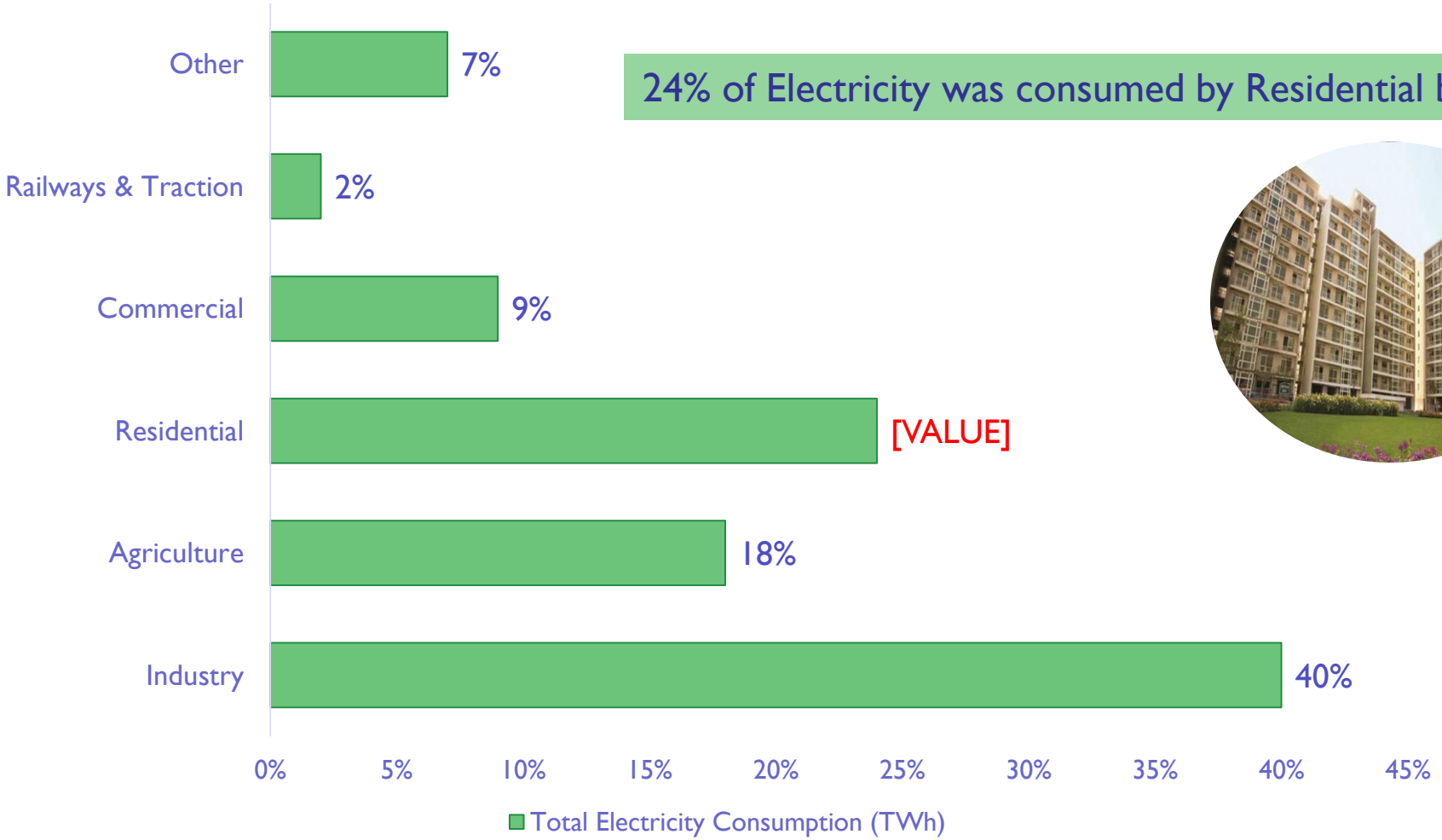
Energy Conservation Building Code for Residential Building Eco-Niwas Samhita 2018

Understanding of Eco-Niwas Samhita 2018

Electricity consumption pattern in India

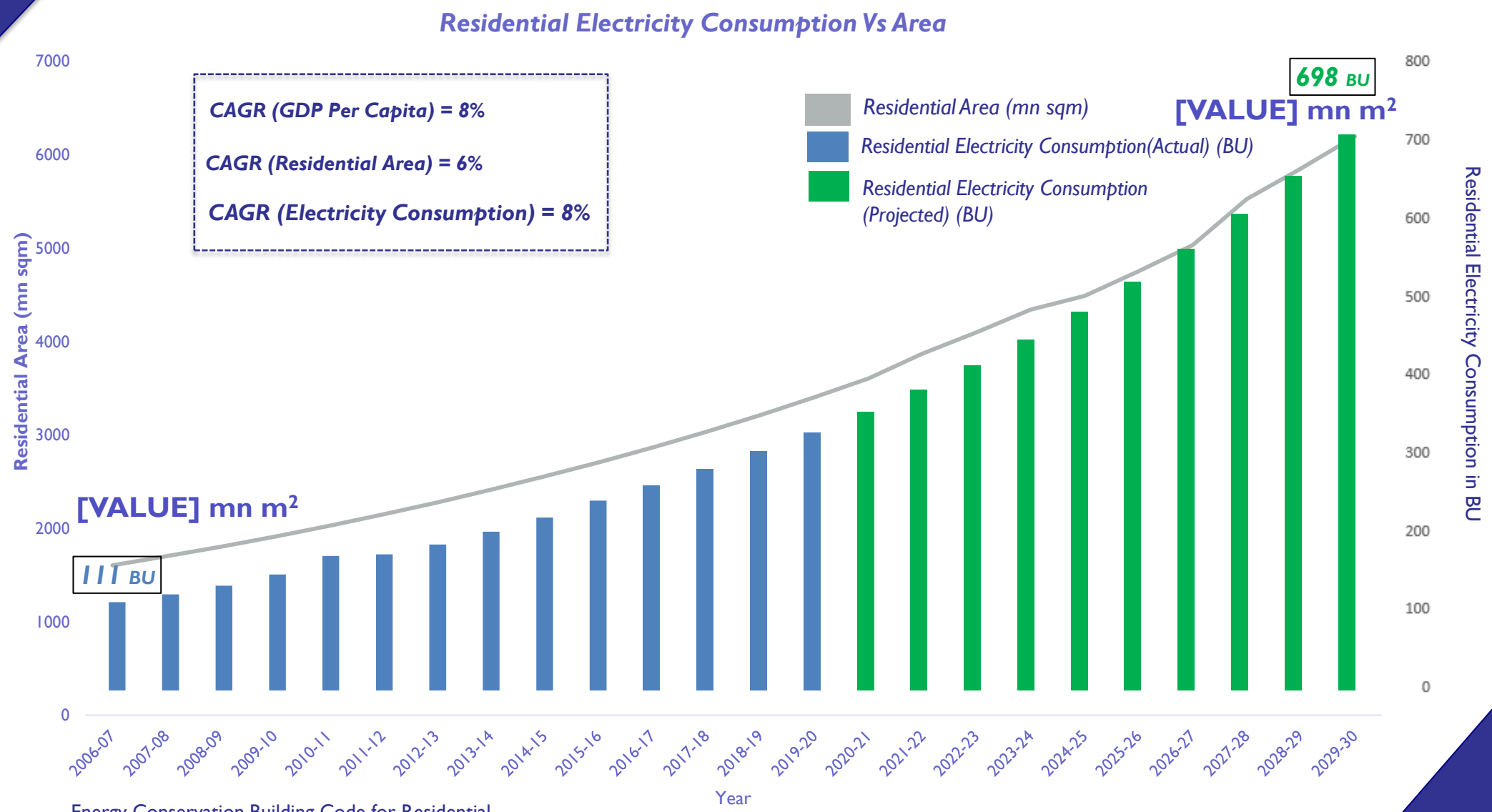
TOTAL ELECTRICITY CONSUMPTION 1066 (BU) IN 2016-17



24% of Electricity was consumed by Residential buildings.

Source: Energy Statistics 2018

Building Sector - Built up area and electricity consumption projection



Energy Conservation Building Code for Residential BuildingEco-Niwas Samhita 2018

Introduction of Eco-Niwas Samhita 2018

Why Eco-Niwas Samhita has been created?

- **Built Up Area -** India will add 3 Billion m^2 by 2030 of New residential building w.r.t Year 2018
- **Energy Demand -** There is a 4 times increase in energy demand for residential units from 1996 – 2016
- Projections show energy demand will be approximately between 630 TWh and 940 TWh by 2032

Source: Eco-Niwas Samhita 2018

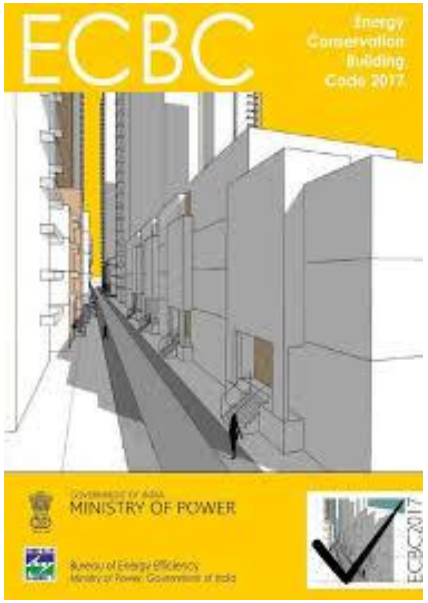
What is Eco-Niwas Samhita 2018?

- ECO-Niwas Samhita 2018 - an Energy Conservation Building Code for Residential Buildings.
- Launched on National Energy Conservation Day in 2018.
- Applicable to all residential units with plot area ≥500m^2 (However, states and municipal bodies may reduce the plot area so that maximum residential buildings fall in the category of ENS compliance)

Other Existing Government initiatives

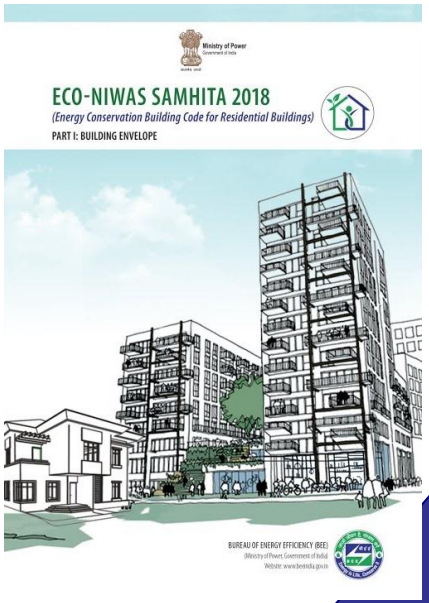
Energy Conservation Building Code (ECBC)

- The ECBC sets minimum energy performance standards for commercial buildings.
- ECBC defines norms of Energy performance for various building components and takes into consideration the climatic region.

