FULL TREASURE

Trend of Dynamic Glass in Green Building

Date: June 7th, 2017

Presented by HY Chiu

Introduction

Glass in Building

Victoria Harbour, Hong Kong

Introduction

Green Building –1990's

Limited resources

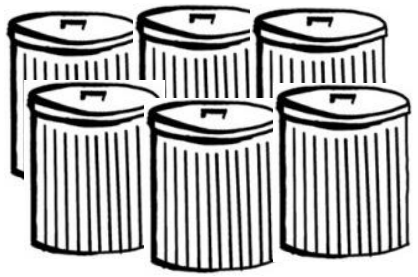
ENERGY

Less harms

Green house gas

CO_2

Global Warming



Introduction

Thermochromic

Electrochromic

Comparison

Introduction

Green Building + Wellness of Humans

Quality of life

Happiness

Health
Wellness
Comfort level

Productivity

Daylighting-to-health
Daylighting-to-productivity
Natural view-to-health

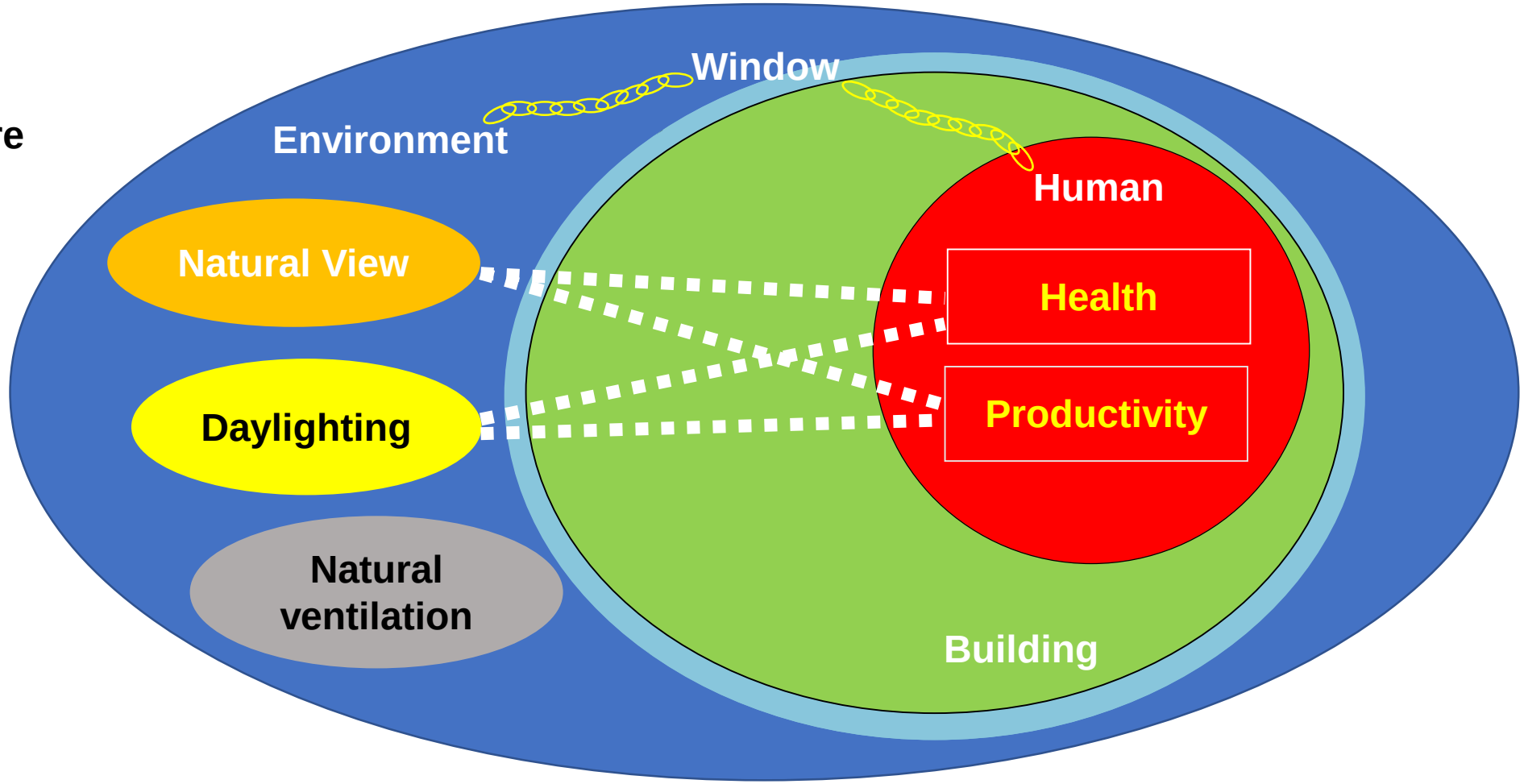
Introduction

Why Dynamic Glass?

Dynamic

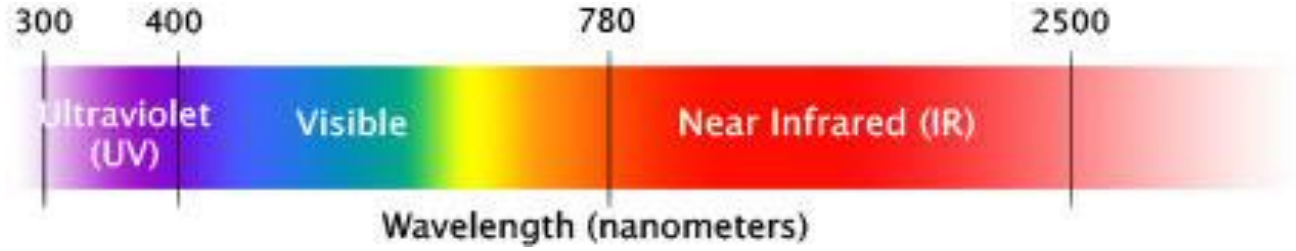
Glass connects humans and nature with shade

