

# **CPWD GREEN RATING MANUAL 2019**

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# **BASIC PHILOSOPHY**

- **GREEN BUILDING CONCEPT IS FOR WELFARE OF PEOPLE HENCE WELFARE MEASURES OF USERS, WORKERS, PUBLIC, SITE STAFF AND (ALL STAKEHOLDERS) IS IMPORTANT.**
- **ENERGY EFFICIENT ARCHITECTURAL DESIGN, EQUIPMENT, GENERATION OF NON CONVENTIONAL ENERGY AND CONSERVATION OF ENERGY LEAD TO GREEN BUILDING CONCEPT.**
- **QUALITY AND SAFETY LEAD TO DURABLE STRUCTURES HENCE LEADS TO GREEN BUILDING CONCEPT.**

# **BASIC PHILOSOPHY**

- **STRUCTURAL SAFETY IS IMPORTANT FOR GREEN BUILDING CONCEPT. UNSAFE STRUCTURES LEAD TO NON DURABLE STRUCTURES HENCE AGAINST GREEN BUILDING CONCEPT.**
- **TIME OVERRUN GENERALLY LEADS TO DETERIORATION OF QUALITY DUE TO COST OVERRUN AND LOW PRODUCTIVITY THUS MAY ADVERSELY AFFECT TO GREEN BUILDING CONCEPT. IT ALSO LEADS TO MORE POLLUTION.**

# **BASIC PHILOSOPHY**

- **EARLY COMPLETION OF WORK LEADS TO SAVINGS OF RESOURCES, POLLUTION, AND EARLY USE OF ASSETS LEADING TO CONSERVATION OF RESOURCES HENCE CONTRIBUTES TO GREEN BUILDING CONCEPT.**
- **NON PREPARATION OF PLANS AND NON AVAILABILITY OF DRAWINGS IN TIME LEAD TO DELAY IN COMPLETION OF WORK HENCE AGAINST GREEN BUILDING CONCEPT.**

# **BASIC PHILOSOPHY**

- **INTEGRATION OF SERVICES AND EASY MAINTENANCE OF SERVICES DURING LIFE CYCLE OF THE BUILDINGS WITHOUT GENERATION OF WASTE LEADS TO GREEN BUILDING CONCEPT.**
- **BUILDING MATERIALS CONSUME LARGE ENERGY IN THEIR CREATION /MANUFACTURING, TRANSPORTATION AND USE IN BUILDINGS HENCE IMPORTANT FOR GREEN BUILDING CONCEPT.**

# **BASIC PHILOSOPHY**

- **ENERGY NET PLUS BUILDINGS NEED TO BE ENCOURAGED AS THEY CONTRIBUTE IN GENERATION OF ENERGY FOR USE IN OTHER BUILDINGS ALSO.**
- **USE OF PRODUCTS FROM WASTE RESOURCES AND NON TOXIC/NON HAZARDOUS PRODUCTS CONTRIBUTE TO GREEN BUILDING CONCEPT.**

# BASIC PHILOSOPHY

- AIR, WATER AND NOISE POLLUTION ADVERSELY AFFECTS GREEN BUILDING CONCEPT.
- CONSERVATION OF WATER AND USE OF WASTE WATER CONTRIBUTE TO GREEN BUILDING CONCEPT.
- NEW AND EMERGING TECHNOLOGIES LEADING TO SPEEDY CONSTRUCTION LEADS TO EARLY COMPLETION OF WORK AND THUS CONTRIBUTES TO GREEN BUILDING CONCEPT.
- TOOLS AND EQUIPMENT AND TECHNOLOGIES NOT GENERATING C&D WASTE LEAD TO GREEN BUILDING CONCEPT.

# **BASIC PHILOSOPHY**

- **INNOVATION LEADS TO OUT OF BOX THINKING AND THUS NEEDS TO BE ENCOURAGED FOR GREEN BUILDING CONCEPT.**
- **TREES TAKES LONG TIME IN GROWING HENCE SHOULD BE PROTECTED.**
- **FELLING OF TREES SHOULD BE AVOIDED AND TRANSPLANTATION ENCOURAGED IN CASE REMOVAL ESSENTIAL.**

# **GREEN BUILDING CONCEPT**

**BASED ON**

- **SUSTAINABLE DEVELOPMENT CRITERION**

# RATING CRITERIA

<b>1. ARCHITECTURAL PLANNING AND DESIGN</b>	<b>16</b>
<b>2. QUALITY AND SAFETY</b>	<b>12</b>
<b>3. SUSTAINABLE BUILDING MATERIALS</b>	<b>16</b>
<b>4. GREEN CONSTRUCTION MEASURES</b>	<b>14</b>
<b>5. WATER CONSERVATION MEASURES</b>	<b>07</b>
<b>6. ENERGY EFFICIENCY MEASURES</b>	<b>22</b>
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<b>8. WELFARE MEASURES</b>	<b>04</b>
<b>9. LANDSCAPE AND HORTICULTURE</b>	<b>05</b>

