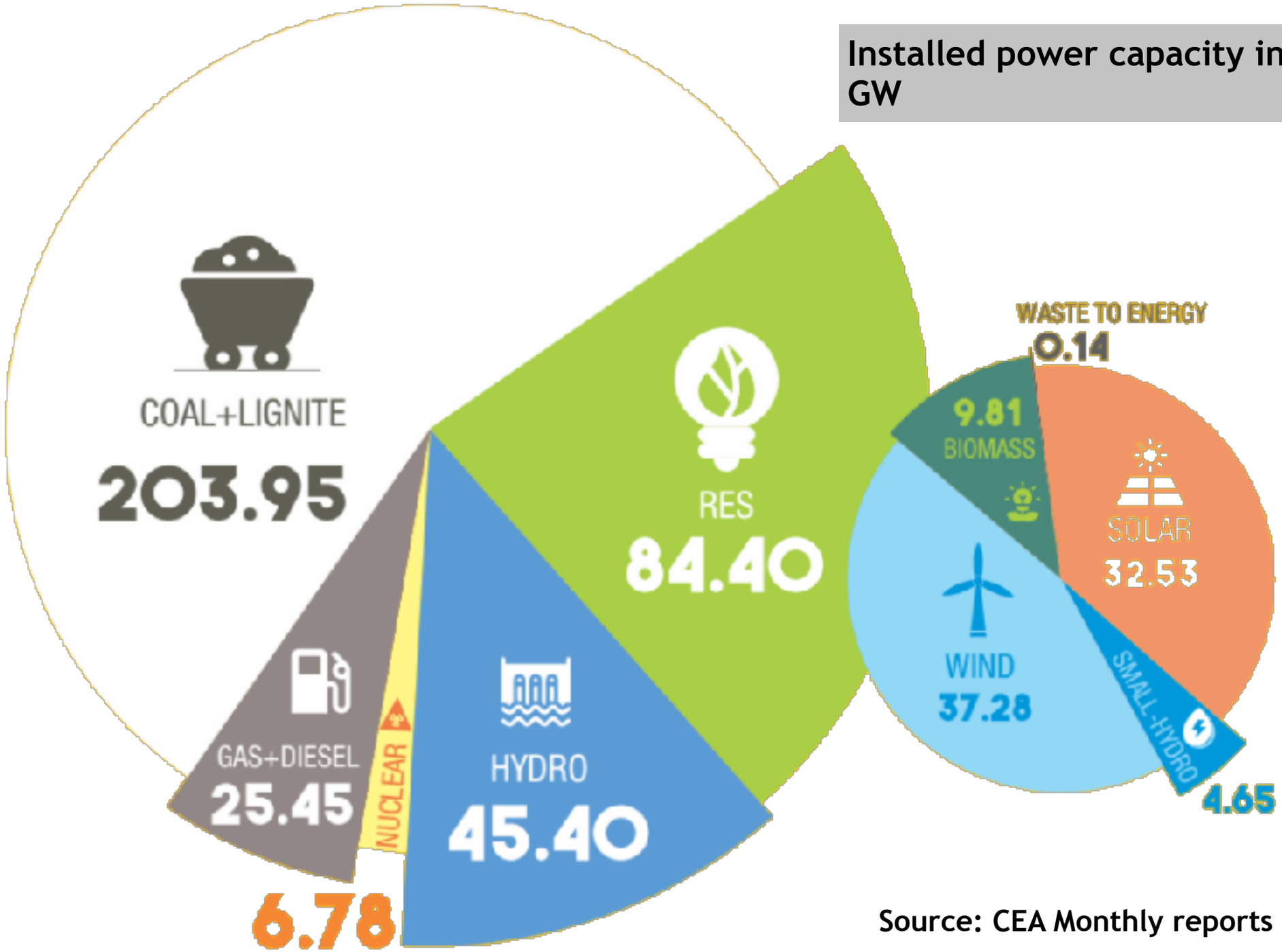
Eco Niwas Samhita - Karnataka

Energy Conservation Building Code for Residential Building

Power Consumption

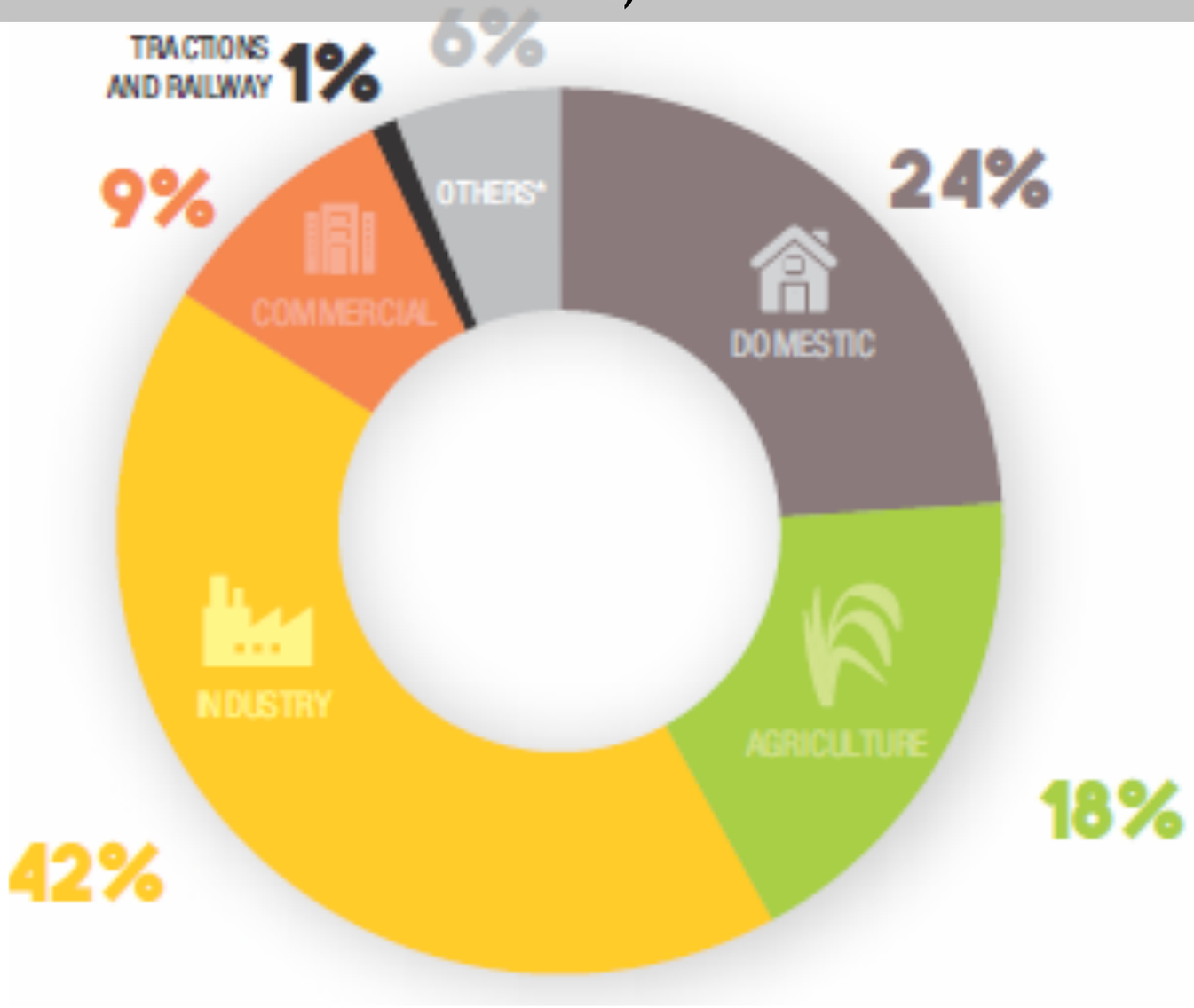
Installed power capacity in GW

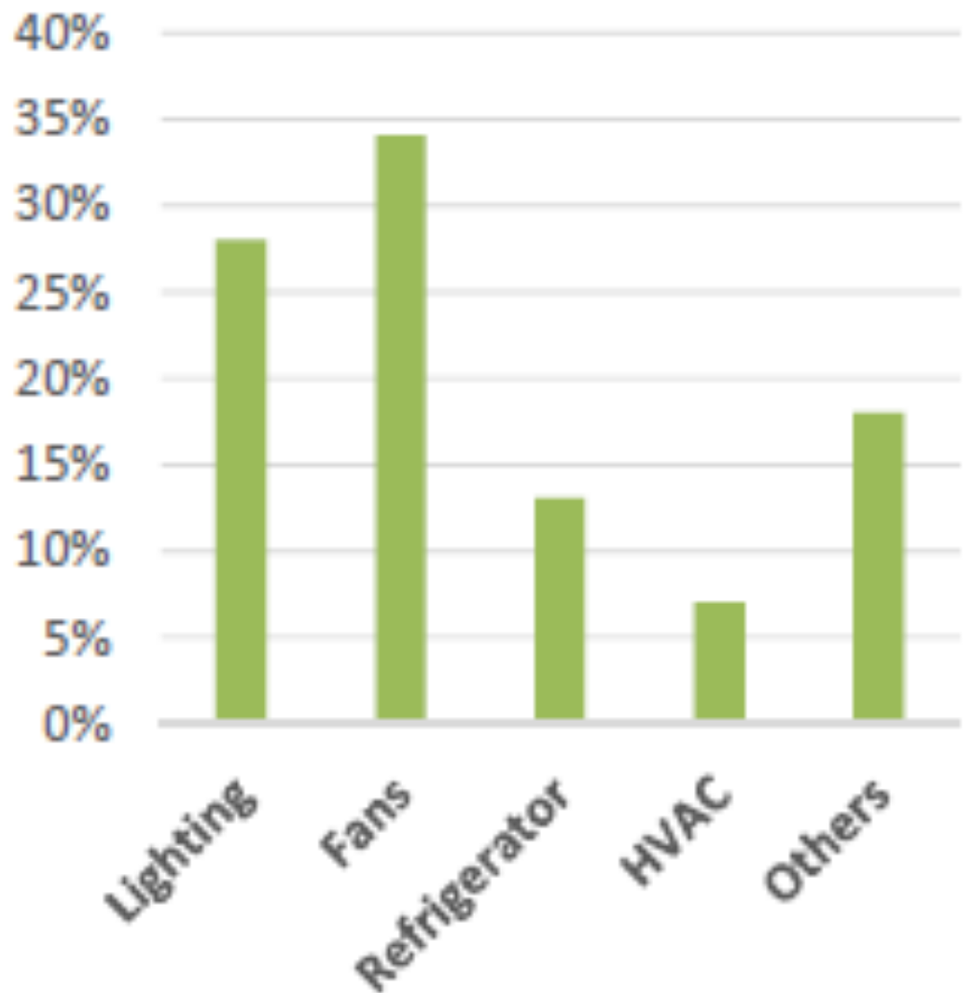


Source: CEA Monthly reports on installed capac

Source wise Energy Consumption

Domestic has the second highest energy consumption rate (24 %)

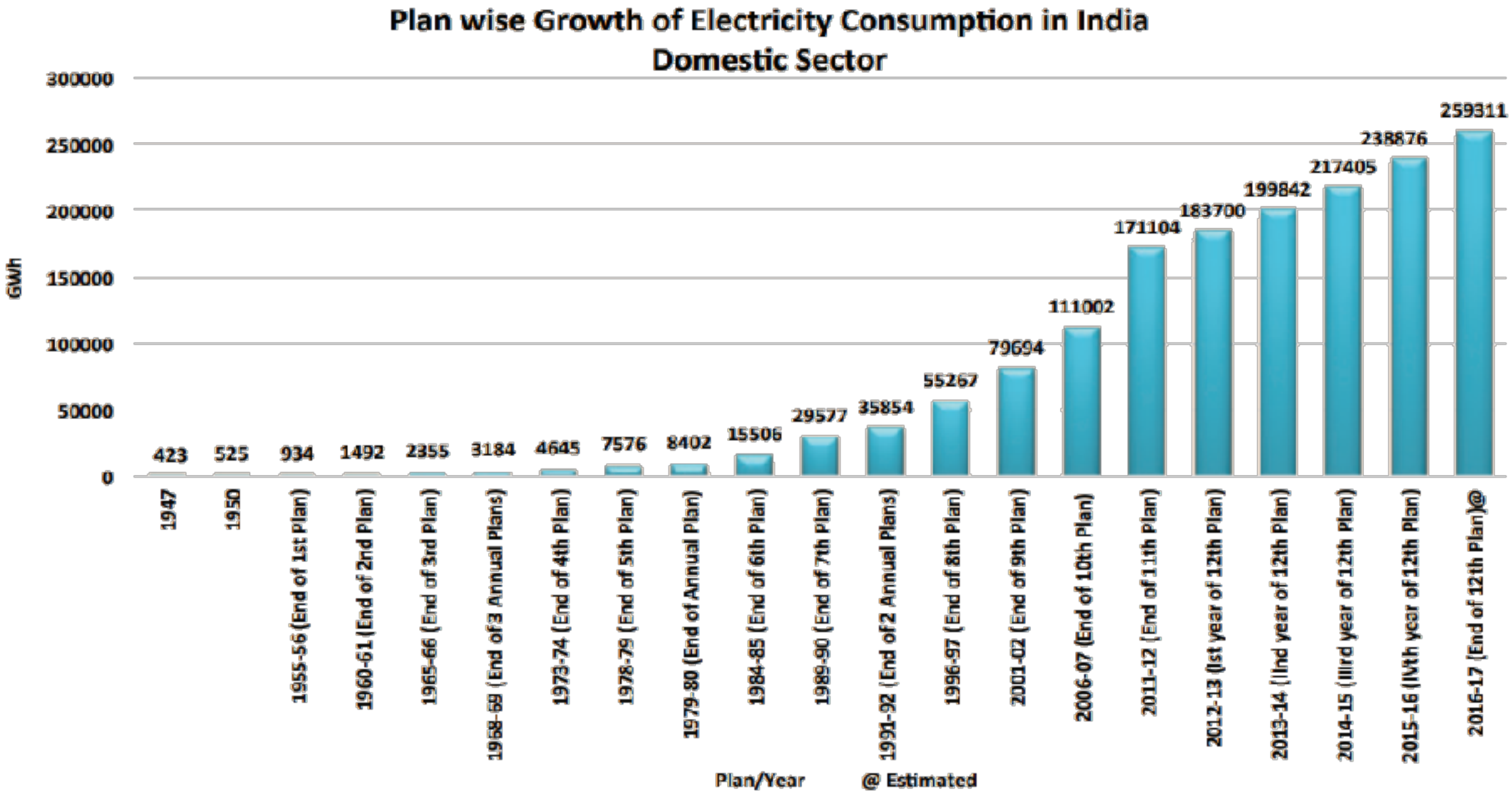




Energy consumption in Residential Buildings

Source: Energy Statistics 2018 **Data of 2017-18**

Energy Scenario In India



Source: Electricity Sector in India

Introduction to Eco Niwas Samhita (ENS)