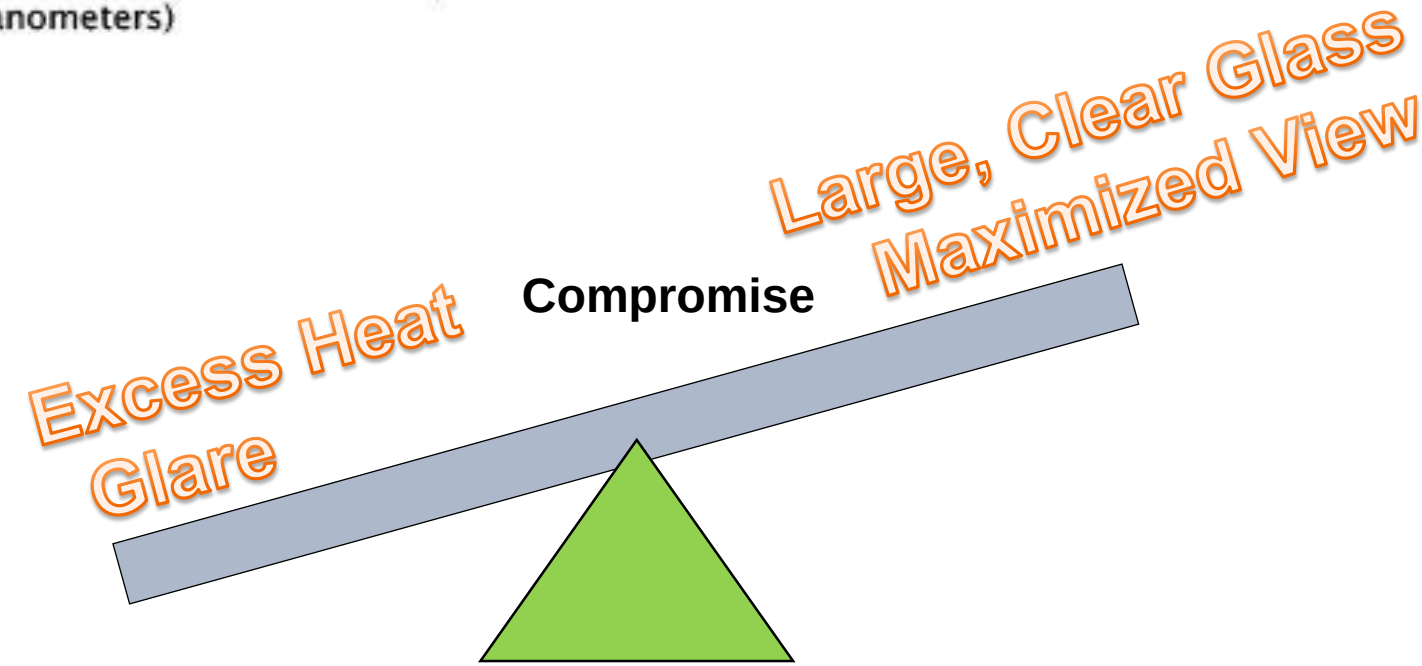
Environment is dynamically changing



Introduction

Design of Glass





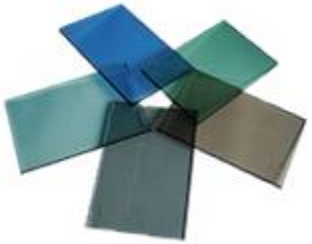
Introduction

Static Glass –Conventional Glass

Automated/manual shades;
Post window film, tinted glass;

Exterior sun-blocking devices;
Interior curtain and blind;

Orientation of building facing to sun



Introduction

Static Glass –Conventional Glass

Shades stay shut

In a study by the USGBC, (From Seduced by the view – Urban Green Council 2013)
59% area of window shades remained shut;
Over 75% of buildings have >1/2 window shut

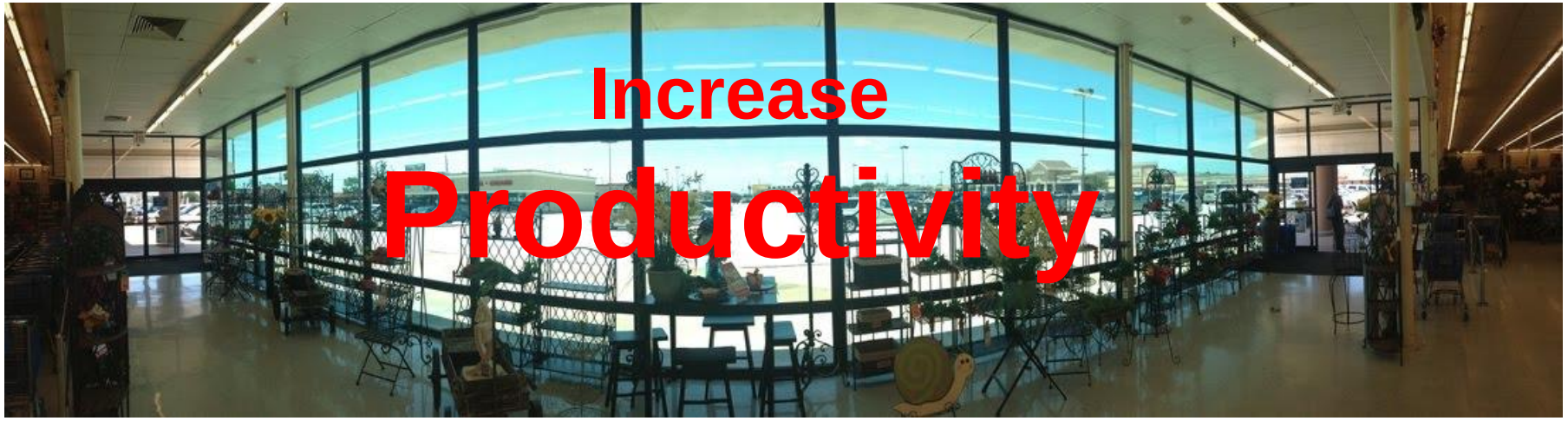
Introduction

Natural Light and Health

Daylighting

+ Positive attitude
+ Improves mood
+ Holding attention
+ Improves sleep

- Lower absenteeism
- Fewer errors
- Reduces fatigue, eyestrain, stress, headaches, SAD (seasonal affective disorder)
- Decreasing anxiety



Introduction

Natural Light and Health

Office
5% to 25% increase in productivity when employees are closer to windows.

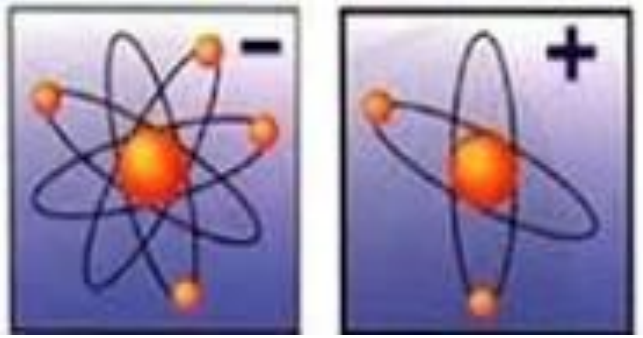
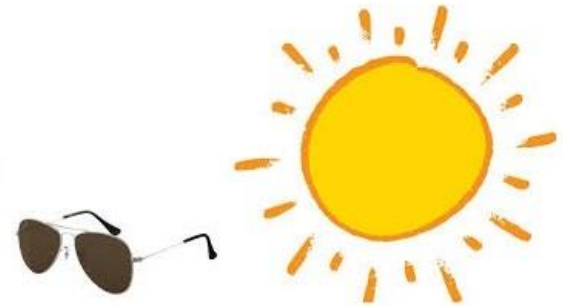
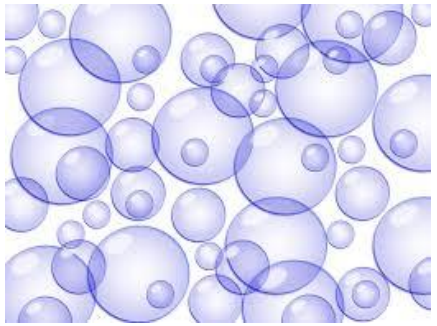
School
7% to 18% higher scores of students in most daylighting classroom.
20% to 26% progress faster in daylighting classrooms.
15% to 23% progress faster in largest window classrooms.

Retail Shop
Stores with skylights experienced 40% higher sales than those without skylights.

Hospital
16% to 41% shorter Average Length of Stay (ALOS) of patients in brighter orientation of a hospital.

