



GLASS: Enhancing quality  
of life & Energy efficiency

# Expressions of Glass in Different Building



Residential



Window

Office



Vision Glazing

Commercial



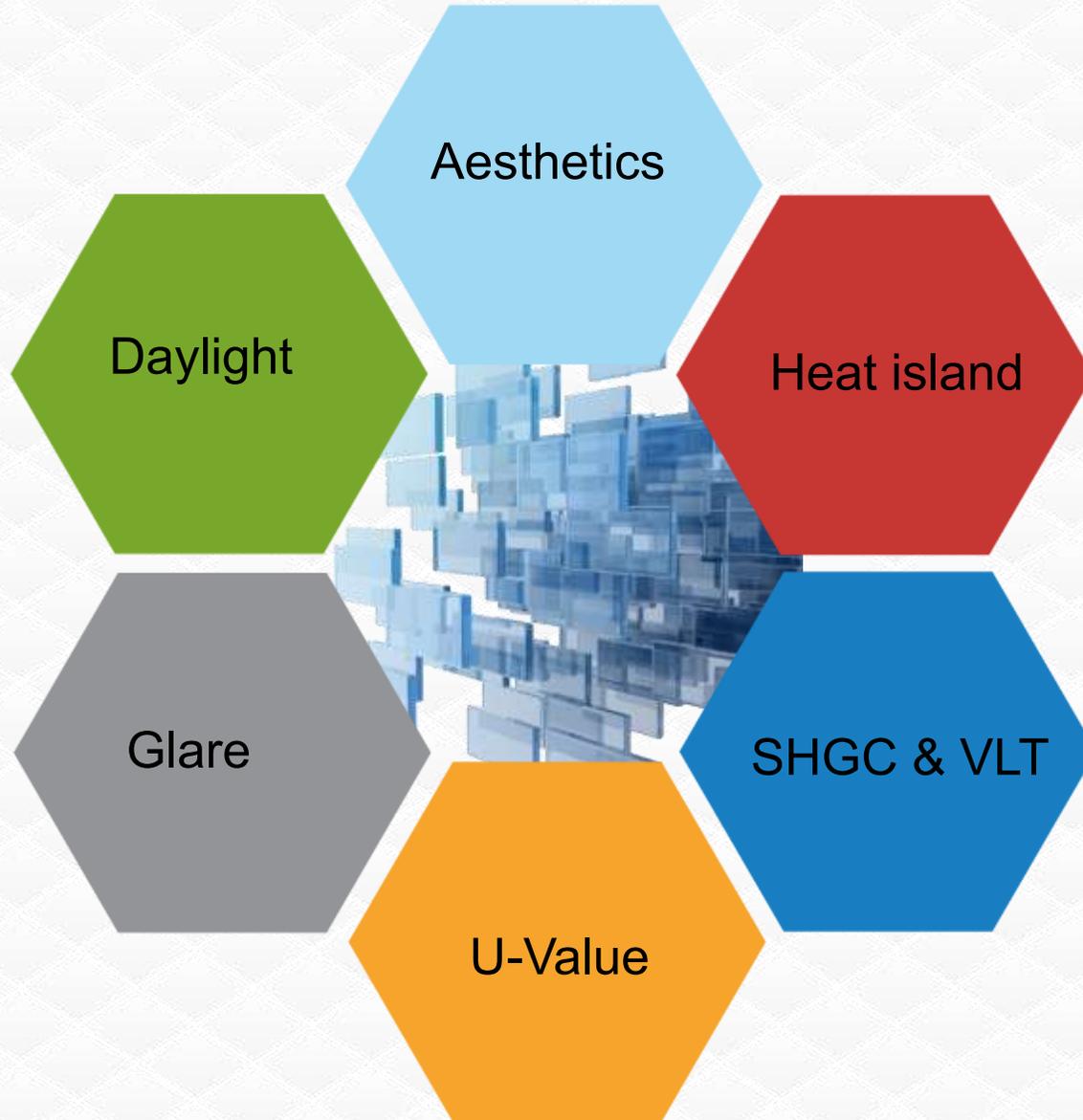
Facade

# Changing Trends in Glass



Glass allows great creative expressions and design flexibility

Phenomenon related to Glass



Many more

## Quality of life

- Daylight
- Aesthetics
- Glare

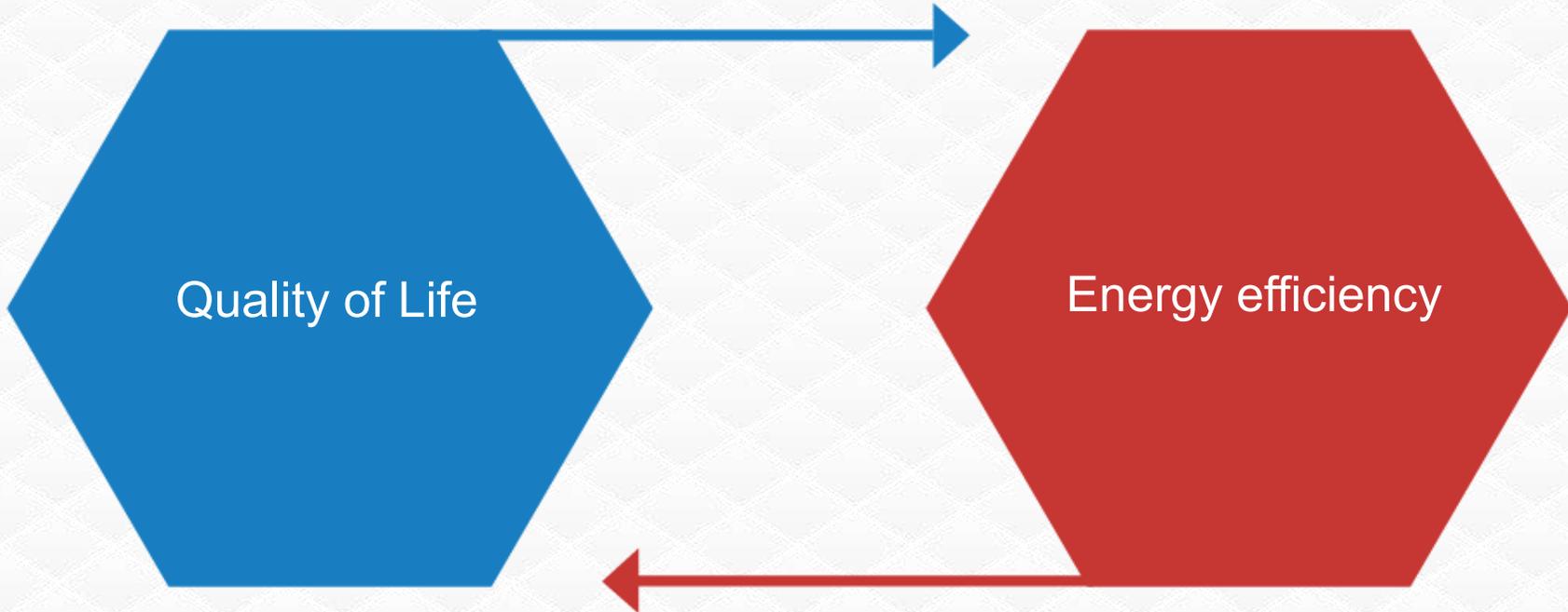
## Energy efficiency

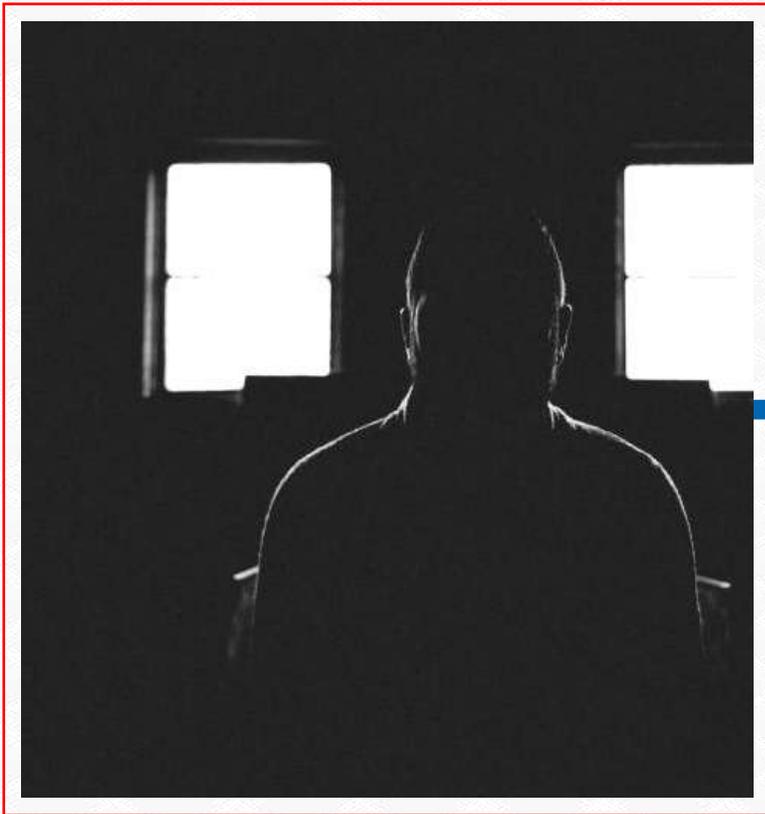
- SHGC & VLT
- U-Value
- Urban heat island

The Priority...



Enhancing human life by  
improving our building's efficiency





