Energy Conservation Building Code-2017

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Anurag Bajpai
ECBC Master Trainer

Technical Session 1

INTRODUCTION

Energy Conservation Building Code

Energy Conservation Building Code (Code) is to provide minimum requirements for the energy-efficient design and construction of buildings.

Energy Conservation Building Code 2017 §1 to §14

- Scope §2
- Compliance Approaches- Mandatory, Prescriptive, WBP §3
- Technical Scope: MEPS (§4 to §7)

ECBC+, Super ECBC, NZEB

- Progressive Approach
- Step Process
- Case Study

SCOPE

ECBC 2017 - SCOPE

COMPLIANCE MECHANISM

New Building	Additions and Alterations to Existing Buildings	Retrofitting
• The Code is applicable to buildings or building complexes that have a connected load of 100 kW or greater or a contract demand of 120 kVA or greater and are intended to be used for commercial purposes. • Buildings intended for private residential purposes only are not covered by the Code.	• If any existing building after additions or alterations changes its connected load to 100 kilo-Watt (kW) or above or a contract demand of 120 kilo-Volt Ampere (kVA) or above shall comply with the provisions of §4 through §7.	• Building Envelope • Mechanical systems and equipment, including HVAC • Interior and exterior lighting • Electrical power and Renewable Energy

ECBC SCOPE VARIATIONS IN VARIOUS STATES

- **Additional Scope- Conditioned Area**
- **5 states**

Odisha,

Kerala,

Rajasthan,

Punjab,

Karnataka

- **Modified the connected load/contract demand**
- **6 states +**

West Bengal, Sikkim, Tripura and Arunachal Pradesh, Mizoram & Assam, Andaman & Nicobar

Uttar Pradesh, UttaraKhand, Andhra Pradesh, Telangna, Himanchal Pradesh

- **Additional Scope- Built Up Area**
- **5 states**

Haryana,

Madhya Pradesh, Pondicherry

- **No change in scope**
- **2 States +**

Source: GT Research

ECBC 2017 - SCOPE

APPLICABLE BUILDING SYSTEMS

- Building Envelope
- Mechanical systems and equipment, including heating, ventilating, and air conditioning, service hot water heating
- Interior and exterior lighting
- Electrical power and motors

EXCEMPTIONS

- Buildings that do not use either electricity or fossil fuels
- Equipment and portions of building systems that use energy primarily for manufacturing processes
- Safety, Health and Environmental codes take precedence

Compliance & Approach

Mandatory + → Prescriptive or WBP Compliance + → EPI Ratio + → Drawings and Specifications

All pertinent data and features of the building

Equipment and systems in sufficient detail

This is done in order to permit the authority having jurisdiction to verify that the building complies with the requirements of the code. The details should include, but not limited to the following building system.

BUILDING ENVELOPE

MECHANICAL SYSTEM

LIGHTS

ELECTRICAL POWER

ECBC Levels

ENERGY EFFICIENCY PERFORMANCE LEVEL

01 **ENERGY CONSERVATION BUILDING CODE COMPLIANT BUILDING**

ECBC Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements or by following the provisions of the Whole Building Performance (WBP)

02 **ENERGY CONSERVATION BUILDING CODE PLUS BUILDING**

Compliance is done by adopting the mandatory and prescriptive requirements listed under ECBC+ compliant Building requirements or by following the provisions of the Whole Building Performance (WBP)

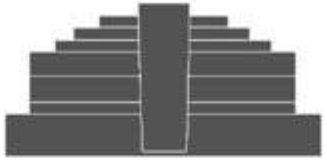
03 **SUPER ENERGY CONSERVATION BUILDING CODE BUILDING**

Super ECBC Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements listed under Super ECBC Compliant Building requirements or by following the provisions of the Whole Building Performance (WBP)

ECBC 2017

BUILDING CLASSIFICATION

Any one or more building or part of a building with commercial use is classified as per the functional requirements of its design, construction, and use.



HOSPITALITY

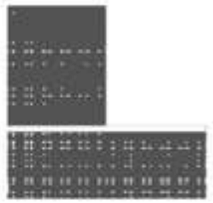
Star Hotel
No Star Hotel
Resort

SHOPPING COMPLEX

Shopping Mall
Stand-alone Retails
Open Gallery Malls
Super Markets

EDUCATIONAL

College
University
Institution
School



BUSINESS

Daytime Use
24- hours Use

Mix use
building Types
<90%

HEALTH CARE

Hospital
Out-patient Healthcare

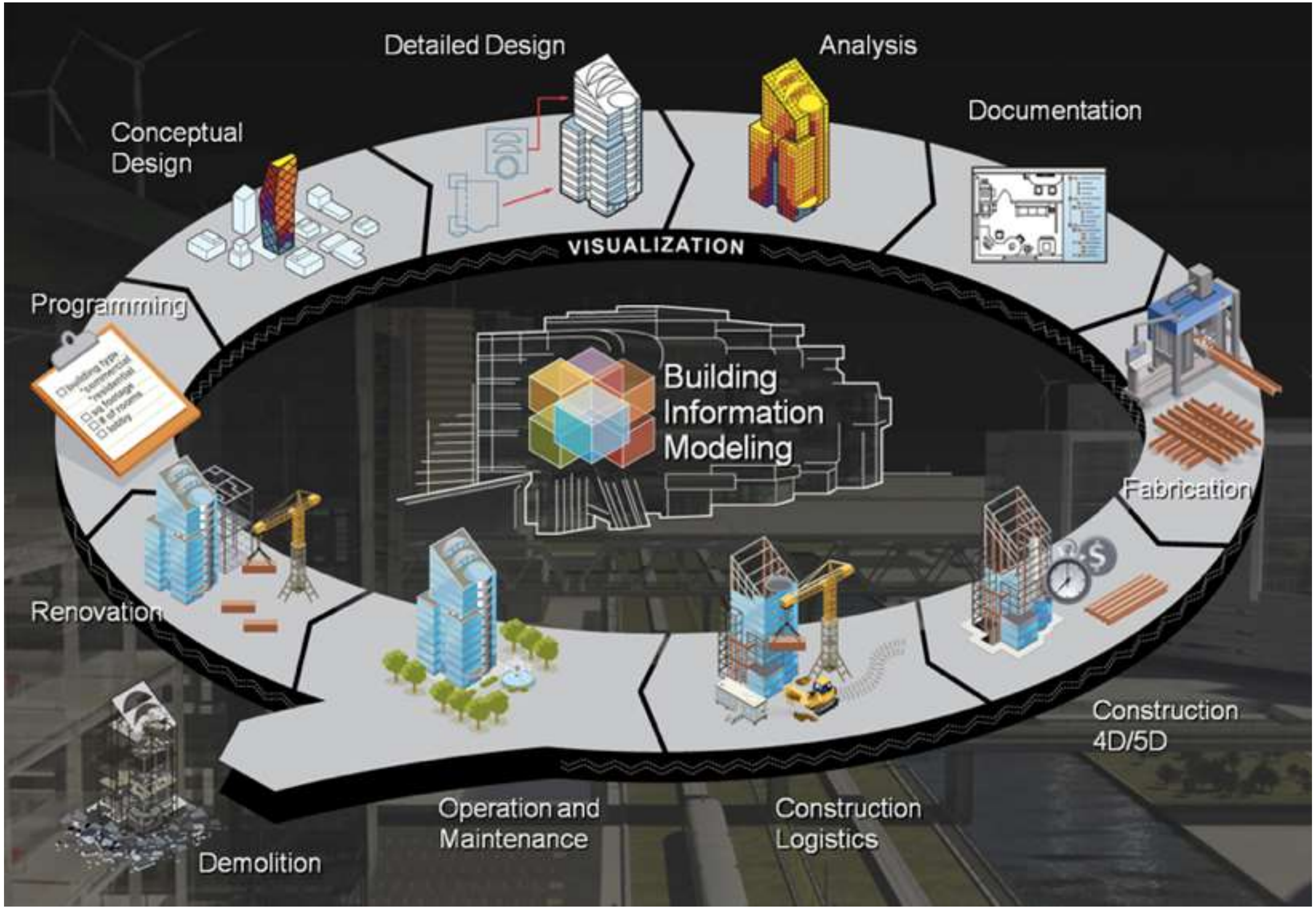
ASSEMBLY

Multiplex
Theatre
Building used for Transport Services

Minimum Energy Performance Standards

Project Life-Cycle

- Building Envelope
- Comfort Systems & Controls
- Lighting & Controls
- Electrical Power & Renewable

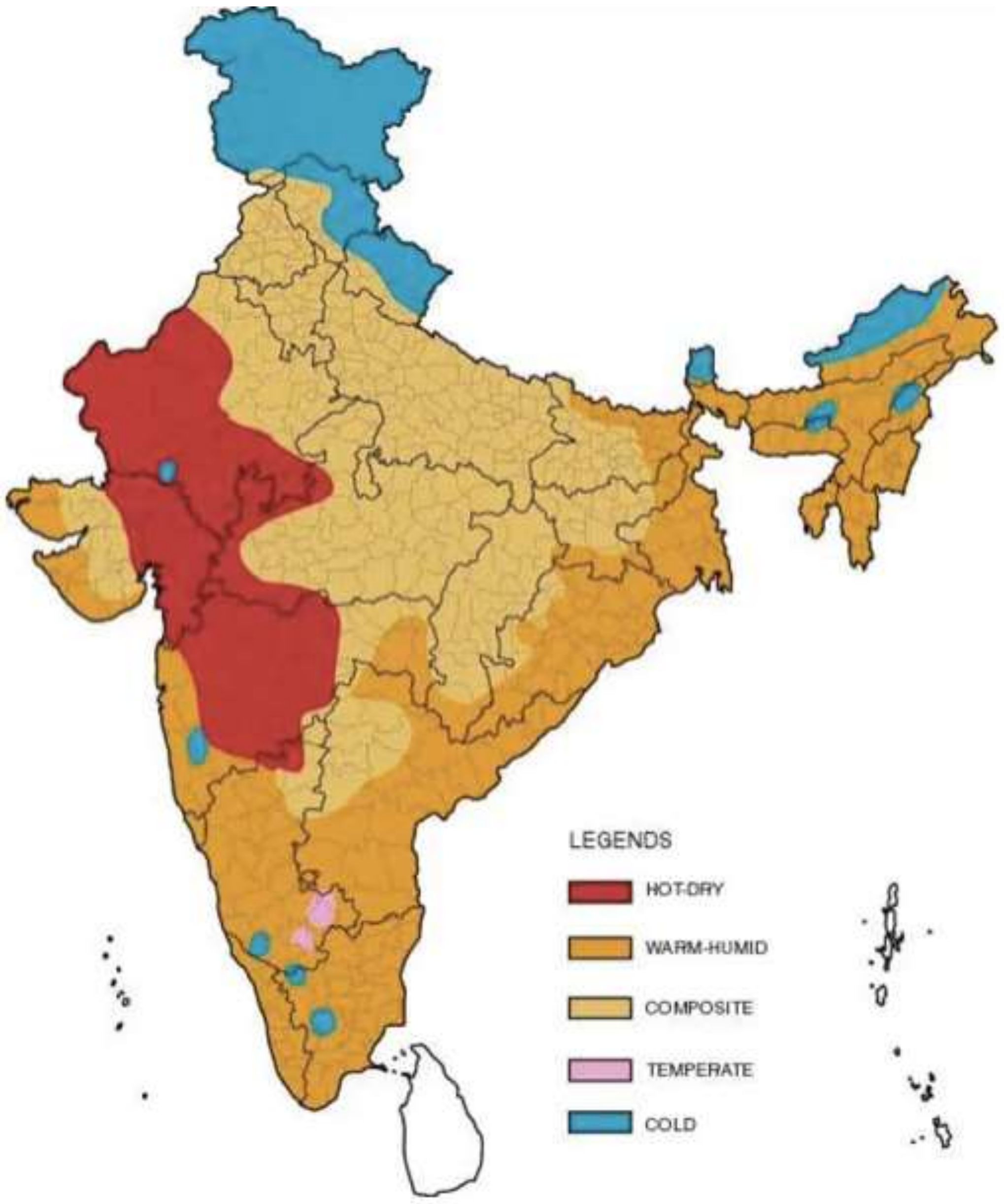


Building Envelope

CLIMATIC ZONES OF INDIA

Identifies 5 climate zones in India and suggests different Compliance for different zones