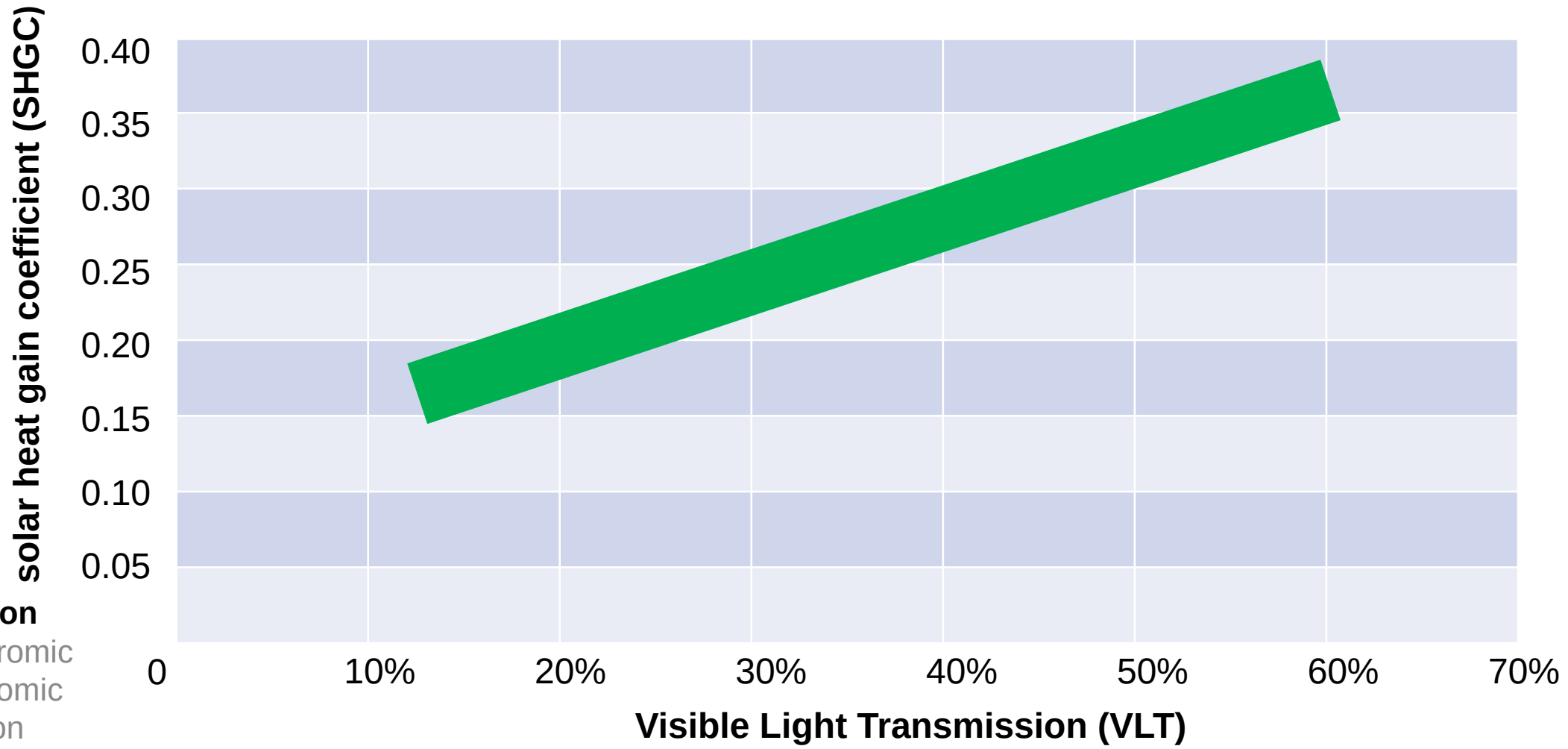
Introduction

Dynamic Glass –Chromogenism

 **Thermochromic TC (passive)** **Thermotropic (passive)**	 **Electrochromic EC (active)**
 **Photochromic (passive)**	 **Gasochromic (active)**

Introduction

Dynamic Glass –SHGC vs VLT



Introduction

Dynamic Glass –Total Costs Reduction

Static Glass

Maintenance Cost
- Maintenance of shading

Operating Cost
- Air-conditioning
- Lighting

Initial Cost
- Glazing
- Automated sun shading
- External shading
- Overhand design
- Internal blind, curtain

Dynamic Glass

Maintenance Cost
- ~~Maintenance of shading~~

Operating Cost
- Less Air-conditioning
- Less Lighting

Down-size HVAC

Initial Cost
- Glazing
- ~~Automated sun shading~~
- ~~External shading~~
- ~~Overhand design~~
- ~~Internal blind, curtain~~

Less LCA (life-cycle assessment)

Introduction

Dynamic Glass –LEED

Energy & Atmosphere - Credit 1: Optimize Energy Performance
(1-10 points possible)
Intent: “Achieve increasing levels of energy performance ... to reduce environmental and economic impacts associated with excessive energy use.”
SunnyGlass™ Contributions:
Reduces solar heat gain entering the building
For new construction, or updating existing buildings, the air-conditioning unit (and associated air movement equipment) can be downsized saving additional operation energy and significant capital costs
Daylight is allowed to enter the building lowering the need for artificial lighting

Materials and Resources - Credit 5.1/5.2: Regional Materials
(2 points possible)
Intent: “Increase demand for building materials and products that are extracted and manufactured within the region ... reducing the environmental impacts resulting from transportation.”
SunnyGlass™ Contributions:
Interlayer produced in the USA
Allows regional fabrication using locally supplied materials – including regionally produced glass panes or completion of IGUs near to Hong Kong

Indoor Environmental Quality - Credit 6.1/6.2: Controllability of Systems
(1-10 points possible)
Intent: “Provide a high level of thermal comfort system control by individuals or groups… and promote their productivity, comfort and well-being.”
SunnyGlass™ Contributions:
- SunnyGlass™ interlayer can be incorporated into windows that can be opened for optimal occupant comfort and control
- Windows are easily to be specified, installed and operated without the need to accommodate wires in the window, power supplies and the controls to drive them
- SunnyGlass™ reduces solar heat gain for increasing occupant’s comfort

Indoor Environmental Quality - Credit 8.1/8.2: Daylight and Views
(2 points possible)
Intent: “Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views ...”
SunnyGlass™ Contributions:
Windows maintain the view at all times - the adaptive nature allows only enough darkening as is required by the directness of the sun
Windows will remain transparent, even in their darkest state, so occupants can always see through the window and enjoy the view

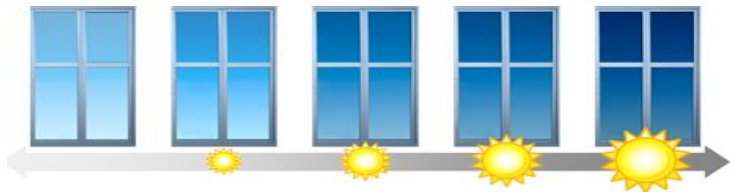
Innovation & Design Process - Credit 1-1.4: Innovation in Design
(4 points possible)
Intent: “To provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by LEED and/or innovative performance in Green Building categories.”
SunnyGlass™ Contributions:
- Solves issues in a way that has not been available previously
- Solar heat gain coefficients obtainable are better than most spectrally selective glazing
- Allows for the use of more glass, often in places where it previously could not be used
- New opportunities provided for innovative and high-performance design

Indoor Environmental Quality - Credit 7: Thermal Comfort Design
(1 point possible)
Intent: “Provide a comfortable thermal environment that sup-ports the productivity and well-being of building occupants.”
SunnyGlass™ Contributions:
SunnyGlass™ reduces the amount of heat felt by occupants which promotes productivity
Reduces solar heat gain, glare and utilizes low-emissivity glass to keep absorbed solar heat out and internal heat in for more consistent indoor temperatures
Due to incorporation in a double or triple IGU, the product offers a low U-value for insulation in any climate

Dynamic Glass

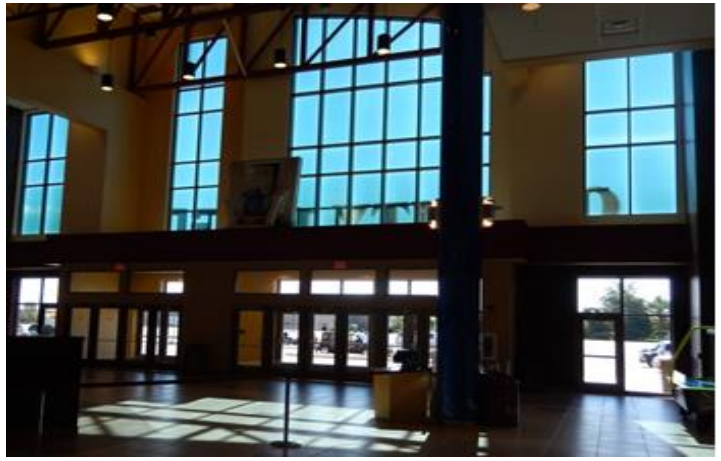
Case Photos

◆**Residential** 			
◆**Commercial** 			



Thermochromic (TC)

