KNOWLEDGE SERIES

2019

nzeb

net zero energy buildings

USAID
FROM THE AMERICAN PEOPLE

GOVERNMENT OF INDIA
MINISTRY OF POWER

An initiative under

MAITREE

MARKET INTEGRATION AND TRANSFORMATION FOR ENERGY EFFICIENCY

maitree.edsglobal.com

eds environmental design solutions

Implementing Partner

8th August, 2019

GLAZING TECHNOLOGIES

SESSION MODERATOR

DEEPA PAREKH
Sr. Project Manager
Environmental Design Solutions

SESSION MODERATOR

DEEPA PAREKH
Sr. Project Manager
Environmental Design Solutions

EXPERT SPEAKER

VENUGOPAL. R
Manager – Design ACE, Saint Gobain
Glass Academy Trainer

BRIEF INTRODUCTION

Choice of glazing impacts the cooling energy use

Balance between light and heat gain is crucial for selecting the glazing

Understanding technical details is key to selecting the right glazing to achieve energy efficiency

High Performance Glazing Technologies

- Venugopal R

Glass, A Sustainable building material

Expectation vs Reality

THE VISION

REALITY

Here are some examples

Problem statement

CONVENTIONAL CLEAR GLASSES , is the most common interface in our building with the outside world.

India in the hot climate zone will face the two main problems that Conventional glasses will bring with them…

PROBLEM 1

EXCESSIVE LIGHT/GLARE

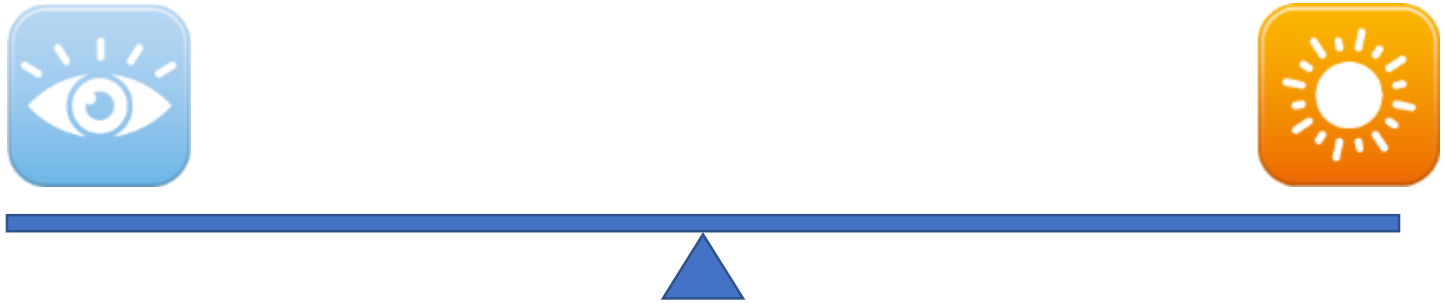
PROBLEM 2

EXCESSIVE HEAT GAIN

One

Solution

Solution - High Performance Glass- Strikes a balance between the Light and Heat needs for a comfortable living Space



- Glasses with improved selectivity- maintaining optimum heat & Light

Ratio of Light Transmission to Solar Gain & Higher value indicate high performance

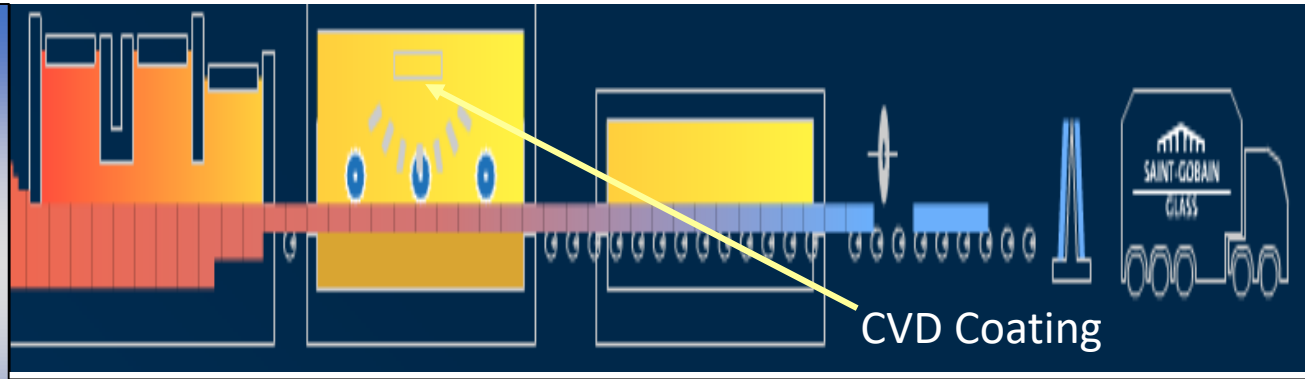
Spectral Selectivity (Light Heat Ratio) = Visual Light Transmission

SF/SHGC/'g'

Coating Technology

COATING TECNOLOGY

Online Coating

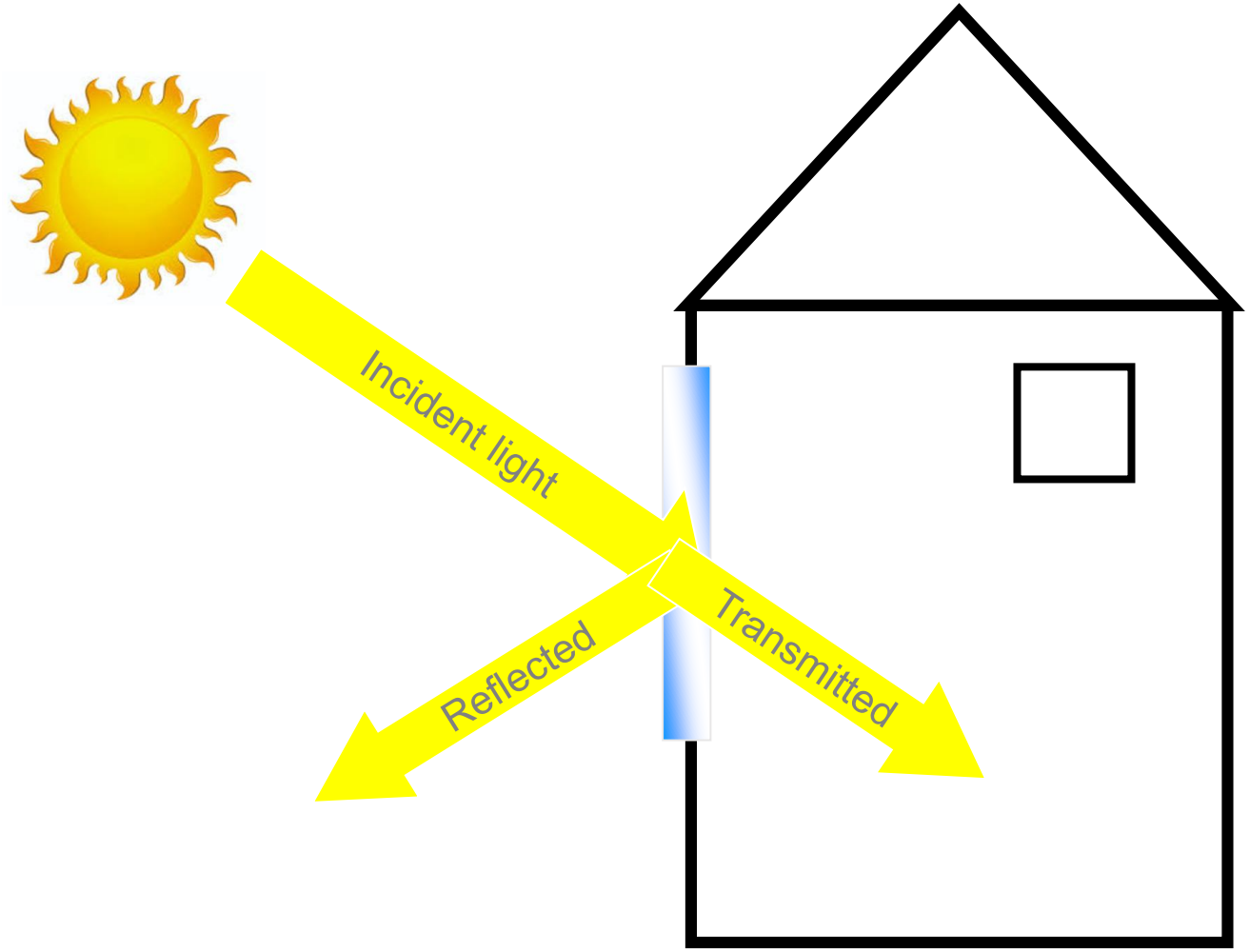


Manufactured during manufacturing of glass it self.
Process of manufacturing known as pyrolysis

Offline Coating

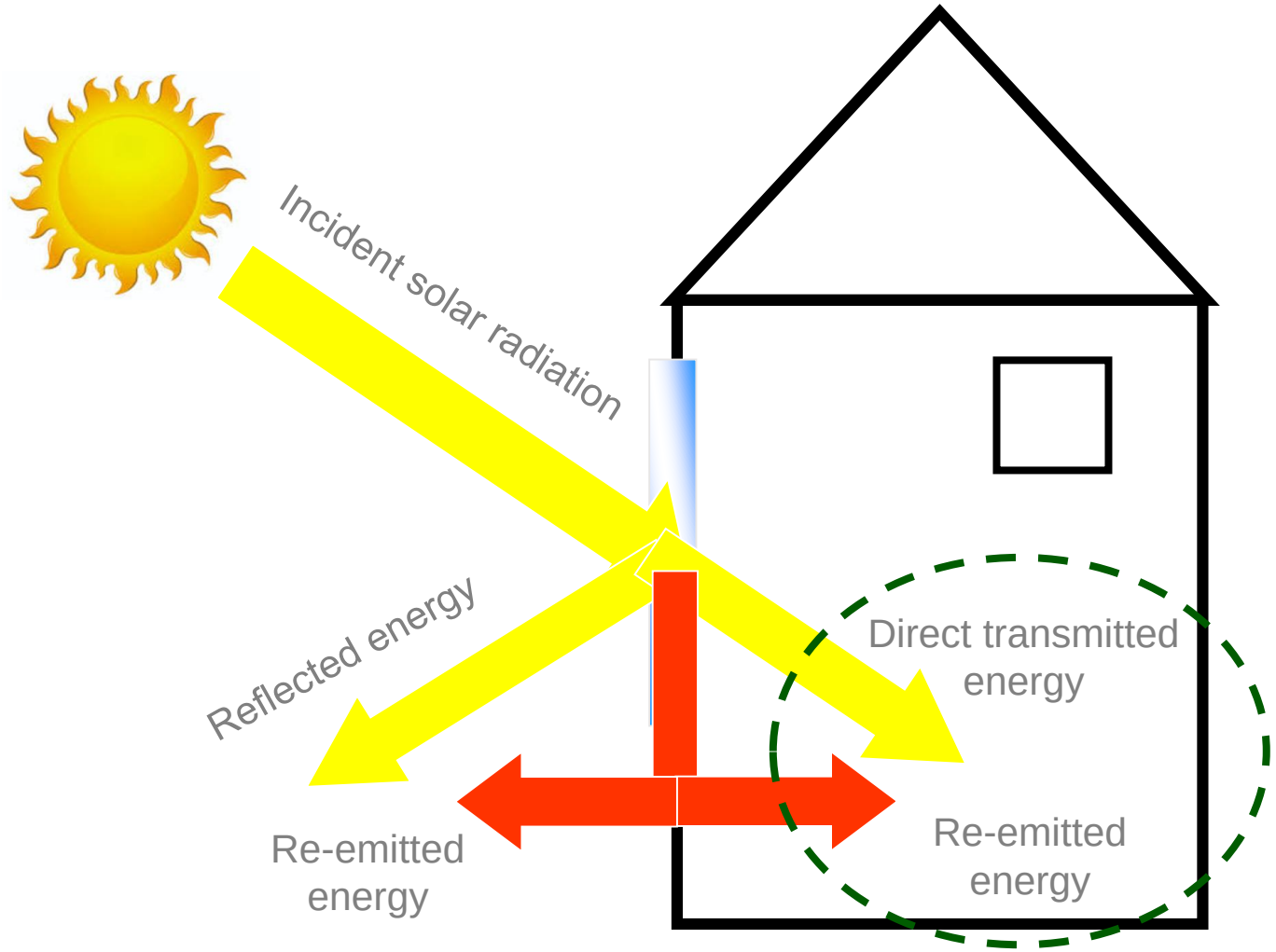
Manufactured in a separate process (offline) by
Magnetron sputtering on to raw glass

