	3,418.81	3,418.81	4,267.65	4,258.86	4,250.07	2,658.54	2,657.01	2,655.37
Double Green	3,396.62	3,396.21	3,395.71	4,291.09	4,285.23	4,276.44	2,658.31	2,656.70	2,654.93
Double lowE.1	3,403.00	3,402.49	3,402.09	4,170.96	4,162.17	4,153.38	2,638.17	2,636.69	2,634.70
Double lowE.04	3,375.09	3,374.58	3,374.08	4,302.71	4,293.92	4,285.13	2,655.79	2,654.24	2,652.36
Triple lowE (film)			3,399.89			4,150.45			2,633.56
Residential									
(Gas heating..)	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl
Double Clr	775.09	774.56	774.00	1,076.13	1,067.76	1,057.46	712.54	710.67	708.45
Double Green	760.59	760.06	759.45	1,091.62	1,083.01	1,072.57	711.27	707.93	706.84
Double lowE.1	761.42	760.86	760.24	1,011.26	1,002.86	992.56	696.28	692.85	692.42
Double lowE.04	744.62	744.05	743.57	1,103.57	1,094.84	1,084.15	709.40	706.50	704.73
Triple lowE (film)			758.69			980.11			691.87



Life Cycle Cost (life=25 years)

Cumulative Life-Cycle SAVINGS (negative entries indicate increased costs)

Base: Double Clear

Office	Miami			Anchorage			Atlanta		
	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl
Double Clear									
Double Green	\$32,493	\$32,644	\$32,642	-\$13,953	-\$14,269	-\$15,146	\$8,408	\$8,405	\$8,630
Double LowE (e2=0.1)	\$20,832	\$20,756	\$20,800	-\$444	-\$1,246	-\$4,523	\$18,636	\$18,998	\$19,593
Double LowE (e2=0.04)	\$56,937	\$57,191	\$57,430	-\$37,527	-\$38,917	-\$40,401	\$2,666	\$7,183	\$8,203
Triple LowE (film)			-\$25,027			-\$52,956			-\$25,910
University									
Double Clear									
Double Green	\$31,967	\$32,073	\$32,971	-\$9,337	-\$9,417	-\$19,967	\$58,208	\$16,609	\$17,067
Double LowE (e2=0.1)	\$17,306	\$17,381	\$18,264	\$12,029	\$12,000	\$0	\$46,646	\$5,046	\$5,535
Double LowE (e2=0.04)	\$55,407	\$55,542	\$56,500	-\$19,953	-\$19,935	-\$30,402	\$67,186	\$25,571	\$26,120
Triple LowE (film)			-\$16,138			-\$37,158			-\$30,095
Residential									
Double Clear									
Double Green	\$67,308	\$67,325	\$67,566	-\$4,369	-\$4,310	-\$4,280	\$26,878	\$26,807	\$27,125
Double LowE (e2=0.1)	\$55,331	\$55,445	\$55,718	\$12,031	\$12,165	\$12,329	\$21,949	\$21,407	\$22,217
Double LowE (e2=0.04)	\$135,638	\$135,783	\$135,156	-\$12,845	-\$12,694	-\$12,605	\$52,267	\$52,894	\$52,571
Triple LowE (film)			\$36,306			-\$10,353			-\$2,036