Self-Tinting Under Heat of Sunlight



Thermochromic (TC)

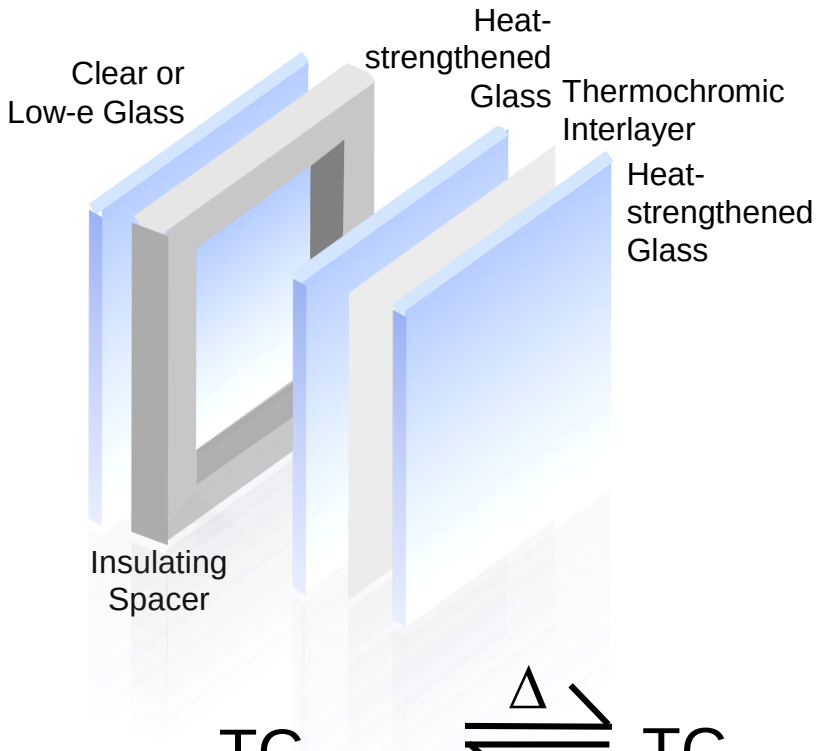
Children’s Learning Adventure

CincoRanchKaty, Texas

Introduction
Thermochromic
Electrochromic
Comparison

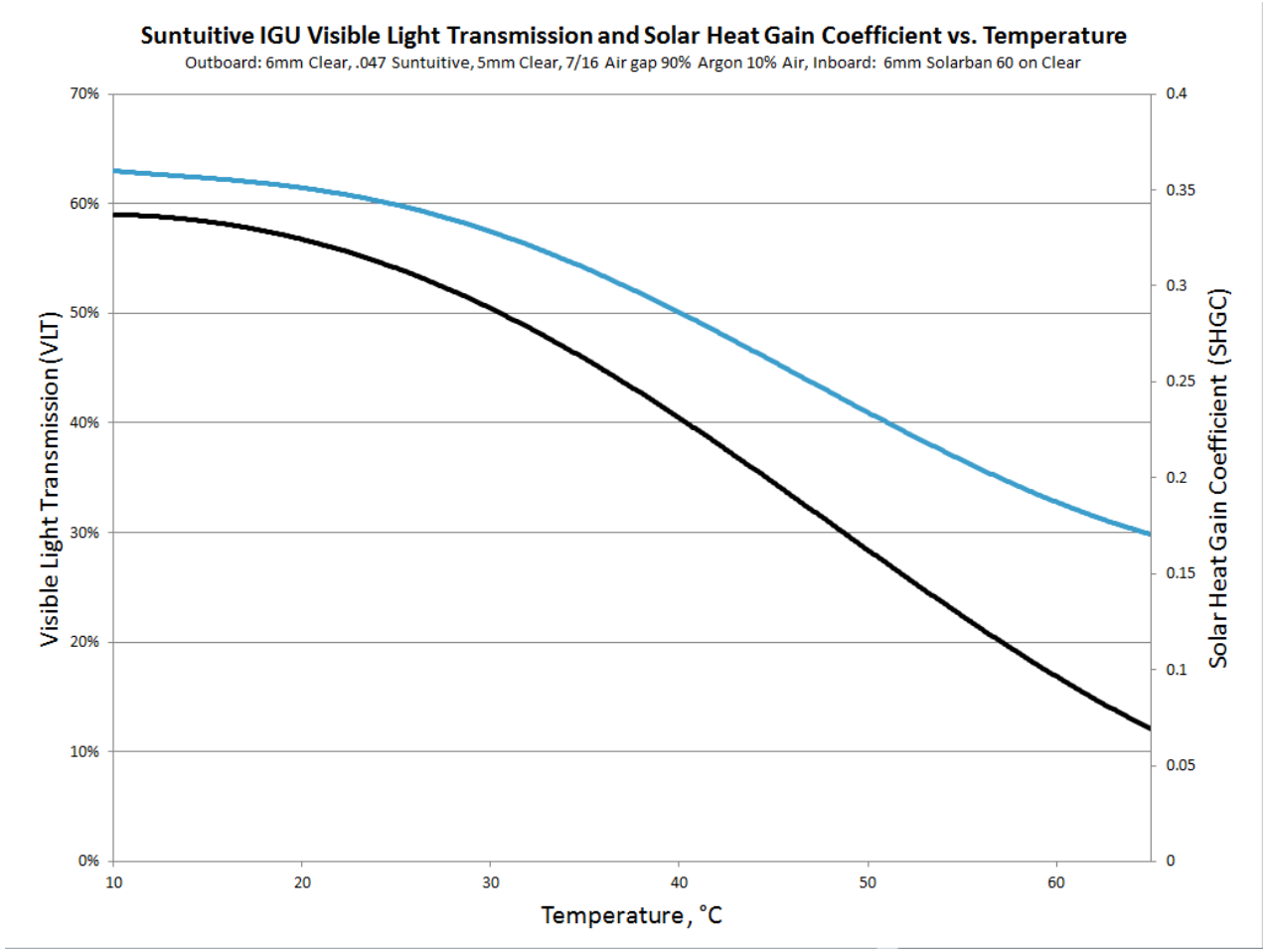
Thermochromic (TC)

Construction



$$TC_{colorless} \underset{-\Delta}{\overset{\Delta}{\rightleftharpoons}} TC_{colored}$$

Operation



Thermochromic (TC)

Performance

Model Name	Stage	VLT(Tvis)	SHGC/SC	LSG	Exterior Reflectance	Total Solar Transmission	Winter U-Value*
GrayStone	Darken	6%	0.13/0.15	0.48	5%	4%	0.24
	Clear	30%	0.24/0.27	1.28	6%	14%	
BronzeBeach	Darken	8%	0.14/0.16	0.54	5%	5%	0.24
	Clear	36%	0.26/0.30	1.37	7%	16%	
BlueOcean	Darken	8%	0.14/0.16	0.58	5%	5%	0.24
	Clear	38%	0.27/0.31	1.43	7%	16%	
GreenForest	Darken	13%	0.17/0.19	0.73	5%	8%	0.24
	Clear	60%	0.37/0.42	1.62	10%	26%	

17.5mm SunnyGlass™ laminated Glass + 11mm 90% Argon/10% Air + 12.5mm SOLARBAN 60/70