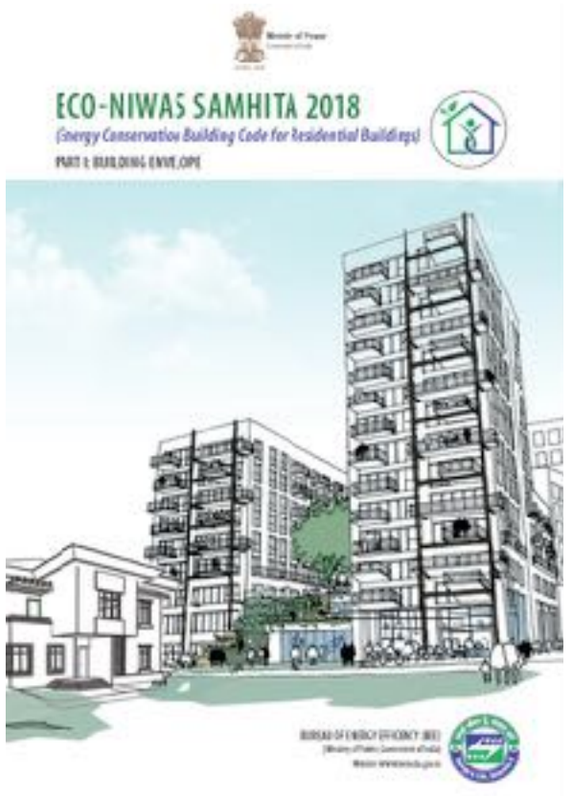
BEE
(BUREAU OF ENERGY EFFICIENCY)

Government of India

+

GIZ
(Deutsche Gesellschaft für Internationale Zusammenarbeit)

Government of Germany



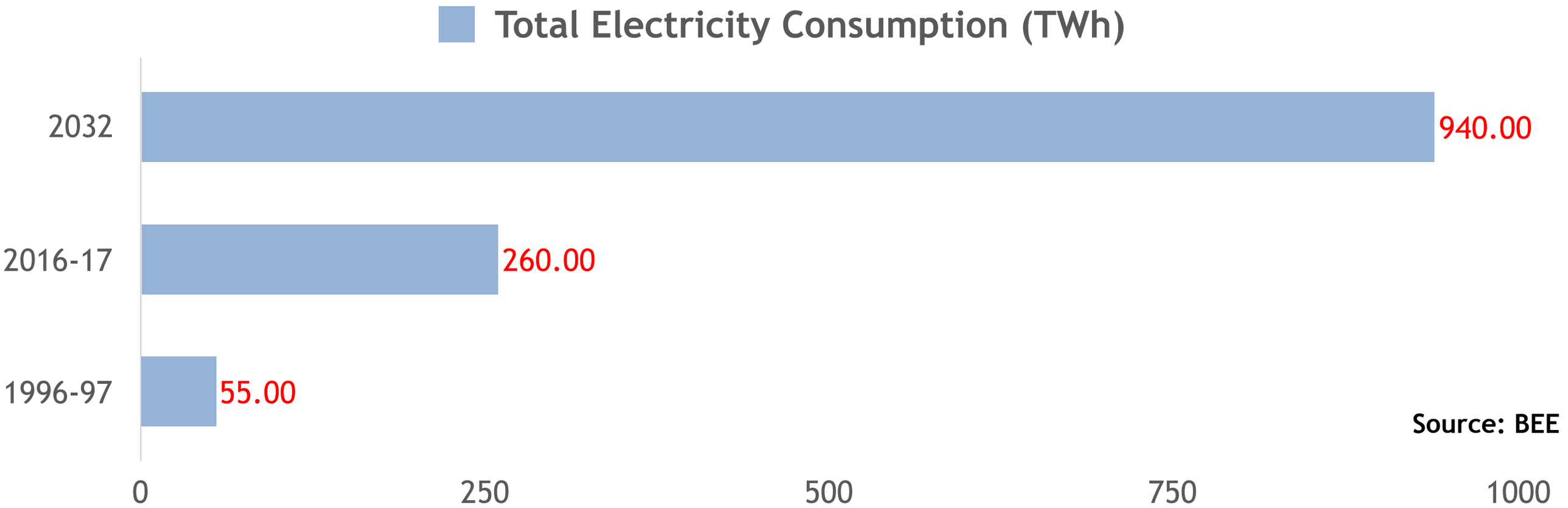
Eco Niwas Samhita

Launch of Eco Niwas Samhita in December 2018

Need for ENS

With respect to **BUILT-UP AREA** , approximately **3 Billion sq-m** of Residential Built-up area will be added by **2030** with an exponential land use increase from **24% to 60%** by **2047.**

ENERGY DEMAND increase is as indicated below



Source: BEE

Bureau of Energy Efficiency, Ministry of Power, Government of India

Eco Niwas Samhita (ENS) - Part 1

Eco Niwas Samhita – Part 1 is designed to define minimum Building Envelope design standards to improve Energy Efficiency in Residential Buildings

1

1. For Adequate natural ventilation potential

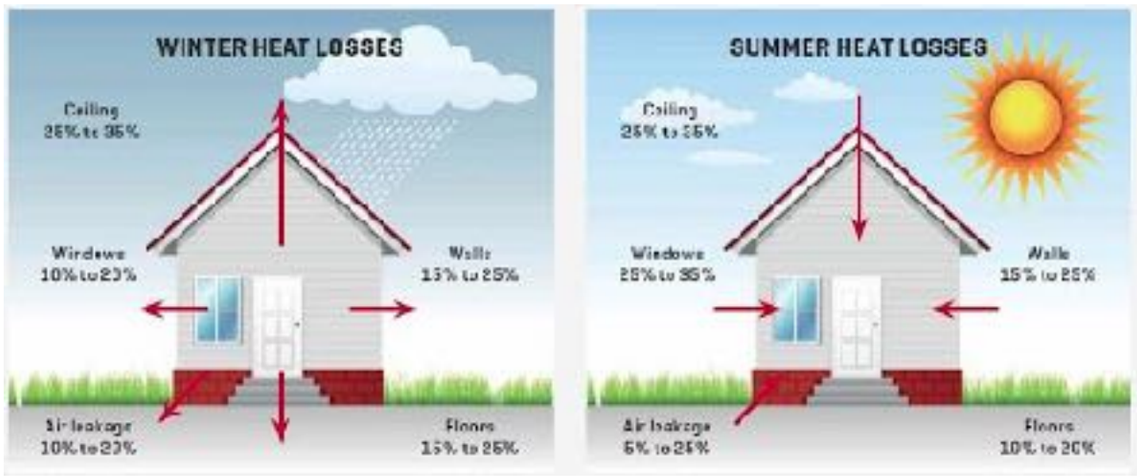
(WFR – Window to Floor Area Ratio)

2. For adequate day light

(WWR- Window to Wall area Ratio)

2

3



3. Limit heat gains / heat loss (U Value – Thermal Transmittance, RETV- Residential Envelope Transmittance Value)

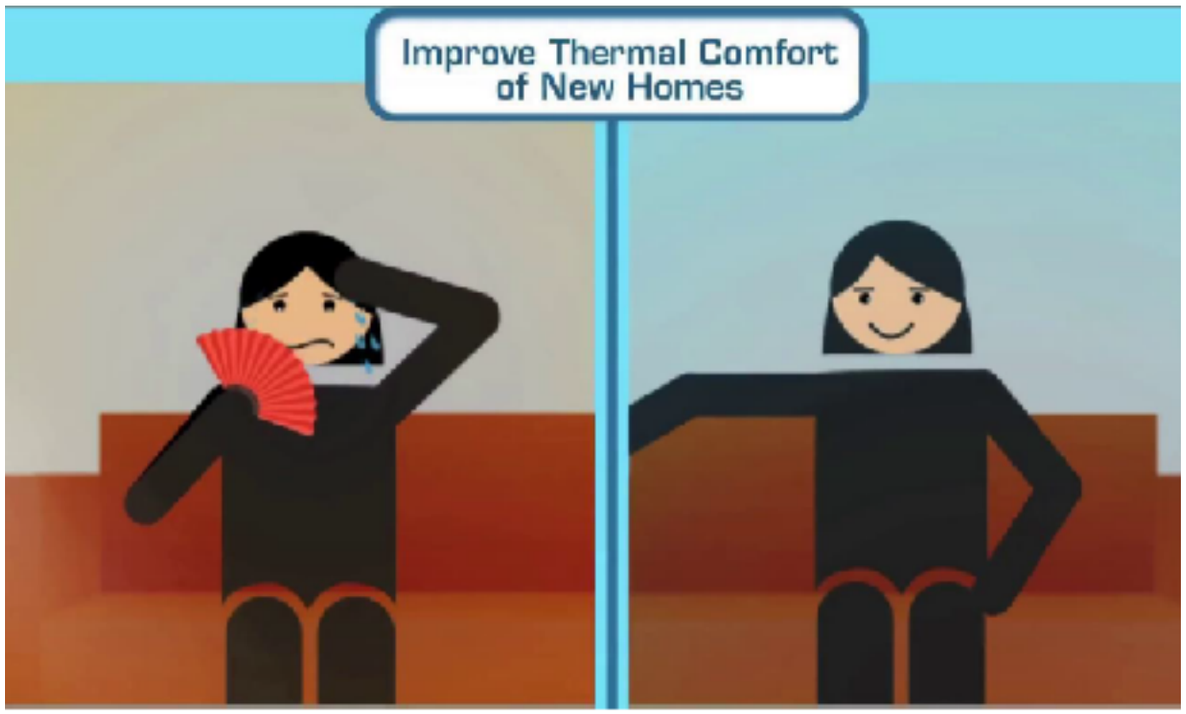
Salient Features of ENS

- ❑ Simple-to-apply format **(Prescriptive Compliance Approach)**
- ❑ Simple calculations based on inputs from the architectural design drawings of buildings.
- ❑ Will **not require any simulation software**.
- ❑ Code to be readily **adopted in the building bye-laws.**
- ❑ A **compliance tool** is also available on BEE website to aid in the calculations and compliance check.

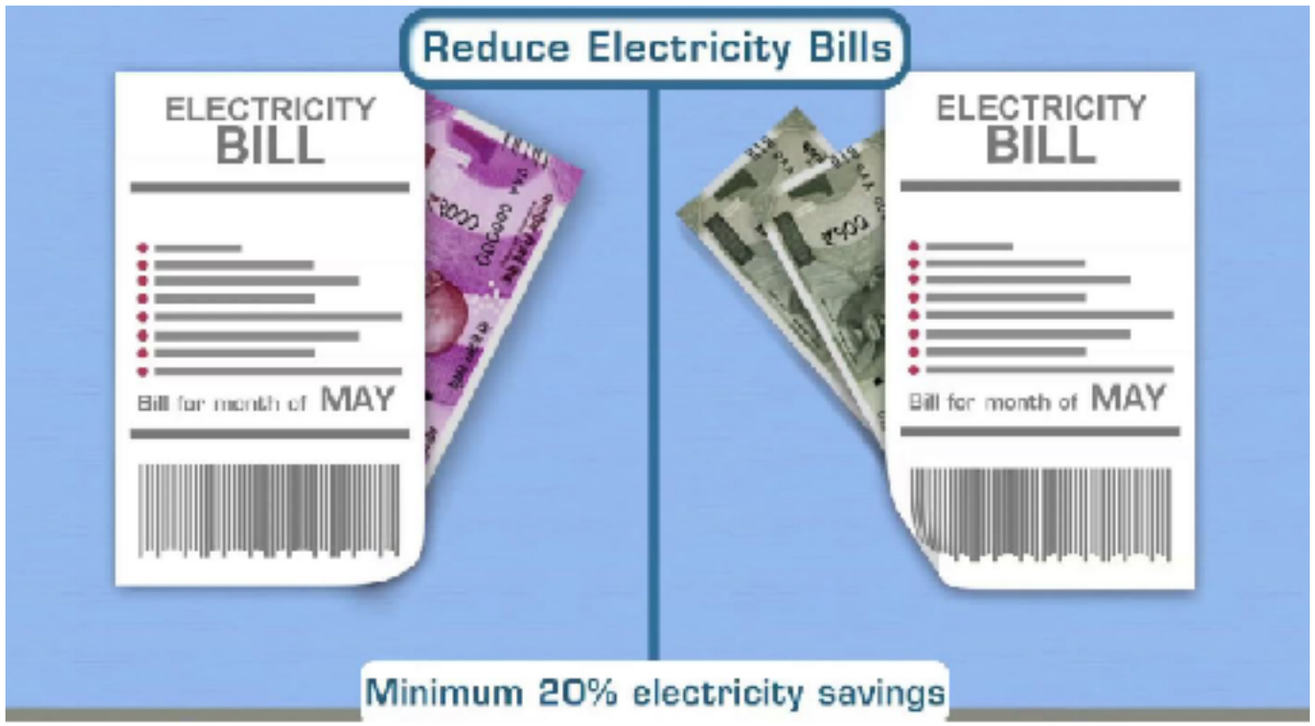
http://www.econiwas.com/

Benefits of ENS

Improve Thermal Comforts



Reduce Electricity Bills



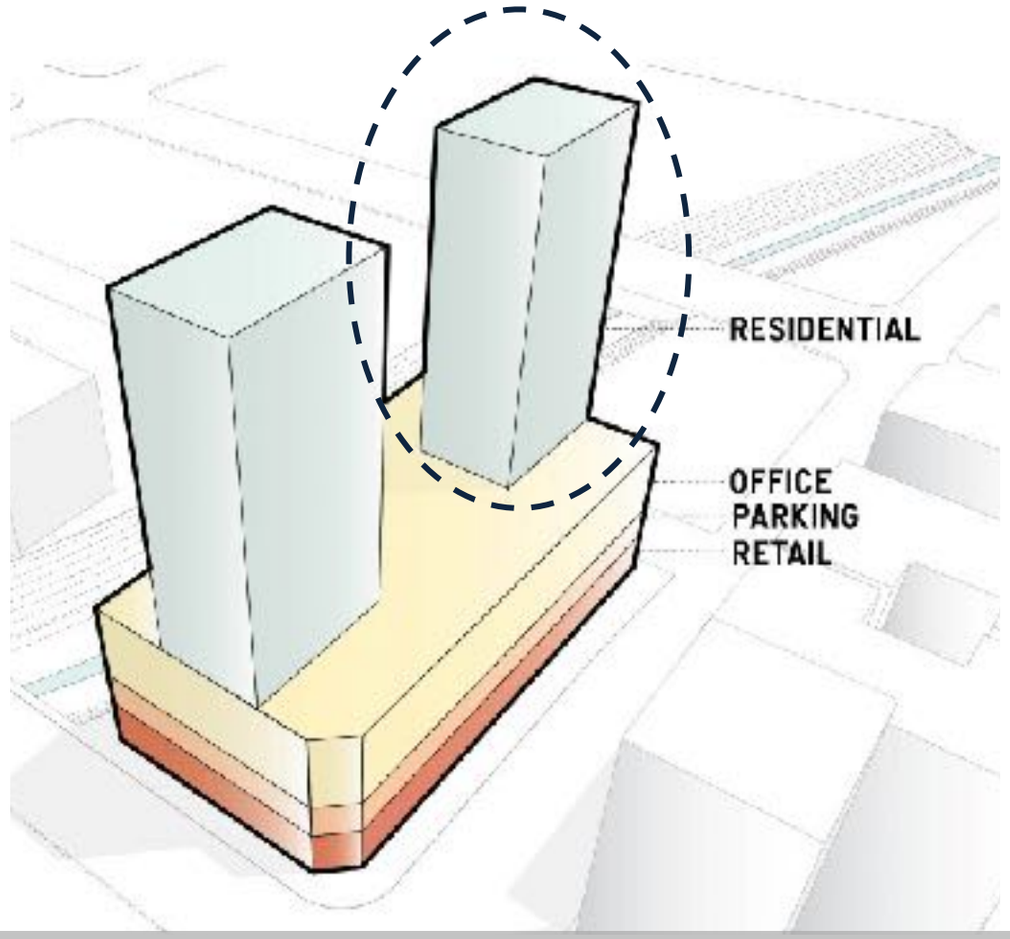
Estimated Impact Of Implementing Eco Niwas Samhita

