



DEVELOPING SUSTAINABLE SOLUTIONS FOR SMART CITIES

Gujarat Guardian Ltd

COMMERCIAL, RESIDENTIAL, INTERIOR GLASS INNOVATION

What is a Smart City?

- A Smart City has-
 - Basic infrastructure,
 - Uses 'smart' solutions to make infrastructure and services better, and
 - Relies on Area based development.

City wide Smart Solutions

E-Governance and Citizen Services



- 1 Public Information, Grievance Redressal
- 2 Electronic Service Delivery
- 3 Citizen Engagement
- 4 Citizens - City's Eyes and Ears
- 5 Video Crime Monitoring

Waste Management



- 6 Waste to Energy & fuel
- 7 Waste to Compost
- 8 Waste Water to be Treated
- 9 Recycling and Reduction of C&D Waste

Water Management



- 10 Smart Meters & Management
- 11 Leakage Identification, Preventive Maint.
- 12 Water Quality Monitoring

Cities may add any number of smart solutions to the area based developments to make government funds cost effective.

Energy Management



- 13 Smart Meters & Management
- 14 Renewable Sources of Energy
- 15 Energy Efficient & Green Buildings

Urban Mobility



- 16 Smart Parking
- 17 Intelligent Traffic Management
- 18 Integrated Multi-Modal Transport

Others



- 19 Tele-Medicine & Tele Education
- 20 Incubation/Trade Facilitation Centers
- 21 Skill Development Centers

Guardian Flat Glass Segments



SunGuard

ADVANCED
ARCHITECTURAL
GLASS



ClimaGuard

ADVANCED
RESIDENTIAL
GLASS



InGlass

ADVANCED
INTERIOR
GLASS



EcoGuard

GREEN ENERGY
MANAGEMENT
SOLUTIONS



Electronics

INDUSTRIAL AND
CONSUMER GLASS



Automotive

AUTOMOTIVE GLASS
AND COATINGS

Float
Pattern
Low-E
Solar Control
LamiGlass
SatinDeco
Tempered
BIPV
EC

Float
Pattern
Low-E
Solar Control
LamiGlass
SatinDeco
Tempered
IGUs

Float
Pattern
Mirror
Non-Glare
LamiGlass
SatinDeco
Tempered
DecoCristal
Switchable
ShowerGuard
DiamondGuard

Float
Pattern
Anti-Reflective
TCOs
CSP Mirrors
CPV Mirrors
Tempered
Thin Float-PV
AGRO Series

Float
Thin Float
Anti-Reflective
TCOs
LamiGlass
Non-Glare
Chemical
Tempering

Float
Mirror
IRR
TCOs
LamiGlass
Tempered
DiamondGuard

Selection Criteria - Performance

Climate conditions

Building orientation/glass surface area

Window to Wall Ratio (WWR)

Local energy codes (eg ECBC)

Possible Green Building certification

Commercial Building Objectives:

- Low Solar Heat Gain Coefficient (SHGC) to reduce air conditioning loads
- Low U-Factor to reduce thermal heat-transfer
- Alternate to expensive external or internal shading systems

Selection Criteria – Design

What is the design intent?

– Aesthetics, matching existing buildings, etc.

Glazing selection objectives:

- ▣ Higher or lower light transmission (glare concerns)
- ▣ Exterior reflectivity vs. transparency
- ▣ Indoor reflection low (improved view and interior aesthetics)
- ▣ Vision to spandrel match
- ▣ Relation to room size and interior lighting

Evolution of Building Facades

Buildings in the Beginning



An Irish Church from 1000 AD composed of just dry-stacked rock.



Mesa Verde, an adobe community built on a superbly located site protected from summer sun



Solid masonry office with generous window area, and fine detailing. Durable, strong, and functional, with moderate R-value, this type of building was common after the Industrial Revolution



A recent “high-tech” building enclosure. Poor thermal performance, little solar control, and many sealed joints, this type of enclosure is a serious energy liability and a step backward in indoor climate control.

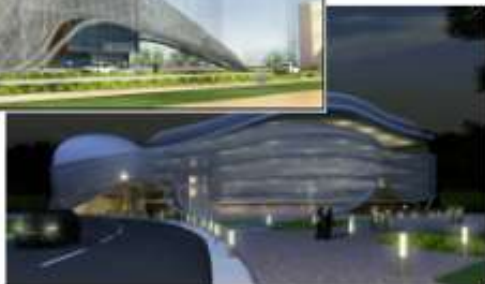
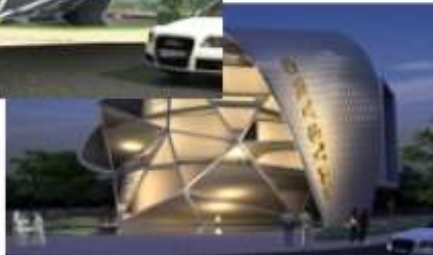


Burj Al Arab, Dubai UAE



The Address Hotel, Dubai UAE

Uneven Shaped Facades



Patterned Type Facade



Yamaha Nikken Sekkei
Japan



The Marina Gate 1,2 & 3
Dubai



Louis Vuitton Shop
Shenzhen, China

Parametric Design Building Facades



Future Modern Building Facades



Future Musuem



Oasis Tower



Technosphere



Rotating Tower



The Icon Hotel

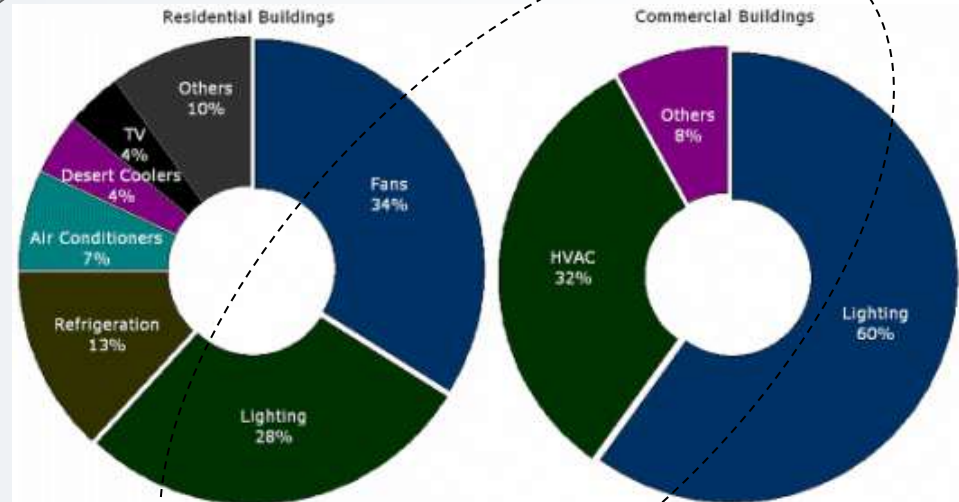


Beach Front Hotel

Energy Consumption In Buildings: India



Buildings



Source: Bureau of Energy Efficiency

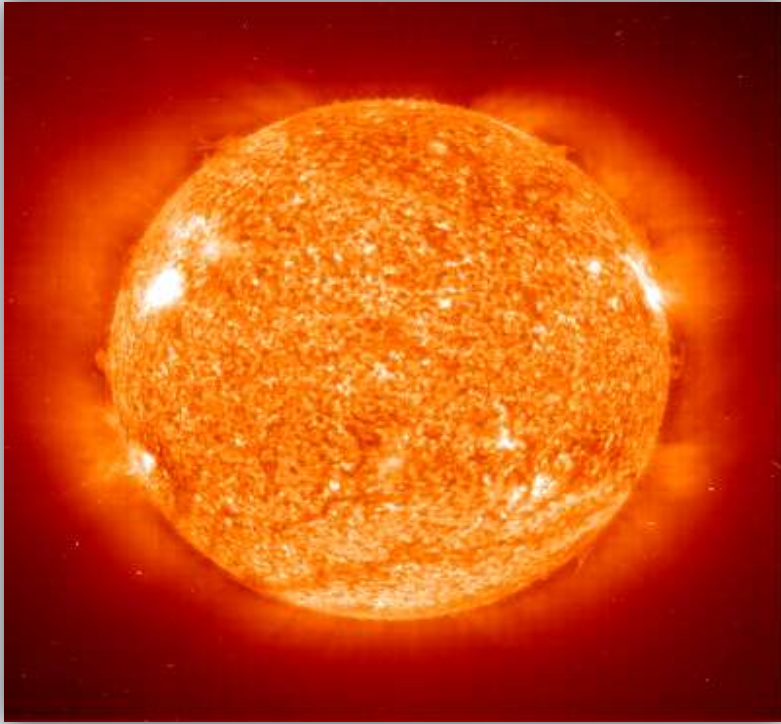
73%

Majority share of Lighting and Air Conditioning costs

Escalating Costs of Electricity

Need to cap the Spiraling Electricity Consumption

The Sun: Source of Solar Energy



Questions:

- How much natural day light do I need for my project?
- Is glass providing more than 70% L.T. a good option for a project in India?
- What about glass reflection?