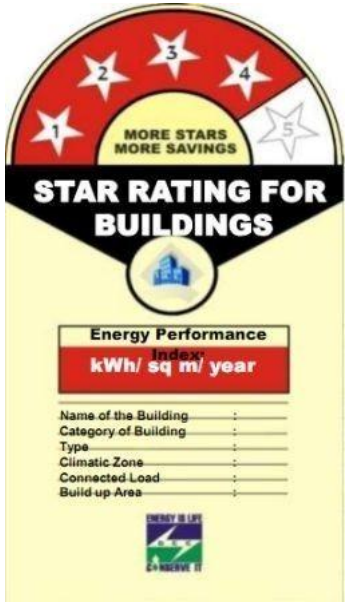


Eco-Niwas Samhita 2018

- Energy Conservation Building Code for Residential Buildings



Other Existing Government initiatives

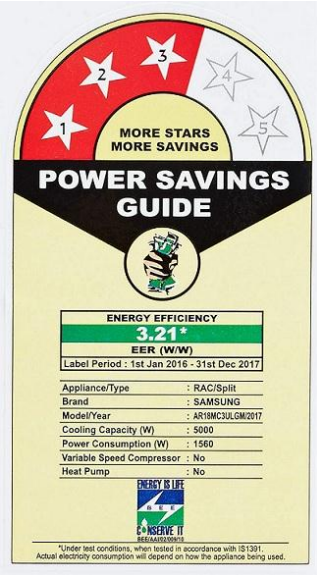


BEE star rating programme for Office buildings.

- BEE has developed a star rating programme for buildings which is based on the actual performance of a building in terms of its specific energy usage in kwh / m² / year. This programme rates commercial office buildings on the scale of 1 - 5 star, with 5 Star labelled buildings being the most efficient.

BEE star rating programme for electrical appliance.

- The star rating is a measure of energy efficiency of an appliance, it is a five points scale where higher the rating, lower is the energy consumed by appliance. The programme has been launched for various appliances such as refrigerators, AC's, geysers, washing machine etc.



New Government initiatives

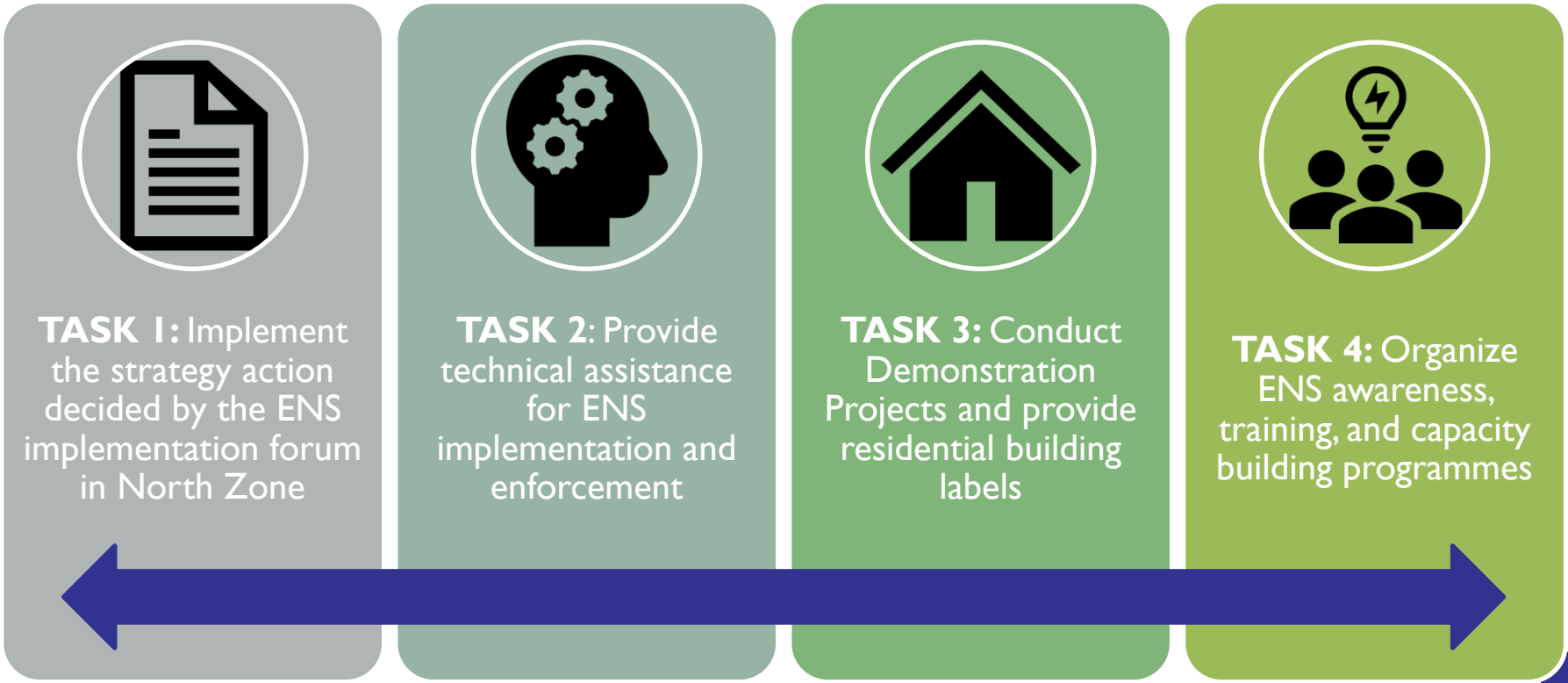
Policies & Regulations-Residential

- Eco-Niwas Samhita (ECBC-R) Part -I
- Star Rating for Buildings (Building Label)

About Eco-Niwas Samhita

Our Program

- The project aims to support the 5 states of India (Delhi, Punjab, Uttar Pradesh, Karnataka, Maharashtra) to implement Eco Niwas Samhita (ENS) developed by the Bureau of Energy Efficiency (BEE), Ministry of Power.
- PwC will be supporting 3 states for establishing ENS cell in respective states.
- ENS Cell has been established by PwC, under PEDA to achieve the following objectives:

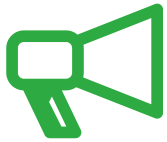


Understanding Eco-Niwas Samhita

Why should developers go for Energy Efficiency?

Marketing, Branding and Recognition

- Studies show that EE homes are sold at higher sale price and lease rates



Add value to the developments

- With implementation at design Stage, ENS compliant buildings can be built at the same cost as conventional buildings with minimum upfront capital cost

Increased Saleability

- In many markets across the globe EE homes sell quicker and at a premium than comparable non EE homes

Recognition from Government for contribution towards National Goals

- Help developers comply with soon to be mandated ENS Code and label throughout the State

Why would end users buy EE homes?

Reduced Health hazards due to Improved Health and Wellbeing specially in the current time of COVID

- ENS Compliant buildings will enhance natural and cross ventilation and provide ample natural daylight

Improved Comfort and productivity

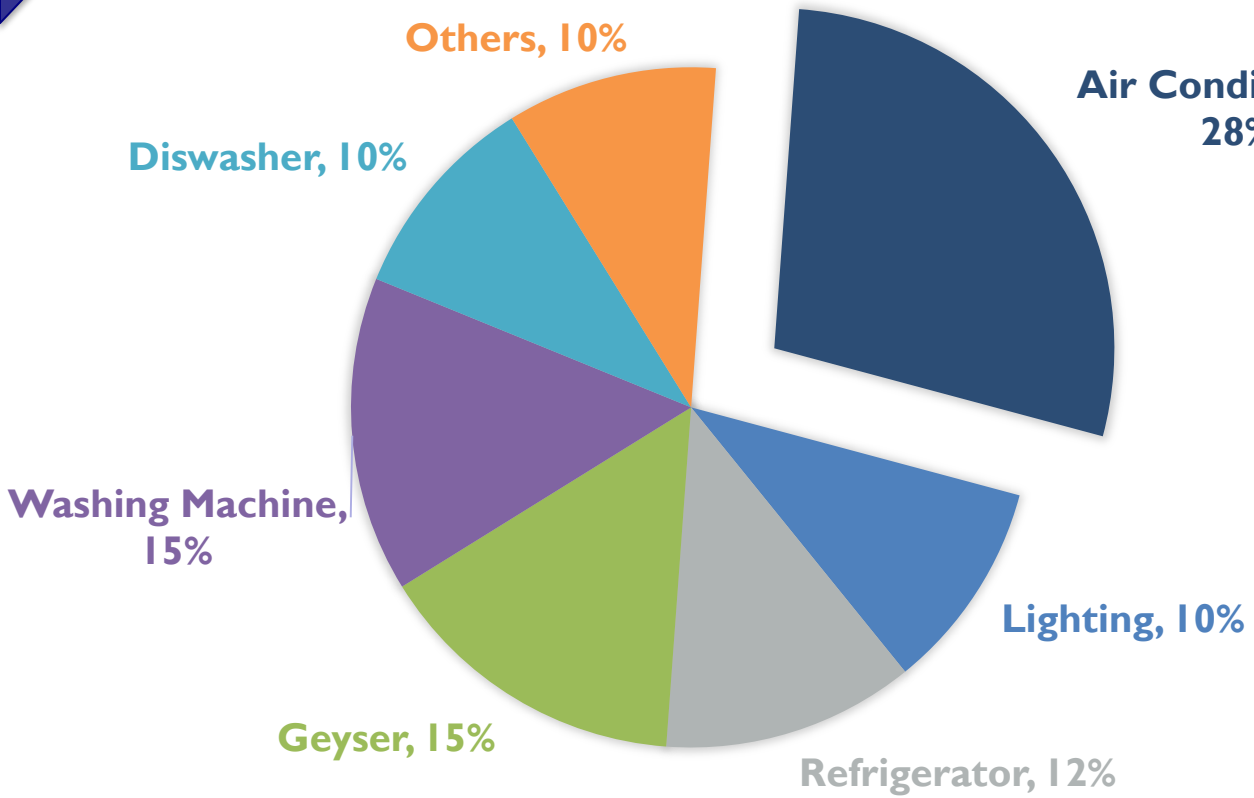
- Use of building materials which ensure comfort in all seasons and enhance living experience of residents

Financial Savings

- Reduce energy bills by minimum 20% every month until the life of the building. Investment in EE offers significant returns in comparison to convectional buildings.

Increase property value

Energy distribution pattern in typical home



Maximum energy consumption in a typical home is from Air conditioning

Source: IGBC Green Homes

Energy distribution pattern in typical home

To provide comfort, we started relying on mechanical systems and artificial lighting which consume a lot of energy. This has created an abnormal increase in the **energy demand**.

This has led to a drastic **increase** in electricity bills of the homes.

Ways to reduce the energy demand of a building

High amount of electricity is required to remove the heat gain in a building and to maintain indoor thermal comfort level in the building.