Visible light transmission



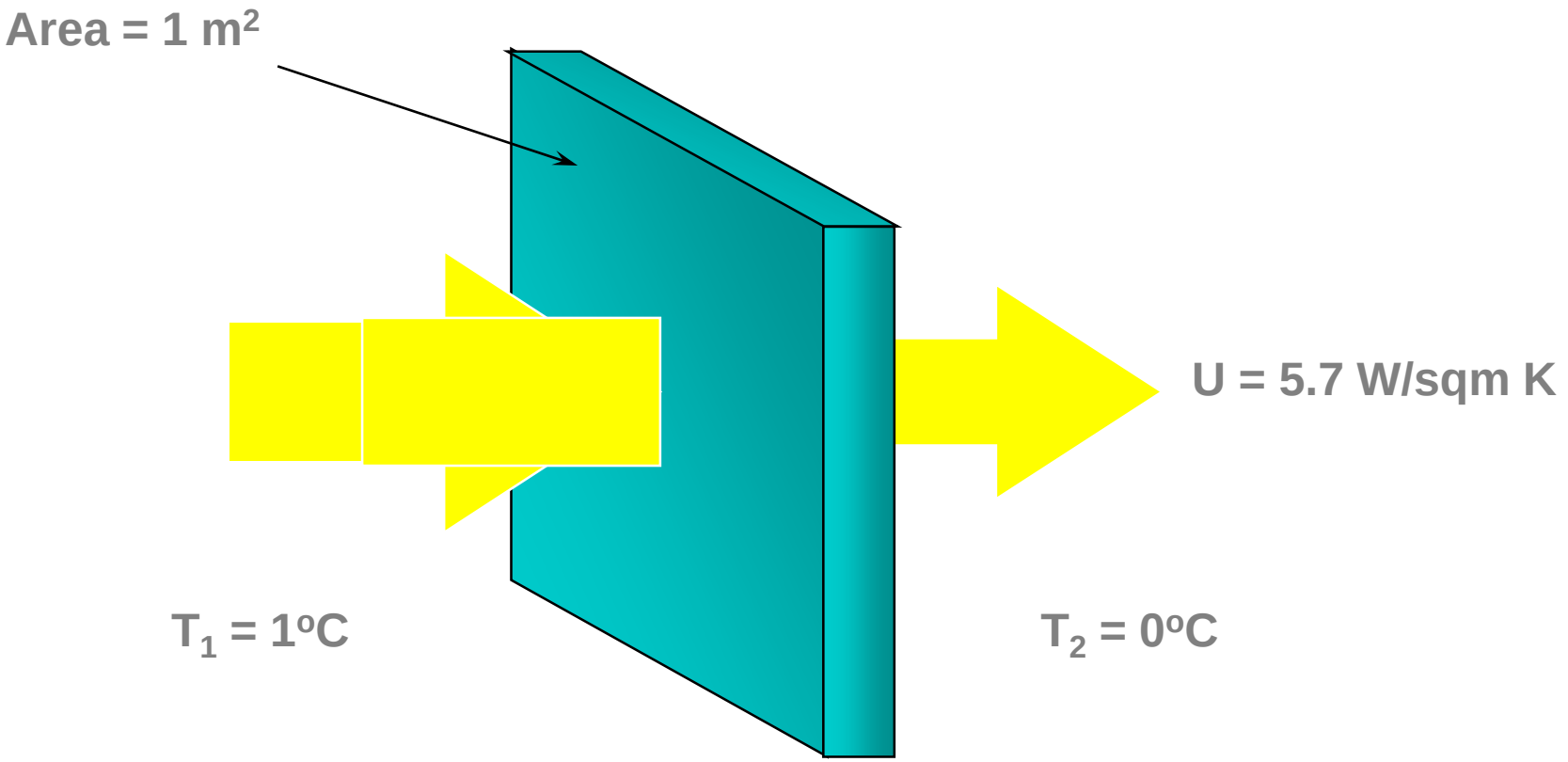
$$VLT = \frac{\text{Transmitted light}}{\text{Incident light}}$$

Heat gain – direct solar radiation



SF = Direct + re-emitted energy

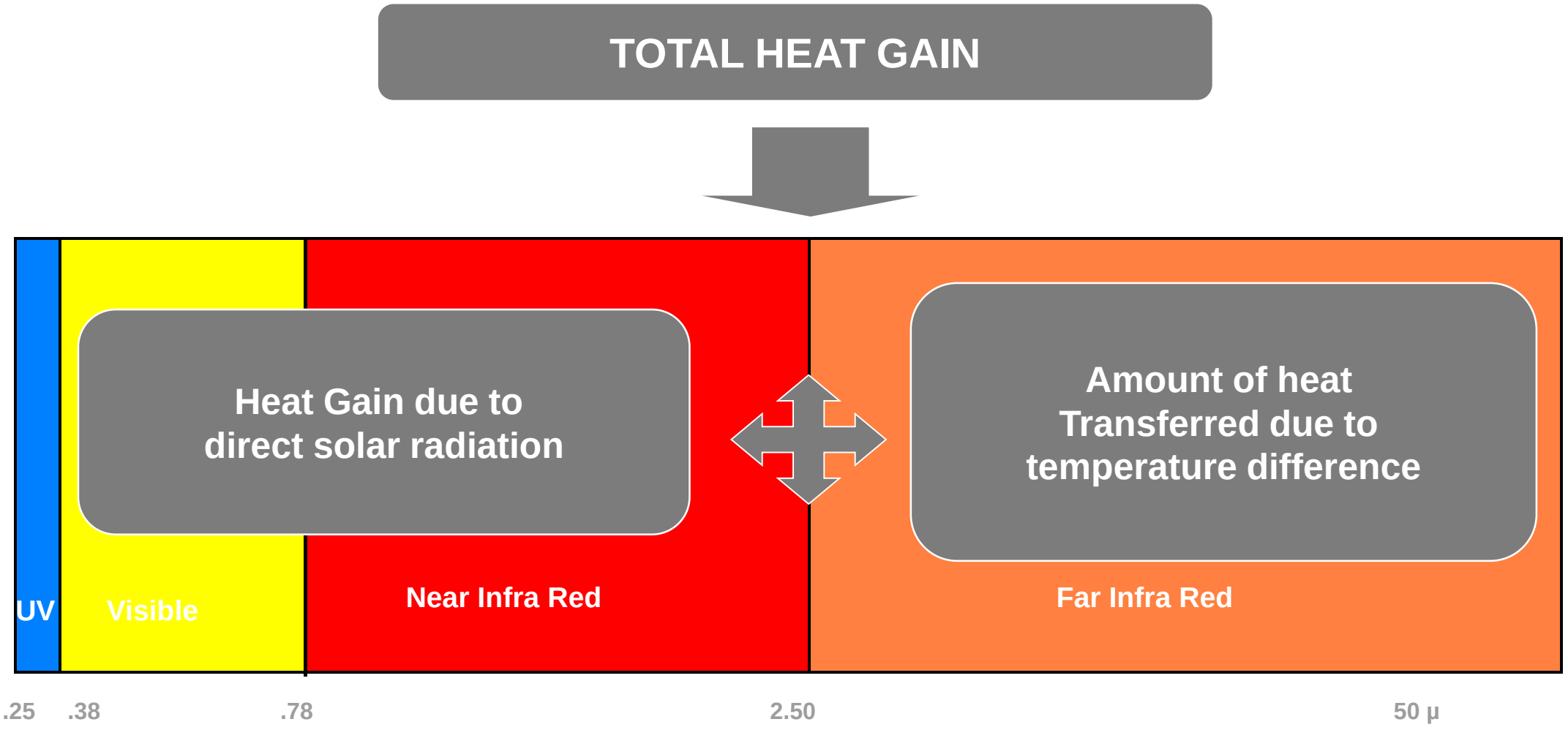
Heat gain – temperature difference



Amount of heat transferred due to temperature difference → **U Value**

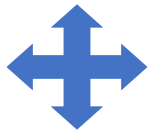
Total Heat gain

ELECTROMAGNETIC SPECTRUM AT TERRESTRIAL LEVEL



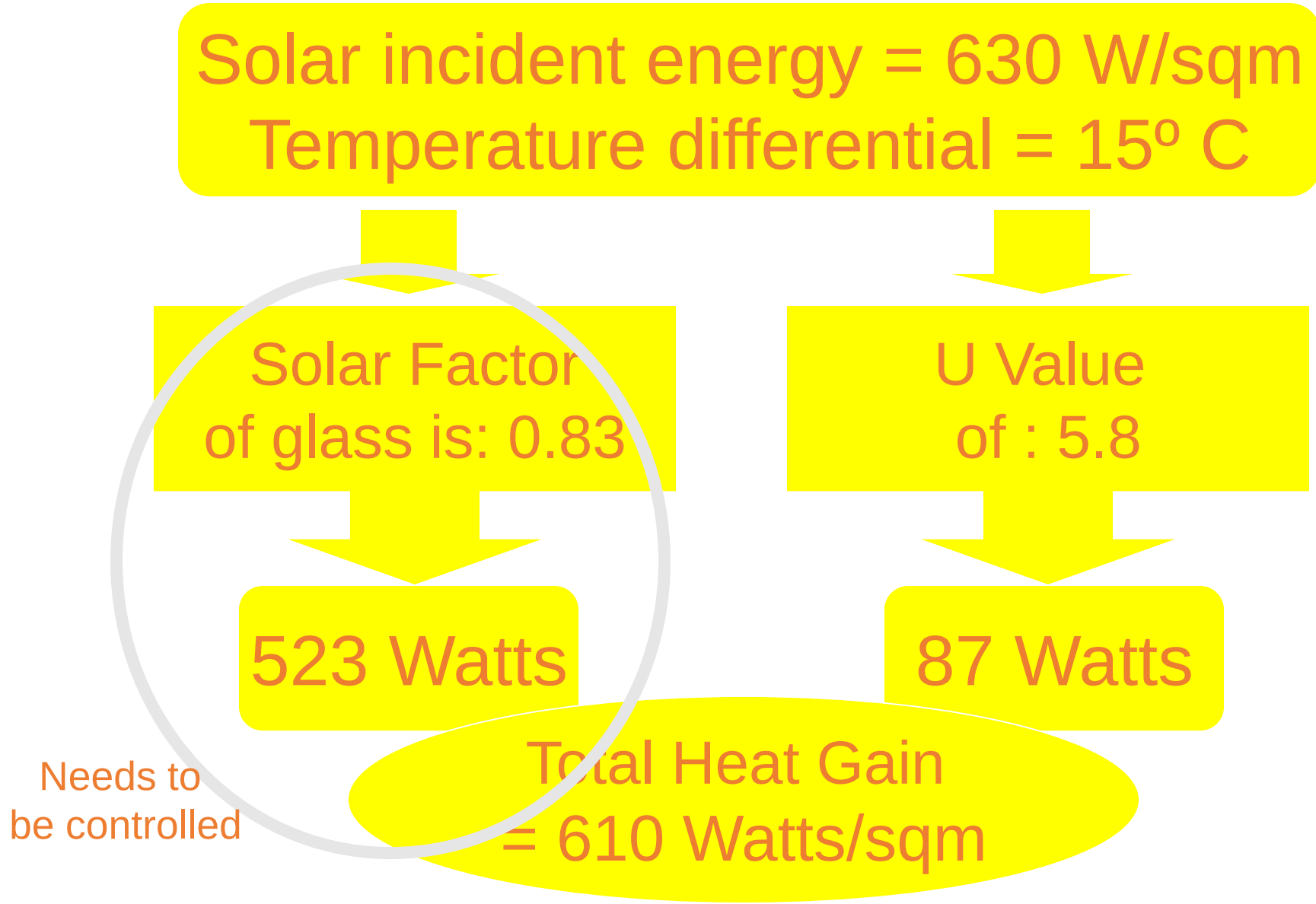
Relative Heat Gain

U Value (Summer) (W/sqm)
X
Temperature difference



Solar Factor
X
Amount of Solar Energy
Incident

Optimise Energy Performance



Energy Performance: Tropical Climate

Solar incident energy = 500 W/sqm

Temperature differential = 15° C

Clear Glass In DGU	Solar Factor: 0.73	365	407 W/sqm	
	U Value: 2.8 W/sqm K	42		
Low e In DGU	Solar Factor: 0.57	285	312 W/sqm	
	U Value: 1.8 W/sqm K	27		
Hard Coat Solar Control In DGU	Solar Factor: 0.34	170	212 W/sqm	
	U Value: 2.8 W/sqm K	42		
High Performance Coated Glass In DGU	Solar Factor: 0.18	90	114 W/sqm	
	U Value: 1.6 W/sqm K	24		
ECBC	Solar Factor: 0.25	125	173 W/sqm	
	U Value: 3.2 W/sqm K	48		

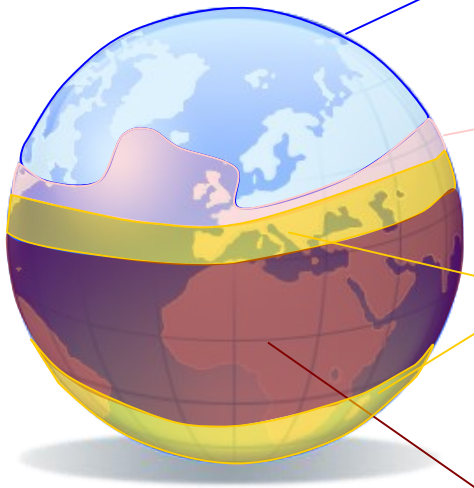
SPECTRAL SELECTIVITY

Ratio of light transmission to solar gain & higher value indicate high performance

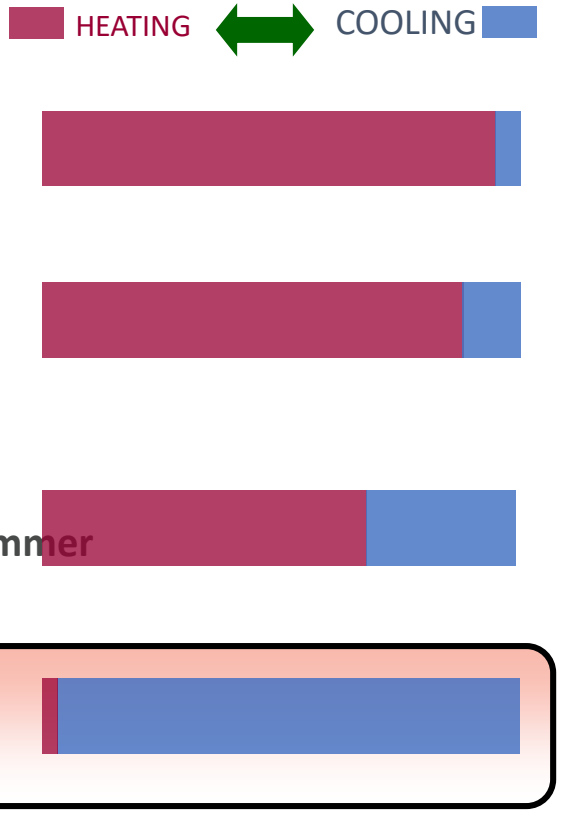
Spectral Selectivity (Light Heat Ratio) = $\frac{\text{Visual Light Transmission}}{\text{SF/SHGC/'G'}}$

Brand	Light Transmission	SF/SHGC/G	Spectral Selectivity
Online Coated – Solar	30%	46%	0.65
Offline Coated – Solar	46%	46%	1.00
Offline Coated – Solar + Thermal (Single Silver)	47%	36%	1.30
Offline Coated – Solar + Thermal (Double Silver)	60%	32%	1.87
Offline Coated – Solar + Thermal (Triple Silver)	60%	28%	2.14

