

Electrochromic Glazing Dynamic Control of Solar Energy

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Learning Objectives

At the end of this program, participants will be able to:

- Analyze the impact of traditional solar control solutions, their associated energy penalty and contrast with the use of dynamic glazing.
- Explain the energy and environmental benefits of electrochromic glass and discuss key control strategies for maximum energy conservation.
- Examine the human factors benefit with electrochromics and discuss how durability improves sustainability.
- Understand key aspects of design for incorporating and specifying electrochromic glass to achieve maximum performance and potential contribution to LEED points.

Course Outline

- Section 1:** Electrochromic Glazing: The Power of Glass Without the Energy Penalty
- Section 2:** Energy and Performance Comparisons
- Section 3:** Sustainability and Human Factors
- Section 4:** Electrochromic Glazing Design Considerations

Section 1: The Power of Glass



Why Do We Use Glass?

Windows:


- Add architectural detail
- Provide a view and connection to the outdoors
- Create a more pleasant environment for building occupants



The Power of Glass

People love glass.

- Windows provide light, views and connection to the outdoors.
- Numerous studies confirm what most people know instinctively: people feel better and perform better in spaces where there is abundant daylight.



However...

Windows have a major impact on energy use – mostly negative.

- In a typical office building, 65% of total energy use is for lighting, heating and cooling.

Problems with Windows


- Heat gain
- Glare
- Energy use



The Conventional Solutions

- “Static” glass
- Interior blinds and shades
- Exterior shades

Expensive
Ineffective
Block view and connection to outdoors
Ongoing maintenance and repair
“Embedded carbon” issues




Dynamic Glazing Options

SPD
Suspended particle device, operating with 110VAC <15A
Powered stage is clear and tinted is off.
Laminate form, organic based compounds.

LCD
Liquid crystal device, operating with 110VAC <15A
Powered stage is clear and translucent is off.
Laminate form, organic based compounds.


Photochromic
Ultra violet light is absorbed by the materials and that absorption results in tinting based on the solar intensity.
Passive system, no electrical controlling capabilities.
Laminate form, organic based compounds.



Dynamic Glazing Options


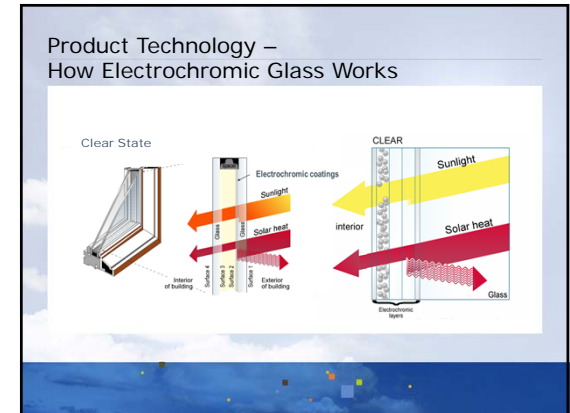
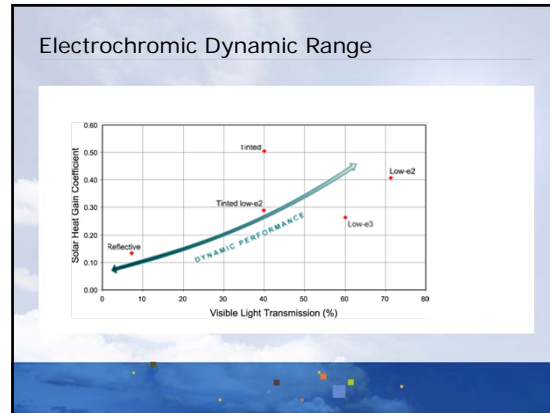
Thermochromic
Heat is absorbed by the materials and that absorption results in tinting with intensity increasing as heat and pressure increase.
Passive system, no electrically controlling capabilities
Laminate form, organic based compounds.

Electrochromic
Thin film technology that tints on demand, <4VDC & <10mA.
Powered stage is tinted, clear is off.
Series of ceramic and metallic films deposited onto glass surface, inorganic solution impervious to UV, high temperature and pressure gradients.



