

Energy Efficient Building Envelope - From the ECBC Perspective

ECBC Awareness Workshop
Saint-Gobain Glass India Ltd

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ECBC - Building Envelope

- Opaque Wall & Spandrels: Insulation materials and their R-values / U Value;
- Vision Glass or fenestration / glazing:
  - U-factors,
  - Solar heat gain coefficients (SHGC) or SF
  - Visible light transmittance
- Shading: overhangs and side fins,
- Air leakage though facade
- Building envelope sealing details

Glass gives beauty & modernity to architecture:

- Architectural master pieces
- Modernity - Transparency

Advantages of using Glass & glazing systems:

1. Faster is construction
2. Thinner structure - increase floor area
3. Advance systems
   - Predictable behavior in case of earth quake and building settlement
   - Water tight
4. Glass is lighter by 12 times than brick wall
   - i.e. 1000sqm of glass of reduces load of building by 500 tons

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Glass is transparent thus:

- Daylight for interiors
- Blends Interiors with Exteriors


Nokia, Gurgaon


Infosys, Mysore


Hyatt Regency, Mumbai


Town Hall London

Key Performance Factors

- Total Heat Gain / Heat Transmission
  - SHGC or SF : Solar Heat Gain Coefficient or Solar Factor
  - U Value
- Light Transmission: percentage of incident light transmitted
  - VLT or Visual Light Transmission

Day Lighting:

Control Light –
Based on direction of façade –
Minimize Glare

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Light Transmission (LT):

How low can the LT of the glass be ?

Sun light: 90,000 to 113000 Lux

Light required for working = 500 Lux

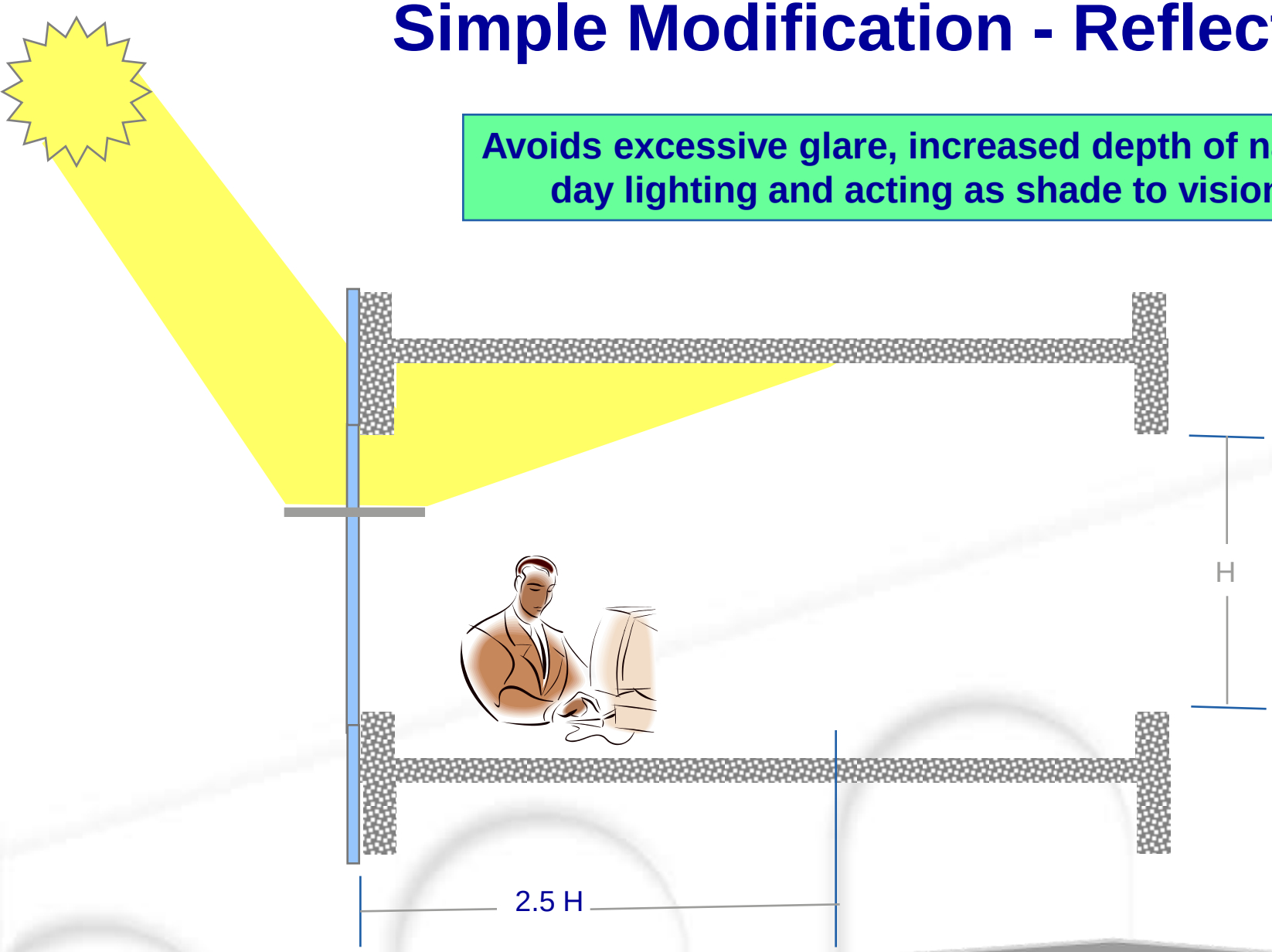
Light Transmitted

Shade : 9,000Lux

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

Simple Modification - Reflectors

Avoids excessive glare, increased depth of natural day lighting and acting as shade to vision area



