Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

THIS PRESENTATION WAS SHARED BY

Mr. Shailesh Ranjan

Head – Business
Planning & Operations, Asahi India Glass,
Navi Mumbai

FOR THE SESSION:

"Embodied Energy and the Life Cycle Approach"

DURING ANGAN 2019

Knowledge Partner teri The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

Event Partner TEC INDIA™
Event & Brand Management Co.

Embodied Energy and the Life Cycle Approach

Glass –

Universal, transparent and sustainable

Augmenting Nature by Green Affordable New-Habitat (ANGAN)

AIS

Asahi India Glass Limited

Preferred building material

- Low cost
- Ease of off-site production (of curtainwalls especially)
- Single-trade, light weight and fast envelope construction
- More available carpet area
- Relative durability of glass,
- Transparency
- Indefinite recycling

Key details

- Composition - **Sand (59%), soda ash (19%), dolomite (15%), limestone (5%) and feldspar (2%)**
- Recycled glass content - **15%**
- Total energy consumption in the Indian glass industry - **1.17 million metric tons of oil equivalent**
- Average energy cost as a percentage of manufacturing cost - **40%**
- Melting and refining (Energy use share) **60-70%**
- Energy Use - **80% Thermal energy**

India Construction Materials Database of Embodied Energy and Global Warming Potential - METHODOLOGY REPORT - NOVEMBER 30, 2017

Universalism

In application

YES

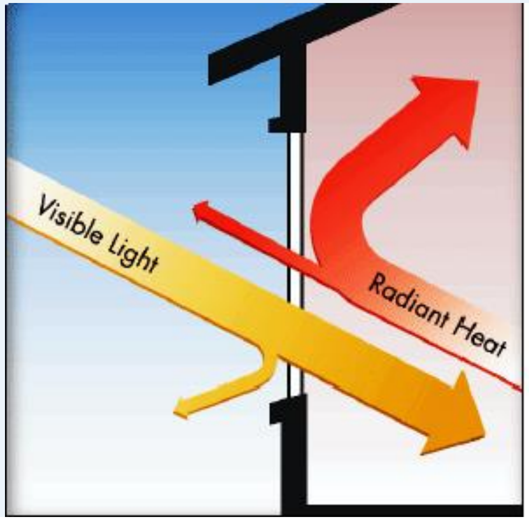




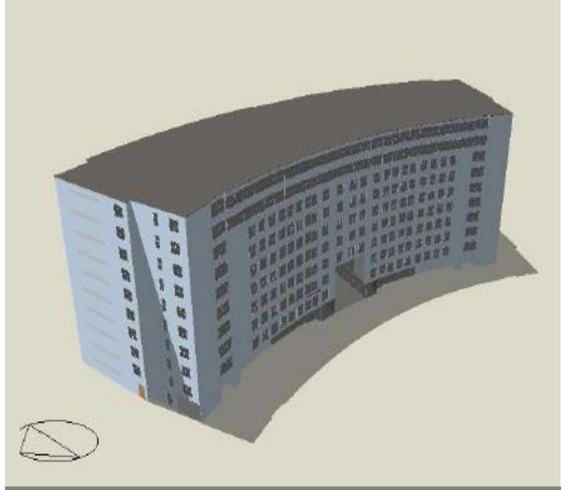



In selection and design

NO

Climate Analysis



Office Building in Bangalore

Climatic condition of the location is important to select type of glazing as different weather conditions have different impact on glass.

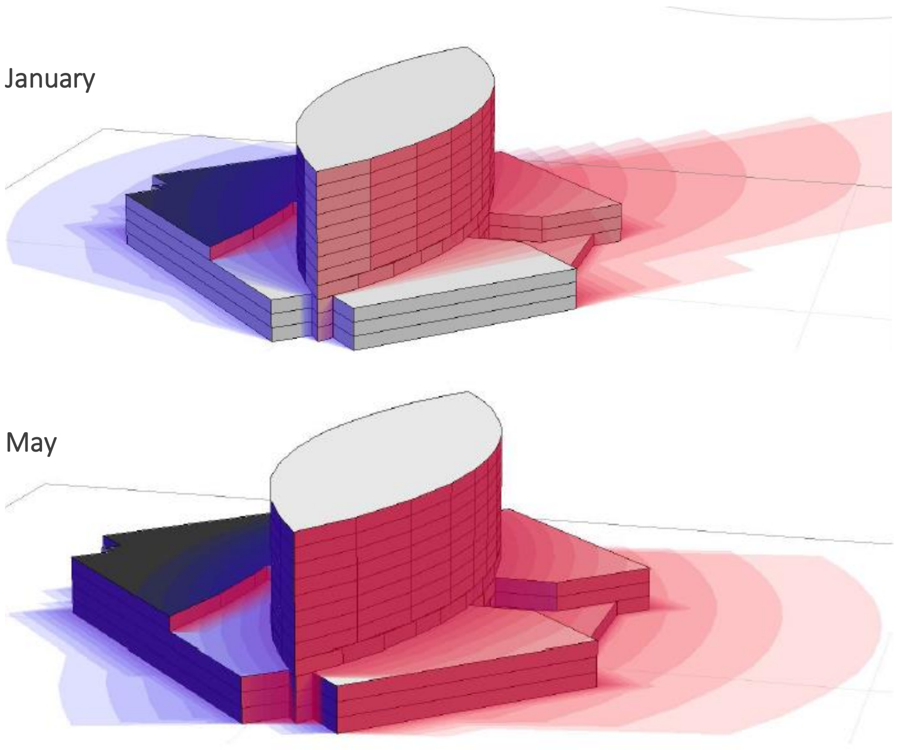
Calculations	Total (KWh)	Cost of Electricity	Savings (Kwh)/ Yr	Savings (Rs.) / Yr	Cost of Glass	Cooling design (Kwh)	Cooling Load In TR	Units	Cost	Saving	Extra Paid for Glass
base case clear Glass SGU	7032860	42197163			2750000	3052	862	300tr*3	21375000		
Enhance Pine SGU	7244067	43464400	-211206	-1267237	5500000	2960	836	300tr*3	21375000	0.00	2750000
Enhance Reef SGU	7034942	42209653	-2082	-12491	5500000	2905	820	300tr*3	21375000	0.00	2750000
Proposed Glass	7099559	40597354	-66699	-400191	5750000	2800	790	300tr*2 + 200tr*1	19000000	2375000	3000000
Proposed Glass with lighting controls	7320208	43921247	-287347	-1724085	5750000	2876	812	300tr*2 + 200tr*1	20187500	1187500	3000000
Proposed Glass without lighting controls	7640898	45845389	-608038	-3648227	4250000	2885	814	300tr*2 + 200tr*1	20187500	1187500	1500000