Ways to reduce energy demand of a building

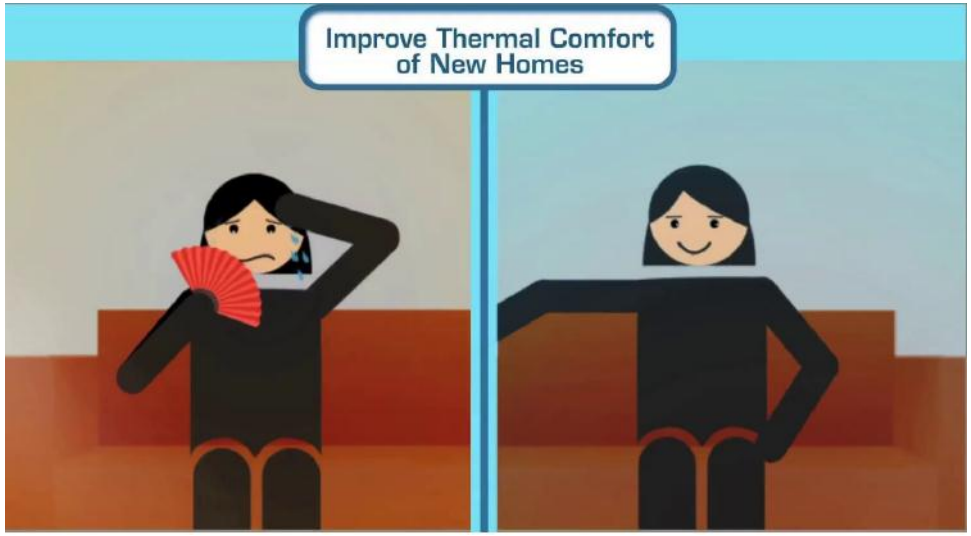
- **Climate Responsive Building Design**
- **Efficient Building Envelope Design**
- **Use of efficient appliances like air conditioning system, lighting etc**
- **Proper maintenance of the electrical appliances**

To address the above factors, Eco Niwas Samhita was created

Launch of Eco-Niwas Samhita 2018

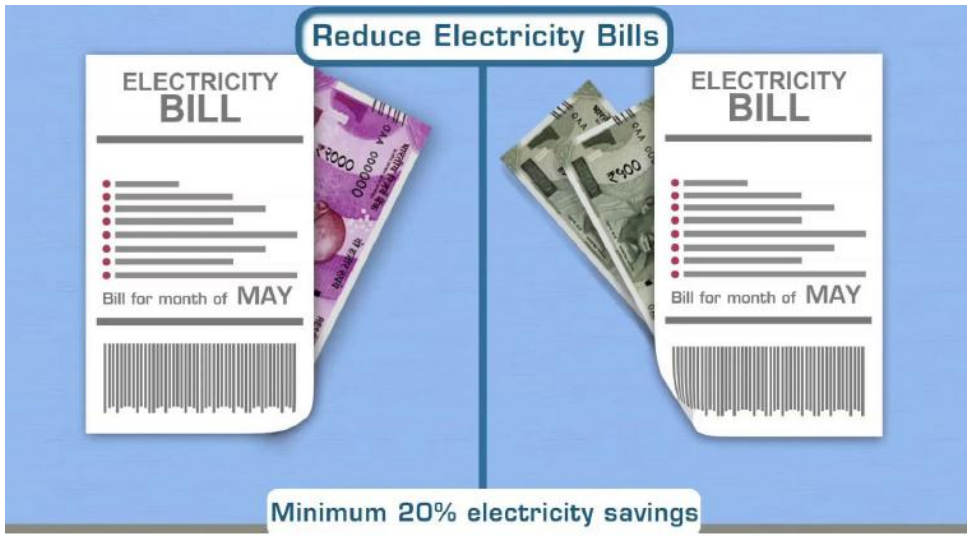
Eco-Niwas Samhita 2018 (Part I: Building Envelope) is the New ECBC for Residential Buildings, launched by Ministry of Power (MoP) on 14 December 2018.

Impact Assessment of Part I



Estimated Savings 2018 – 2030

- Minimum 20% Cooling Energy
- 125 billion kWh Electricity
- 100 million Tons of CO2 Equivalent

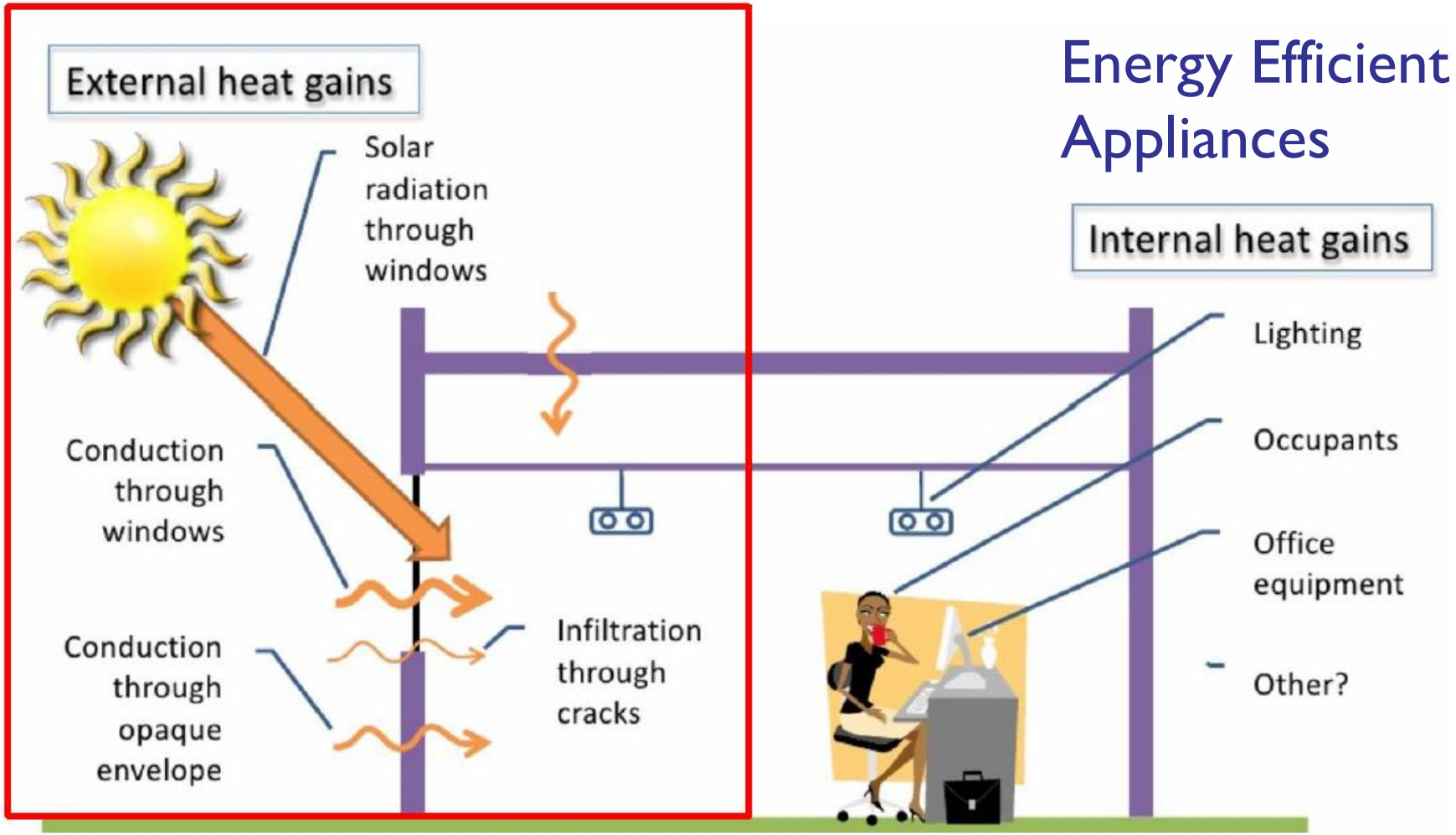


- Improved Thermal Comfort and daylighting for residents

Building Envelope

Sources for heat gain in a building

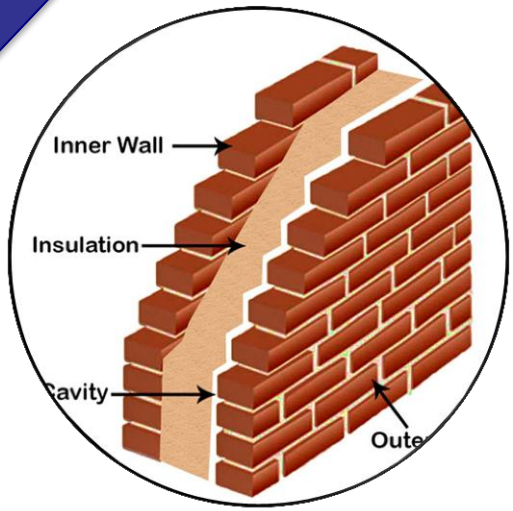
Design and Material Selection



Energy Efficient Appliances

Building envelope design is the key of energy efficient residential buildings

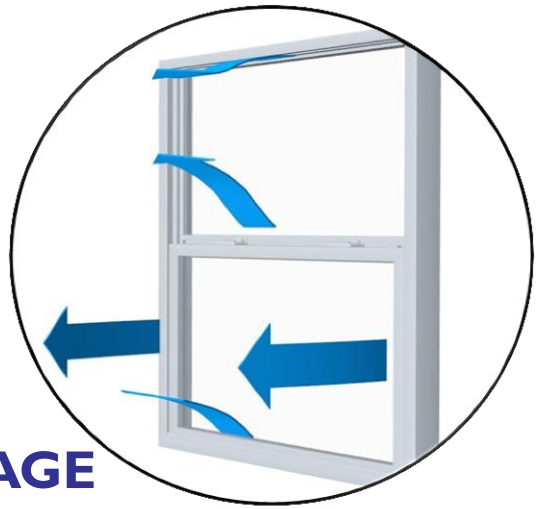
Understand the heat gain through envelope in the building



WALL
15-25%

ROOF
25-35%

GLAZING
25-35%



AIR LEAKAGE
5-10%

What is U- Value ?

Definition:

Thermal transmittance is the rate of heat transfer through materials

Unit of U-Value : W/(m²K)

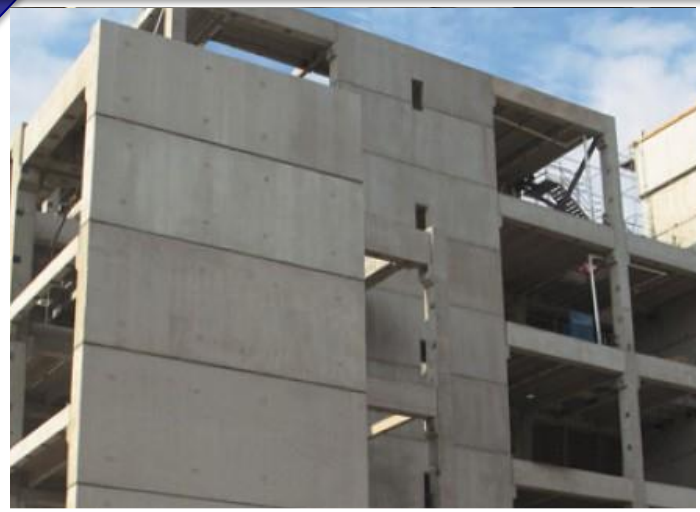
$$\text{U-Value} = \frac{1}{Thermal\ Resistance\ of\ a\ material\ (R)}$$

$$\text{Where R} = \frac{Thickness\ of\ material\ (t)}{Conductivity\ (k)}$$

Conductivity (k) is the rate at which heat travels through 1 meter thick material. It is a property of a material

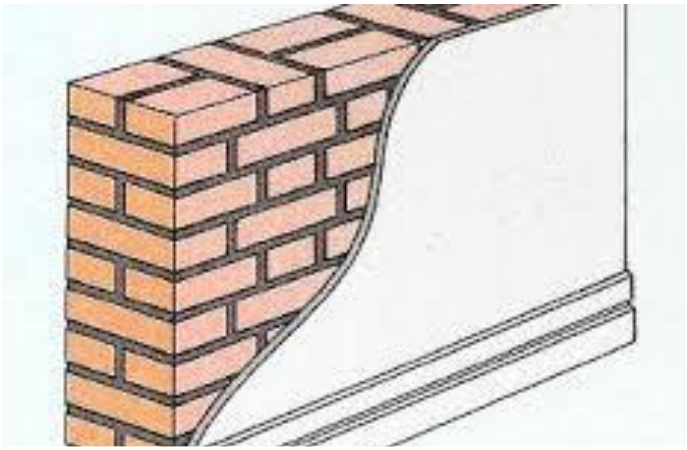
The lower the U-value, the lower is the heat gain/loss in the building.