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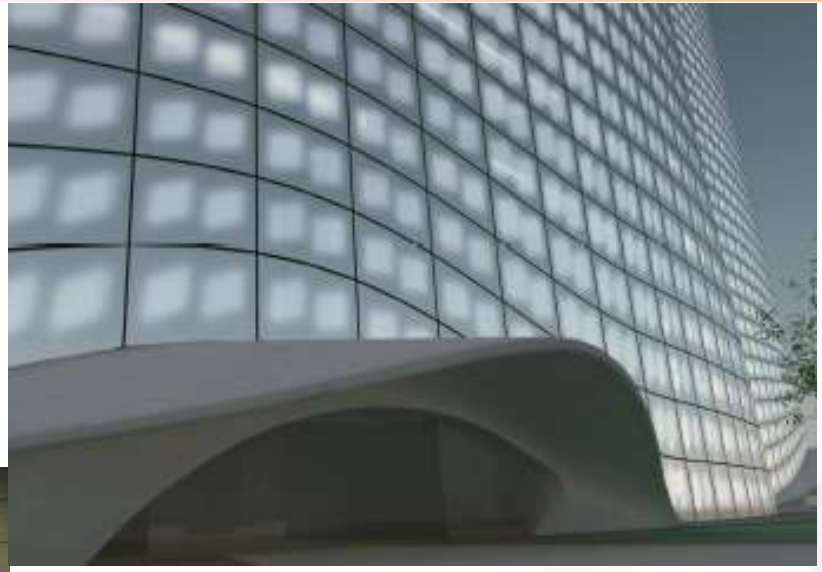
Modern Mechanism: Effective Day Light

Automated Louvers

Light Selves



Ceramic Fritting

Shading Device: Horizontal or vertical

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Total Heat Gain / Heat Transferred

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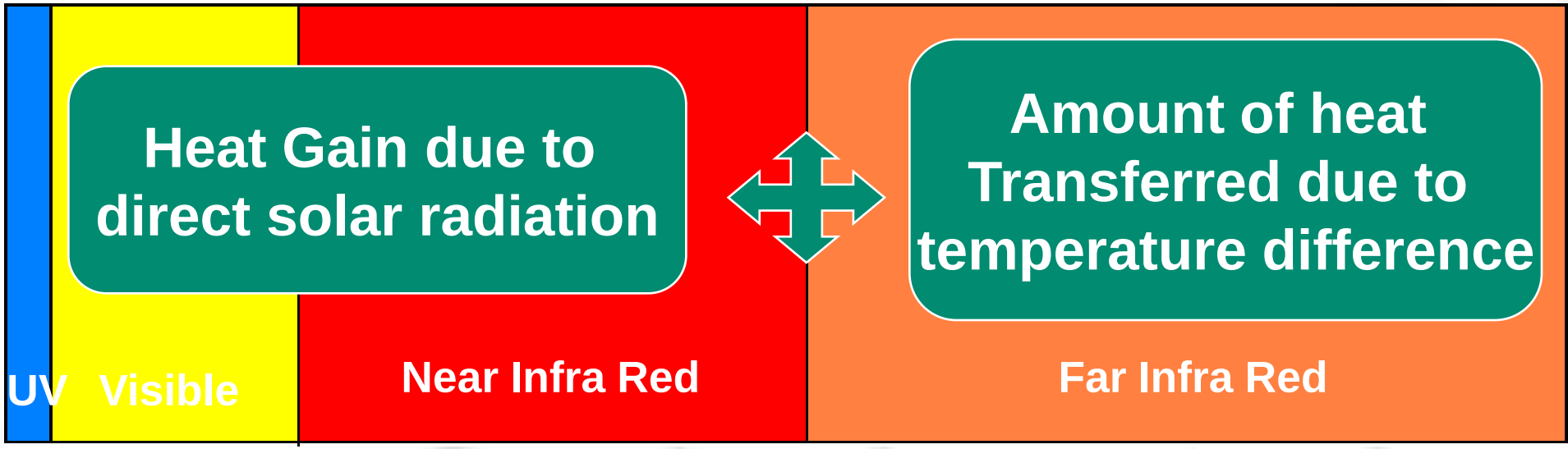
Total Heat Gain

