The energy benefits of View Dynamic Glass

Workplace demonstration

Figure 1. Demo room A: Low-e glass

Figure 2. Demo room B: View Dynamic Glass

Executive summary

View Dynamic Glass represents a big step forward in building facades. Using electrochromic technology, View Dynamic Glass transitions between clear and various tint states on demand, providing unprecedented control over heat and glare. With View Dynamic Glass, windows are no longer a static component in a building; it is a responsive facade solution for optimum solar control and occupant comfort.

To demonstrate the potential energy saving benefits for a typical commercial office application, View constructed a demonstration site with two identical south-facing perimeter offices in the San Francisco bay area; one installed with traditional Low-e glass (Figure 1) and the other with View Dynamic Glass (Figure 2).

Energy monitoring over a period of 12 months resulted in the commercial office room installed with View Dynamic Glass saving 39 percent of the total energy consumed compared to the office room installed with traditional Low-e glass.

Setup and methodology

Room configuration – The offices, located in Milpitas, CA, are located on the second floor of a low-rise commercial office building. The two rooms are built with identical office footprints, furniture, and heating, ventilation and air-conditioning (HVAC) systems. They are adjacent south-facing perimeter offices and receive the same level of sun exposure. Demo room A was installed with dual pane Low-e glass and manual motorized shades. Demo room B was installed with dual pane View Dynamic Glass.

Occupancy – To maintain a controlled environment, both rooms were unoccupied during the duration of the monitoring period.

HVAC – The HVAC systems for both rooms are comprised of two dedicated dual duct variable air volume (VAV) boxes that supplied conditioned air to each room. Both systems were tied to a building automation software platform used to control and calculate energy consumption.

Lighting – Dimmable lighting was installed in both rooms with identical lighting set points (25 foot candles).

Schedules – The lighting and HVAC occupancy schedule stayed active from 7:00am-7:00pm on weekdays. The HVAC schedule switched to a setback mode during unoccupied periods.

Sensors – Multiple indoor and outdoor sensors were deployed in both rooms to monitor various parameters including illuminance levels, power consumption of equipment, artificial lighting, and indoor temperatures.

Facade control strategy – View's proprietary Intelligence control package was implemented into the demo room starting October 2012. The Intelligence package uses geometrical solar penetration, radiated energy and real time environmental condition monitoring to automatically change the tint state of the glass for optimal solar control and comfort.

Baseline commissioning – Prior to installing View Dynamic Glass in demo room B, it was necessary to ensure that both rooms were indeed receiving identical solar radiation exposure and room performance (HVAC, insulation, and lighting). Both rooms were fitted with the same Low–e glass and monitored for two weeks. The sensors and controls were calibrated and tuned to identical parameters. The resulting data showed there was less than a 2 percent difference between the two rooms. See Appendix A for more details.

Monitoring time period – Monitoring began in May 2012 and is ongoing. This performance assessment reflects 12 months of data collected from October 2012 to September 2013.

Summary of findings

View Dynamic Glass results in 39% total energy savings

Cooling, heating, lighting and total energy parameters were monitored. Figure 3 demonstrates the average total energy consumption from October 2012 to September 2013. Under glare conditions (which typically relate to high radiation) View Dynamic Glass transitions to the fully tinted state blocking more than 90 percent of the solar heat entering the space, resulting in significant cooling savings. In its fully tinted state, demo room B required slightly more artificial lighting to maintain desired light levels. However the additional energy required for lighting was negligible compared to the total cooling energy saved.