- Hot – Dry
- Warm – Humid
- Composite
- Temperate
- Cold

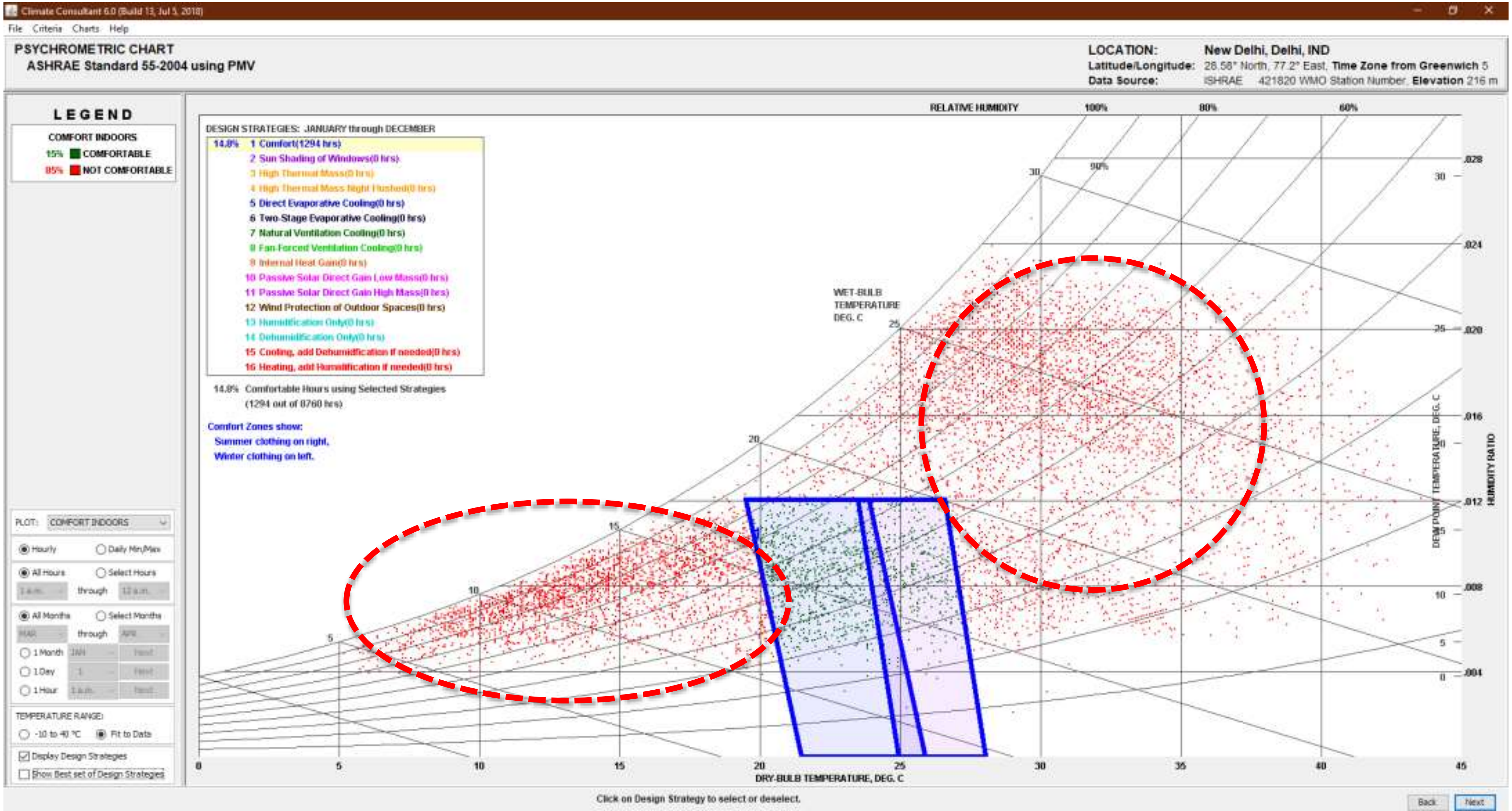


The laws of physics dictate the thermal behavior of a building

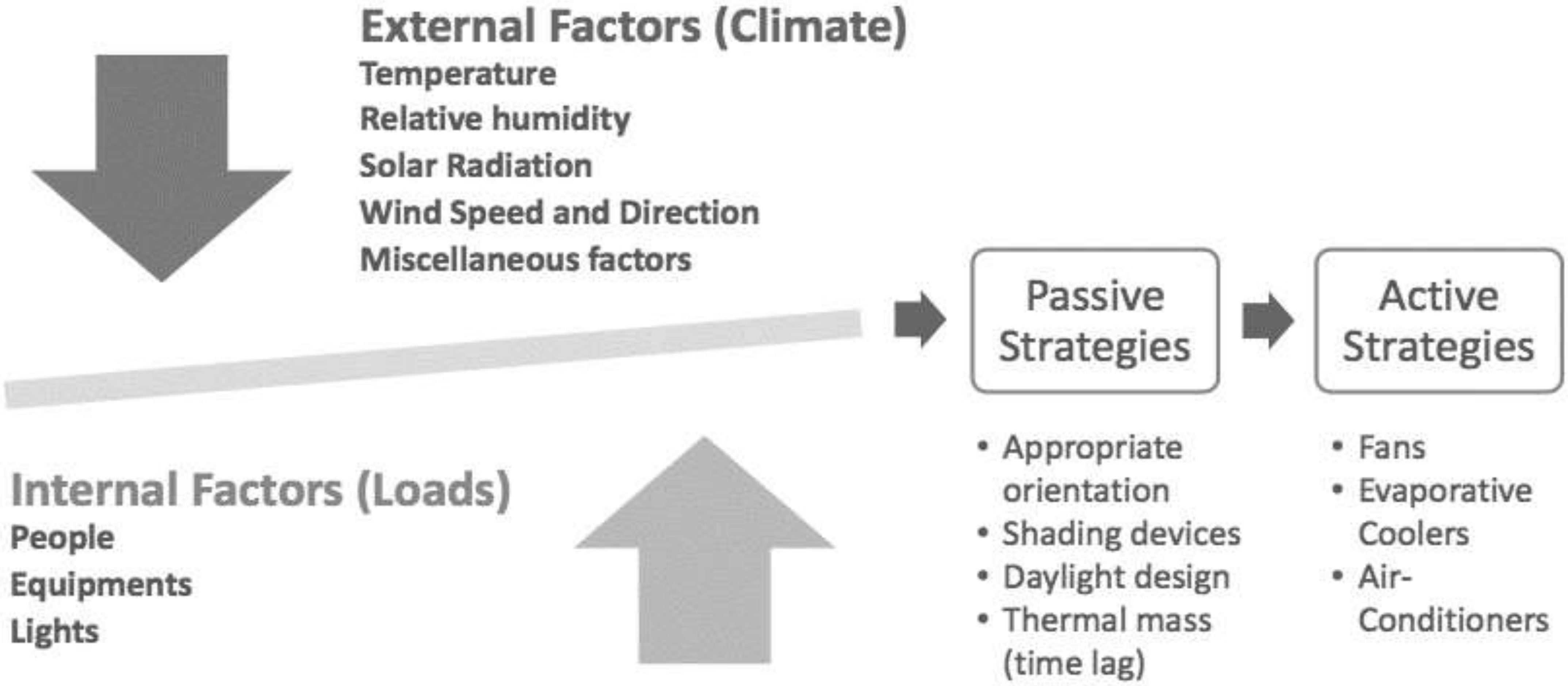
Composite Climate Zone

Thermal Requirements	Physical Manifestation
Reduce Heat Gain in Summer and Reduce Heat Loss in Winter	
Decrease exposed surface area	Orientation and shape of building. Use of trees as wind barriers
Increase thermal resistance	Roof insulation and wall insulation
Increase thermal capacity (Time lag)	Thicker walls
Increase buffer spaces	Air locks/Balconies
Decrease air exchange rate	Weather stripping
Increase shading	Walls, glass surfaces protected by overhangs, fins and trees
Increase surface reflectivity	Pale color, glazed china mosaic tiles, etc.
Reduce solar heat gain	Use glazing with lower SHGC and provide shading for windows. Minimize glazing in East and West
Promote Heat Loss in Monsoon	
Increase air exchange rate (Ventilation)	Courtyards/wind towers/arrangement of openings
Increase humidity levels in dry summer	Trees and water ponds for evaporative cooling
Decrease humidity in monsoon	Dehumidifiers/desiccant cooling

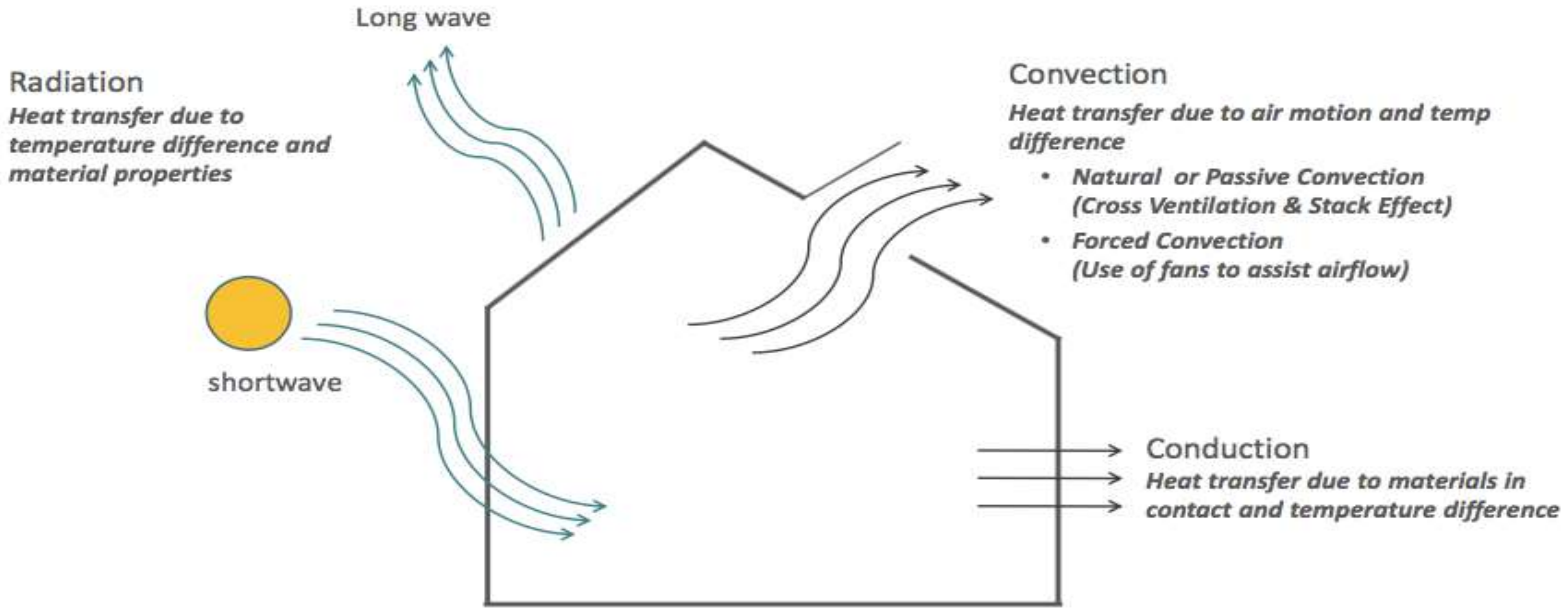
Psychrometric Chart



Optimizing Energy Use for Thermal Comfort



Building Heat Transfer



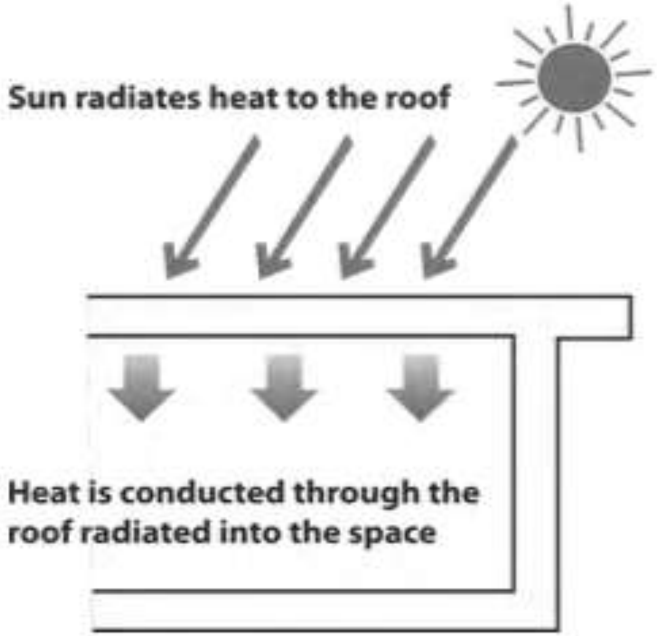
TOTAL ENVELOPE HEAT TRANSFER = Conduction + Convection + Radiation

SOURCE: From "Introduction to Building Physics" presentation prepared by Univ. Prof. Dr. A. Mahdavi, Department of Building Physics and Building Ecology, Vienna University of Technology, Vienna, Austria

Building Heat Transfer

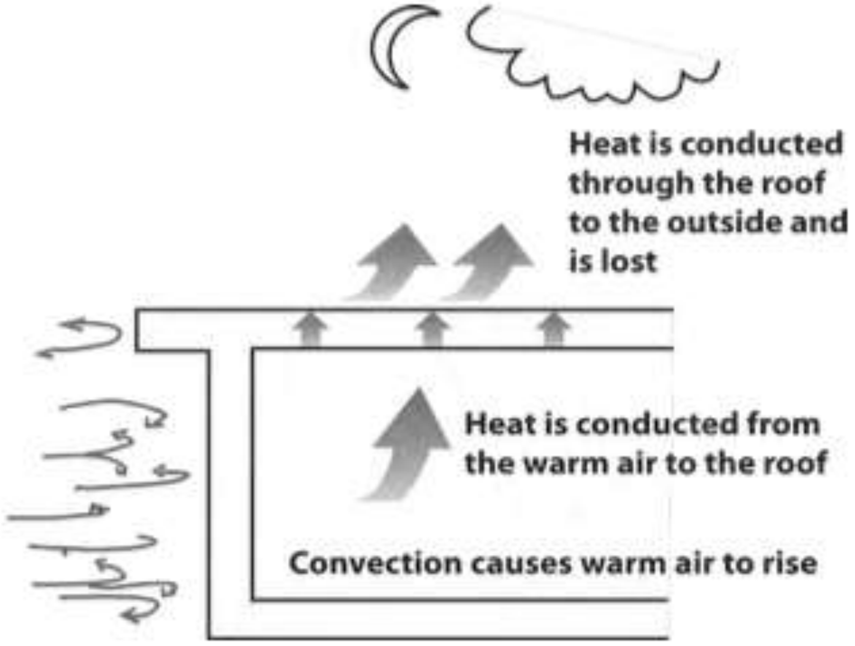
Day Time Heat Transfer

Heat Transfer takes place from OUTSIDE TO INSIDE of the building (Tout > Tin)



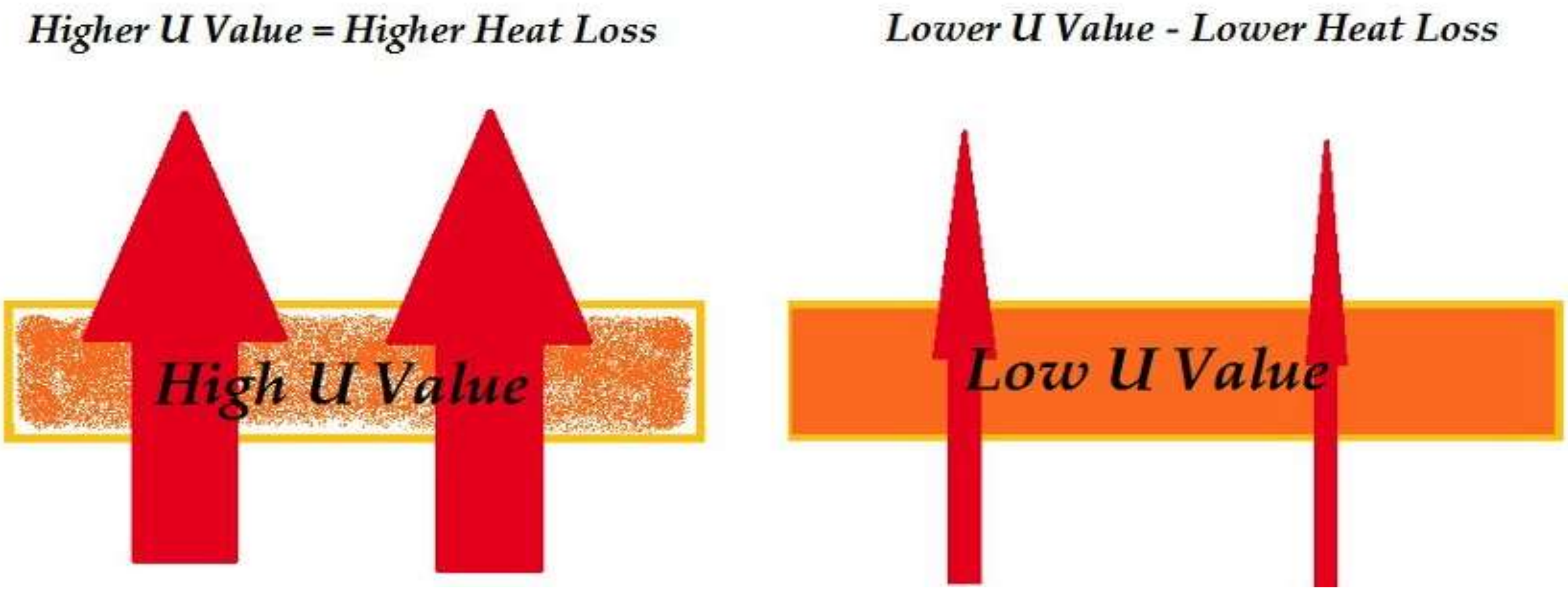
Night Time Heat Transfer

Heat Transfer takes place from INSIDE to OUTSIDE of the building (Tout < Tin)



Building Heat Transfer

- Conductance to heat flow
- Reciprocal of Thermal Resistance (R)
- Lower the U-Value the better the performance of insulation
- Measures heat transfer through the envelope due to a temperature difference between the indoors and outdoors (Unit = W/m^2·K)