**Vs**



A person sitting in a dark room

Exposed to outside environment

## Main symptoms of sick building syndrome

Sore eyes

Headache

Palpitations

Feeling of suffocation

Agitation

Nausea

Dry, sore throat

Anxiety

Cold sensitivity

Cough

Dizziness

Numbness

Back ache

Sleeplessness

Easily fatigued

Intermittent fatigue

Psoriasis

**Psychological impact...**

# Energy Conservation Building Code (ECBC) for Glass



WWR (Wall window ratio) should not exceed more than 60%

Different thresholds of SHGC for WWR <40% and 40%-<60%

SRR (Skylight roof ratio) should not exceed more than 5%

Different thresholds of SHGC for SRR <2% and 2%-<5%

# Building Rating Systems in India



TERI- GRIHA



IGBC-LEED



USGBC-LEED



ECO-Housing

Guideline provided by various rating systems to adopt ***Sustainability***

To ensure the optimum daylight inside the space. Different threshold as per building.

90% of the occupants should have outside environment view

To ensure the best visual and thermal comfort



Building Rating Systems

Energy Efficiency

Materials & Resources

Indoor Air Quality

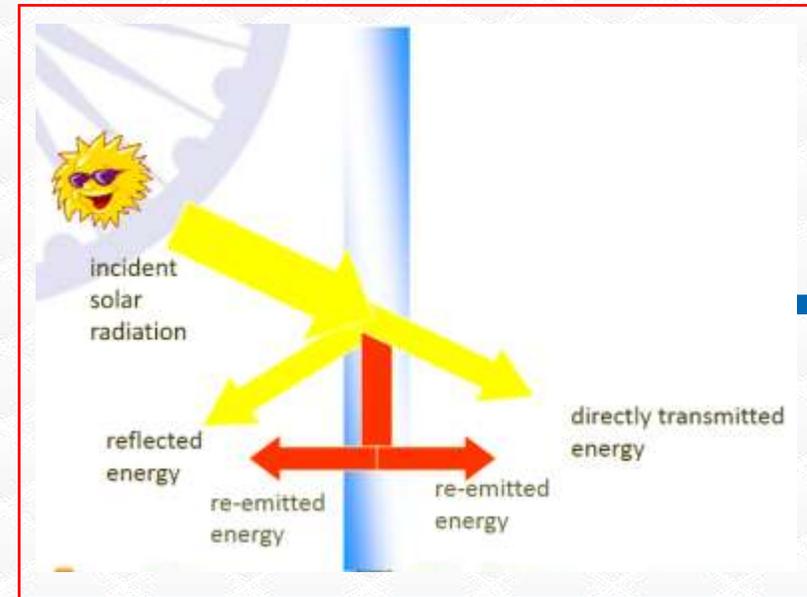
## VLT- Visual Light Transmission

- VLT is the amount of light coming inside the space through glass
- The higher the VLT, the higher is the light intensity inside the building.