- Minimum **20% energy saving** as compared to a typical Building
- **125 billion KWH** of electricity Saving
- **100 million tonnes of CO_2** equivalent abatement

Scope of ENS

The code is applicable to

(a)Residential Buildings with **plot area ≥ 500m²**



(b) Residential part of **"Mixed Land-use building projects" built on plot area of ≥ 500m².**

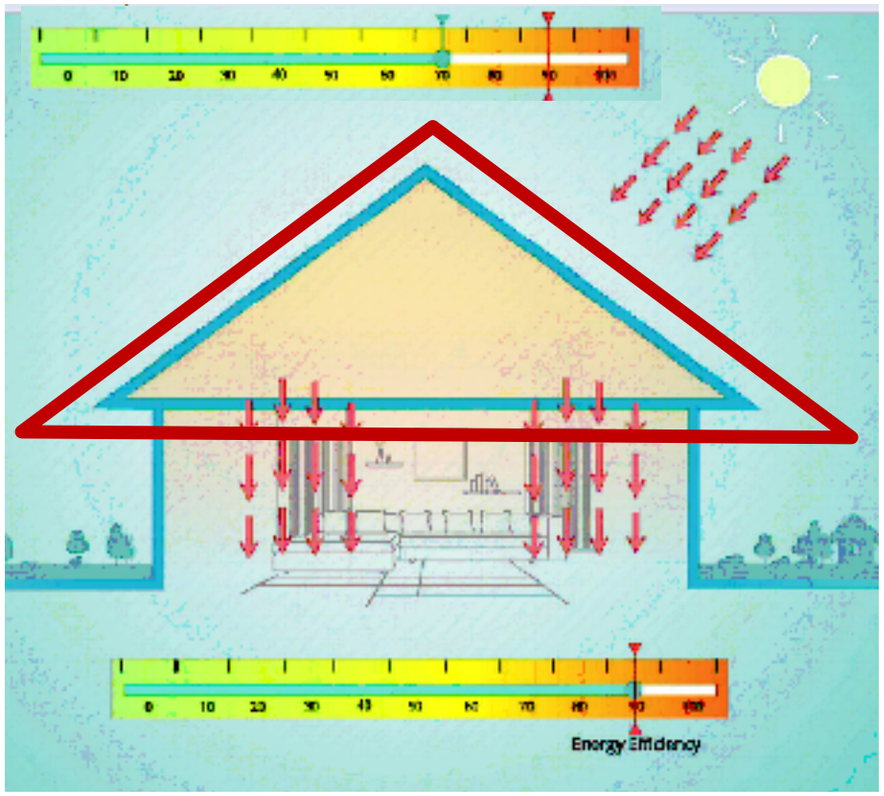
Excluded from the code

Dormitories

Hotels

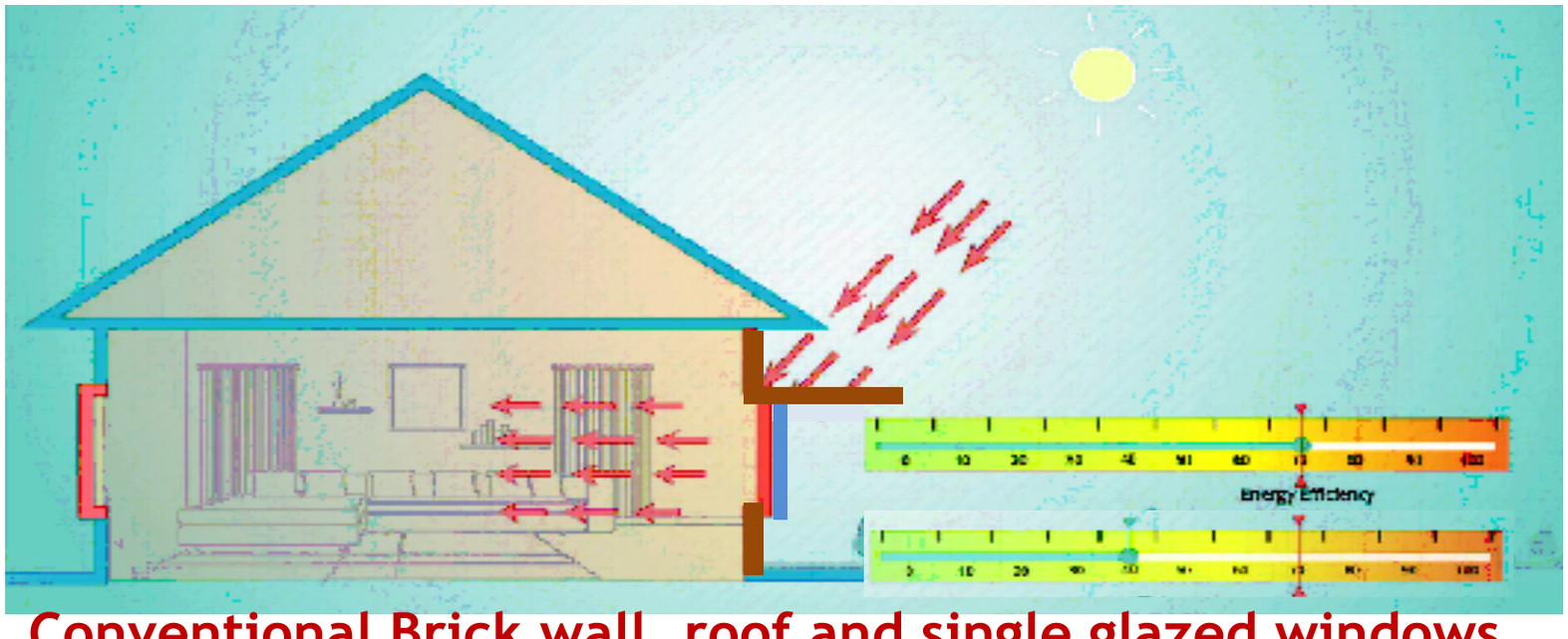
Lodging Rooms

Conventional Building VS ENS Compliant Building



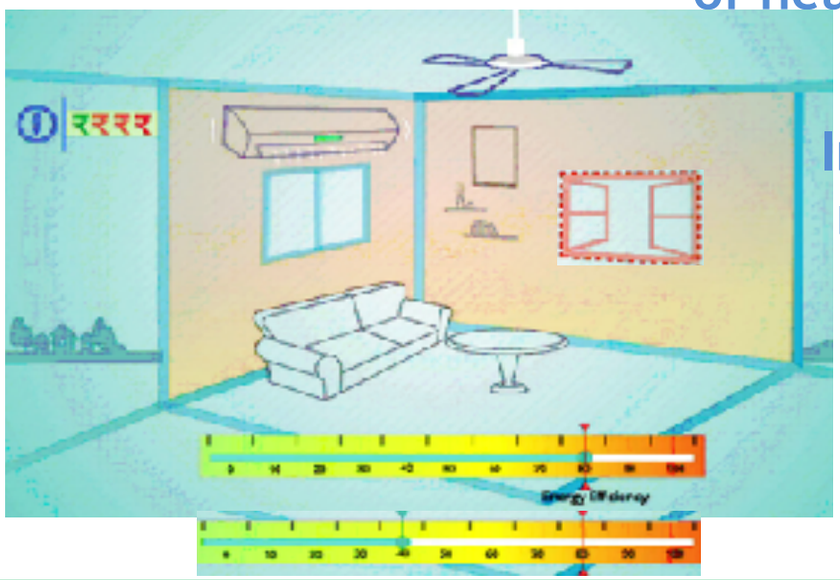
Non-insulated roof absorbs more heat and radiates inside the building

Proper Insulating materials can reduced heat gain



Conventional Brick wall, roof and single glazed windows, traps heat

Proper shading, glazing, Wall & Roof insulation reduces impact of heat



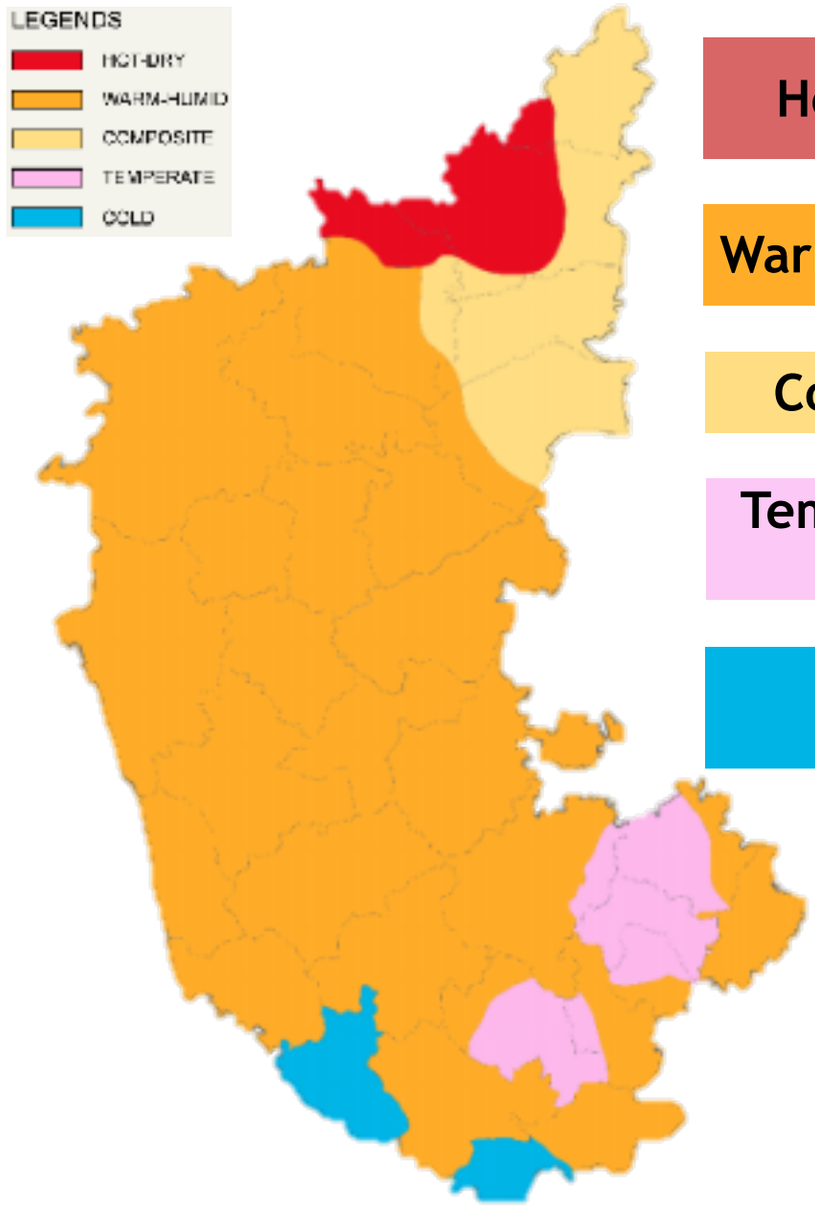
Increases in cross-ventilation reduces dependency on Air conditioners & coolers, thereby reduces electricity bills

Karnataka ENS Code

SCOPE: The Karnataka ENS code is applicable to Residential Buildings with **plot area ≥ 500m²** and Residential part of **"Mixed Land-use building projects" built on plot area of ≥ 500m².**

APPLICABILITY: The Karnataka ENS code is applicable to **all 5 climatic zones** (Composite, Hot & Dry, Warm & Humid, Temperate & Cold), that all districts fall under. **Latitude below 23.5 ° N**

Climate Map -Karnataka



Hot -Dry : Tumakuru

Warm-Humid : Mangaluru

Composite : Belagavi

Temperate : Bengaluru, Mysuru

Cold : Coorg

Performance Standards for Building Envelope

3.1 Openable Window to Floor Area Ratio (WFR_{op}) — For Natural Ventilation

3.2 Visible Light Transmittance (VLT)- Derived from WWR — For Day Light Potential

3.3 Thermal Transmittance of Roof (U_{roof})

3.4 Residential Envelope Transmittance Value (RETV)

3.5 Thermal Transmittance for Cold Climate ($U_{envelope,cold}$)

For Thermal Transmission

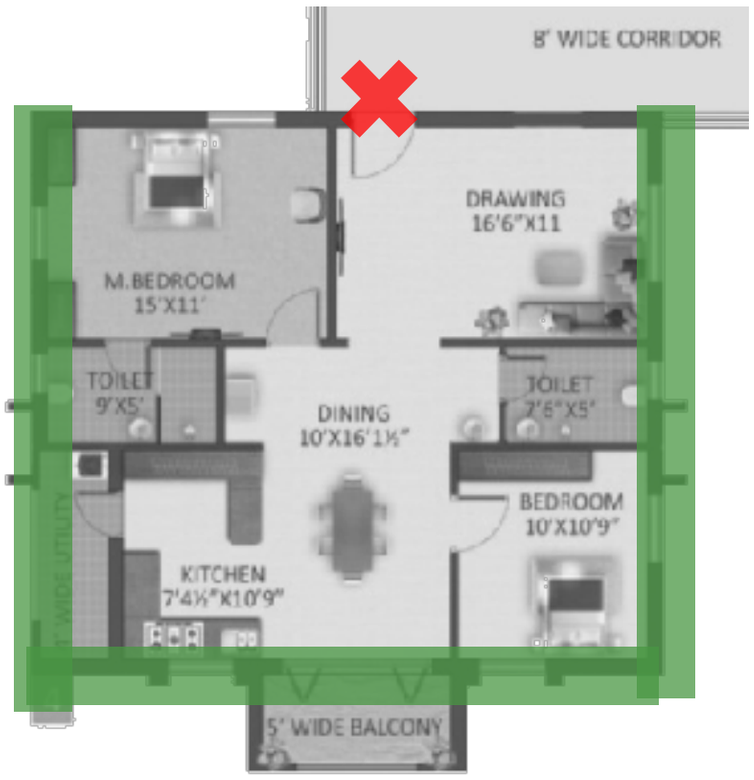
Source: Eco Niwas Samhita 2018

3.1 Openable Window to Floor Area Ratio (WFR_{op})

$$WFR_{op} = \frac{A_{openable}}{A_{carpet}}$$

Window to floor area ratio is the ratio of Openable area to the carpet area of the dwelling Units.