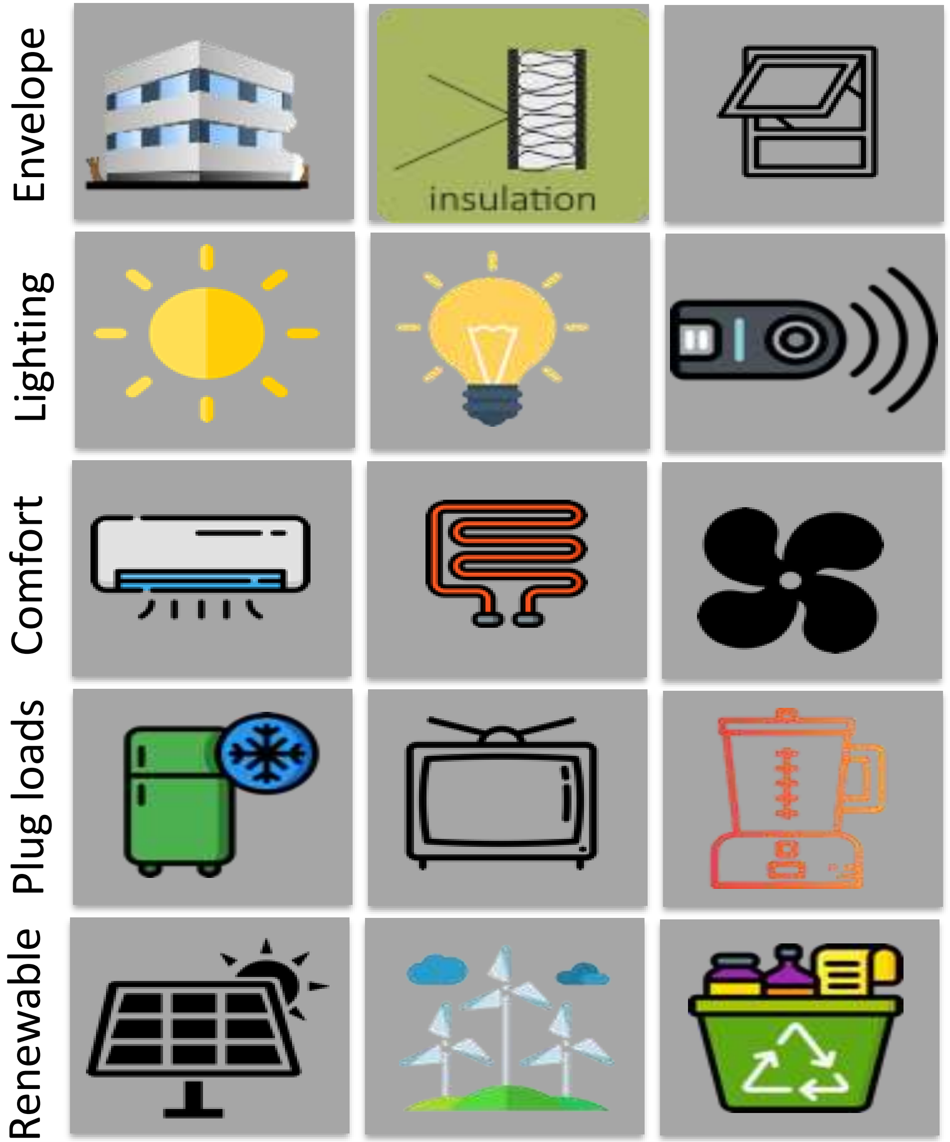
Building Components

Building Envelope
- Appropriate Orientation & Shading
- Enhanced Roof, Wall, Glazing
- Daylight

Comfort Systems & Controls
- Natural ventilation
- Comfort Systems

Lighting & Controls
- Lighting Controls
- Lighting Power Density

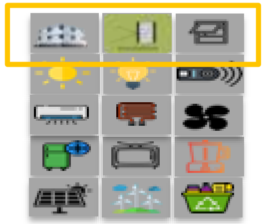
Electrical
- Electrical Power
- Renewable Energy



BUILDING ENVELOPE

Building Envelope

Envelope Design Considerations ECBC §4

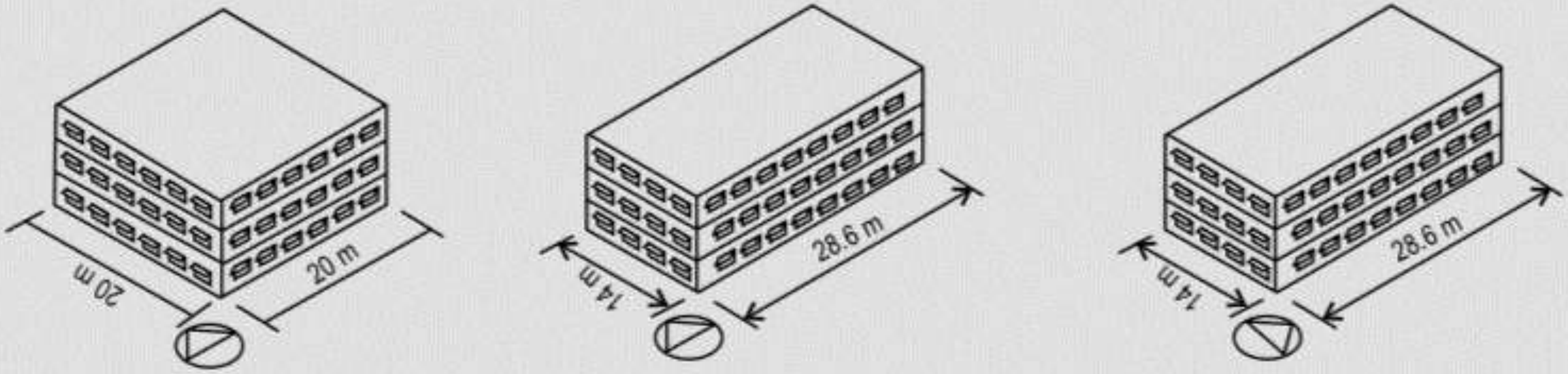


- **Appropriate Orientation & Shading**
- Enhanced Wall & Roof Insulation
- Efficient Glazing

Building Envelope: Design Considerations

Box 4.1 Simulations carried out on reference buildings to explain the strategies

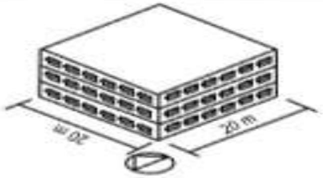
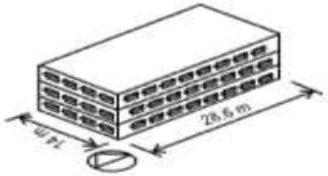
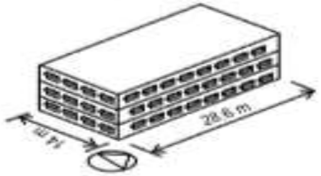
To explain the strategies, a hypothetical case of a small office building, three storeys high, having a total built-up area of 1200 m^2 was considered. For a building in Belagavi, simulations of cooling demand, daylight access, and natural ventilation were carried out for different options (shapes, orientation, openings, etc.). This analysis was carried out using two software—Design Builder (cooling loads and daylighting) and FloVENT (natural ventilation).



Source: BEE

Building Envelope: Design Considerations

Table 4.1 Results of the analysis of the effect of building massing on cooling load for an intermediate floor (Belagavi)

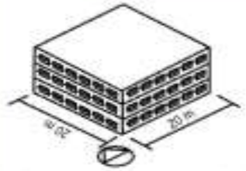
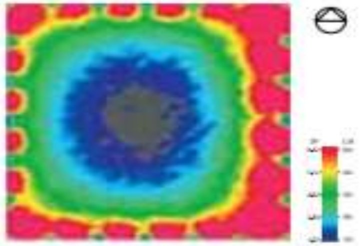
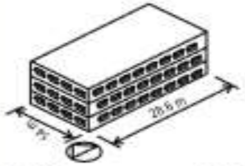
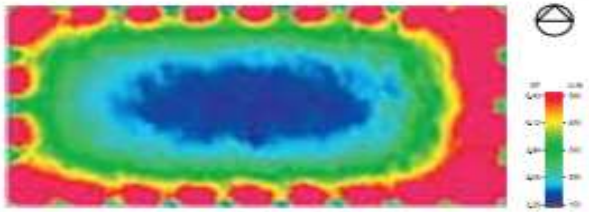
Case	Model	Properties	Total cooling load (kWh) on an intermediate floor for March to May period
Case 1	 Built-up area: 1200 m^2 Floor-plate dimension: 20 x 20 m	WWR: 20% on all façades, Overhangs: 600 mm fixed, Glazing type: Single clear 6 mm (U-value: 6.1 W/m^2.K, VLT: 88%, SHGC: 0.81), Level: Intermediate floor 6 inch RCC slab with plaster (U-value: 3.8 W/m^2.K) Intermediate floor (no heat exchange through the floor and the ceiling with other floors), No internal loads considered, Cooling set-point: 26 °C, Fresh air + Infiltration: 1 ach	3782
Case 2	 Built-up area: 1200 m^2 Floor-plate dimension: 14.0 x 28.6 m Orientation: N–S		3677 GOOD
Case 3	 Built-up area: 1200 m^2 Floor-plate dimension: 14.0 x 28.6 m Orientation: E–W		4305

Note: SHGC – solar heat gain coefficient; RCC – reinforced concrete slab; WWR – window-to-wall ratio; and VLT – visual light transmittance

Source: BEE

Building Envelope: Design Considerations

Table 4.2 Results of daylight access in Cases 1 and 2

Case	Model	Properties	Daylight
Case 1	 Built-up area: 1200 m² Floor-plate dimensions: 20 x 20 m	WWR: 20% on all façades Overhangs: 600 mm fixed Glazing type: Single clear 6 mm (U-value: 6.1 W/m².K, VLT: 88%, SHGC: 0.81)	
Case 2	 Built-up area: 1200 m² Floor-plate dimensions: 14.0 x 28.6 m Orientation: N–S		 GOOD

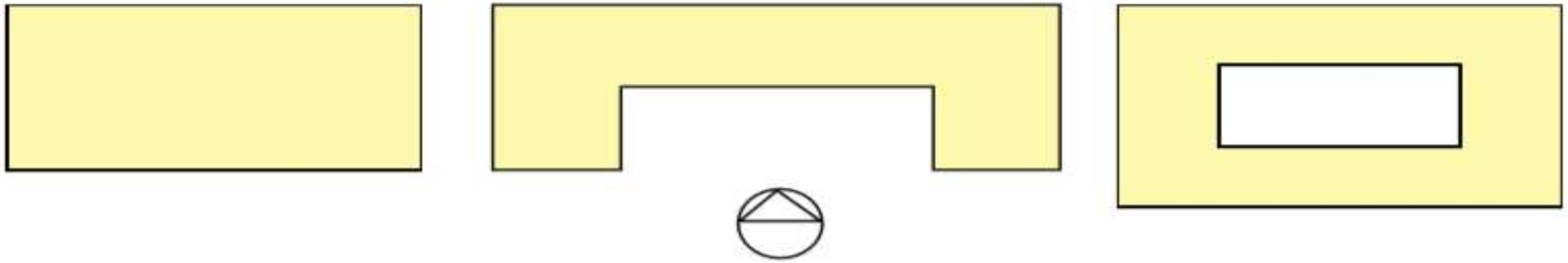
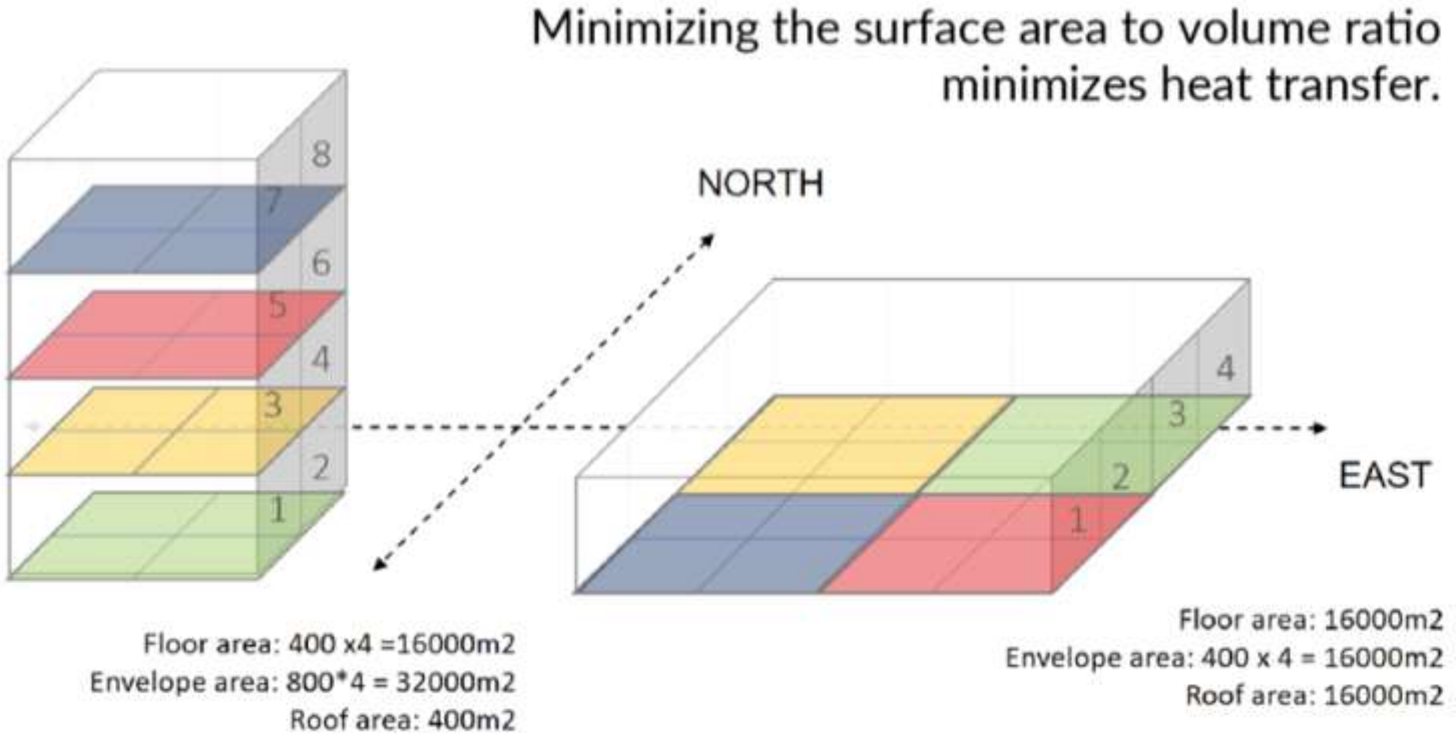
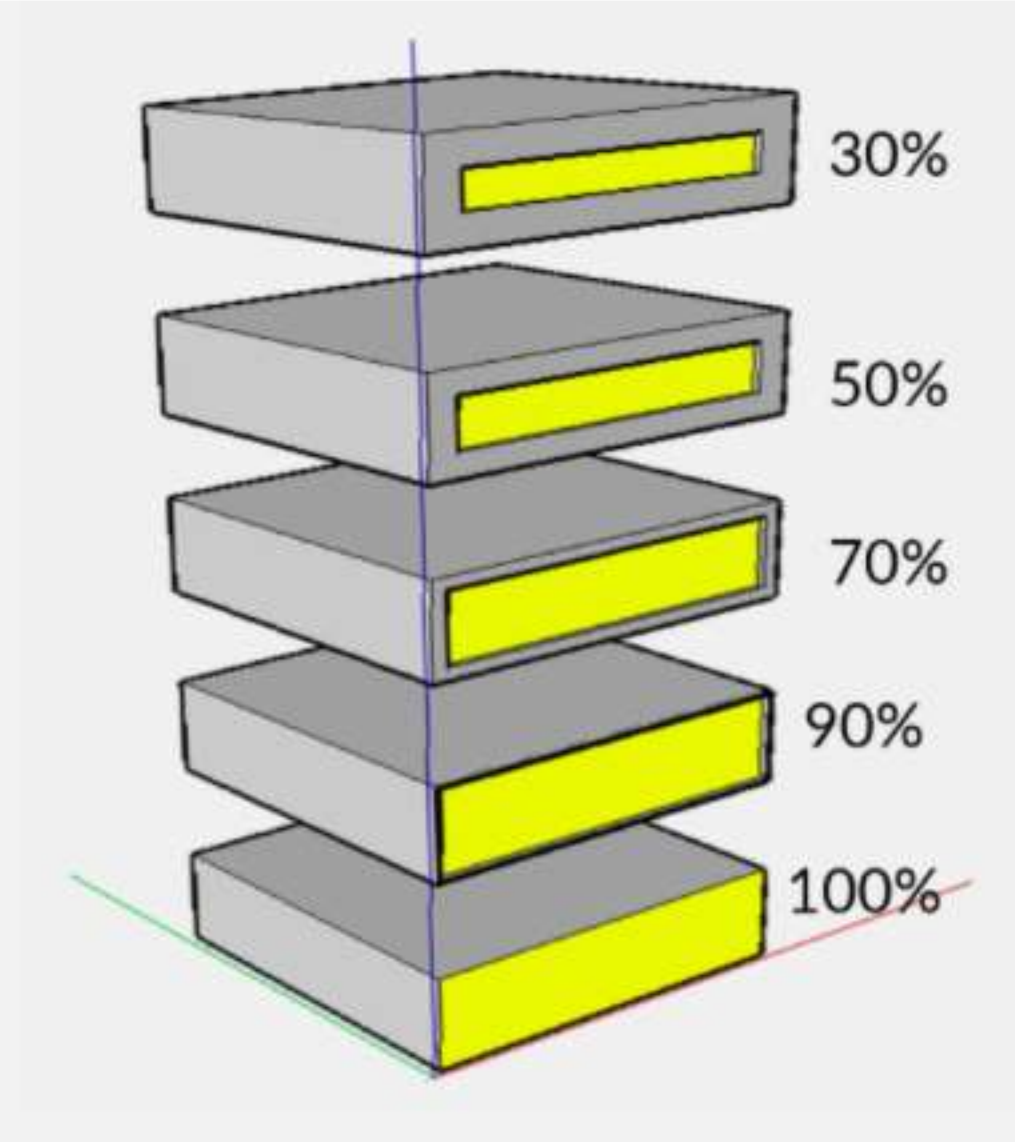