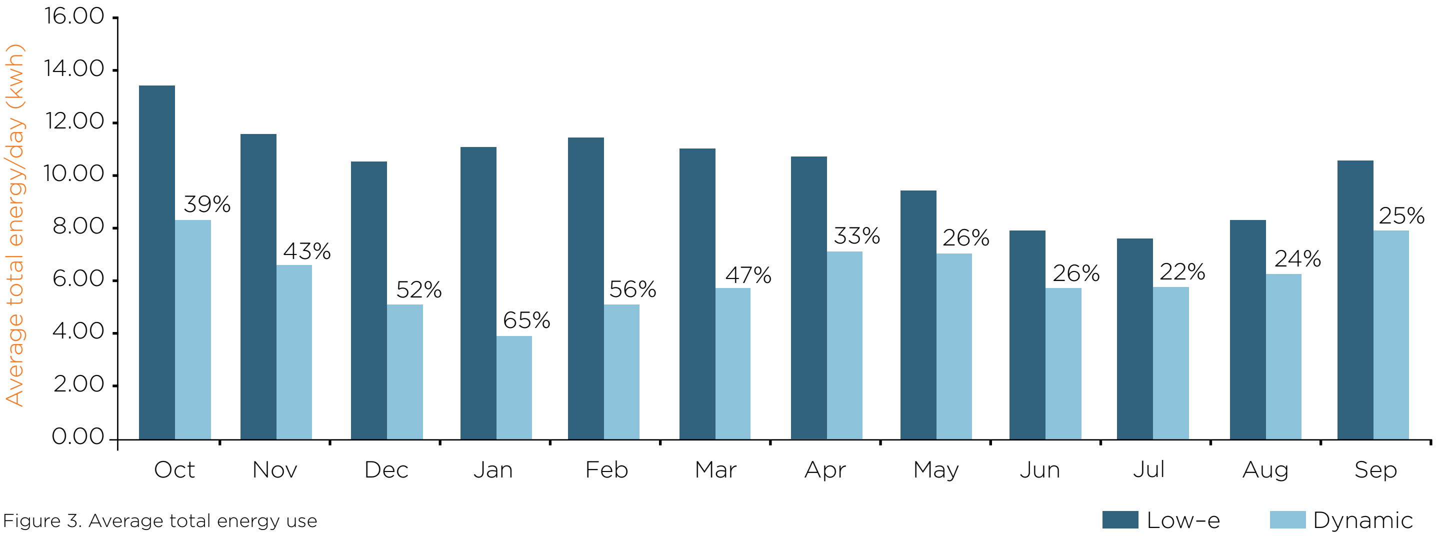


Figure 3. Average total energy use

View Dynamic Glass results in more than 85% cooling savings during the weekend

Figure 4 illustrates the total energy use on one of the summer weeks in August. Results reveal significant savings of over 85 percent during the weekend. Upon further investigation it was determined that this is due to the weekend cooling setback set point. On weekdays, the cooling set point is 73°F, meaning cool air will be supplied to the room once it detects a temperature of 73°F or higher. It is common to raise the setback temperature on weekends due to building vacancy and therefore there is no need to cool the area as attentively. Hence during the weekend, the setback temperature is set to 82°F. View Dynamic Glass' excellent solar heat gain coefficient keeps the temperature inside the space so cool that it hardly goes above 82°F during the day, requiring minimal cooling as opposed to Low-e glass.

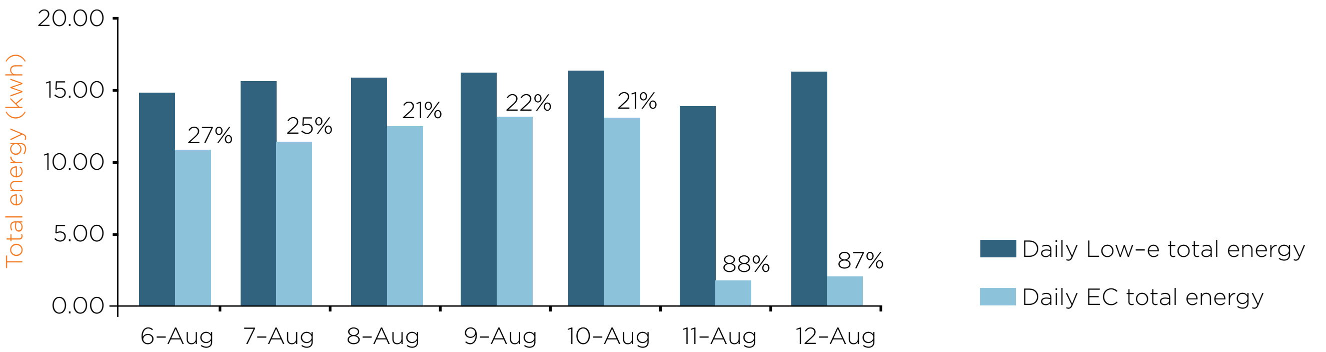


Figure 4. Average total energy use for a typical summer week (August)

View Dynamic Glass performs even in the winter

Heat gain through windows comes in two forms: conductive and radiative. Unlike the summer, radiative heat gain dominates during the winter due to a combination of low sun angle and cooler temperatures. View Dynamic Glass excels in blocking radiative heat due to its low SHGC values resulting in a higher percentage in savings in the winter as compared to the summer (Figure 5). Typical perimeter offices in this climate are cooling dominated hence there are very few days when heating is required.