# 1. ARCHITECTURAL PLANNING AND DESIGN (16 MARKS)

## CRITERION 1.1: PASSIVE ARCHITECTURAL DESIGN STRATEGY: 4 MARKS

A. ORIENTATION AND WWR INCLUDING DESIGN OF OPENINGS/ FENESTRATION: 2

B. ZONING AND MASSING AS PER SOLAR PATH ANALYSIS AND WIND DIRECTION: 1

C. ANY OTHER CLIMATE RESPONSIVE PASSIVE ARCH DESIGN STRATEGY: 1

## CRITERION 1.2: ACCESSIBILITY IN BUILT ENVIRONMENT: 2 MARKS

A. ALL THE NORMS OF BARRIER FREE ENVIRONMENT FOLLOWED: 2

B. MORE THAN 60% FOLLOWED (PHYSICAL): 1

# **1. ARCHITECTURAL PLANNING AND DESIGN (16 MARKS)**

## **CRITERION 1.3: AVAILABILITY OF INTEGRATED DRAWINGS BEFORE INVITATION OF BIDS: 5 POINTS**

**A. ALL THE DRAWINGS AVAILABLE WITH BIM: 5**

**B. ONLY BUILDING DRAWINGS AVAILABLE WITH SERVICES BUT WITHOUT DETAILING (WITHOUT BIM): 2**

**C. ONLY ARCHITECTURAL DRAWINGS AVAILABLE WITHOUT SERVICES AND DETAILING UPTO 1ST FLOOR : 1**

## **CRITERION 1.4: LAYOUT/SITE PLANNING: 3 MARKS**

**A. MINIMIZATION OF ROADS AND HARD AREAS: 1**

**B. SEGREGATION OF PEDESTRIAN AND VEHICULAR TRAFFIC: 1**

**C. MINIMUM DISTURBANCE TO LAND/SITE TOPOGRAPHY: 1**

## **CRITERION 1.5: INNOVATIONS: 2 MARKS**

# 2. QUALITY AND SAFETY (12 MARKS)

- **CRITERION 2.1: QUALITY ASSURANCE - 4 MARKS**

- 1A. QUALITY ASSURANCE PLAN AVAILABLE BEFORE COMMENCEMENT OF WORK: 2
- 1B. AVAILABILITY AFTER COMMENCEMENT: 1
- 2A: 100% EXECUTION/IMPLEMENTATION OF QA PLAN: 2
- 2B: PART IMPLEMENTATION: 0

- **CRITERION 2.2: SAFETY ASSURANCE – 4 MARKS**

- A. SAFETY ASSURANCE PLAN AVAILABLE BEFORE COMMENCEMENT OF WORK: 2
- B. AVAILABLE AFTER COMMENCEMENT: 1
- 2. (a) Implementation of safety plan as per the policy of the Department: 2 points
- (b) Part implementation of safety plan or not being implemented: Nil

- **CRITERION 2.3: STRUCTURAL SAFETY ASSURANCE – 4**

- A. ALL STRUCTURAL DRAWINGS AVAILABLE BEFORE COMMENCEMENT OF WORK IN EPC AND BEFORE AWARD IN OTHER CONTRACTS: 4
- B. PARTLY AVAILABLE BUT MADE AVAILABLE BEFORE COMMENCEMENT OF ACTIVITIES WITHOUT HINDRANCE IN ANY ACTIVITY LEADING TO NO DELAY IN WORK: 2
- C. OTHER CASES: NIL

# 3. SUSTAINABLE BUILDING MATERIALS (16 MARKS)

- **CRITERION 3.1: USE OF WASTE PRODUCTS IN MASONRY WORKS: 2**
  - A. USE OF FLYASH/AAC/RECYCLED C&D WASTE BLOCKS IN FULL MASONRY: 2
  - B. MORE THAN HALF: 1
- **CRITERION 3.2: USE OF WASTE PRODUCTS OR ALTERNATIVES TO NATURAL TIMBER: 2**
  - A. IN FULL WOODWORK: 2
  - B. IN MORE THAN HALF: 1
- **CRITERION 3.3: USE OF CEMENT MANUFACTURED FROM WASTE PRODUCTS: 2**
  - A. USE OF FLYASH IN 100% CC WITH OPC OR PPC AND USE OF PPC/BLENDED CEMENTS IN ALL OTHER WORKS: 2
  - B. MORE THAN 50%: 1
- **CRITERION 3.4: USE OF LOCAL MATERIALS: 2**
  - A. USE OF LOCAL MATERIALS (AVAILABLE WITHIN 100KMS) TO THE EXTENT OF 5% OR MORE TO THE COST OF CONSTRUCTION: 2
  - B. 2-5%: 1

# 3. SUSTAINABLE BUILDING MATERIALS (16 MARKS)

- **CRITERION 3.5: USE OF RECYCLED MATERIALS: 3**
  - A. USE OF RECYCLED SAND, AGGREGATES OR MANUFACTURED SAND , MIMIMUM 25%: 1
  - B. USE OF RECYCLED MATERIALS IN FLOORING AND FALSE CEILING: 1
  - C. USE OF RECYCLED MATEIALS IN LANDSCAPE/ARTWORK: 1
- **CRITERION 3.6: ADHERANCE TO MII POLICY: 2**
  - A. FULL ADHERENCE : 2
  - B. NON ADHERENCE FULLY: NIL
- **CRITERION 3.7: USE OF NON TOXIC AND NON HAZARDDDOUS MATERIALS: 3**
  - A. USE OF LOW VOC PRIMER AND PAINT (< 50g/l) in 100% applications: 2
  - B. Other cases: nil
  - 2A. FOLLOWING HAZARDOUS WASTE MANAGEMENT RULES/POLICY DURING CONSTRUCTION/MANINTENANCE: 1

# **4. GREEN CONSTRUCTION MEASURES (14 MARKS)**

- **CRITERION 4.1: AIR POLLUTION AND NOISE CONTROL MEASURES: 2**
  - A. AIR POLLUTION CONTROL MEASURES AT SITE: 1
  - B. BARRICADING OF MINIMUM 3M HT OR AS PER NORMS OF ULB: 1
- **CRITERION 4.2: TRENCHES FOR INTEGRATED SERVICES: 2**
  - A. TRENCHES FOR ALL SERVICES: 2
  - B. TRENCHES FOR PART SERVICES: 1
- **CRITERION 4.3: NEW CONSTRUCTION TECHNOLOGIES FOR GREEN CONSTRUCTION: 3**
  - A. ADOPTION FOR BUILDING/ROADWORK, FLOORING, PLASTERING, TILEWORK, LAYING UTILITY SERVICES ETC: 3
  - B. ADOPTED PARTLY: 1