Types of wall & their U Value



150 mm RCC (No plaster)
U Value 3.77 W/m^{2}K

200 mm Solid Concrete Block with 15 mm plaster on both sides –
U Value 2.8 W/m^{2}K



230 mm Brick with 15 mm plaster on both sides
U Value 1.72 - 2.24 W/m^{2}K

Types of wall & their U Value

200 mm Autoclaved Aerated Concrete (AAC) with 15 mm plaster on both side
U Value 0.77 W/m^{2}K

300 mm Autoclaved Aerated Concrete (AAC) with 15 mm plaster on both sides
U Value 0.54 W/m^{2}K

Different type of bricks

Concrete hollow bricks (k=0.143 W/mK)

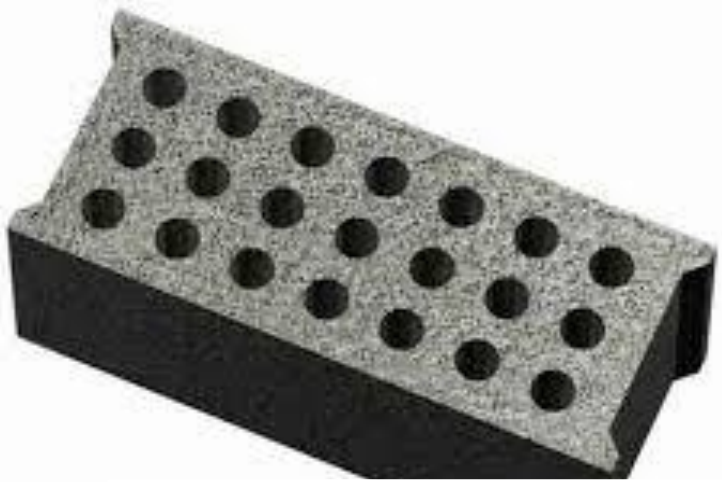
Perforated clay bricks (k=0.63 W/mK)

Autoclaved aerated concrete (k=0.189 W/mK)

Concrete solid bricks (k=1.4 W/mK)

Different type of bricks

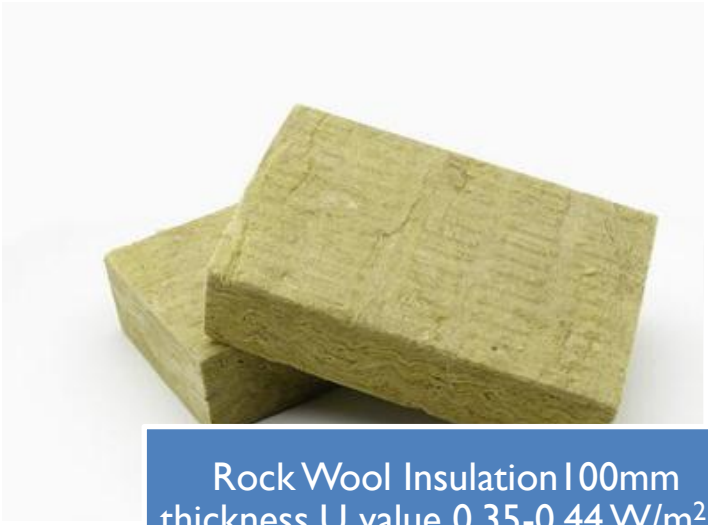
Fly ash bricks
(k=0.2-0.4 W/mK)



Perforated concrete blocks (k=0.1-0.2 W/mK)

Common Types of Insulation & their U Value

Glass Wool Insulation 100mm thickness U value 0.32-0.44 W/m^{2}K



Rock Wool Insulation 100mm thickness U value 0.35-0.44 W/m^{2}K

Extruded Polystyrene Insulation 100mm thickness U value 0.29-0.36 W/m^{2}K

Polyurethane foam board Insulation 100mm thickness U value 0.22-0.29W/m^{2}K

Benefits of Thermal Insulation

Maintains temperature, the room feels cooler in summer and warmer in winter.

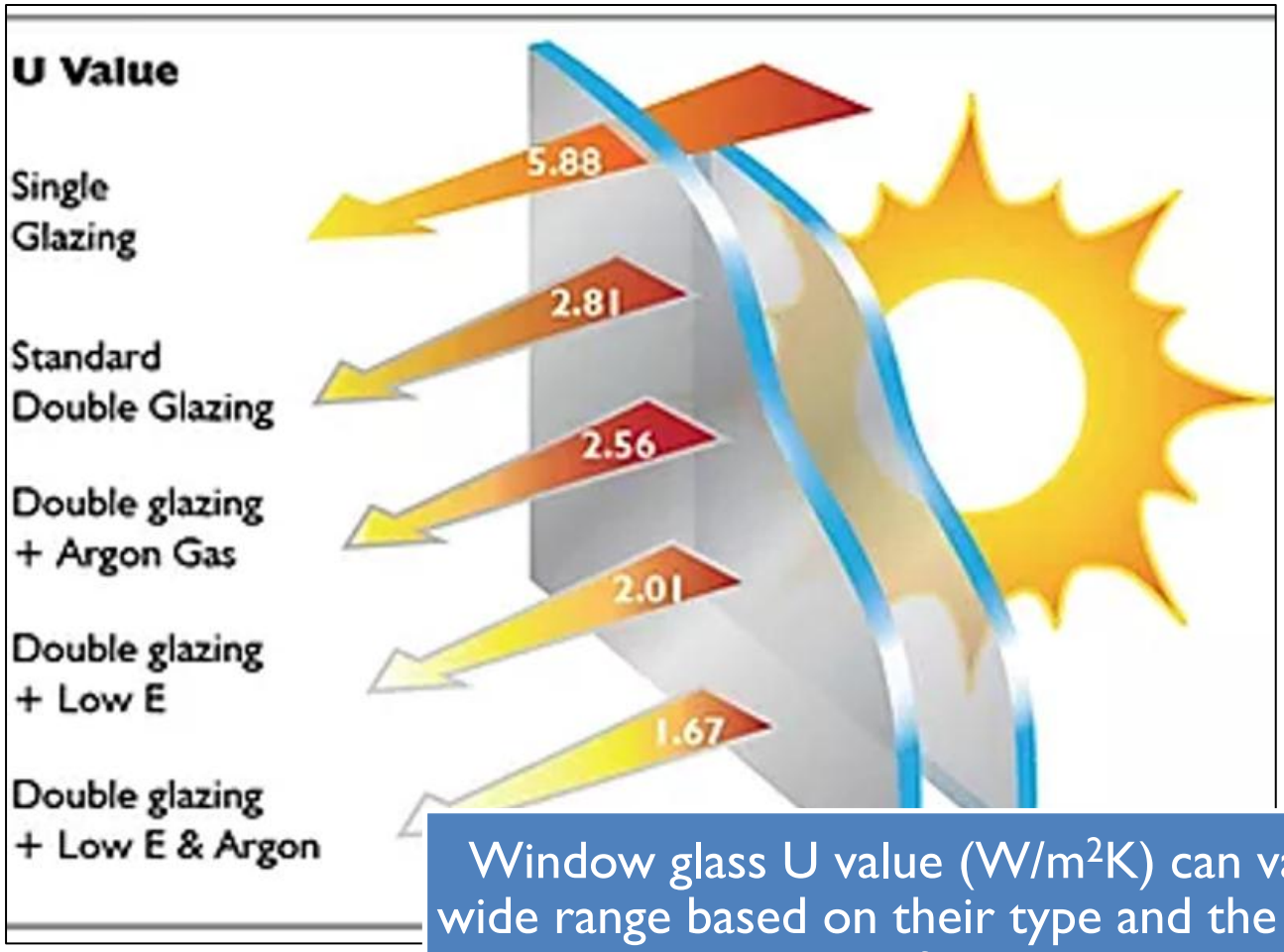
Reduce energy consumption and hence, cut down utility bills.

Reduces thermal stress on the roofs and prevents cracks of the roof.

It is an easy and cost-effective solution

Non-toxic and eco-friendly solution

Types of glass & their U Value range



Window glass U value (W/m^2K) can vary to wide range based on their type and the type of manufactures

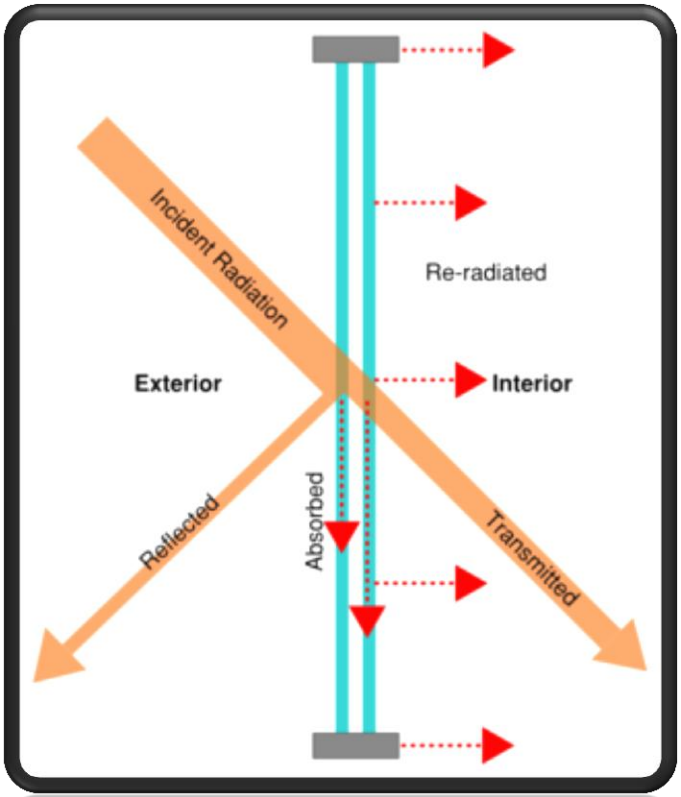
What is SHGC

Solar Heat Gain Coefficient

Definition:

SHGC is the fraction of incident solar radiation admitted through a window, both directly transmitted and absorbed and subsequently released inward.

The value of SHGC varies from 0 - 1



What is VLT

VLT is Visual Light Transmittance

Definition:

The amount of light in the visible portion of the spectrum that passes through a glazed material.

5% **15%** **20%** **30%** **35%** **50%** **75%**

Higher the VLT, more is the daylight received inside the building through glass.

Sample glass cutsheet

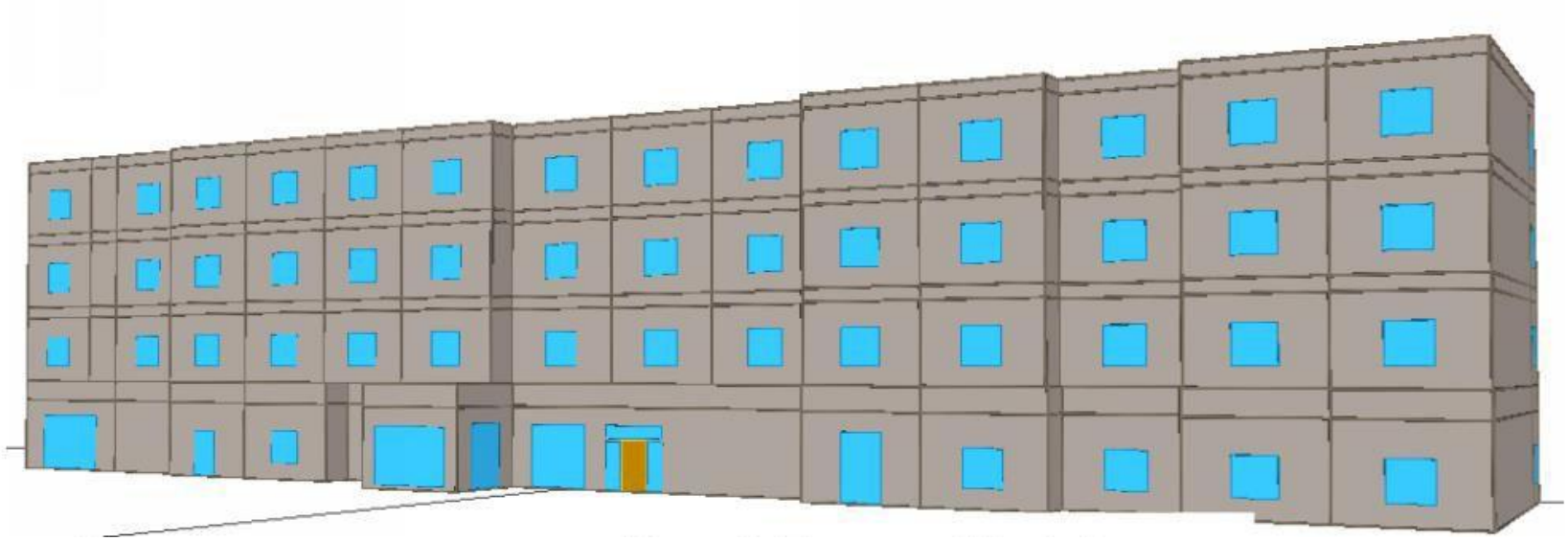
From where can we obtain the VLT, SHGC & U-Value of the Glass?