What is the optimum 'Visible Light Transmission' for the India?



Sometimes too much day light & glare could be annoying for

Visible Light Transmission for the India?



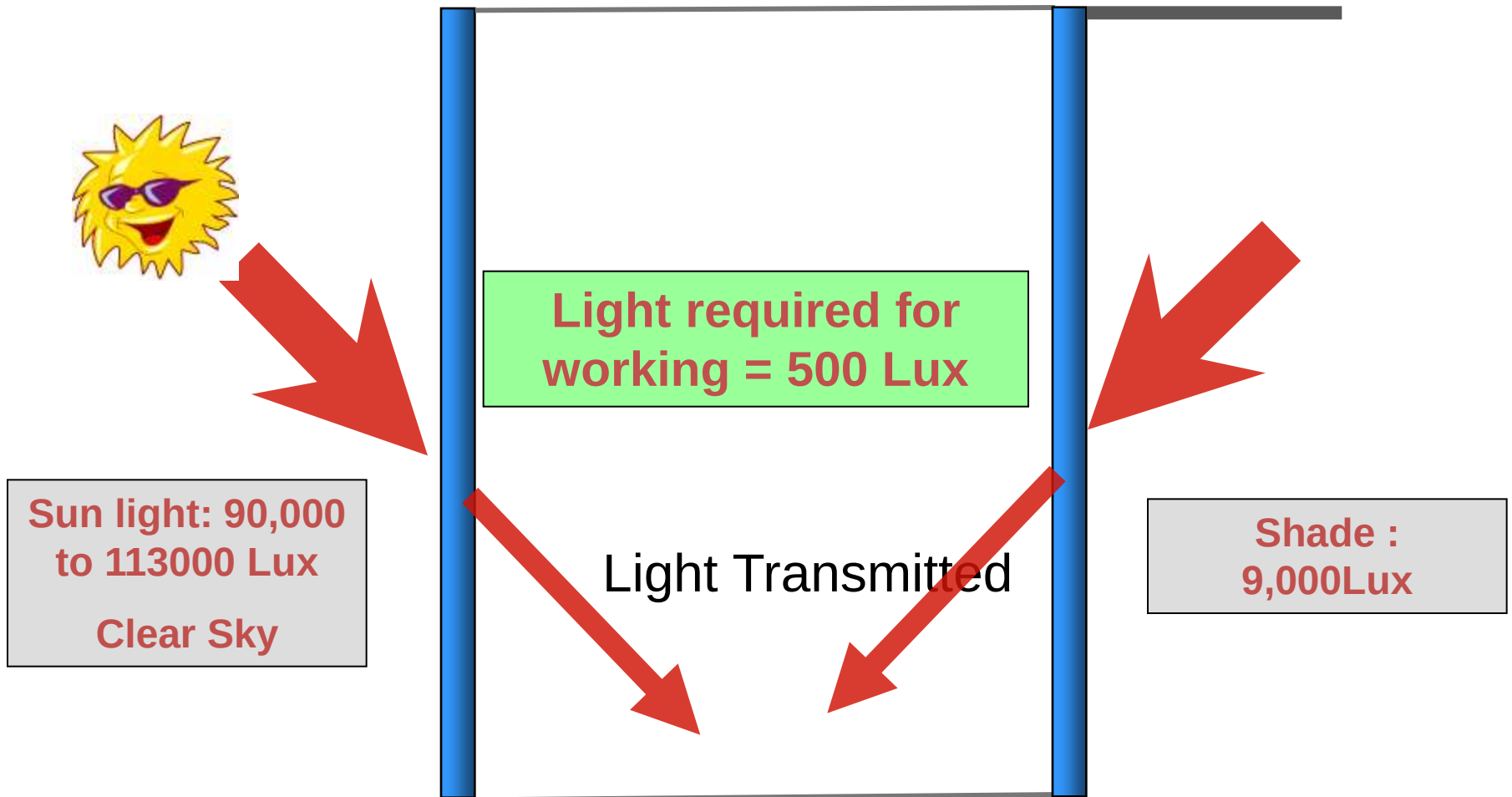
Is this what you want
from your windows?



Can't see outside because
of the blinds?

Why have glass at all?

What is the optimum 'Visible Light Transmission' for the India?



Thus.....
Light transmission needs to be optimized to reduce
GLARE and enhance occupant COMFORT

First Rule of Optics !!!

REFLECTION

TRANSMISSION

ABSORPTION

$$R (\%) + T (\%) + A (\%) = 100\%$$

ALWAYS !!!

Transmission & Reflection

Design Criteria

High Transmission

Central Station, Berlin
SunGuard® HP Neutral 60/40
 $T_L = 60\%$



Low Transmission

Burj Khalifa, Dubai
SunGuard® Solar Silver 20
 $T_L = 19\%$



Color Rendering Index

- Method for distinction of color shifting
- The color rendering index defines the “spectral quality” of glass transmission.
- Example
 - Sun/ clear sky = **100**
 - Architectural glass basing on **clear** float glass = **90...99**
 - Architectural glass basing on **green** float glass = **80...90**
 - Architectural glass basing on **blue** float glass = **60...80**
- 90...100 is considered as excellent
- E.g. museums specify often ≥ 95

Color Rendering Index

View from inside



Pyrolithic coatings on body tinted glass



Colored Magnetron Sputtered coatings on clear glass

Color Rendering Index

Example

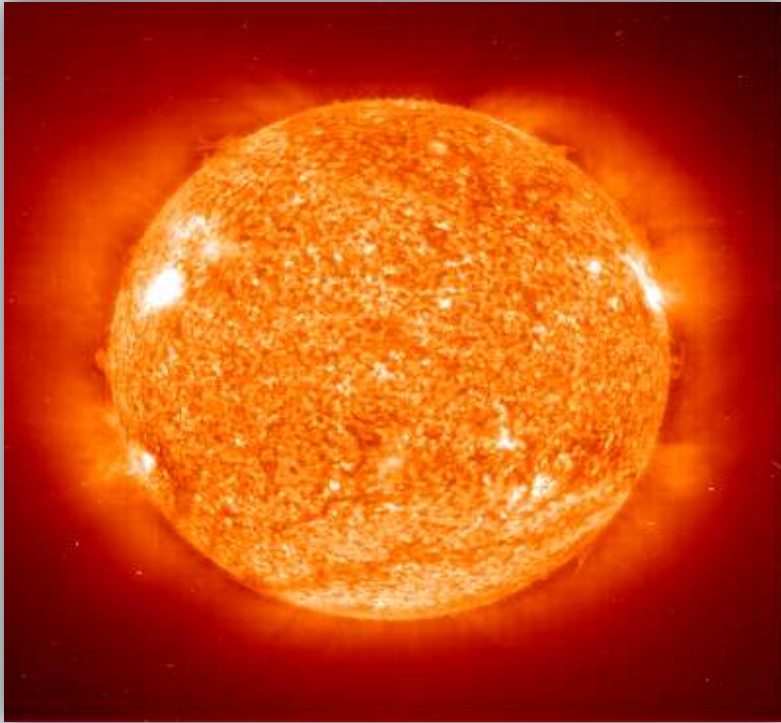


View through body tinted
blue glass



View through Guardian blue
reflective glass, coated on clear
glass

The Sun: Source of Solar Energy



Questions:

-How much Solar Infrared (Heat) should I keep away from my project?

How to achieve these properties with glass?