Location specific needs



- **COLD CLIMATE**
  - Focused on thermal insulation
- **INTERMEDIATE CLIMATE**
  - Driven by energy balance
- **WARM CLIMATE**
  - Balancing between insulation and summer comfort
- **HOT CLIMATE**
  - Focused on low solar heat gain

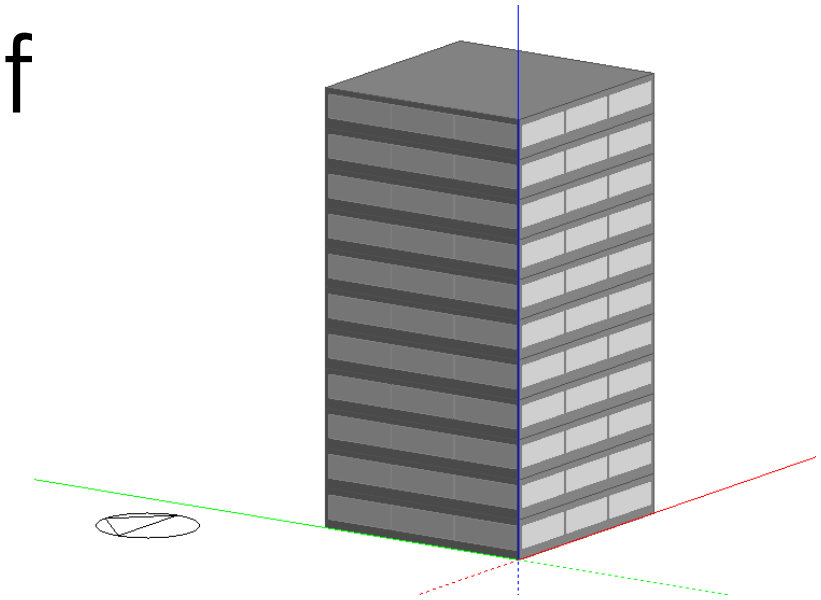


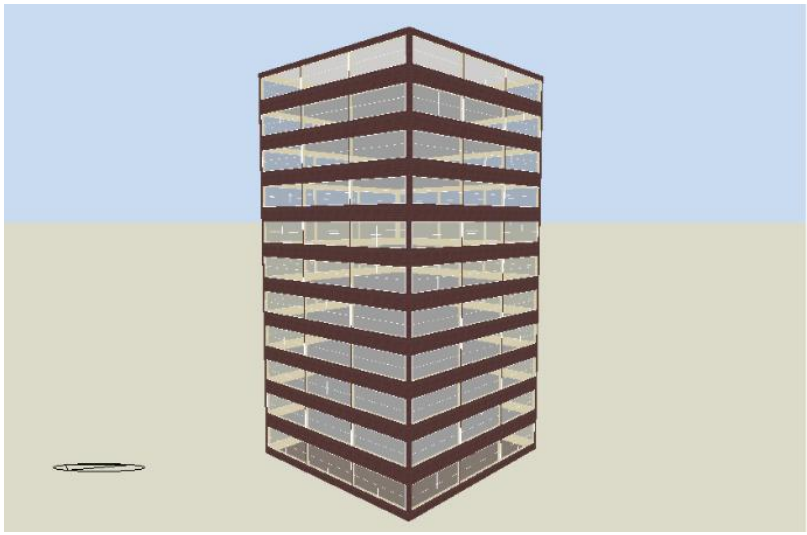
IMPACT OF SHGC AND VLT ON THE BUILDING

ENERGY simulation with an off

- Building Under study: G+10
- Glass Area: 188260 sqft.

Assumption Points		Value	Units
Activity	Cooling setpoints	24.4	°C
	Cooling Setback	26.6	°C
	Occupant Density	0.01	ppl/sqft
Lighting	Target illuminamce	280	lux
	Normalised power density	0.05	W/sqft.ft.candela
	Control Type	Linear	
Construction	Wall U-Value	0.3472	W/m2.K
	Roof U-value	0.2464	W/m2.K
	WWR	60%	-
HVAC	Cooling COP	3.5	-
Weather file	IND_CHENNAI_IWEC	-	-
Template	Activity	Ashrae 90.1 Occupancy - Office	



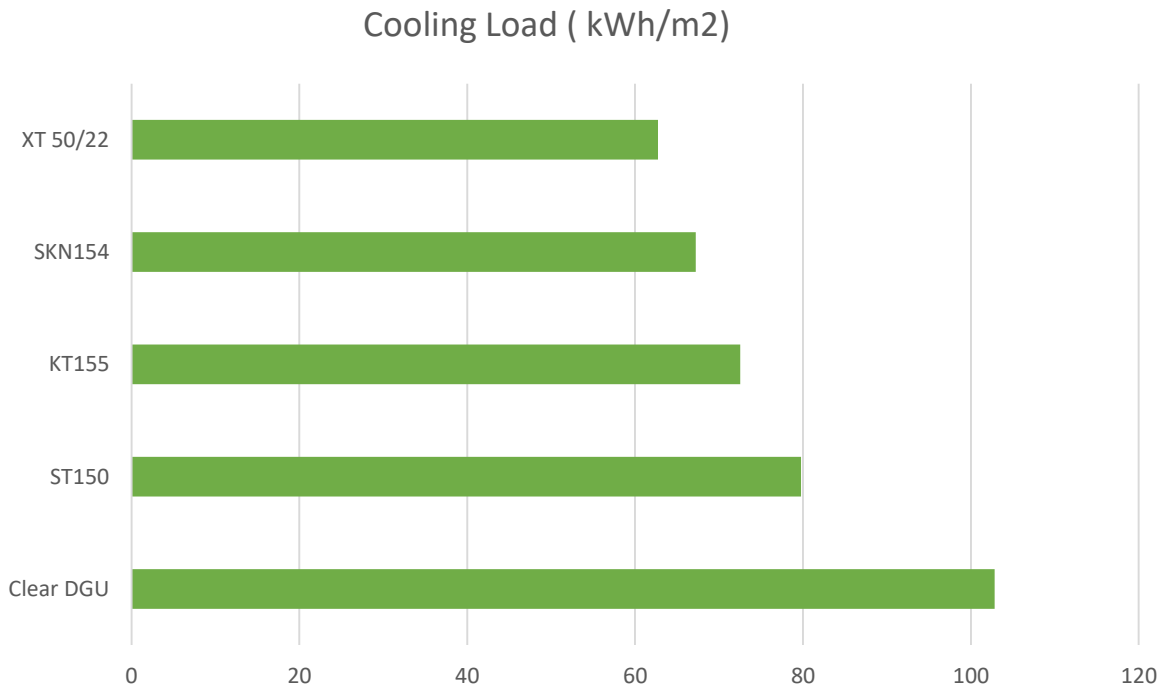


Glass options considered for analysis

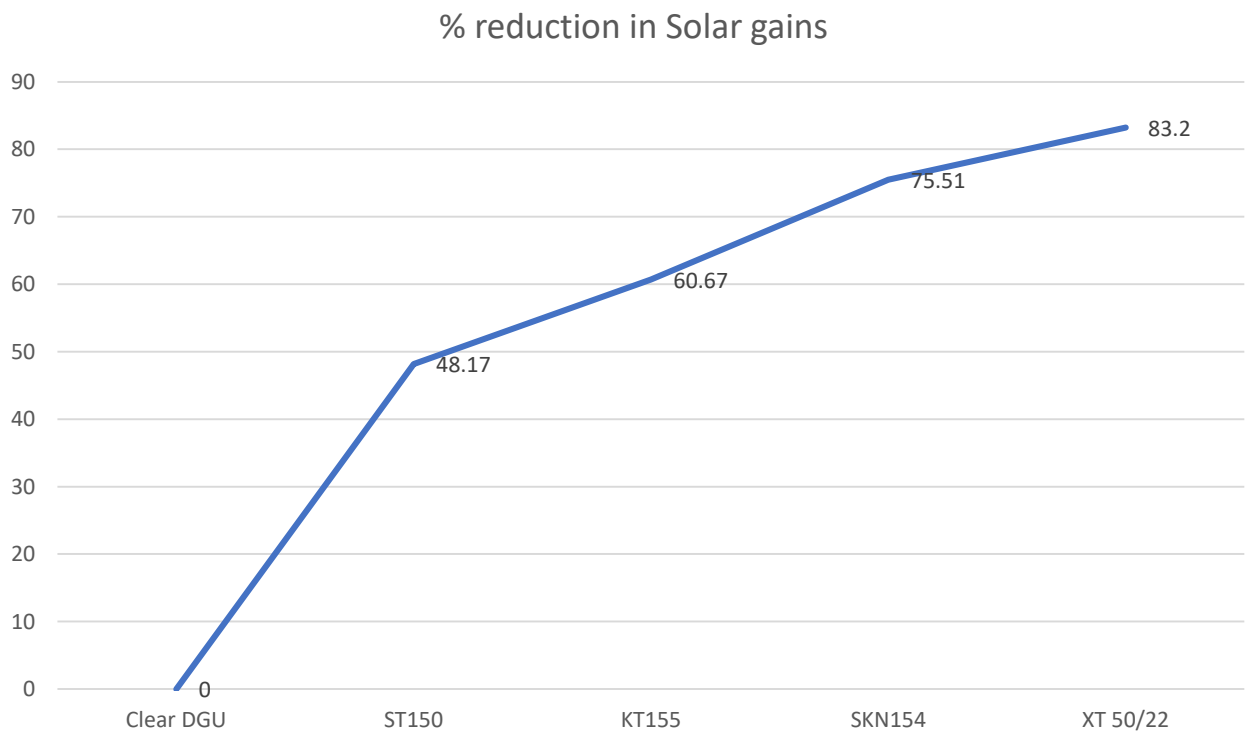
Products	Combination	VLT (%)	External reflection (%)	Internal reflection (%)	SF	SC	U Value (W/m2-K)
Clear DGU	6+12+6	80	15	15	0.76	0.87	2.8
ST150	6+12+6	46.2	20.2	21.8	0.47	0.54	2.79
KT155	6+12+6	47.1	17	10.5	0.38	0.43	1.88
SKN154	6+12+6	50.1	18	26	0.28	0.32	1.54
XT 50/22	6+12+6	46.6	16	17.7	0.22	0.25	1.54

Energy Consumption for various glazing

Glass options	Cooling Load (kWh/m2)	%Redn. In Total Load
Clear DGU	102.85	<BASE>
ST150	79.76	22.4
KT155	72.51	29.52
SKN154	67.22	34.65
XT 50/22	62.71	39.03



Solar Gain reduction for various glazing



- It can be noted that there is a significant reduction in Solar gain as the selectivity of products increases.

Product	Solar Gain (kWh/m2)	%redn
Clear DGU	187.93	0
ST150	97.39	48.17
KT155	73.91	60.67
SKN154	46.01	75.51
XT 50/22	31.56	83.2

REQUIREMENTS FROM GREEN BUILDING RATING STANDARDS

8.1.2: Peak heat gain through building envelope (for each AC building individually) should meet the GRIHA Building Envelope Peak Heat Gain Factor thresholds – **2 points**

GRIHA Thresholds for Building Envelope Peak Heat Gain Factor (W/sqm)	
Climate	Threshold
Composite/Hot & Dry	40
Warm and Humid	35
Moderate	30

8.1.3: Demonstrate that 100% of outdoor lighting fixtures (lamps + lamp housing) meet the luminous efficacy requirements of GRIHA – **1 point**

- All lamps + lamp housing must demonstrate luminous efficacy of at least 75 lumens/watt.

8.1.4: Demonstrate (through simulations) that project EPI is below GRIHA benchmark[8] - Mandatory

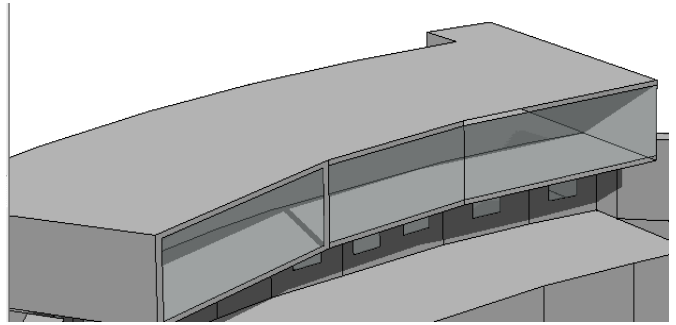
8.1.5: Additional reduction in EPI will be awarded points as mentioned below:

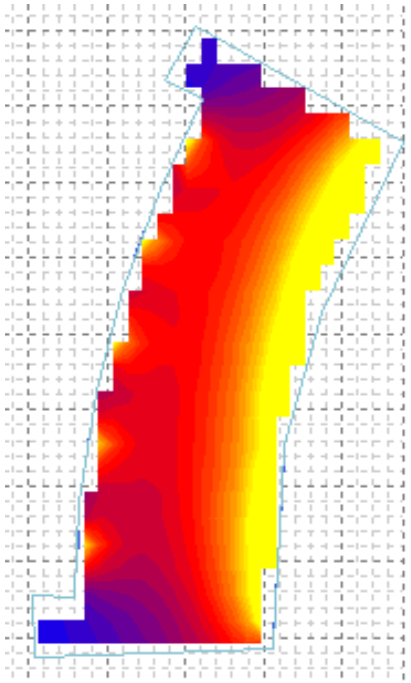
Reduction from EPI benchmark	Points
10%	2
20%	3
30%	5
40%	7
50%	10

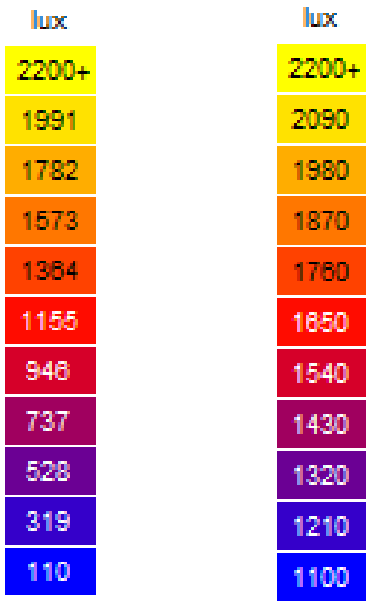
Energy Performance Index Benchmarks (EPI) – (kWh/ m²/year)		
Climate Classification	Day time occupancy	24 hours Occupancy
	5 Days a week	7 Days a week
Commercial/Institutional/Academic/Hospital buildings		
Moderate	75	225
Composite / Warm and humid / hot and dry	90	300
Residential buildings/Hostels		
Moderate	50	
Composite / Warm and humid / hot and dry	70	