Openable Area



Windows, Ventilators, opening directly to
- External air,
- Open balcony,
- Corridor,
- Shaft

Doors opening directly into
- Open balcony

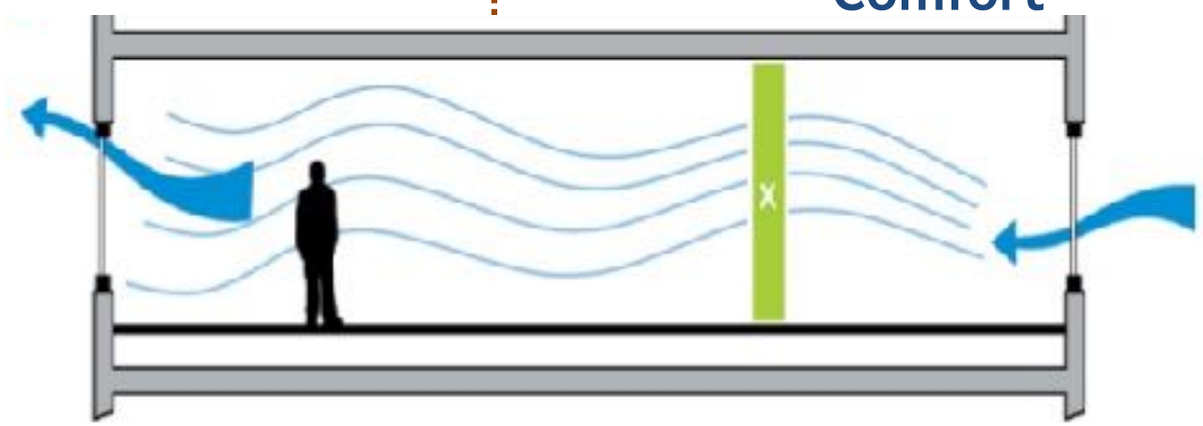
Carpet Area

- Total Internal Area of the habitable space Balconies - Excluded

3.1 Openable Window to Floor Area Ratio (WFR_{op})

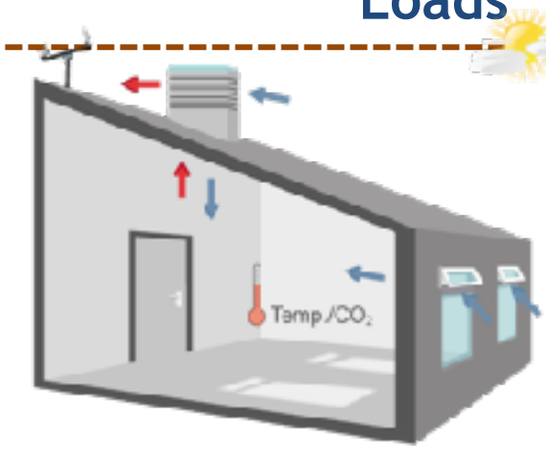
Minimum WFRop helps in

Natural Ventilation



Improvement in Thermal Comfort

Reduction in Cooling Energy Loads

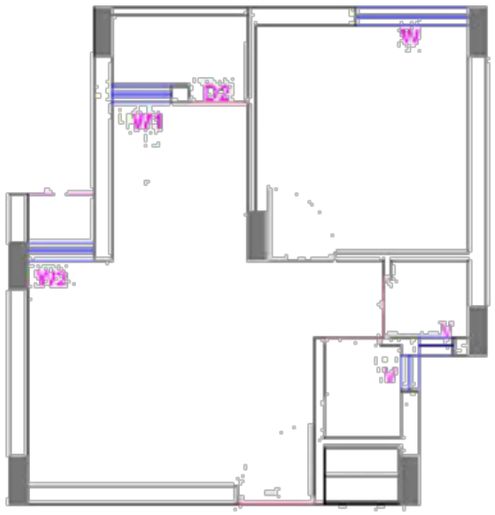


Minimum requirement of window-to-floor area Ratio	
Climate Zone	**Minimum WFRop**
Composite	12.50
Hot-Dry	10.00
Warm-Humid	16.66
Temperate	12.50
Cold	8.33

Openable Area Percentages (In case the exact Openable is not known)	
Type of Window/Door/ Ventilator	**Percentage Openable Area**
Casement	90%
Sliding (2 Panes)	50%
Sliding (3 Panes)	67%

3.1 WFR_{op} - Example

Calculation of WFR for a dwelling unit situated in Rajkot



Wall

200 mm AAC blocks with plaster on both sides; U-value = 0.78 W/ m2.K

Roof

150 mm RCC with 40mm Polyurethane foam (PU) insulation

Glass in windows

Single clear glass with; SHGC = 0.80, VLT = 85%, and U-value = 5.80 W/m2.K

Opening window/ door/ ventilator	Opening width (m)	Opening height (m)	Opening area (m2)	Width of glass in Opening (m)	Height of glass in Opening (m)	Glass area in opening (m2)	Opaque area (m2)
W1	1.20	1.60	1.92	1.20	0.53	0.64	1.28
W2	0.80	1.30	1.04	0.80	0.43	0.35	0.69
W3	0.80	1.60	1.28	0.80	1.60	1.28	0.00
D	0.75	2.50	1.87	0.00	0.00	0.00	1.87
V (2 nos)	0.65	0.40	0.26	0.65	0.40	0.26	0.00

3.1 WFR_{op} - Example

Opening name	Opening area (m2)	Openable area (m2)	Remarks
W1	1.92	1.73	90% Openable
W2	1.04	0.94	
W3	1.28	1.15	
D (opening into balcony)	1.87	1.69	
V(2nos)	0.52	0.47	
Openable area for the dwelling unit		**5.97**	

Carpet Area - $A_{carpet} = 26.6\ m^2$

$$WFRop = \frac{A_{openable}}{A_{carpet}} = \frac{5.97}{26.6}$$

= 22.44%

Rajkot is in the composite climate.

As per Table, the minimum *WFRop for this climate is 12.5%.*

Thus, this project complies with this requirement.

3.2 Window to Wall Area Ratio (To arrive at Optimum VLT)

$$WWR = \frac{A_{non-opaque}}{A_{envelope}}$$

WWR - Window to wall area ratio
Area (non-opaque) -
Total glass area in the opening .
Excluded - Opaque part of the total opening size.
Area(Envelope) -
Total envelope area of all facades.
Included – opaque and non-opaque

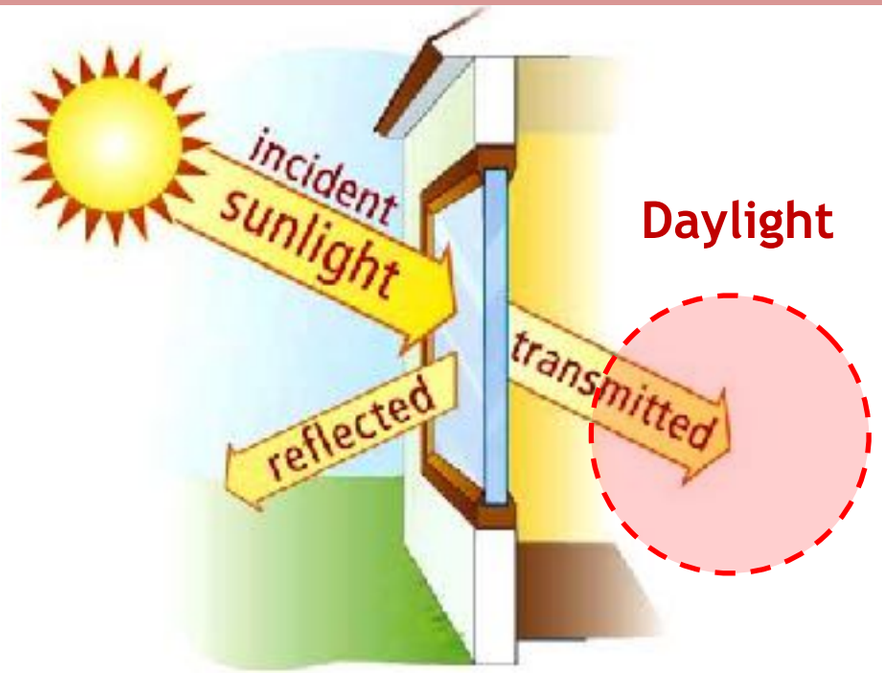
*** Note for WWR ≤ 0.15 , VLT - 40%**

Relation between WWR and Visual Light Transmittance

Window to Wall Ratio (WWR)	Minimum VLT
0-0.30	0.27
0.31-0.40	0.20
0.41-0.50	0.16
0.51-0.60	0.13
0.61-0.70	0.11

3.2 Window to Wall Area Ratio (To arrive at Optimum VLT)

Total light transmitted in any area through Glass.

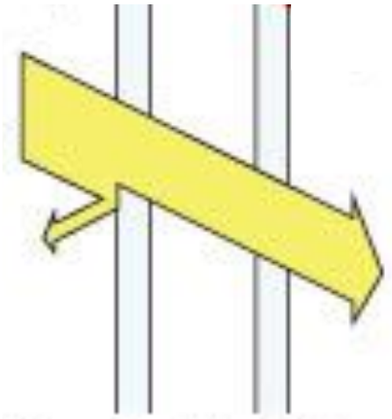


- Factors affecting VLT
  - Glazing type,
  - No. of panes in an area,
  - Coating on the glass

Reduced energy usage for artificial lighting

Daylight savings

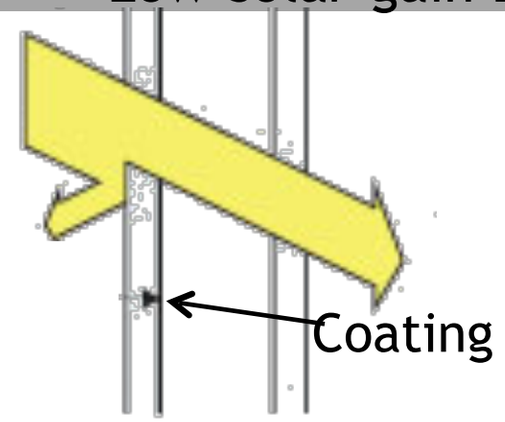
Clear Double Glazing



VLT = .79

79% of visible light transmitted

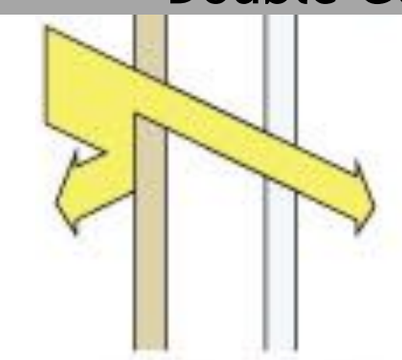
Low-solar-gain Low-E double Glazing



VLT = .69

69% of visible light transmitted

Double Glazing with Bronze Tint



VLT = .48

48% of visible light transmitted

3.2 Window to Wall Area Ratio (To arrive at Optimum VLT)

From where can we obtain the VLT of the Glass ?

Colour / Performance	Thickness (mm)	Light Transmittance LT	Light Reflectance LR	Total Solar Radiant Heat Transmittance	Total Shading Coefficient	U Value (W/m^2K)	R_w Value (dB)
Clear	10	0.77	0.14	0.67	0.77	2.7	38
Clear	12	0.76	0.14	0.64	0.74	2.7	38
Clear	15	0.74	0.13	0.60	0.69	2.6	40
73/42	10	0.69	0.10	0.40	0.46	1.4	38
70/39	10	0.67	0.12	0.37	0.43	1.3	38
69/37	10	0.66	0.11	0.35	0.40	1.3	38
62/29	10	0.58	0.09	0.29	0.33	1.3	38
50/27	10	0.48	0.10	0.26	0.30	1.3	38
30/17	10	0.29	0.24	0.19	0.22	1.3	38

VLT of a Glass can be obtained from the Glass cut sheet available with any Glass manufacturer

3.2 Window to Wall Area Ratio (To arrive at Optimum VLT)

Calculation of WWR for a dwelling unit situated in Rajkot

$$WWR = \frac{A_{non\text{-}opaque}}{A_{envelope}} = \frac{253.16}{3478.26} = 0.073$$

As per Table, for WWR of 0.073 (range 0-0.30), **the minimum required VLT is 27%.** The glass used in this **project has a VLT of 85%** (as mentioned).Thus, this project complies with this requirement.

Orientation	Opening name	Opening area (m2)	Non-opaque (glass) area in opening (m2)	No. of openings	Total opening area (m2)	Total non-opaque (glass) area (m2)
North	W1	1.92	0.64	56	107.52	35.62
North	W2	1.04	0.35	56	58.24	19.26
North	W3	1.28	1.28	56	71.68	71.68
North	D	1.88	0.00	56	105.00	0.00
South	W1	1.92	0.64	56	107.52	35.62
South	W2	1.04	0.35	56	58.24	19.26
South	W3	1.28	1.28	56	71.68	71.68
South	D	1.88	0.00	56	105.00	0.00
Total					684.88	**253.16**

Orientation	Total wall length (m), exposed to ambient	Total wall height (m), exposed to ambient	Envelope area (m_2)
North	51.58	21.06	1086.27
South	51.58	21.06	1086.27
East	31.00	21.06	652.86
West	31.00	21.06	652.86
Envelope area(m_2),excluding roof			**3478.26**

3.3 Thermal Transmittance - U_{roof}

Thermal Transmittance of roof U_{roof} - Is the rate of transfer of heat through the roof structure (which can be a single material or an assembly), divided by the difference in temperature across that structure.

Limiting U_{roof} by helps in reducing heat gains or losses from the roof. Ex : Insulation, Cool Roofs, Green Roofs

Thermal transmittance of roof shall comply with U_{roof} value - 1.2 W/ m^2.k

Source: Eco niwas Samhita -2018, Annexure - 8

3.3 Thermal Transmittance - U_{roof}

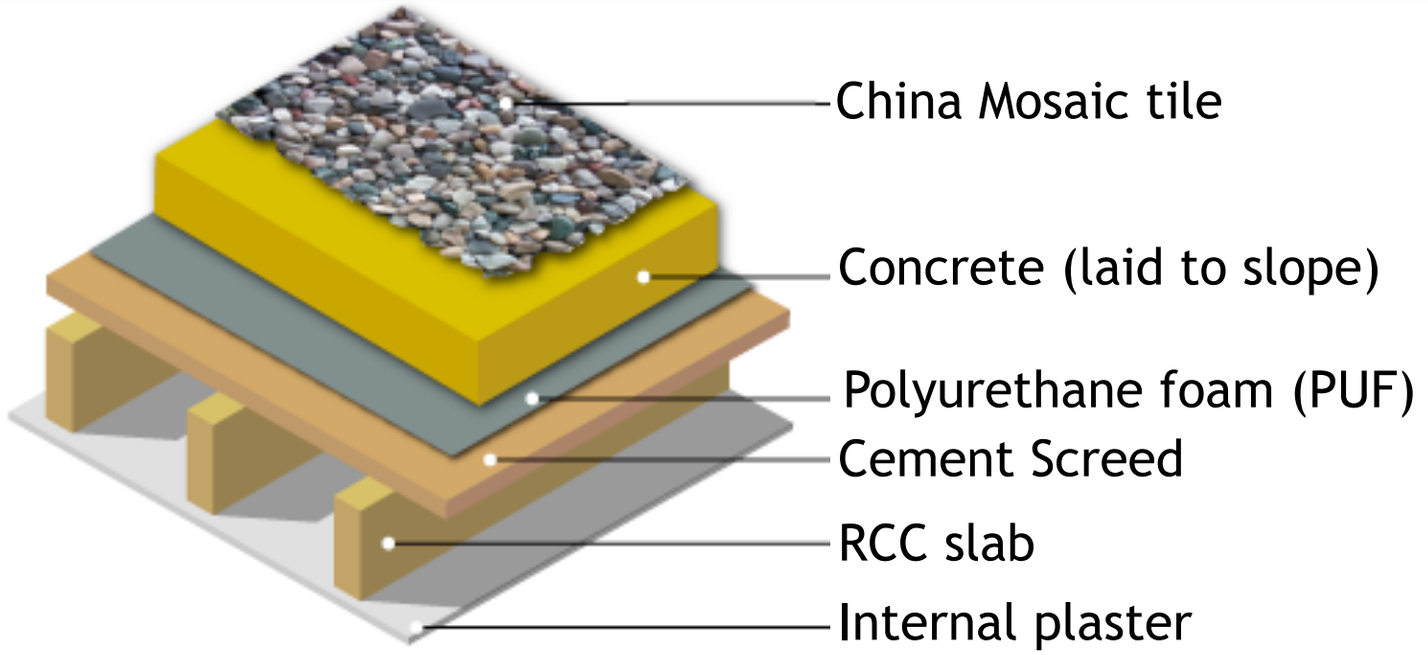
Total thermal Resistance -

$R_t = R_{si} + R_{se} + R1 + R2 + R3 \ldots\ldots$

$= 0.17 + 0.04 + 1.917 = 2.127\ m^2.K/W$

Total Thermal Transmittance (Roof)-

$U_{roof} = 1/RT = 0.47\ W/m^2.K$



Material Layer	Thickness,(t)	Thermal Conductivity- k (W/m.K)	Thermal Resistance , R=t/k(m^2.K/w)
China mosaic tile	0.007	1.500	0.005
Concrete (laid to slope)	0.050	1.740	0.029
Polyurethane foam (PUF)	0.040	0.023	1.739
Cement screed	0.020	0.720	0.028
RCC slab	0.150	1.580	0.095
Internal plaster	0.015	0.720	0.021
Sum of all material thermal resistance			1.917