Electromagnetic Spectrum at Terrestrial Level

TOTAL HEAT GAIN



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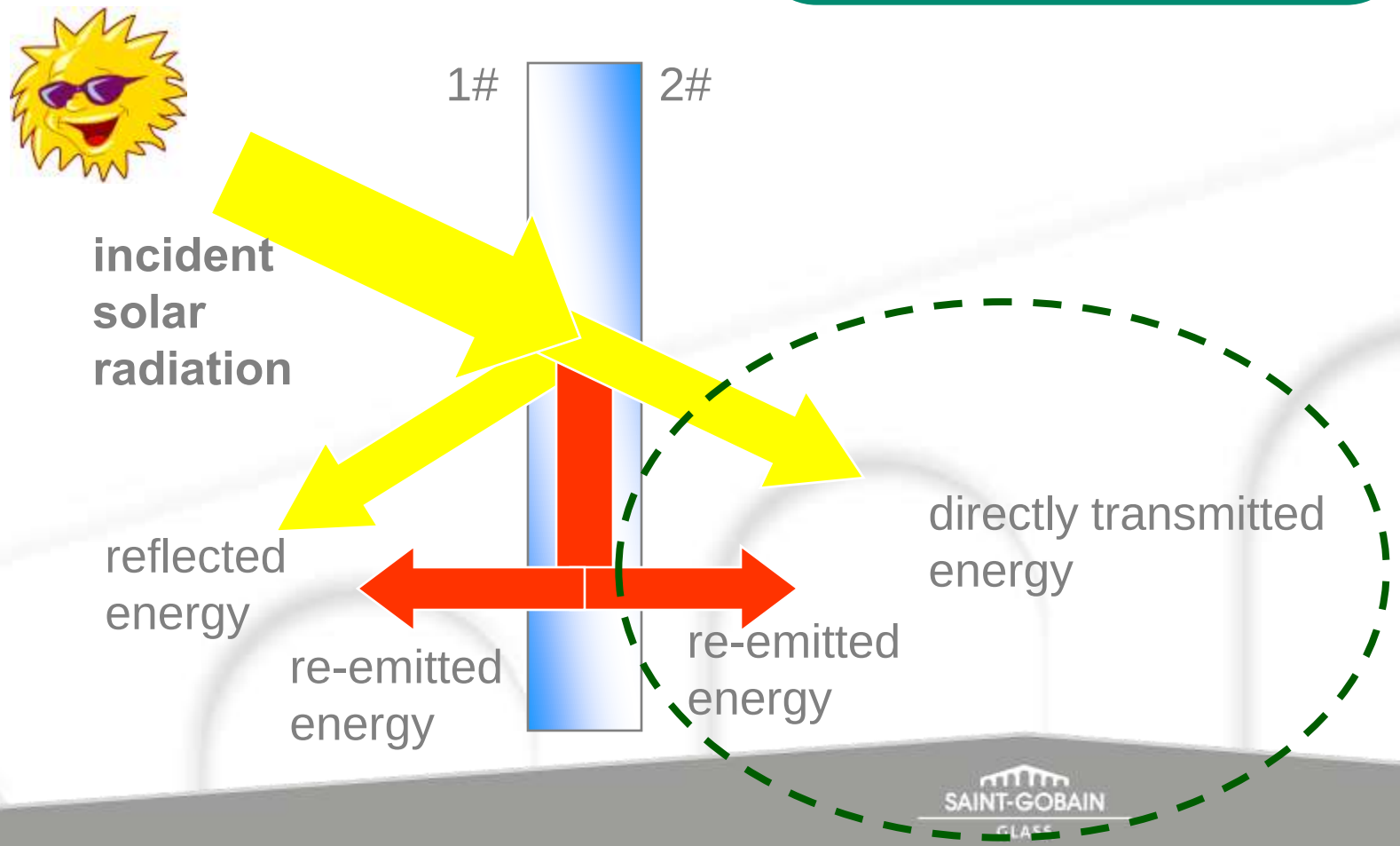
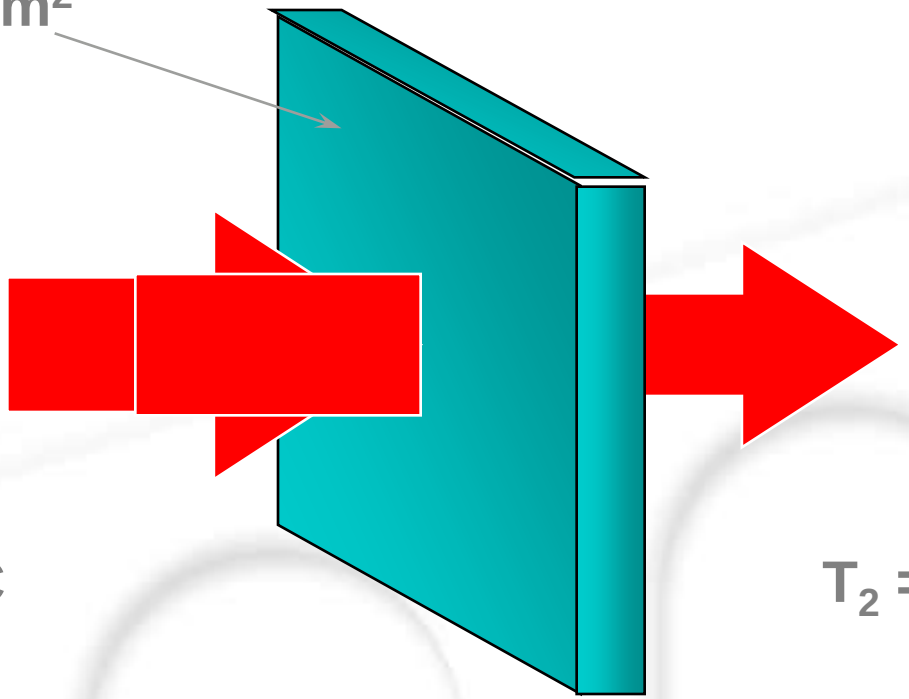
Heat gain due to Direct solar radiation

directly +
re-emitted energy
= **S F / SHGC**



Amount of heat Transferred due to temperature difference

U Value



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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	129 W/sqm	
	U Value: 2.6 W/sqm K	39		
ECBC	Solar Factor: 0.25	125	173 W/sqm	
	U Value: 3.2 W/sqm K	48		

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In tropical countries – In General Sense

1: Select a glass with lowest SOLAR FACTOR

2: High Performance glass solutions is a direction in future

Remember : Only low U Value glass will lead to heat build up inside the building

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Example – Cost Benefit Analysis (CBA)

Basic Solar Control Glass / Tinted DGU	SHGC: 0.6	U Value: 3 W/sqm K
ECBC Complaint Glass	SHGC: 0.25	U Value: 3 W/sqm K

Assuming a glass area in Sqm	1000 sqm
Cost difference between glass is	11 lakhs
A/C tonnage saved - capital	50tons
Capital investment saved	20 Lkahs
Running Cost per year saved per annum	12 lakhs