Electrochromic Focus

- Controllable
- Drives occupant comfort and energy efficiency
- Maintains view and connection to the outdoors
- Durable
- Energy Efficient
- Aligns with current IGU installation

Up-front Cost Comparison

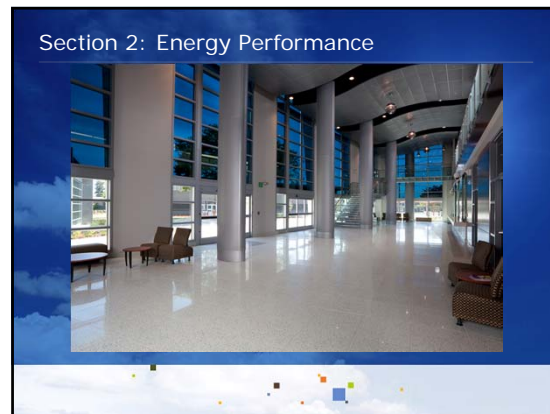
Conventional Solutions



Electrochromic Glass



- Increased HVAC
- Sunshades
- Low-e IGU
- Automated Blinds
- EC Glass



Impact on Performance

Lawrence Berkeley National Lab, CA


- Energy & Human Factors Evaluation

Energy Results

- Up to 20% cooling energy savings
- Up to 60% reduction in lighting
- Up to 30% reduction in peak demand

Human Factors Results


Employees greatly preferred to be in the room with Electrochromic windows vs. static glass



EC Glass Energy Performance

DoE2.1 Building Simulation Model

- 8 story office building
- 160,000 square feet floor space
- 37,500 square feet window area
- Multiple climate zones
 - Minneapolis
 - Washington, DC
 - Phoenix

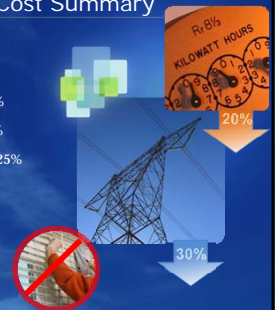


Energy Performance Results

	Percent Annual Energy Savings			Percent Peak Demand Reduction (kW)		
	MN	DC	AZ	MN	DC	AZ
EC Double Pane						
Compared to:						
Single-Pane Clear	45%	45%	46%	40%	35%	39%
ASHRAE 90.1-2007	21%	22%	22%	24%	18%	14%
EC Triple Pane						
Compared to:						
Single-Pane Clear	56%	53%	n/a	45%	41%	n/a
ASHRAE 90.1-2007	37%	34%	n/a	29%	23%	n/a
Static Triple	14%	16%	n/a	26%	21%	n/a

Energy and Operating Cost Summary

- Reduces energy use by up to 20%
- Lowers peak demand by up to 30%
- Lowers lighting costs by up to 60%
- Can reduce HVAC sizing by up to 25%
- Eliminates need for blind / shade maintenance



Section 3: Sustainability and Human Factors

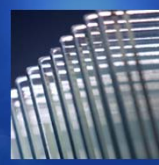


Key Factors of Sustainability

Controlling glare improves occupant comfort and productivity, and increases the effectiveness of daylighting strategies.

Controlling solar radiation eliminates embedded costs of manufacturing, transporting, maintaining, replacing and disposing of large amounts of interior materials otherwise damaged by fading.

Durability of the window means that maintenance and replacements costs of the Solar Control Solution are reduced.




Controlling Glare

Discomfort due to temperature or glare have a proven negative impact on occupant comfort and productivity.


In a world of technology with its multiple reflective screens, glare is a significant problem in the workplace.

But in addition, glare has a significant negative impact on energy use due to increased lighting costs.




Controlling Solar Radiation: Fading Protection

Glass Type	Tdw-K	Tdw-ISO
Clear Glass	45%	30%
Low-E2	77%	52%
EC Glass (clear state)	82%	62%
EC Glass (tinted state)	98%	97%




• Tdw-K: Weighted transmission of the sun's energy that causes fading using the Kirschmann Damage Function (300 - 500nm)
 • Tdw-ISO: Weighted average of the sun's energy that causes fading using a function developed by the International Commission on Illumination (300 - 700nm)
 • Data from Lawrence Berkeley National Laboratory's Window 5.2 software

Durability



ASTM Test Standard E-2141-06 evaluates:
 "...the combined degradative effects of elevated temperature, solar radiation and extended electrical cycling through 50,000 cycles..."



...equivalent to switching a window 9 times per day for 365 days/year across a 40-year lifetime.