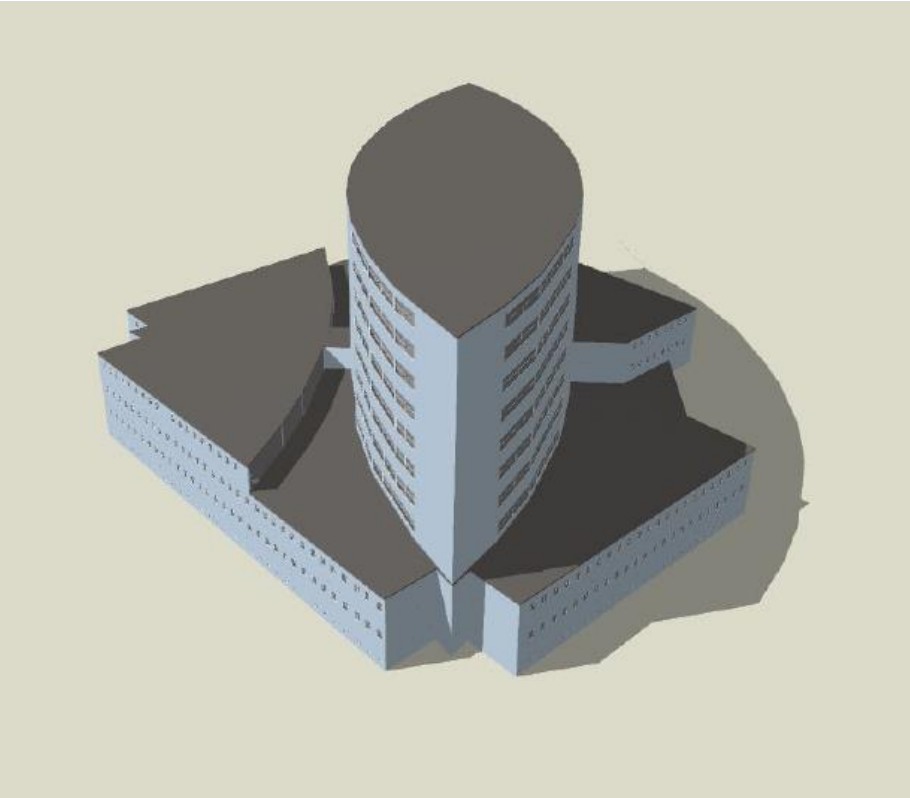
Glass with SF of 37 & U-Val – 5.7 was as efficient as a glass with SF of 25 & U-Val – 3.7. The building design & the local weather conditions meant that you can relax the glass values and still be energy efficient.

Orientation

A commercial complex at Navi Mumbai with glazing on the Eastern and Southern façade showed that Clear Glass performed as good as "high-performing glasses" and the choice came down to aesthetics.

Shadow Analysis:

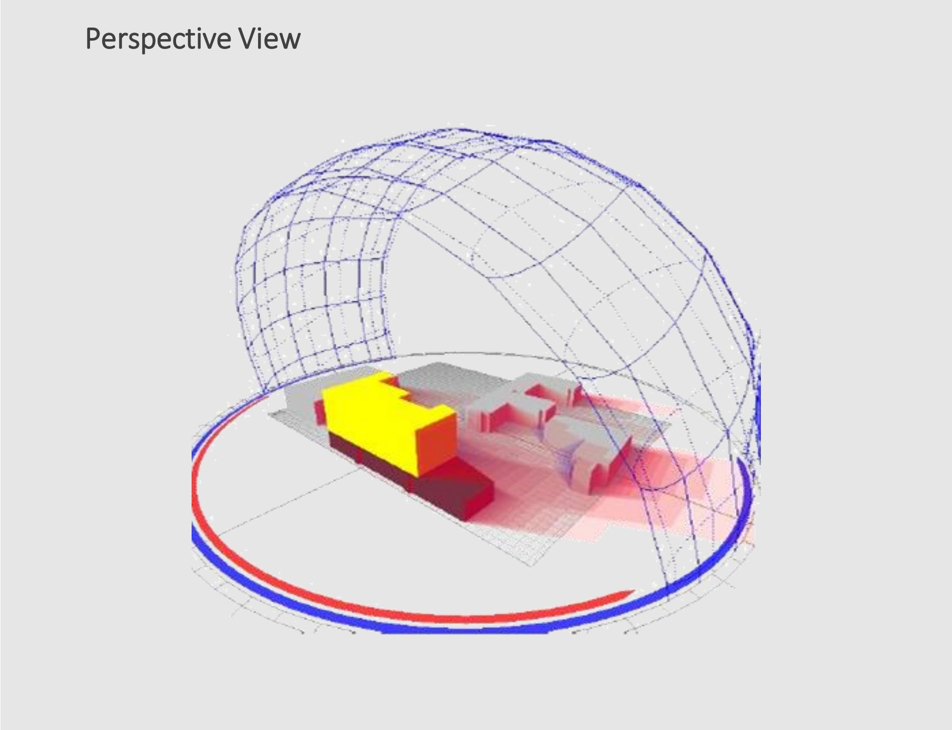


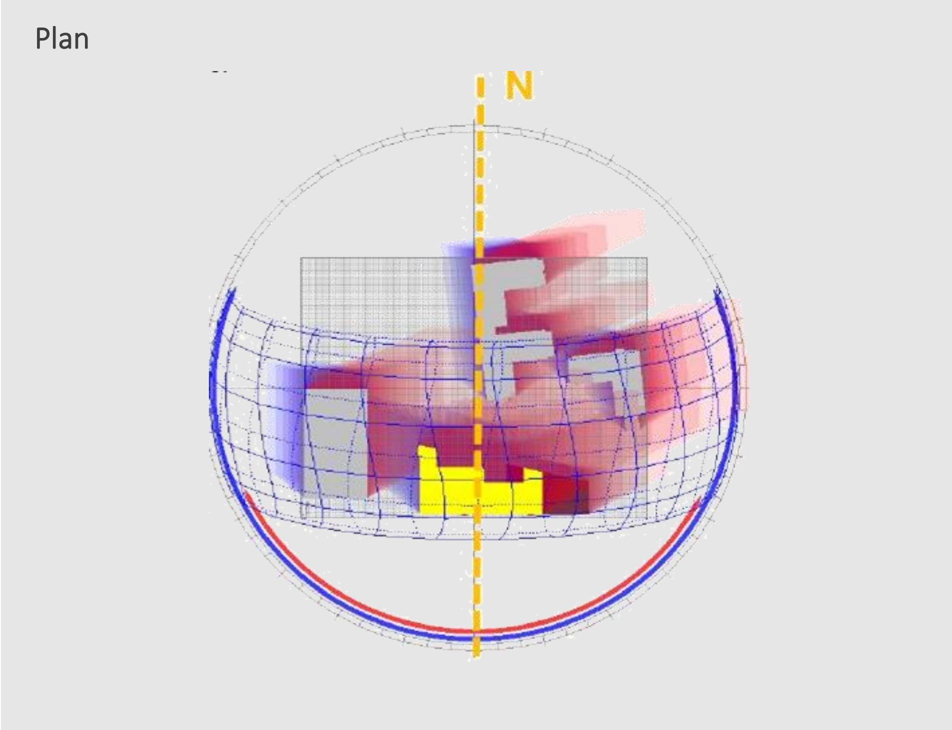


Right orientation reduces the demand for high performance parameters.

Shadow Analysis:

Blue indicates the sun’s path in summer and Red indicates the sun’s path in winter.





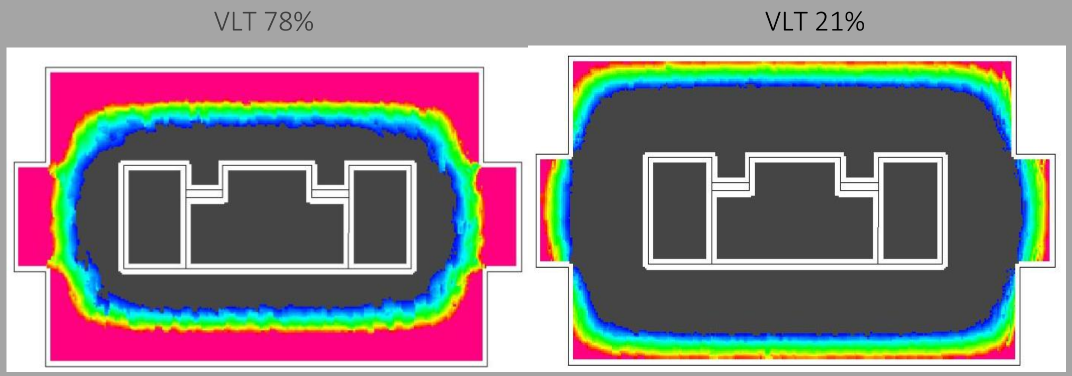
Shadow Analysis suggests the optimum requirement of Glazing performance parameter to be used.

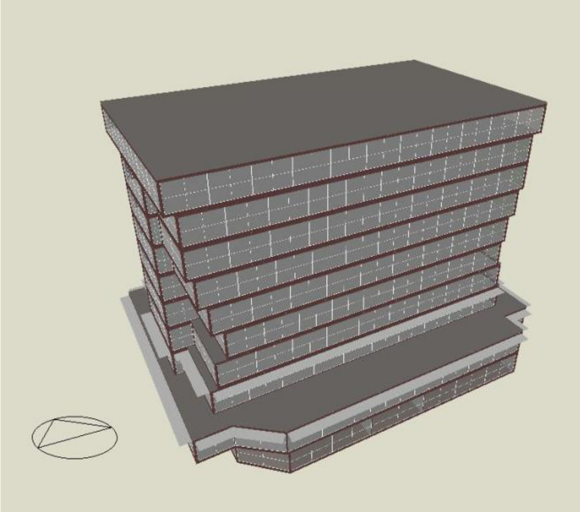
Inclined Facade

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.