## SHGC- Solar Heat Gain Co-efficient

SHGC refers to the ratio of the solar heat that passes through the glazing to the total incident solar radiation.

The lower the SHGC, the lesser the direct incident heat gains from the glazing surfaces.



## U-Value

- U-value is the rate of heat flow through a unit area building component through an overall unit temperature difference between the two sides of the component.
- The lower the U-value, the lower is the heat gain/loss in the building.

## Glass Selection: Orientation & Climate

- Heat and glare

## Glass Selection: Space use

- Percentage and properties of glass shall be decided on the space use

## LPD Reduction

- **Optimum daylight ingress would lead to savings in lighting.**

## Reduced HVAC loads

- Proper selection glass properties will lead to cooling loads

## Reduced capital cost

## The various simulations involved in rating systems

### Energy Simulation

- Energy Simulation is a process to devise simulation model for optimizing energy efficiency of the proposed building.
- Building Model encompasses building geometry, spatial relationships, geographic information and quantities and properties of building components.

### Daylight Simulation

- Daylight Simulation is a process to determine the areas that are well lit throughout the day-time operations and the areas where artificial lighting is necessary

### Lighting Simulation

- Lighting Simulation is a process to determine the lux level through the lighting design for interior and exterior spaces

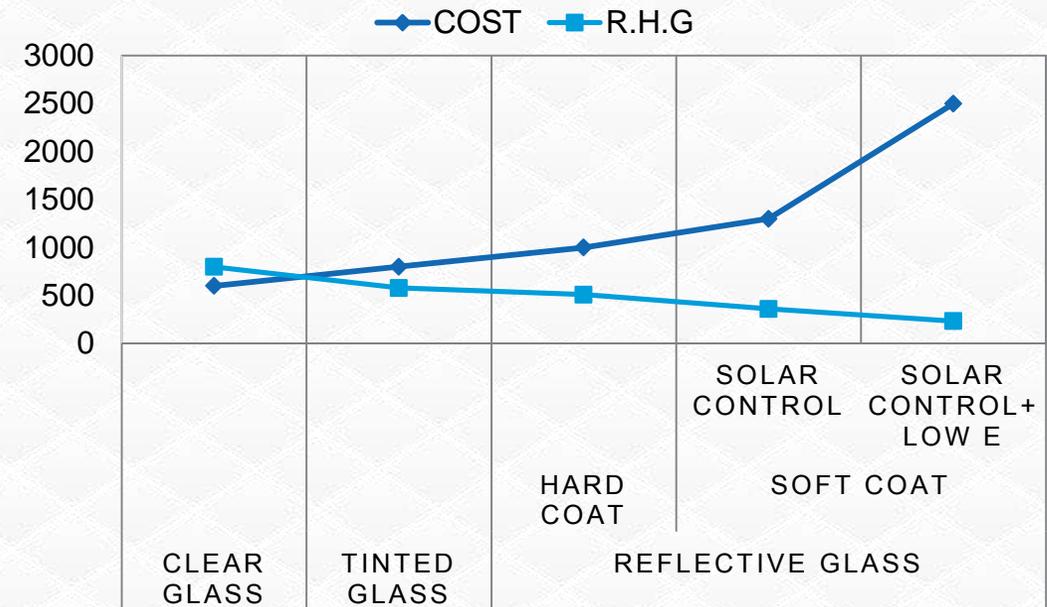


## Glazing selection Parameters

| Parameters            | Importance                                               |
|-----------------------|----------------------------------------------------------|
| Aesthetic             | Enhances look of the building                            |
| Energy Efficiency     | It is a combination of lighting & cooling energy saving  |
| Improved Day-lighting | Reduces artificial lighting requirement by using glazing |
| Glare Reduction       | It can defeat the purpose of using glass                 |

| Glass | Colour | VLT | IR | ER | SF | SC | U value | RHG    |
|-------|--------|-----|----|----|----|----|---------|--------|
| A     | Shade  | %   | %  | %  | %  |    | W/m2    | W/m2.k |

## Glazing Cost and Performance :



High performance glasses are innovative products which are **expensive but cost beneficial** as the amount of heat gain is less and hence more energy saving.