Prescriptive

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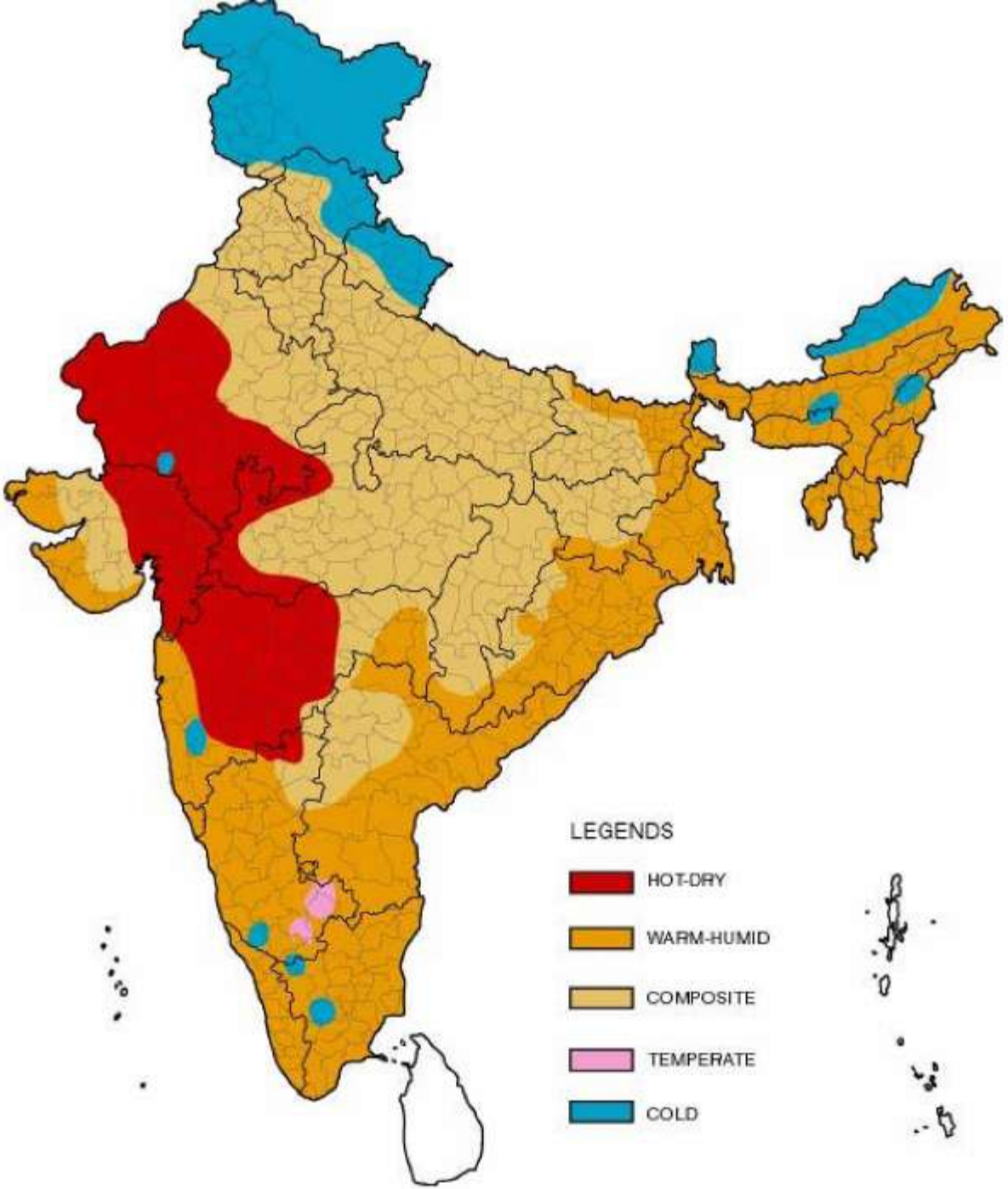
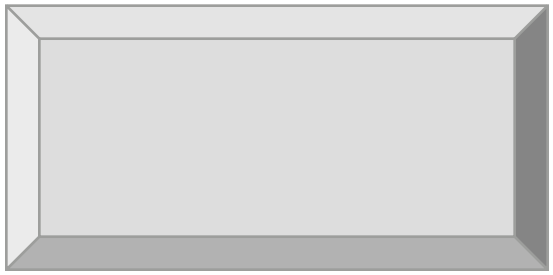
Climatic zone map of India



WWR: Window to wall ratio

Case 1



15M

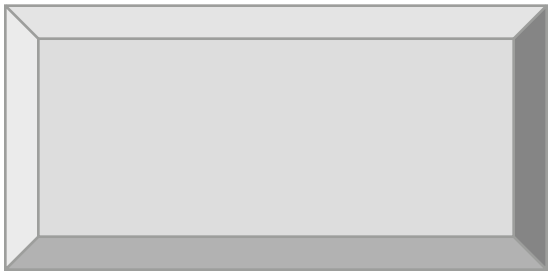
30M

800
2400
800

16M

$$WWR = \frac{2.4*(30+15)*2*4}{16*(30+15)*2}$$

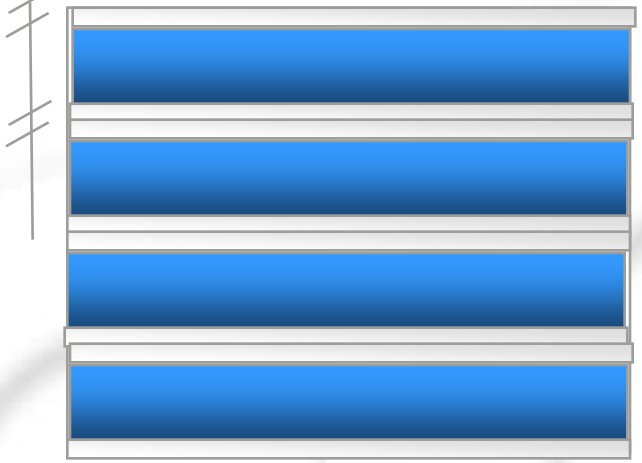
Case 2



15M

30M

800
2400
800



16M

$$WWR = \frac{2.4*(30+15)*2*4}{16*(30+15)*2}$$

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Compliance Requirement: Heat Gain through glazing