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

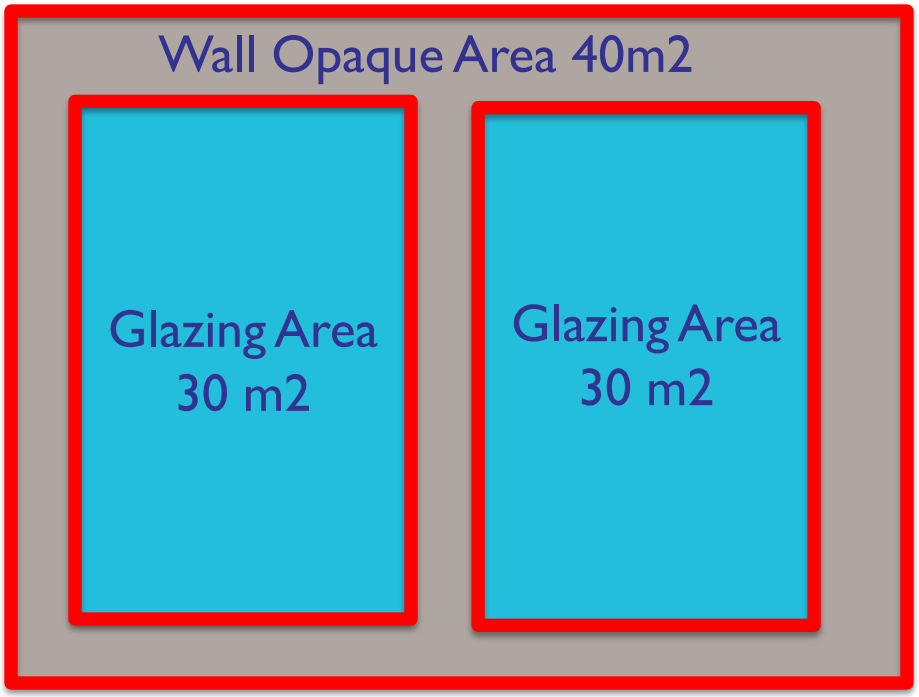
VLT of a Glass can be obtained from the Glass cut sheet available with all Glass manufacturers

What is Window to Wall Ratio (WWR)

$$WWR = \frac{Area\ of\ Non-Opaque\ Windows\ \&\ Openings}{Total\ Area\ of\ Exterior\ Walls\ Including\ Windows\ \&\ Openings}$$



WWR Sample calculation



$$WWR = \frac{30 + 30}{40 + 30 + 30}$$

$$WWR = \frac{60}{100}$$

$$WWR = 0.6$$

$$= 60\%$$

Code Compliance : VLT & WWR

Minimum VLT shall not be less than the values given in Table below:-

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

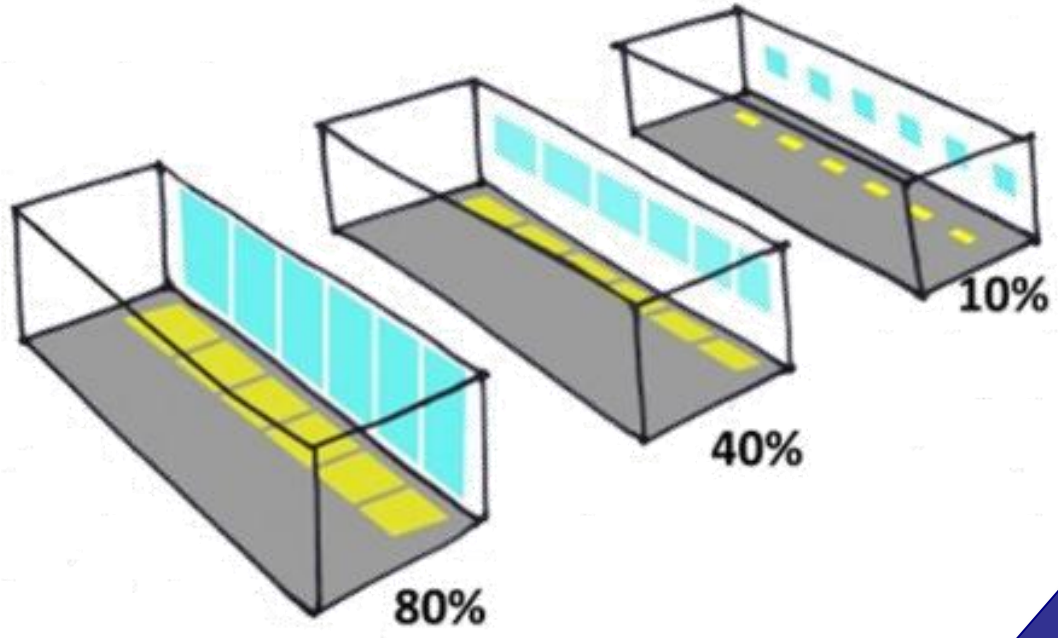
Window to Floor Area Ratio

WFR_{OP} is Openable Window to Floor Area Ratio

Definition:

The openable window-to-floor area ratio (WFR_{op}) is the ratio of openable area to the carpet area of dwelling units.

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



WFR Sample Calculation

Calculation:

$$WFR = \frac{54}{100}$$

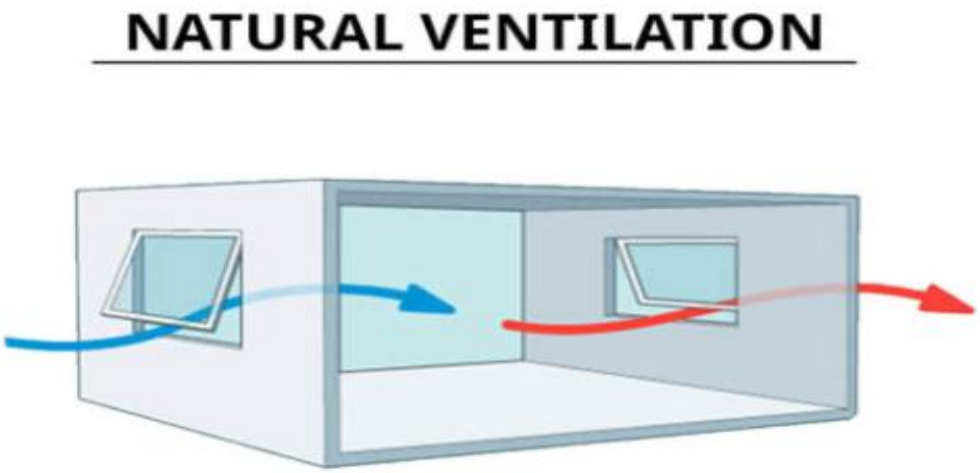
$$WFR = 0.54$$

$$= 54\%$$

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

Higher WFR_{op} helps in enhancement in

- Natural cross ventilation in building which can also help in reduce the spread of Coronavirus
- Thermal comfort can be achieved with minimal use AC in ENS compliant buildings.



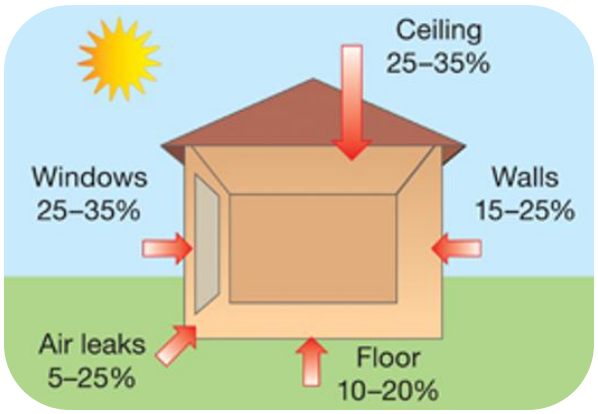
Openable Window-to-Floor Area Ratio (WFR_{op})

Climatic Zone	Minimum percentage (%) of WFR_{op}
Composite	12.50
Hot-Dry	10.00
Warm - Humid	16.66
Temperate	12.50
Cold	8.33