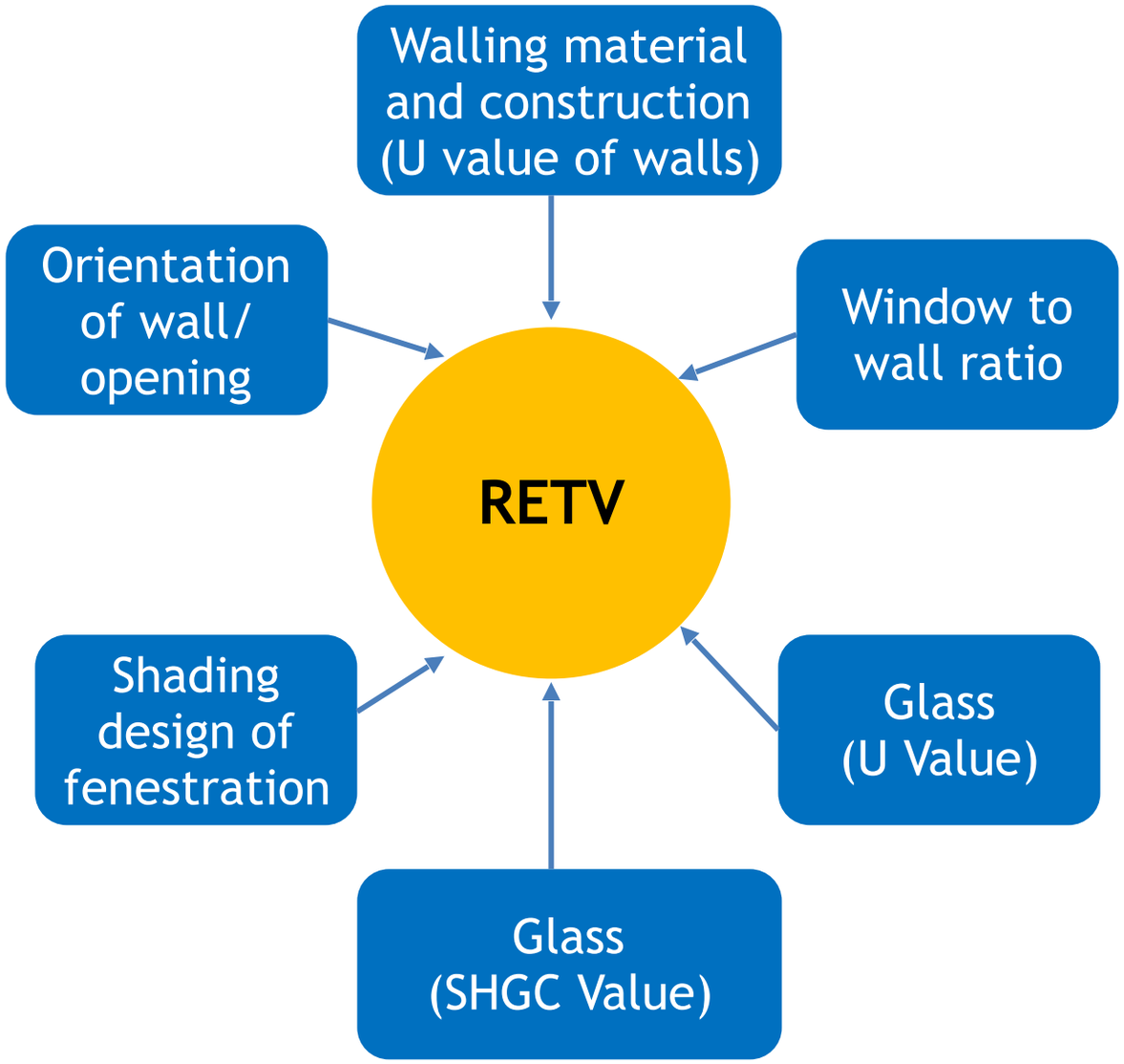
Source: Eco niwas Samhita -2018, Annexure - 8

3.4 Residential Envelope Transmittance Value (RETV)

Solar Radiation through non-opaque surfaces

Conduction through opaque surfaces

Conduction through non-opaque surfaces



3.4 Residential Envelope Transmittance Value (RETV)

The net heat gain rate through building Envelope

$$RETV = \frac{1}{A_{envelope}} \times \left[\begin{array}{l} \left\{ a \times \sum_{i=1}^{n} \left(A_{opaque_i} \times U_{opaque_i} \times \omega_i \right) \right\} \\ + \left\{ b \times \sum_{i=1}^{n} \left(A_{non-opaque_i} \times U_{non-opaque_i} \times \omega_i \right) \right\} \\ + \left\{ c \times \sum_{i=1}^{n} \left(A_{non-opaque_i} \times SHGC_{eq_i} \times \omega_i \right) \right\} \end{array} \right]$$

RETV accounts for –

➢ heat conduction through opaque and non-opaque building envelope components.

➢ Solar radiation through non-opaque building envelope components

SHGC –Solar heat gain coefficient

A_{opaque} , $A_{non\text{-}opaque}$ - area of opaque and non-opaque areas in the building envelope

W_i - Orientation Factor

U_{opaque}, $U_{non\text{-}opaque}$ - Thermal transmittance of opaque and non-opaque building envelope components.

a,b,c – Coefficients for different climatic zones

$A_{envelope}$ – Envelope area of dwelling units, except roof area.

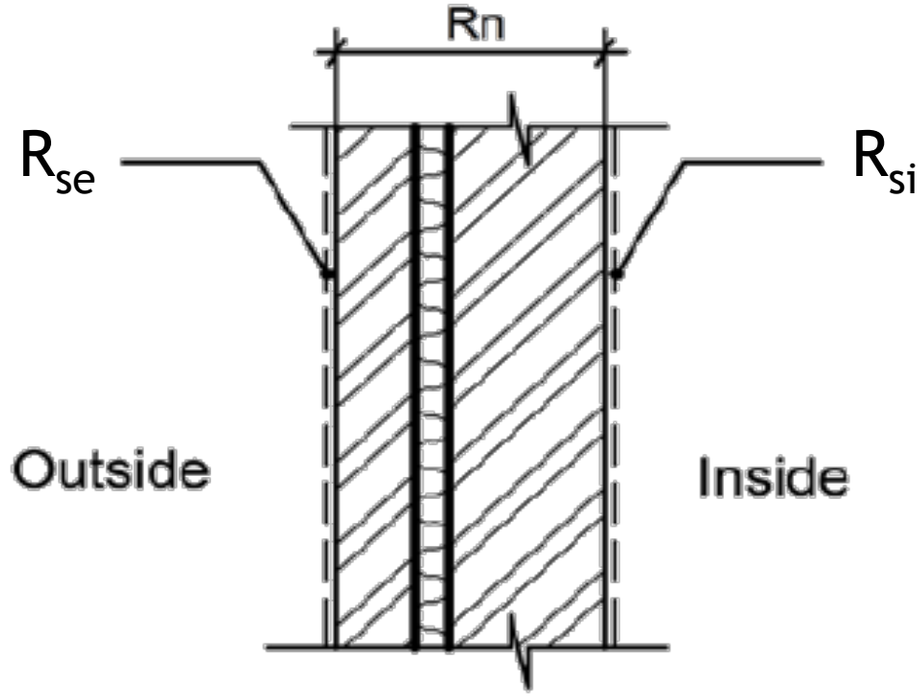
3.4 U- Value - Thermal Transmittance - Wall

U-value - Rate of transfer of heat through a structure (which can be a single material or an assembly), divided by the difference in temperature across that structure. **(W/m^2K)**

$$U = 1 / R_t$$

$$U = 1/ (R_{so} + \sum R_n + R_{si})$$

U-value is the reciprocal of Thermal Resistance (R)



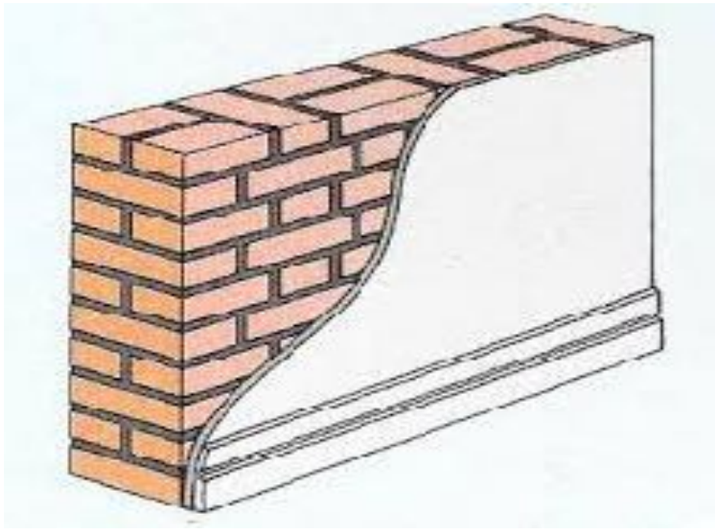
	Wall	Roof	
	All climatic Zones	Composite , Hot-Dry, Warm-humid, and Temperate climate	Cold climate
Rsi (m2.K/W)	0.13	0.17	0.10
Rse (m2.K/W)	0.04	0.04	0.04