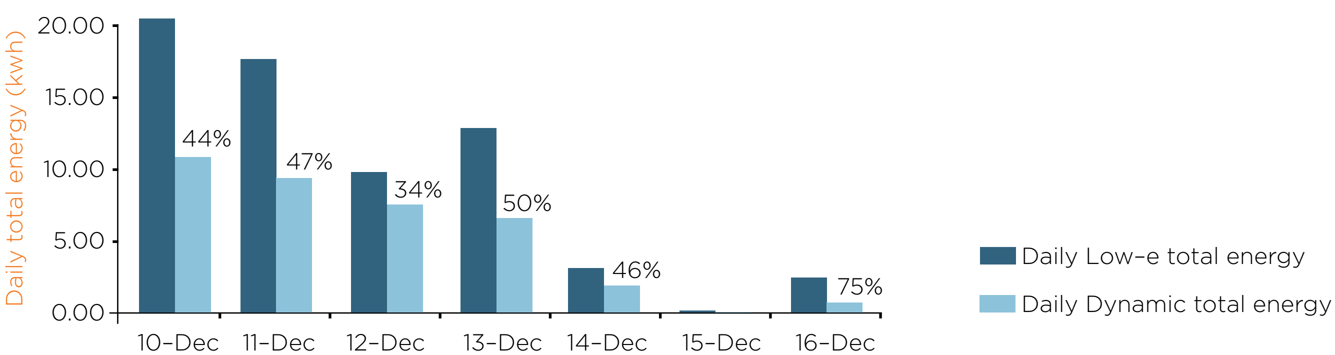


Figure 5. Average total energy use for a typical winter week (December)

Conclusion

View Dynamic Glass significantly reduces the cooling load of the space resulting in 39 percent in total energy savings compared to standard Low-e glass.

Appendix A

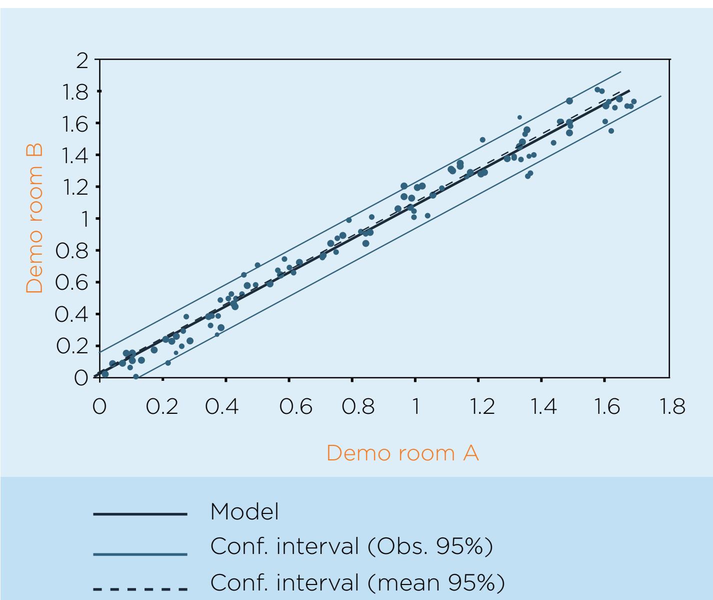
Baseline commissioning

Prior to Dynamic Glass monitoring, both rooms were fitted with the same Low–e glass and monitored for two weeks. Using a building automation platform by Automated Logic Controls, energy consumption was calculated from direct measurements of temperature and air flow of the supply air (hot and cold deck) and return air at 1–minute intervals. The 1–minute data points were then integrated into a 1–hour data set for analysis. A total of 183 hourly energy usage data points were collected during the test campaign.

