

# Addressing visual comfort, daylight access and solar shading with fixed external shading devices: A simplified approach

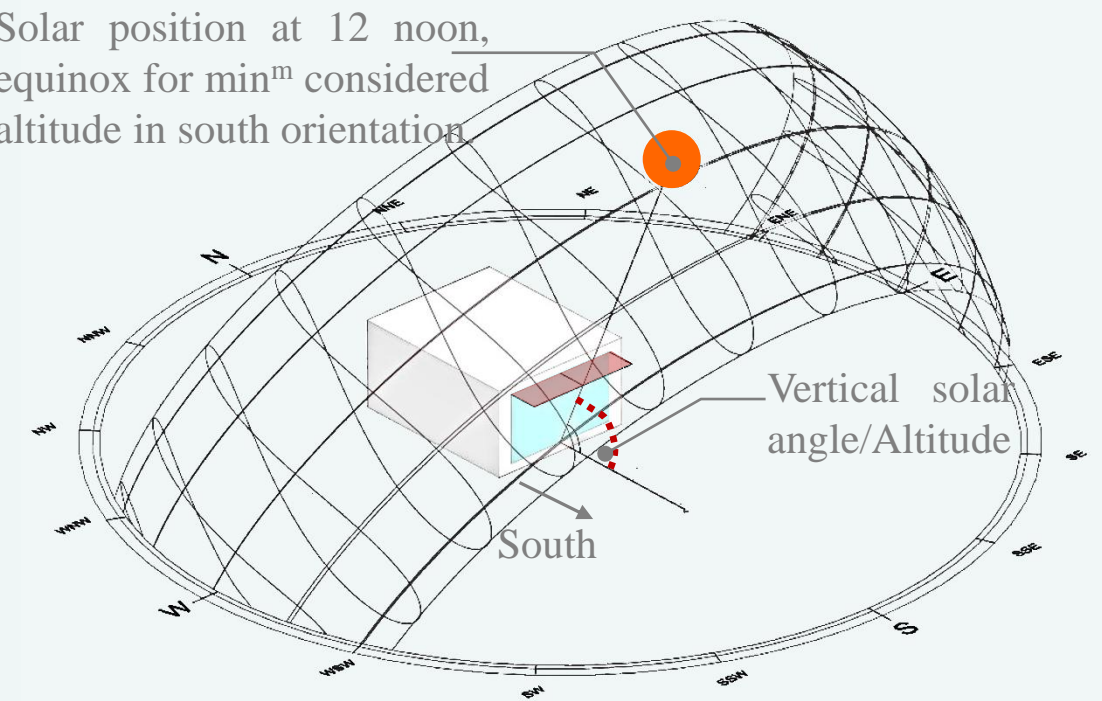
Focus areas: Geometric approach-Early design stage-Daylight access(Sky view factor)-Visual comfort(Guth position index)-Radiation mitigation(SHGC)-Resultant Energy Use Intensity

1

### Introduction to problem statement

- Balancing energy demand , daylight access & visual comfort
- Simplified geometric approach suitable to early design
- Sample space: Office building in Delhi, India (Composite Climate, 28.7° N, 77.1° E)
- Energy conservation Building Code (ECBC) used for base geometry. (Fig. 1)

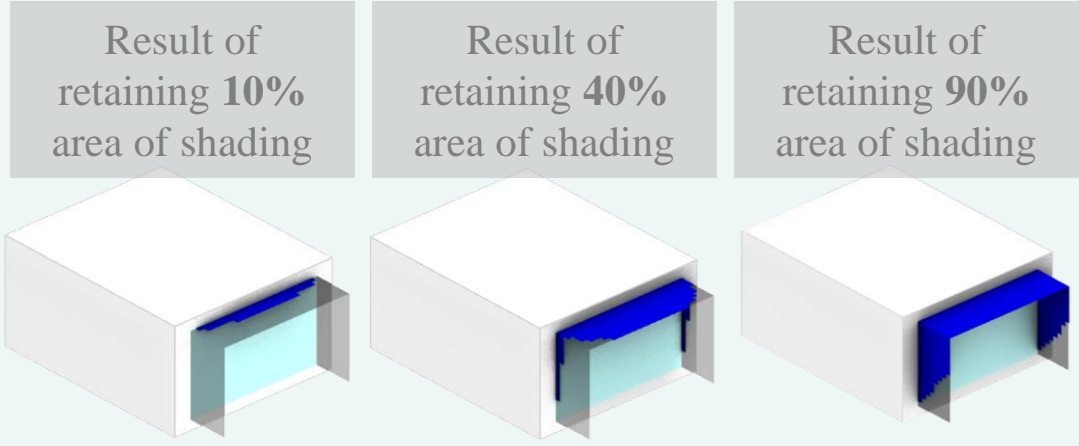
Solar position at 12 noon, equinox for min<sup>m</sup> considered altitude in south orientation