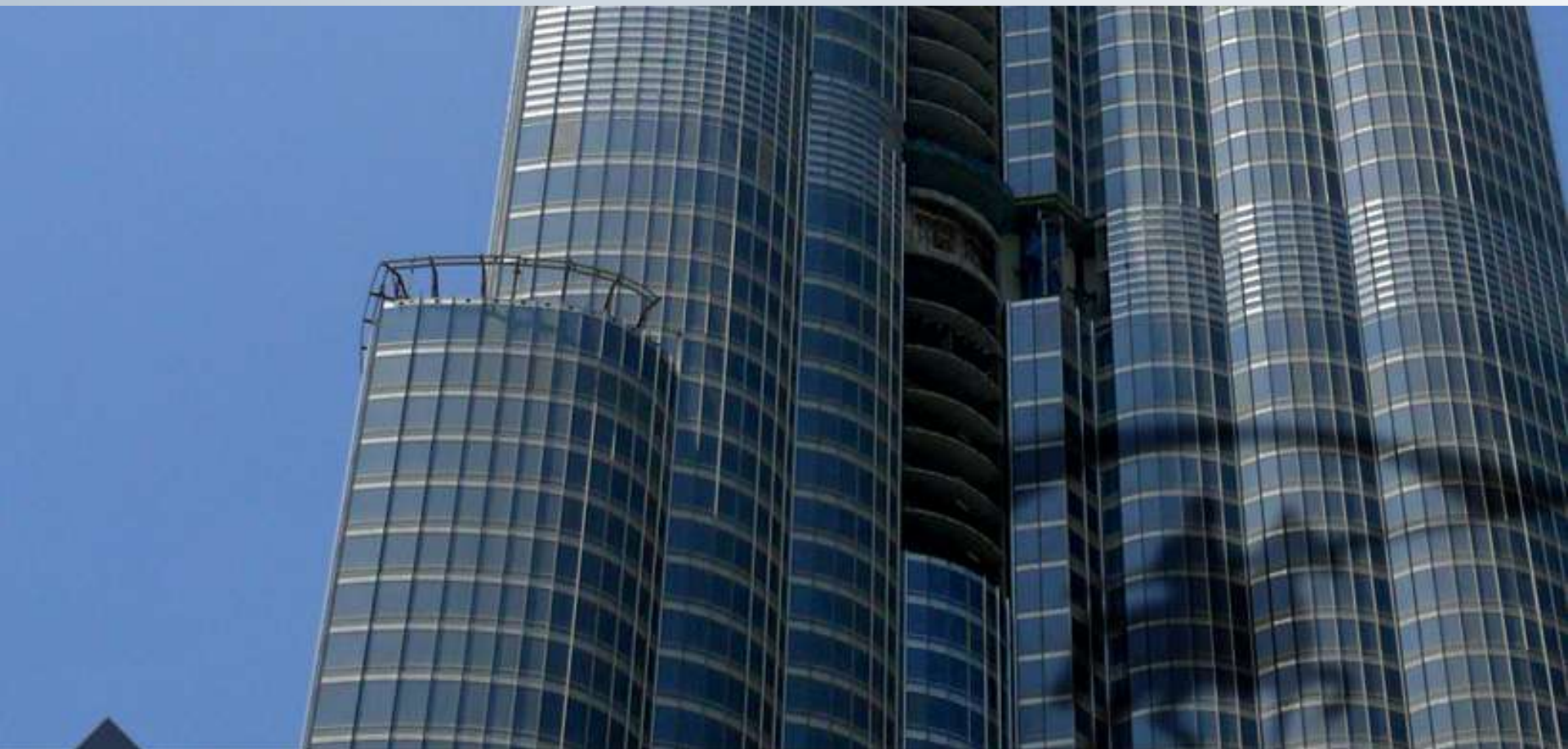
- Apply Coatings on Glass
- Change the thermal properties of the glass by
 - Reducing the emissivity (thermal heat)
 - u-value  (Low -e glass)
 - Increasing the energy reflectance
 - solar factor  Solar control glass G
- Optimizing the light transmission reducing the glare and optimizing the lightning

Selection of the right glazing



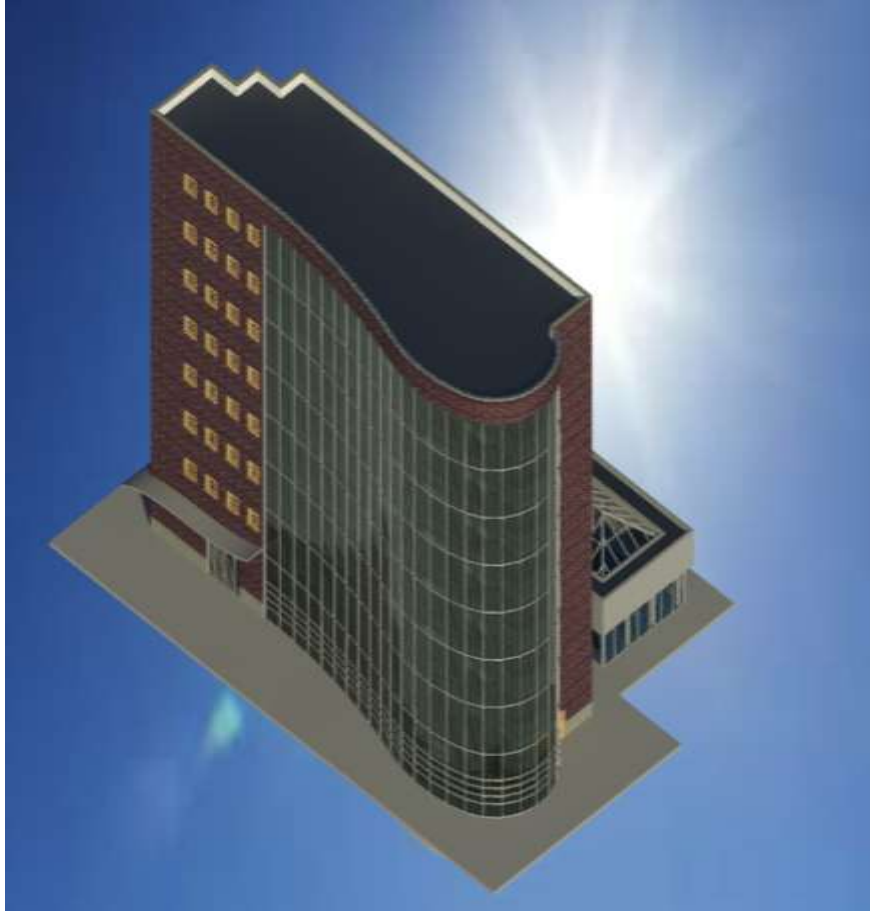
Both Buildings could have the same Solar Factor and U-Value but the Light Transmission And Outdoor Light Reflections differs

Consequence: Solar Factor and U-Value are not necessarily related to Light Transmission