ENS Part I - Building Envelope and It's components

Code Compliance Requirements - Envelope

Transparency



Heat Transmission

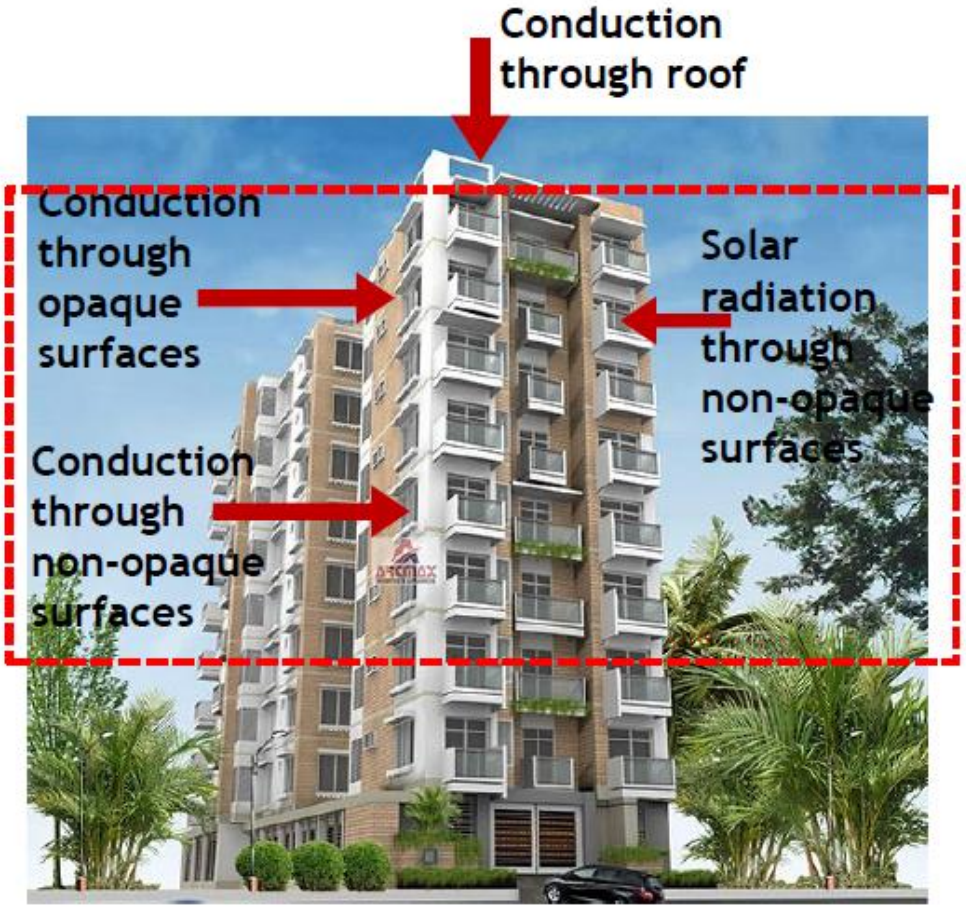
Ventilation

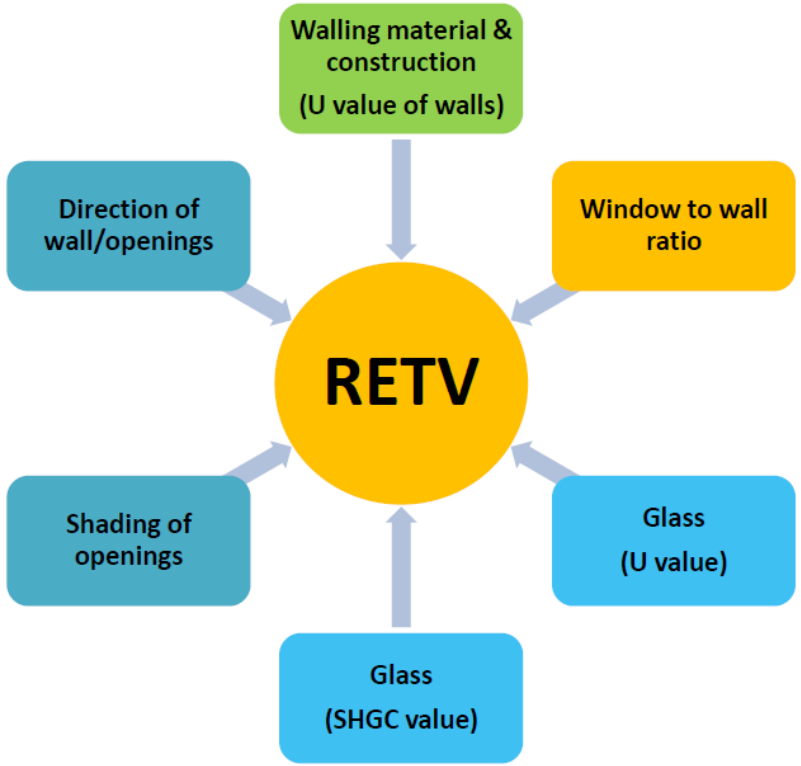
1. Window to Wall Ratio
2. Visual Light Transmittance

3. U-Value of Walls
4. U-Value of Windows
5. Solar Heat Gain Coefficient
6. U-Value of Roofs

7. Window to Floor Area Ratio

Residential Envelope Transmittance Value (RETV) for building envelope (except roof)





Residential Envelope Transmittance Value (RETV)

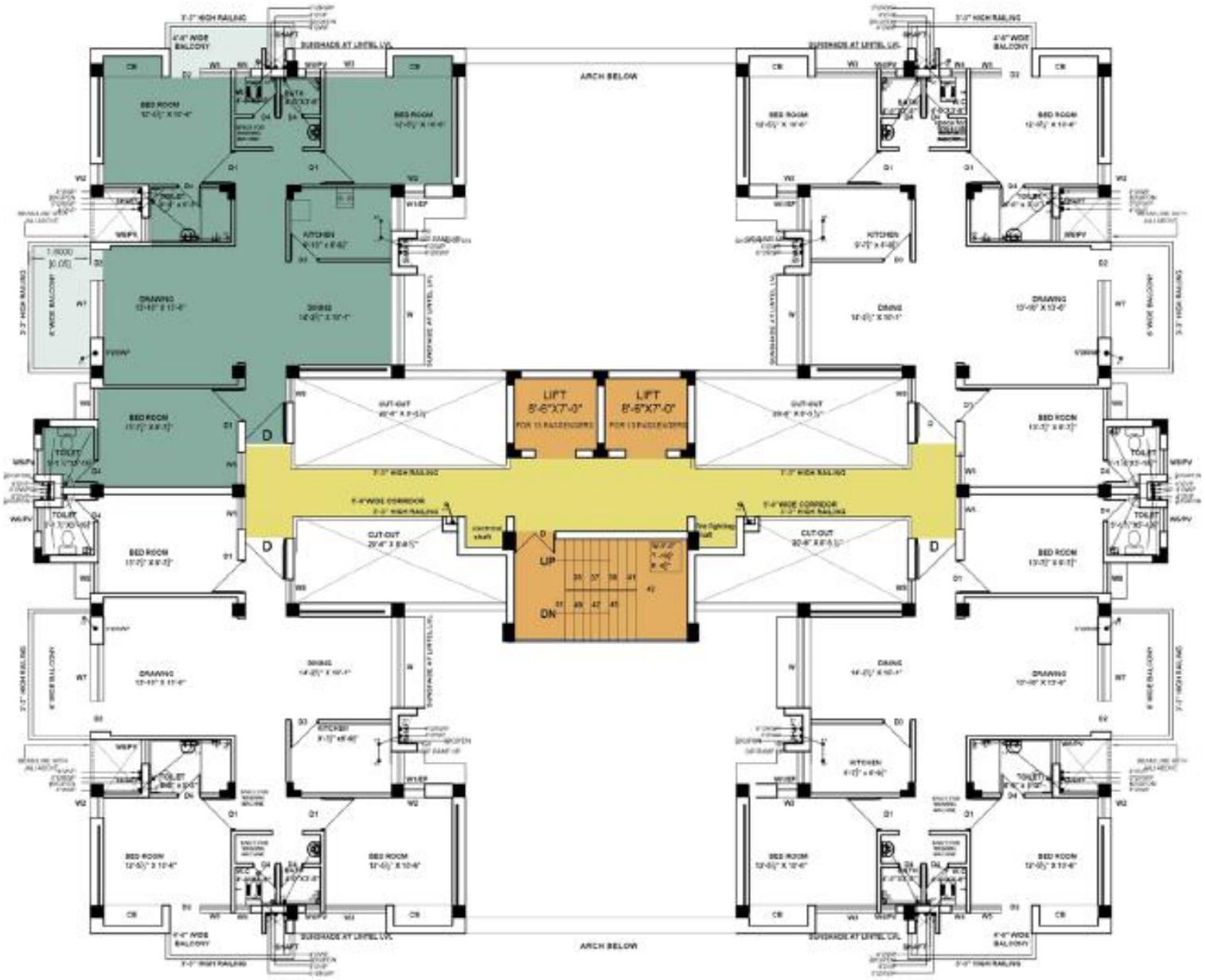
The RETV of the building envelope (except roof) for four climate zones, namely, Composite Climate, Hot-Dry Climate, Warm-Humid Climate, and Temperate Climate, shall comply with the maximum **RETV of 15 W/m²**

Eco-Niwas Samhita - Case Study

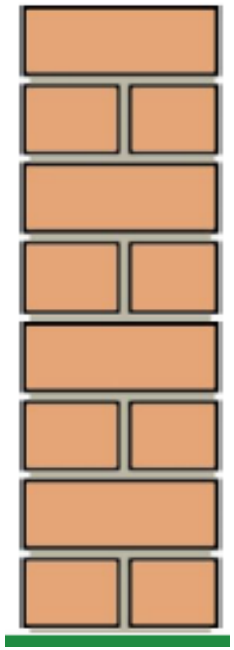
Case study project details

- Case study project is a residential quarters built for the NABARD *(National Bank For Agriculture & Rural Development)* staff at Mohali.
- The climate type is composite and is similar to that of Chandigarh.
- **No. of dwelling units in Block II (DU): 20 (all 2 BHK) Stilt + 5 storeys**

Floor Plan layout of the NABARD project



Case I: 230 mm brick wall + Normal WWR + Single Clear Glazing + No Shading of Windows

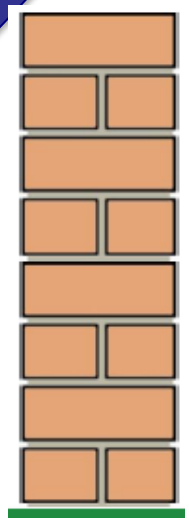


230mm Normal Brick wall with U value – 2 w/m^{2}k

	RETV (I Term) Wall conduction	RETV (II Term) Window conduction	RETV (III Term) Window transmittance	RETV (TOTAL)
Case.I • Brick Wall • No Shading • Single clear glazing • WWR: ~14%	10.1	1.8	9.6	**21.5**

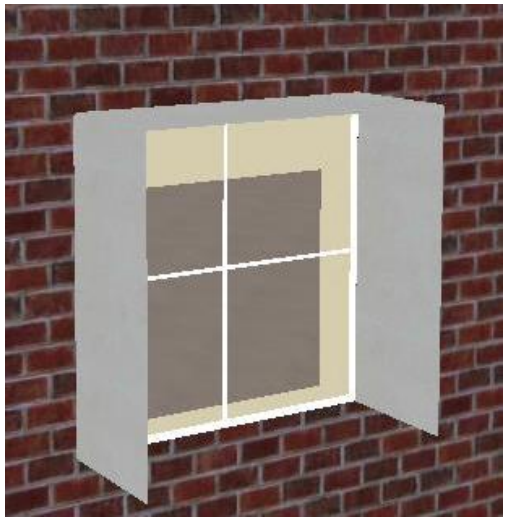
- **RETV = 21.5, (high compared to cut-off of 15 W/m^2 as per ECBC-R)**
- **Heat conduction through wall is high and high heat gain through windows with no shading**

Case II: Case I + Proper Shading of Windows



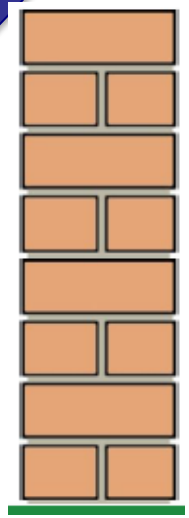
230mm Normal Brick wall with U value – 2 w/m^{2}k

	RETV (I Term) Wall conduction	RETV (II Term) Window conduction	RETV (III Term) Window transmittance	RETV (TOTAL)
Case.2 • Brick Wall • Shading with overhang & Fins • Single clear glazing • WWR: ~14%	10.1	1.8	**6.7**	**18.6**



- **RETV = 18.6 W/m^2**
- **Shading helps in reducing heat gain through windows**

Case III: Case II+ Single reflective glass

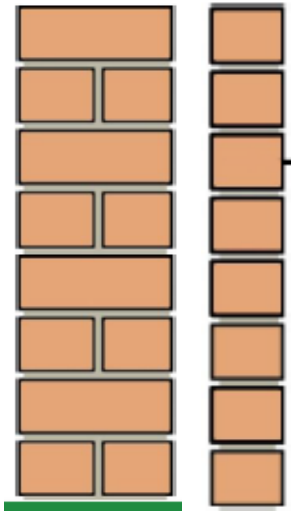


230mm Normal Brick wall with U value – 2 w/m^{2}k

	RETV (I Term) Wall conduction	RETV (II Term) Window conduction	RETV (III Term) Window transmittance	RETV (TOTAL)
Case.3 • Brick Wall • Shading with overhang & Fins • Single reflective glazing • WWR: ~14%	10.1	1.8	**4.5**	**16.3**

- **RETV = 16.3 W/m^2**
- **Using single reflective glass instead of single clear glass reduces heat gain due to window transmittance**

Case IV: (Final Design Constructed) Brick cavity wall+ Shading+ Single reflective glass