# **4. GREEN CONSTRUCTION MEASURES (14 MARKS)**

- **CRITERION 4.4: USE OF EQUIPMENT/TECHNOLOGIES AVOIDING GENERATION OF C&D WASTE: 3**
  - A. **NO CUTTING OF BRICKWORK/CONCRETE FOR LAYING WATER SUPPLY LINES: 1**
  - B. **NO CUTTING FOR ELECTRICAL SERVICES: 1**
  - C. **NO CUTTING FOR ANY OTHER SERVICES: 1**
- **CRITERION 4.5: NEW CONSTRUCTION TECHNOLOGIES FOR SPEEDY CONSTRUCTION: 4**
  - A. **COMPLETION OF WORK AS PER PE: 2**
  - B. **BEFORE 1/ 16<sup>TH</sup> PERIOD: 3**
  - C. **BEFORE 1/8<sup>TH</sup> PERIOD: 4**

# 5. WATER CONSERVATION MEASURES (7 MARKS)

- **CRITERION 5.1: RECYCLING WATER – 3**
  - A. RECYCLING TO THE EXTENT OF 80% WATER OR MORE: 3
  - B. 50-80%: 2
  - C. 20-50%: 1
- **CRITERION 5.2: RAIN WATER HARVESTING – 2**
  - A. USE OF RAIN WATER HARVESTING TO THE EXTENT OF 50-100% OF THE RAINFALL ON ROOFTOP OF THE BUILDINGS OR 100% GROUND WATER RECHARGING : 2
  - B. NO GROUND WATER RECHARGING BUT RAIN WATER HARVESTING 20-50%: 1
- **CRITERION 5.3:USE OF WATER EFFICIENT FIXTURES – 2**
  - A. USE OF LOW WATER SUPPLY FIXTURES: 1
  - B. USE OF LOW FLOW/WATERLESS URINALS/FLUSHING FIXTURES: 1

# 6. ENERGY EFFICIENCY MEASURES (22 MARKS)

- **CRITERION 6.1: ENERGY EFFICIENT BUILDING ENVELOPE – 4**
  - A. SUPER **ECBC** COMPLIANT: 4
  - B. ECBC+ COMPLIANT: 3
  - C. ECBC COMPLIANT: 2
- **CRITERION 6.2: ENERGY EFFICIENT LIGHTING, FANS, ACs WITH CONTROLS-4**
  - A. USE OF 100% LED LIGHTS (INDOOR AND OUTDOOR): 2
  - B. 75-100%: 1
  - 2A. USE OF ENERGY EFFICIENT 5 STAR FANS AND UNITARY ACs: 2
  - 2B. 75-100%: 1

**IN CASE OF HVAC/VRV SYSTEM**

  - A. ENERGY EFFICIENT 5 STAR FANS, UNITARY ACs(IF PROVIDED) AND FOR HVAC/VRV SYSTEM MINIMUM COP AND IPLV (INTEGRATED PART LOAD VALUE) AS PER ECBC NORMS: 2
  - B. ONLY HVAC ENERGY EFFICIENT AS ABOVE BUT NOT THE FANS/UNITARY ACs: 1

# 6. ENERGY EFFICIENCY MEASURES (22 MARKS)

- **CRITERION 6.3: ENERGY EFFICIENT PUMPS, LIFTS AND OTHER EQUIPMENTS-2**
  - A. ENERGY EFFICIENT PUMPS AND DG SETS: 1
  - B. ENERGY EFFICIENT LIFTS/REGENERATIVE LIFTS: 1
- **CRITERION 6.4: INTEGRATION OF CONTROLS WITH IBMS AND SENSORS FOR LIGHTING FIXTURES-3**
  - A. PROVIDING IBMS: 2
  - B. SENSORS FOR LIGHTING FIXTURES: 1
- **CRITERION 6.5: GENERATION OF RENEWABLE ENERGY – 8**  
**ON SITE SOLAR OR OTHER NON CONVENTIONAL POWER GENERATION**
  - A. 10% OF TOTAL REQUIREMENT: 2
  - B. 100%: 8
  - C. FOR OTHER CONDITIONS POINTS ON PRO-RATA BASIS
- **CRITERION 6.6: INNOVATION IN ENERGY EFFICIENCY - 1**

## 6. ENERGY EFFICIENCY MEASURES (22 MARKS)

- ~~• IN CASE OF NET ZERO / 100% ONSITE ENERGY PRODUCING BUILDING FULL 16 MARKS TO BE AWARDED WITHOUT ANY FURTHER ANALYSIS.~~
- IN CASE OF NET PLUS TO THE EXTENT OF 20% OR MORE ONSITE ENERGY EFFICIENT BUILDING ADDITIONAL 4 POINTS TO BE AWARDED I.E. ~~26~~ 12 POINTS AGAINST 8.

# **7.WASTE MANAGEMENT (4 MARKS)**

- **CRITERION 7.1: WASTE MANAGEMENT POLICY – 1**
  - A. **AVAILABILITY OF WASTE MANAGEMENT PLAN CONFORMING TO SWM RULES BEFORE AWARD OF WORK: 1**
- **CRITERION 7.1: ORGANIC WASTE CONVERTORS/COMPOST PITS – 2**
  - A. **PROVIDING ORGANIC WASTE CONVERTORS: 2**
  - B. **PROVIDING COMPOST PIT: 1**
- **WASTE SEGREGATION: 1**
  - A. **PROVIDING SEGREGATION FACILITIES FOR C&D WASTE, WET AND DRY WASTE: 1**

# **8. WELFARE MEASURES (4 MARKS)**

- **CRITERION 8.1: TOILET FACILITIES DURING CONSTRUCTION – 2**
  - A. **TOILETS FOR WORKERS AND STAFF AS PER NORMS WITH SIGNAGE: 1**
  - B. **SEPARATE TOILET FACILITIES FOR LADIES (WORKERS AND STAFF) AS PER NORMS WITH SIGNAGE: 1**
- **CRITERION 8.2: WELFARE MEASURES DURING CONSTRUCTION – 2**
  - A. **WELFARE MEASURES FOR WORKERS AND STAFF WITH SIGNAGE: 1**
  - B. **CONSTRUCTION OF CONFERENCE ROOM, AND DISPLAY ARRANGEMENTS : 1**