Pink region shows area which will have glare and Grey indicates sub-optimal lighting
In 2nd case, we can see reduction in glare area without reducing optimum lux level.

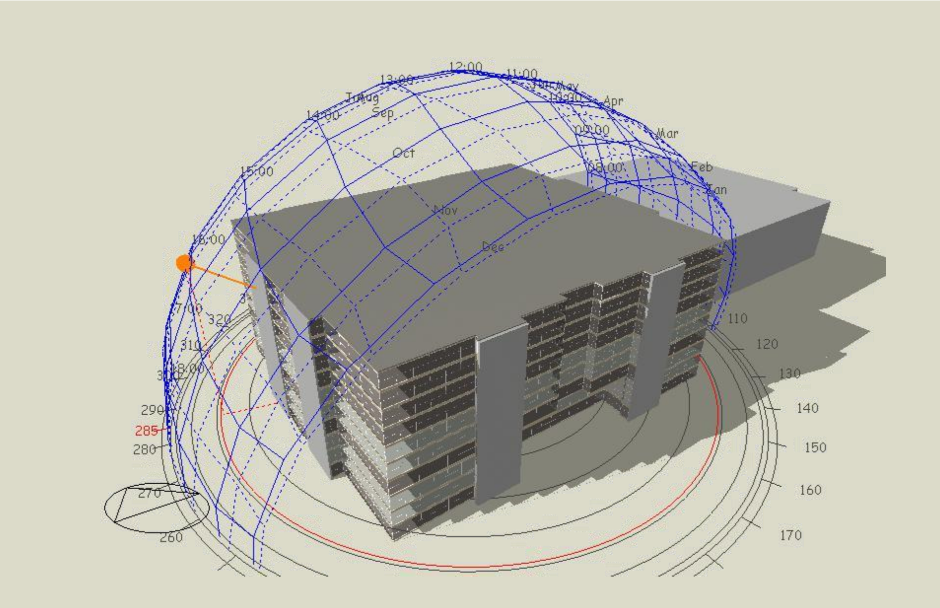


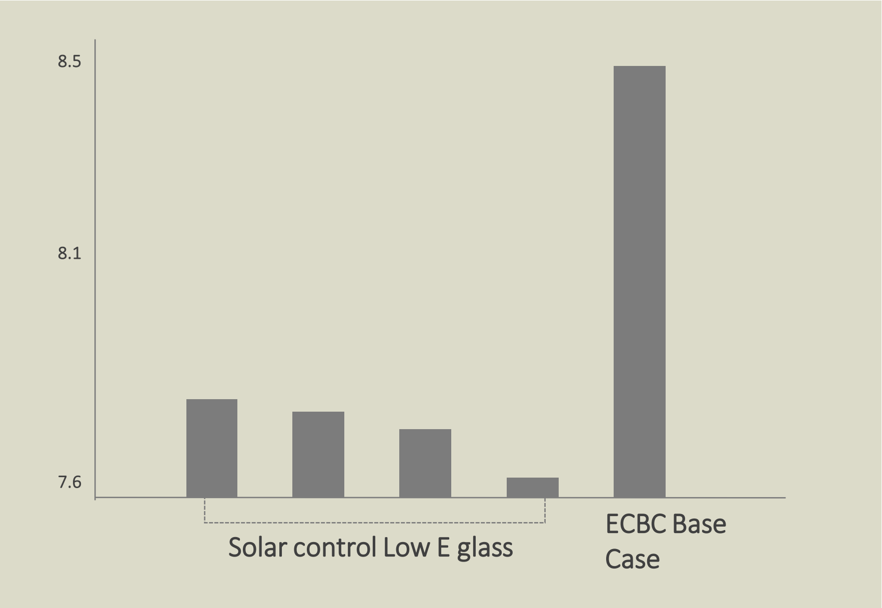


- Daylight analysis is important as it prevents overdesigning of the building and at the same time optimizes VLT requirement.
- In the case mentioned, we can use high performance glass which will reduce cooling load without compromising on lighting load

Active Design - Cooling Loads Reduction

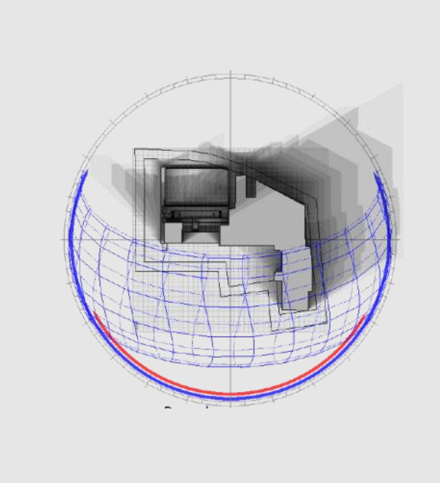
Type	Electricity Cost	Savings	Money
	Annual (Rs.)	Annual (Rs)	% saving
SGU			
Base case - ECBC	23091954.1		
Bronze Brook	18365575.2	4726378.9	20.5
Bronze vision	18229707.1	4862247.0	21.1
Grey Radiance	17901711.5	5190242.6	22.5
Gray Lite	17345102.2	5746851.8	24.9





Commercial building, Bangalore - Electricity consumption reduces by 20–25%, if solar control low-E glasses are used.