Figure 4.2 *Recommended building forms for climate-responsive building massing*

Source: BEE

Building Envelope: Design Considerations

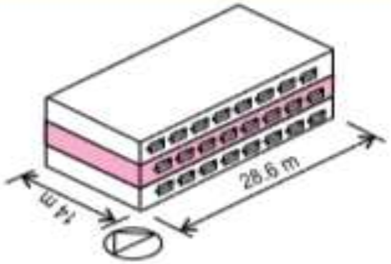
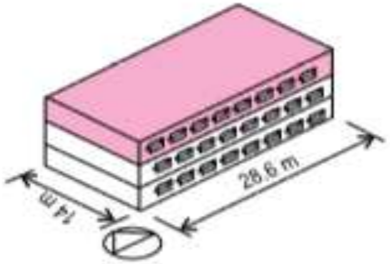




Source: Edge

Building Envelope: Design Considerations

Table 4.6 Comparison of heat gain through different components of building envelope on an intermediate floor and top floor

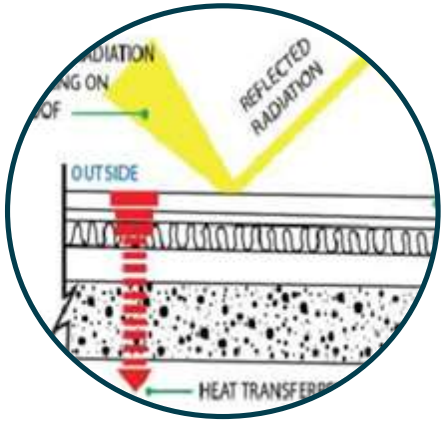
Components of a building envelope	Properties	Heat gain from roof (kWh)	Heat gain from wall (kWh)	Heat gain through windows (kWh)
 Level: Intermediate floor 6 inch RCC slab with plaster (U-value: 3.8 W/m^2.K)	Built-up area: 1200 m^2 Floor-plate dimension: 14.0 x 28.6 m Orientation: N–S No windows on east and west Overhangs: 600 mm fixed Glazing type: Single clear 6 mm (U-value: 6.1 W/m^2.K, VLT: 88%, SHGC: 0.81) No heat exchange through upper and lower floors No internal loads Cooling set-point: 26 °C Fresh air + Infiltration: 1 ACH	0	93	3106
 Roof: 150 mm RCC slab with plaster (U-value: 3.8 W/m^2.K)		7293	–791[9]	2770

Source: BEE

Building Envelope

COMPLIANCE MECHANISM

ROOF



ROOF

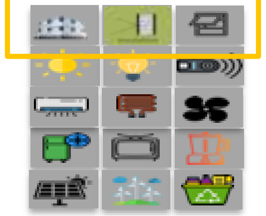
- Roofs shall comply with the maximum assembly U-factor
- The roof insulation shall be applied externally as part of structural slab and not as a part of false ceiling.

	COMPOSITE	HOT & DRY	WARM & HUMID	TEMPERAT E	COLD
All building types, except below	0.33	0.33	0.33	0.33	0.28
School <10,000 m2	0.47	0.47	0.47	0.47	0.33
Hospitality > 10,000 m2	0.20	0.20	0.20	0.20	0.20

Source:
Table 4-4 Roof Assembly U-factor (W/m2.K) Requirements for ECBC Compliant Building

Building Envelope

Envelope Design Considerations ECBC §4



- Appropriate Orientation & Shading
- **Enhanced Wall & Roof Insulation**
- Efficient Glazing

Reduction by 4 °- 5°

Building Envelope

COOL ROOF

- Roofs that are not covered by solar photovoltaic, or solar hot water, or any other renewable energy system, shall be either cool roofs or vegetated roofs.
- For qualifying as a cool roof, roofs with slopes less than 20° shall have an initial solar reflectance of no less than 0.60 and an initial emittance no less than 0.90.
- Solar reflectance shall be determined in accordance with ASTM E903-96 and emittance shall be determined in accordance with ASTM E408-71 (RA 1996).
- For qualifying as a vegetated roof, roof areas shall be covered by living vegetation.



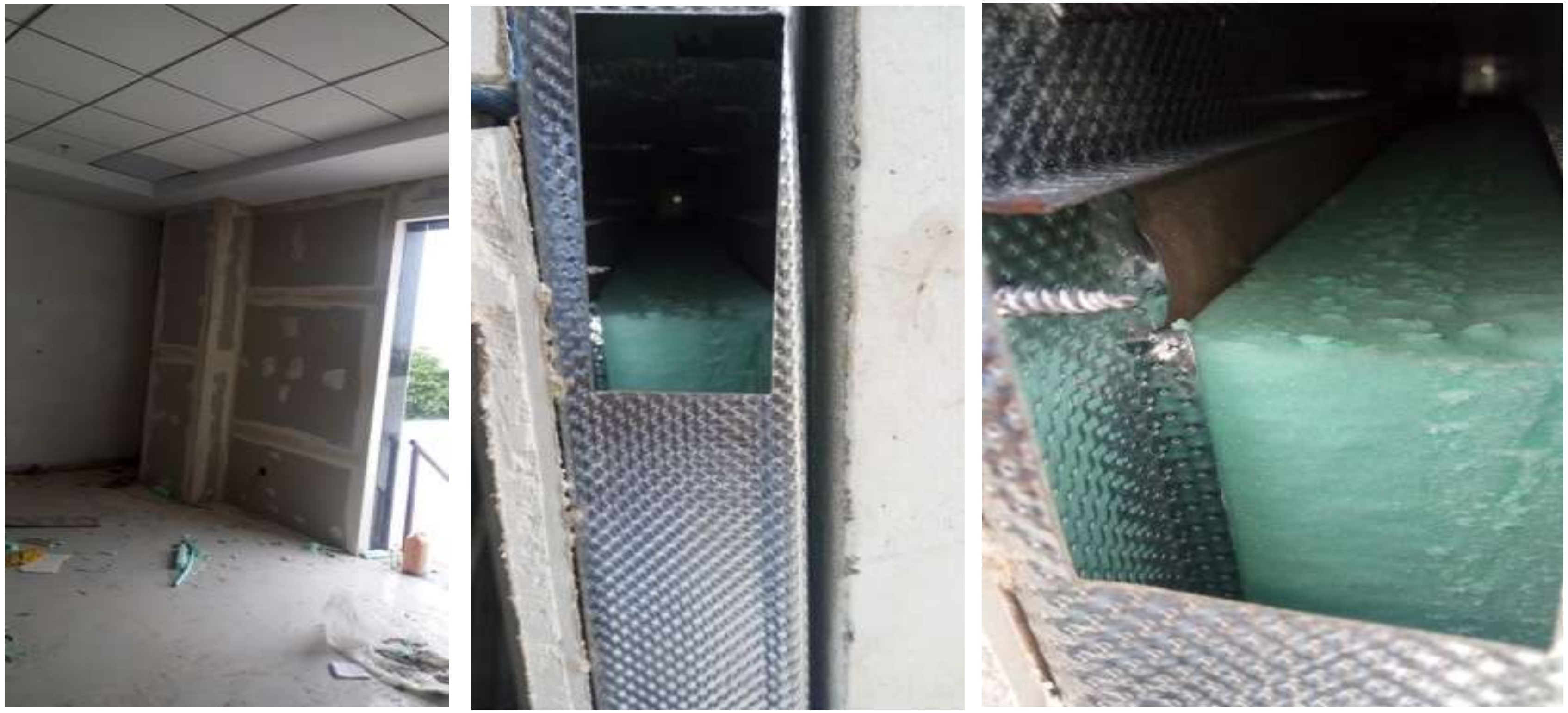
Building Envelope

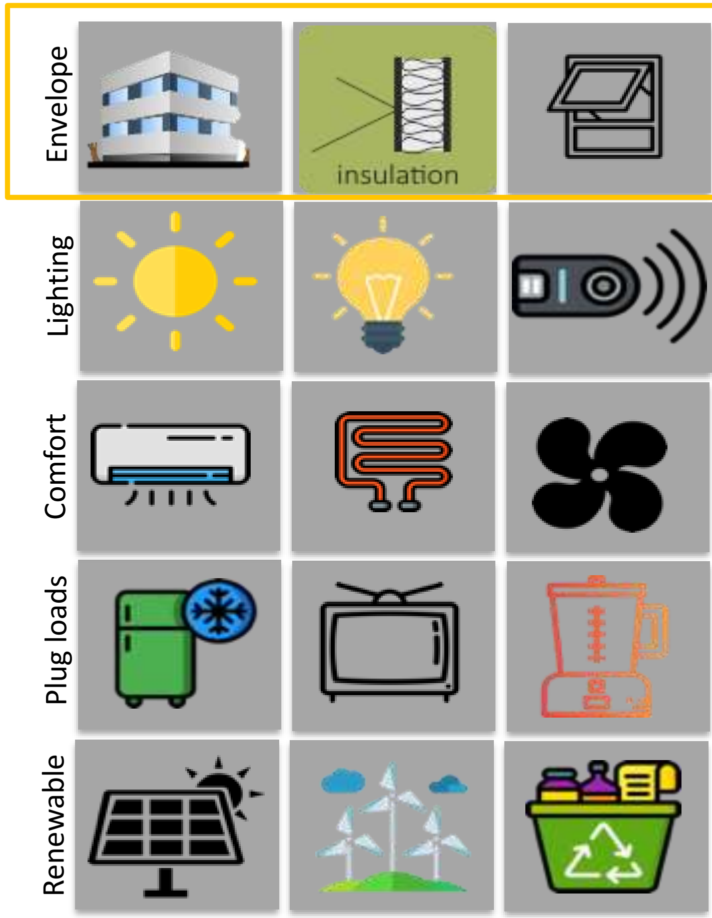
5- 10%

Reduction by 5 °- 8°

Envelope Design Considerations ECBC §4

- Appropriate Orientation & Shading
- **Enhanced Wall & Roof Insulation**
- Efficient Glazing



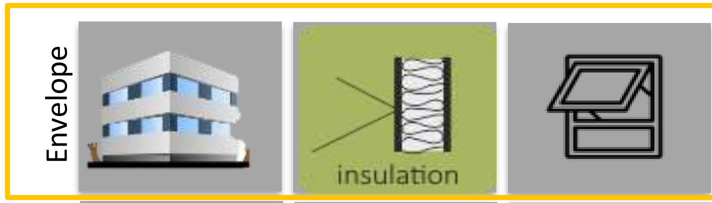


Building Envelope

Envelope Design Considerations ECBC §4

- Appropriate Orientation & Shading
- **Enhanced Wall & Roof Insulation**
- Efficient Glazing

Source: Edge



Insulation Type	Thickness (mm) Approximate values to achieve U-value of 0.45W/m²K
Vacuum Insulated Panels	10–20mm
Polyurethane (PU)	40–80mm
Polyisocyanurate (PIR)	40–60mm
Phenolic Foam (PF)	40–55mm
Expanded Polystyrene (EPS)	60–95mm
Extruded Polystyrene (XPS)	50–80mm
Wool and Fiber	60–130mm

Building Envelope

COMPLIANCE MECHANISM

WALL

WALL

- Opaque construction materials and their thermal properties including thermal conductivity, specific heat, density
- Opaque external walls shall comply with the maximum assembly U-factors ($W/m^{2}\cdot K$)

	COMPOSITE	HOT & DRY	WARM & HUMID	TEMPERATE	COLD
All building types except below	0.40	0.40	0.40	0.55	0.34
No. star hotel< 10000 m2	0.63	0.63	0.63	0.63	0.40
Business<10000m^2	0.63	0.63	0.63	0.63	0.40
School< 10000m^2	0.85	0.85	0.85	1.00	0.40

Source:

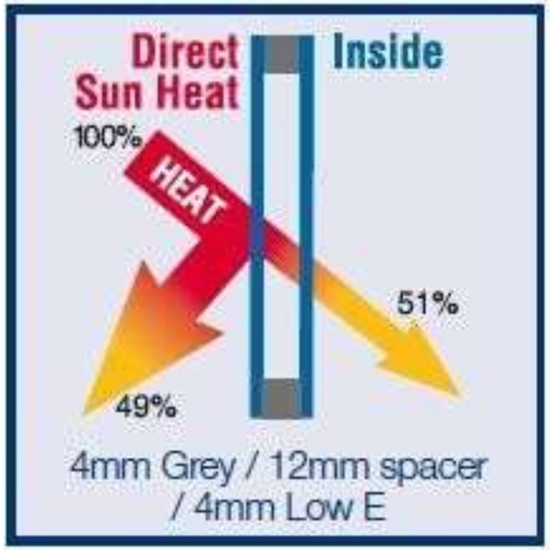
Table 4-7 Opaque Assembly Maximum U-factor (W/m2.K) requirements for ECBC compliant Building; ECBC Manual

Building Envelope

Envelope Design Considerations ECBC §4

- Appropriate Orientation & Shading
- Enhanced Wall & Roof Insulation
- **Efficient Glazing**

Standard single glazed glass offers little resistance



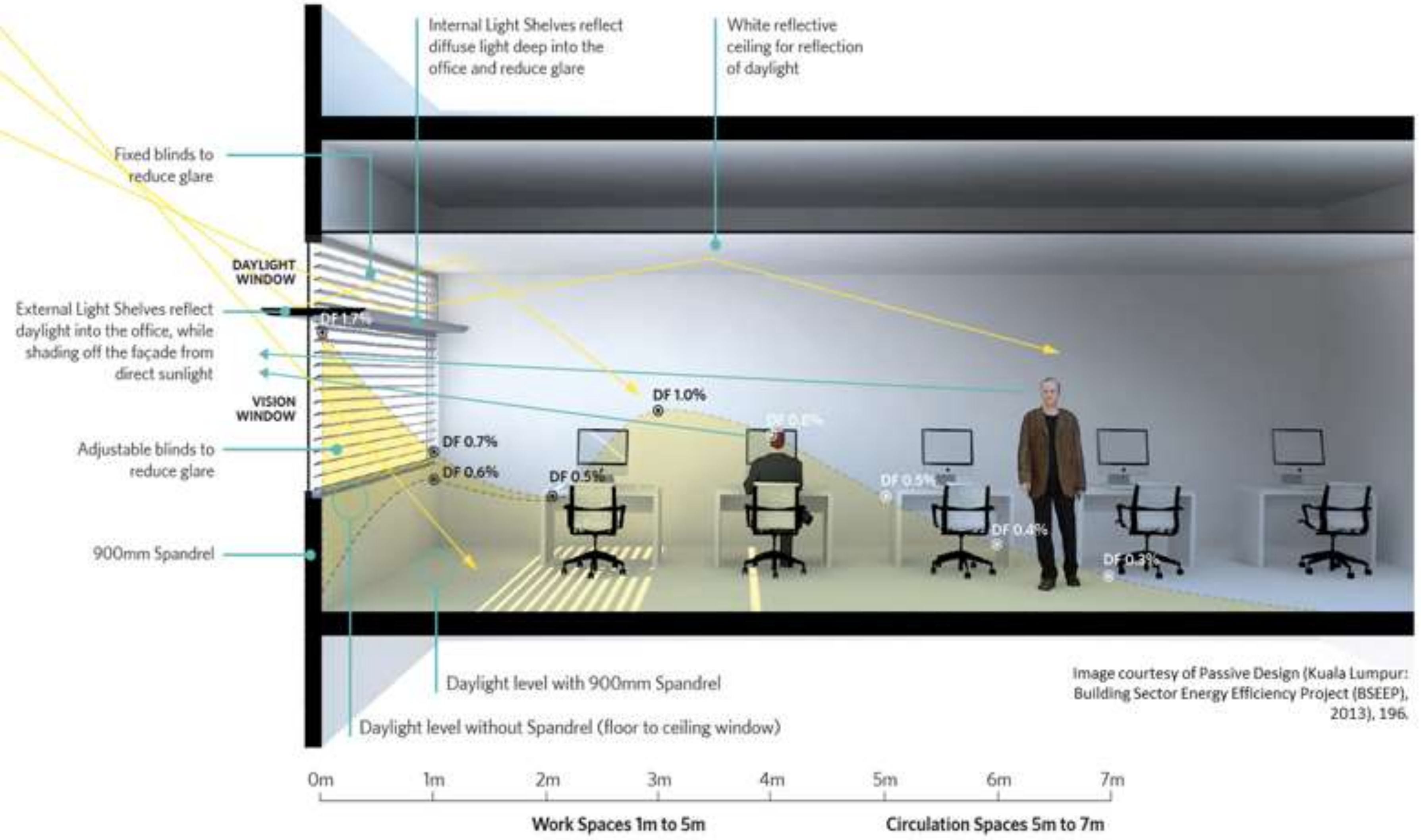
Low EInsulated glass can reduceheat gain by 33%.

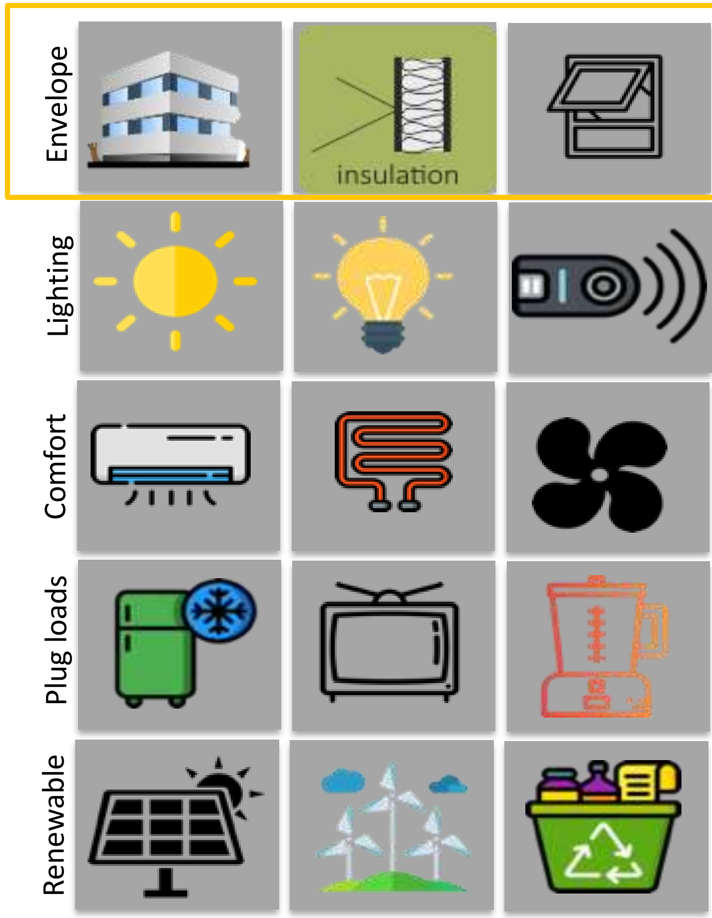
Building Envelope: Design Considerations

Source: Edge

Building Envelope

Daylighting and Energy Efficient Lighting





Building Envelope

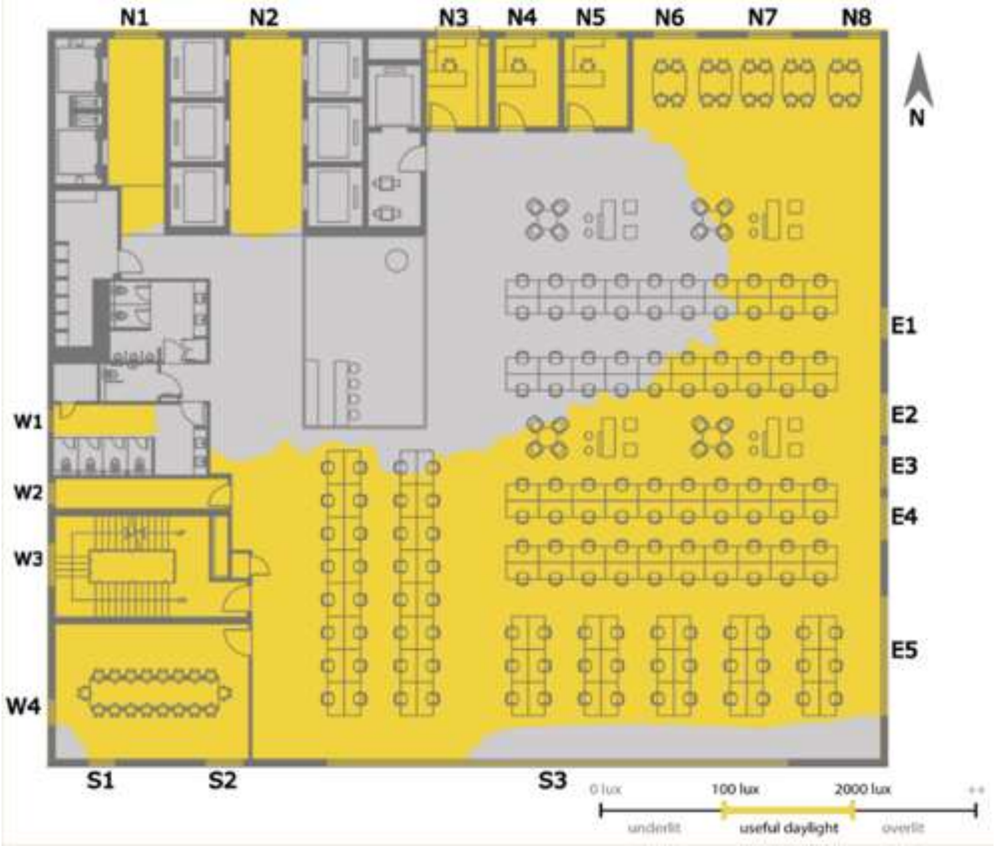
Daylighting

Table 4-1 Daylight Requirement

Building Category	*Percentage of above grade floor area meeting the UDI requirement*		
	ECBC	ECBC+	SuperECBC
Business, Educational	40%	50%	60%
No Star Hotel Star Hotel Healthcare	30%	40%	50%
Resort	45%	55%	65%
Shopping Complex	10%	15%	20%
Assembly*	Exempted		

*and other buildings where daylighting will interfere with the functions or processes of 50% (or more) of the building floor area

Using Simulation Tools **or** **Manual Calculation**



Building Envelope

COMPLIANCE MECHANISM

FENESTRATIONS

3. FENESTRATION

- U-value, SHGC and U-value is considered while selecting the fenestration type.
- Vertical fenestration assembly requirements for ECBC

	COMPOSITE	HOT & DRY	WARM & HUMID	TEMPERATE	COLD
Max. U-factor ($W/m^2.K$)	3.00	3.00	3.00	3.00	3.00
Max. SHGC Non-North	0.27	0.27	0.27	0.27	0.62
Max. SHGC North for latitude >15° N	0.50	0.50	0.50	0.50	0.62
Max. SHGC North for latitude <15° N	0.27	0.27	0.27	0.27	0.62

Source:

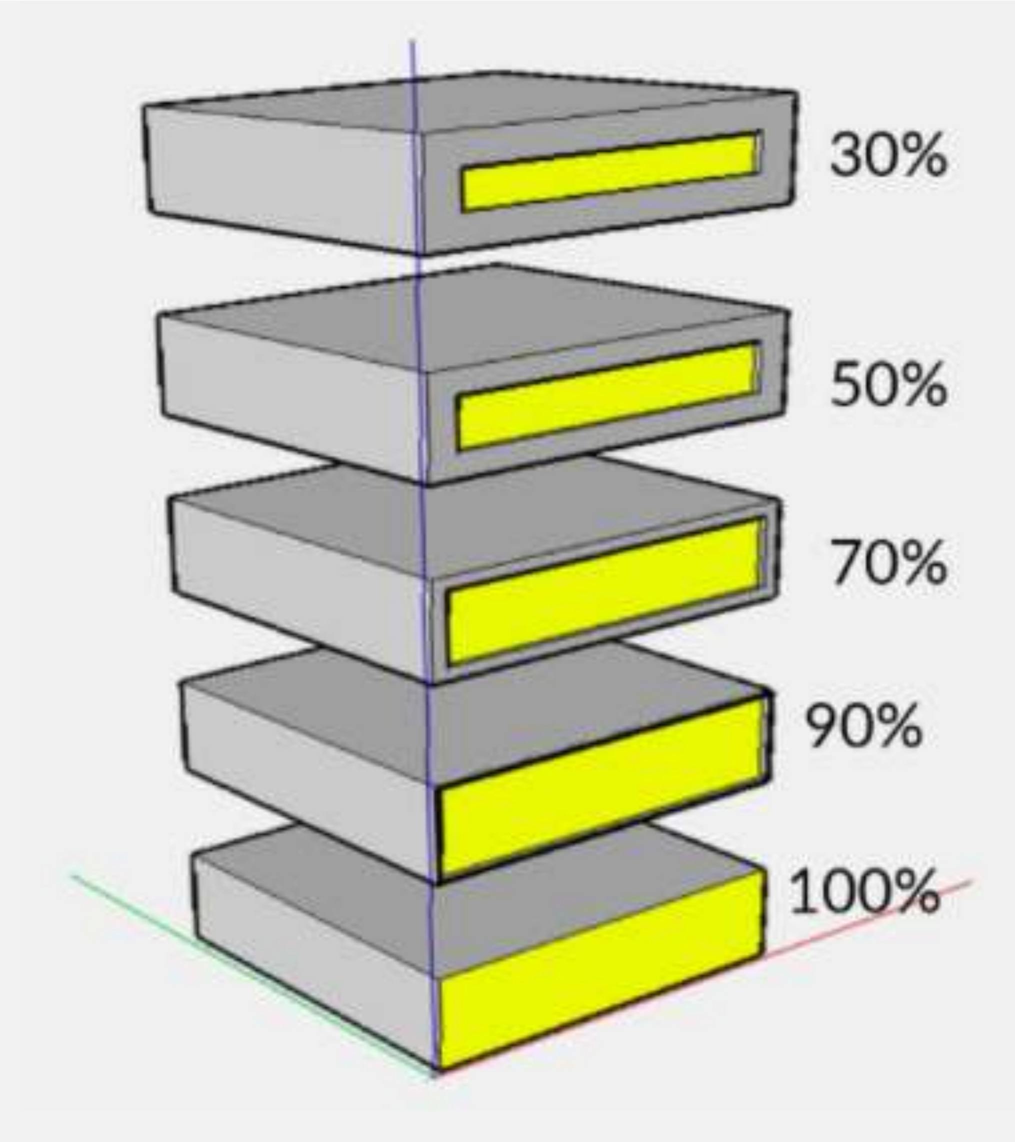
Table 4-10: Vertical Fenestration Assembly U-factor and SHGC Requirements for ECBC Buildings; ECBC Manual

ECBC Req: Prescriptive (Vertical Fenestration)

(a) Maximum allowable Window Wall Ratio (WWR) is 40% (applicable to buildings showing compliance using the Prescriptive Method, including Building Envelope Trade-off Method)