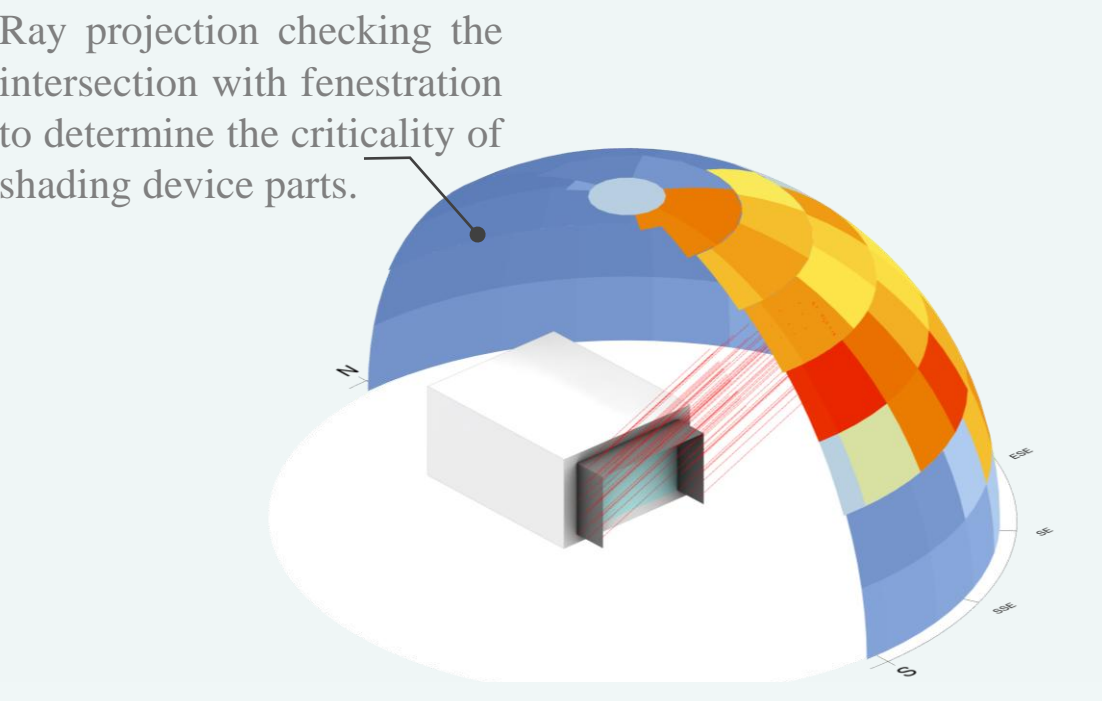
2

### SHADERADE: Balance between Solar gains & Daylight access

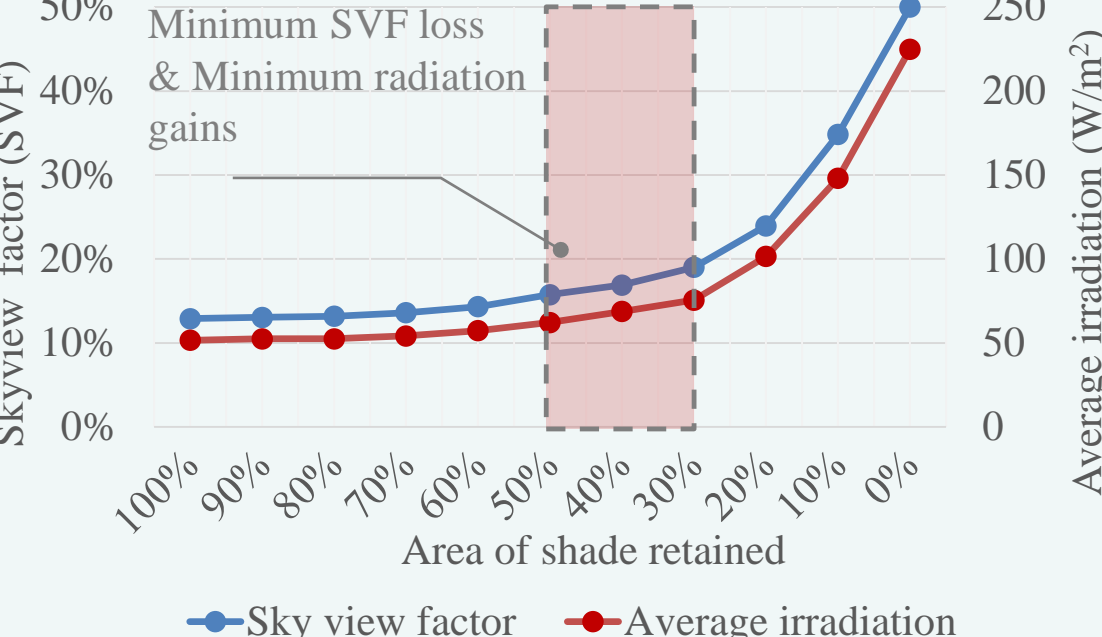
- Intersection of ray with shading device & glass to check protection from radiation.
- Assigning weightage geometric grid of shading device based on its ability to protect from solar radiation.
- Most critical 40% geometry is kept intact as it optimises Sky view factor (SVF) & Radiation gains.
- Glare mitigation not addressed yet