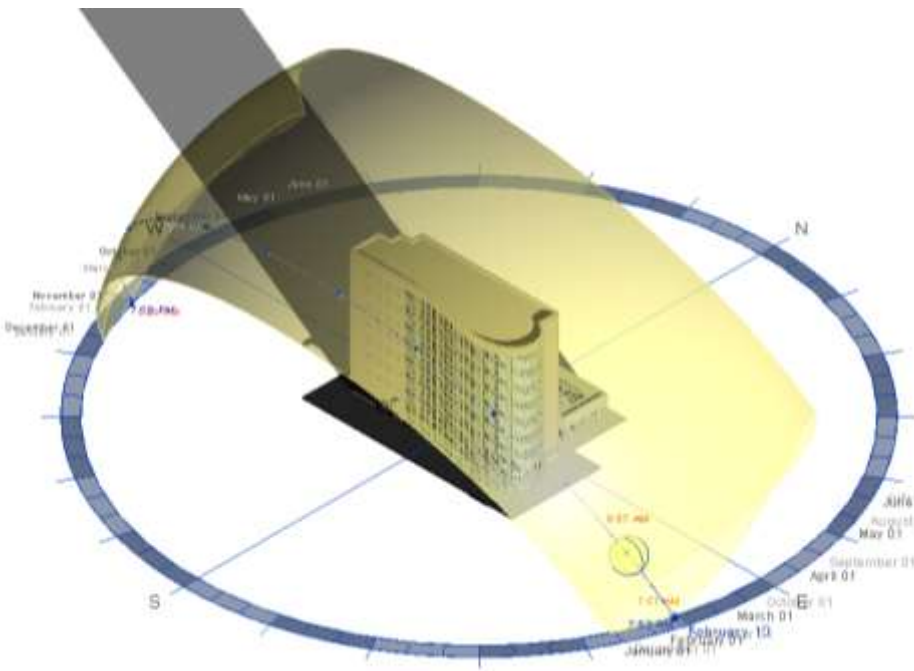
Building Energy Calculator

Summer – Clear Daylight

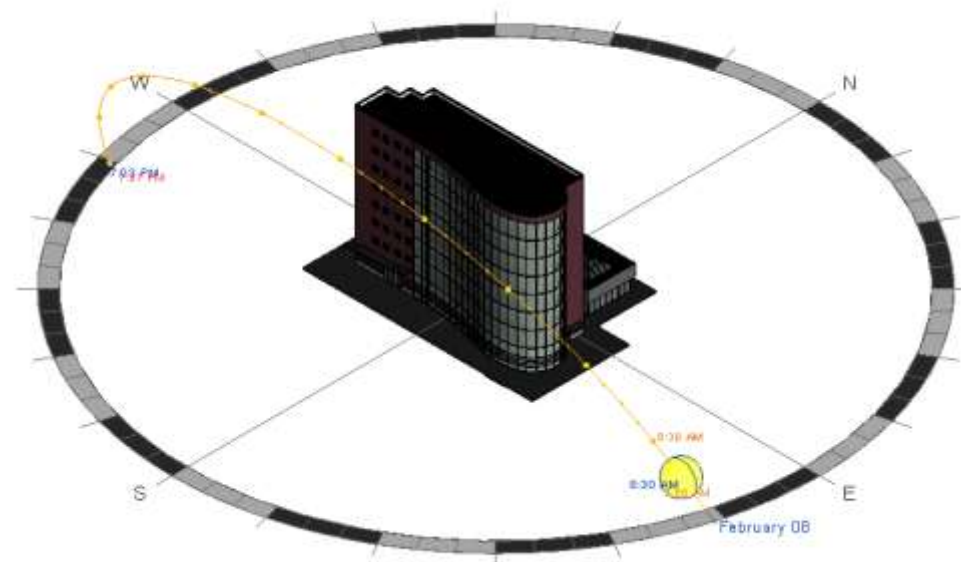


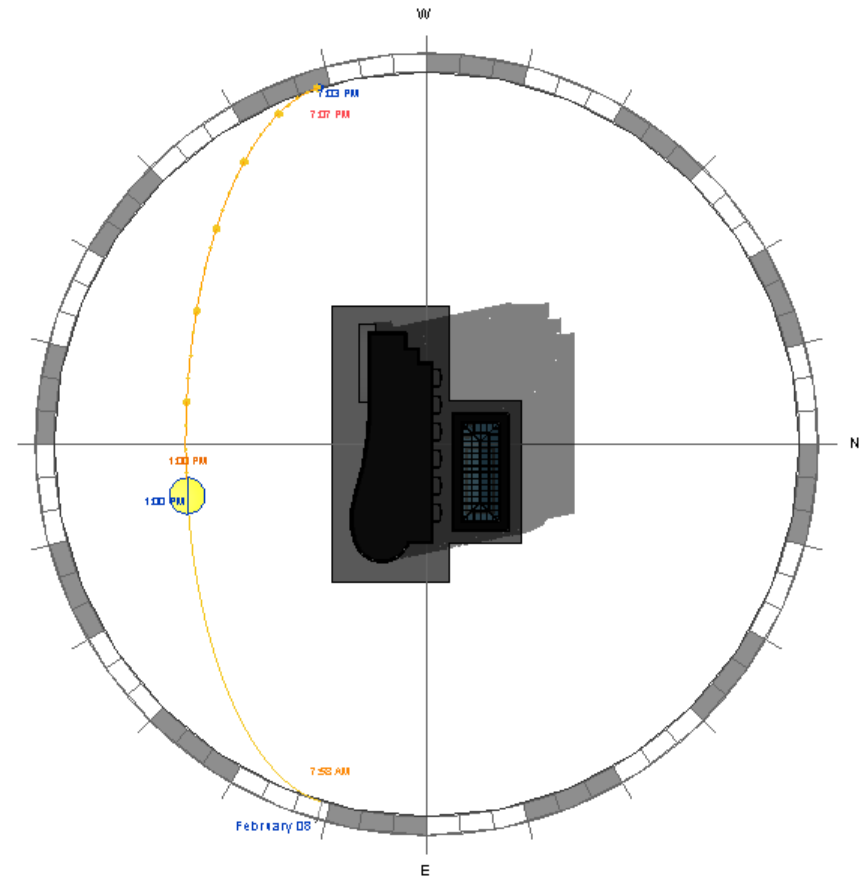
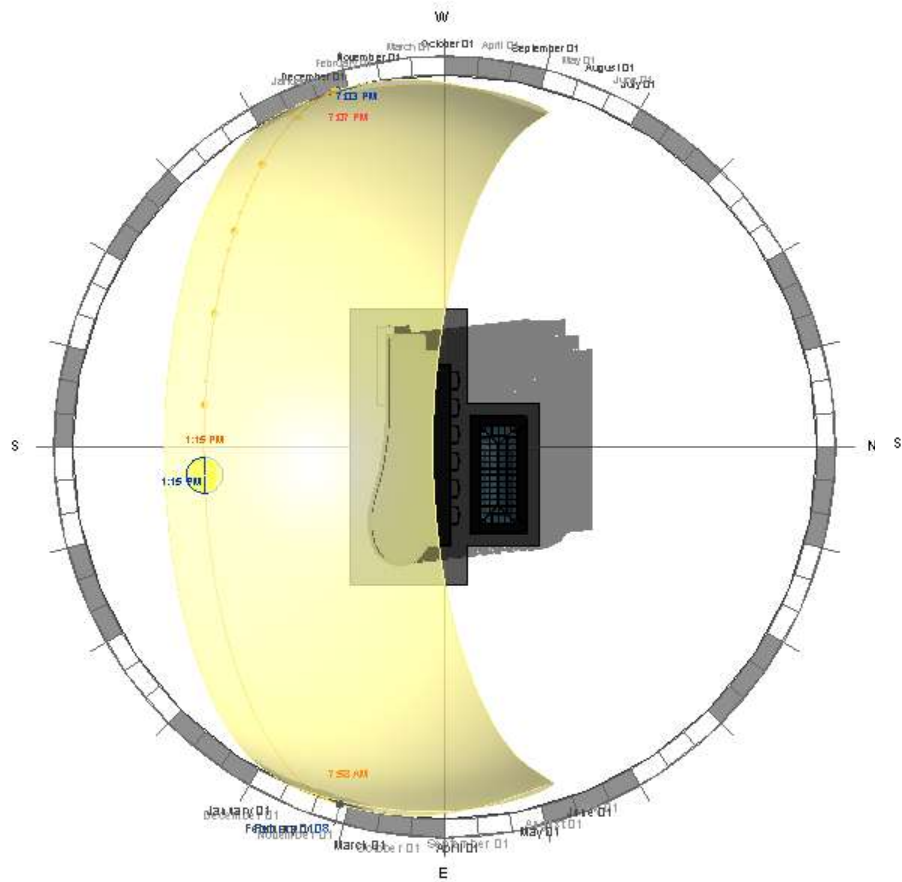
Winter – Cloudy Day





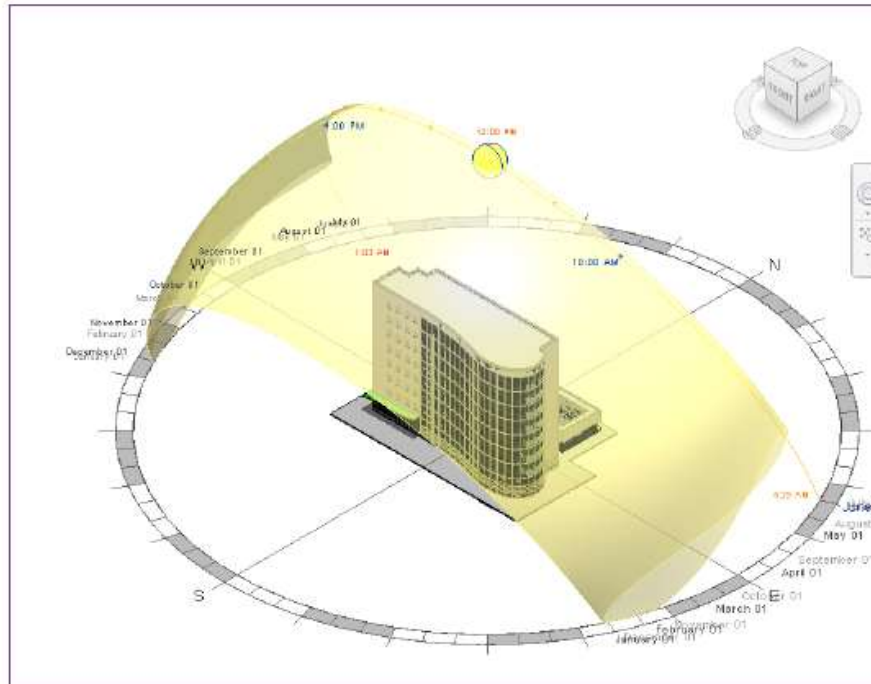
Perspective (3D View)