Source: Eco Niwas Samhita -2018, Table 6, Annexu

3.4 Types of wall and their U-value

150 mm RCC (No plaster)
U Value - 3.77 W/m²K

200 mm Solid Concrete Block with 15 mm plaster on both sides
U Value- 2.8 W/m²K

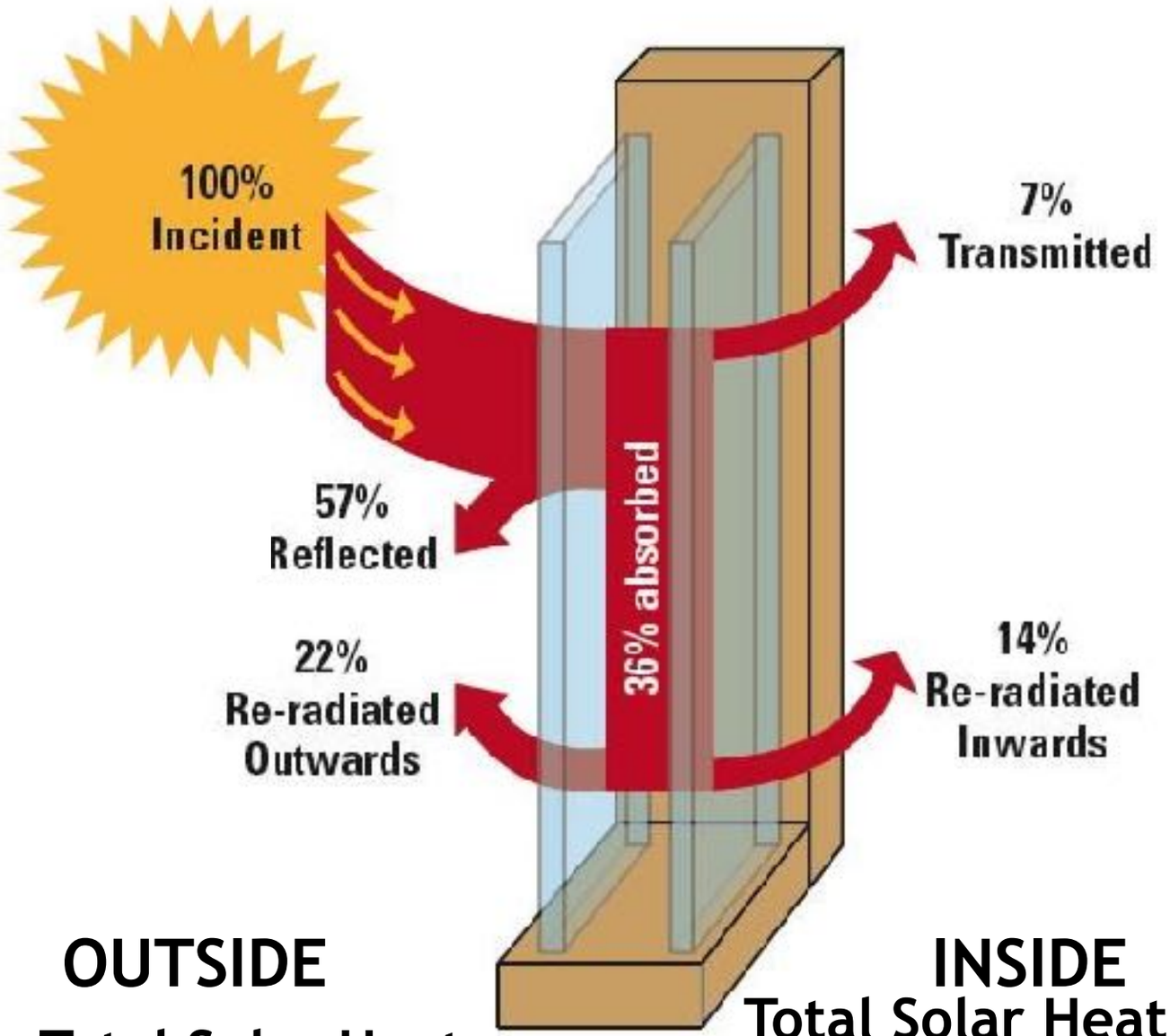


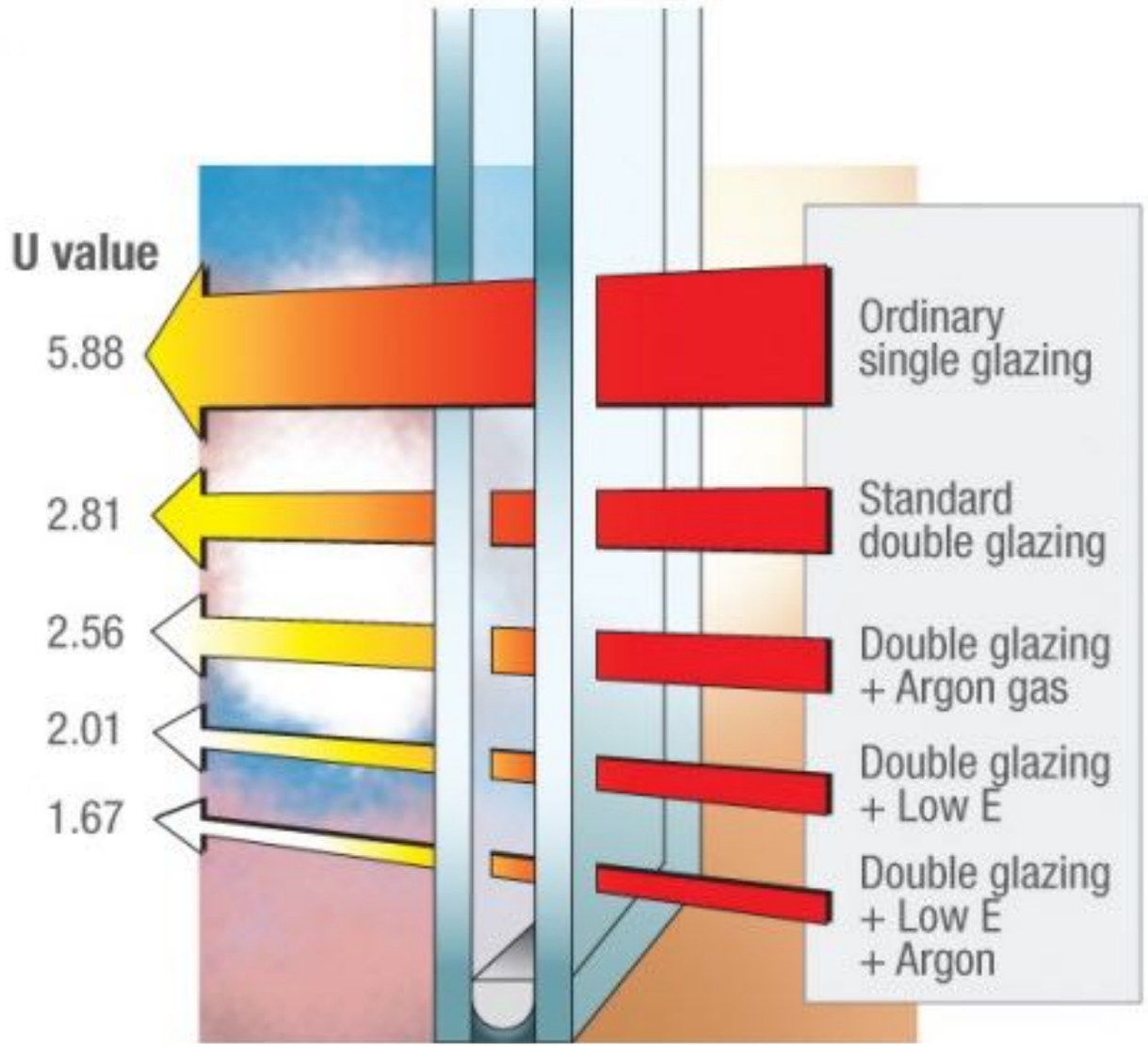
230 mm Brick with 15 mm plaster on both sides
U Value 1.72 - 2.24 W/m²K

200 mm Autoclaved Aerated Concrete (AAC) with 15 mm plaster on both side
U Value- 0.77 W/m²K

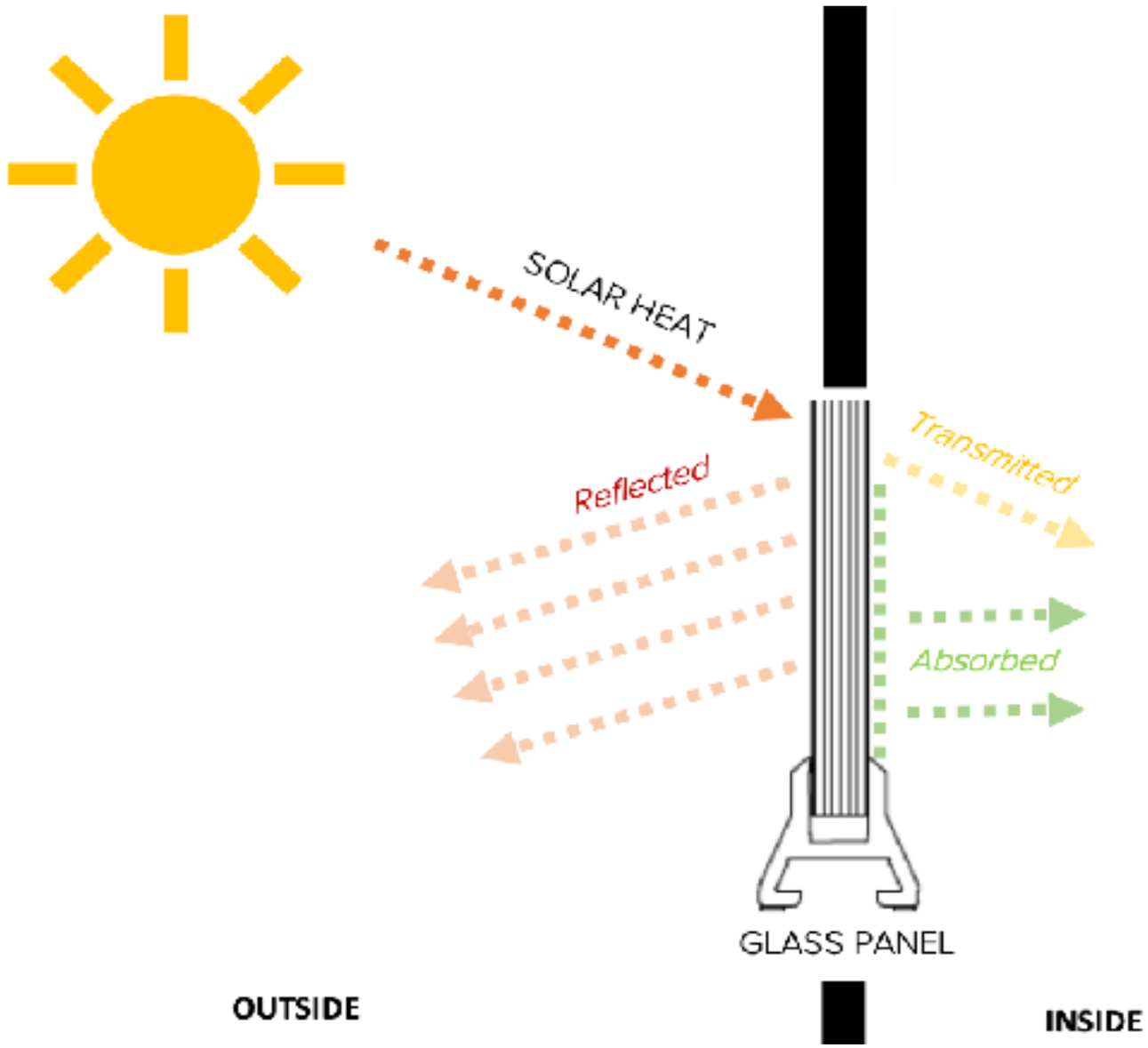
300 mm Autoclaved Aerated Concrete (AAC) with 15 mm plaster on both sides
U Value - 0.54 W/ m²K

3.4 U- Value - Thermal Transmittance - Non-Opaque





3.4 Solar Heat Gain Coefficient (SHGC) - Non-Opaque



Solar heat gain coefficient is the measure of solar heat –

- Absorbed
- Transmitted

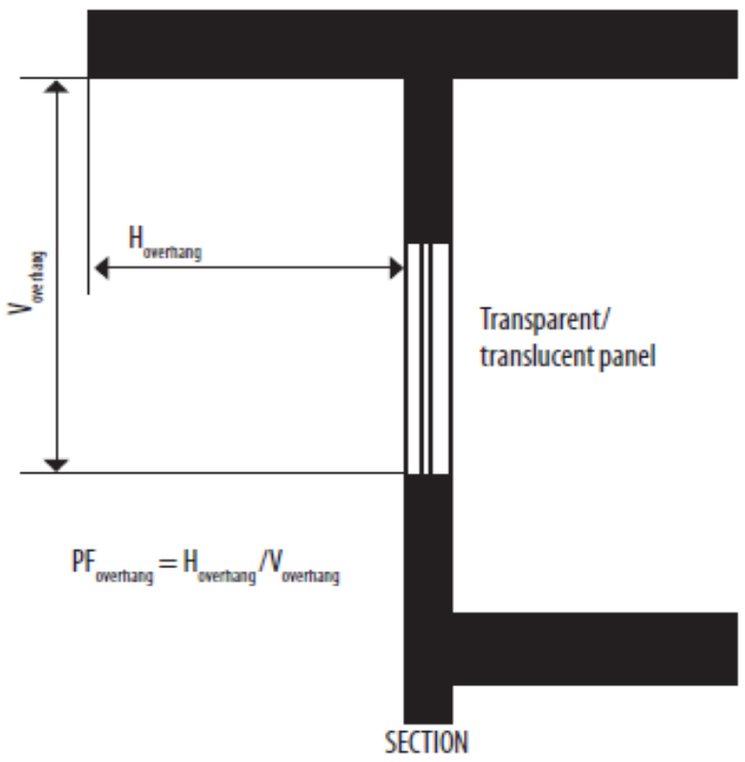
Lower SHGC ∝ lesser Heat Transfer

Solar Radiation is subsequently released inward through conduction, convection and radiation.

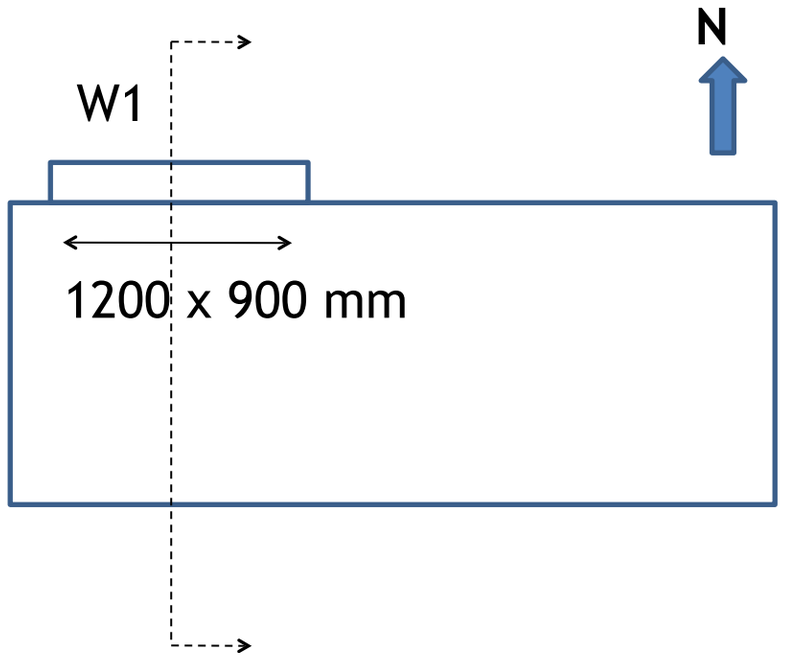
3.4 Projection factor (PF)

Projection Factor (PF) is the ratio of the horizontal depth of the external shading projection ($H_{overhang}$) to the bottom of the farthest point of the external shading projection ($V_{overhang}$), in consistent units.

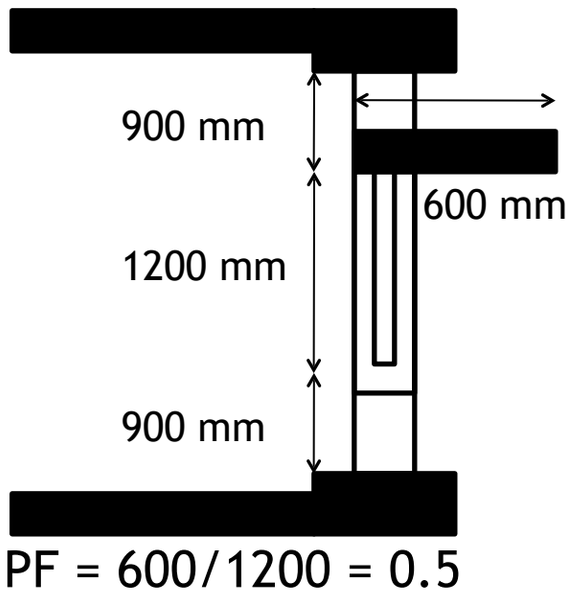
$$PF_{overhang} = \frac{H_{overhang}}{V_{overhang}}$$



Solved exercise: Considering a room size of 3m * 5m, with a window W1 shown in plan and section. The projection factor for the same is calculated, to arrive at the ESF (Effective Shading Factor). Glass parameters; Single Glazing Unit (SGU), U value = 5.6 W/m2 K, SHGC = 0.6, VLT = 0.7

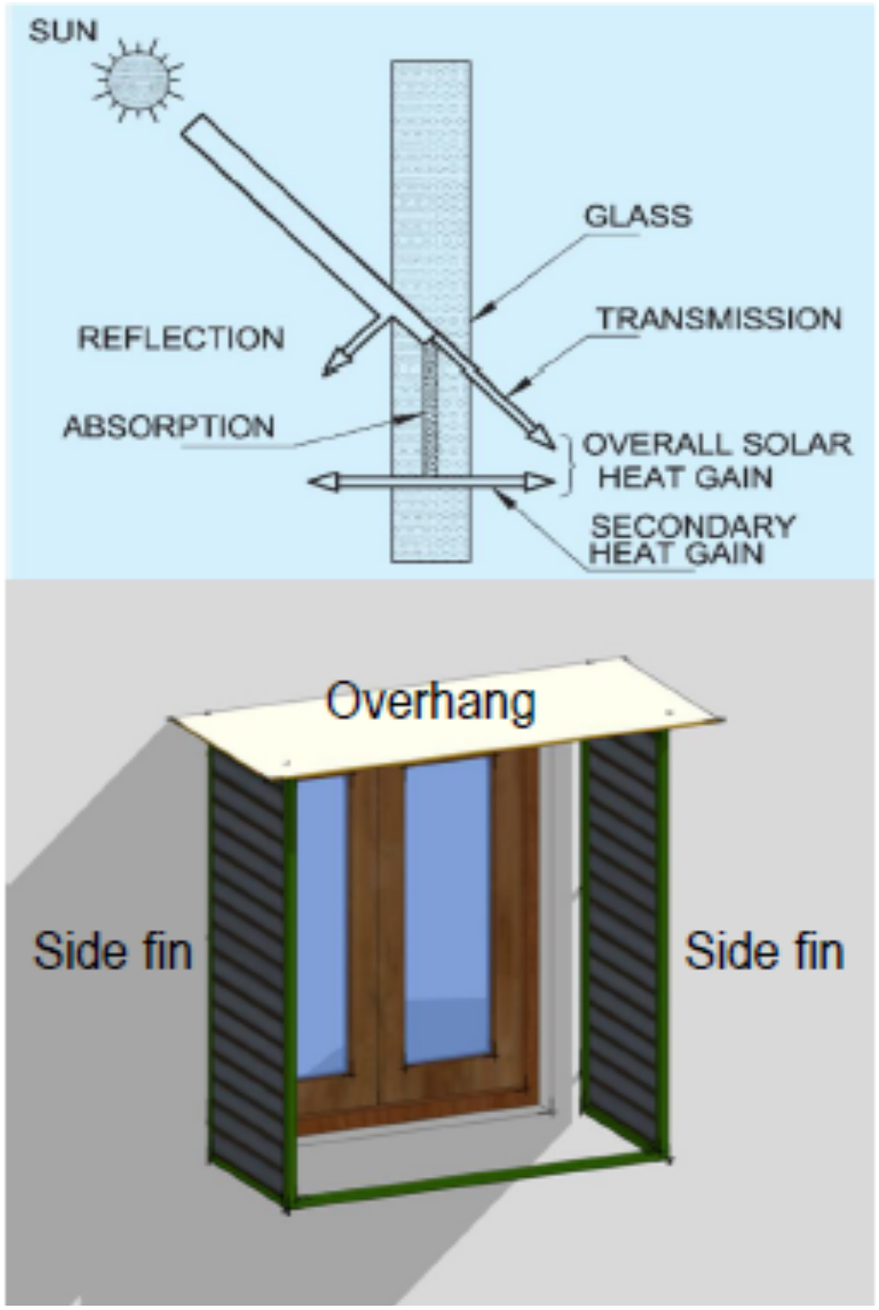


Plan



Section

3.4 Equivalent SHGC



$$SHGC_{\text{unshaded gain}} = \frac{\text{Transmission + Secondary heat}}{\text{Incident Solar radiation}}$$