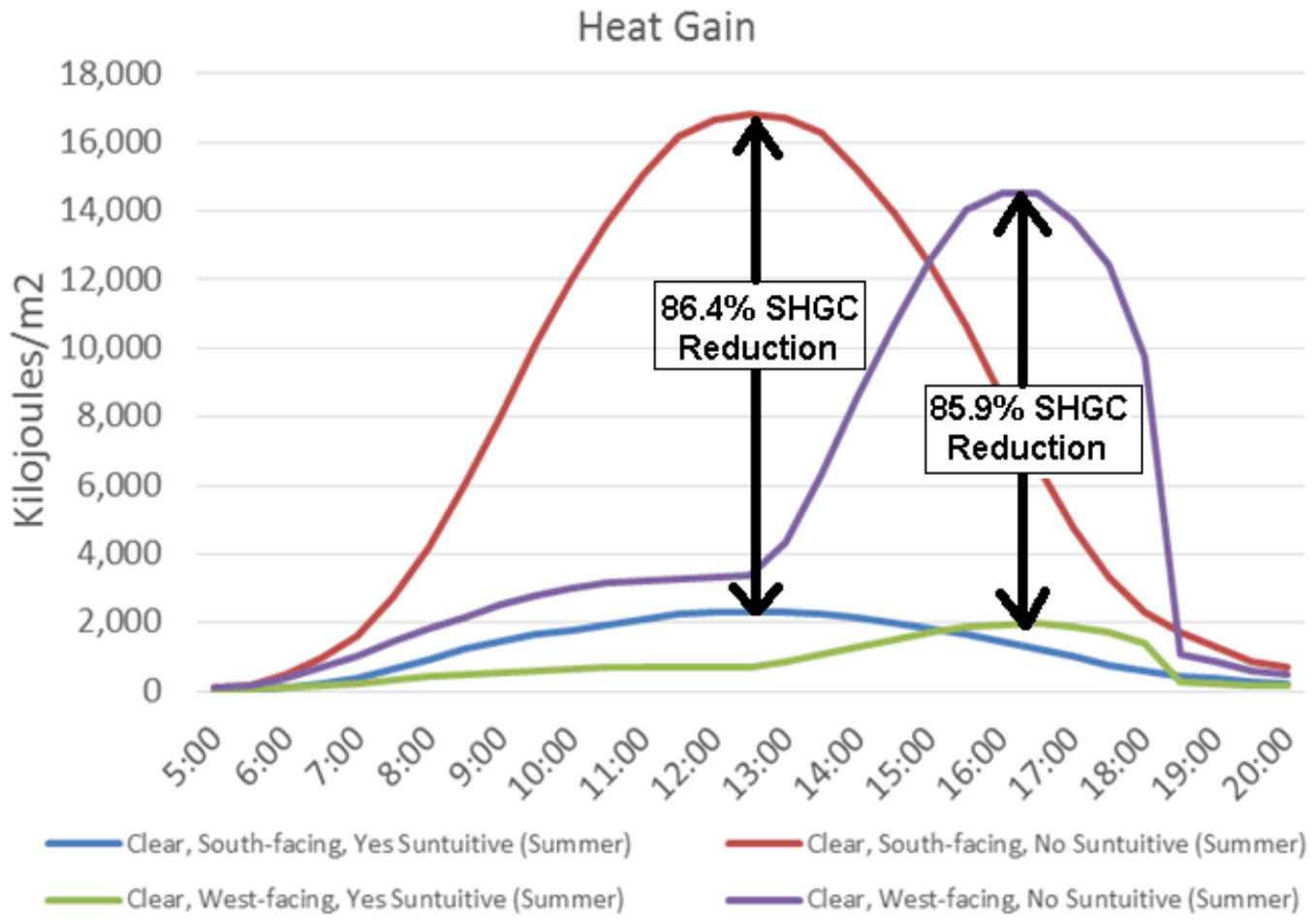
*U-Value in BTU/h-ft^2-F

LSG: Light to Solar Heat Gain Ratio (Tvis/SHGC)

Maximum Dimension per single panel:
1,600mm (63inch) x 6,096mm (240inch)

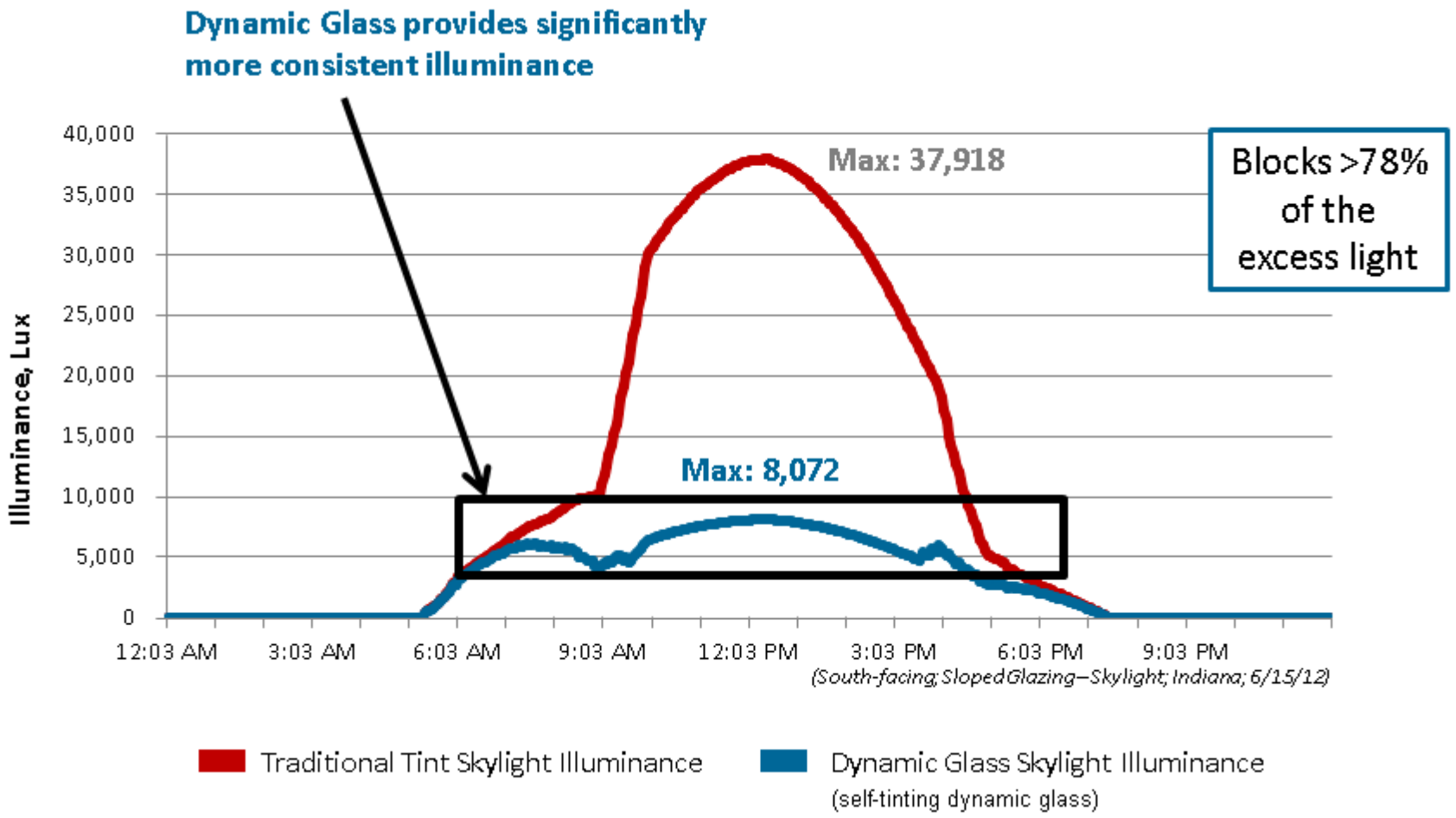
Thermochromic (TC)