Climate Factor	WWR Ratio			
	≤ 40%		41% to 60%	
	SF or SHGC	U Value	SF or SHGC	U Value
Hot & Dry	0.25	3.3	0.2	3.3
Composite	0.25	3.3	0.2	3.3
Warm & Humid	0.25	3.3	0.2	3.3
Moderate	0.4	6.9	0.3	6.9
Cold	0.51	3.3	0.51	3.3

Compliance Requirement: Glass Light Transmission

WWR	Minimum Light Transmission
≤ 30%	27%
31% to 40%	20%
41% to 50%	16%
51% to 60%	13%
61% to 70%	11%

Trade off

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Trade Off: Glass - SF/SHGC
Horizontal Shading: 0.5m to 0.75m

		North	South	East/West
North India	M Factor	0.8	0.64	0.65
	SF / SHGC	0.31	0.39	0.38
Rest of India	M Factor	0.74	0.69	0.66
	SF / SHGC	0.34	0.36	0.38

Trade Off: Glass

- Shading
  - Horizontal: for different horizontal projection you can calculate the shading Factor
  - Vertical shading would also give benefit
- Heat Gain Through Envelope
  - Covers: heat gain through: Wall, Fenestration, Roof
  - Calculate heat gain as per prescribed value
  - Calculate heat gain of actual use. This should be less than equal to above heat gain

Case Study

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Case Study :Single Room Office-Glazing & Energy Efficiency

- Location : Chennai
- Floor to Floor height : 3.7 m
- Length : 4m
- Width : 4m
- Windows : 1 on each wall
- Window – Wall Ratio : 10 %
- Activity : Office
- Work Timings : 8 am to 5 pm

The effect of different glazing on the Energy Consumption was studied.

Energy Simulation Tool Used : eQUEST

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6 Types of Glazing were studied

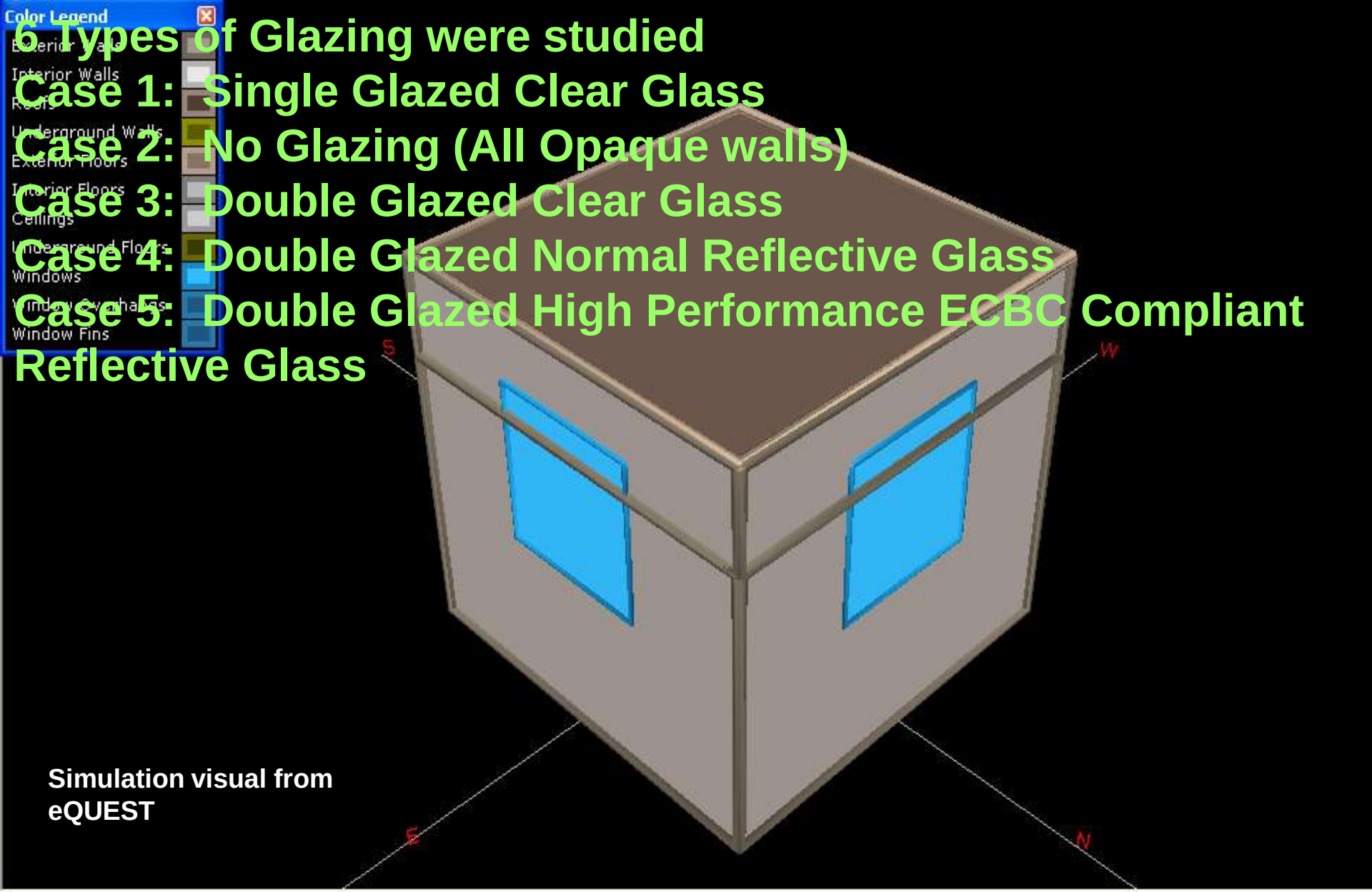
Case 1: Single Glazed Clear Glass

Case 2: No Glazing (All Opaque walls)