VISUAL COMFORT – CASE STUDY

Case 1: VLT of 60%





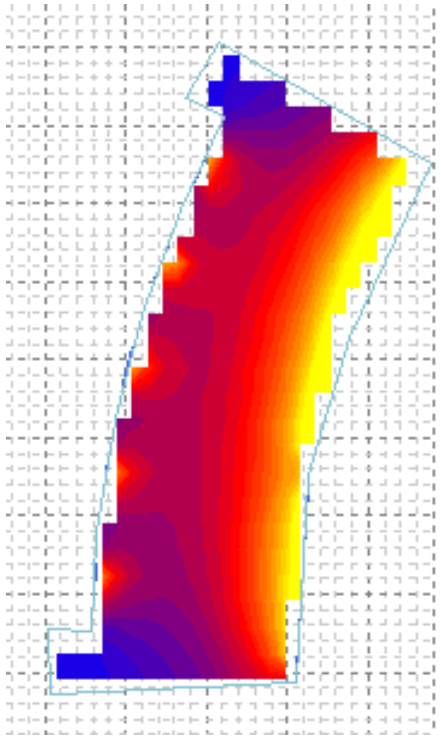


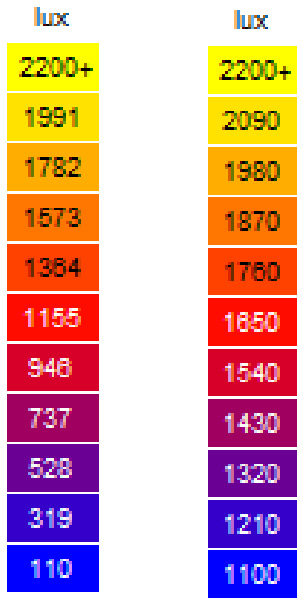
Floor area with lux levels> 110 Lux = 100%

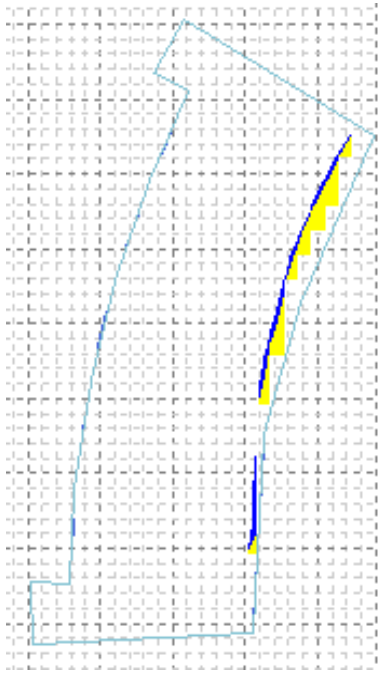
Floor area with lux levels> 2200 Lux = 16%

Average Lux level = 1693 Lux

Case 2: VLT of 50%





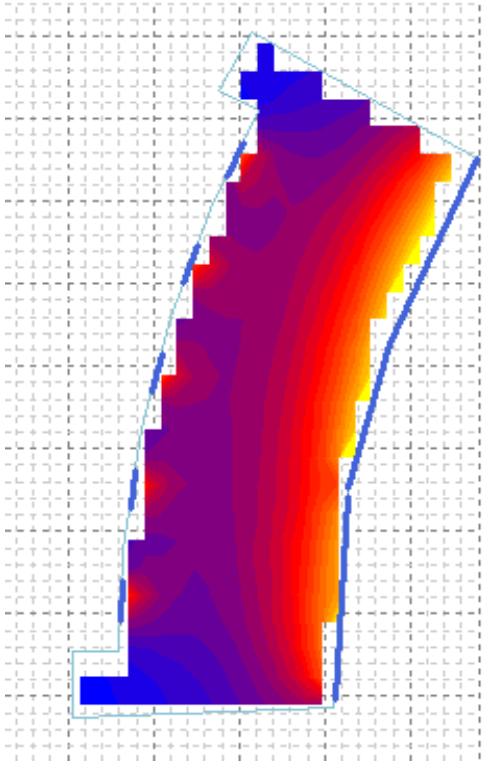


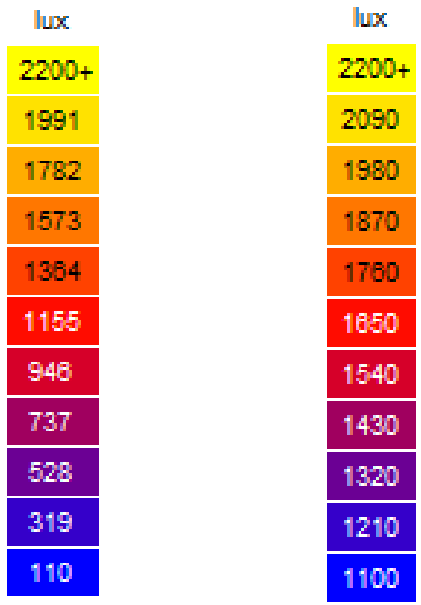
Floor area with lux levels> 110 Lux

Floor area with lux levels> 2200 Lux = 8.3%

Average Lux level = 1353 Lux

Case 3: VLT of 40%



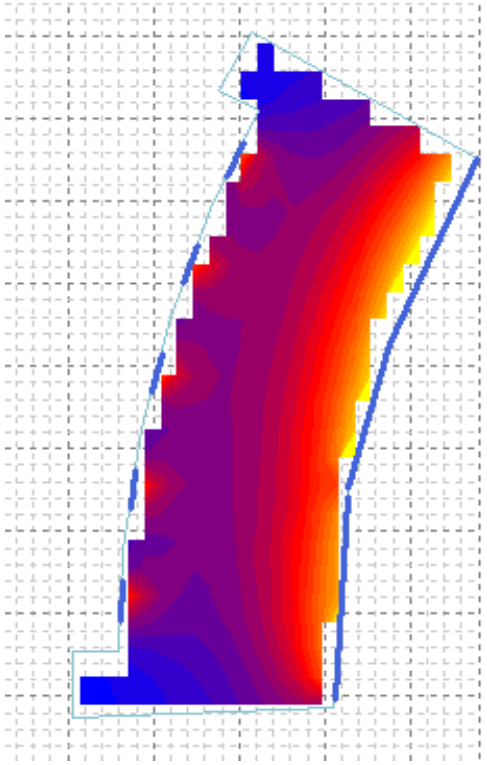


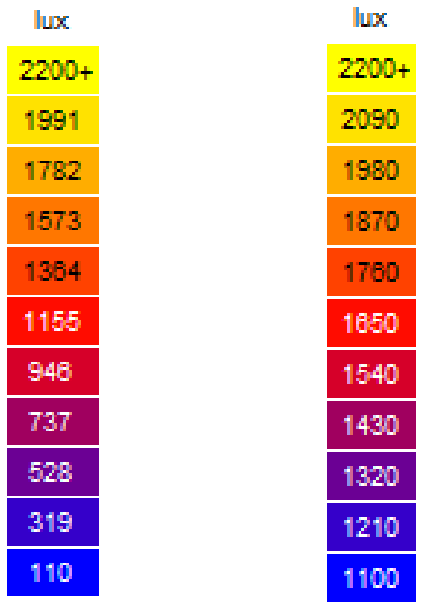
Floor area with lux levels> 110 Lux

Floor area with lux levels> 2200 Lux = 2.1%

Average Lux level = 1043 Lux

Case 4: VLT of 30%



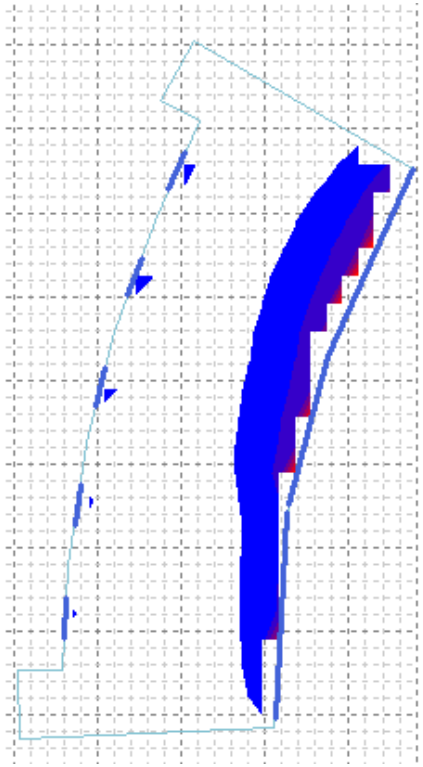


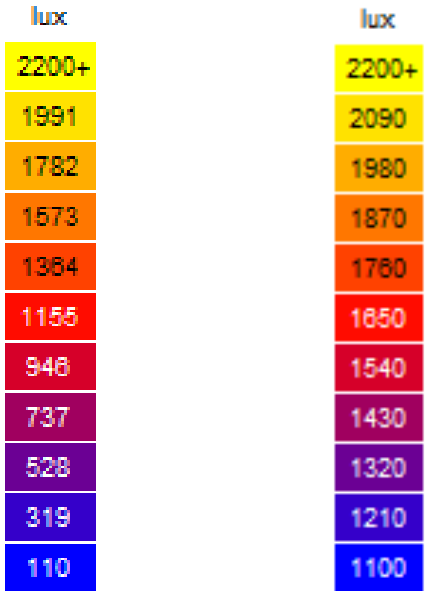
Floor area with lux levels> 110 Lux

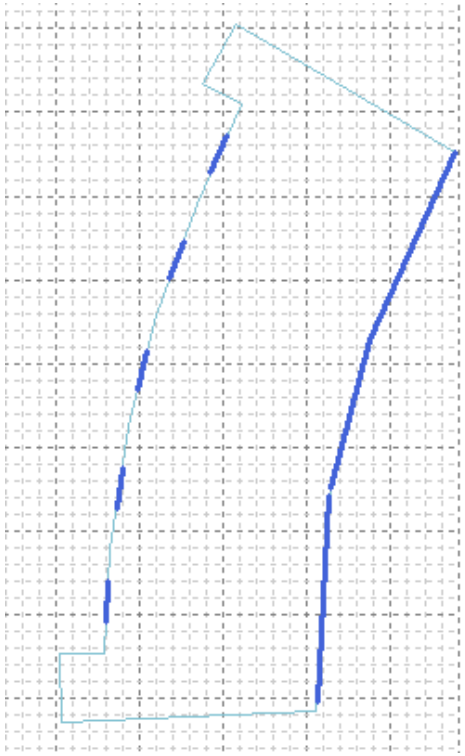
Floor area with lux levels> 2200 Lux=1.8%

Average Lux level = 746 Lux

Case 5: VLT of 20%







Floor area with lux levels> 110 Lux

Floor area with lux levels> 2200 Lux=0%

Average Lux level = 102Lux

Note: Daylight simulation was done on a typical floor plate with the time set as 21st September, 12 noon.

RESULTS OF ANALYSIS

CASE	1	2	3	4	5
VLT (%) Vs % Area	60%	50%	40%	30%	20%
>110 Lux	100%	100%	100%	100%	27%
>300 Lux	98.5%	96.3%	94.2%	89.9%	3.7%
>550 Lux	92.3%	89.6%	83.1%	48.3%	2.1%
>1100 Lux	64.1%	38.7%	24.8%	10%	0%
>2200 Lux	16%	8.3%	2.1%	1.8%	0%
Average Lux level	1693	1355	1043	746	102

DAYLIGHTING - METRICS

1.Point In Time metrics
2. Annual metrics / CBDM

Point In Time Metrics:

- Point in Time Illuminance -> Lux level inside the room at a particular point in time
- Daylight Factor – Illuminance in the room as a factor of ambient lux level

Annual Metrics:

- Daylight Autonomy(DA) – How much % Floor area is above a particular lux level for a particular % of time in the year
- Useful Daylight Index(UDI) – Annual metric(Like DA) with upper and lower limit
- Annual Solar Exposure(ASE)

Annual Metrics:

-> Lux level / Threshold(300, 3000, 1000 lux etc)

->No. of hours – 50% occupied hours, 10% occupied hours, 260 hours etc

-> % of floor area

REQUIREMENTS FROM GREEN BUILDING RATING STANDARDS

Alternative 1	Alternative 2
The WWR and SRR to not exceed 60% & 5% respectively &; All the fenestrations meet the SHGC requirement of ECBC-2007/Weighted Façade average SHGC (for each orientation) meets SHGC requirements of ECBC-2007 OR; Alternatively use Tables 9 & 10 of SP 41 to design the shading device for the windows. OR; Conduct solar path analysis for windows of AC as well as non-AC spaces, to ensure that the window is completely shaded for the duration between 10:00 am on 1st April to 15:00 on 30th September OR; Any combination of the above strategies on 100% of the fenestrations – Mandatory	• Demonstrate that the mean DA requirements (300* lux or more) are met over the total living area for at least 25% of total annual analysis hours (area-weighted) – Mandatory • Demonstrate that the mean DA requirements (3000 lux or more) are never exceeded over the total living area for across the total annual analysis hours – Mandatory • Demonstrate that the mean DA requirements (300* lux or more) are met over the total living area for at least 50%/75% of total annual analysis hours (area-weighted) – 2/4 points *annual analysis hours – 800 to 1800 each day*
• Minimum of 25% of the living area should meet adequate level of daylight (daylight factors) as prescribed in SP 41 – Mandatory • If the adequate daylight factors are achieved in more than 50%/75% of total living area - 2 /4 points	

GRIHA CRITERIA 11

REQUIREMENTS FROM GREEN BUILDING RATING STANDARDS

Requirements

Provide manual or automatic (with manual override) glare-control devices for all regularly occupied spaces.

Select one of the following three options.