Result of retaining 10% area of shading      Result of retaining 40% area of shading      Result of retaining 90% area of shading



Ray projection checking the intersection with fenestration to determine the criticality of shading device parts.



Minimum SVF loss & Minimum radiation gains

Skyview factor (SVF)      Average irradiation (W/m<sup>2</sup>)

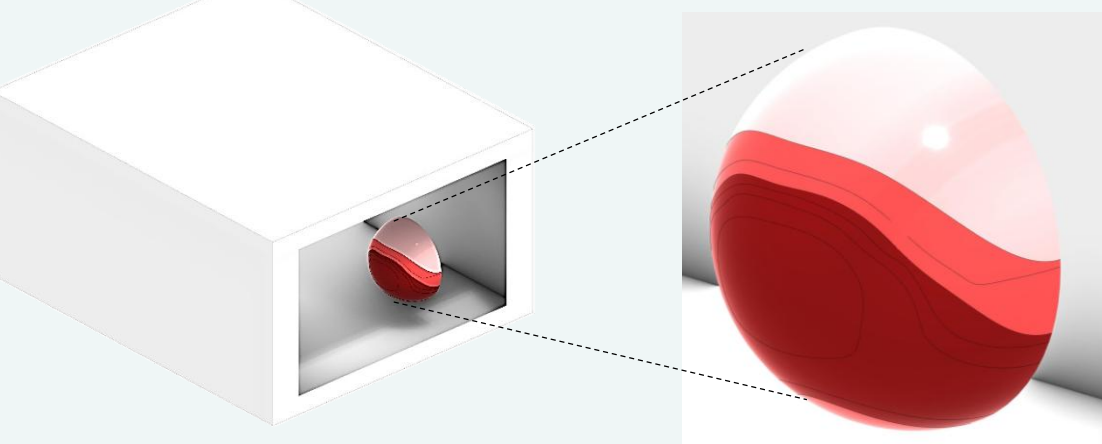
Area of shade retained

— Sky view factor      — Average irradiation

3

### Glare mitigation through Guth position index

- Guth position index allocates scores to view angles with respect to user direction and perception of glare
- Index diagram is projected on the shading device, creating a division in the parts of shading device as per the criticality gradation



NON-CRITICAL (Safe) Position index more than 12      CRITICAL (Not safe) Position index between 4 & 12

