ENERMODAL
ENGINEERING INC.
1554 EMERSON STREET
DENVER. CO 80218
TEL: (303) 861-2070 FAX: (303) 830-2016
EMAIL : denver@enermodal.com

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Cost Benefits of SunGuard SN 54

Guardian Industries recently introduced SunGuard SN 54 low-E glass. This new low-E glass is clear in appearance and has optimal energy performance for commercial building applications. A study of the influence of SunGuard SN 54 on commercial building energy performance found that it has the potential to save $2.50 per square foot of glass from downsizing the chilled water and air distribution systems. In terms of operational cost savings, annual energy costs are lowered by as much as $1.60 per square foot of glass in a building with glare and daylighting controls.

Overview of Study

Table 1 Glazing System Properties

Glazing System	U-Factor Btu/hr-ft2-F	Solar Heat Gain Coefficient	Visible Light Transmittance
Standard Commercial Low-E (double silver)	0.29	0.37	67%
SunGuard SN 54 (2)	0.29	0.28	54%

The study examined SunGuard SN 54 in comparison to standard commercial low-E glazing (Table 1). The units are insulating glazing units with the low-E coating on the second surface and clear glass to the inside. SunGuard SN 54 and the standard low-E glazing have the same U-Factor, so the differences in energy performance are in solar heat gain coefficient and visible light transmittance.

A 175,000 sf, 10-story office building was simulated with the DOE-2.2 hourly building energy simulation software. The percentage of window-to-wall area is varied between 30% (18,839 sf of glass), 40% (25,118 sf of glass) and 50% (31,398 sf of glass) and the windows are distributed proportionally around the building. The heating, ventilating and air conditioning system is variable air volume with a central plant. The central plant has water-cooled chillers and natural-gas fired boilers. The heating, ventilating and air conditioning system is sized based on the ASHRAE RTS load calculations (ASHRAE Handbook of Fundamentals 2005). The model insulation levels, lighting, and heating, ventilating and air conditioning systems meet the minimum requirements of ASHRAE 90.1-2004, the commercial building energy efficiency standard. The climates in the study are Chicago, Seattle and Houston. The utility costs reflect actual rates in each of the cities; the average cost for electricity and natural gas in each city is shown in
Table 3.

The analysis also evaluated the influence of glare control and daylighting control. Glare is visual discomfort that is caused by light that is brighter than the light to which our eyes are adapted. In the simulation model, a glare index of 22 represents the level at which an occupant experiences visual discomfort. For glare control, blinds with a 20% solar transmittance were simulated. There is a 90% probability the blinds are closed when the glare index exceeds 22. There is a 50% probability that the blinds are reopened after they had been closed. The blinds start in the open position each morning. The view azimuth is parallel to the windows.

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To realize the benefits of the use of natural light in lieu of electric lighting to illuminate a room, daylighting controls are necessary. In this analysis, continuous dimming controls dim the lights to achieve an illuminance level in a space of 35 footcandles. The perimeter offices are 15 feet deep and the controls are located at 7.5 feet from the windows 30 inches above the floor. The minimum setting for the daylighting controls is 20% power at 10% light output.

First Cost Savings from Downsizing HVAC Equipment

The first cost savings from downsizing the chilled water system and the air distribution system with SunGuard SN 54 are significant (Table 2 and Table 3). For the study, each ton reduction in cooling saves $1200. This covers the cost for the chiller, cooling tower, pumps, piping, and chilled water coils. On the air side, a savings of $3.50/cfm of delivered air is assumed and includes the fans and ductwork. The sizing calculations do not account for the effect of blinds or daylighting controls.

Table 2 shows the predicted cooling capacity and design air flow for the case with 40% window area (25,118 sf of glazing). It also breaks down the cost savings for the chilled water and air distribution systems. The cooling capacity is rounded to the nearest ton, although the cost savings are based on the difference in the cooling load. There is the potential to save $1.63/sf of glass on the air distribution system and $1.03/ sf of glass on the chilled water system as compared to the standard low-E glazing. These results are consistent for the different window area percentages.