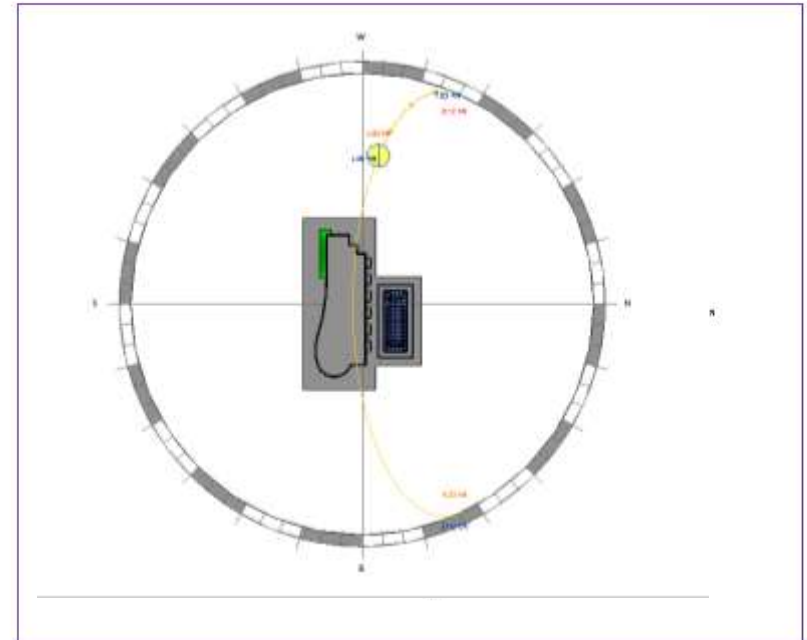
Site Plan - 8 FEB - 1 PM

5th February – 9 :29 am



Tue 2017/01/31	08:27	09:13 of daylight	17:23
Wed 2017/02/01	08:20	09:16 of daylight	17:30
Thu 2017/02/02	08:19	09:19 of daylight	17:38
Fri 2017/02/03	08:17	09:23 of daylight	17:40
Sat 2017/02/04	08:15	09:26 of daylight	17:42
Sun 2017/02/05	08:14	09:29 of daylight	17:44
Mon 2017/02/06	08:12	09:33 of daylight	17:45
Tue 2017/02/07	08:10	09:36 of daylight	17:47
Wed 2017/02/08	08:09	09:40 of daylight	17:49
Thu 2017/02/09	08:07	09:43 of daylight	17:51
Fri 2017/02/10	08:05	09:47 of daylight	17:53
Sat 2017/02/11	08:03	09:51 of daylight	17:54
Sun 2017/02/12	08:01	09:54 of daylight	17:56

4th June – 16:20 pm



Tue 2017/05/30	05:36	16:12 of daylight	21:48
Wed 2017/05/31	05:35	16:13 of daylight	21:49
Thu 2017/06/01	05:35	16:15 of daylight	21:50
Fri 2017/06/02	05:34	16:17 of daylight	21:51
Sat 2017/06/03	05:33	16:19 of daylight	21:52
Sun 2017/06/04	05:33	16:20 of daylight	21:53
Mon 2017/06/05	05:32	16:22 of daylight	21:54
Tue 2017/06/06	05:32	16:23 of daylight	21:55
Wed 2017/06/07	05:31	16:24 of daylight	21:56
Thu 2017/06/08	05:31	16:26 of daylight	21:57
Fri 2017/06/09	05:30	16:27 of daylight	21:58
Sat 2017/06/10	05:30	16:28 of daylight	21:58
Sun 2017/06/11	05:30	16:30 of daylight	21:59

Depending on the location , you get to view the sunrise, sunset and total daylight time for any day of the year.

Building Energy Calculator Project Settings



[My Settings](#) | [Order a Sample](#) | [SunGuard Website](#)

 **GUARDIAN SUNGUARD®** | PERFORMANCE & BUILDING ENERGY CALCULATORS

[Performance Calculator](#) | [My Project Center](#) | [Analyze](#) | [Energy Calculator](#)

Energy Calculator

[Collapse](#) [First-time user? Download our guide.](#) [Assumptions and Terminology](#)

The Guardian Building Energy Calculator helps you compare annual energy costs for a variety of glazing types in locations throughout North America and Latin America. Set up your project; choose a building type, and add some building details. Compare energy cost and consumption information for as many glass make-ups as you'd like. Results are summarized in data tables, illustrated graphically, and available for customized report generation when you're done.

Guardian developed the Building Energy Calculator for use by its sales and technical staffs to perform general comparative energy analyses of various combinations of glazing products. The Energy Calculator is intended for general comparative purposes only. Please consult a qualified professional for project-specific energy analysis.

Project Settings

[Collapse](#)

Select Project:	WWR Analysis	Fuel Type:	Electric + Gas Heat
Region:	North America	Average Gas Cost:	0.954 USD/Therm
Location:	USA, AZ, Phoenix	Average Electricity Cost:	0.073 USD/kWh
Currency:	United States Dollar	Electric Demand Charge:	8.25 USD/kW

Electric Only
Electric + Gas Heat

Building Energy Calculator Project Settings

Building Settings {x} Collapse

Office
Multi-family
Medical Office Bldg
Hotel
Primary School
University
Hospital
Retail

Building Type: Office

Number of Stories: 6

Floor Length (long axis) (ft): 400

Floor Width (ft): 242

Floor-to-ceiling Height (ft): 10

Perimeter Zone Depth (ft): 15

Analyze the Impact of Automated Daylighting Controls: ☐

Window Area
(area²)
Window to Wall Area
(1-100%)

Elevation 1

Elevation 2

Elevation 3

Elevation 4

Window to Wall Area (1-100%): 65

20

[Same As Elevation 1](#)

[Same As Elevation 1](#)

Overhang (ft): 0.2

[Same As Elevation 1](#)

[Same As Elevation 1](#)

[Same As Elevation 1](#)

Window Type: Curtain Wall

Ribbon

Punched

[Same As Elevation 1](#)

Curtain Wall
Ribbon
Punched Opening

Window Height (ft): 10

6

6

[Same As Elevation 1](#)

Window Width (ft): 5

4

4

[Same As Elevation 1](#)

Frame Type: T/B Aluminum

Spacer Type: T/B Aluminum

Building Energy Calculator Project Site Orientation

Site Orientation {x} Collapse

Elevation View



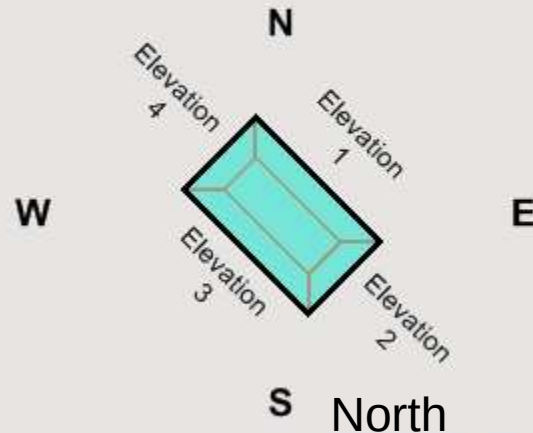
Elevation
on 1

Elevation
on 2

Elevation
on 3

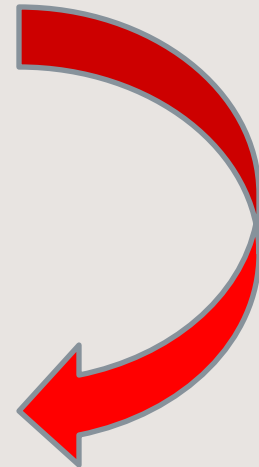
Elevation
on 4

Plan View



Orient Elevation 1 to Face:

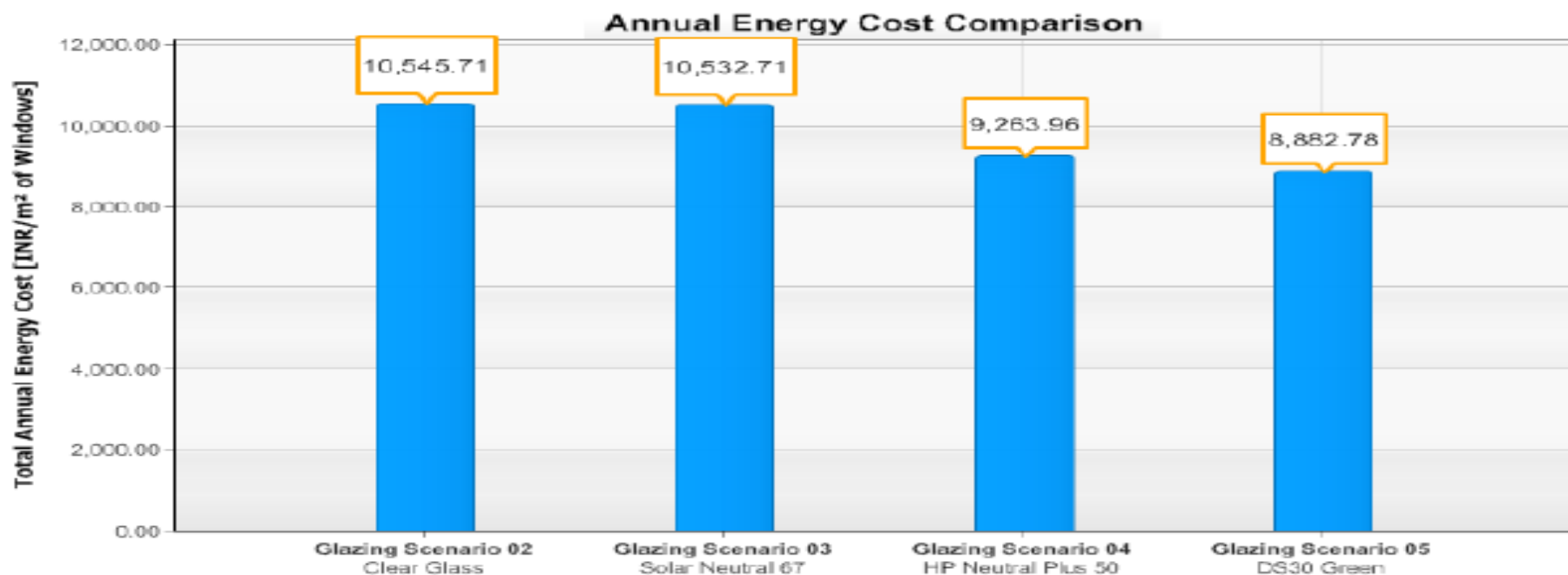
North
Northeast
East
Southeast
South
Southwest
West
Northwest