Case 3: Double Glazed Clear Glass

Case 4: Double Glazed Normal Reflective Glass

Case 5: Double Glazed High Performance ECBC Compliant Reflective Glass



Simulation visual from eQUEST

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The Results

CASE	Solar Factor	U Value W/m2K	Light Transmission %	HVAC Consumption kWh	Lighting Consumption kWh	Total kWh	Savings / Year kWh
1. Single Clear	0.83	5.7	87	3033	160	4052	Base
2. No Glazing	NA	NA	NA	2397	504	3760	292
3. Clear Glass + Clear Glass- Double Glazed	0.71	2.0	81	2965	161	3984	68
4. Normal Reflective + Clear Glass Double Glazed	0.3	2	50	2436	292	3586	466
5. High Performance ECBC Compliant Glass	0.2	2	50	2331	292	3481	571

16 % Savings on Total Consumption with ECBC Compliant Glass

35 kWh/m2 of built space

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How do we get this performance from Glass ?

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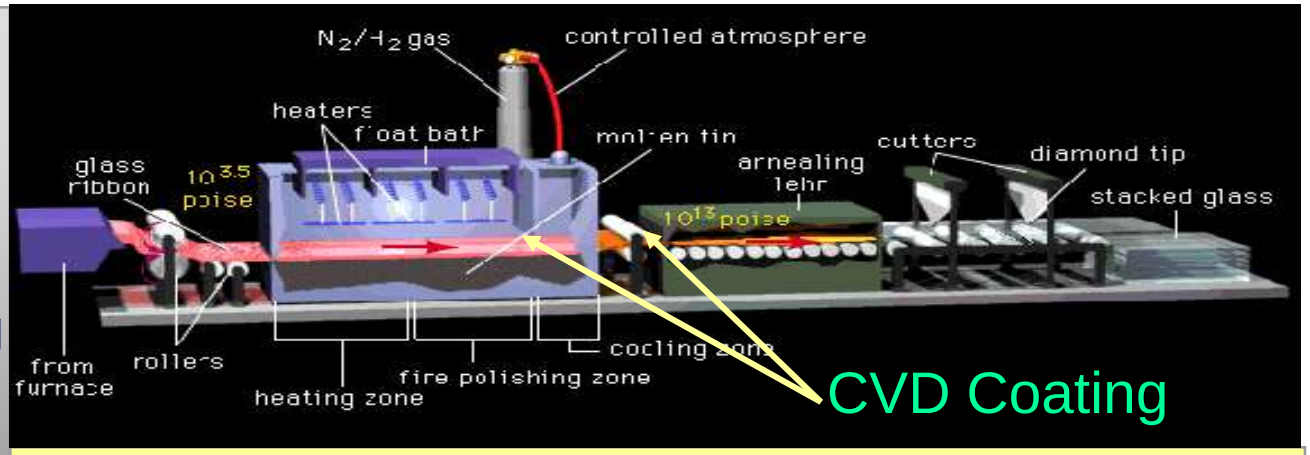
Online Coating