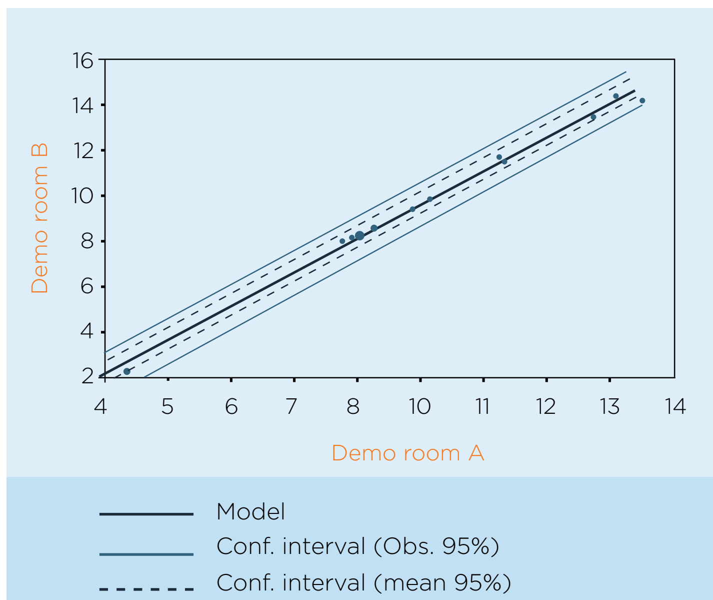
Regression plots of the hourly data revealed that a direct correlation model (demo room A = demo room B) had an R^2 correlation coefficient of 0.981. Among the 12 day energy usage data points, the R^2 was 0.988. The scatter plots with R^2 and 95 percent confidence interval overlays are shown below.

Further statistical analysis revealed that the two rooms displayed very high agreement. For one set of data, the 95 percent confidence interval of measurement difference for an average 10.325 kWh day's usage is –0.726 kWh and +0.557 kWh. The statistical bias between rooms on similar average days is –0.085 kWh, or –0.24 percent.

Regression of hourly data (R2=0.981)



Regression of daily data (R2=0.988)



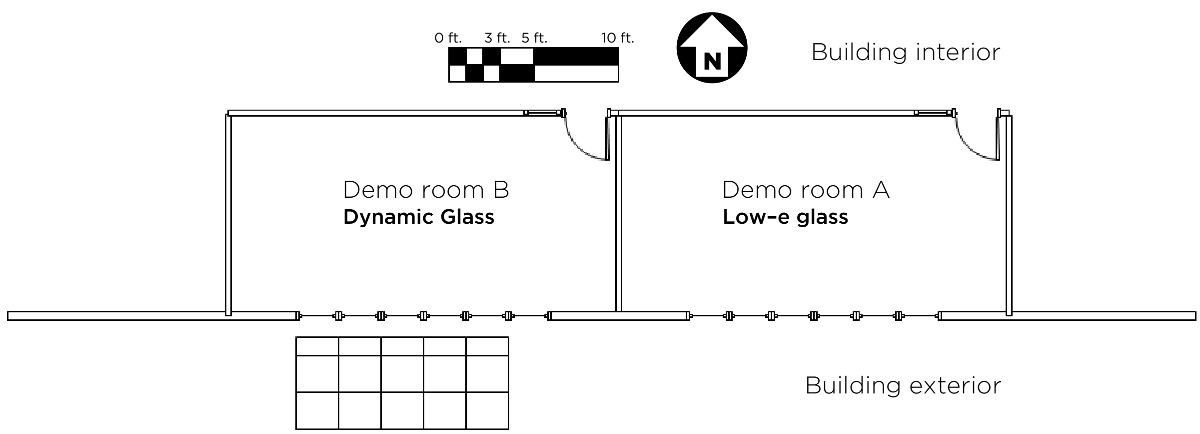
Conclusion

The measured performance between demo room A and demo room B exhibits no appreciable bias between the test rooms and is sufficient for publication. As long as measurement methods remain consistent, no treatment or correction for directly measured data is required for accurate glass comparisons.

Appendix B

Test room configuration details

Setup description – The windows in each room were simultaneously exposed to the same exterior and interior conditions with no obstruction to the direct sun. The rooms were surrounded by a secondary conditioned space with all adjacent spaces maintained at similar room temperatures to avoid heat transfer between the conditioned spaces. The rooms were equipped with multiple sensors monitoring illuminance levels, power consumption of mechanical equipment, electric lighting, indoor temperatures and other data required for an accurate analysis.