Table 2 Chilled Water and Air Distribution System Cost Savings (40% Window Area)

Location	Glass	ARI Rated Cooling Capacity Tons	Chilled Water Savings %	CHW Cost Savings $	Total Air Flow CFM	CFM Savings %	CFM Cost Savings $	Total Savings $
Chicago, IL	Standard Low-E	516			124497			
	SN54 on Clear (2) /Clear	495	4%	$0.98	114835	8%	$1.63	$2.61
Houston, TX	Standard Low-E	528			130114			
	SN54 on Clear (2) /Clear	509	4%	$0.90	120536	7%	$1.62	$2.51
Seattle, WA	Standard Low-E	394			121415			
	SN54 on Clear (2) /Clear	373	5%	$1.03	111840	8%	$1.61	$2.64

* Savings are shown relative to Standard Low-E in each city.

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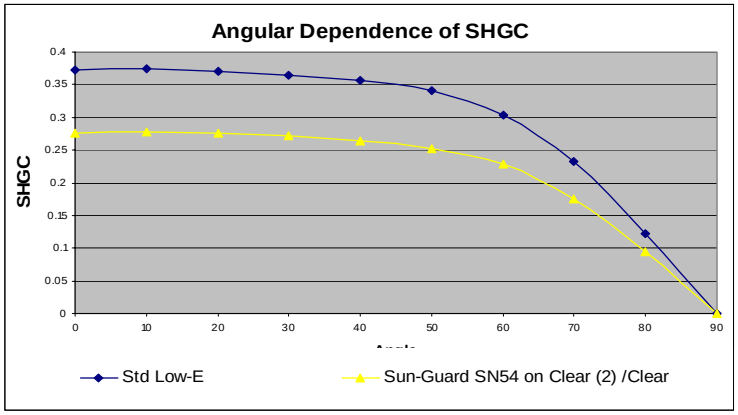
In Table 3, the annual energy cost savings and the equipment cost savings are shown for the three window areas, or window-to-wall ratios (WWR), included in this study. The savings are shown per square foot of glazing area. The first year savings for the building are presented as well and this reflects the sum of the equipment cost savings and the annual energy savings multiplied by the area of glazing in the building. The first year savings with the high performance low-E products and no special controls vary from $50,000 to over $80,000. Glare control increases the savings by another $1,000, and daylighting and glare controls together increase the savings by $20,000 to $30,000. These savings occur in the first year. In subsequent years, the owner would benefit from the reduction in annual energy costs.

Table 3 Annual Energy and First Cost Savings

		30% WWR (18,839 sf)			40% WWR (25,118 sf)			50% WWR (31,398 sf)		
Location	Glass	Annual Energy Savings $/ft2 glass	Equip Savings $/ft2 glass	First Year Cost Savings $/yr	Annual Energy Savings $/ft2 glass	Equip Savings $/ft2 glass	First Year Cost Savings $/yr	Annual Energy Savings $/ft2 glass	Equip Savings $/ft2 glass	First Year Cost Savings $/yr
Chicago, IL	**Std Low-E(U=.29,SHGC=0.37)**									
$0.092/kWh	w/ Glare Control	$0.09		$1,732	$0.09		$2,321	$0.10		$3,080
$0.659/therm	w/ Daylighting	$1.06		$20,062	$0.78		$19,565	$0.63		$19,664
	w/ Glare & Daylighting	$1.19		$22,326	$0.91		$22,808	$0.74		$23,159
	SN54 on Clear (2) /Clear	$0.08	$2.57	$50,071	$0.10	$2.61	$68,131	$0.12	$2.63	$86,306
	w/ Glare Control	$0.14	$2.57	$51,217	$0.17	$2.61	$69,778	$0.18	$2.63	$88,326
	w/ Daylighting	$1.14	$2.57	$70,026	$0.88	$2.61	$87,794	$0.75	$2.63	$106,170
	w/ Glare & Daylighting	$1.23	$2.57	$71,602	$1.00	$2.61	$90,856	$0.84	$2.63	$108,946
Houston, TX	**Std Low-E(U=.29,SHGC=0.37)**									
$0.103/kWh	w/ Glare Control	$0.06		$1,194	$0.09		$2,324	$0.10		$3,257
$0.960/therm	w/ Daylighting	$1.42		$26,685	$1.05		$26,269	$0.82		$25,780
	w/ Glare & Daylighting	$1.45		$27,389	$1.12		$28,028	$0.91		$28,460
	SN54 on Clear (2) /Clear	$0.17	$2.50	$50,303	$0.18	$2.51	$67,491	$0.18	$2.51	$84,475
	w/ Glare Control	$0.21	$2.50	$51,039	$0.23	$2.51	$68,958	$0.24	$2.51	$86,486
	w/ Daylighting	$1.58	$2.50	$76,897	$1.22	$2.51	$93,736	$1.01	$2.51	$110,462
	w/ Glare & Daylighting	$1.59	$2.50	$77,035	$1.26	$2.51	$94,753	$1.05	$2.51	$111,898
Seattle, WA	**Std Low-E(U=.29,SHGC=0.37)**									
$0.056/kWh	w/ Glare Control	$0.03		$534	$0.03		$746	$0.02		$746
$1.018/therm	w/ Daylighting	$0.54		$10,165	$0.39		$9,710	$0.30		$9,489
	w/ Glare & Daylighting	$0.56		$10,533	$0.41		$10,366	$0.32		$10,130
	SN54 on Clear (2) /Clear	$0.07	$2.54	$49,303	$0.08	$2.64	$68,430	$0.09	$2.56	$83,097
	w/ Glare Control	$0.09	$2.54	$49,570	$0.10	$2.64	$68,874	$0.11	$2.56	$83,704
	w/ Daylighting	$0.61	$2.54	$59,435	$0.47	$2.64	$78,215	$0.39	$2.56	$92,542
	w/ Glare & Daylighting	$0.61	$2.54	$59,443	$0.49	$2.64	$78,546	$0.40	$2.56	$93,069