External Shading (overhang,side fins)cut the solar radiation

External Shading Factor ($ESF_{total} \leq 1$) accounts the impact of shading.

$$SHGC_{eq} = SHGC_{unshaded} \times ESF_{total}$$

3.4 Equivalent SHGC

Orientation / $PF_{overhang}$	External Shading Factor for Overhang ($ESF_{overhang}$) for LAT < 23.5°N							
	North (337.6°–22.5°)	North-east (22.6°–67.5°)	East (67.6°–112.5°)	South-east (112.6°–157.5°)	South (157.6°–202.5°)	South-west (202.6°–247.5°)	West (247.6°–292.5°)	North-west (292.6°–337.5°)
<0.10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.10-0.19	0.931	0.924	0.922	0.910	0.896	0.910	0.922	0.924
0.20-0.29	0.888	0.864	0.855	0.834	0.816	0.834	0.854	0.864
0.30-0.39	0.860	0.818	0.797	0.771	0.754	0.771	0.796	0.818
0.40-0.49	0.838	0.782	0.747	0.721	0.708	0.720	0.746	0.782
0.50-0.59	0.820	0.755	0.705	0.682	0.675	0.681	0.705	0.755
0.60-0.69	0.806	0.734	0.670	0.651	0.653	0.651	0.670	0.734
0.70-0.79	0.793	0.718	0.641	0.628	0.638	0.627	0.640	0.717
0.80-0.89	0.783	0.706	0.616	0.610	0.628	0.609	0.615	0.705
0.90-0.99	0.775	0.696	0.596	0.596	0.621	0.596	0.595	0.695
≥1	0.768	0.688	0.579	0.585	0.616	0.585	0.578	0.688

$$SHGC_{eq} = SHGC_{unshaded} \times ESF_{total}$$

$$= 0.6 * 0.820$$

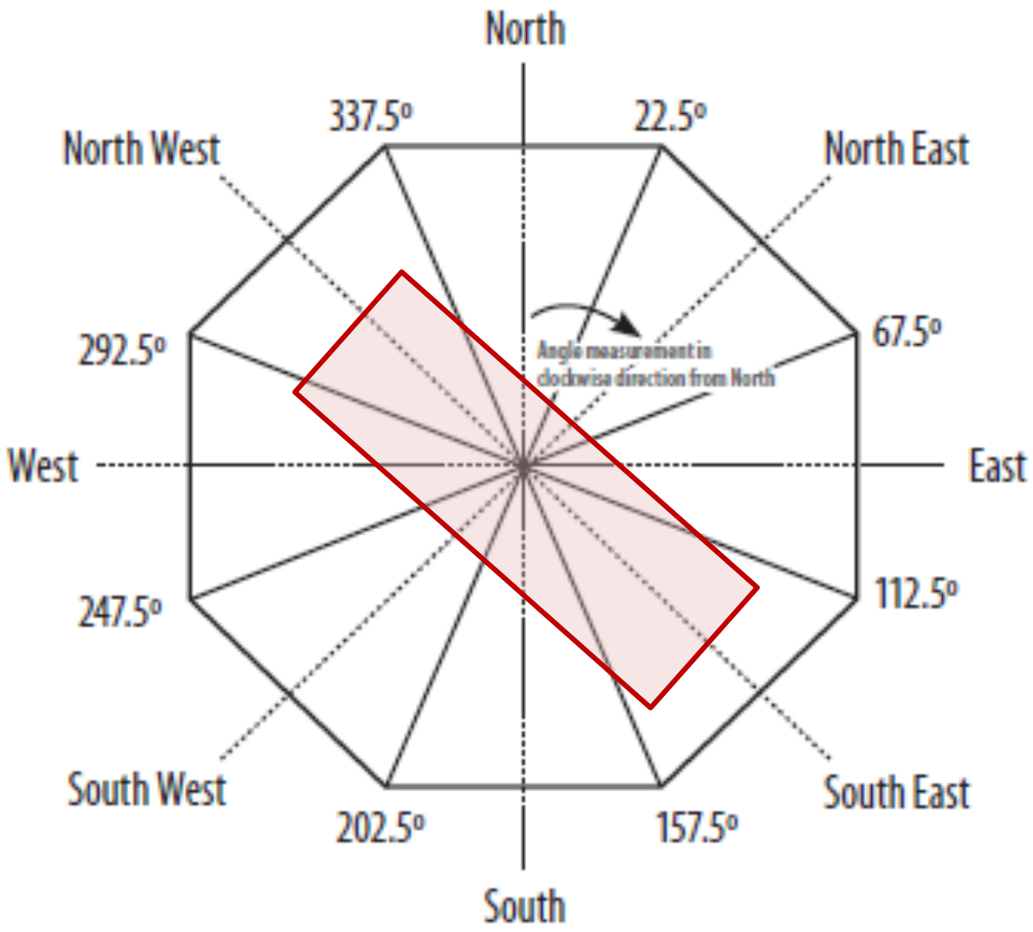
$$= 0.492$$

Source: Eco Niwas Samhita -2018, Table 11, Annexure

3.4 Orientation factor (ω)

The orientation factor (ω) is a measure of the amount of direct and diffused solar radiation that is received on the vertical surface in a specific orientation

Orientation	Orientation factor (ω) Latitudes <23.5°N
North (337.6°–22.5°)	0.659
North-east (22.6°–67.5°)	0.906
East (67.6°–112.5°)	1.155
South-east (112.6°–157.5°)	1.125
South (157.6°–202.5°)	0.966
South-west (202.6°–247.5°)	1.124
West (247.6°–292.5°)	1.156
North-west (292.6°–337.5°)	0.908



The building is oriented at 45 ° N, then the corresponding Orientation factor = 0.906

3.4 Residential Envelope Transmittance Value (RETV)

TABLE 3 Coefficients (a, b, and c) for RETV formula

Climate zone	a	b	c
Composite	6.06	1.85	68.99
Hot-Dry	6.06	1.85	68.99
Warm-Humid	5.15	1.31	65.21
Temperate	3.38	0.37	63.69
Cold	Not applicable (Refer Section 3.5)		

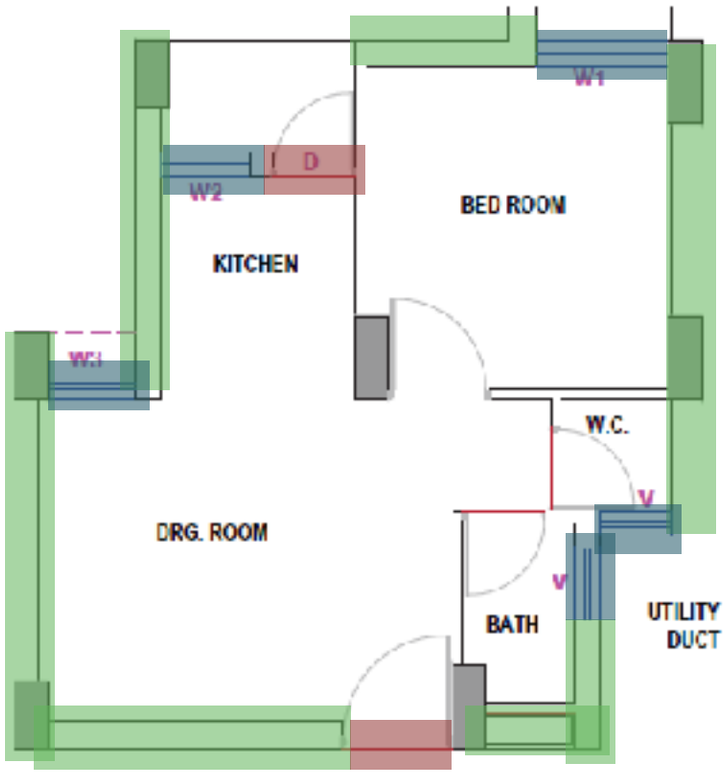
RETV for the building envelope (except roof) for four climate zones, namely, Composite Climate, Hot-Dry Climate, Warm-Humid Climate and Temperate

Climate shall comply with the maximum RETV of **15 W/m²**

3.5 Thermal Transmittance - Wall (Except roof) for Cold Climate (U envelope, cold)

$$U_{envelope,cold} = \frac{1}{A_{envelope}}\left[\sum_{i=1}^{n}(U_i \times A_i)\right]$$

➢The thermal transmittance of the building envelope (except roof) for cold climate shall comply with the maximum of **1.8 w/M²K**



	Area (sq mt)	U- value (w/ m²k)
Wall (opaque)	2793.38	0.78
Door (opaque)	210	5.23
Window (non-opaque)	475.88	5.80

AAC Wall
Wooden Door
Glass Window

$$U_{envelope,cold} = \frac{(2793.38 \times 0.78) + (210.00 \times 5.23) + (474.88 \times 5.80)}{2793.38 + 210.00 + 474.88} = 1.73 \ \mathbf{W/m^2.K}$$

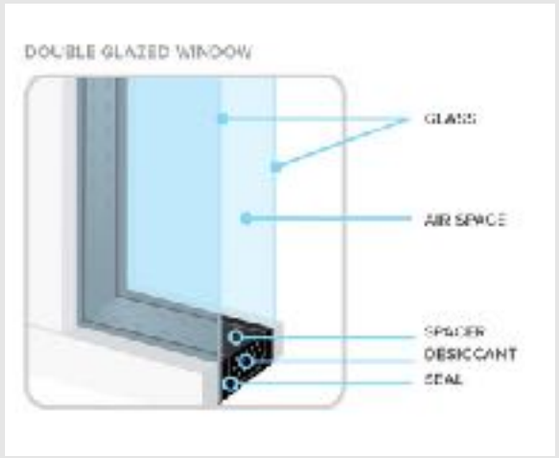
RETV Case - 1

Case 1	 	External wall	Roof Construction	Glazing	Window to wall Ratio
		230mm thick Solid Burnt Clay Brick	150 mm thick RCC slab + 50mm thick EPS	50 mm Steel Frame; Single glazed Unit U Value = 5.7 W/m2k, SHGC = 0.56, VLT=0.51	22.55%
		RETV - 14.92 W/m².K			

RETV Case - 2

Case 2	 	External wall	Roof Construction	Glazing	Window to wall Ratio
		200mm thick AAC Block wall	150 mm thick RCC slab + 50mm thick EPS	50 mm Steel Frame; Single glazed Unit U Value = 5.7 W/m2k, SHGC = 0.56, VLT=0.51	22.55%
		RETV - 9.71 W/m².K			

RETV Case - 3

Case 3		External wall	Roof Construction	Glazing	Window to wall Ratio
		200mm thick AAC Block wall	150 mm thick RCC slab + 50mm thick EPS	Double glazed Unit - Asahi LC 54/37 U Value = 1.64 W/m2k, SHGC = 0.36, VLT=0.52	22.55%
		**RETV - 6.62 W/m².K**			

RETV Case - 4

Case 4		External wall	Roof Construction	Glazing	Window to wall Ratio
		200mm thick AAC wall, 50 mm EPS, high SRI paint	150 mm thick RCC slab + 50mm thick EPS	Double glazed Unit - Asahi LC 54/37 U Value = 1.64 W/m2k, SHGC = 0.36, VLT=0.52	22.55%
					