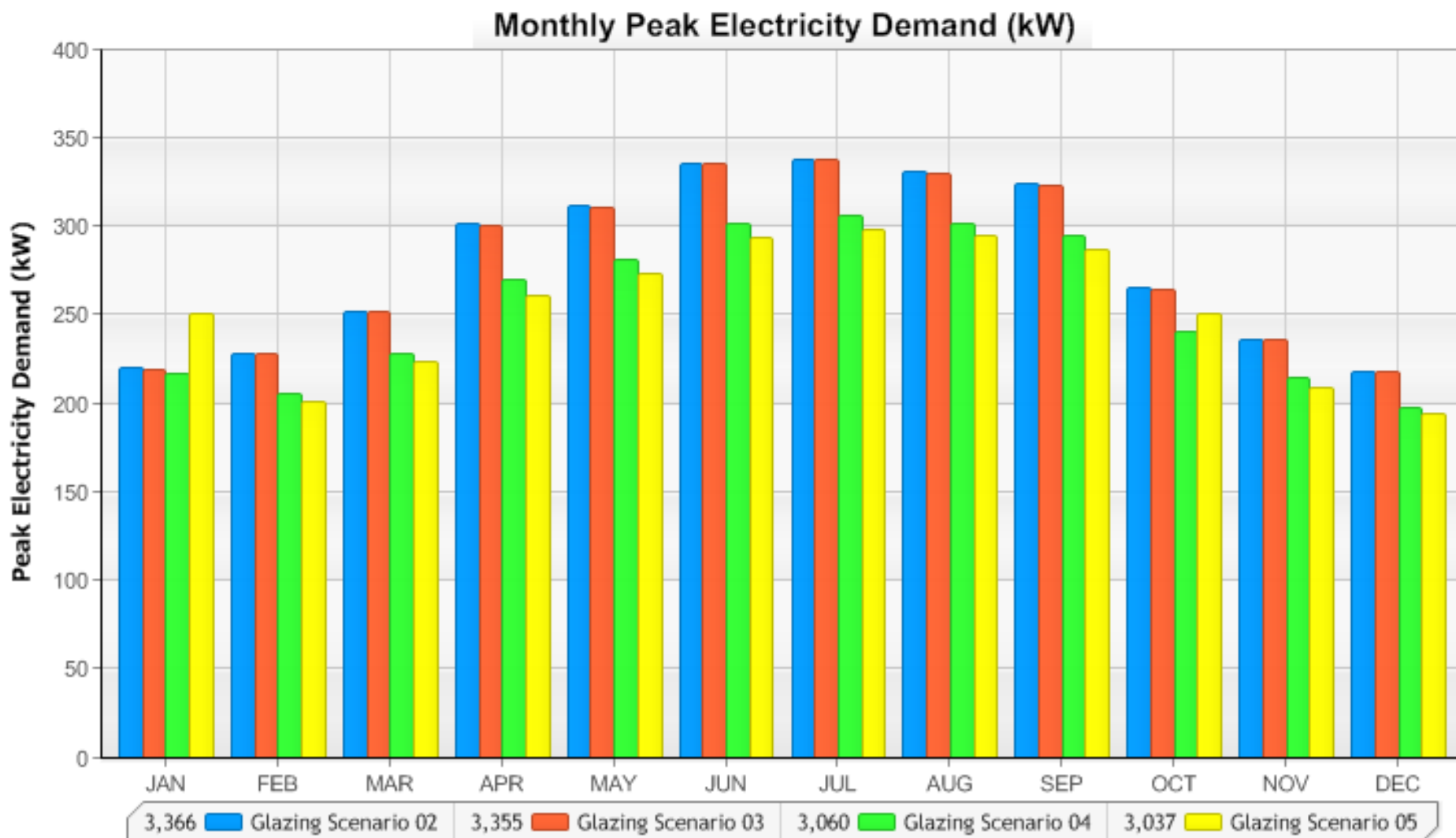
Building Energy Calculator: Scenario Comparison and Payback Analysis

Payback

Glazing Scenario	Glass Make-up Cost (per m²)	Building Glass Cost	Annual Building Energy Cost (Glass)	Initial HVAC Cost Compared To Baseline	Payback Period	First Year Savings (HVAC and Energy Costs)	Ten-Year Savings (HVAC and Energy Costs)
Glazing Scenario 02	800.00	590,816	7,788,212				
Glazing Scenario 03	+400.00	+295,409	-9,598	-6,019	30.2 years	-279,792	-193,414
Glazing Scenario 04	+1,400.00	+1,033,928	-946,597	-76,946	1.0 years	-10,383	+8,508,990
Glazing Scenario 05	+1,600.00	+1,181,632	-1,228,101	-97,049	11 months	+143,518	+11,196,427



Building Energy Calculator Report Example



Why do we apply coatings on glass?

Chemical Vapor
Deposition (CVD)

Pyrolytic process

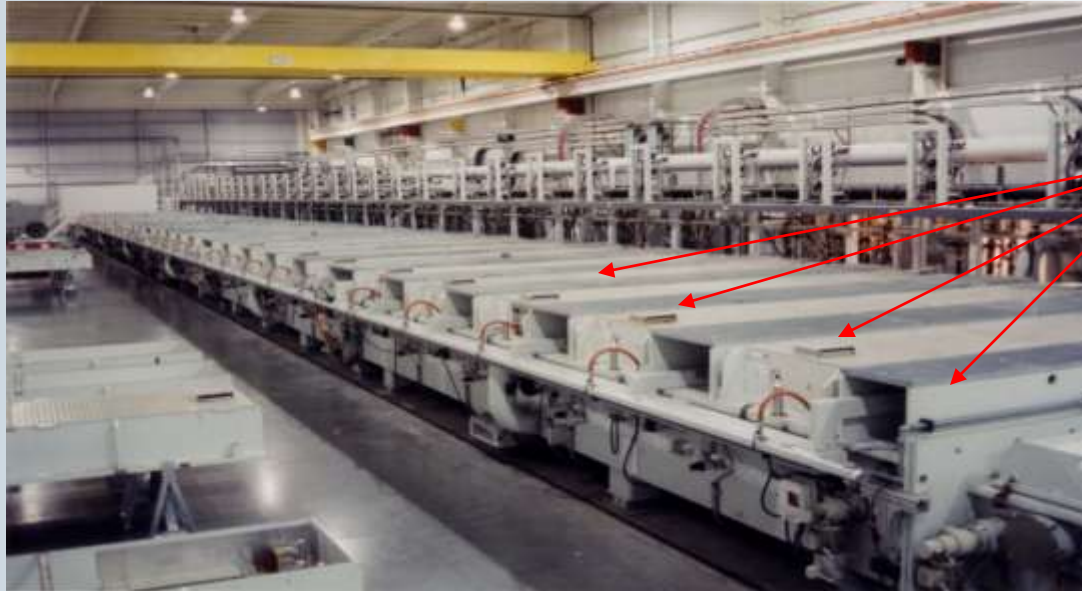
- On-Line process

Physical Vapor
Deposition (PVD)

Magnetron Sputtering

- Off-Line Process

Magnetic Vacuum Sputter Deposition Coater



Note compartments
("targets")

- \$40-50 million dollar equipment
- Coatings applied in vacuum
- Coating complexity dictates number of "targets" required
- Coatings often referred to as "soft coats"

How Glass is Coated?

Sputter Coating “Stack”

*Sputter coatings consist of multiple layers of metals whose combined thickness is only $1/1000^{\text{th}}$ the thickness of a human hair!