Option 1. Simulation: Spatial Daylight Autonomy (2–3 points, 1-2 points Healthcare)

Demonstrate through annual computer simulations that spatial daylight autonomy$_{300/50\%}$ (sDA$_{300/50\%}$) of at least 55%, 75%, or 90% is achieved. Use regularly occupied floor area. Healthcare projects should use the perimeter area determined under EQ Credit Quality Views. Points are awarded according to Table 1.

Table 1. Points for daylit floor area: Spatial daylight autonomy

New Construction, Core and Shell, Schools, Retail, Data Centers, Warehouses & Distribution Centers, CI, Hospitality		Healthcare	
sDA (for regularly occupied floor area)	Points	sDA (for perimeter floor area)	Points
55%	2	75%	1
75%	3	90%	2

AND

Demonstrate through annual computer simulations that annual sunlight exposure$_{1000,250}$ (ASE$_{1000,250}$) of no more than 10% is achieved. Use the regularly occupied floor area that is daylit per the sDA$_{300/50\%}$ simulations.

LEED v4 IEQ CRITERIA Option 1

ECBC Recommendations

Table 4-10 Vertical Fenestration Assembly U-factor and SHGC Requirements for ECBC Buildings

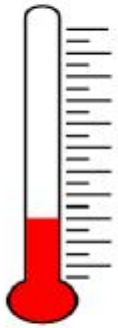
	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor (W/m².K)	3.00	3.00	3.00	3.00	3.00
Maximum SHGC Non-North	0.27	0.27	0.27	0.27	0.62
Maximum SHGC North for latitude ≥ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.27	0.27	0.27	0.27	0.62
See Appendix A for default values of unrated fenestration					

Table 4-11 Vertical Fenestration U-factor and SHGC Requirements for ECBC+ buildings and SuperECBC buildings

	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor (W/m².K)	2.20	2.20	2.20	3.00	1.80
Maximum SHGC Non-North	0.25	0.25	0.25	0.25	0.62
Maximum SHGC North for latitude ≥ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.25	0.25	0.25	0.25	0.62

Glass contribution in Sustainable Buildings

Visual Comfort



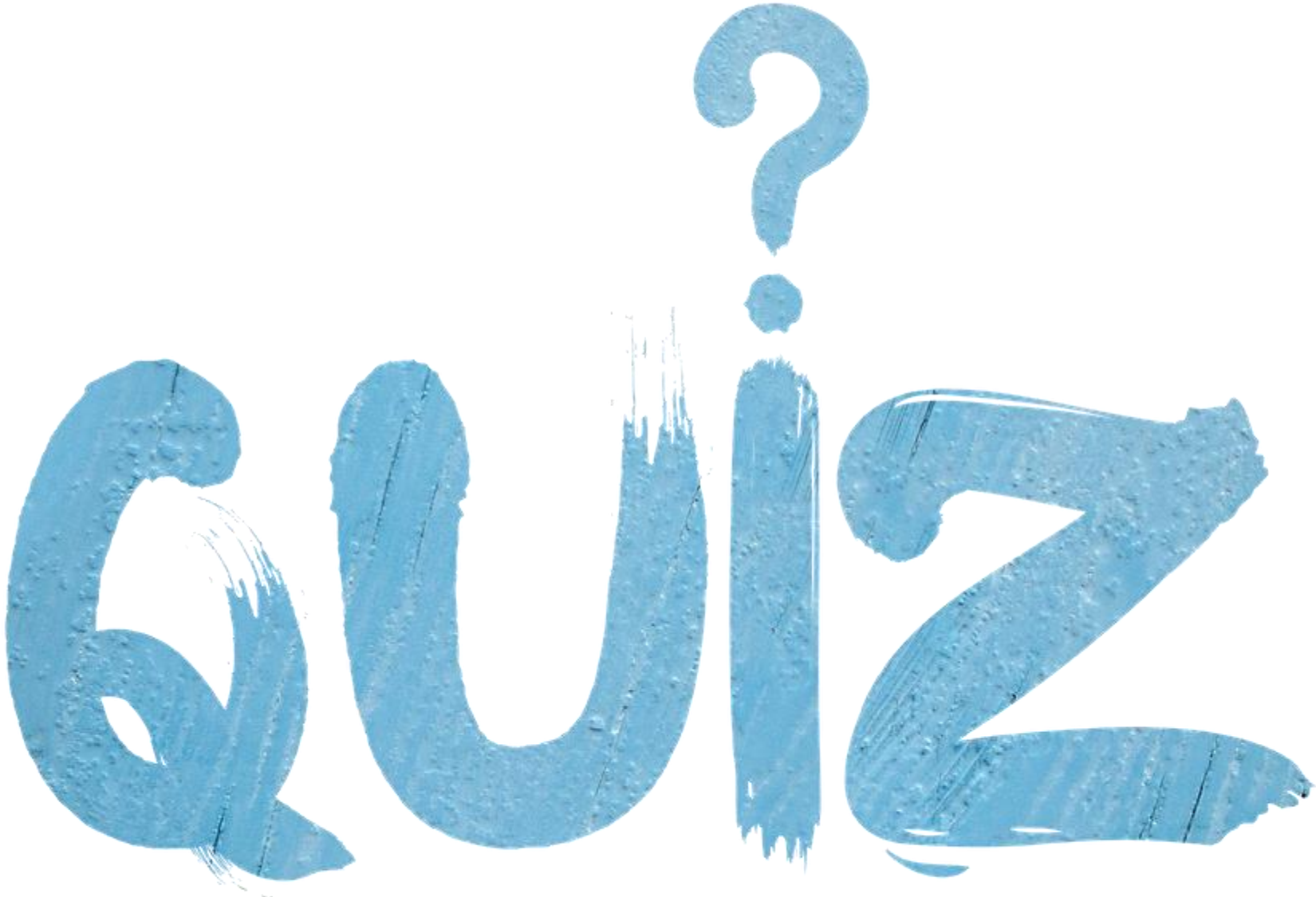
Thermal Comfort

Energy Savings

Acoustics

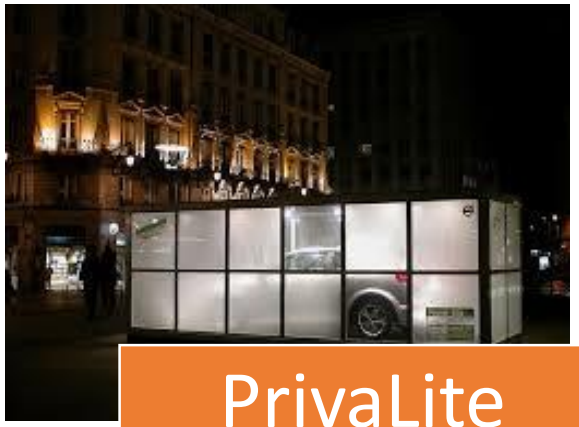
UV protection

Aesthetics


QUIZ

Advanced Technologies

- Innovations in Glass



PrivaLite

PICTURE IT.

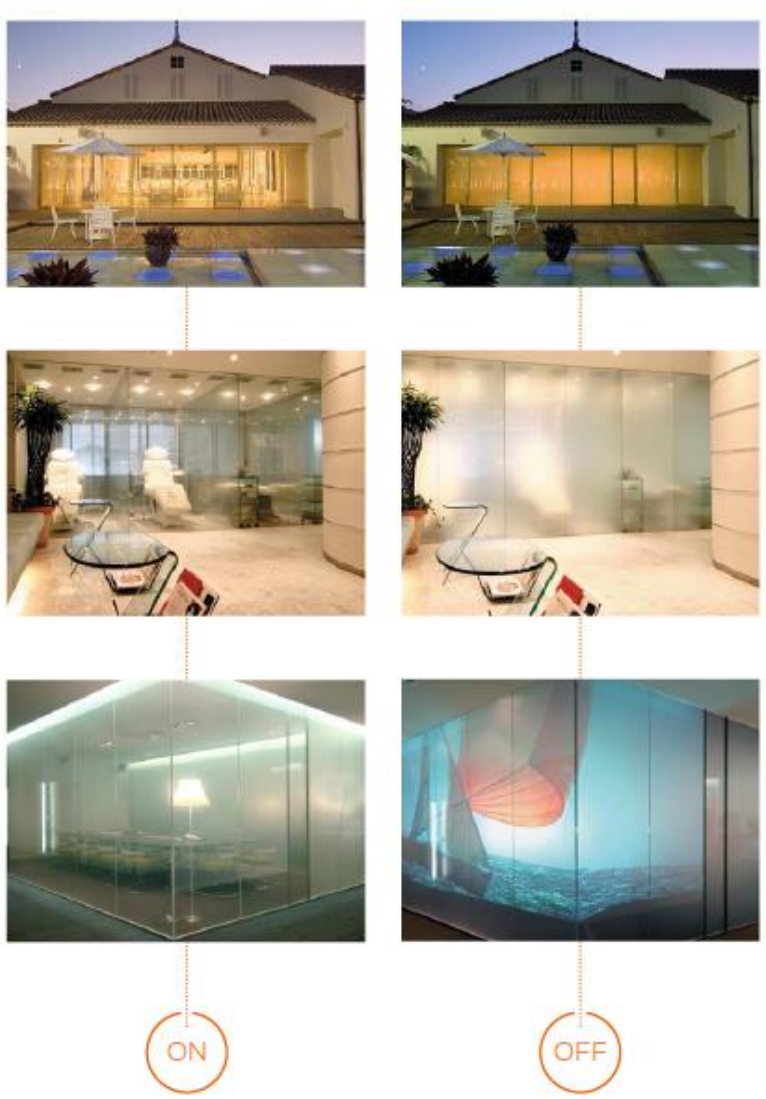
PictureIT

SageGlass®

SageGlass

Priva–lite classic & XL

- Comfort/privacy/design



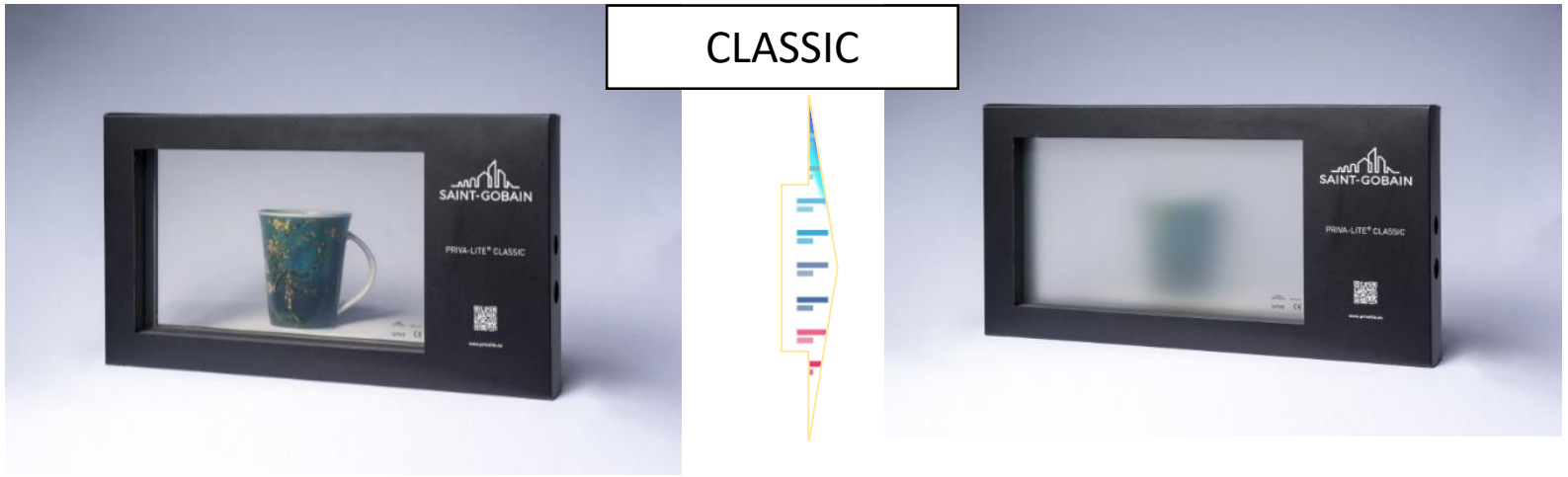
PRIVA-LITE
Modern and sophisticated solutions for buildings.

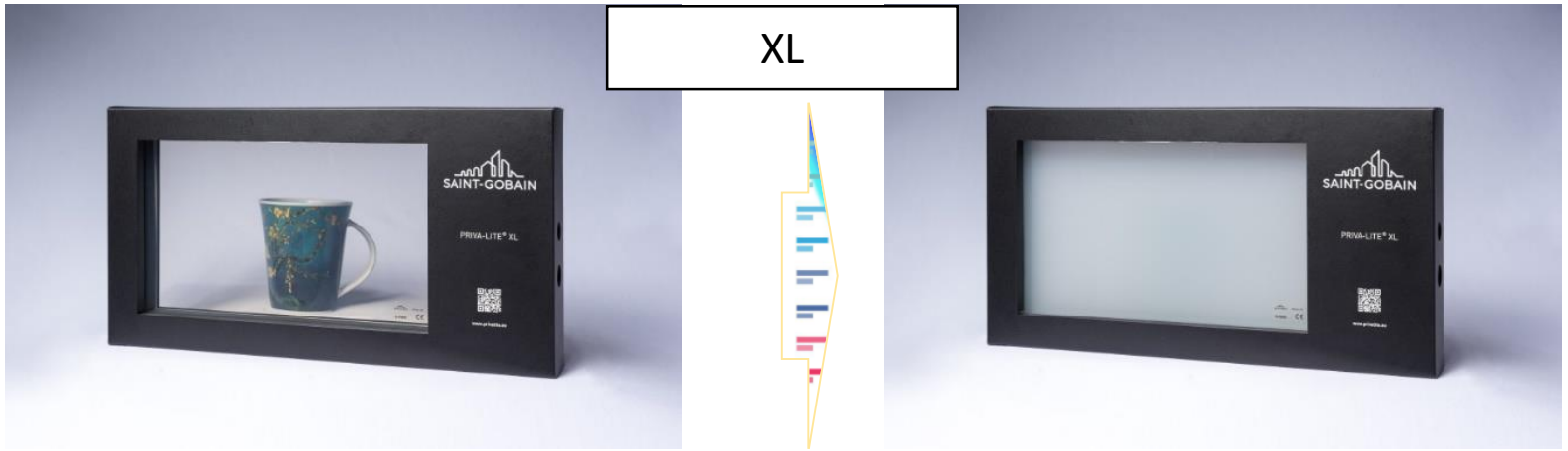
PRIVA-LITE
Offering privacy, light, aacoustics and safety.