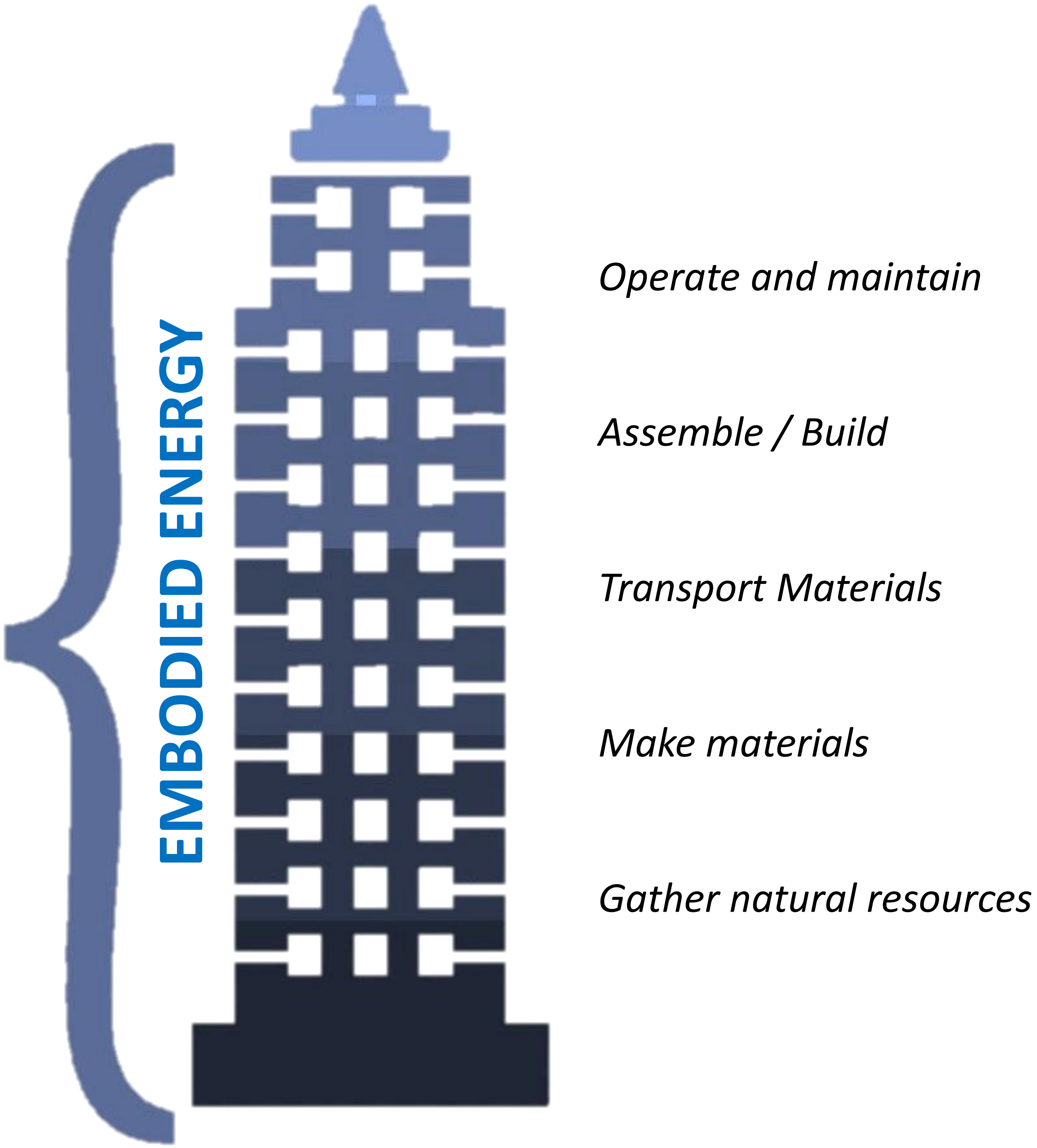
Passive Design



A hotel building in Gurgaon had avoided their demand of high performance glasses just by adding shading devices.

Correct shading reduces overall solar radiation intake in the building and also optimises light inside the building.

Embodied Energy



Embodied Energy is the energy consumed by all the processes associated with the production of a product from the acquisition of natural resources to the product delivery.

Indian buildings are highly energy intensive with specific energy consumption ranging from **280 kWh/m²** to **400 kWh/m²**, depending upon the climatic conditions and/or the type of buildings.

The calculation of embodied energy and emissions has been calculated as follows:

Embodied energy –

Quantity of the material x Embodied energy coefficient

CO2 Emissions (MT) –

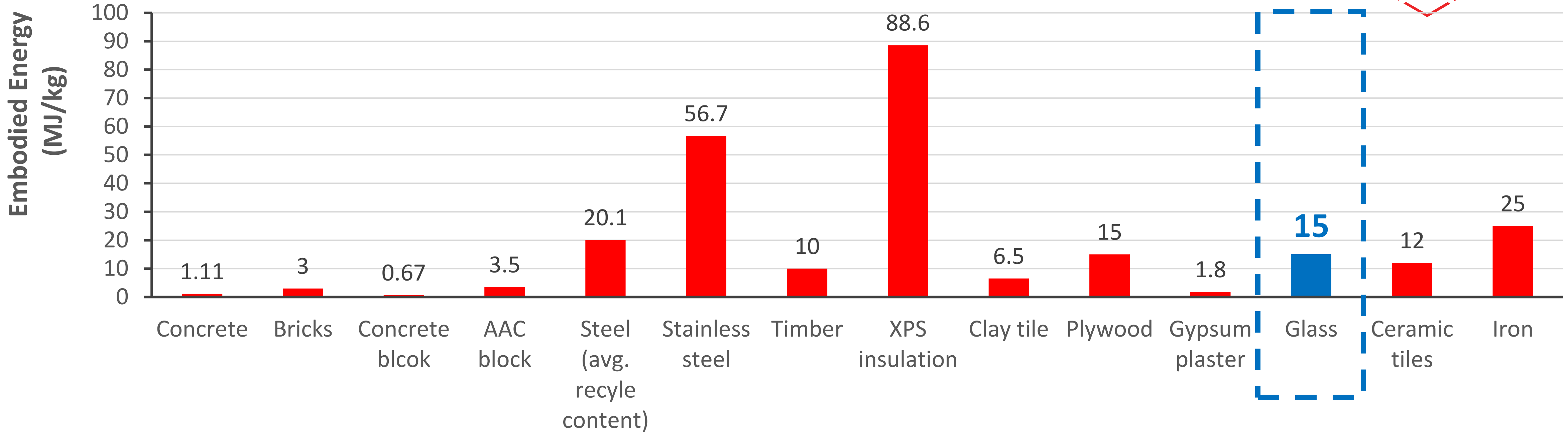
Energy Consumption (kWh) x Emission Factor/1000

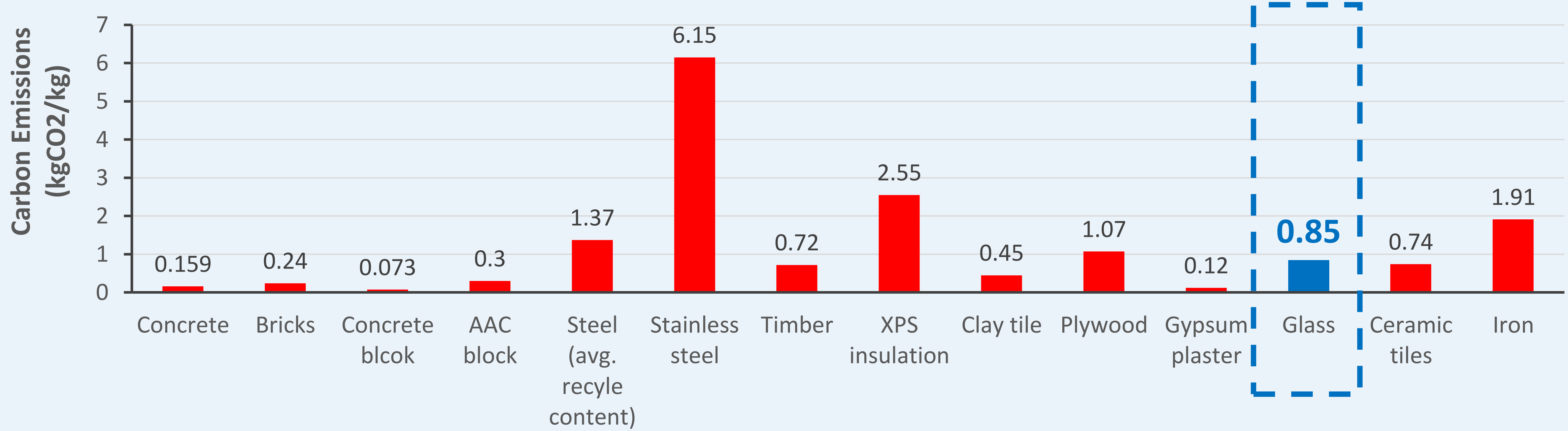
Emission Factor = 0.76 (kg/kWh)

Indexing of Building Materials with Embodied, Operational Energy and Environmental Sustainability with Reference to Green Buildings. Ashok Kumar1, D. Buddhi2, and D. S. Chauhan3*

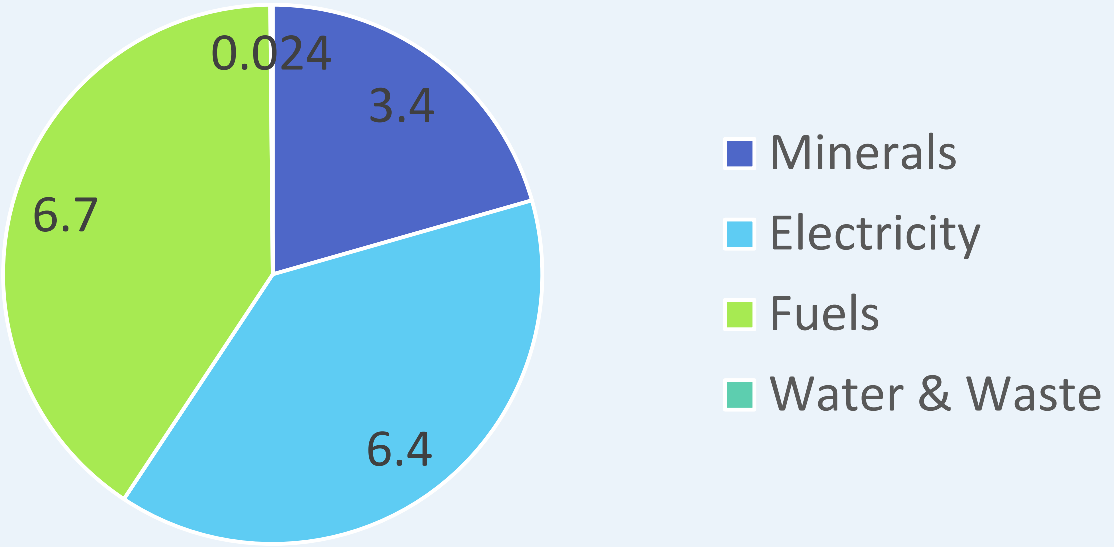
Reddy, B.V.V.; "Sustainable Building Technologies", J. Current Science, Vol. 87(7), pp. 899-907,2004.