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

Advantages

- Large production run
- Economical
- Easy to manufacture, install and maintain

Disadvantages

- Limitation in performance
- Non selective coatings

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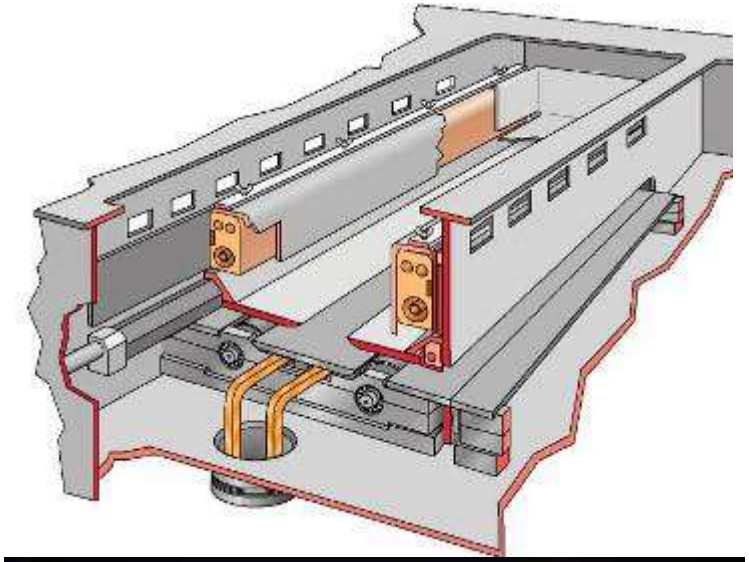
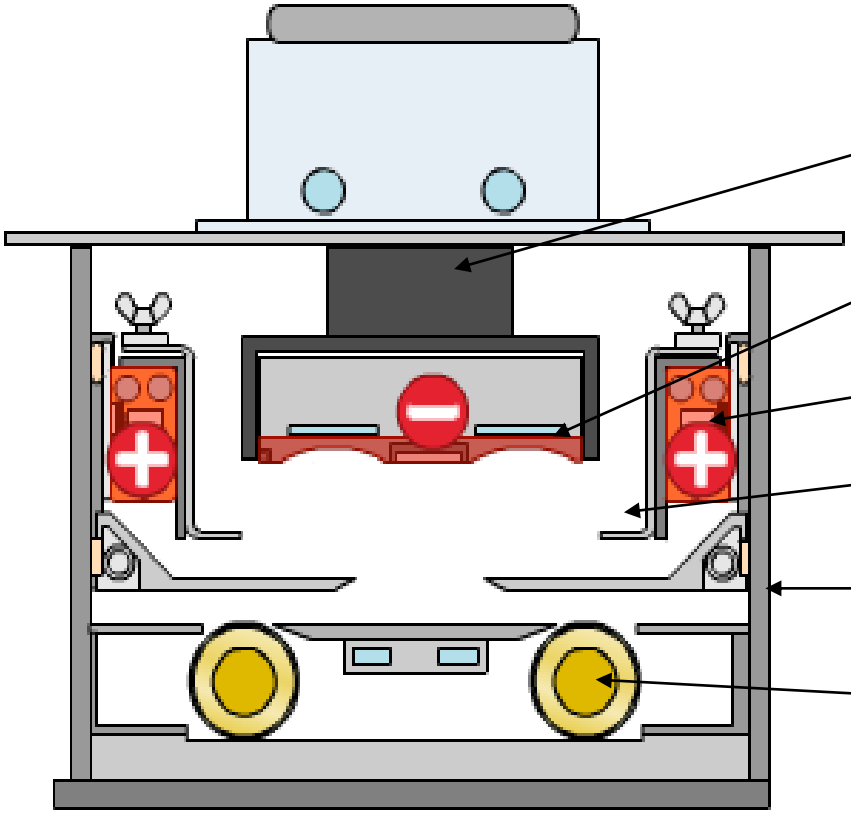
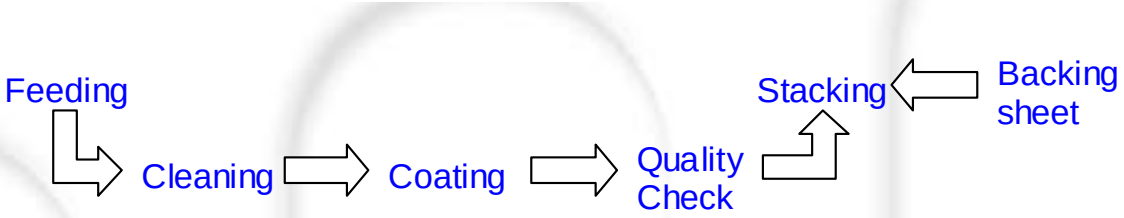
Off Line Coating (Soft Coating)







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Off Line Coating (Soft Coating)

Coating Process:

- Argon gas is pumped into the chamber.
- The cathode, supplies the chamber with electrons, which bombard the argon gas, ionising it.
- The magnets, and cathode situated above or within the target material, focus the movement of the ionised argon atoms towards the target
- The argon ions bombard the target, forcing atoms of the target to be released into the chamber.
- The positive target ions are sputtered onto the glass