PRIVA-LITE
Support for communication with back projection possibility (OFF mode)

Priva–lite classic & XL

- Comfort/privacy/design



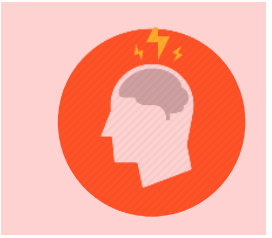


Possibilities ??

Projection Screens

Lobbies, Facades, Windows

Partitions



PRIVA - LITE CLASSIC & XL
COMFORT / PRIVACY / DESIGN

Priva–lite colour


Bahama Yellow


Coral Sea


Sunset Red


Olive Green


Sapphire Sky


Twilight


Morning Rose


Ocean Grey


Bluish Violet


Emerald Stone


Orange Tree


Aqua Marine

Full range of 12 modern & fashionable colors

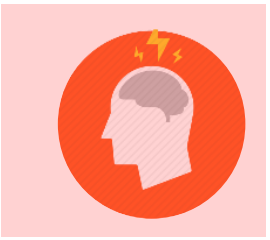
PRIVA - LITE COLOR
COMFORT / PRIVACY / DESIGN

PictureIT-Designer Facades

- Digitally ceramic printed facades

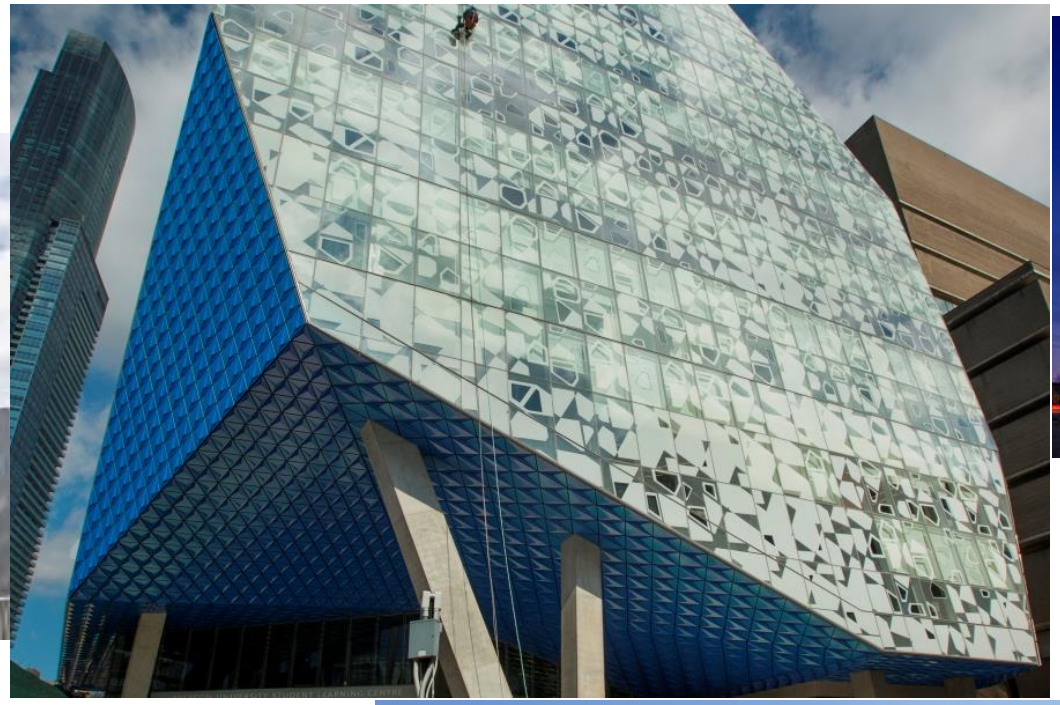
PictureIT-Designer Facades

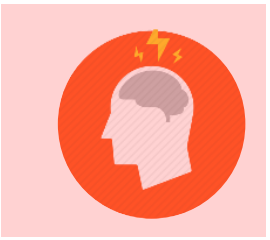
- Digitally ceramic printed facades



What is the product?

- Uses enamel inks to print on glass
- Suited for outdoor, indoor, public space, private space
- Permanently stable in dry and humid environment
- Can sustain very hot and very low temperature

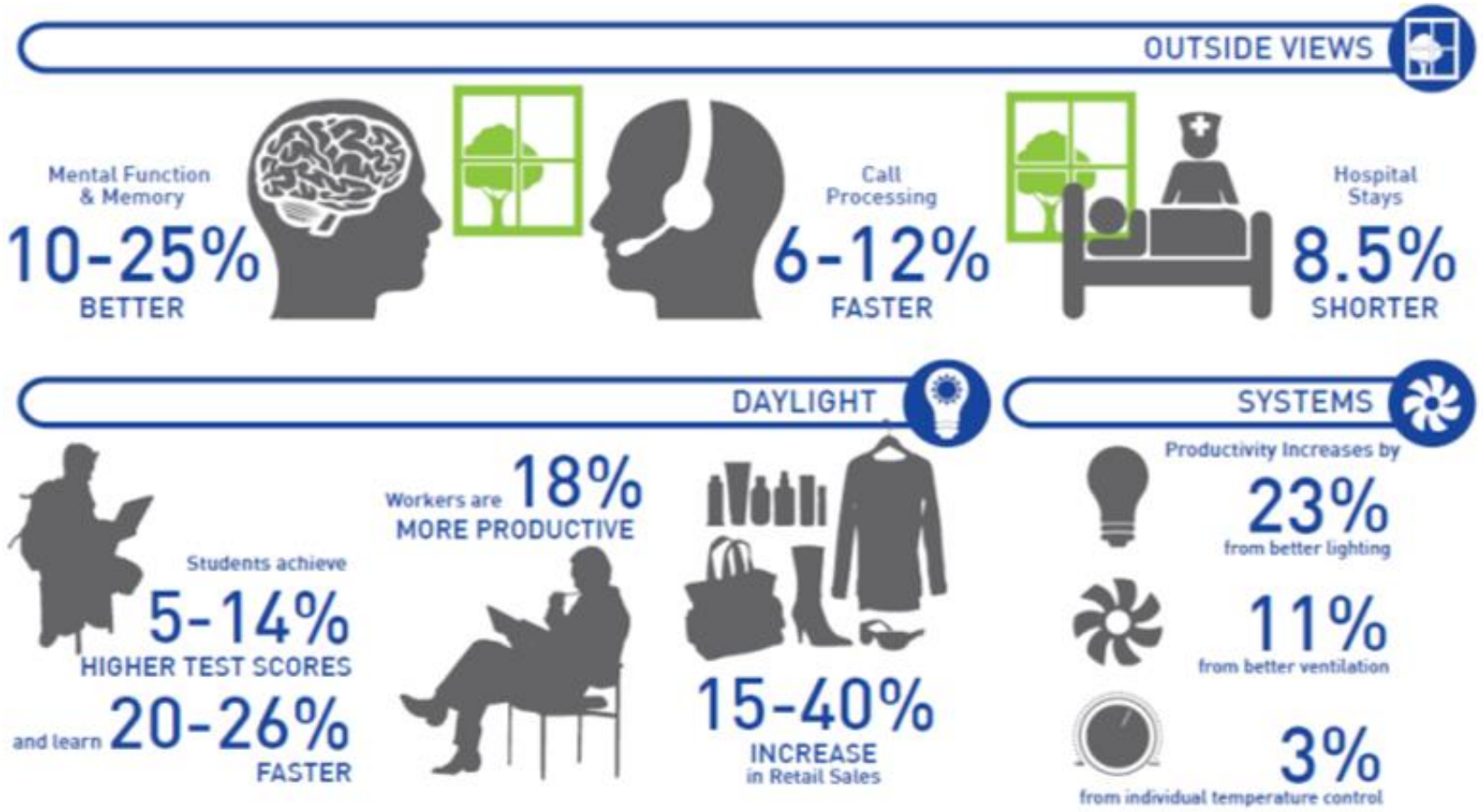




SageGlass®, a product from Saint-Gobain

What makes people comfortable and productive

- Proven health benefits of daylight and view

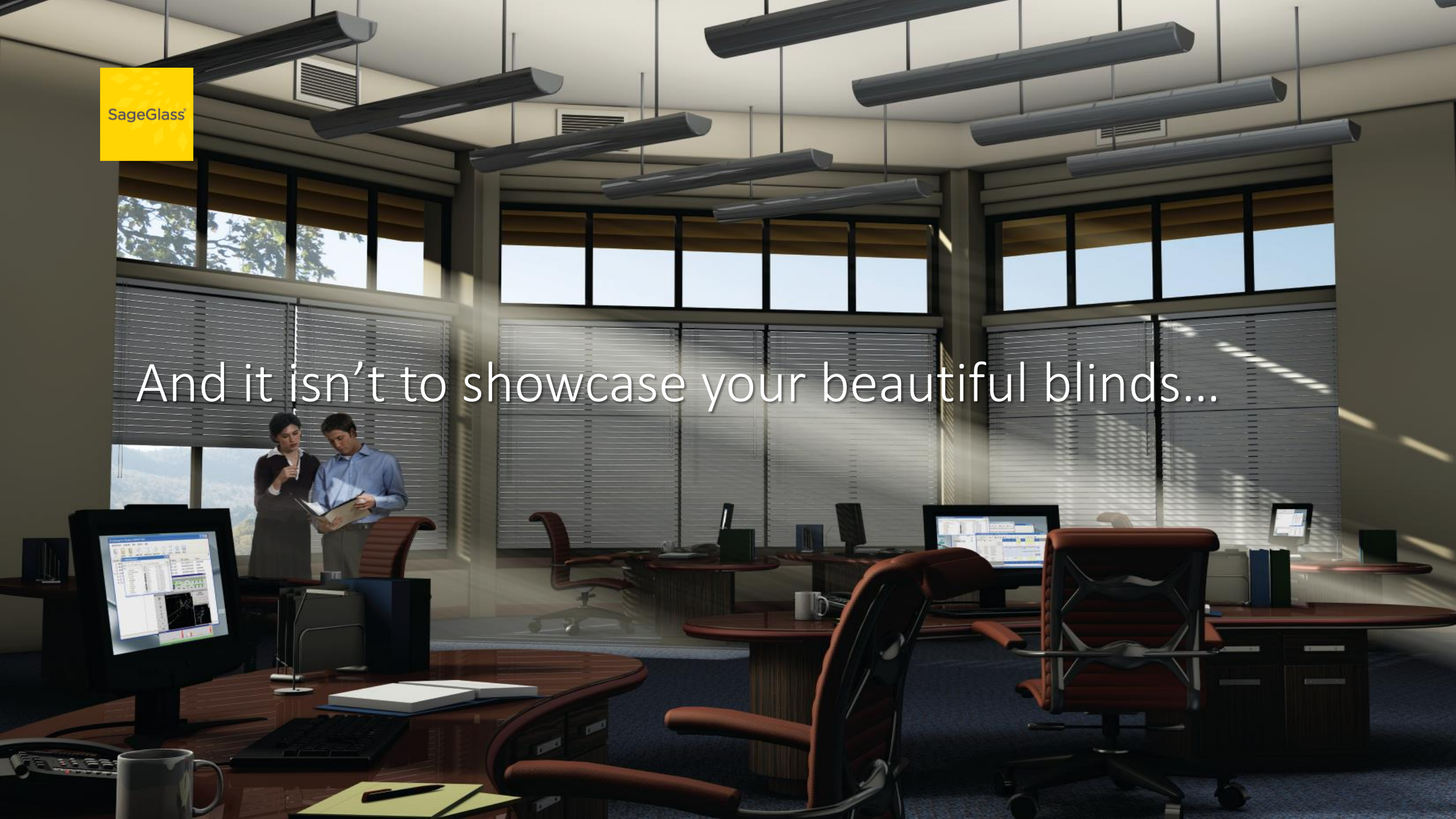


Net present value analysis of the operational cost and productivity and health benefits of LEED® certified buildings (World Green Building Council, 2013)