"Energy use in Commercial buildings", Survey CBECS, 1995.

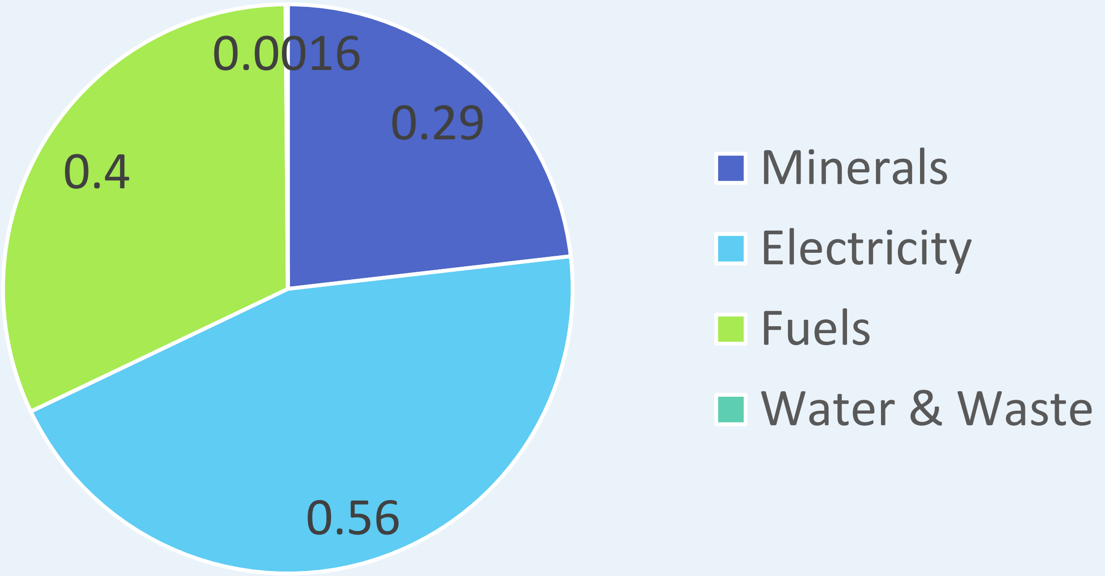

Embodied Energy (MJ/kg)
100
90
80
70
60
50
40
30
20
10
0
1.11
3
0.67
3.5
20.1
56.7
10
88.6
6.5
15
1.8
15
12
25
Concrete
Bricks
Concrete blcok
AAC block
Steel (avg. recyle content)
Stainless steel
Timber
XPS insulation
Clay tile
Plywood
Gypsum plaster
Glass
Ceramic tiles
Iron


Carbon Emissions (kgCO2/kg)
7
6
5
4
3
2
1
0
0.159
0.24
0.073
0.3
1.37
6.15
0.72
2.55
0.45
1.07
0.12
0.85
0.74
1.91
Concrete
Bricks
Concrete blcok
AAC block
Steel (avg. recyle content)
Stainless steel
Timber
XPS insulation
Clay tile
Plywood
Gypsum plaster
Glass
Ceramic tiles
Iron

Detailed Embodied Energy (MJ/kg)



Detailed Global Warming Potential Results ($kg\ CO_2/kg$)



Case study

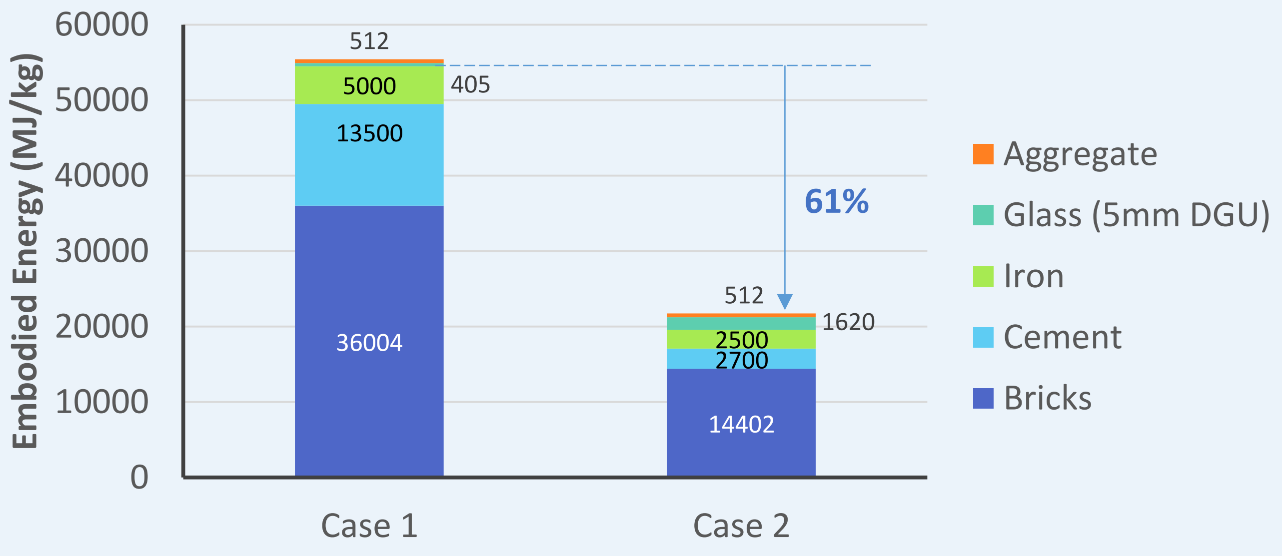
Low embodied energy materials conserve energy and
limit Green House Gases (GHG) emissions
thus, limiting the impact on the environment.

