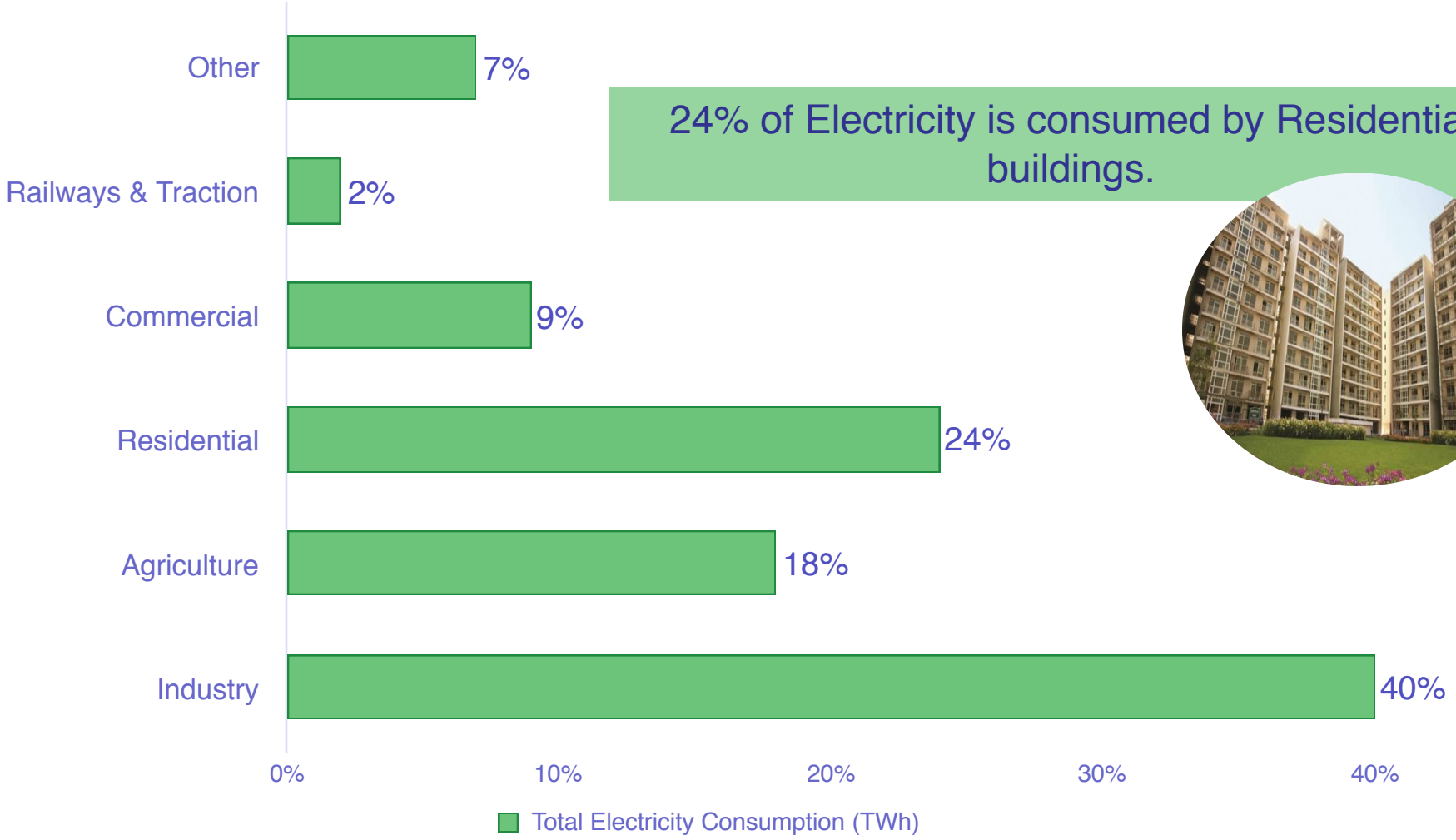
Energy Conservation Building Code for Residential Building
Eco-Niwas Samhita 2018