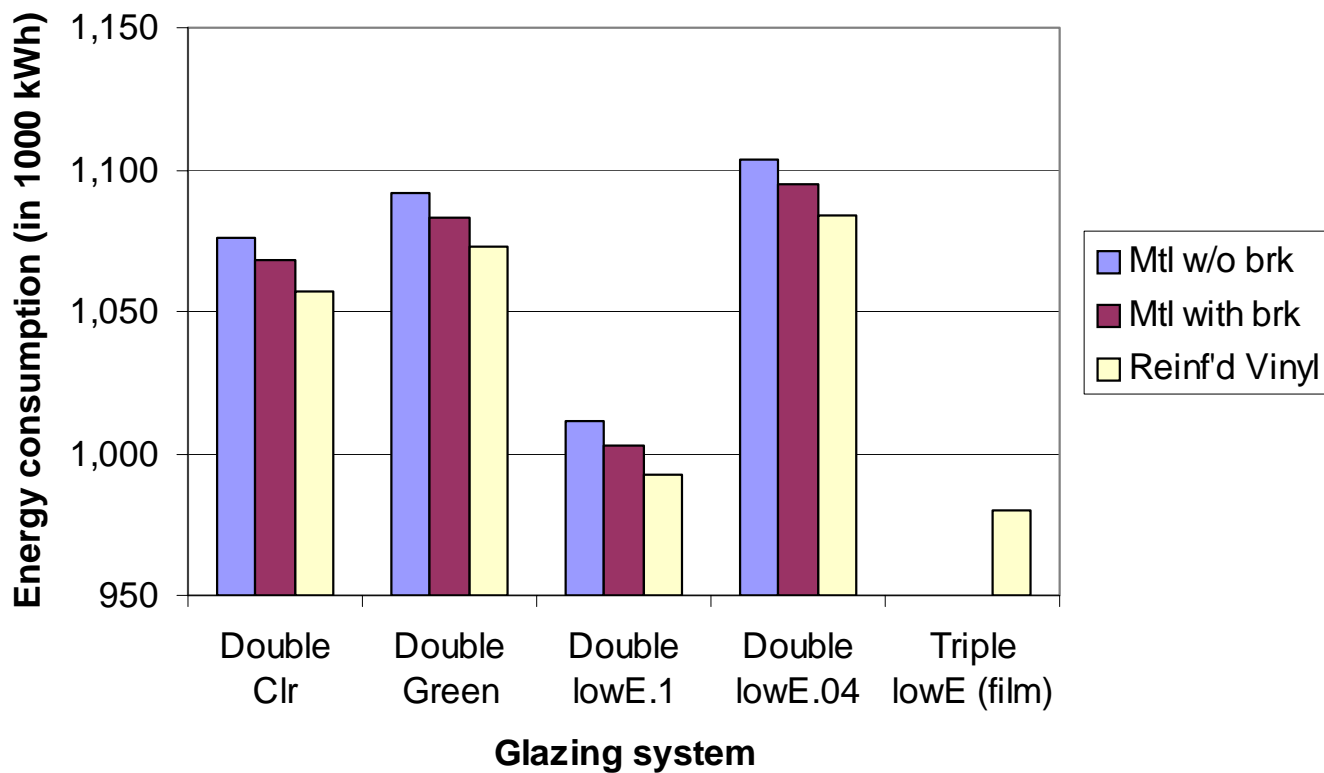
FINDINGS

1. Prescription of maximum or no criteria for SHGC in mixed and cold climates is not warranted
2. Mixed and cold climates should have minimum SHGC criteria (current and proposed requirement is max SHGC)
3. Framing system selection has negligible effect in some of the buildings
4. Depending on the building and climate some of the glazing indicate better energy performance but LCC shows the reverse trend

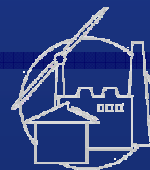


Prescription of maximum or no criteria in cold and very cold climates is not warranted