		RETV - 5.13 W/m².K			

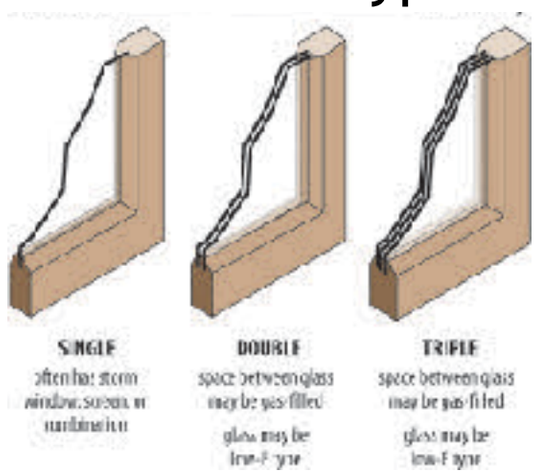
Building Design Flexibility by ENS

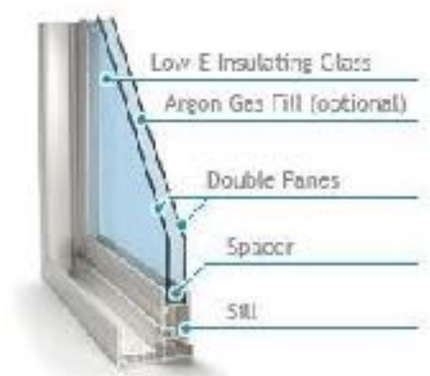
Material wall Assembly

Design of Window Panel

Shading of external Windows

Type of glazing

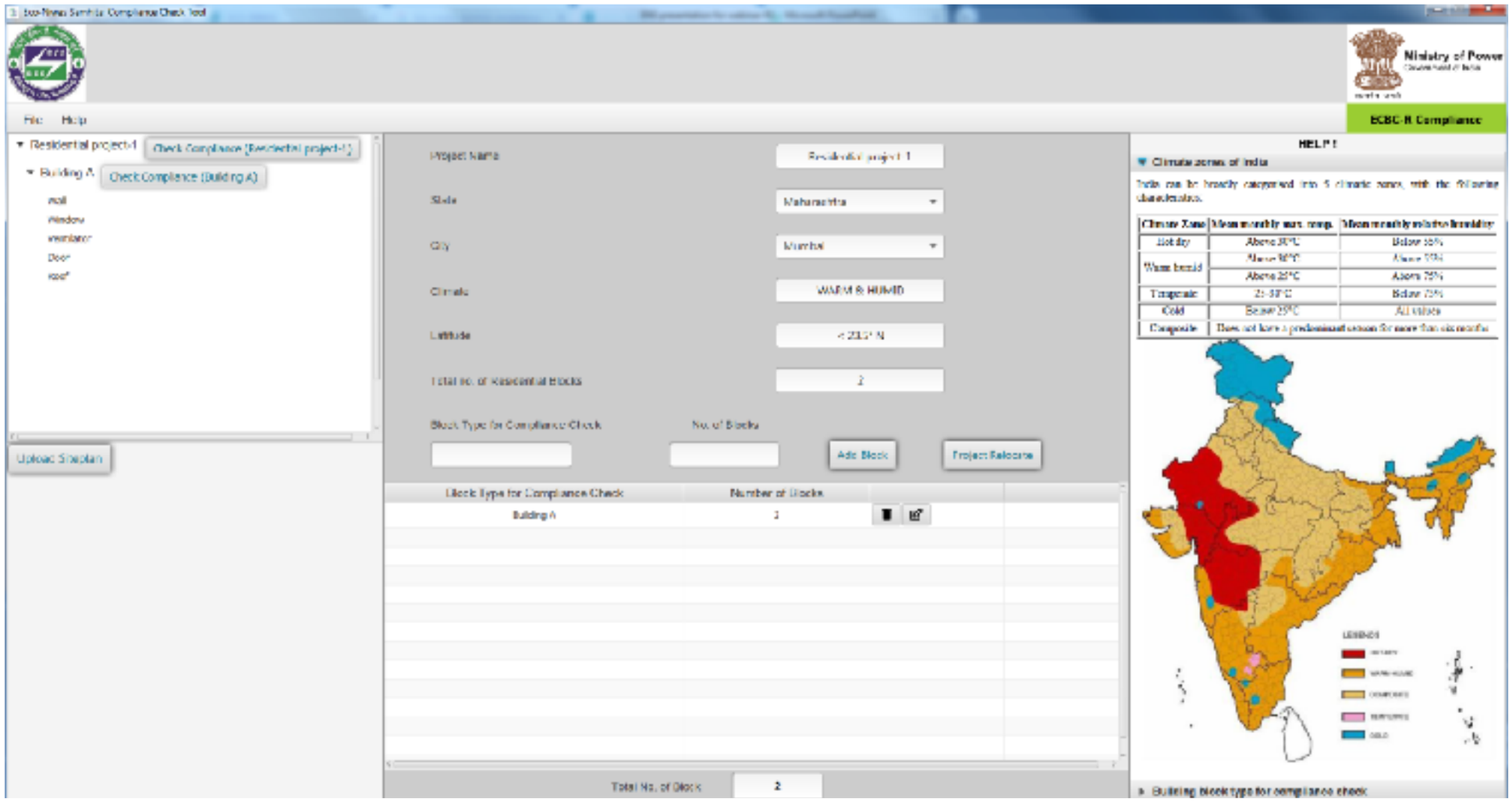




Eco-Niwas Samhita Compliance Approach Tool

Eco Niwas Samhita – Compliance Tool

Java based ENS compliance check tool has been developed to check compliance for residential project.

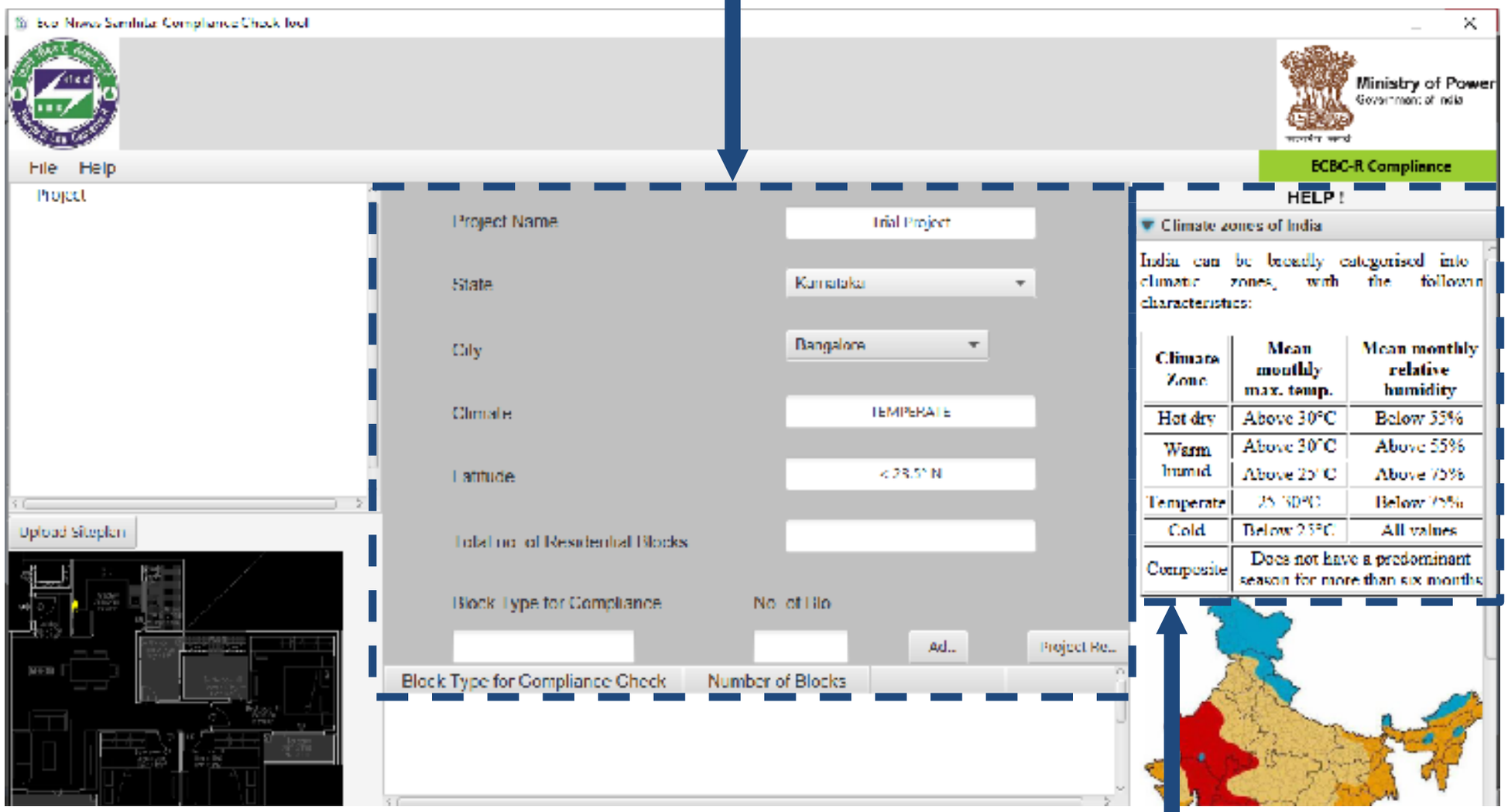


Available on Bureau of Energy Efficiency's website for download.

Link - https://beeindia.gov.in/content/ecbc-residential

Eco Niwas Samhita – Compliance Tool

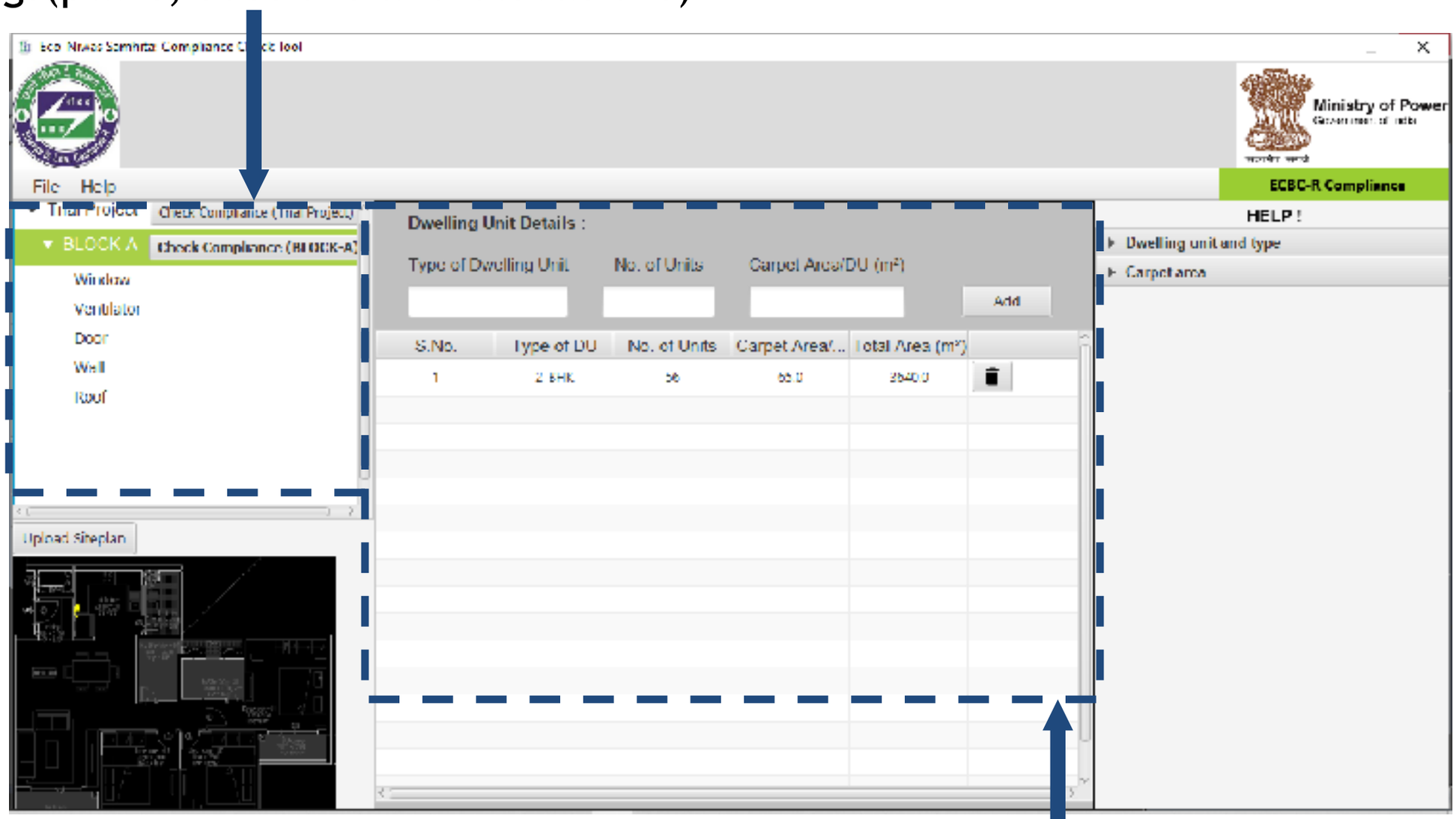
Project related details are entered in the tool for compliance check



Climate data after entering the project location details

Eco Niwas Samhita – Compliance Tool

Details of various building components will be added for Compliance check- Architectural drawings(plans, sections and elevations)



Details of the blocks are submitted and can be seen here

Eco Niwas Samhita – Compliance Tool

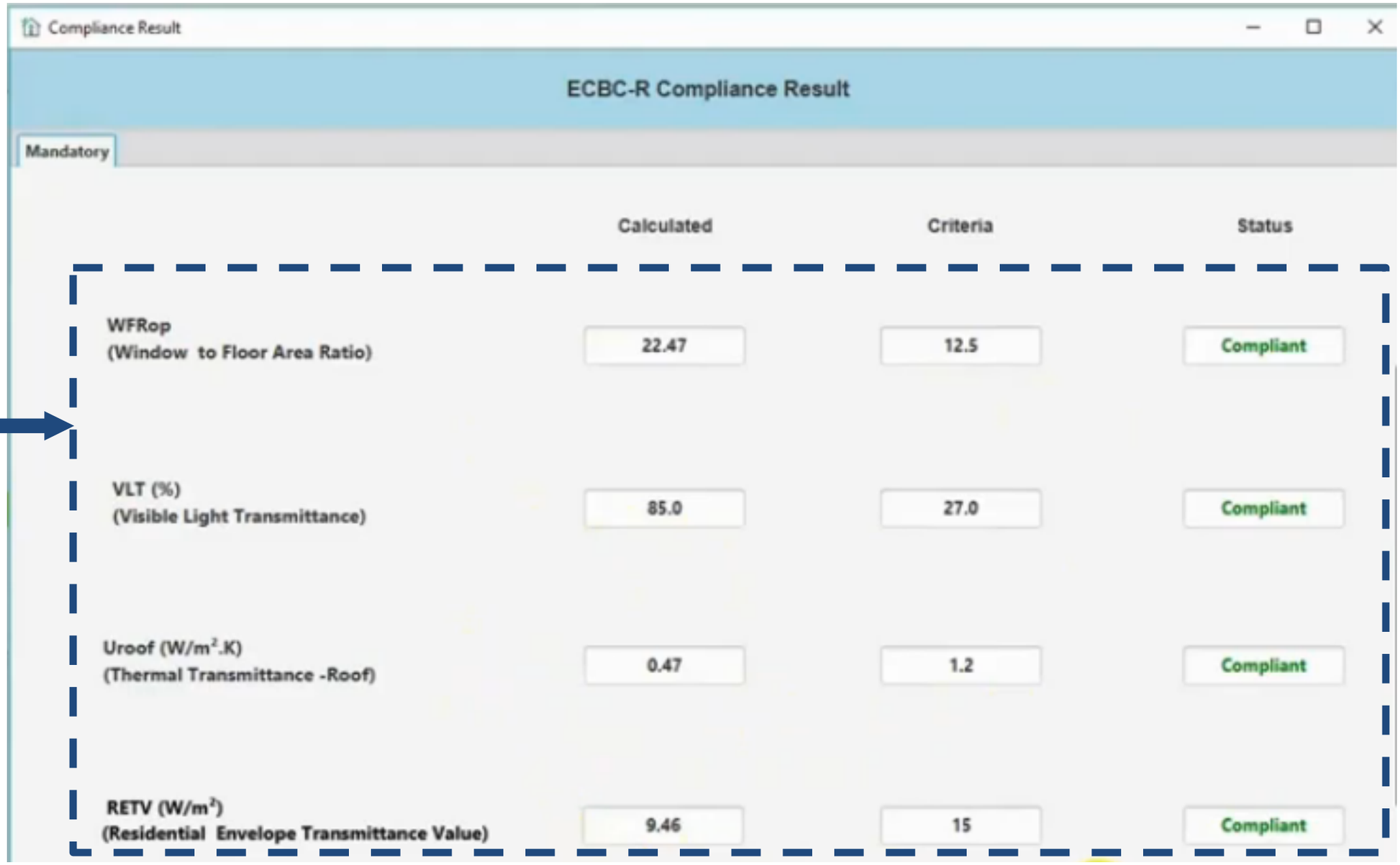
Construction material details are entered in the tool. Window details are shown here for example

All the details related to window are submitted for the compliance

Similarly, other block details are added in the table for checking different design alternatives

Eco Niwas Samhita – Compliance Tool

Result of the compliance of code provisions shown



A report is generated once all the design provisions are complaint to the code

Generate Report

Implemented by

Supported by

Thank You

Knowledge Partner