INTERMEDIATE Position index between 12 & 4

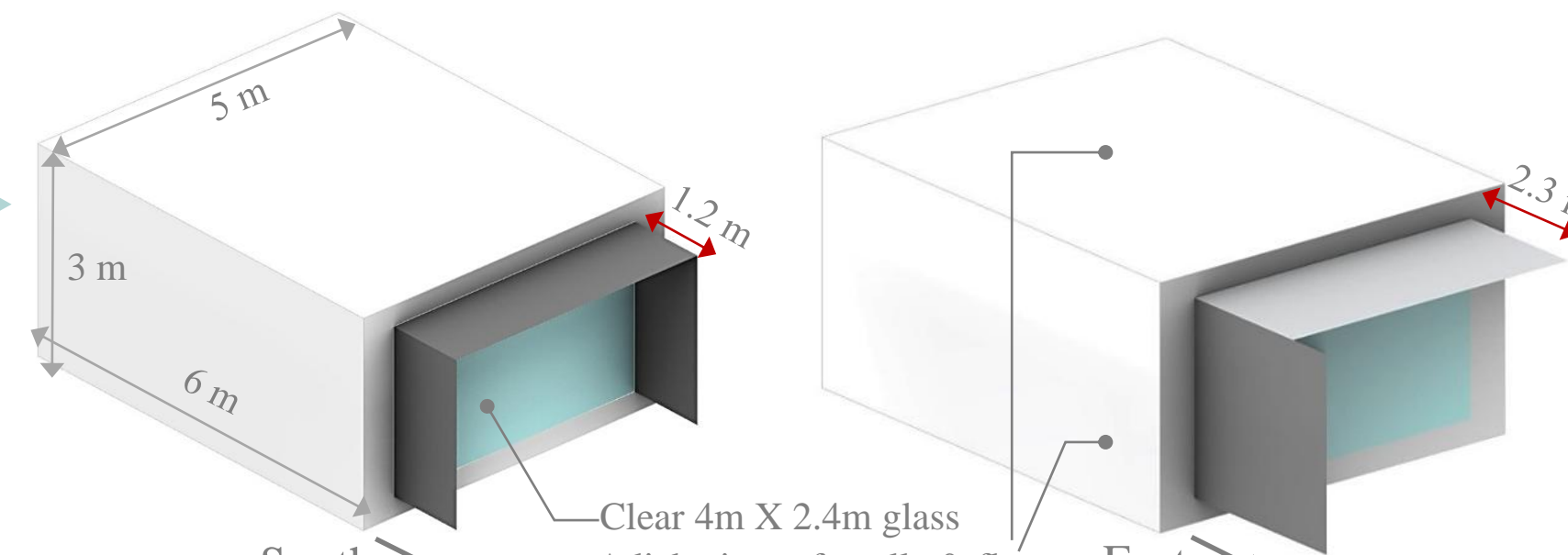
4

### Resultant LITERADE case: Overlapping of parameter

- Result includes overlap of Solar radiation logic & Guth position index gradation.
- Perforation sizes used as one of the methods to control light transmission as per criticality.
- Resultant Literade case balances daylight access, radiation control and glare mitigation.

Colour code	Radiation protection (Shaderade)	Glare protection (Guth position)	Daylight access	Design decision
Dark Purple	Critical	Critical	Non-critical	Least light transmission (20% open)
Medium Purple	Critical	Intermediate	Non-critical	Least light transmission (20% open)
Light Purple	Critical	Non-critical	Non-critical	Medium light transmission (40% open)
Dark Red	Not critical	Critical	Non-critical	Least light transmission (20% open)
Red	Not critical	Intermediate	Non-critical	Medium light transmission (40% open)
Light Red	Not critical	Non-critical	Non-critical	Maximum light transmission (80% open)