National Renewable Energy Laboratory

Sustainability and Human Factors

The qualities that make electrochromic glazing sustainable also contribute to the comfort and performance of the building's occupants.




Human Factors

- Maintains occupants' view and connection to outdoors
- Harvests natural light
- Improves comfort
- Eliminates glare helping to improve employee productivity and satisfaction




Section 4: Design




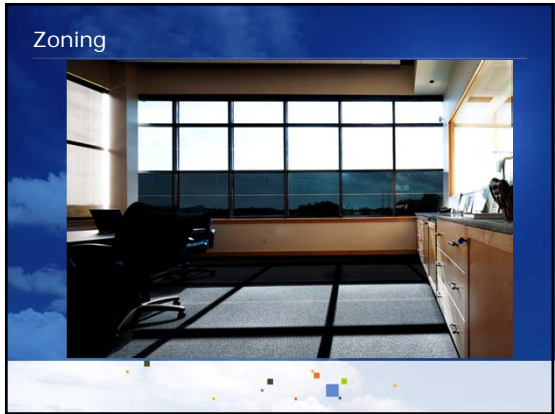
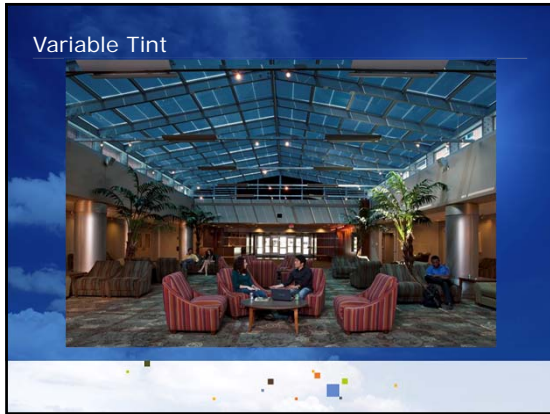
EC Glass Design Features

- Double or Triple pane construction
- Broad control options
- Variable tint
- Zoning
- Superior fading protection
- Supports LEED
- Familiar installation



EC Control Systems

- Simple switch
- Automation using manufacturer controls
- Automation in conjunction with a building control system
- Hybrid: Automation with manual override

EC Glass LEED® Certification Credits

EC glass can help earn credits in the following areas:

- E&A Credit 1: Optimize energy Performance
- IEQ Credit 6: Controllability
- IEQ Credit 7: Thermal Comfort
- IEQ Credit 8: Daylight & Views
- SS Credit 8: Light Pollution
- I&DP Credit 1: Innovation In Design



EC Glass Installation

EC glass is easy to specify, integrate, install and use

Proven integration with a wide variety of window, skylight and curtain wall manufacturers

Architectural Solutions consulting team




Electrochromic Product Attributes



- Size
 - 2012: Up to 40" x 60"
 - 2013: Up to 60" x 120"
- Non rectangular shapes
 - Parallelograms
 - Trapezoids
 - Triangle
- Selection of colors
 - 2012: Transmitted Color Options
 - 2013: Exterior / Reflected Color Options
- Power consumption
 - Up to 2000 ft² draws no more than a 60 watt light bulb





Electrochromic Installations





Century College, White Bear Lake, MN


Chabot College, Hayward, CA


Landis Hall, Greenwich, CT



Landis Hall, Greenwich, CT



PV solar panels



Kimmel Center, Philadelphia, PA



Siemens Wind Turbine Facility, Hutchinson, KS



Siemens Wind Turbine Facility, Hutchinson, KS



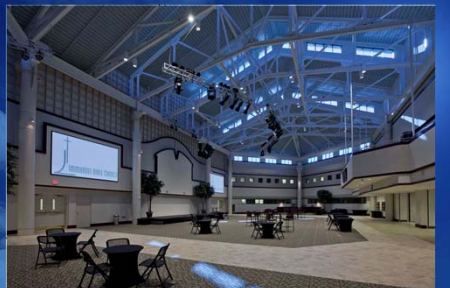
Ball State University, Muncie, IN



Club Porticello, Oconomowoc, WI



Immanuel Bible Church, Springfield, VA



Port of Entry, Torrington, WY



St. Johnsbury Athenaeum, St. Johnsbury, VT



Summary

Dynamic Glass → **Glass in**

Elegant Sustainable Glare

Comfortable

Cost Effective Durable



Where do you sit?



Presenting glass so cool it draws a crowd.

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Program

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