* Savings are shown relative to Standard Low-E with no controls in each city.



The ASHRAE RTS load calculations account for the angular dependence of the solar heat gain coefficient. Most sizing calculations ignore the angular dependence of glazing, although at sun angles greater than 40° the solar heat gain coefficients begin to drop off significantly, as shown in Figure 1.

Figure 1 Angular dependence of Solar Heat Gain Coefficient (WINDOW 5.2).

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Annual Energy Cost Savings

SunGuard SN 54 reduces electricity use and peak electricity demand. Heating energy use slightly increases in Chicago with SunGuard SN 54; however, the electricity and peak demand savings more than offset the increase in heating energy use. Table 4 shows the annual electricity and gas savings, along with the peak demand savings for the case with 40% window area. For example, the high performance glazing results in a peak demand reduction in the building of 25 kW. Without glare or daylighting controls, the annual energy cost savings range between $0.07/yr to $0.18/yr per square foot of glass. Assuming a 4% discount rate over 10 years, the net present value of these annual cost savings ranges from $0.60 to $1.60 per square foot of glass.

Table 4 Annual and Peak Energy Savings for 40% Window Area and No Controls

Location	Glass	Electricity Savings kWh/yr/sf glass	Peak Demand Savings W/sf glass	Natural Gas Savings Therms/yr/sf glass	Annual Energy Savings* $/sf glass
Chicago, IL	Standard Low-E SN54 on Clear (2) /Clear	1.0	0.8	-0.02	$0.10
Houston, TX	Standard Low-E SN54 on Clear (2) /Clear	1.6	0.5	0.01	$0.18
Seattle, WA	Standard Low-E SN54 on Clear (2) /Clear	0.9	0.9	0.03	$0.08

* Savings are shown relative to Standard Low-E in each city.

Glare control results in higher energy cost savings as compared to the case without glare control. Glare is controlled through the use of manually operated blinds; a typical condition in office buildings. In Seattle, there is an increase of $0.02/sf of glass in annual energy savings from the case with no glare control to the case with glare control. In Chicago, the savings are an additional $0.06/sf of glass; and in Houston, the savings increase by $0.07/sf of glass.

Daylighting controls increase annual energy cost savings by 4 to 15 times over the case with no controls. The combination of daylighting control and glare control results in the greatest cost savings. In Chicago (Figure 2), daylighting controls reduce annual energy costs with SunGuard SN 54 by $0.88/sf of glass. The combination of daylighting and glare controls, saves an additional $0.12/sf of glass. In Houston (Figure 3), a hotter climate with higher energy costs than Chicago, the cost savings with daylighting controls are $1.22/yr/sf of glass. In Seattle (Figure 4), daylighting controls save $0.47/yr/sf of glass. In Houston and Seattle, glare control increases the annual energy cost savings with daylighting by $0.04 and $0.02 respectively.