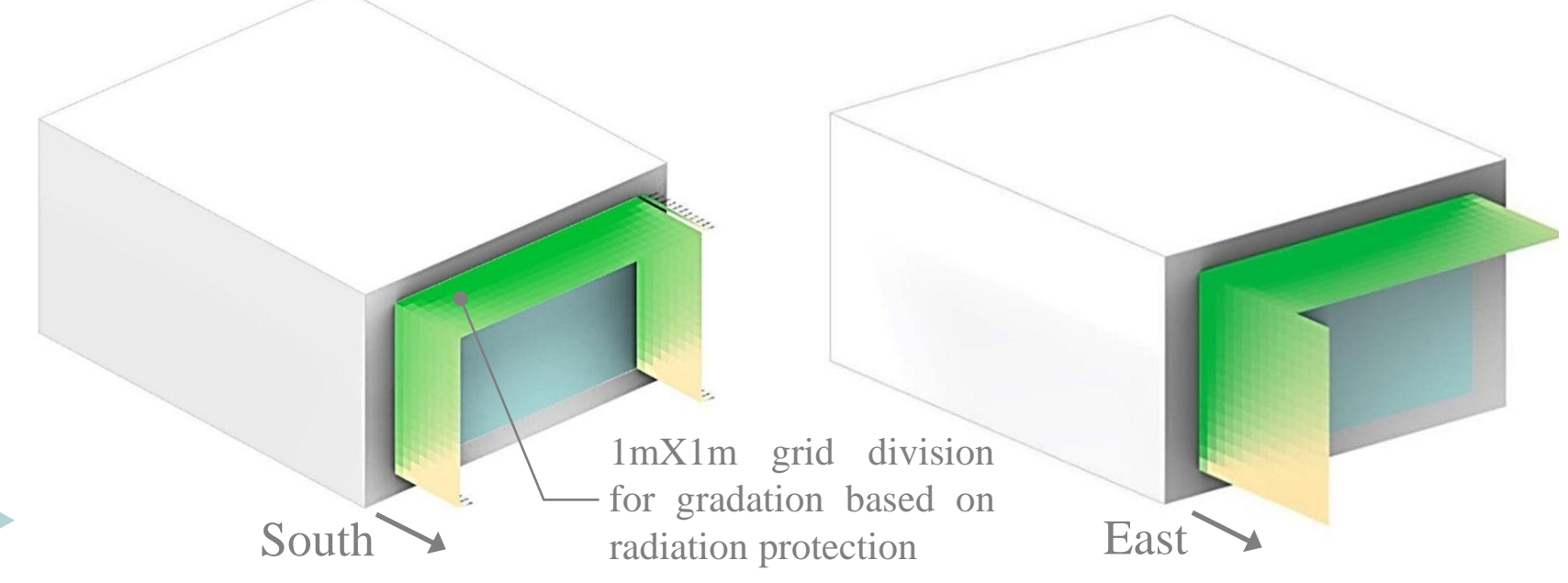
### Code compliant (ECBC) case



South      East

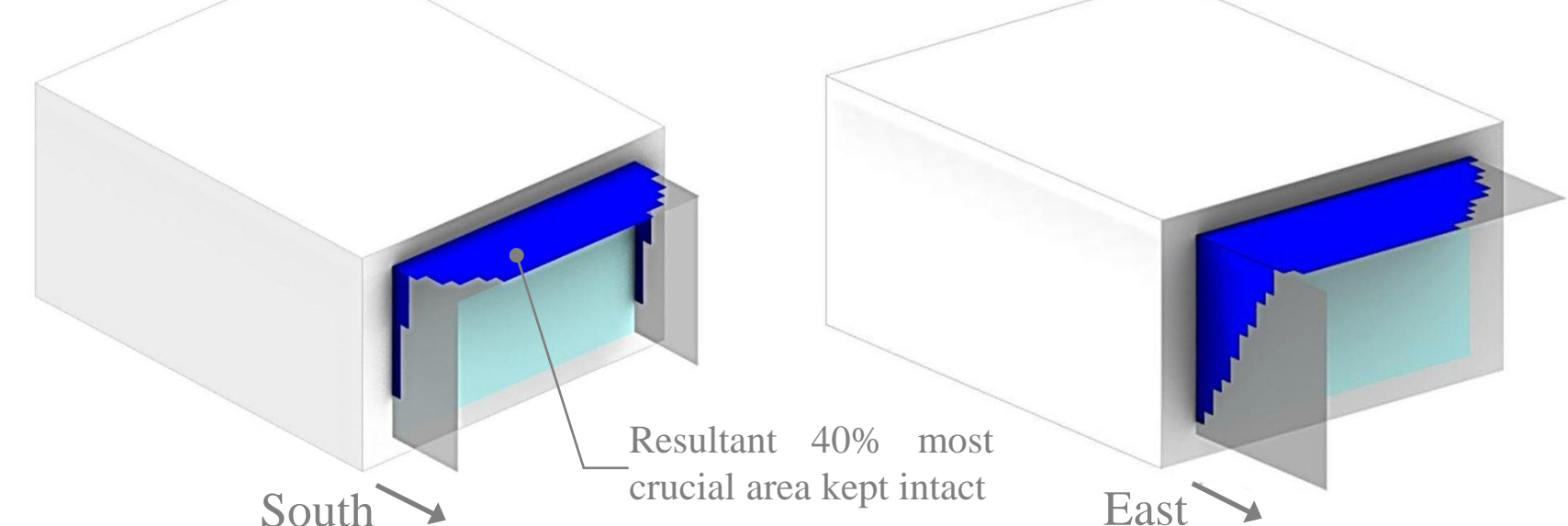
Clear 4m X 2.4m glass  
Adiabatic roof, walls & floor