(b) Minimum allowable Visual Light Transmittance (VLT) is 0.27

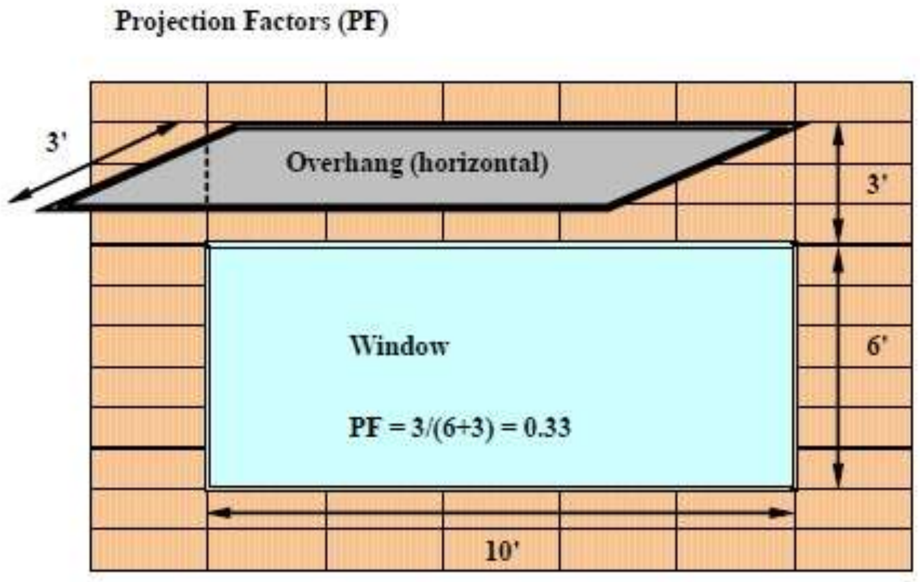
(c) Assembly U-factor shall be determined for the overall fenestration product(including the frame and glass)

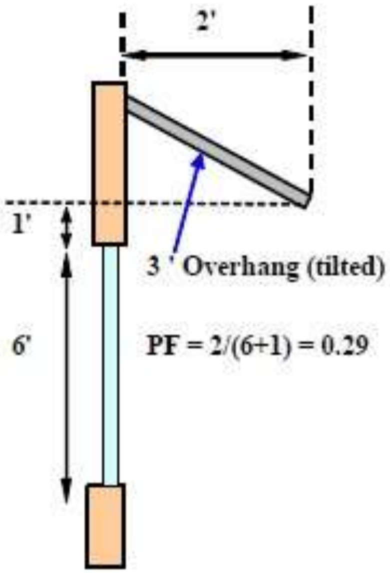


Projection Factor (PF)

- The ratio of the distance the overhang projects from the window surface to its height above the sill of the window it shades.
- Projection Factor is required to determine **Coefficient of shading Factor**

$$PF = \frac{\text{Overhang(Horizontal)}}{\text{Height above the sill of the window(Vertical)}}$$

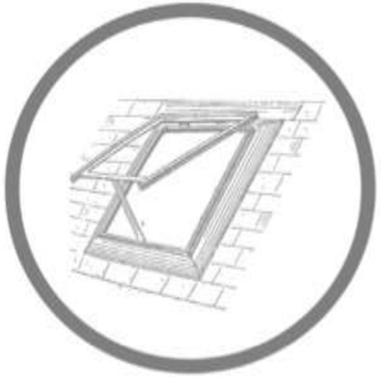




Building Envelope

COMPLIANCE MECHANISM

SKYLIGHT



SKYLIGHT

- Skylights shall comply with the maximum U-factor and maximum SHGC requirements
- Skylight roof ratio (SRR) is limited to a maximum of 5% for ECBC Building, ECBC+ Building, and SuperECBC Building, when using the Prescriptive Method for compliance.

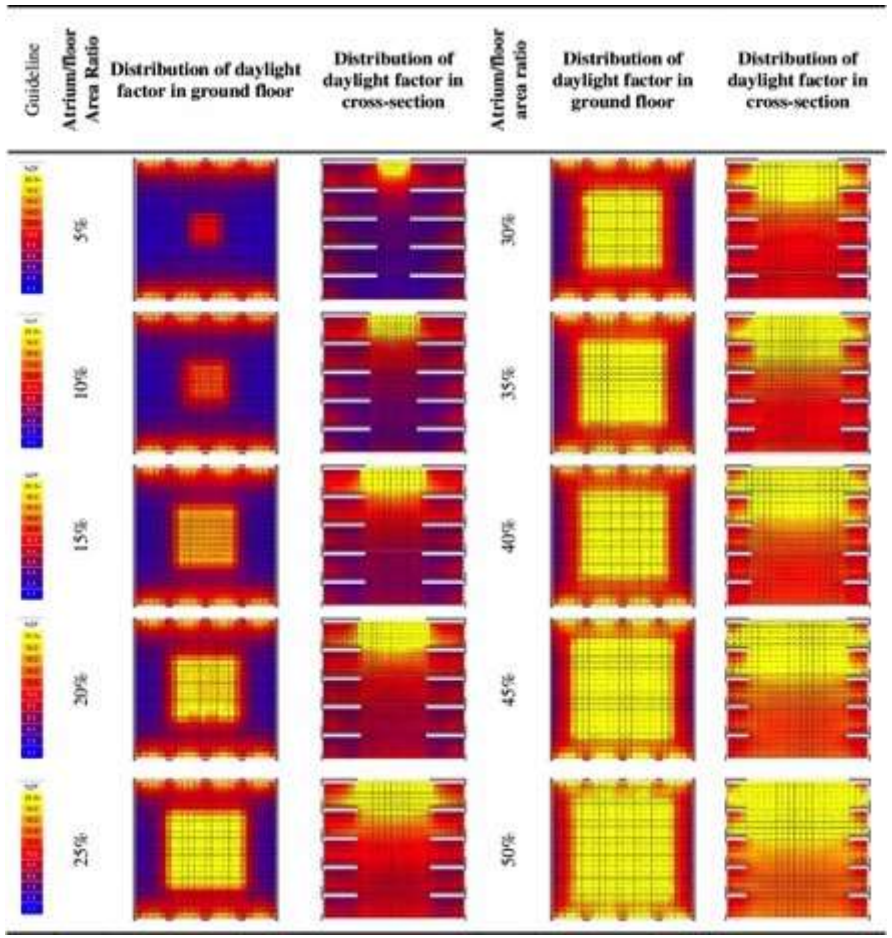
CLIMATE	MAX. U-VALUE	MAX. U-VALUE
All climatic zones	4.25	0.35

Source:

Table 4-15 Skylight U-factor and SHGC Requirements (U-factor in W/m2.K)