# 9. LANDSCAPE AND HORTICULTURE (5 MARKS)

- **CRITERION 9.1: TREES PROTECTION AND TRANSPLANTATION – 3**
  - A. **NO CUTTING (FELLING): 3**
  - B. **80-100% TRANSPLANTATION OF EXISTING TREES: 2**
  - C. **60% TRANSPLANTATION OF EXISTING TREES: 1**
- **CRITERION 9.2: IRRIGATION SYSTEM - 1**
  - A. **EFFICIENT IRRIGATION SYSTEM LIKE MICRO/DRIP/SPRINKLER: 1**
- **CRITERION 9.3: REUSE OF EXCAVATED SOIL – 1**
  - A. **100% REUSE: 1**

# **RATING GRADES**

- **GREEN: 55-70**
- **GREEN PLUS: 71-85**
- **SUPER GREEN: 86-100**

# QUALIFYING MARKS

**MARKS NOT TO BE GIVEN IN DECIMALS. ANY DECIMAL WILL BE CONSIDERED NEXT FULL NUMBER**

In case, any specific criterion is not applicable, the same will not be considered and the marks will be proportioned based on total marks excluding the marks of such criterion/criterion from 100 marks. For example, if after excluding a particular criterion, marks obtained are 65 out of maximum marks 95, the same will be proportioned as  $65 * 100 / 95 = 68.42$  rounded off to next full number i.e. 69.

**MINIMUM MARKS REQUIRED IN EACH MAIN CRITERION WILL BE 50% OF THAT CRITERION e.g. IN ARCHITECTURAL PLANNING AND DESIGN, MINIMUM SCORE SHOULD BE 8 FOR QUALIFYING AS GREEN BUILDINGS.**

# **RATING CRITERIA**

- **PLANNING STAGE**
- **EXECUTION STAGE**
- **COMPLETION STAGE**

**FINAL RATING TO BE AWARDED  
WITHIN 3 MONTHS OF  
OCCUPANCY.**

# DOCUMENTATION

- **ENGINEER IN CHARGE TO REGISTER THE PROJECT ONLINE FOR THE RATING. NECESSARY DOCUMENTATION TO BE DONE BY THE SITE ENGINEERS ON LINE OR IN PHYSICAL FORM.**
- **A TEAM OF ARCHITECTS, CIVIL AND E& M ENGINEERS AND HORTICULTURE OFFICER HAS TO INSPECT THE DOCUMENTS AND SITE FOR VERIFICATION.**

**AWARD**

**CERTIFICATE AND PLAQUE  
SIGNED BY DG**



Government of India  
Central Public Works Department



**Central Public Works Department (CPWD)**

hereby certifies that

.....(Name of Building)

**GHAR Registration No.....**

has successfully achieved the Green Building Standards required for  
the following level of certification

**Green/Green Plus/Super Green**

under the

**Green Habitat Accomplished Rating**

**(Director General)**

# PLAQUE

- **SUGGESTIONS ON DESIGN INVITED**
- **OR BASED ON LOGO AND CERTIFICATE**



# RATING TEAMS

- **DELHI NCR AND BUILDINGS NOT CONSTRUCTED BY CPWD**
  - CPWD TRAINING ACADEMY TEAMS CONSTITUTED FROM CIVIL, ELECTRICAL, ARCHITECTURE AND HORTICULTURE
- **OTHERS**
  - PROJECT REGIONS TEAMS CONSTITUTED FROM CIVIL, ELECTRICAL, ARCHITECTURE AND HORTICULTURE

# BUILDINGS

- **NEW**
  - DOCUMENTATION, INSPECTION AND AUDIT REQUIRED
- **EXISTING**
  - BASED ON DOCUMENTATION AND INSPECTION.  
OR ?
  - SUGGESTIONS INVITED ?

# FEE

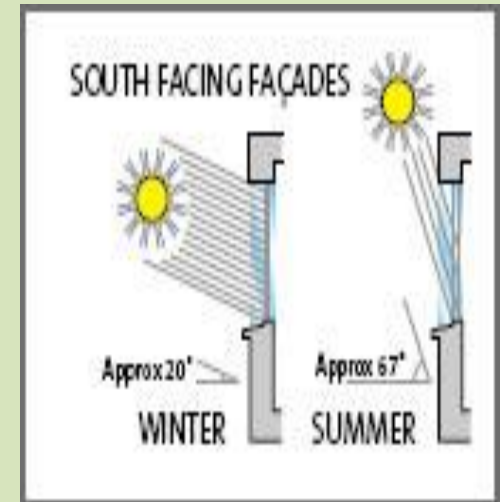
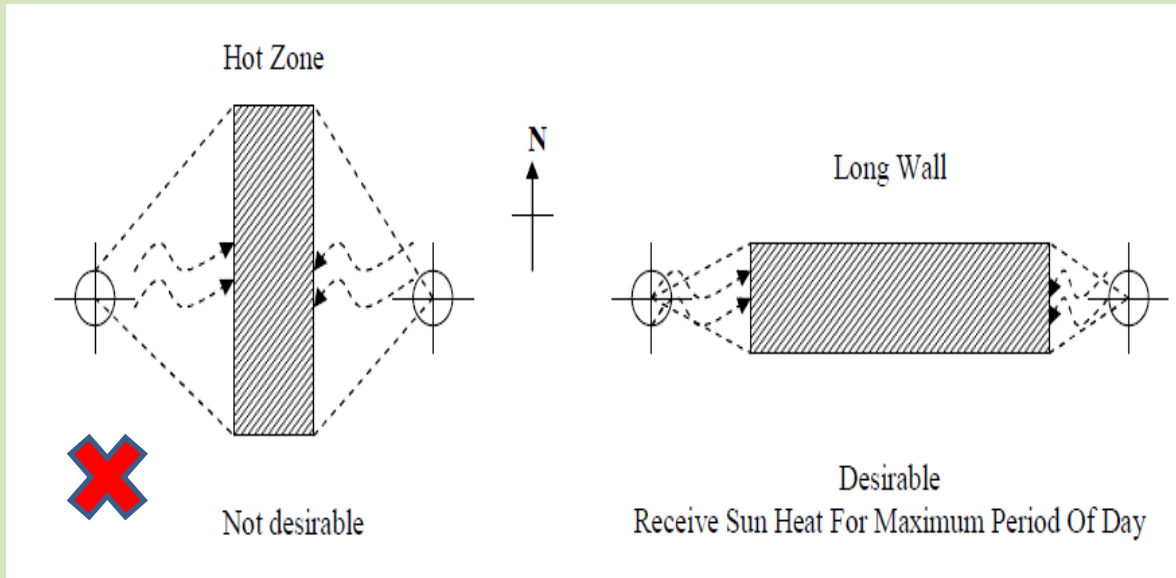
- AT PRESENT NO FEE IS PROPOSED FOR CPWD CONSTRUCTED BUILDINGS OR GOVERNMENT BUILDINGS.
- FEE STRUCTURE FOR EXISTING GOVERNMENT BUILDINGS ?
- SUGGESTIONS INVITED