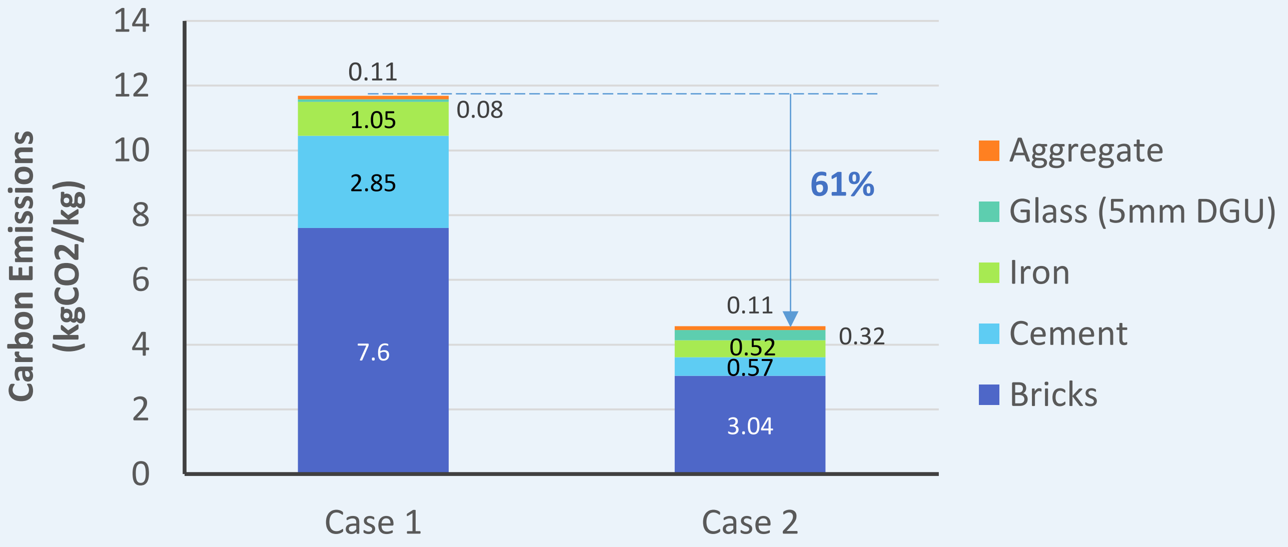
A sample building

Location: Delhi
Climate: Composite

Case 1:
Size: 3.0 m x 3.0 m x 3.0 m (L x W x H)
Opening – North window - 2.23 sq.m.

Case 2:
Size: 3.0 m x 3.0 m x 3.0 m (L x W x H)
WWR – 50%





Environment Product Declaration

Life Cycle Assessment of Processed Glass
Asahi India Glass Ltd. (AIS)

LCA model was created using the GaBi 8 Software system for life cycle engineering, developed by Thinkstep AG.

Quantification of environmental impacts for one square meter of Processed glass (Heat Tempered Glass, Laminated Glass, IGU Glass and Printed Glass) of 6 mm thickness manufactured at AIS over the cradle to gate system boundary' as per ISO 14040/44 standard.

Life Cycle stages	Life Cycle sub-stages
Materials	Primary raw materials production
Upstream Transport	Ocean Rail and Road Transport
Manufacturing	Processed Glass Production by mixing of raw materials and disposal of waste generated.

Environment Product Declaration

Components	Tempered Glass (6 mm thick)	Laminated Glass (6 mm thick)	IGU Glass (6 mm thick)	Printed Glass (6 mm thick)
Global Warming Potential (kg CO_2-Equiv.)	44.7	93.6	52.7	47.2
Ozone Layer Depletion Potential (kg CFC 11-Equiv.)	$6.4E^{-10}$	$1.5E^{-09}$	$7.8E^{-10}$	$6.9E^{-10}$
Acidification Potential (kg SO_2-Equiv.)	0.41	0.86	0.46	0.44
Eutrophication Potential (kg Phosphate-Equiv.)	0.025	0.046	0.028	0.026
Photochemical Ozone Creation Potential (kg Ethene-Equiv.)	0.019	0.042	0.022	0.021
Abiotic depletion potential (ADP element) (Kg Sb-Equiv)	$1.7E^{-04}$	$1.9E^{-04}$	$4.0E^{-04}$	$1.7E^{-04}$
Abiotic depletion potential for fossil resources (ADP fossil) (MJ)	500	1124.5	603.6	526.6
hazardous waste generated (kg)	$8.07E^{-07}$	$1.16E^{-06}$	$1.23E^{-06}$	$8.3E^{-07}$
radioactive waste disposed (kg)	$3.5E^{-03}$	$9.4E^{-03}$	$7.04E^{-03}$	$3.8E^{-03}$
net fresh water used (m^3)	0.29	0.61	0.36	0.31


THANK YOU
ANY QUESTIONS?