### SHADERADE case



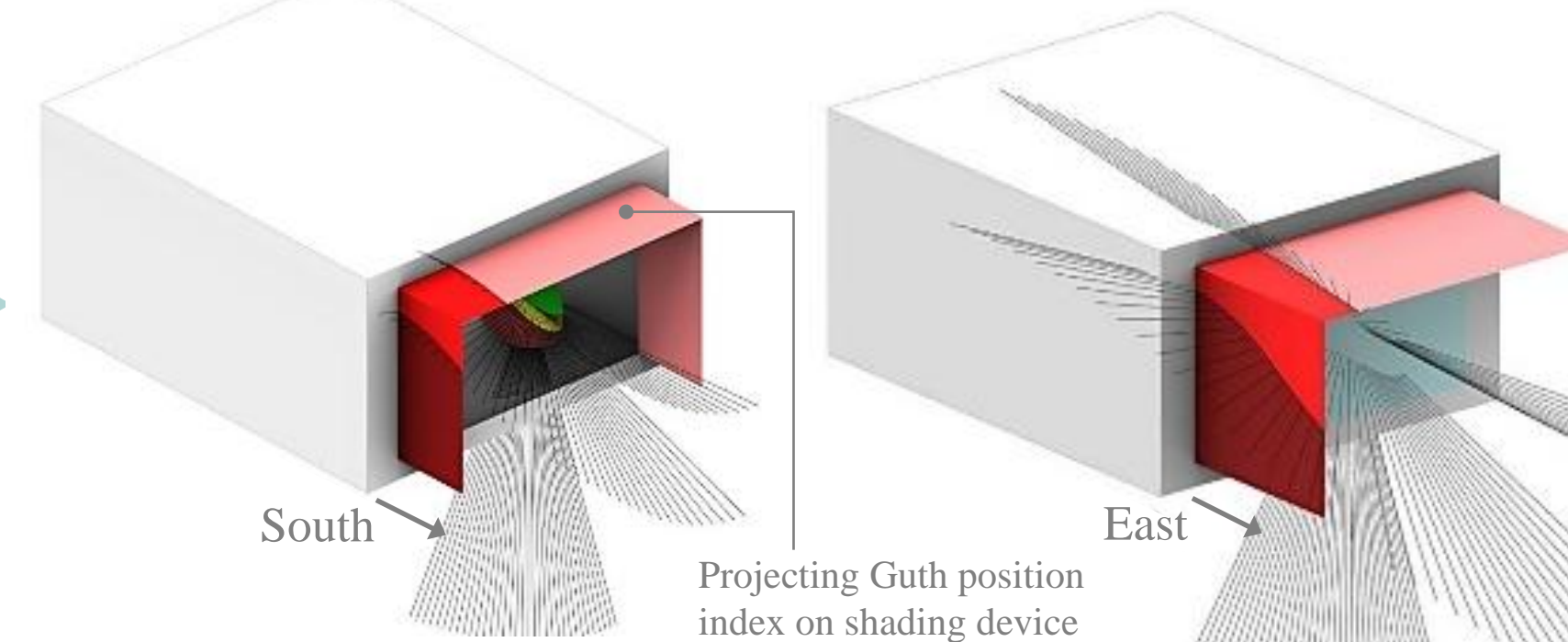
South      East

1mX1m grid division for gradation based on radiation protection



South      East

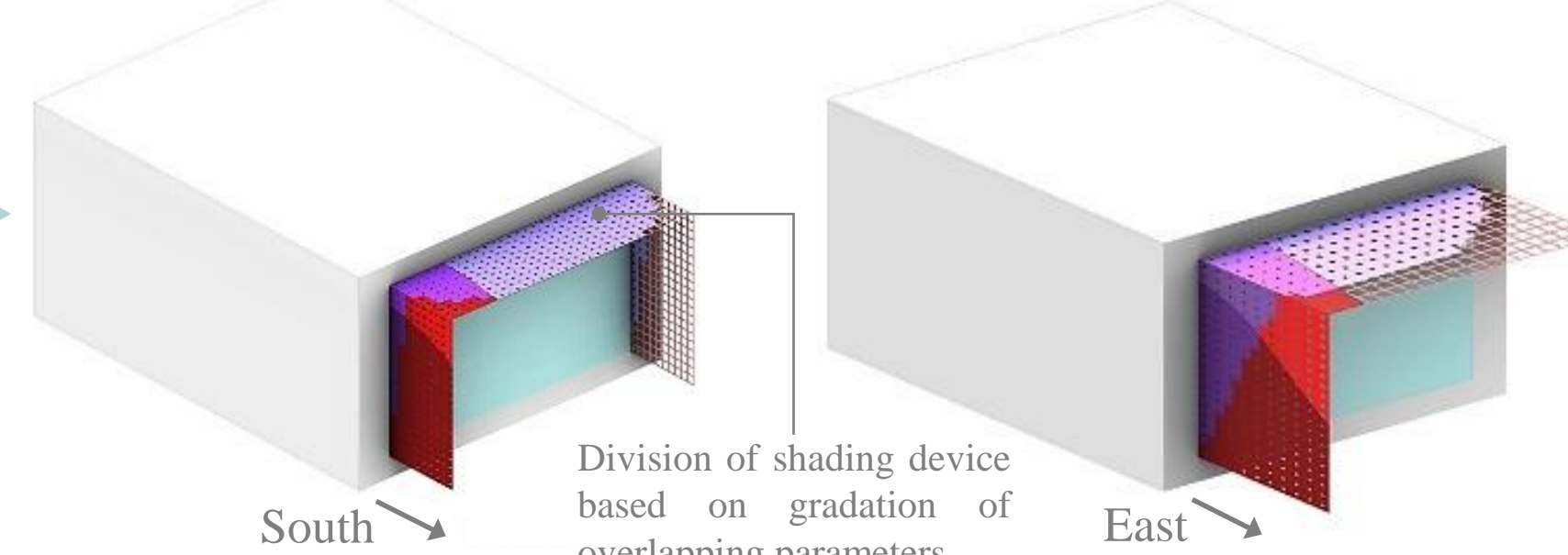
Resultant 40% most crucial area kept intact