## Glazing: The aesthetic way to saving energy and costs

### Orientation Analysis

- If the building is less optimally oriented, it will lead to extensive heat gains from east and west, and hence to increasing HVAC loads
- Optimum orientation for building is along E-W axis at 147° N (highlighted in blue)

| Glass     | VLT | SF | U-Value | Rate (Rs. / sq. m.) | Daylight % | Total Electricity Consumption (KWH) | Annual Electricity Cost (Rs.) | Annual Savings (Rs.) | Glazing Cost (Rs.) | Extra Payment for HP Glass (Rs.) | Payback (Months) |
|-----------|-----|----|---------|---------------------|------------|-------------------------------------|-------------------------------|----------------------|--------------------|----------------------------------|------------------|
| base case | 92  | 87 | 5.8     | 800                 | 40         | 1715343                             | 1,02,92,061                   |                      | 28,00,000          |                                  |                  |
| HPG 1     | 35  | 46 | 5.8     | 1300                | 16         | 722184                              | 43,33,104                     | 59,58,956            | 45,50,000          | 17,50,000                        | 3.5              |
| HPG 2     | 43  | 48 | 5.8     | 1300                | 24         | 753348                              | 45,20,090                     | 57,71,971            | 45,50,000          | 17,50,000                        | 3.6              |
| HPG 3     | 46  | 47 | 5.8     | 1300                | 25         | 737392                              | 44,24,355                     | 58,67,706            | 45,50,000          | 17,50,000                        | 3.6              |
| HPG 4     | 56  | 48 | 5.8     | 1300                | 32         | 753023                              | 45,18,137                     | 57,73,924            | 45,50,000          | 17,50,000                        | 3.6              |
| HPG 5     | 25  | 35 | 5.8     | 1300                | 10         | 587213                              | 35,23,276                     | 67,68,785            | 45,50,000          | 17,50,000                        | 3.1              |
| HPG 6     | 35  | 46 | 5.8     | 1300                | 12         | 722303                              | 43,33,819                     | 59,58,242            | 45,50,000          | 17,50,000                        | 3.5              |
| HPG 7     | 39  | 52 | 5.7     | 1300                | 21         | 821483                              | 49,28,898                     | 53,63,163            | 45,50,000          | 17,50,000                        | 3.9              |

### Result:

Climatic and Shadow Analysis and Building Energy Simulations were conducted using 'Ecotect' software and 'Design Builder' software, respectively. The end results clearly showed that the glazing enabled a high level of both energy and cost savings.

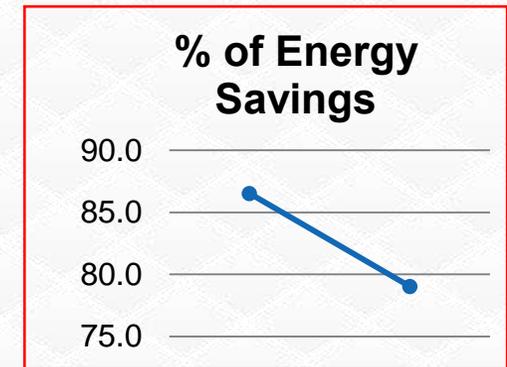
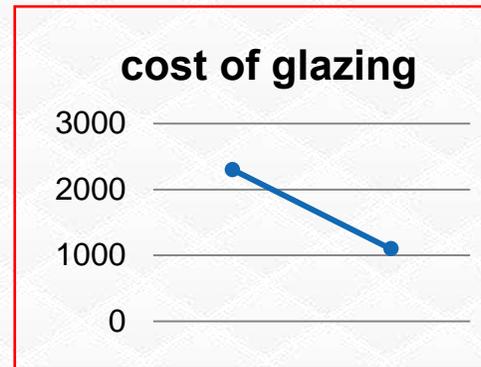
# Case 1: Cost Benefits of Glazing