CONDITION IN CASE OF NO FEE: ANY REHABILITATION REQUIRED TO MAKE THEM GREEN, SHOULD BE TAKEN UP BY CPWD e.g. ACCESSIBILITY MEASURES, ECBC NORMS COMPLIANT MEASURES, PROVISION OF ROOFTOP SOLAR PLANTS, TREE PLANTATION, RECYCLING WATER ARRANGEMENTS, RWH MEASURES, WASTE MANAGEMENT MEASURES etc.

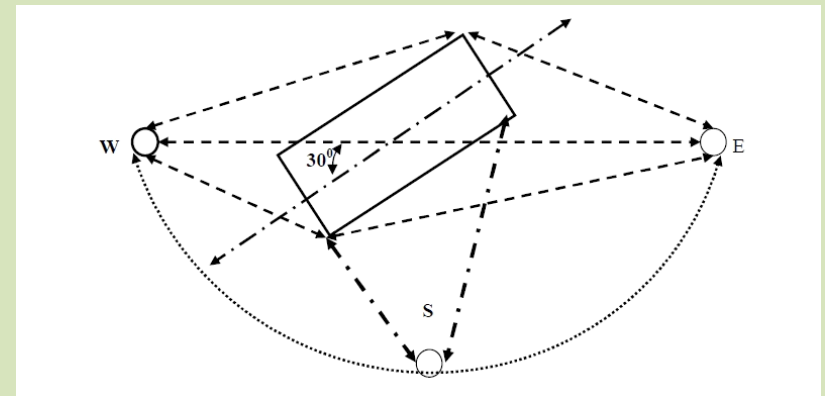
**THANK YOU**

# ORIENTATION

**In hot zone (Hot & Dry, Hot & Humid) the building has to be oriented North- South.**

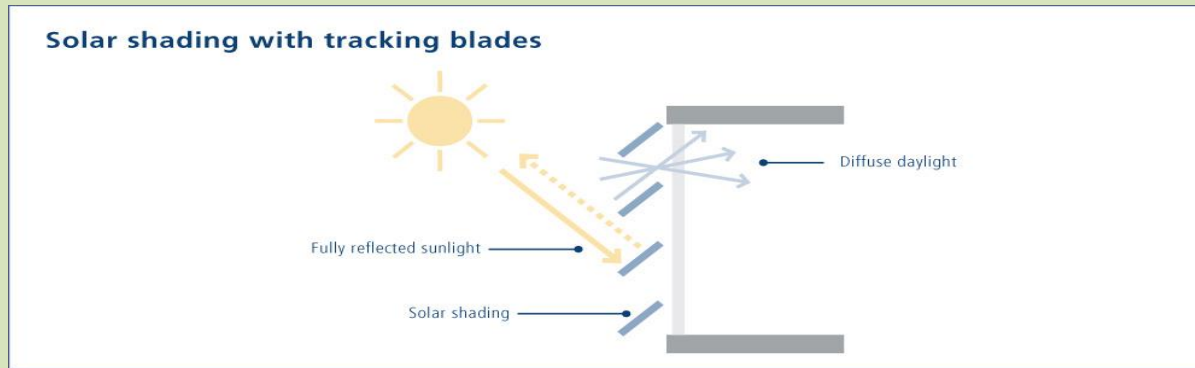


**In cold zone If the long axis of the building makes an angle of 30° with E-W direction, it receives sun heat for maximum duration.**



# SHADING DEVICES

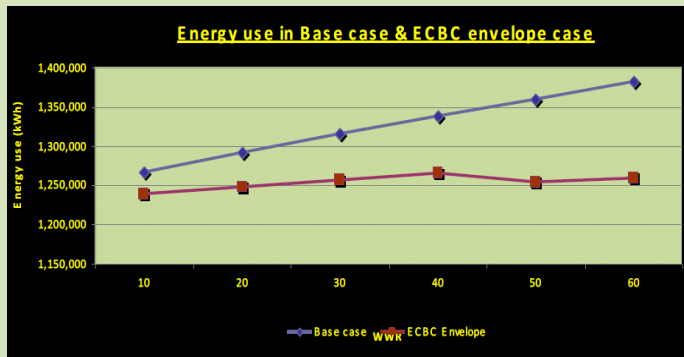
External shading devices need to be designed according to the orientation of facade.



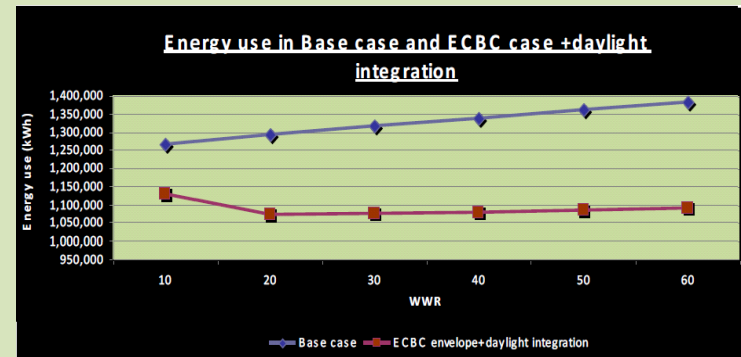
- North - no shading is required.
- South - permanent shading required as sun faces most part of the day.
- East and West - preferable to design vertical movable shading devices.
- Walls and roof can be shaded in many ways e.g. plants, solar panels, louvers, paragolas etc. for energy-efficiency.