A modern glazing is a sophisticated filter

nitride - 40 nm

oxide - 54 nm

Ag - 10 nm

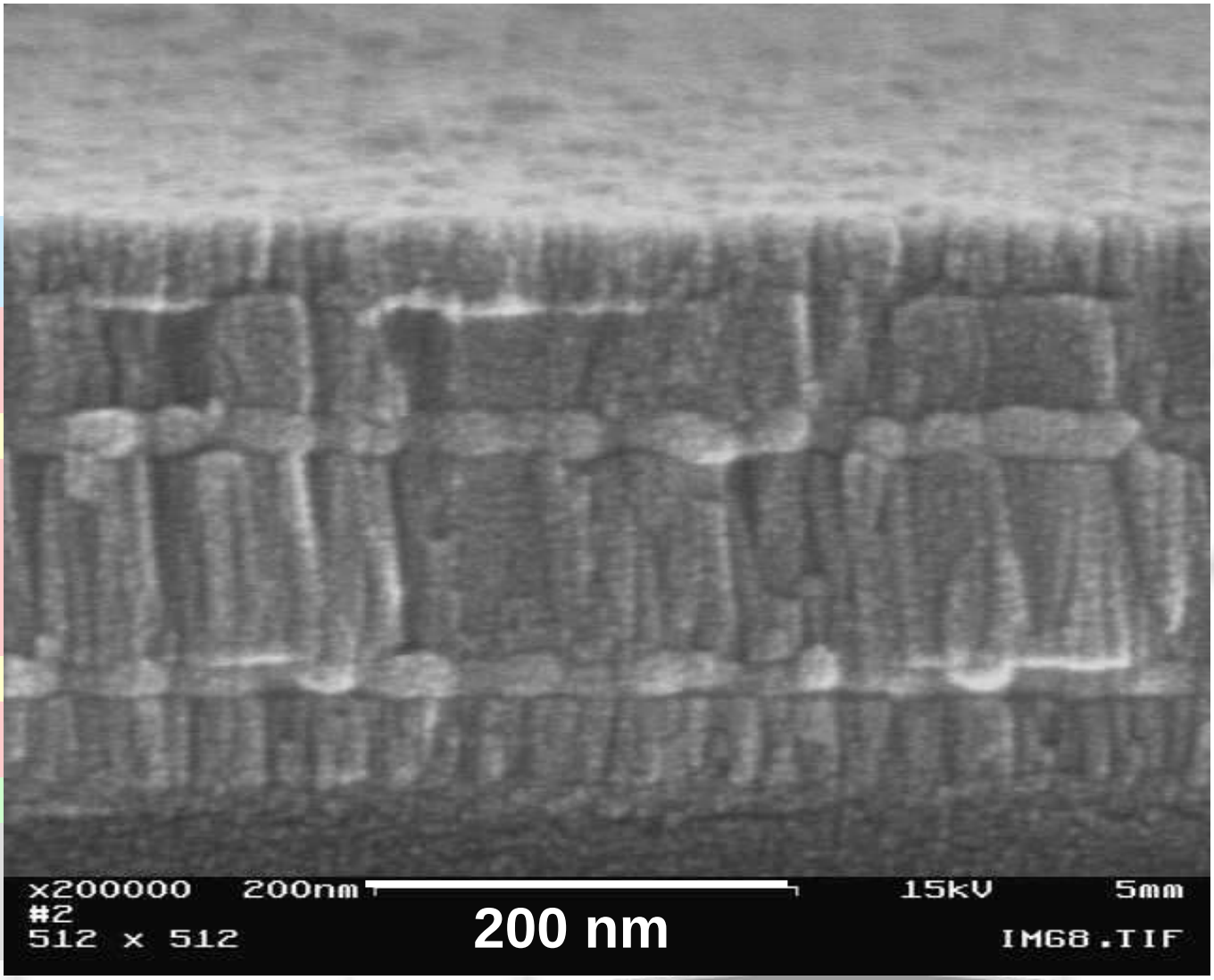
oxide - 100 nm

Ag - 11 nm

oxide - 54 nm

oxide - 16 nm

glass



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Coating- offline

Advantages

- Better energy performance
- Selective coatings
- Large range
- Today, coating are flexible, can be
  - Bent / curved glazing
  - Tempered
  - laminated

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Conclusion

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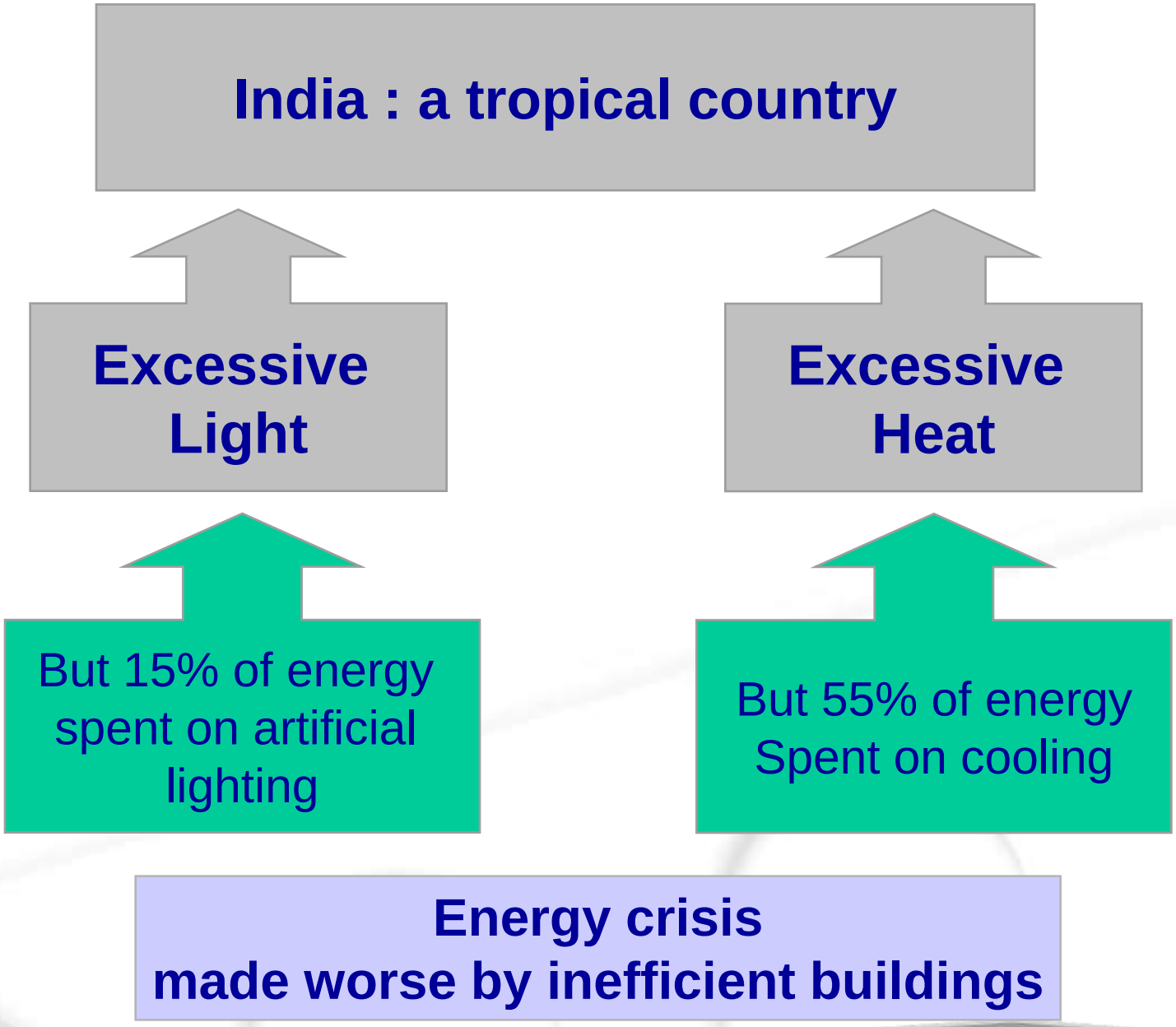
India : a tropical country
Excessive Light
Excessive Heat
But 15% of energy spent on artificial lighting
But 55% of energy Spent on cooling
Energy crisis made worse by inefficient buildings

World Glass Complex, Sriperumbadur, Chennai, India

- Campus spread over 177 acres
- Total investment of Rs 1500 crores
- Employs 800 people

Thank you