“Double Silver”
or
“Double Stack”

Each layer has a purpose

Layer

1

Silicon Nitride Barrier Layer

2

Optical Filter Layer

3

Nickel-chrome Adhesive Barrier Layer

4

Silver Thermal & Solar Performance Layer

5

Performance Enhancing Layer

6

Optical Filter Layer

7

Nickel-chrome Adhesive Barrier Layer

8

Silver Thermal & Solar Performance Layer

9

Performance Enhancing Layer

10

Optical Enhancing Layer

11

Silicon Nitride Barrier Layer

Base

Glass

SunGuard Global Product Series'

SNX (Triple Silver)	SN (Double Silver)	DS (Double Silver)	HIGH PERFORMANCE (HP)	HP COLORS	SOLAR	HD	HD COLORS
<u>Example Products</u>	<u>Example Products</u>	<u>Example Products</u>	<u>Example Products</u>	<u>Example Products</u>	<u>Example Products</u>	<u>Example Products</u>	<u>Example Products</u>
SNX 62/27 SNX 60/28 SNX 50/23	SN 68 SN 70/37 SN 29/18	DS 50 DS 40 DS 30	HP Neutral 60/40 HP Neutral 50/32 HP AG 43	HP Green Plus 50 HP Bronze 40/27 HP Royal Blue 40	Solar Neutral 67 Solar Silver 20 Solar Royal Blue 20	HD Neutral 67 HD Silver 20 HD Royal Blue 20	HD Grey HD Blue HD Bronze
• Low-E • LSG 2.2 - 2.3 • Dual Product A/T • Low Rout • Edge Del. Req. • TPF for HT	• Low-E • LSG 1.7 - 2.0 • Dual Product A/T • Low Rout • Edge Del. Req. • TPF for HT	• Low-E • LSG 1.6 - 1.7 • Dual Product A/T • Mod.-Low Rout • No Edge Del. Req. • No TPF Req. • IG or Emb. Lami Versions • Min. Fab. Reqs.	• Low-E • LSG 1.3-1.5 • Single Product • Mod.-High Rout • No Edge Deletion • No TPF Req.	• Low-E • LSG 1.3-1.5 • Single Product • Mod.-High Rout • No Edge Deletion • No TPF Req.	• Not Low-E • LSG < 1.2 • Single Product • Mod.-High Rout • No Edge Deletion • No TPF Req.	• Not Low-E • LSG < 1.0 • Monolithic use • Single Product • Mod.-High Rout • No Edge Deletion • No TPF Req.	• Not Low-E • LSG < 1.0 • Monolithic use • Single Product • Mod.-High Rout • No Edge Deletion • No TPF Req.

Guardian Advantage.....

SunGuard SuperNeutral Series can be used in drilled & point-supported applications...



Guardian SunGuard can be bent...



Guardian SunGuard
products can be
heat soaked...



Guardian SunGuard coatings can be supplied on heavy glass...



Colour Matching Vision-Spandrel Solutions

VISION:

SunGuard® HP Royal Blue 40

Colour matching spandrel:

**SunGuard® Solar Royal
Blue 20 + System140 12
4060**

Example

Lotte Plaza, Moscow



Colour Matching of Curved and Flat Façade

Examples

- **Glasstype:**
SunGuard® HP Green 43
- **Project:**
Ministry of Planning, Kuwait
- **Performance:**
U-value: 1,2 W/m²K
Solar Factor: 21 %
Selectivity: 1,7



Colour Matching of Curved and Flat Façade

Examples – Concave & Convex

- **Glasstype:**
SunGuard® SuperNeutral
62/34 HT
- **Project:**
CMP, Aachen, Germany
- **Performance:**
U-value: 1,0 W/m²K
Solar Factor: 34 %
Selectivity: 1,8





Total requirement is @ 12000 Sq Mts.

Products specified is Neutral 40 on Grey and HD Grey.

Façade contractor- Shreebrook

Façade consultant- Façade testing.

PMC- Synergy.

Kochi Smart City, Kochi



Glass for Interior Markets

BRILLIANT SOLUTIONS

Innovative products

Broad portfolio

High quality and
global availability

Ongoing innovation

UNLEASH THE POTENTIAL OF GLASS

Float Glass

Basic glass substrates

UltraMirror

Corrosion-resistant mirror

Tinted Mirror

High-Luster Durability mirror

DecoCristal

Back-Painted glass

SatinDeco

Acid-etched glass

UltraClear

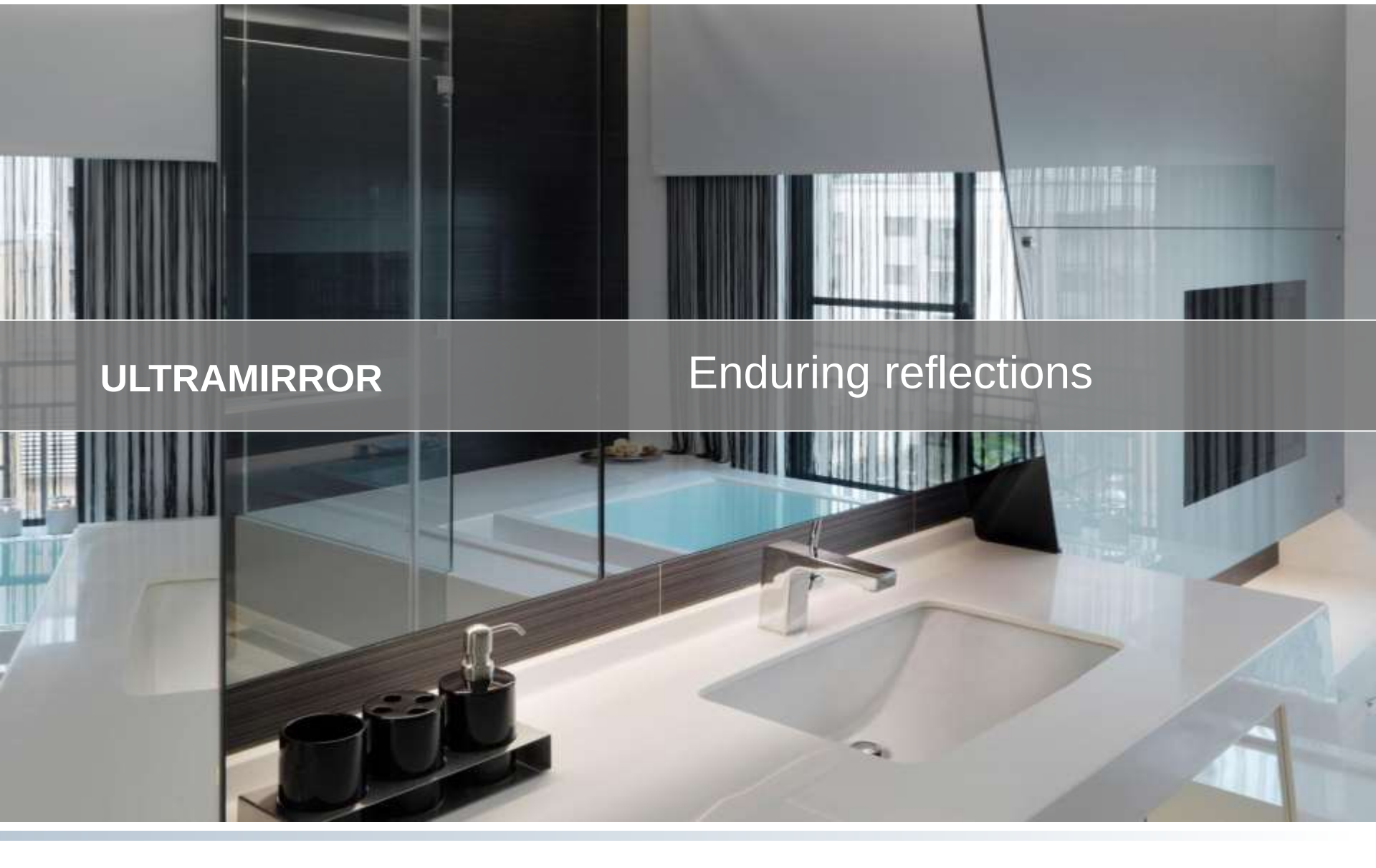
Low-iron glass



FLOAT GLASS

The basis for innovative solutions





ULTRAMIRROR

Enduring reflections

New Modiguard Mirror

Quality Smooth Surface

- High slip characteristics, prevent scratching
- Improved adhesion with tape applied for processing

Better humidity resistance

- Reduced Puddling on condensation & in humid conditions.

Stands to temperature variations.