Reduce Heat Gain



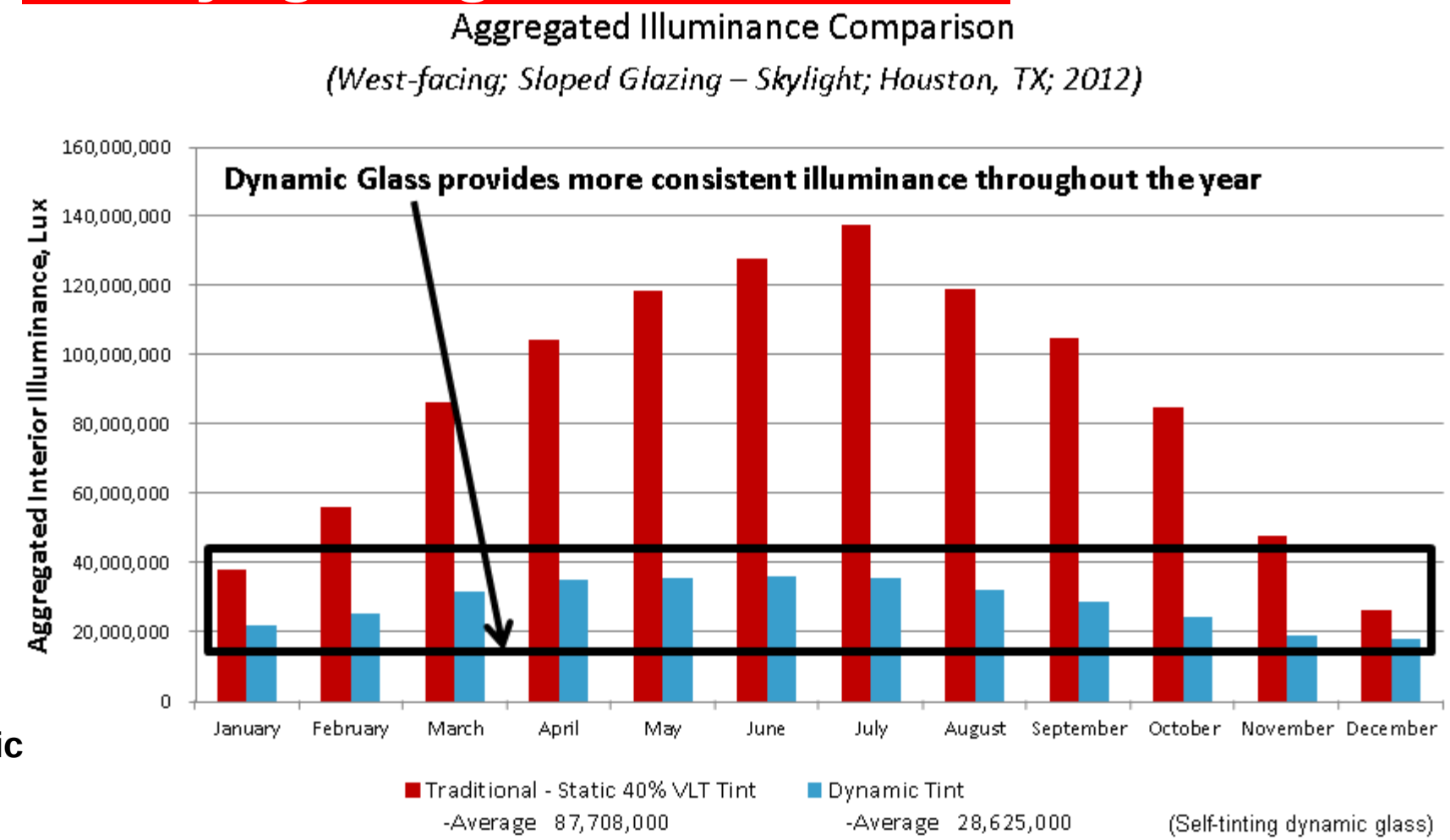
Thermochromic (TC)

Daylighting–Over a Day



Thermochromic (TC)

Daylighting–Over a Year



Thermochromic (TC)

Benefits + Add

Occupant		+ Always a 100% undistorted view + natural daylight + connection to outdoor
		+ Increase indoor comfort (visual and thermal) + well being
		+ Increase productivity of occupants if more natural light are receiving
Landlord		+ Enhanced value of the building
		+ Smart glass – innovative
Design		+ Add potential credit points to Green Building Certification eg LEED or HKBEAM
		+ Design flexibility to new construction or retrofit buildings, less shading devices
		No wires, no control, no power supply and no electrical installation are needed

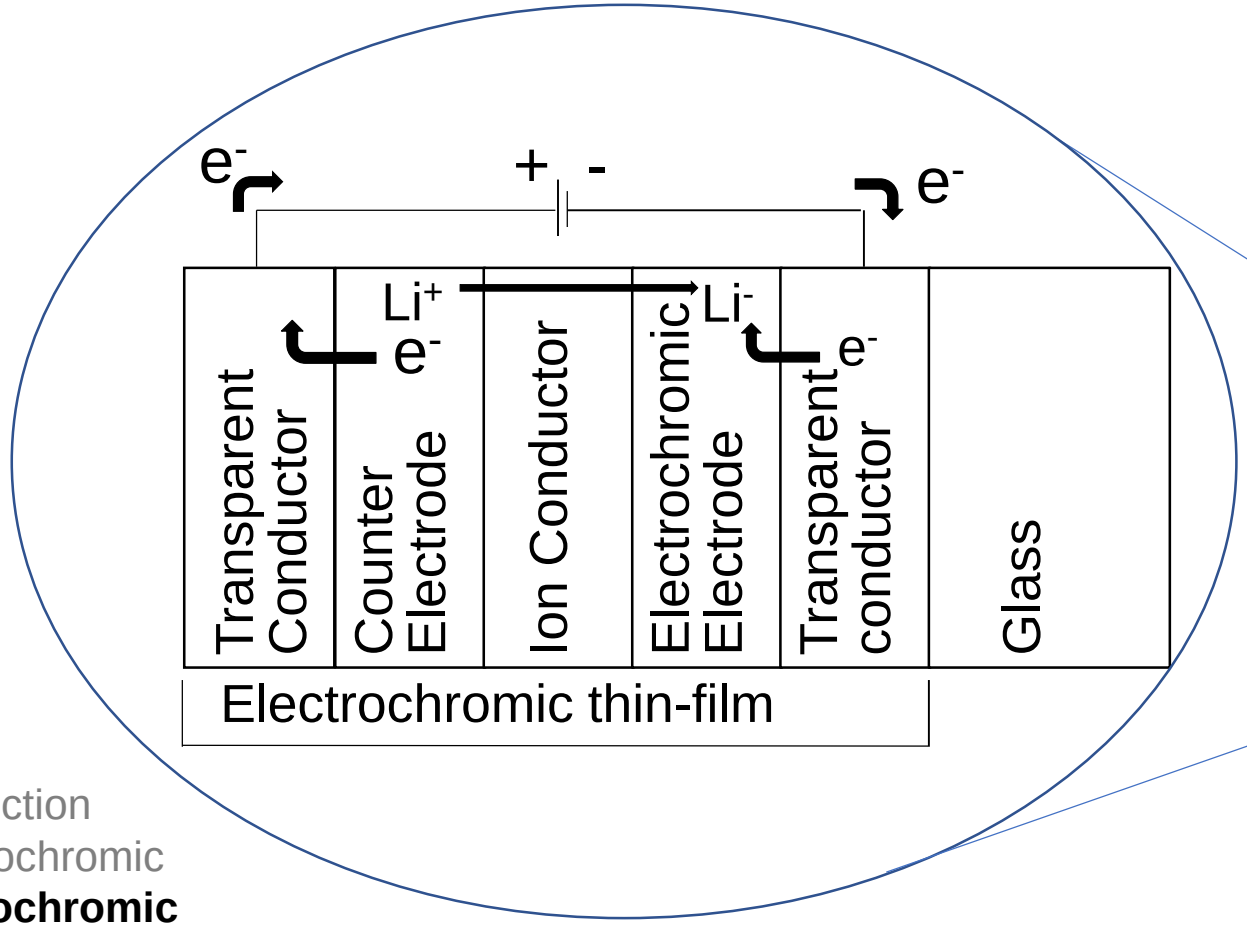
Thermochromic (TC)