# APPROPRIATE WWR FOR LIGHT & MINIMISING HEAT INGRESS

**Design that increase daylight and reduces the need for daytime artificial lighting.**



**Lowest energy consumption is in the case of WWR 10%. But electricity consumption increases due to artificial lighting**



**Minimum electricity consumption with sufficient daylight is in the case where WWR is 20-30%.**

# ECBC 2017

- ECBC 2017 prescribes 3 levels of energy efficiency:
- (a) Energy Conservation Building Code Compliant Building (ECBC Building)
- (b) Energy Conservation Building Code Plus Building (ECBC+ Building)
- (c) Super Energy Conservation Building Code Building (SuperECBC Building)

# WALL ASSEMBLY U-FACTOR AS PER ECBC 2017

## Opaque Assembly Maximum U-factor (W/m<sup>2</sup>.K) Requirement for ECBC Complaint Building

	Composite	Hot and dry	Warm and humid	Temperate	Cold
<b>All building types, except below</b>	0.40	0.40	0.40	0.55	0.34
<b>No Star Hotel &lt;10,000 m<sup>2</sup> AGA</b>	0.63	0.63	0.63	0.63	0.40
<b>Business &lt;10,000 m<sup>2</sup> AGA</b>	0.63	0.63	0.63	0.63	0.40
<b>School &lt;10,000 m<sup>2</sup> AGA</b>	0.85	0.85	0.85	1.00	0.40

## Opaque Assembly Maximum U-factor (W/m<sup>2</sup>.K) Requirements for ECBC + Compliant Building

	Compos ite	Hot and dry	Warm and humid	Tempera te	Cold
<b>All building types, except below</b>	0.34	0.34	0.34	0.55	0.22
<b>No Star Hotel &lt;10,000 m<sup>2</sup> AGA</b>	0.44	0.44	0.44	0.44	0.34
<b>Business &lt;10,000 m<sup>2</sup> AGA</b>	0.44	0.44	0.44	0.55	0.34
<b>School&lt;10,000 m<sup>2</sup> AGA</b>	0.63	0.63	0.63	0.75	0.44

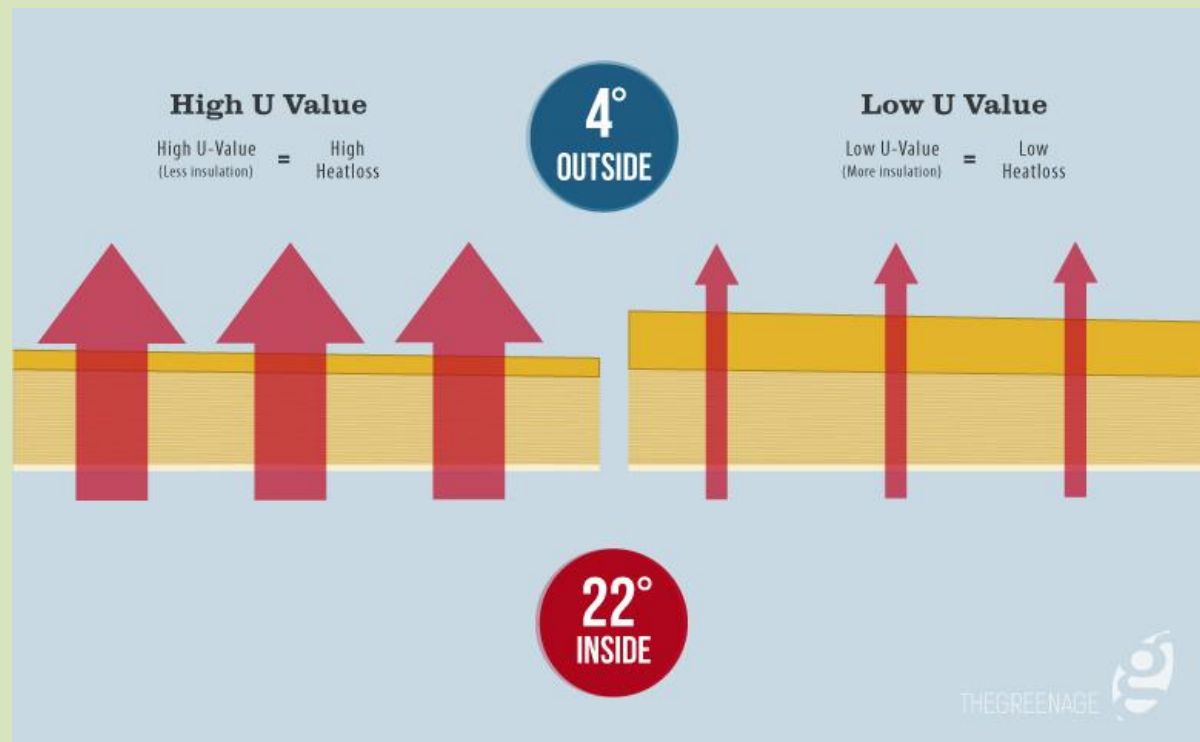
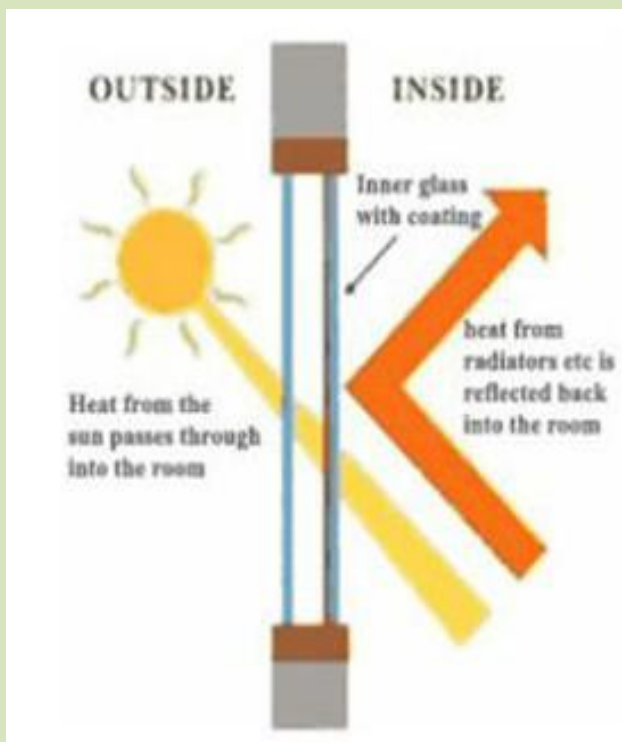
## Opaque Assembly Maximum U-factor (W/m<sup>2</sup>.K) Requirements for Super ECBC Building