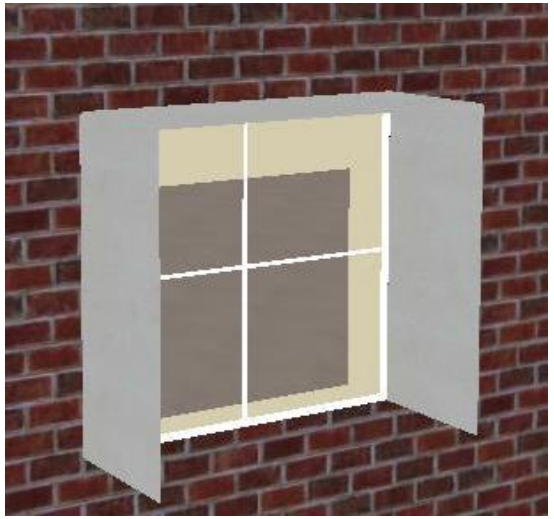
230 mm + 40 mm cavity +115 mm brick with U value – 1.1 w/m^{2}k

	RETV (I Term) Wall conduction	RETV (II Term) Window conduction	RETV (III Term) Window transmittance	RETV (TOTAL)
Case.4 • Brick Wall • Shading with overhang & Fins • Single reflective glazing • WWR: ~14%	**6.6**	1.8	4.5	**12.8**

- **RETV = 12.8 W/m^2**
- **Using Brick cavity wall with 40mm air gap reduces the heat gain due to wall conduction**

Case V: Extra measure: AAC block wall + Shading of Windows+ Single reflective glass)

200 mm AAC block with U value – 0.7 w/m^{2}k



	RETV (I Term) Wall conduction	RETV (II Term) Window conduction	RETV (III Term) Window transmittance	RETV (TOTAL)
Case.5 • AAC Block • Shading with overhang & Fins • Single reflective glazing • WWR: ~14%	**4.7**	1.8	4.5	**10.9**

- **RETV = 10.9 W/m^2**
- **Reduced thermal conduction from walls; use of single reflective glass and shading helps in reducing heat gain through windows**

Key Envelope Parameters & it's impact on RETV

	RETV (I Term) Wall conduction	RETV (II Term) Window conduction	RETV (III Term) Window transmittance	RETV (TOTAL)
Case.1 • Brick Wall • No Shading • Single clear glazing • WWR: ~14%	10.1	1.8	9.6	**21.5**
Case.2 • Brick Wall • Shading with overhang & Fins • Single clear glazing • WWR: ~14%	10.1	1.8	**6.7**	**18.6**
Case.3 • Brick Wall • Shading with overhang & Fins • Single reflective glazing • WWR: ~14%	10.1	1.8	**4.5**	**16.3**
Case.4 • Brick Wall • Shading with overhang & Fins • Single reflective glazing • WWR: ~14%	**6.6**	1.8	4.5	**12.8**
Case.5 • AAC Block • Shading with overhang & Fins • Single reflective glazing • WWR: ~14%	**4.7**	1.8	4.5	**10.9**

Cost Comparison of Conventional building vs ENS Compliant Building

Specification of Conventional vs ENS compliant building

No. of floors : G+4 Residential Building

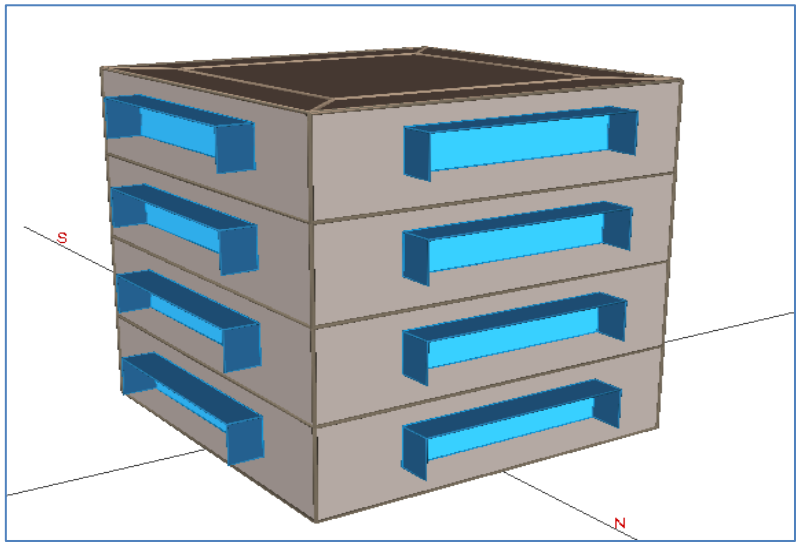
Location: Amritsar, Punjab

Built-up area : 20,000 sqft

Conditioned area : 9900 Sqft

WWR : 30%

AC : Packaged System with EER 8.5



Parameters	Conventional Building	ENS compliant Building
Wall specification	230 mm Red Brick wall with plaster on each side	200 mm AAC with plaster on each side
Roof specification	150mm concrete without insulation with red brick tile	150mm concrete with 50mm insulation china mosaic tile
Glazing specification	Single clear glazing (U value= 5.3 w/m2k, SC= 0.74 ,VLT= 65%)	Single tinted glazing (U value= 5.3 w/m2k, SC= 0.44, VLT= 36%)

Materials used in Conventional vs ENS compliant building

Conventional Residential Building

Red Brick Construction (U Value = 2.169 W/m^{2}K)

ENS Compliant Residential Building

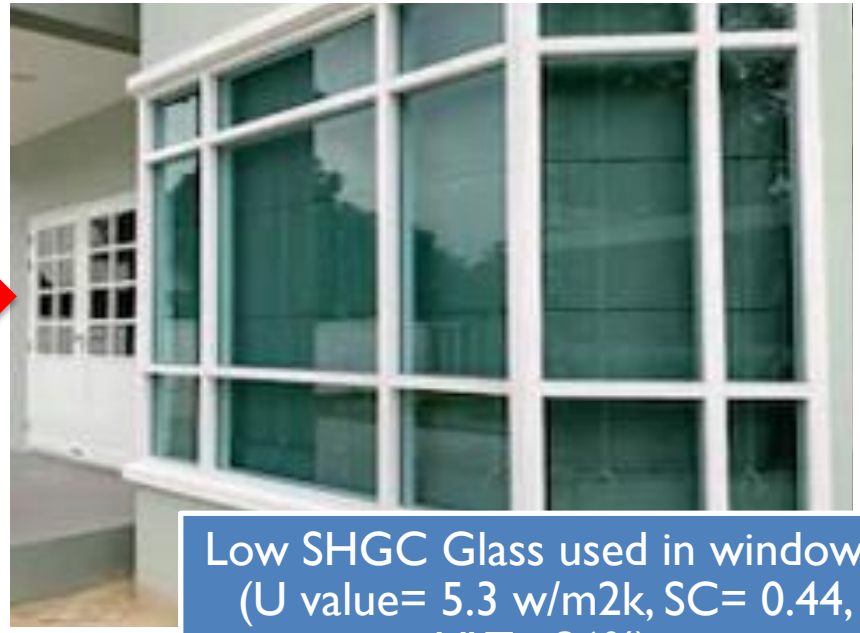
AAC block construction (U Value = 0.775 W/m^{2}K)

Materials used in Conventional vs ENS compliant building

Conventional Residential Building

Clear Glass used in Windows (U value= 5.3 w/m2k, SC= 0.74 ,VLT= 65%)

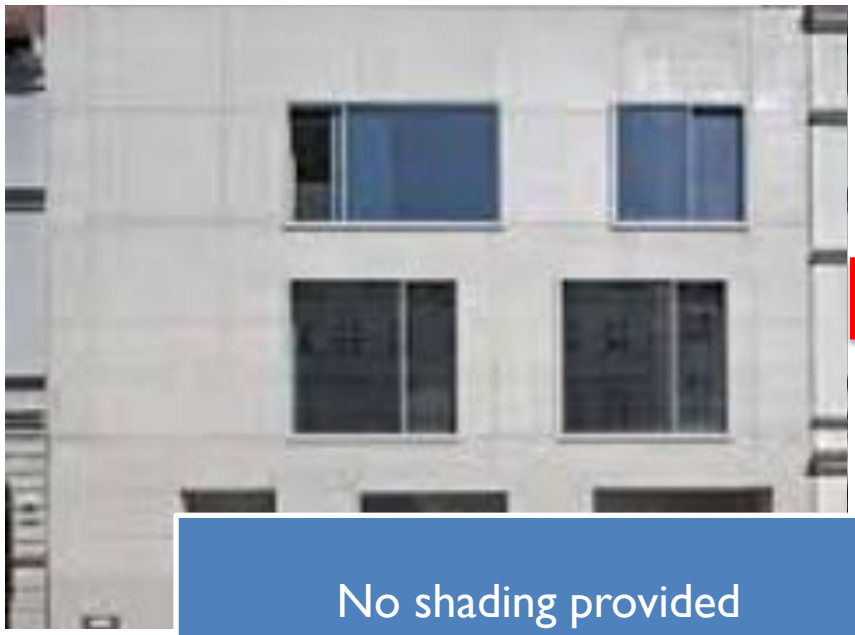
ENS Compliant Residential Building



Low SHGC Glass used in windows (U value= 5.3 w/m2k, SC= 0.44, VLT= 36%)

Materials used in Conventional vs ENS compliant building

Conventional Residential Building



No shading provided

ENS Compliant Residential Building

Shading provided using overhang & Fins

Materials used in Conventional vs ENS compliant building

Conventional Residential Building

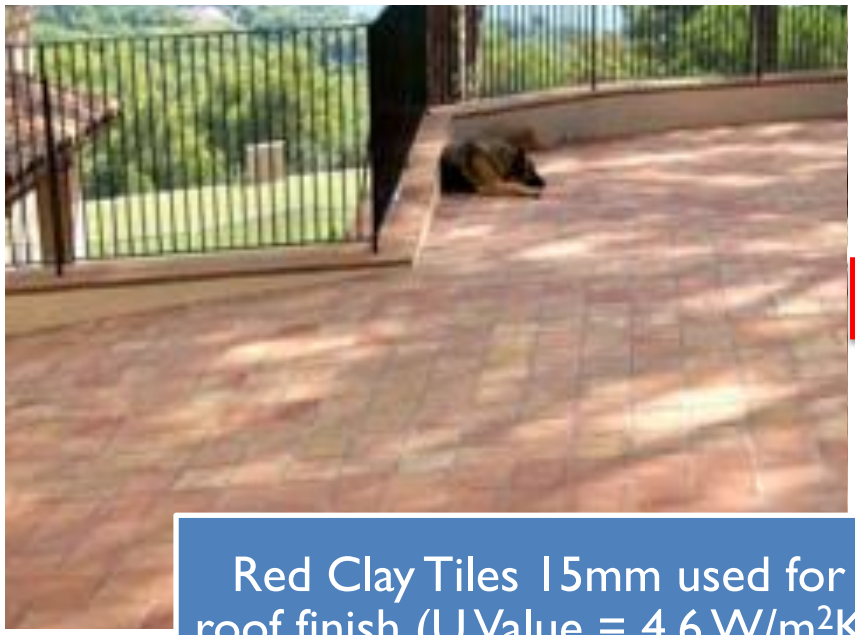
150mm Concrete with No Insulation (U Value = 2.604 W/m^{2}K)

ENS Compliant Residential Building

150mm Concrete roof with 50mm PUF insulation (U Value = 0.392 W/m^{2}K)