Understanding of Eco-Niwas Samhita 2018

Electricity consumption pattern in India

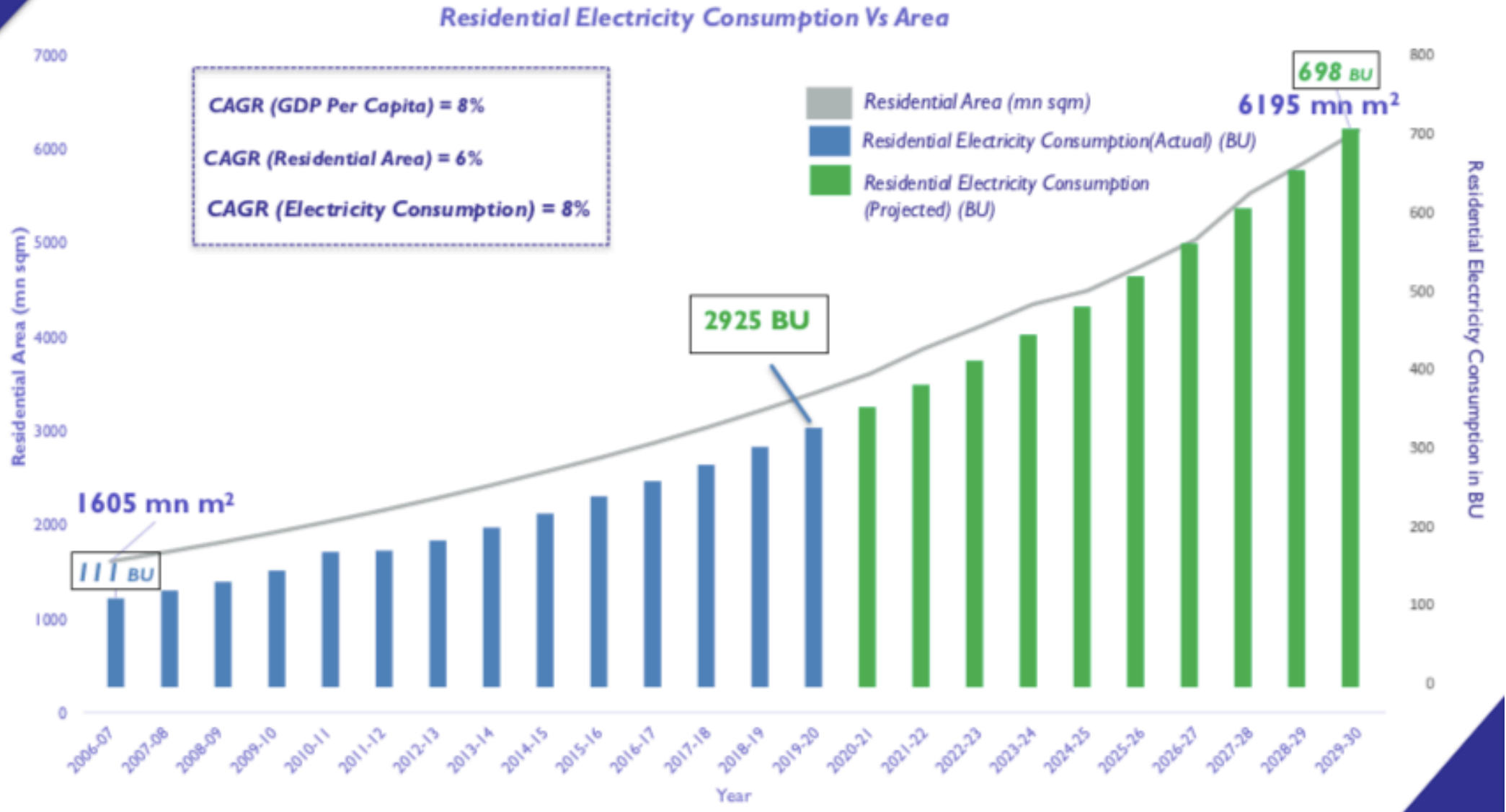
Total Electricity Consumption 1066 (BU) in 2016-17



24% of Electricity is consumed by Residential buildings.