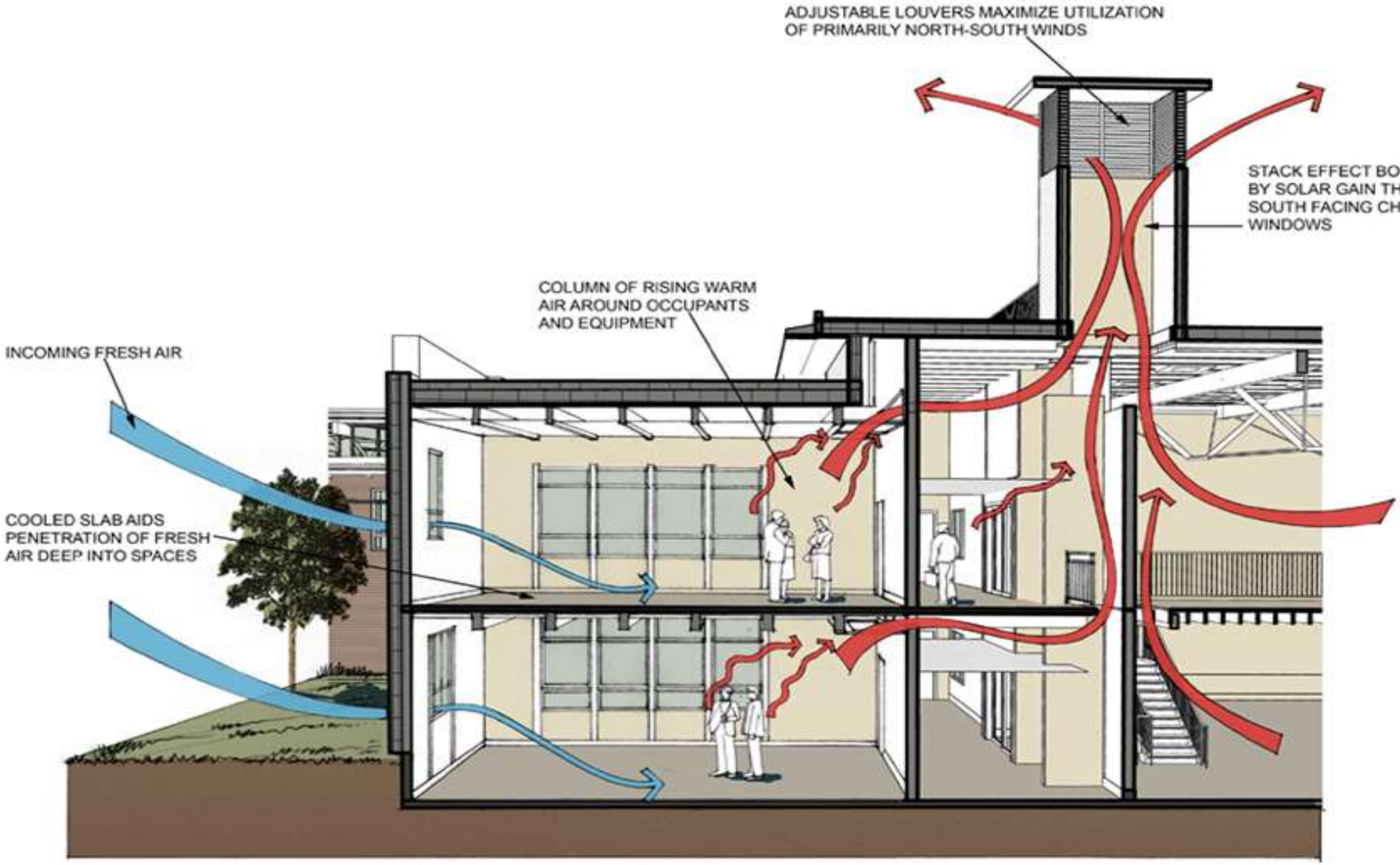
Building Envelope

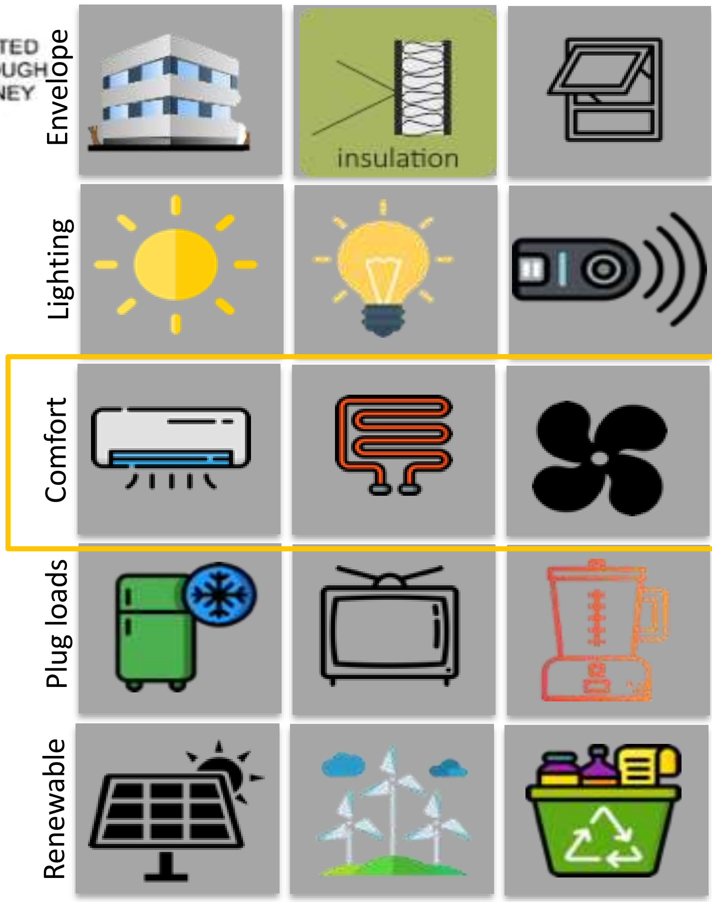
Daylighting – Horizontal Fenestration



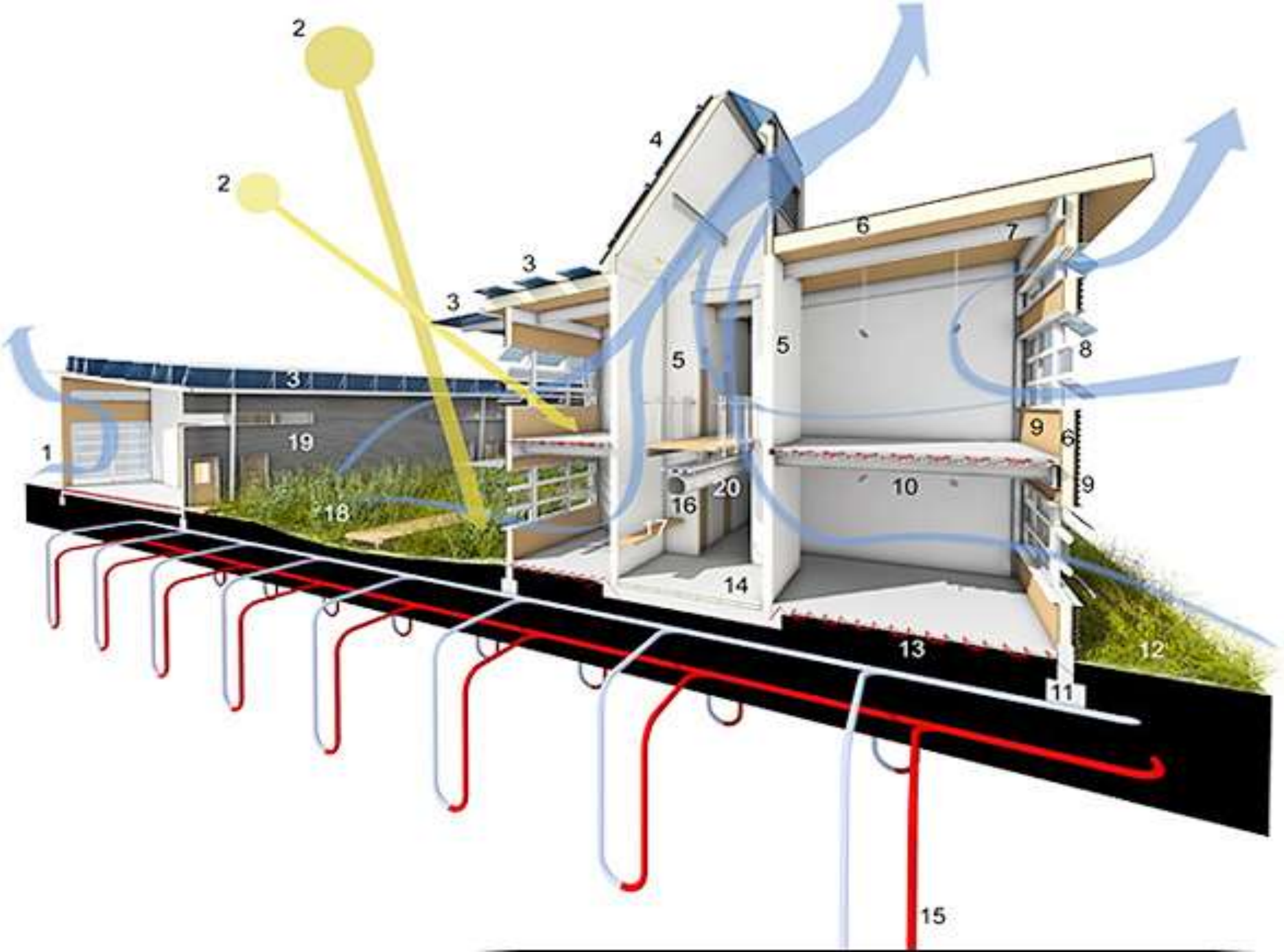
COMFORT SYSTEMS & CONTROLS

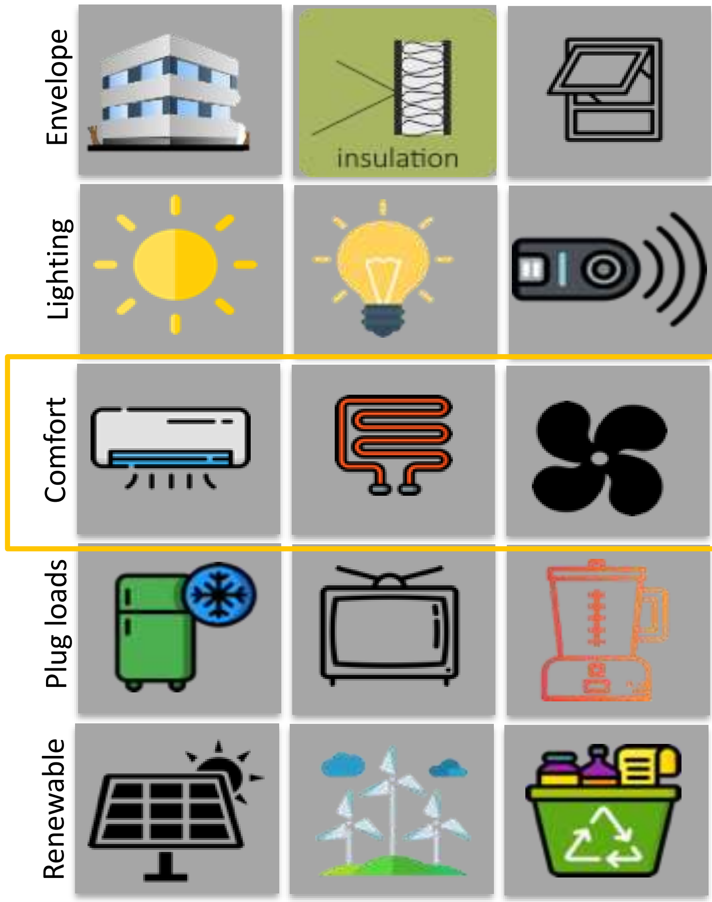
Comfort Systems & Controls



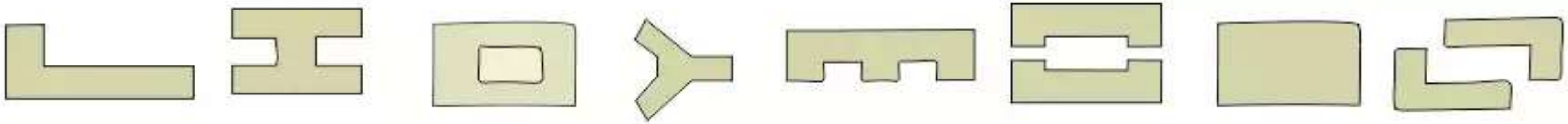


Comfort Systems & Controls

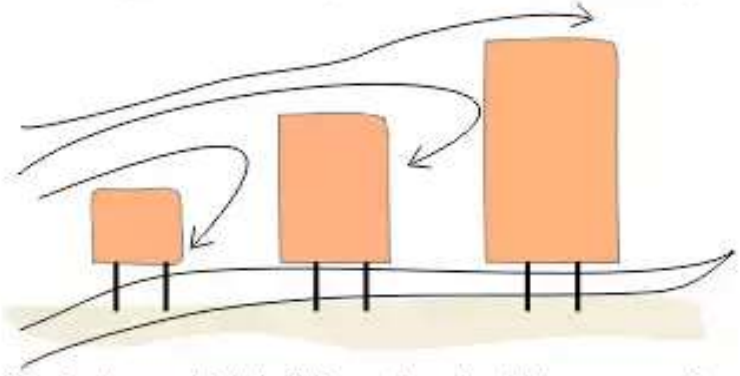




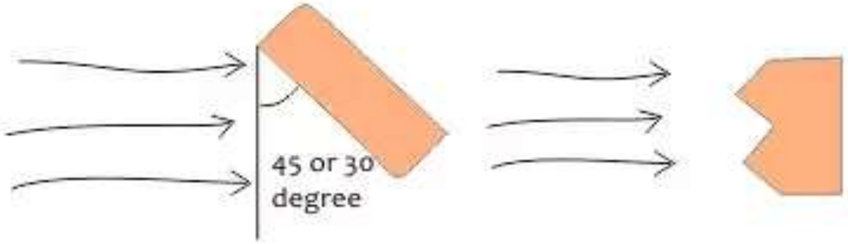
Natural Ventilation: Considerations



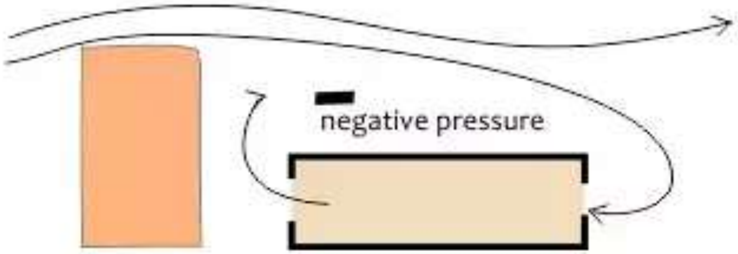
Orient longer facades along the north. This will provide glare free light in summer from north without shading and winter sun penetration from the south.



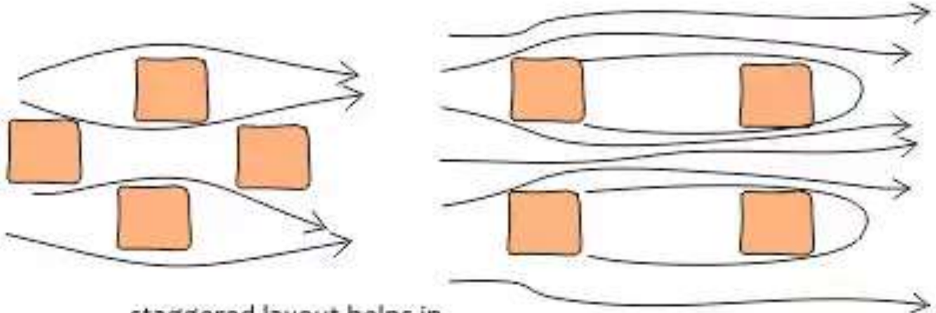
if a site has multiple buildings, they should be arranged in ascending order of their heights and be built on stilts to allow ventilation



Place buildings at a 30 or 45 degree angle to the direction of wind for enhanced ventilation. Form can be staggered in the wind facing direction also to achieve the same result.



Taller forms in the wind direction of prevailing wind can alter the wind movement pattern for low lying buildings behind them



staggered layout helps in accentuating wind movement

Source: Edge

Comfort Systems & Controls

COMPLIANCE MECHANISM

VENTILLATION

All heating, ventilation, air conditioning equipment and systems and controls shall comply with the mandatory provisions

- All habitable spaces shall be ventilated with outdoor air in accordance with the requirements of and guidelines specified in the National Building Code 2016 *(Part 8: Building Services, Section 1: Lighting and Natural Ventilation, Subsection 5: Ventilation).*

- Ventilated spaces shall be provided with outdoor air using one of the following:

  - **Natural ventilation**
  - **Mechanical ventilation**
  - **Mixed mode ventilation**

Comfort Systems & Controls

VENTILATION

All heating, ventilation, air conditioning equipment and systems and controls shall comply with the mandatory provisions

Thermo Siphon

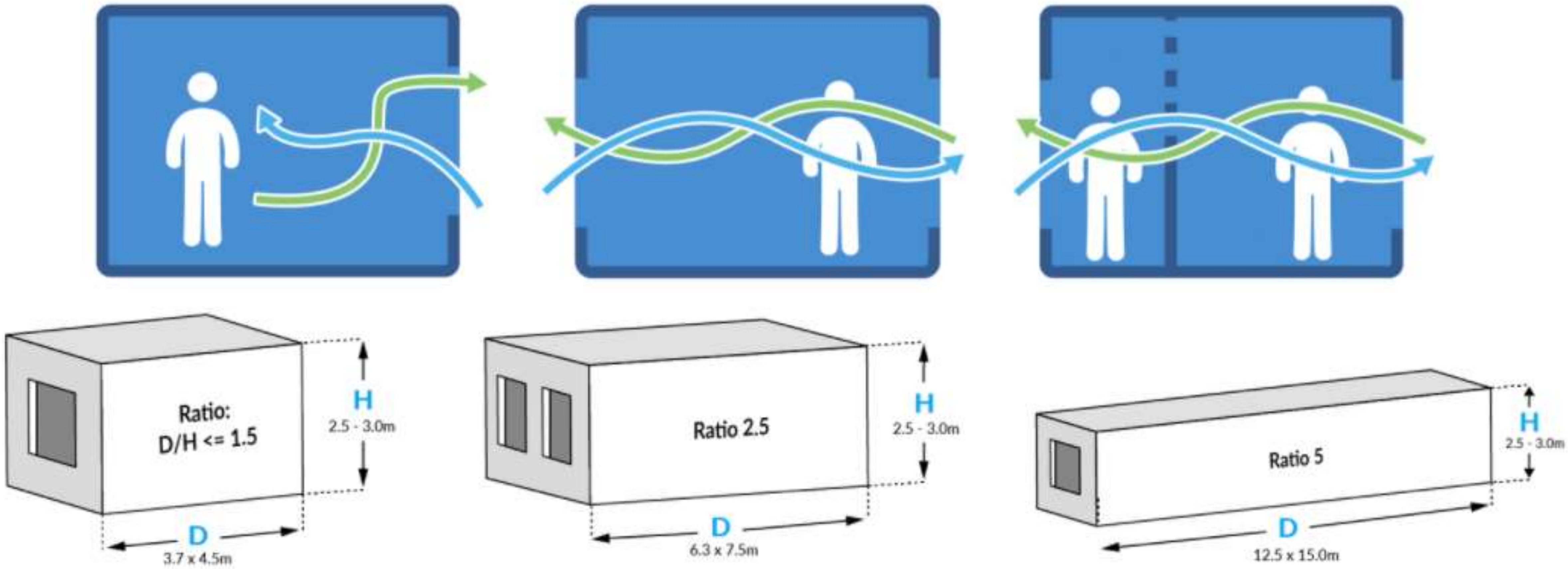
Stack Effect

Source: Edge

Wind Driven

Comfort Systems & Controls

Ventilation Strategies



Single-sided, single opening

Maximum depth of floor to ceiling height ratio: 1.5

Single-sided, multiple openings

Maximum depth of floor to ceiling height ratio: 2.5

Cross ventilation

Maximum depth of floor to ceiling height ratio: 5.0

Source: Edge

Comfort Systems & Controls

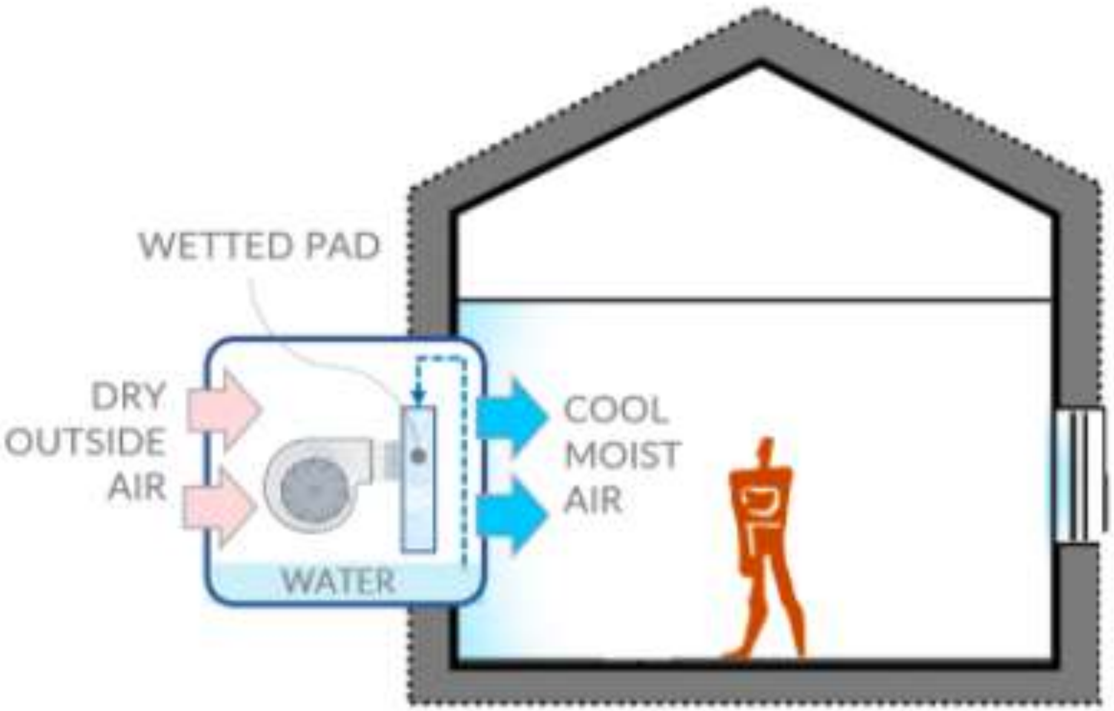
MINIMUM SPACE CONDITIONING EQUIPMENT EFFICIENCIES

- Unitary, Split, Packaged Air-Conditioners
- Variable Refrigerant Flow
- Chiller
- Air Conditioning and Condensing Units Serving Computer Rooms
- Low Cooling Energy Systems
- Passive Cooling Energy Systems