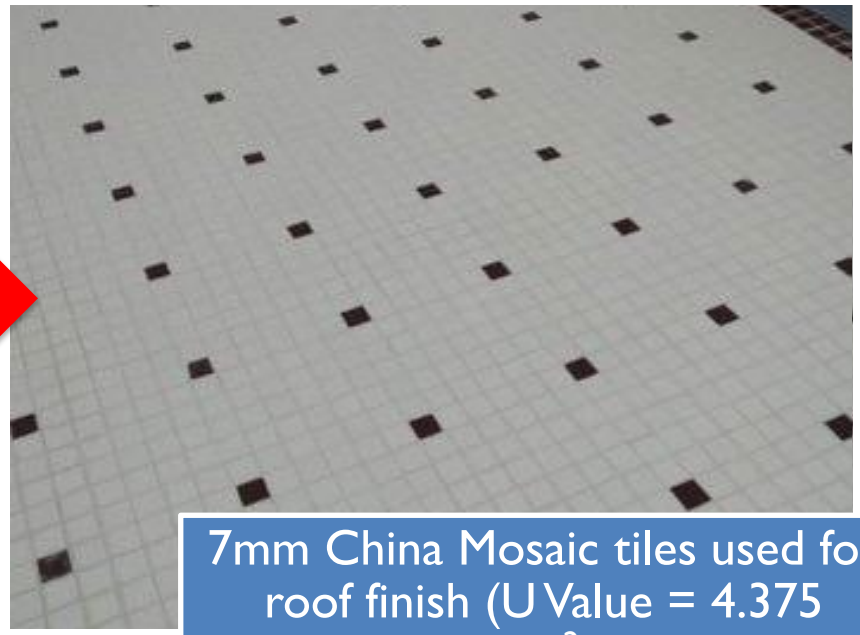
Materials used in Conventional vs ENS compliant building

Conventional Residential Building



Red Clay Tiles 15mm used for roof finish (U Value = 4.6 W/m^{2}K)

ENS Compliant Residential Building



7mm China Mosaic tiles used for roof finish (U Value = 4.375 W/m^{2}K)

Materials used in Conventional vs ENS compliant building

Conventional Residential Building

ENS Compliant Residential Building

- **Incremental Cost for Envelope Construction Materials is 2-5% with payback in less than 2 years**
- **Energy savings compared to conventional building – 25-30% per year till the life of the building**

Financial Incentives for EE Housing

Few indicative Financial Initiatives for Energy Efficient Housing in India

SUNREF India Housing Programme[1]

Credit line of **EUR100 million** from AFD

Subsidy of **EUR 12 million** granted by the EU

Technical assistance grant of **EUR 3 million** for promotion of the programme in India

Up to **EUR 1 million** is available to support the cost of green label certifications incurred by the project developer

Citation 1: Feb'2020 – Programme for Allocation of resources for promotion of green and affordable housing project

Indo-German Development Corporation

KfW and SBI partnership for energy-efficient housing program in India for USD 277 million

LOC of EUR 50 million for promoting Energy Efficient residential Housing with technical assistance grant of EUR 1.5 million

Over EUR 2bn of loans allocated by AFD, including over EUR 1bn already disbursed. Programme is to promote investments in energy and environmental services in developing countries

Energy Conservation Building Code for Residential BuildingEco-Niwas Samhita 2018

Reference Reads

Eco-Niwas Samhita Compliance Approach

Eco-Niwas Samhita (ENS) Compliance Tool

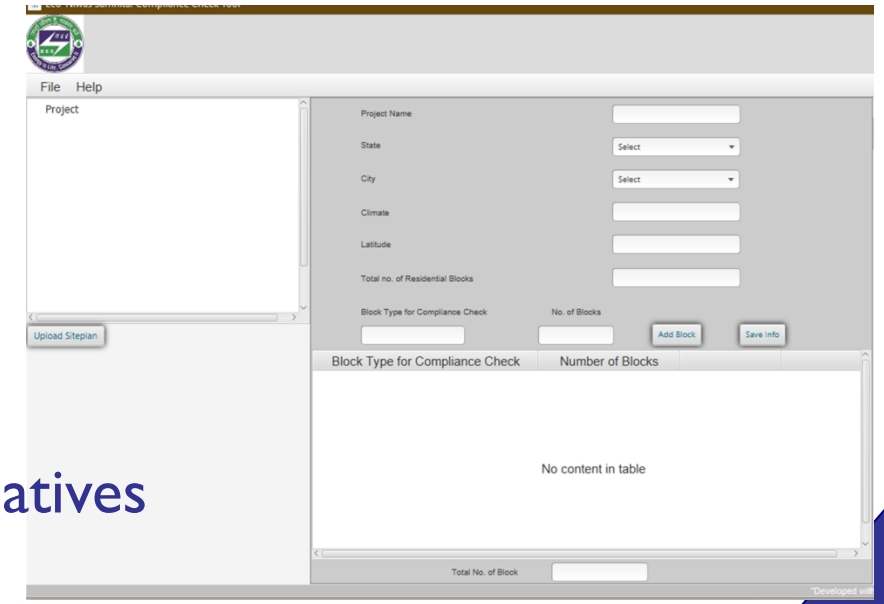
- Offline application tool along with it's user manual and tool demonstration video can be downloaded from **BEE website**

Inputs to software

- Architectural drawings (plans, sections and elevations)
- Construction material details

Results

- Code Compliance check
- RETV
- Comparison of different design alternatives



Eco-Niwas Samhita (ENS) Compliance Tool

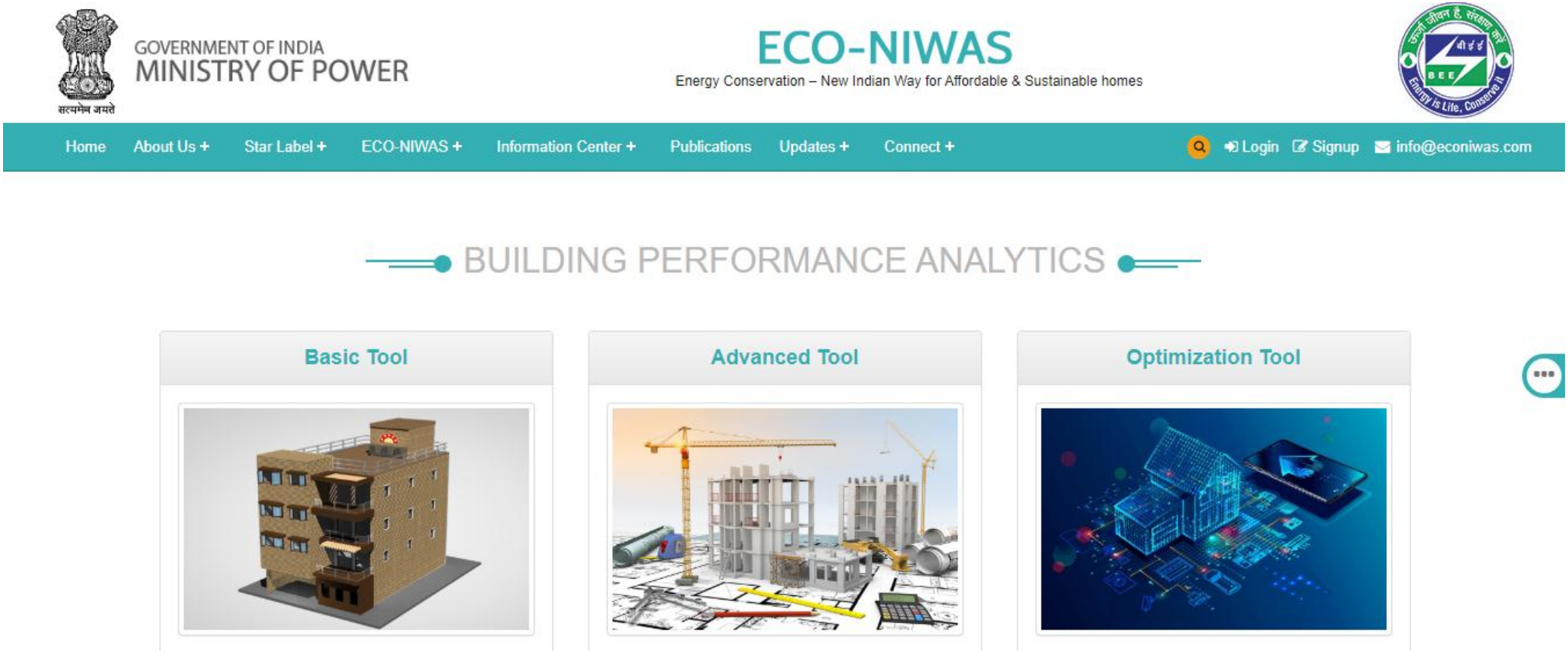
Eco-Niwas Samhita: Compliance Check Report

1. ECBC-R Compliance Results

S/No.	REQUIREMENT	CALCULATED	CRITERIA	STATUS
Block-1				
1	WFRop	28.83	12.5	Compliant
2	VLT %	85.0	27.0	Compliant
3	Uroof	0.49	1.2	Compliant
4	RETV	4.54	15	Compliant

Eco-Niwas Samhita (ENS) Compliance Tool

- Online application tool along with it's user manual and tool demonstration video is available on **ECONIWAS.COM website**

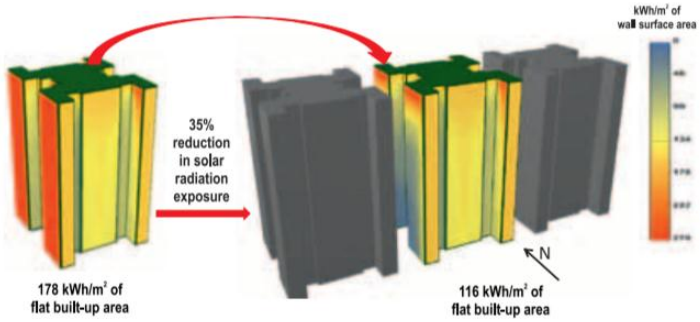


Nomination for Demonstration Project

Demonstration Project - Objective

Objective - Provide technical assistance to residential buildings to make them energy efficient and provide residential building labels

- To showcase the technical practicalities in achieving ENS compliance in buildings constructed in each state
- To demonstrate the benefits of ENS compliant building in terms of thermal comfort, energy and cost saving and financial viability of the project
- To provide evidence and confidence to designers and developers



Demonstration Project - Approach

Approach – The process of work includes the following:

➢Step 1
Identification of new residential buildings

➢Step 2
➢Collection of data

➢Step 3
➢Techno-economic analysis - Performing simulations to improve the energy performance as per ENS

Step 4
Submission of Report with recommendations

➢Step 5
➢ Registering building on portal to analyze label – 4 star label will be awarded to individual dwelling units

Support required from Building Owner/Developer

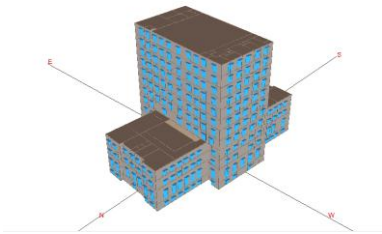
➢Undertaking document from developers to ensure the ENS compliance of the respective building

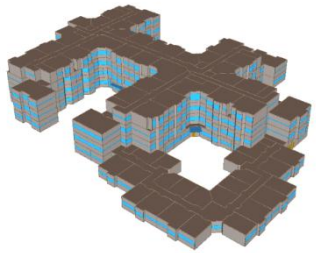
➢Share Building Information and Site visit allowance - Architectural and MEP Drawings, material specifications, BOQ

➢Discussion with Building owner/ developer on various energy conservation measures

Acceptance letter from Building Owner on the final report

➢Submit online application fees for obtaining Star label for each dwelling unit





Building label design

Questions-Answers

THANK YOU

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