	Compos ite	Hot and dry	Warm and humid	Tempera te	Cold
<b>All buildings types</b>	0.22	0.22	0.22	0.22	0.22

Roof Assembly U-factor (W/m2.K) Requirement for ECBC Complaint Building					
	Composite	Hot and dry	Warm and humid	Temperate	Cold
All building types, except below	0.33	0.33	0.33	0.33	0.28
School <10,000 m2 AGA	0.47	0.47	0.47	0.47	0.33
Hospitality>10,000 m2 AGA	0.20	0.20	0.20	0.20	0.20
Roof Assembly U-factor (W/m2.K) Requirements for ECBC + Compliant Building					
	Composite	Hot and dry	Warm and humid	Temperate	Cold
Hospitality Healthcare Assembly	0.20	0.20	0.20	0.20	0.20
Business Educational Shopping Complex	0.26	0.26	0.26	0.26	0.20
Roof Assembly U-factor (W/m2.K) Requirements for Super ECBC Building					
	Composite	Hot and dry	Warm and humid	Temperate	Cold
All buildings types	0.20	0.20	0.20	0.20	0.20

# U-VALUE

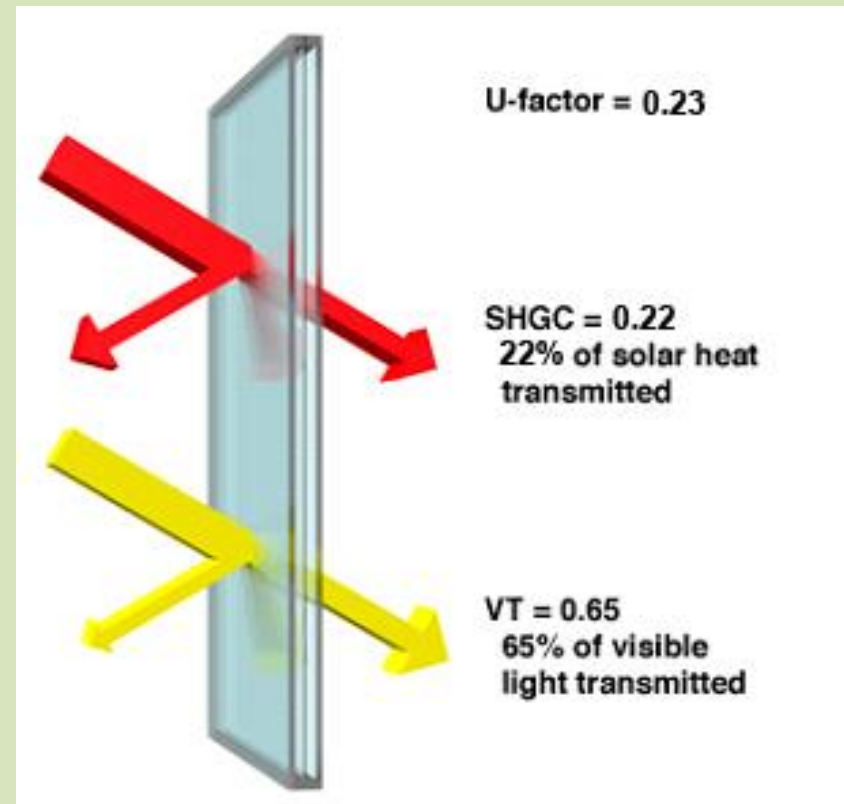
U-value describes thermal performance of a material.  
The lower the U-value, the more energy efficient is the system .