Current UltraMirror Offerings



Standard mirror available from 2mm – 8mm

Sheet size is 3'x6'ft to 8'x12'ft

Standard cut sizes are stocked

Mirror is also applied to additional glass types including UltraClear low iron, and Tinted glass

Sparkle Mirror, Grey Mirror and Bronze Mirror
Sheet size is 6'x8'ft and thickness 4, 5, 6mm



New Offerings in Mirror

Sparkle Mirror

Grey Tinted Mirror

Bronze Tinted Mirror

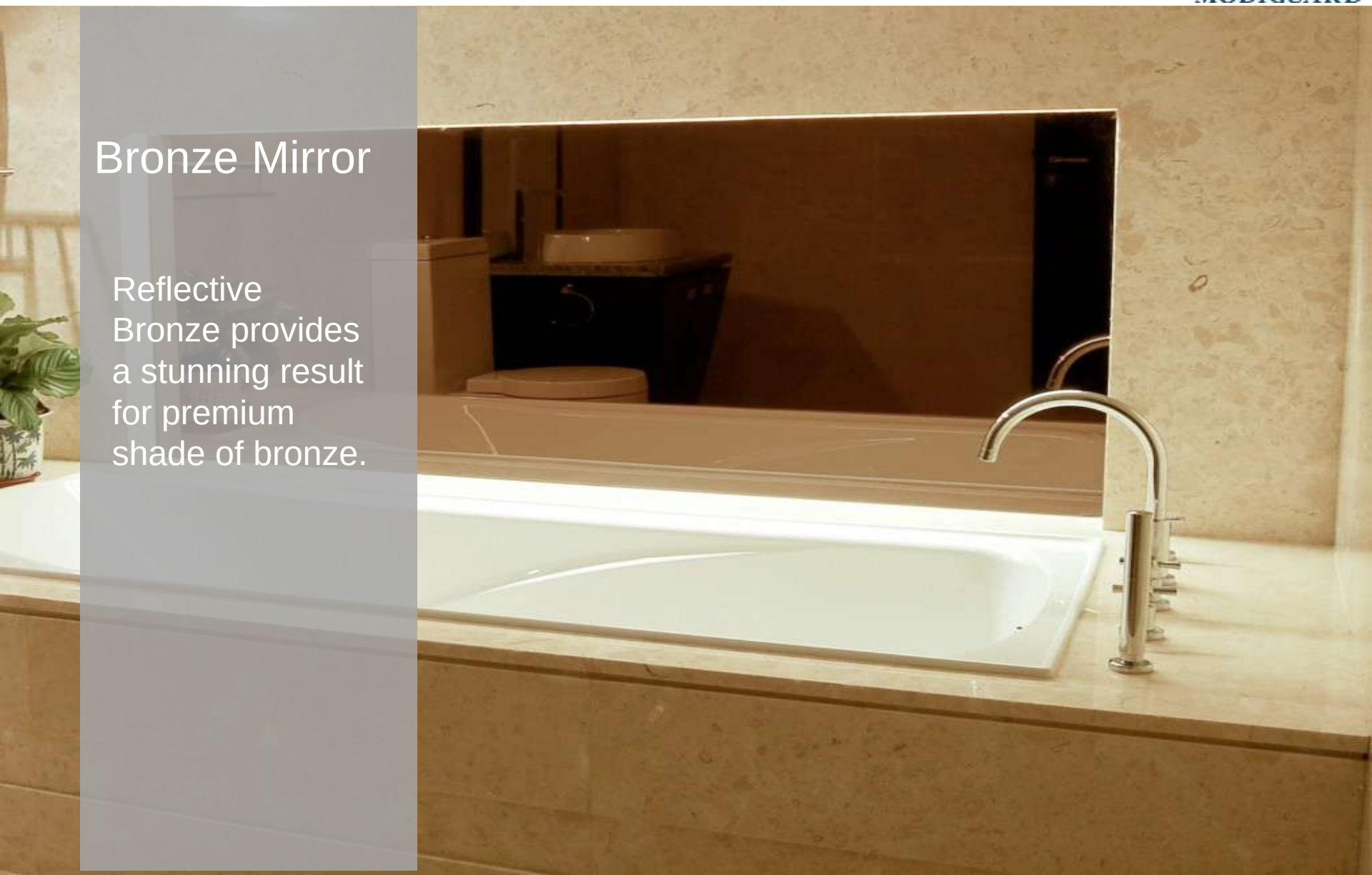
Sparkle Mirror

Provide Stunning
Bright appearance
to interiors.



Bronze Mirror

Reflective
Bronze provides
a stunning result
for premium
shade of bronze.



Grey Mirror

Reflective Grey provides a stunning result for premium shade of Grey.



Dielectric Mirror

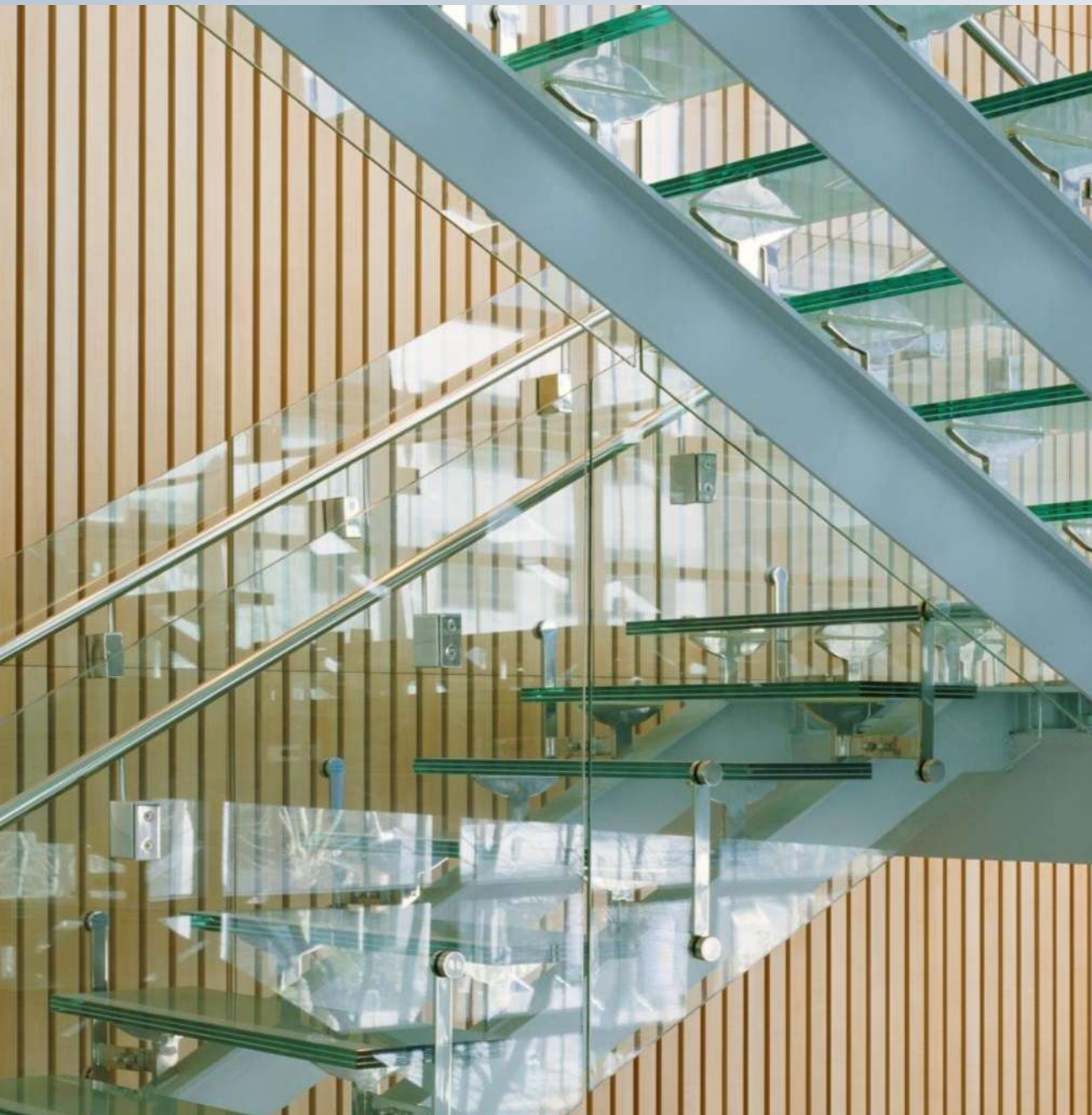


Dielectric Mirror



DecoCrystal





SLIDING DOORS

**WALLS &
PARTITIONS**

**FURNITURE,
TABLES
CASEGOODS &
SURFACES**

**DECORATIVE
SURFACES**

WARDROBE DOORS

**ELEVATORS &
ESCALATORS**

**DISPLAYS &
FIXTURES**

**STAIRCASES &
RAILINGS**

Ice White

Opaque white provides a stunning result for essential shade of white.



Ultra White

Manufactured on
Ultra Clear
Glass. Offers
vibrant white
lacquered finish.



Black

Opaque black provides a stunning result for essential shade of black.



Fluo Green

Enhance design
with saturated,
rich colour on
decorative
surfaces.



Red

Bright Red, opaque, highly reflective colour brings a statement to any space.



Blue Lagoon

Enhance design with saturated, rich colour on decorative surfaces, doors, walls, partitions, and so much more.





EXCEPTIONAL SUPPORT

Lifetime Modiguard InGlass Support



INGLASS SAMPLE DISPLAY KIT

Touch it. Try It. Experience it.



To learn more, visit sunguardglass.com