Office building, Noida WWR > 60%



| Type        | Electricity consumption due to solar gains (KWH) | Electricity cost Annual (Rs) | Savings Annual (Rs) | Glazing Cost (Rs) | Extra payment for HP glass (Rs) | Payback years |
|-------------|--------------------------------------------------|------------------------------|---------------------|-------------------|---------------------------------|---------------|
| Clear SGU   | 7924493                                          | 55471453                     |                     | 18000000          |                                 |               |
| Blue Vision | 1068413                                          | 7478894                      | 47992560            | 69000000          | 51000000                        | 1.1           |
| Spring SGU  | 1661261                                          | 11628826                     | 43842627            | 33000000          | 15000000                        | 0.3           |



## Case 2: Inclined Facades

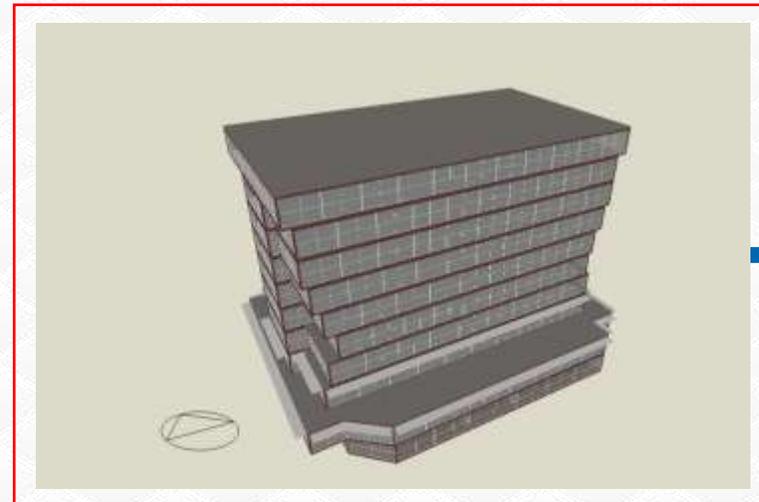
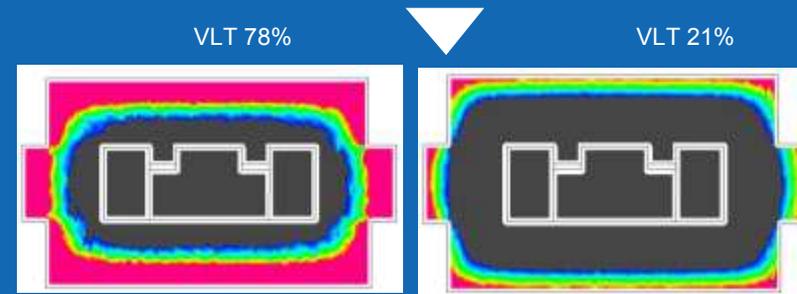


### Daylight Analysis:

For a corporate building in Mumbai, daylight analysis was done for Clear Glass (VLT = 78%) and the high performance glass (VLT = 21%). Both the glasses performed identically in terms of achieving the optimal lux levels. Clear Glass, in fact, caused glare in certain portions of the building.

- Daylight analysis prevented overdesigning of the building and at the same time optimize VLT requirement.
- High performance glass was used to reduce cooling load without compromising on lighting load

Pink region shows area which will have glare. Grey indicates sub-optimal lighting. In 2nd case, we can see reduction in glare area



Glass is a expensive building material.?

Excess use of glass in campus will lead to heat island effect.?

If WWR is kept more than 60%.?

Retrofitting of building demands dismantling of the glass for better performance of glass façade. It turns out to be expensive affair.



**Thank You**