South      East

Projecting Guth position index on shading device

### LITERADE case (Proposed)

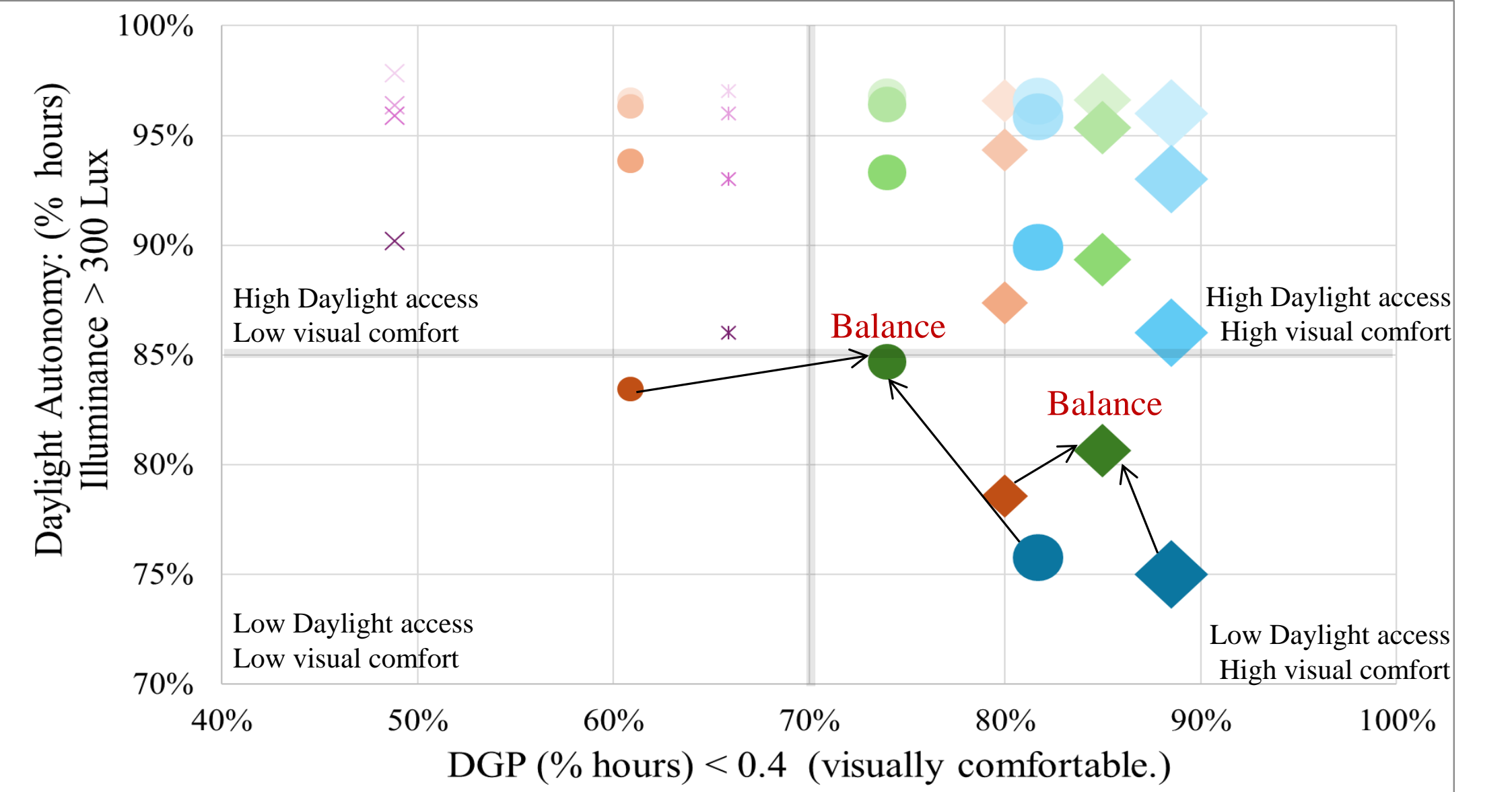


South      East

Division of shading device based on gradation of overlapping parameters

## PERFORMANCE ANALYSIS

- For South oriented window, **10% improvement in Daylight autonomy** from ECBC case and **12% improvement in DGP** from SHADERADE case, hence balanced.