Heat and glare can counteract the positive benefits of daylight and views


SageGlass®

There’s a reason your building has windows…

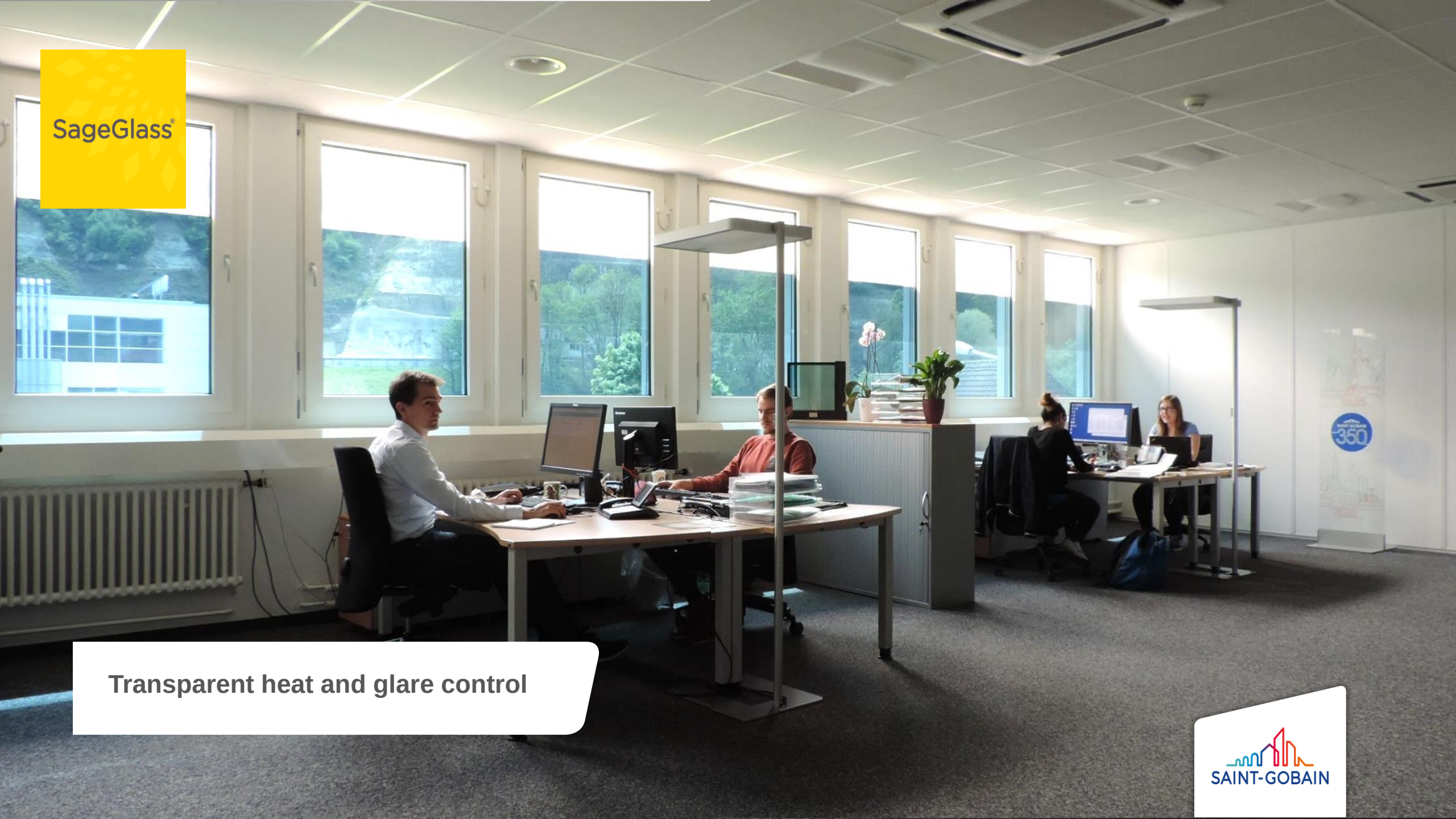

SageGlass
And it isn’t to showcase your beautiful blinds…

…it's for the view and connection to the outdoors

Tavares Pavilion on the Lake, Tavares, FL

Presenting to you, the cutting edge solution!

LOOK AGAIN !

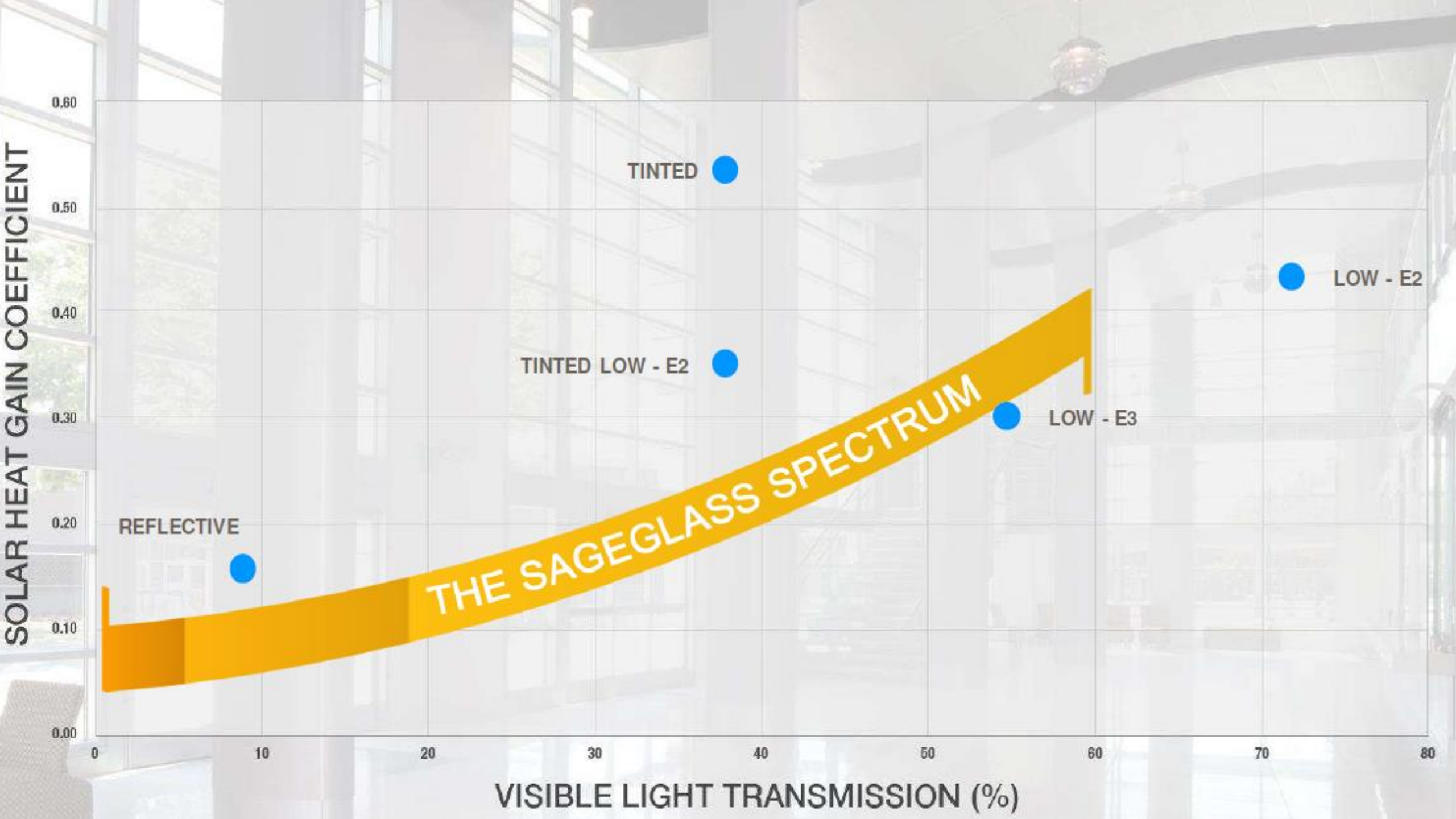

SageGlass®
Transparent heat and glare control
SAINT-GOBAIN

- **LightZone™**
- The ultimate comfort

LightZone™

- The ultimate comfort

- No more glare !
- Natural daylight color
- Boundless flexibility

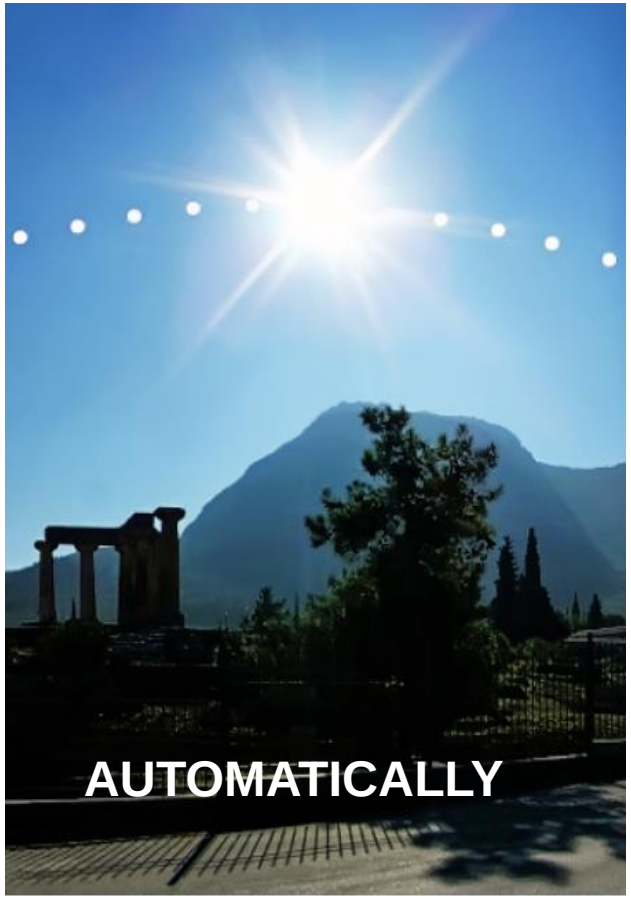

SOLAR HEAT GAIN COEFFICIENT
0.60
0.50
0.40
0.30
0.20
0.10
0.00
TINTED
LOW - E2
TINTED LOW - E2
LOW - E3
REFLECTIVE
THE SAGEGLASS SPECTRUM
0
10
20
30
40
50
60
70
80
VISIBLE LIGHT TRANSMISSION (%)

SageGlass®

SAINT-GOBAIN

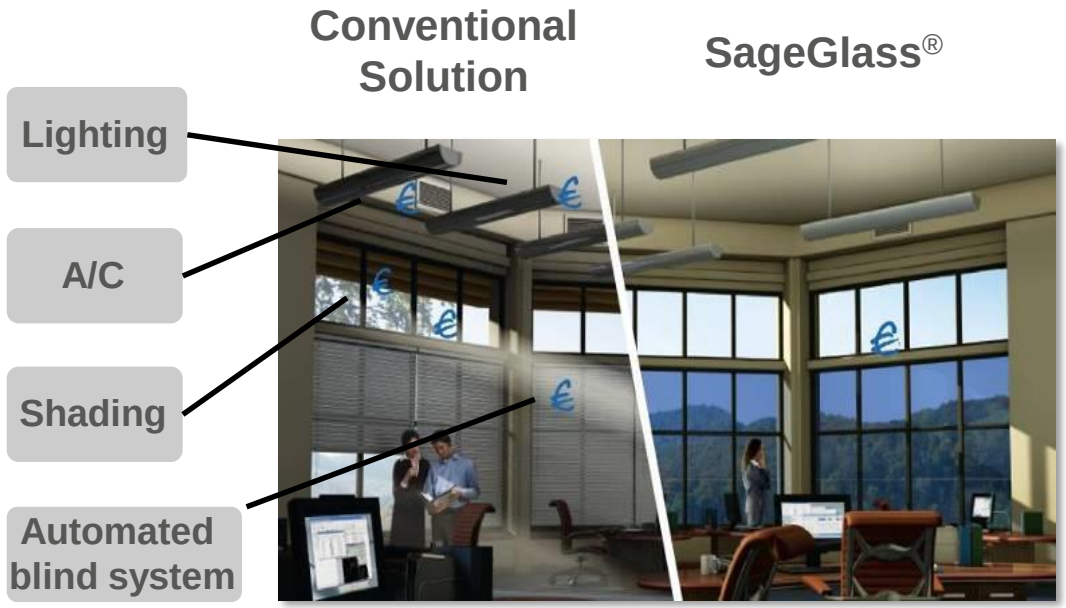
A façade you can interact with

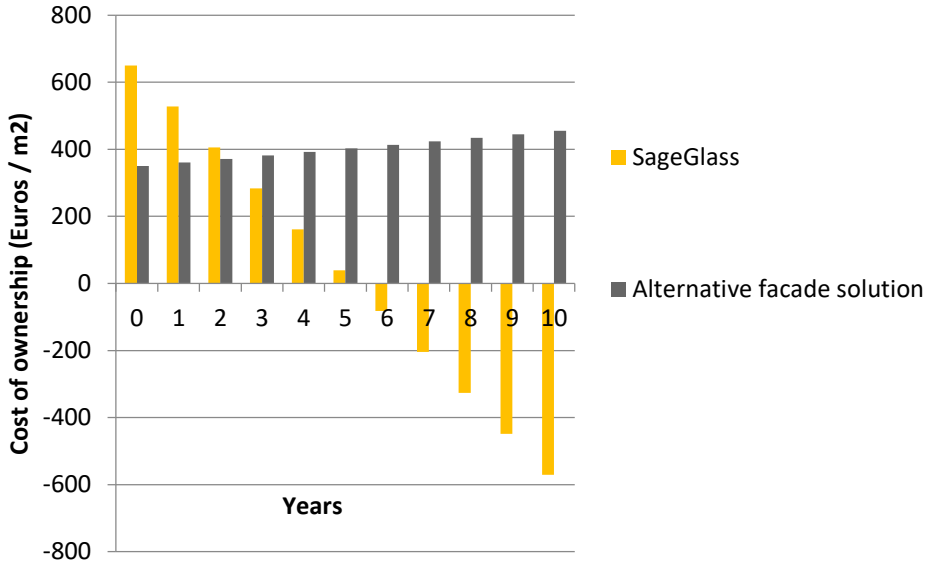
- Higher performance, greater emotion



An investment that pays back

- Save on energy & maintenance, boost human productivity





- **NO** maintenance costs
- Save up to **60%** on lighting and **25%** on air conditioning

Productivity, **energy** and **maintenance benefits** pay back in only a few years!

71Above Restaurant
Los Angeles, USA

SAINT-GOBAIN


SageGlass
• EPFL University
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
• Lausanne, Switzerland
SAINT-GOBAIN

EPFL University
Lausanne, Switzerland

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

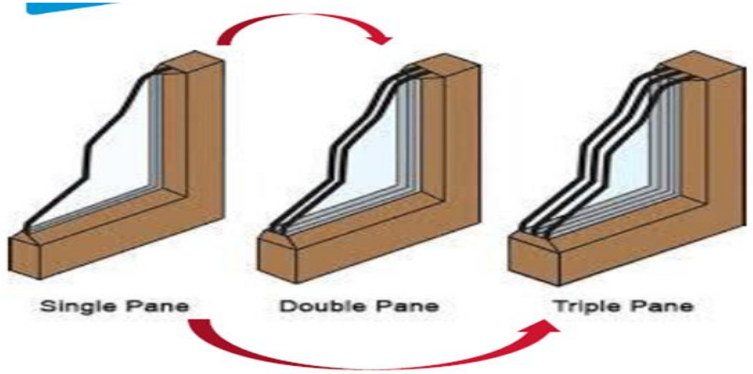
SAINT-GOBAIN


SageGlass
EPFL University
Lausanne, Switzerland
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
SAINT-GOBAIN

- **Putnam Building**
- Greenwich, Connecticut, USA

RETROFITTINGSOLUTIONS: EVOLVE

HASSLE FREE UPGRADE TO DGU!