Benefits - Reduce

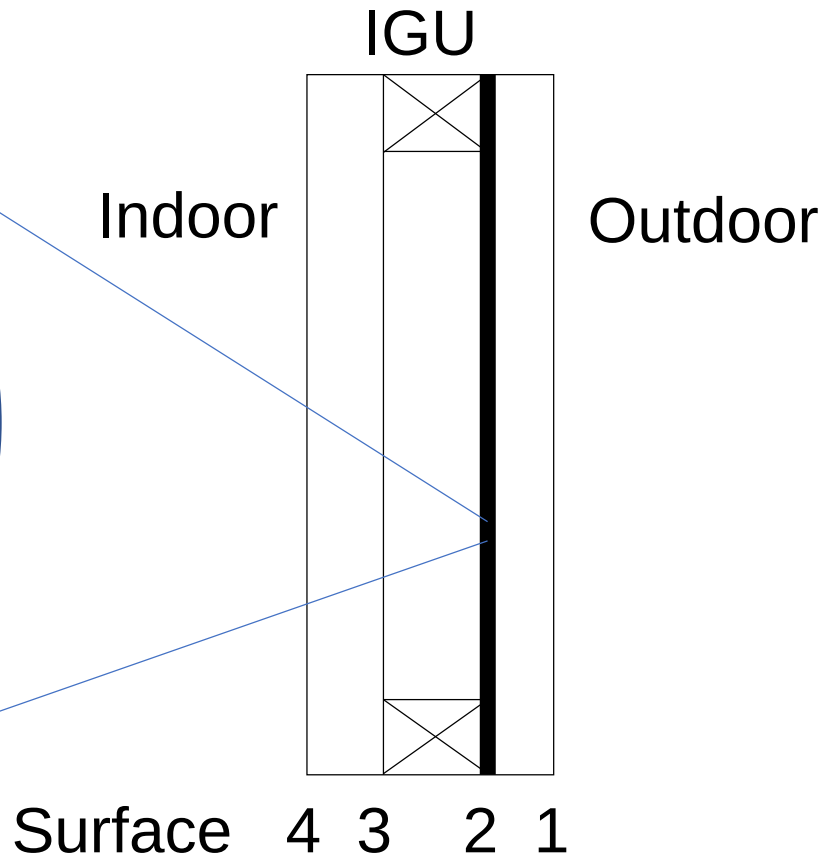
	- Save overall energy costs from 17% to 30%.
	- Reduces window heat gain by 58% over the baseline low-e window and more than 80% over clear-glass window
	- Reduce glare discomfort
	- Block 99.96% UV
	- It also reduces 10% in annual HVAC cooling electricity consumption over low-e window and more than 20% over clear-glass window.
	- Reduce the production costs and carbon-foot-print of the glass.
	- Reduce HVAC and lighting costs, up to 30% energy reduction
	- No maintenance trouble (that is maintenance-free).

Electrochromic (EC)

How Does It Works



Construction of Glass Panel



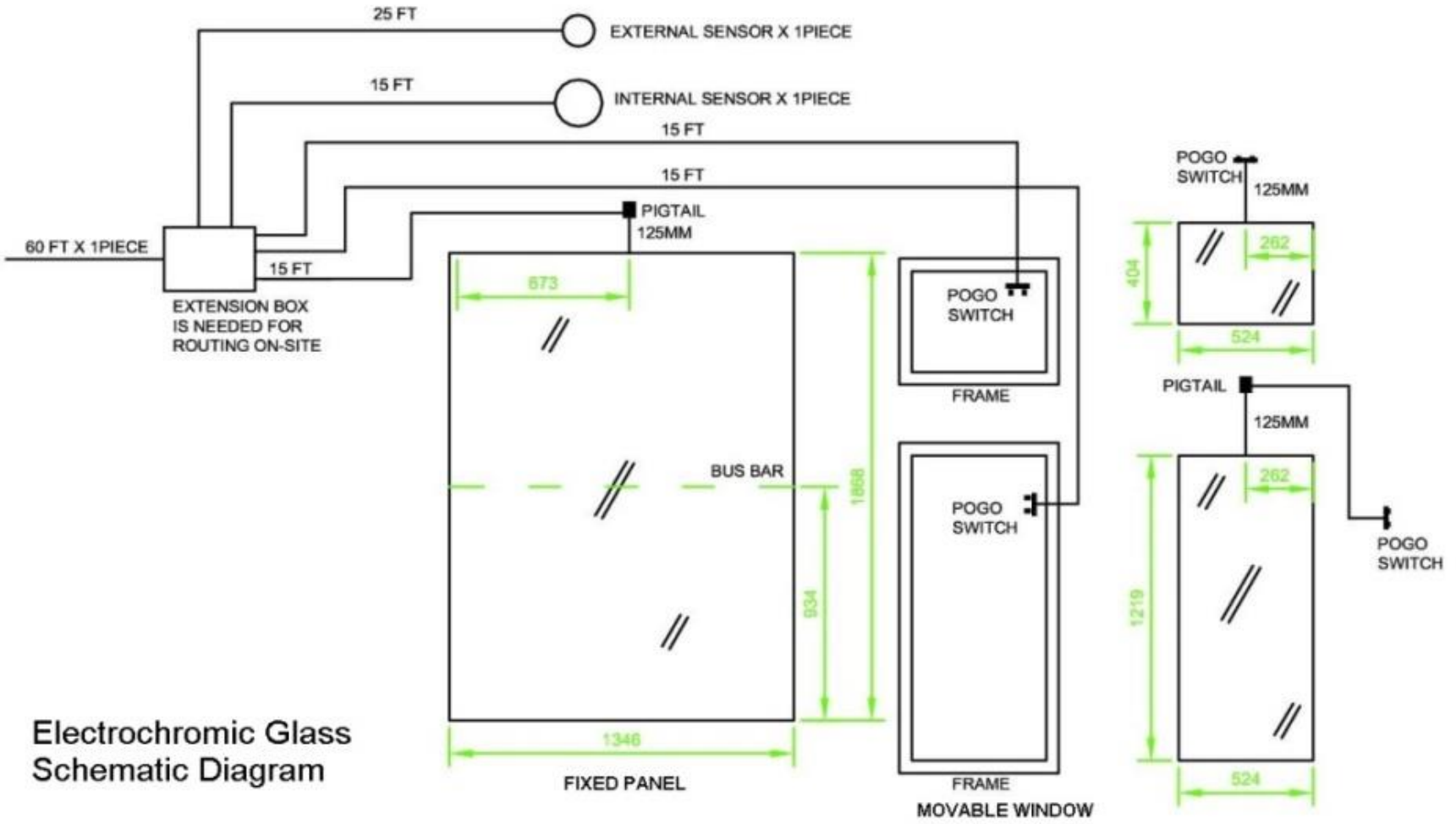
Electrochromic (EC)

Performance

Stage of Tinting	VLT	Solar Transmittance	UV Transmittance	U-Factor (Winter)	U-Factor (Summer)	SHGC
Clear	62%	38%	5%	0.29	0.28	0.47
Stage 1	21%	9%	3%	0.29	0.28	0.17
Stage 2	6%	2%	1%	0.29	0.28	0.11
Fully Tinted	2%	0.7%	0.5%	0.29	0.28	0.09

Electrochromic (EC)