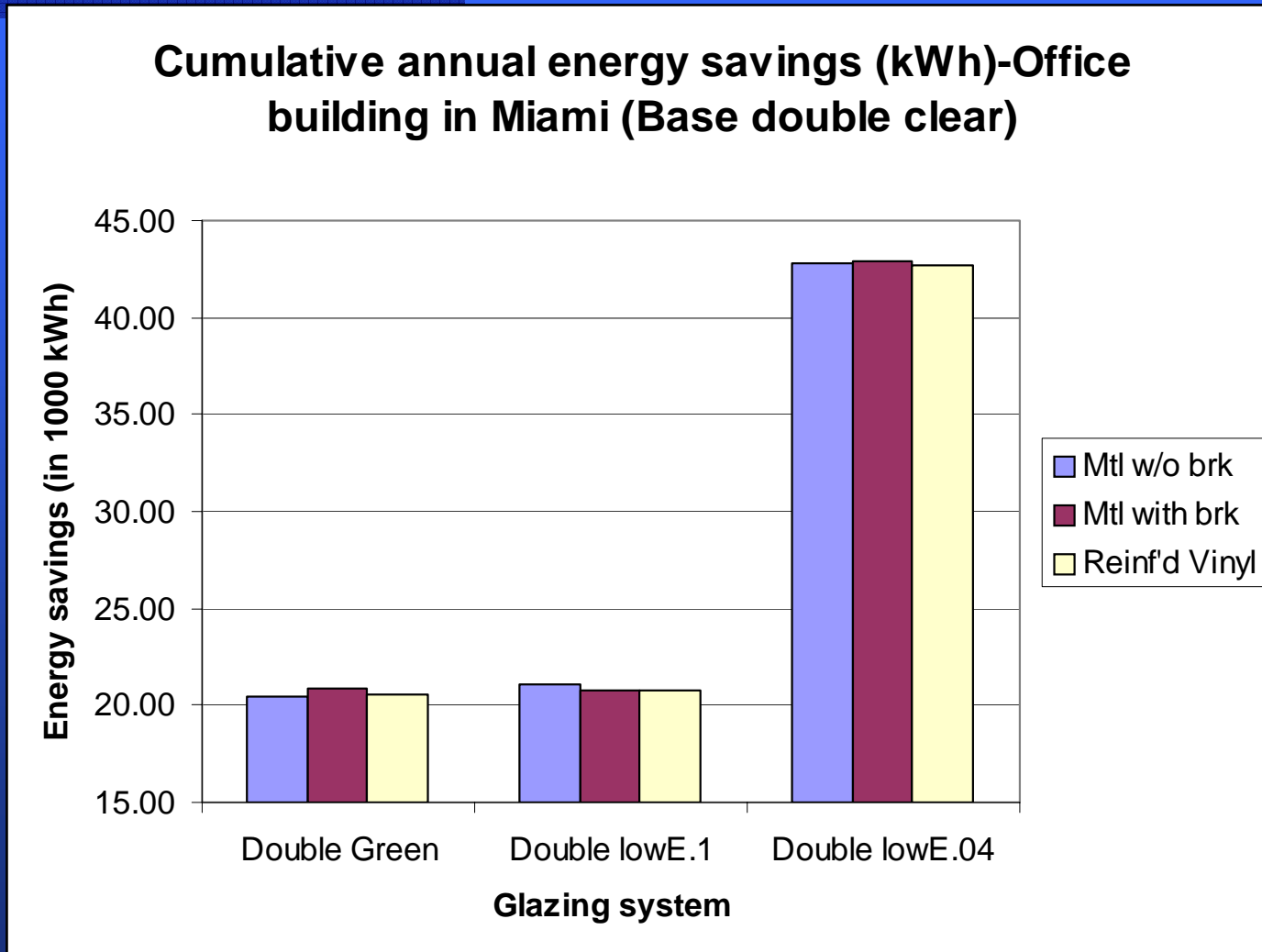
**Total annual energy consumption (kWh)-
Anchorage (High rise residential)**



Glazing	U	SHGC
Double clear	0.48	0.76
Double Green	0.48	0.57
Double lowE Pye (e2=0.1)	0.27	0.54
Double lowE Spe (e2=0.04)	0.25	0.39
Triple lowe (film)	0.22	0.51



Framing system selection has negligible effect in some of the buildings



Depending on the building and climate some of the glazing indicate better energy performance but LCC shows the reverse trend

Office building in Anchorage - Base case double clear

Total Annual Cumulative Energy Savings (kWh x 1000)			Cumulative Life-Cycle SAVINGS		
Mtl w/o brk	Mtl with brk	Reinf'd Vinyl	Mtl w/o brk	Mtl with brk	Reinf'd Vinyl
-33.33	-33.43	-36.66	-\$13,953	-\$14,269	-\$15,146
45.28	45.18	36.09	-\$444	-\$1,246	-\$4,523
-64.53	-67.86	-74.02	-\$37,527	-\$38,917	-\$40,401
57.10	51.04	36.09	-\$99,494	-\$82,047	-\$52,956



Conclusions

- This case study shows that the effect of SHGC is more prominent than U factor for energy savings in mixed, and cold climates. Therefore more case studies need to be made before concluding the U factor and SHGC requirement as proposed in Table B4-B8.
- More case studies need to be done using the real building scenarios for the validity of the correlations established by the parametric studies conducted by Envelope subcommittee.