Room area (each)	260 ft^2
Glass area	94 ft^2
Window-to-wall ratio = 45%	
Window azimuth = 155	

Facade – Listed below are the facade characteristics of the rooms.

	View Dynamic Glass	High performance Low-e
Daylight dimming controls	Yes	Yes
Blinds, drapes	No	Yes (manual mechoshades)
Window frames	Old Castle VistaWall 3000 2″ x 4.5,″ thermally broken, center set storefront	Old Castle VistaWall 3000, 2″ x 4.5,″ thermally broken, center set storefront
U-value (center of glass)	0.29 Btu/ft^2 • °F • hr	0.29 Btu/ft^2 • °F • hr
Solar heat gain coefficient	0.46 (clear) / 0.09 (tinted)	0.38
Visible transmission	58% (clear) / 4% (tinted)	69%
Energy consumption	0.1 W/ft^2 (hold) 0.28 W/ft^2 (switch)	N/A

Note: Low-e specifications are for Guardian SN-68 dual pane unit

Building Management System (BMS) – Automated Control Logic's Building Management System (with BACnet as the communication protocol) was used for controlling the building systems and for energy calculations and monitoring.

HVAC – Dedicated dual duct variable air volume (VAV) boxes provide conditioning to each room, with identical controls and set points. HVAC setpoints were 73°F for cooling and 68°F for heating. The setback temperatures on the weekends were 82°F for cooling and 60°F for heating.

Lighting – Electric lighting power consumption was monitored using the BMS system. Two 2′ x 3′ with three T8 (34W each) CFL fixtures (with dimmable ballasts) were installed in each room. The electric lighting maintains the rooms at 25 foot candles (fc).

Operating schedules (except weekends and holidays)

Type	Schedule
HVAC	7:00am–7:00pm
Lighting	7:00am–7:00pm

Appendix C

Calculation details

HVAC energy calculations – Heating and cooling energy were measured separately for both rooms. Based on supply and return air temperatures and the supply air CFM, energy use was calculated for each room. An integration function was used to convert the instantaneous demand in kilowatt hours (kWh) of energy use. To separate cooling and heating energy, the following logic was applied in the automated control; if Cold Deck (CD) Flow > 60 CFM, cooling is on. If Hot Deck (HD) Flow is > 50 CFM, heating is on. The minimum Cold Deck Flow in the room at any given time is 50 CFM.

Instantaneous demand (BTU/hr) = ΔT (RATemp .– DA Temp.) * CFM *1.08

Where

RA: return air temperature

DA: delivered air temperature

CFM: cooling/heating air flow in cubic feet per minute

1.08: coefficient for standard air

Energy consumption – During the winter, demo room B uses more heating energy than demo room A. Due to lower emissivity, the Low-e room loses less heat during the evening than the View Dynamic Glass room. This results in demo room B consuming higher heating energy in early morning hours. However the additional energy required for the higher heating load was significantly smaller than the cooling energy saved at the end of the day. View Dynamic Glass transitions to its darkest tint during conditions of direct glare. There are a few instances where demo room B uses more heating energy than demo room B during the day because it transitions to a darker tint to block glare and thus blocking potential passive gains. However, the total energy savings using View Dynamic Glass was significant even in the heating season.

Monitored data filtering – There were several days during the test period when the rooms contained visitors, were occupied or had some other non-test related activity such as a HVAC malfunction or hardware software update for the controls. Data was filtered for these days and excluded from the data set shown in the analysis.

Sources of errors – Although the test bed was engineered to create two identical spaces, not every system variable could be accounted for. The potential differences on comparative performance include:

1. Thermal loads: Even though both rooms are built with typical construction techniques and identical material for both rooms, some differences in thermal heat transfer is expected.
2. HVAC system accuracy: A difference in actual flow rates of the systems and damper positioning could affect the amount of air entering and leaving the rooms.
3. Sensor sensitivity: Although the sensors have been calibrated, there may be differences in the sensitivity between the sensors in each room.
4. There may also be differences in air infiltration or leakages into the rooms.

Power consumption by EC windows – View Dynamic Glass consumes power to switch between states and to hold a particular tint state. Peak/transition power consumption is 0.1 W/ft^2 (1.0 W/m^2) and average/hold power consumption is 0.03 W/ft^2 (0.3 W/m^2). The average annual energy as calculated was less than 12 kWh and hence is not a part of the total energy savings calculations.