Step 1

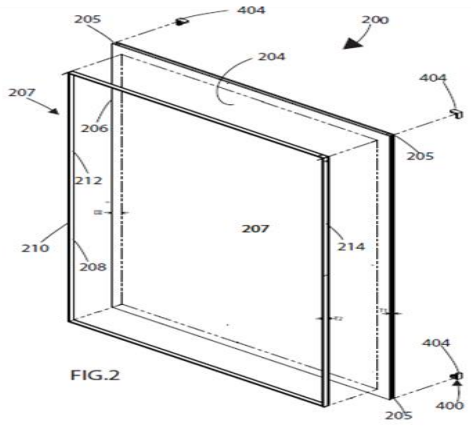


FIG.2

Step 2

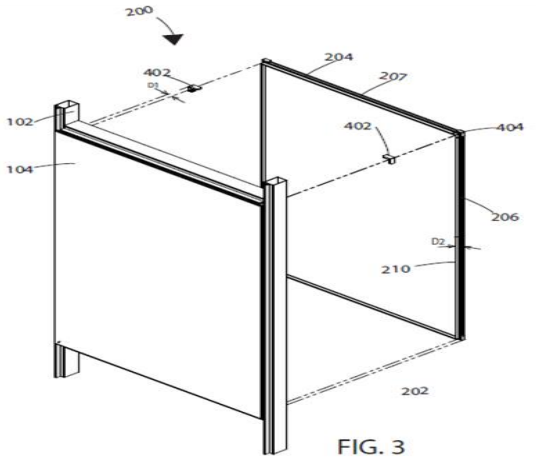


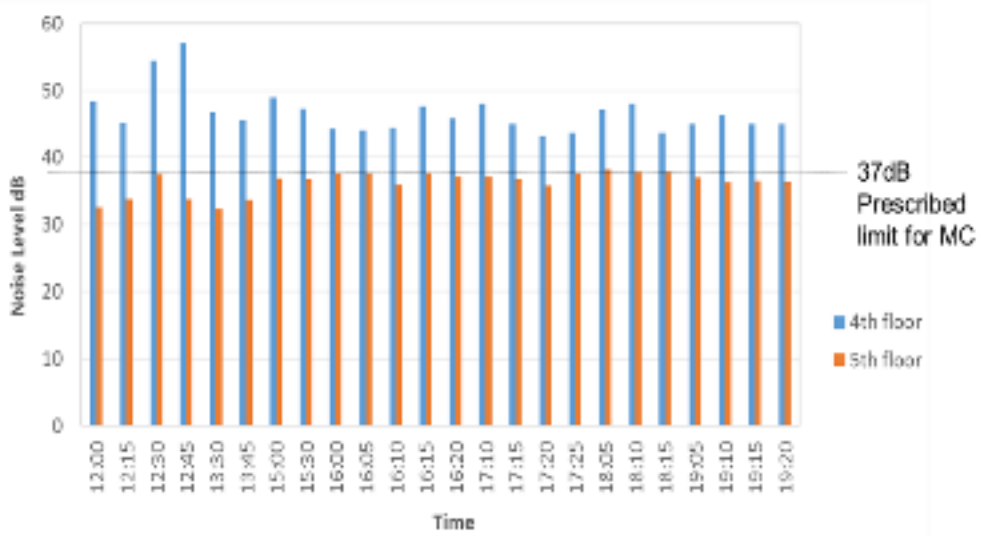
FIG. 3

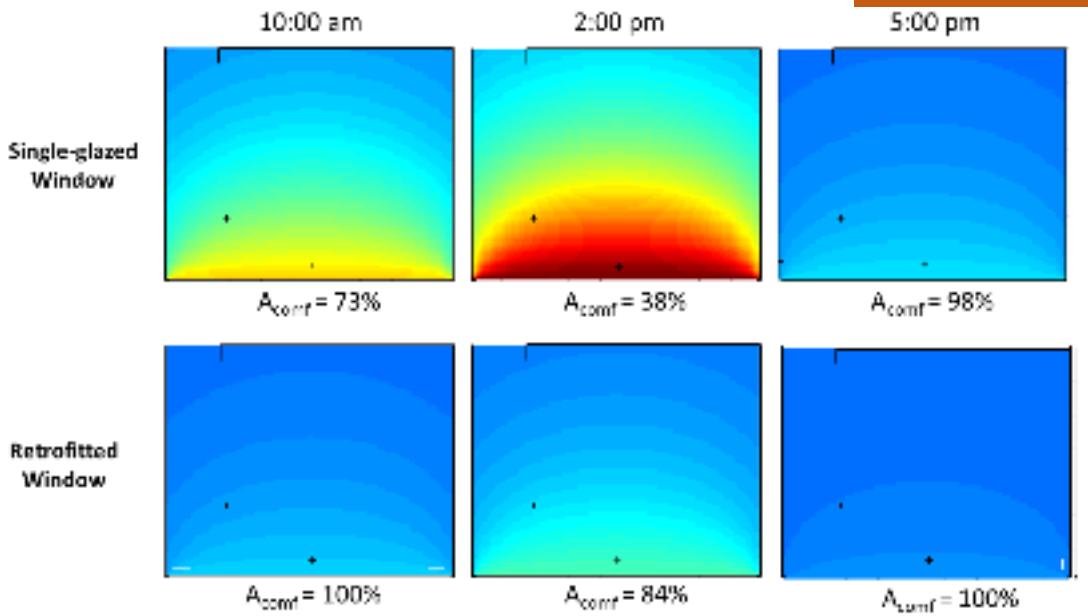
SPACER WITH STRUCTURAL GLAZING TAPE ON BOTH SIDES **EXISTING FAÇADE** WITH A SINGLE-GLAZED UNIT

ONSITE DGU RETROFITTING: ADVANTAGES

- **RETROFITTING SOLUTIONS for energy efficiency with the following benefits:**
- (a) Conversion from inside the building
- (b) Without removal of the existing glass
- (c) With minimum disturbance to occupants
- (d) No productivity loss as building remains functional
- (e) Boost in the energy efficiency of the building
- (f) Saint Gobain credible vendor on-board
- (e) Saint Gobain expert supervision for implementation

On Site DGU – For Existing Buildings





- ✓ *Can improve SHGC and U value of Openings in existing Buildings*
- ✓ *It can be a good energy conservation measure for buildings from Building Envelope Gains point of view and thermal, Visual, Acoustic Comfort*

PERFORMANCE GLASS TESTING FACILITIES IN INDIA

- GSI is a not for profit, independent, inclusive organization working on Testing and Certification of Building Envelopes and its materials for High Performance in the areas of Energy, Safety, Structural, Acoustics, Fire Resistance and others

Centre for Advanced Research in Building Science and Energy (CARBSE), CEPT University, Ahmedabad

- Joint venture of GSI and CEPT University
- First of its kind, World Class Facility for Energy Performance testing and simulation of Glass, Glazing System & Insulation materials
- Supported by MNRE, BEE, Industry, USAID, NFRC (USA), LBNL (USA), GEDA and others
- Would be the regional aggregator for IGDB

Facilities

Spectrophotometer, FTIR, Solar Calorimeter, Guarded hot box, Air leakage chamber and others

Structural Glass Research and Testing (SGRT) Facility Civil Engineering Department, IIT Madras, Chennai

- Joint venture of GSI and IIT Madras
- First of its kind, World Class Facility for testing Processed Glass in India
- Supported by Industry : Glass Manufacturers and FOSG

Facilities

Climate chamber, LASER Gasp, Argon GAS GLASS, Humidity chamber, Impact test setup, Waviness gauge, High temperature chambers, Fragmentation setup and others

Architectural Glass Research and Testing (AGRT) facility at Central Glass and Ceramics Research Institute, Kolkata

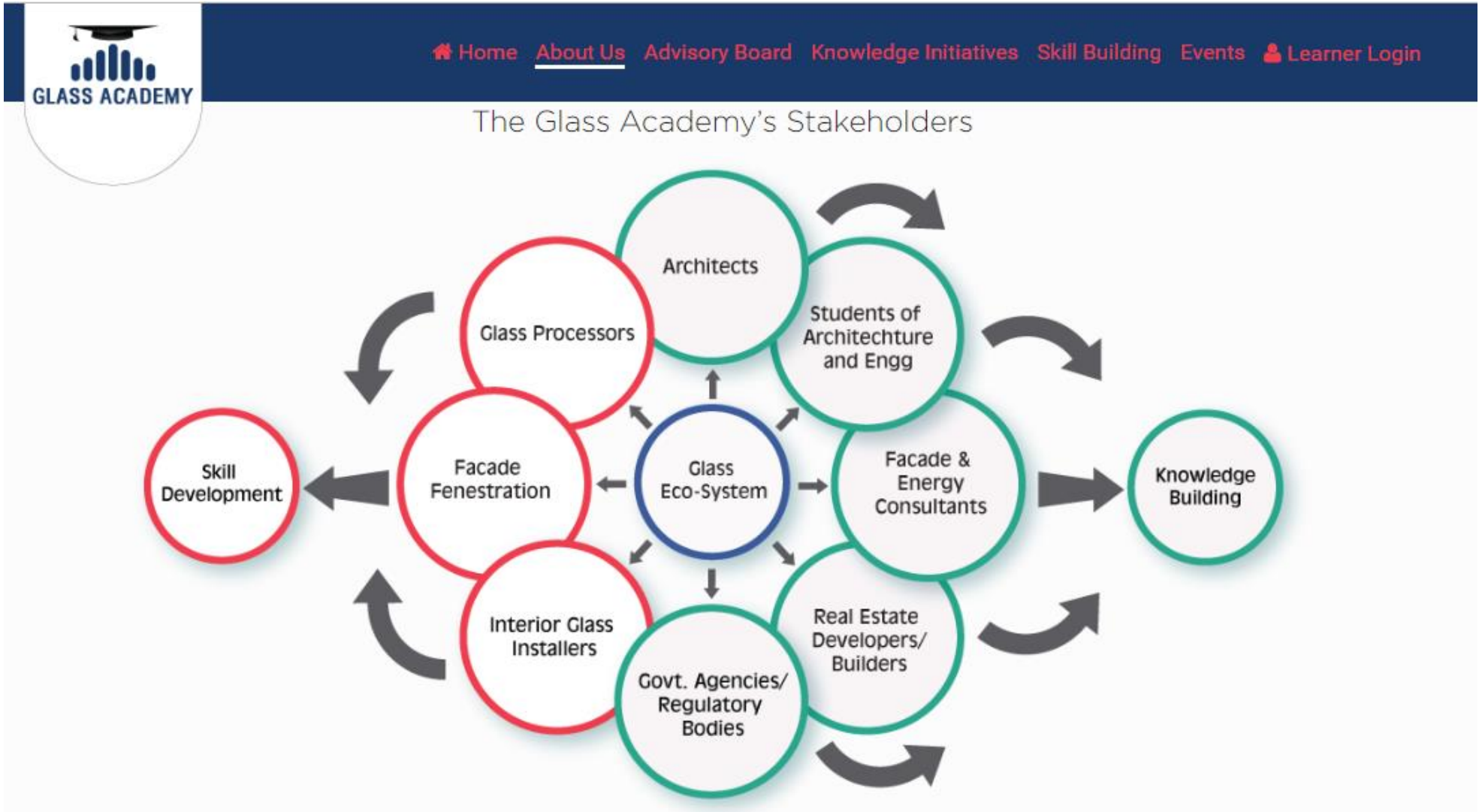
- Joint venture of GSI and CSIR-CGCRI
- World Class Facility for Energy Performance testing and simulation of Glass, Glazing System & Insulation materials
- Supported by CSIR-CGCRI and Industry

Facilities

Spectrophotometer, FTIR, Melting furnace, Observation furnace, Planar Magnetron DC Sputtering Unit, Interferometer, Polarimeter, Raman Spectrometer and others

https://www.glazingsociety.com/

GLASS ACADEMY



http://www.glass-academy.com

Thank you !

For Further Queries Contact me @

+91 9176049300

Venugopal.r@saint-gobain.com


ASK


END OF
WEBINAR..

NZEBs Case Studies

Case studies of energy efficient and net zero energy with a focus on India, provide important insights to the feasibility of the concept.

Considering the concept is still in its nascent stage in India, it is very useful to study how architects and building owners have gone about setting net-zero and energy efficiency goals in the selected buildings. Moreover, the selected case studies are in various stages of design and implementation, with some already in the measurement & verification stage, enabling the demonstration of different aspects of net-zero implementation. This section contains the details of operational NZEBs, and will be updated periodically as more NZEBs emerge on the horizon.

The focus of the case studies is on the energy efficiency measures that have been implemented in the projects, the range of energy performance indices (EPI) the

NZEBs in India

international case studies

detailed case studies

nalanda university [PACE-D pilot]

NZEB Tours

Plant 13 Annexe, Mumbai
9th August

CARBSE at CEPT, Ahmedabad
24th August

NZEB International Conference

15-16 October, Delhi

Subscribe to our monthly newsletter

The NZEB Times

INSPIRE 2019

COMPETITION

Home | Knowledge Centre | Definitions & Policies | Case Studies | Alliance | News & Events | Blog | About Us | Glossary | FAQs | Resource

Home › Case Studies

nzeb
net zero energy buildings

SIGN UP TODAY!

http://www.nzeb.in/

NZEBs Case Studies

Case studies of energy efficient and net zero energy with a focus on India, provide important insights to the feasibility of the concept.

Considering the concept is still in its nascent stage in India, it is very useful to study how architects and building owners have gone about setting net-zero and energy efficiency goals in the selected buildings. Moreover, the selected case studies are in various stages of design and implementation, with some already in the measurement & verification stage, enabling the demonstration of different aspects of net-zero implementation. This section contains the details of operational NZEBs, and will be updated periodically as more NZEBs emerge on the horizon.

The focus of the case studies is on the energy efficiency measures that have been implemented in the projects, the range of energy performance indices (EPI) the

NZEBs in India

international case studies

detailed case studies

nalanda university [PACE-D pilot]

USAID
FROM THE AMERICAN PEOPLE

GOVERNMENT OF INDIA
MINISTRY OF POWER

MAITREE

MARKET INTEGRATION AND TRANSFORMATION FOR ENERGY EFFICIENCY

eds environmental design solutions

Implementing Partner