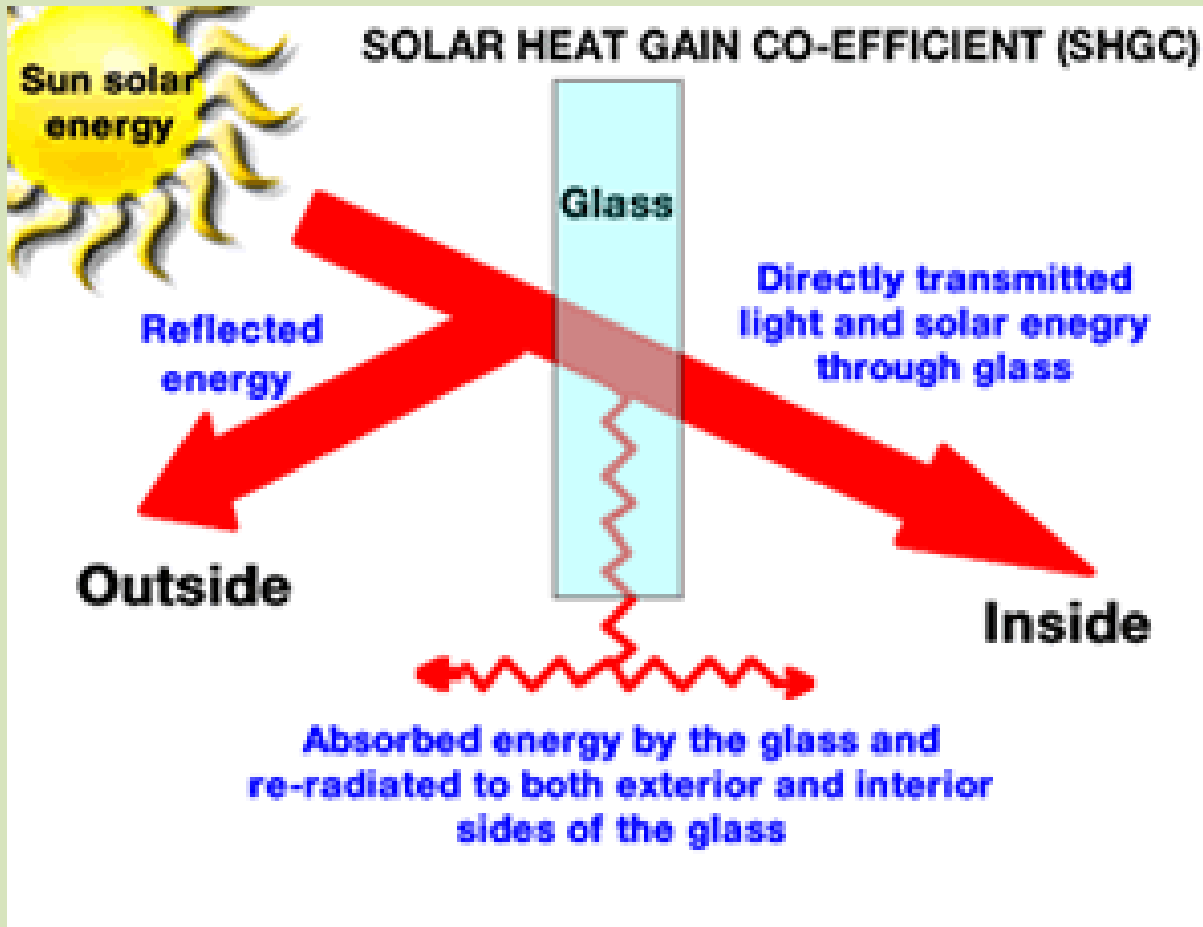
Vertical Fenestration Assembly U-factor and SHGC Requirement for ECBC Building					
	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor (W/m2.K)	3.00	3.00	3.00	3.00	3.00
Maximum SHGC Non-North	0.27	0.27	0.27	0.27	0.62
Maximum SHGC North for latitude>15* N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude<15* N	0.27	0.27	0.27	0.27	0.62
Requirement for ECBC + Building And Super ECBC Building					
	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor (W/m2.K)	2.20	2.20	2.20	3.00	1.80
Maximum SHGC Non-North	0.25	0.25	0.25	0.25	0.62
Maximum SHGC North for latitude>15* N	0.50	0.44	0.44	0.44	0.34
Maximum SHGC North for latitude<15* N	0.25	0.25	0.25	0.25	0.62

# U FACTOR IN GLASS

- **U-factor** and **U-value** are interchangeable terms referring to a measure of the heat gain or loss through **glass** due to the difference between indoor and outdoor air temperatures.
- **U-factor** or **U-value** is also referred to as the overall coefficient of heat transfer. A lower **U-value** indicates better insulating properties.



# SHGC



The SHGC is the fraction of the heat from the sun that enters through a window.

SHGC is expressed as a number between 0 and 1.

The lower a window's SHGC, the less solar heat it transmits, and better the product performs.

Choose products with least SHGC and U value and optimum VLT.

# U-values

- To understand the use of U-values it is necessary to distinguish between the thermal measurement expressions below:
- Thermal conductivity (K-value) The heat (W) transmitted through unit area ( $m^2$ ) of a material of unit thickness (m) for unit temperature difference (K) between inside and outside environments, expressed as  $W/mK$  (or  $W/m\ ^\circ C$ )
- Thermal resistivity (R-value) The reciprocal of thermal conductivity, It measures how well a material resists the flow of heat by conduction.
- Thermal transmittance (U-value) The reciprocal of thermal resistance, i.e.  $W/m^2K$  (or  $W/m^2\ ^\circ C$ ). This measures the amount of heat transmitted per unit area of a particular thickness per unit temperature difference between inside and outside environments.

## U-value calculation formula:

$$U = \frac{1}{R_{SI} + R_{SO} + R_A + R_1 + R_2 + R_3 \dots}$$

- where  $R_{SI}$  = thermal resistance of internal surface  
 $R_{SO}$  = thermal resistance of external surface  
 $R_A$  = thermal resistance of air spaces within construction  
 $R_1, R_2, R_3, \text{ etc.}$  = thermal resistance of successive components

$$R = \frac{1}{\text{K-value}} \times \frac{\text{thickness of material mm}}{1000}$$

# K-values

## Thermal conductivity of typical building materials

Material		kg/m <sup>3</sup>	W/mK	Material		kg/m <sup>3</sup>	W/mK
asphalt	19mm	1700	0.50	phenolic foam	board	30	0.020
blocks	lightweight	1200	0.38	plaster	gypsum	1280	0.46
	med. weight	1400	0.51		sand/cement	1570	0.53
	heavyweight	2300	1.63		vermiculite	640	0.19
bricks	exposed	1700	0.84	plasterboard	gypsum	950	0.16
	protected	1700	0.62	polystyrene	expanded	25	0.032
calcium silicate	board	875	0.17				-0.040
chipboard		800	0.15	polyurethane	board	30	0.025
concrete	aerated slab	500	0.16				-0.028
	lightweight	1200	0.38	rendering	external	1300	0.50
	dense	2100	1.40	roofing tiles	clay	1900	0.85
felt/bitumen	3 layers	960	0.50		concrete	2100	1.10
fibreboard		300	0.06	screed		1200	0.41
fibreglass	quilt	25	0.033	stone	reconstructed	1750	1.30
			-0.04		sandstone	2000	1.30
glass	sheet	2500	1.05		limestone	2180	1.50
hardboard	standard	900	0.13		granite	2600	2.30
mineral wool	quilt	12	0.033	stone chippings		1800	0.96
			-0.04	timber	softwood	650	0.14
	slab	25	0.035	vermiculite	loose	100	0.063
mortar	normal	1750	0.80	woodwool	slabs	600	0.11