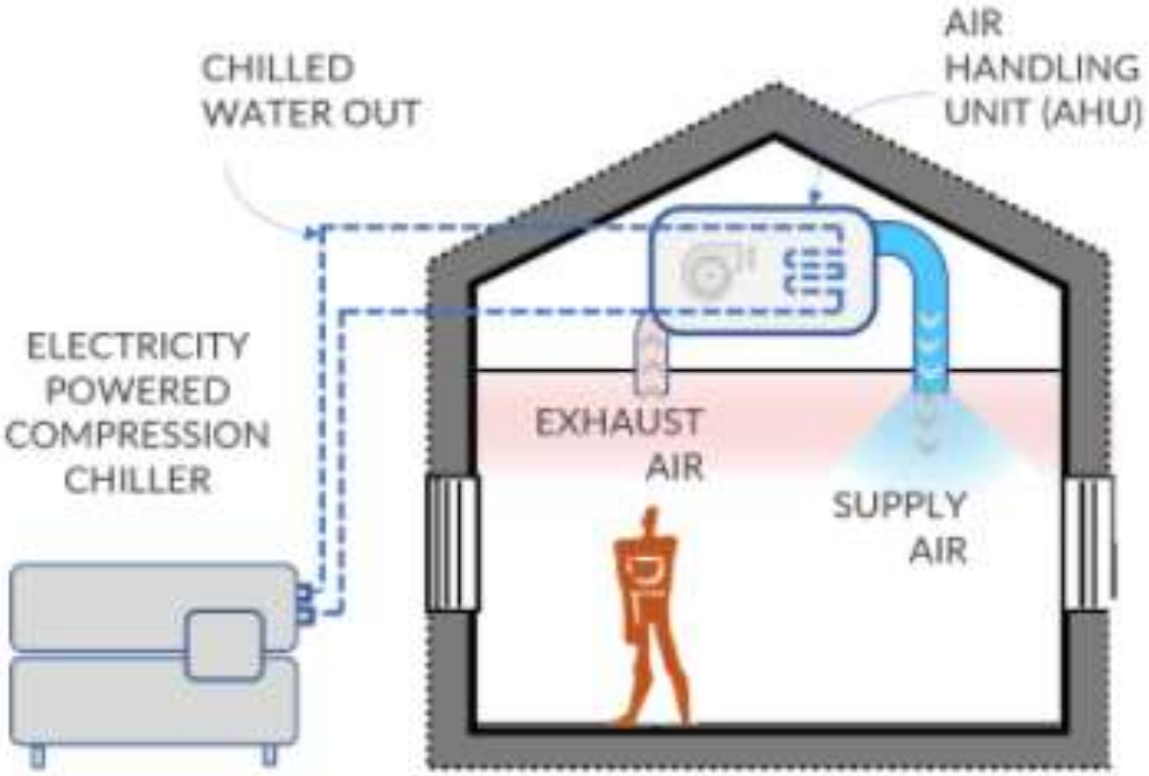
Comfort Systems & Controls

COMPLIANCE MECHANISM

EVAPORATIVE COOLING



VAPOR COMPRESSOR CHILLERS

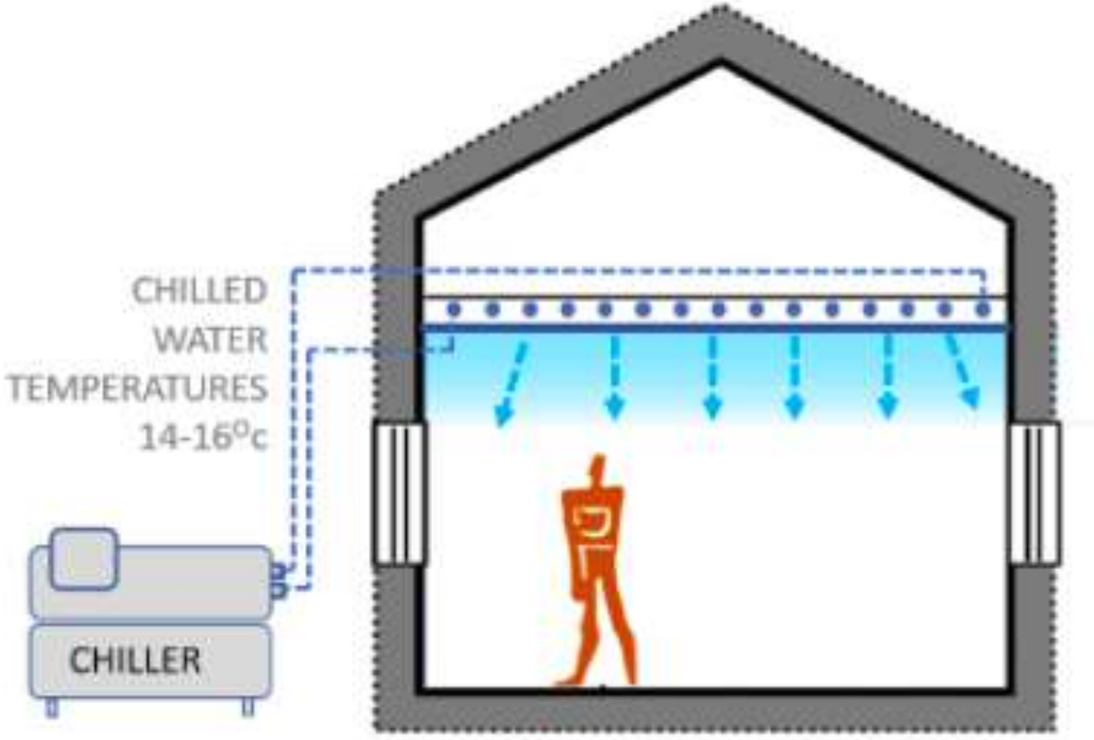


Source: Edge

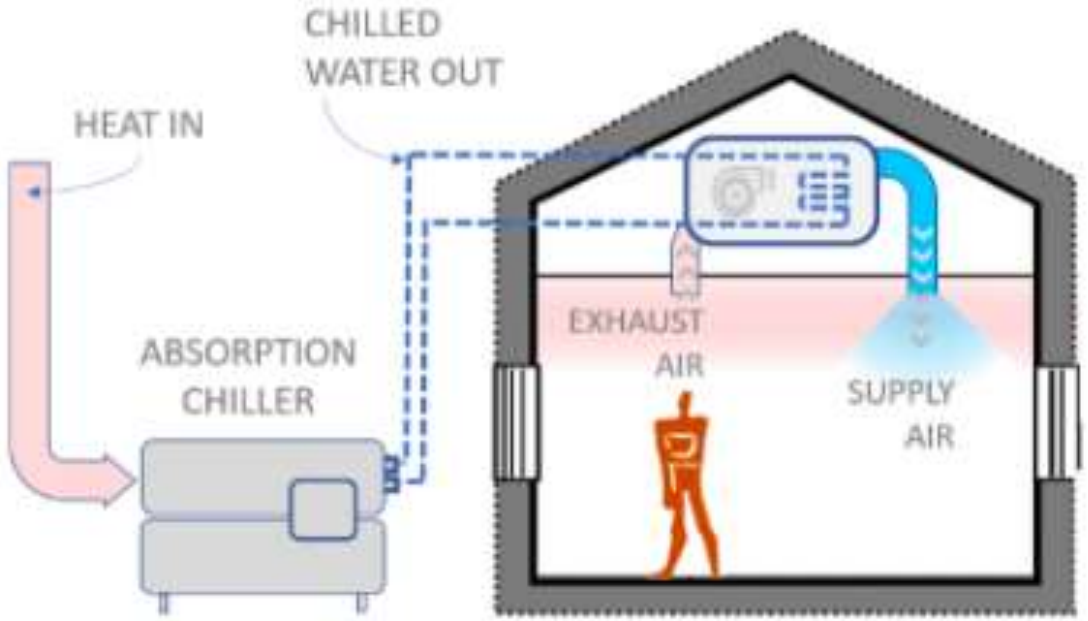
Comfort Systems & Controls

COMPLIANCE MECHANISM

CHILLED BEAMS



VAPOR ABSORPTION MACHINES (VAM)



Source: Edge

Comfort Systems & Controls

COMPLIANCE MECHANISM

Chillers

- Chillers shall meet or exceed the minimum efficiency requirements presented in under ANSI/ AHRI 550/ 590 conditions.

- The application of air-cooled chiller is allowed in all buildings with cooling load less than 530 kW. For buildings with cooling load equal to or greater than 530 kW

- The number of air-cooled chiller shall be restricted to 33% of the total installed chilled water capacity unless the authority having jurisdiction mandates the application of air cooled chillers.

- Minimum efficiency requirements under BEE Standards and Labelling Program for chillers shall take precedence over the minimum requirements

Fig. water cooled Chiller

Comfort Systems & Controls

COMPLIANCE MECHANISM

Chillers

- To show compliance to ECBC, minimum requirement of both COP and IPLV requirement of ECBC Building shall be met. To show compliance with ECBC + Building and Super ECBC Building, minimum requirement of either COP or IPLV of respective efficiency level shall be met.

WATER COOLED Chillers

	ECBC BUILDING		ECBC + BUILDING		SUPER ECBC BUILDING	
Chiller Capacity (kWr)	**COP**	**IPLV**	**COP**	**IPLV**	**COP**	**IPLV**
<260	4.7	5.8	5.2	6.9	5.8	7.1
≥260 & <530	4.9	5.9	5.8	7.1	6.0	7.9
≥530 &<1,050	5.4	6.5	5.8	7.5	6.3	8.4
≥1,050 &<1,580	5.8	6.8	6.2	6.2	6.5	8.8
≥1,580	6.3	7.0	6.5	6.5	6.7	9.1

Source: Table 5-1 Minimum Energy Efficiency Requirements for *water cooled Chillers*

Comfort Systems & Controls

COMPLIANCE MECHANISM

UNITARY SPLIT PACKAGES AIR CONDITIONERS

- Unitary air-conditioners shall meet or exceed the efficiency requirements.
- Window and split air conditioners shall be certified under BEE’s Star Labeling Program.
- EER shall be as per IS 8148 for all unitary, split, packaged air conditioners greater than 10 kWr

COOLING CAPACITY (kWr)	WATER COOLED	AIR COOLED
≤ 10.5	NA	BEE 3 Star
> 10.5	3.3 EER	2.8 EER

Source: Table 5-3 Minimum Requirements for Unitary, Split, Packaged Air Conditioners in ECBC *Building*

COOLING CAPACITY (kWr)	WATER COOLED	AIR COOLED
≤ 10.5	NA	BEE 4 Star
> 10.5	3.7 EER	3.2 EER

Source: Table 5-4 Minimum Requirements for Unitary, Split, Packaged Air Conditioners in ECBC+*Building*

Indoor section

Split system

Single package

Comfort Systems & Controls

COMPLIANCE MECHANISM

VARIABLE REFRIGERANT FLOW

- Generally installed for areas less than 1 lakh sqft
- BEE Standards and Labeling requirements for VRF shall take precedence over the current minimum requirement.

HEATING OR COOLING OR BOTH			
TYPE	**SIZE CATEGORY(kWr)**	**EER**	**IEER**
VRF Air Conditioners, Air cooled	< 40	3.28	4.36
	>= 40 and < 70	3.26	4.34
	>= 70	3.02	4.07

Fig. variable refrigerant flow

Comfort Systems & Controls

COMPLIANCE MECHANISM

TIMECLOCK

Mechanical cooling and heating systems in **Universities** and **Training Institutions** of all sizes and all **Shopping Complexes** with built up area greater than **20,000 m²** shall be controlled by time clocks that:

a) Can start and stop the system under different schedules for at least three different day-types per week,

b) Are capable of retaining programming and time setting during loss of power for a period of at least 10 hours, and

c) Include an accessible manual override that allows temporary operation of the system for up to 2 hours.

Exceptions to §5.2.3.1:

(a)Cooling systems less than 17.5 kWr

(b)Heating systems less than 5.0 kWr

(c)Unitary systems of all capacities

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COMPLIANCE MECHANISM

TEMPERATURE CONTROLS

- Each floor or a building block shall be installed with at least one control to manage the temperature. These controls should meet the following requirements:

  I. Where a unit provides both heating and cooling; controls shall be capable of providing a temperature dead band of 3.0°C within which the supply of heating and cooling energy to the zone is shut off or reduced to minimum.

  II. Separate thermostat control shall be installed in each

    - Guest room of Resort and Star Hotel
    - Room less than 30 m2 in Business
    - Air-conditioned class room, lecture room, and computer room of educational
    - In-patient and out-patient room of Healthcare

Comfort Systems & Controls

COMPLIANCE MECHANISM

OCCUPANCY CONTROL

Occupancy controls shall be installed to de-energize or to throttle to minimum the ventilation and/or air conditioning systems when there are no occupants in:

- Each guest room in a Resort and Star Hotel
- Each public toilet in a Star Hotel or Business with built up area more than 20,000 m^2
- Each conference and meeting room in a Star Hotel or Business
- Each room of size more than 30 m^2 in Educational buildings

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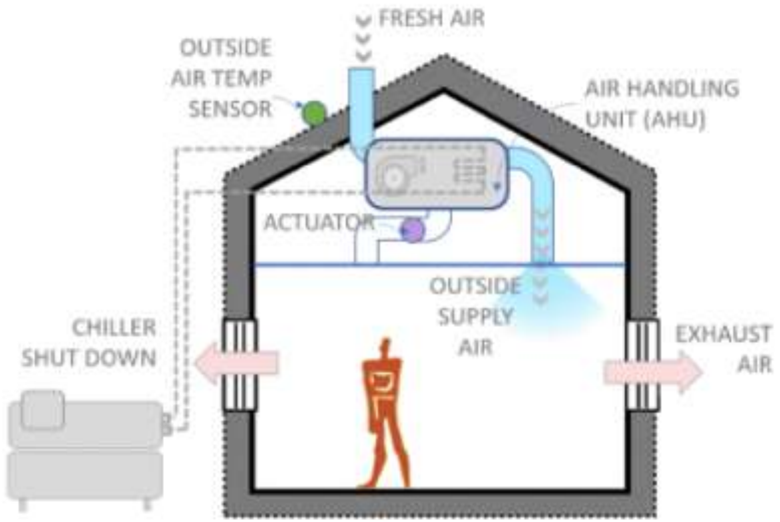
COMPLIANCE MECHANISM

AIR SIDE ECONOMIZER



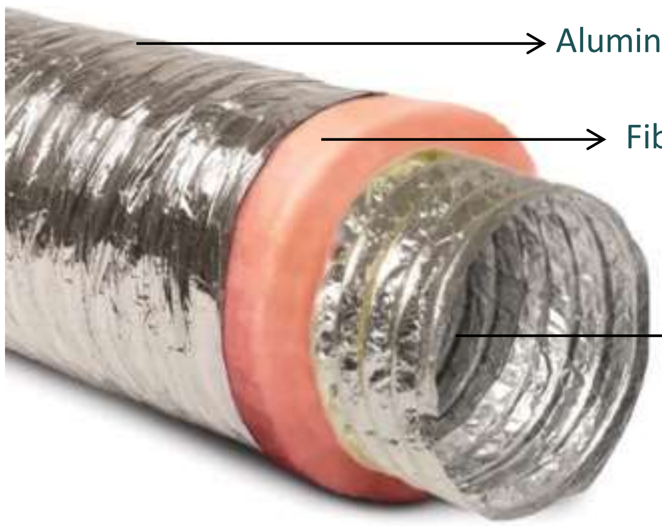
Source: Edge

Comfort Systems & Controls

COMPLIANCE MECHANISM

PIPING INSULATION

- Piping for heating, space conditioning, and service hot water systems shall meet the insulation requirements
- Insulation exposed to weather shall be protected by aluminium sheet metal, painted canvas, or plastic cover.



OPERATING TEMPERATURE (°C)	PIPE SIZE (mm)	
	<25	>40
	INSULATION R VALUE(m^2.K/W)	
Heating System		
94 °C to 121 °C	0.9	1.2
60°C to 94°C	0.7	0.7
40°C to 60°C	0.4	0.7
Cooling System		
4.5°C to 15°C	0.4	0.7
< 4.5°C	0.9	1.2
Refrigerant Piping (Split systems)		
4.5°C to 15°C	0.4	0.7
< 4.5°C	0.9	1.2

Source: Table 5-8 Insulation Requirements for Pipes in ECBC Building

ECBC Master Trainer
Anurag Bajpai | +91-9891 852 358 | anurag@greentree.global