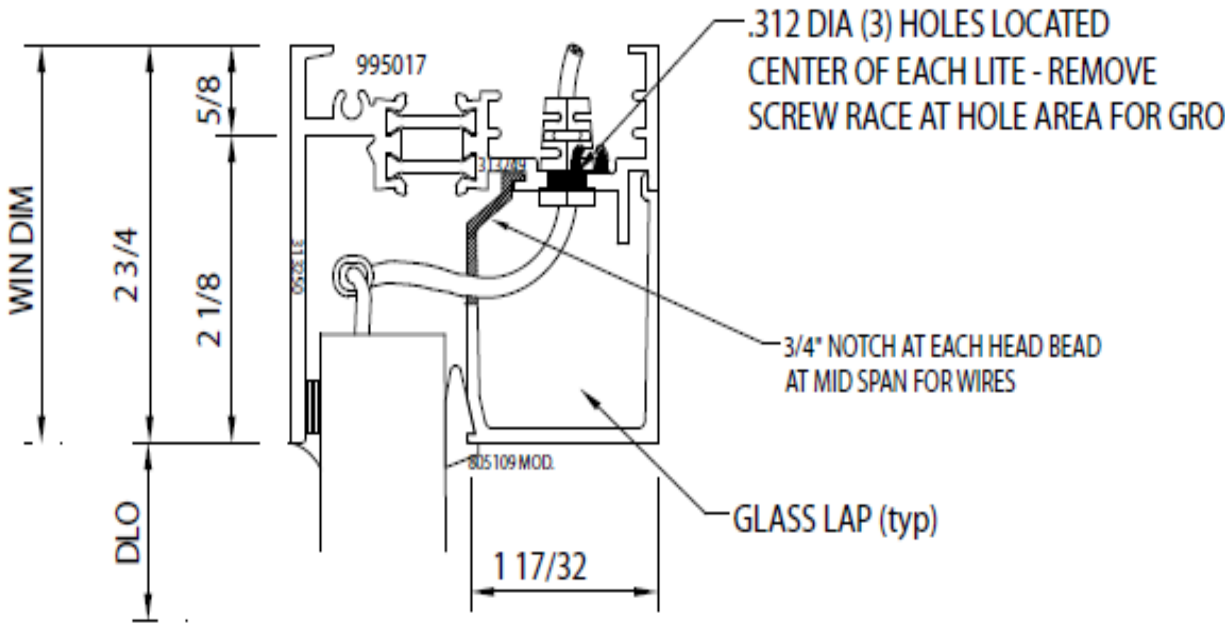
Control and Wiring

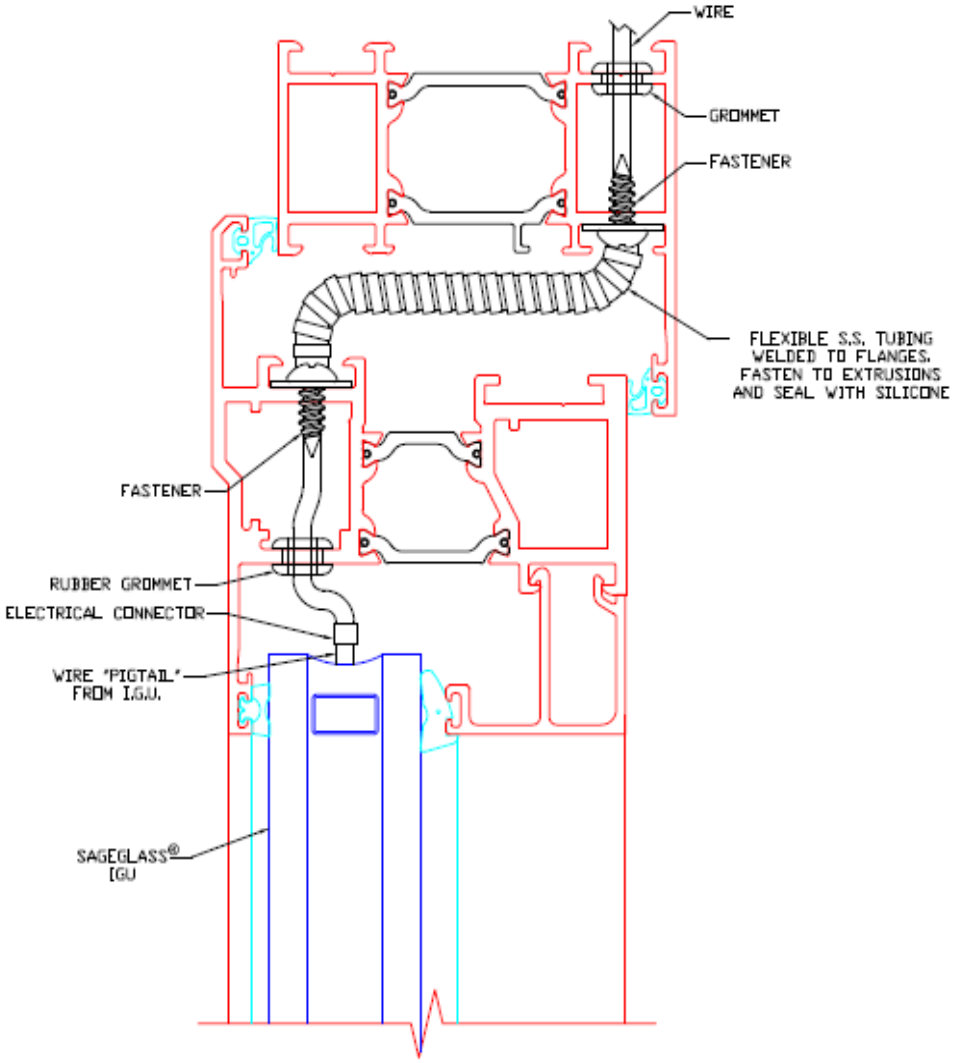


Electrochromic Glass
Schematic Diagram

Electrochromic (EC)

Wiring





Comparison

TC vs EC

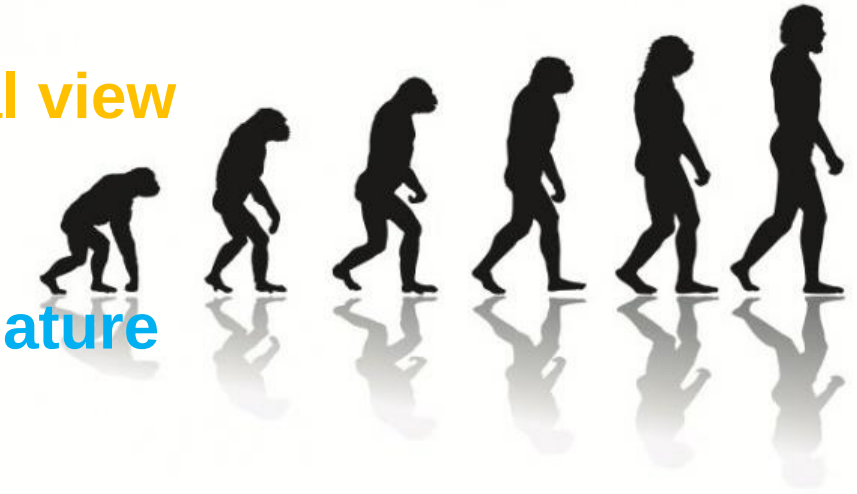
Description	Transmission Stages	Size Limitations	Shapes	Wiring (Installation)	~IGU Cost/ Sq. Ft.
Thermochromic					
Gradually changes from high light/heat transmission to low light/heat transmission when temperature is increased.	Infinite (Progressive)	64" Wide, No Height Limits	Yes	No	$$
Thermotropic					
Changes from clear to tinted with change in temperature from a defined set-point (e.g. 45°C or 50°C)	2 (Clear, Dark)	48" x 48" Only	No	No	$$$
Electrochromic					
Changes from high light/heat transmission to low light/heat transmission when electrical voltage is applied. Must "clear" and cycle through all 4 "states" every 8 hrs.	4 (Defined "states")	60" Wide x 120" High (Buss bars every 32")	Limited	Yes	$$$$

Both earns credits for LEED/Green Building Certification

Summary

Glass in building
Large panel + heat gain
Shade, blind, curtain
Always shut
Block the view & daylighting
Barrier between human and natural view
Health and productivity

Dynamic Glass
Reconnect human, daylighting and natural view
Good health and well being
Increase productivity
Re-think about & explore the treasure of nature
Back to basic and simplicity
Harmony of Nature
Thanks to God-given gift - Glass



Thank You

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