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Conclusions

The results of the energy analysis highlight the benefits of SunGuard SN 54 in reducing HVAC equipment sizes and reducing annual energy costs. For the office building used in this study, the 4% reduction in the size of the chilled water system from switching from a glazing system with a solar heat gain coefficient of 0.37 to SunGuard SN 54 translates into first cost savings of $1/sf of glass. The impact on the air distribution system is even greater. The 8% reduction in design air flow results in first cost savings of $1.60/sf of glass.

The annual energy cost savings are more closely tied to climate, window area, controls and energy rates. The building in this study was modeled with and without shade control, i.e. glare, and daylighting controls. Almost all buildings have shades to control glare from windows. The annual energy cost savings with SunGuard SN 54 and glare control are $0.10/sf of glass in Seattle, $0.17/sf of glass in Chicago, and $0.23/sf of glass in Houston for the case with 40% windows. For this same case, daylighting controls in addition to glare control save $0.49/sf of glass in Seattle, $1.00/sf of glass in Chicago, and $1.26/sf of glass in Houston. The net present value of these annual energy savings are $3.92/sf of glass in Seattle, $8.00/sf of glass in Chicago, and $10.08/sf of glass in Houston based on a 4% discount rate over 10 years. This study demonstrates the potential for the new SunGuard SN 54 to reduce first costs and operating costs in commercial buildings.

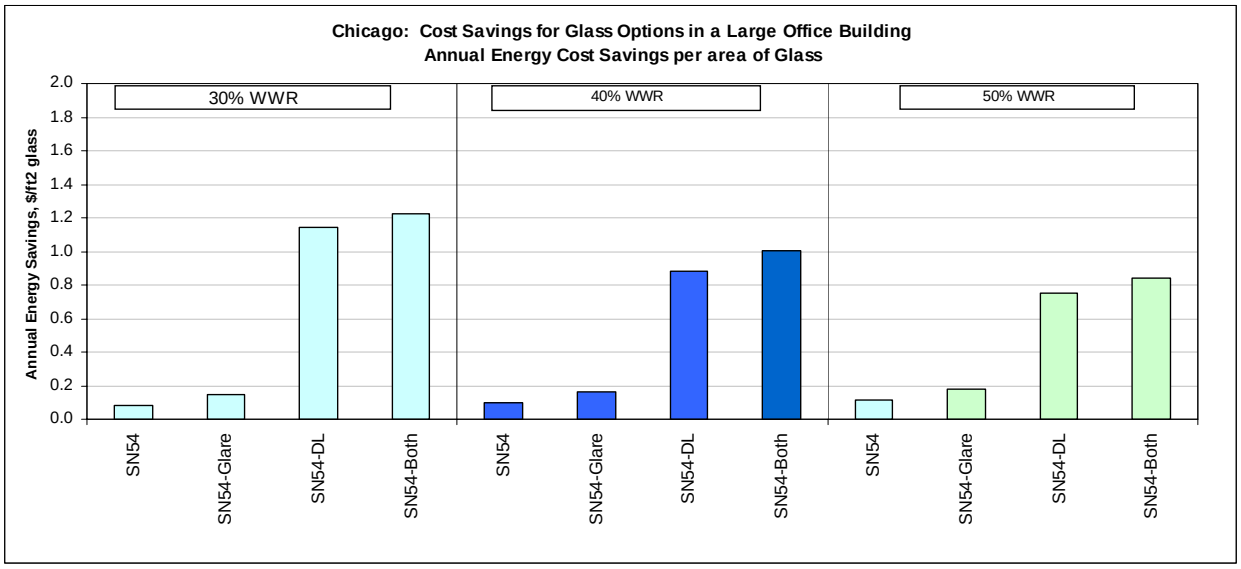

Figure 2 Annual energy cost savings in Chicago.