Daylight Autonomy: (% hours) Illuminance > 300 Lux

DGP (% hours) < 0.4 (visually comfortable.)

High Daylight access Low visual comfort      High Daylight access High visual comfort

Low Daylight access Low visual comfort      Low Daylight access High visual comfort

Balance

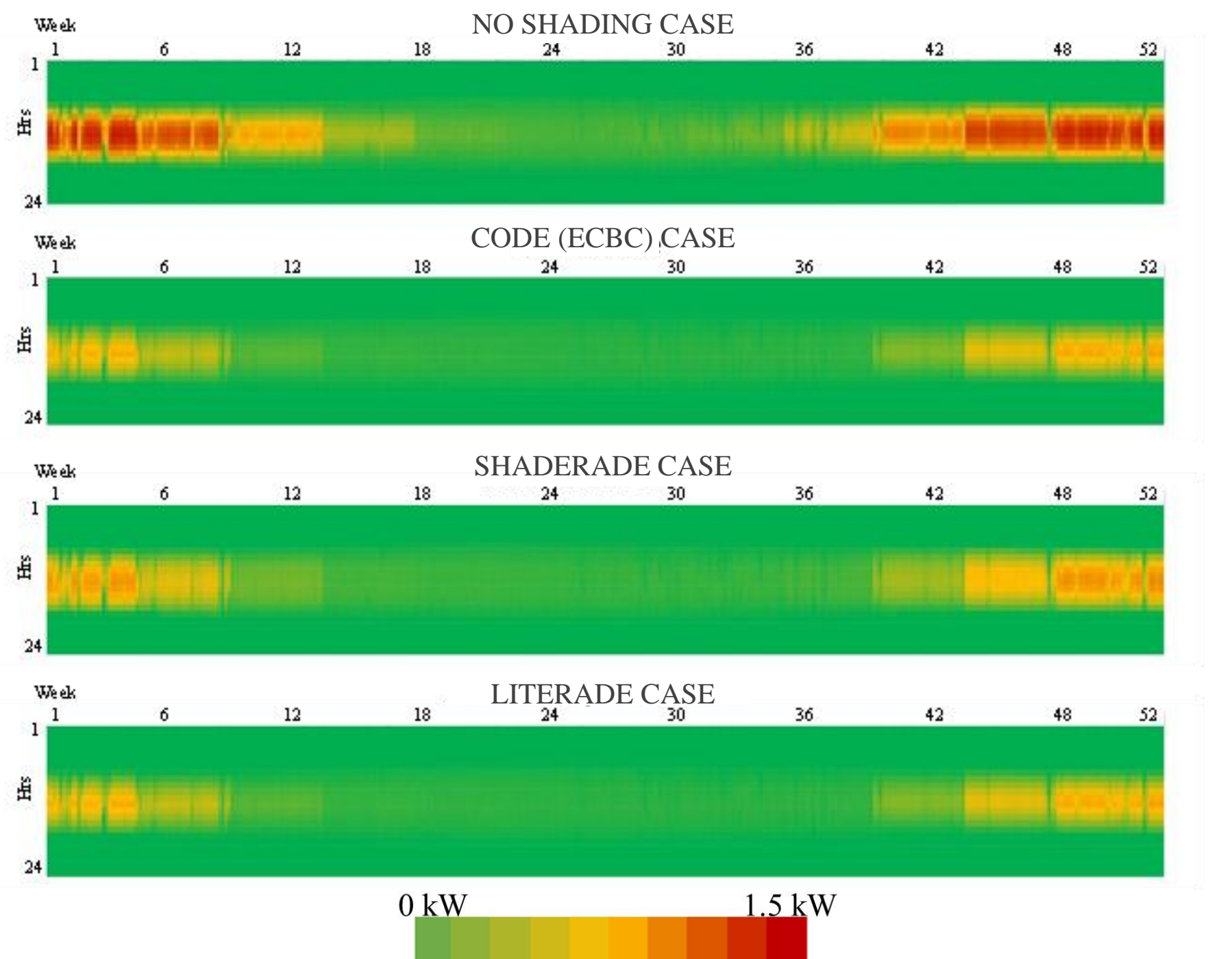
Balance

DA4 DA3 DA2 DA1      DA4 DA3 DA2 DA1

No shading case      Shaderade case      South orientation

Code (ECBC) case      Literade case      East orientation

- Graph represents Solar radiation transmission through window annually. **13% reduction in annual Energy Use Intensity (EUI) observed**



NO SHADING CASE

CODE (ECBC) CASE

SHADERADE CASE

LITERADE CASE

Week 1 6 12 18 24 30 36 42 48 52

Hrs 1 24

0 kW      1.5 kW