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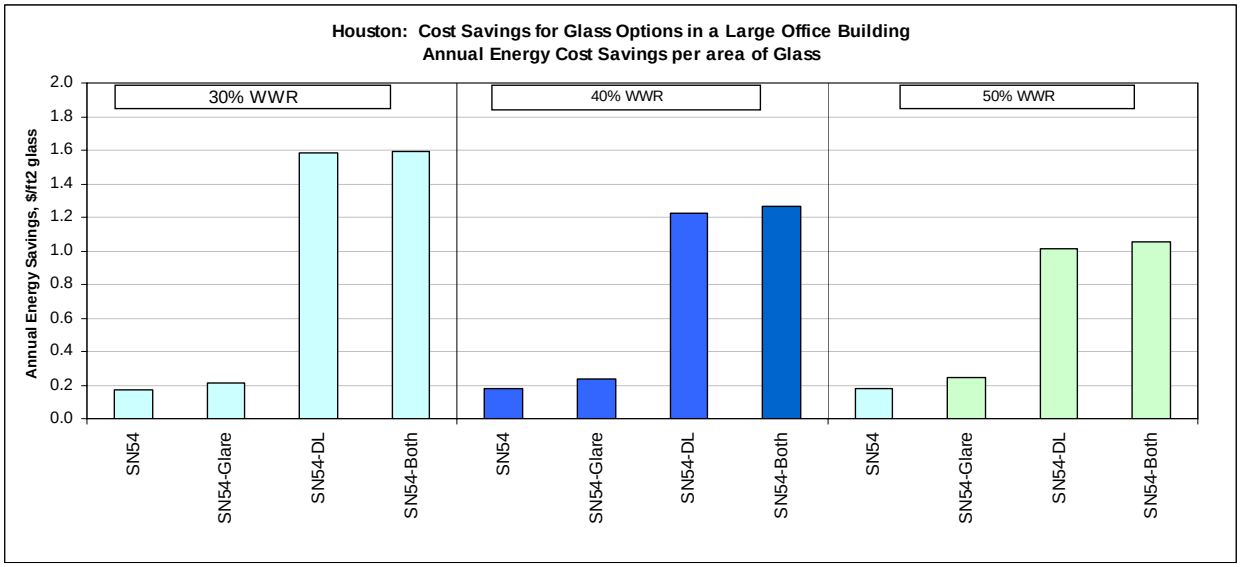

Figure 3 Annual energy cost savings in Houston.

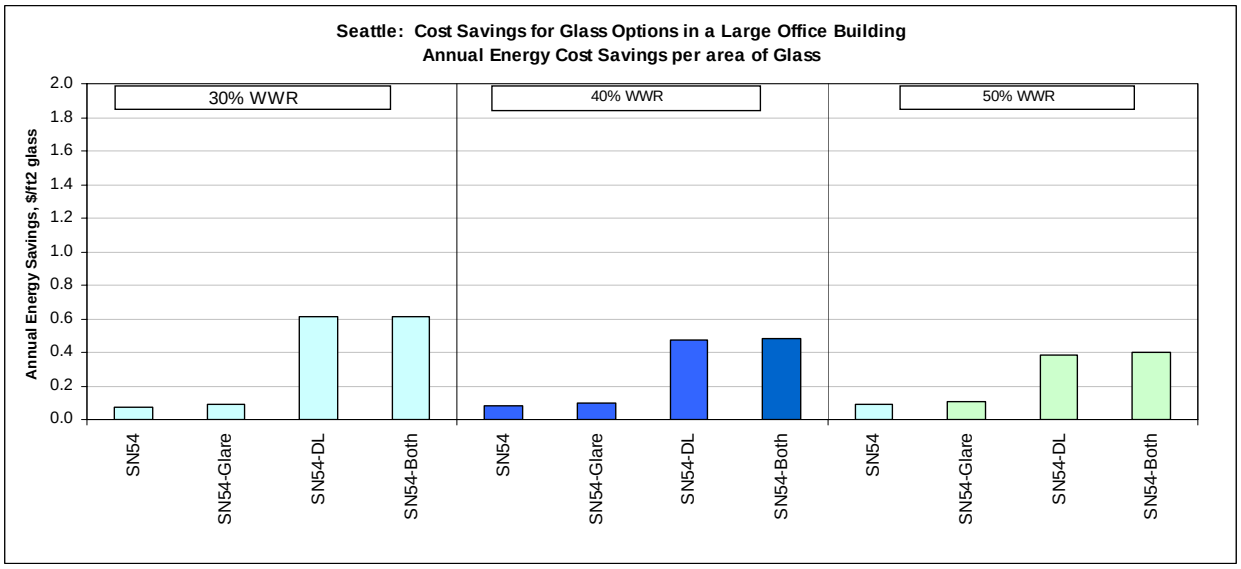

Figure 4 Annual energy cost savings in Seattle.

Authors: Susan Reilly of Enermodal Engineering, Inc. and Paul Reeves of the Partnership for Resource Conservations performed this glazing study. The authors both have over 20 years of experience working with DOE-2 and modeling the energy performance of buildings.