Source: Energy Statistics 2018

Building Sector - Built up area and electricity consumption projection



Introduction of Eco-Niwas Samhita 2018

Why Eco-Niwas Samhita has been created?

- **Built Up Area -** India will add 3 Billion m² 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

Introduction of Eco-Niwas Samhita 2018

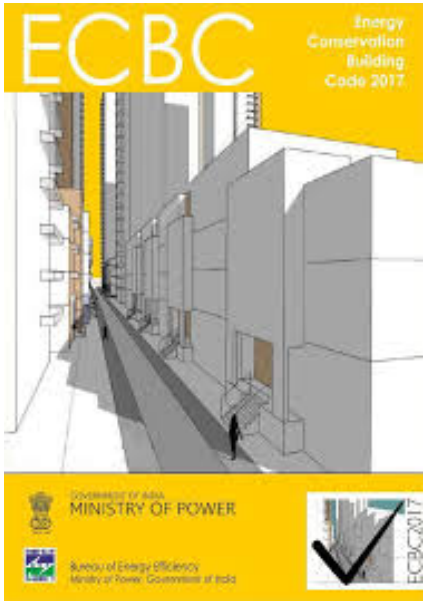
What is Eco-Niwas Samhita 2018?

- 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

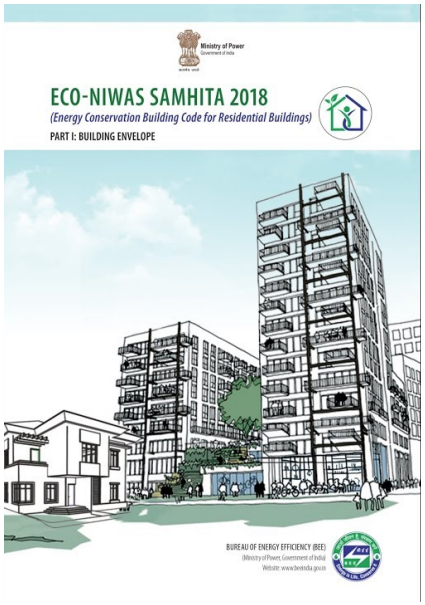
Energy Conservation Building Code (ECBC)

- 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.

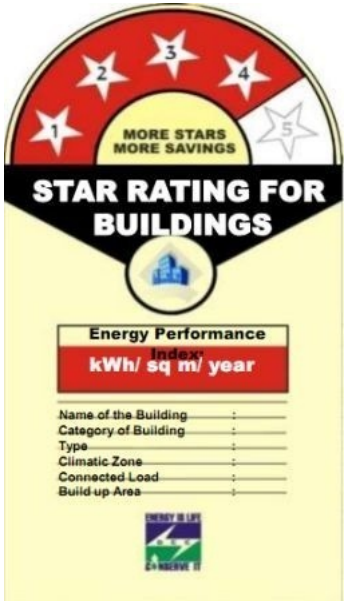


Eco-Niwas Samhita 2018

- Energy Conservation Building Code for Residential Buildings



Other Existing Government initiatives

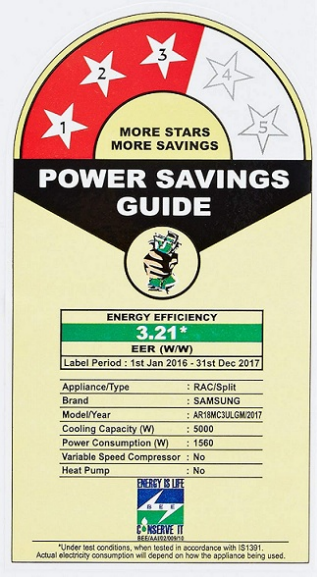


BEE star rating programme for Office buildings.

- 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.



New Government initiatives

Policies & Regulations-Residential

- Eco-Niwas Samhita (ECBC-R) Part -1
- Star Rating for Buildings (Building Label)

Supporting Government Initiatives

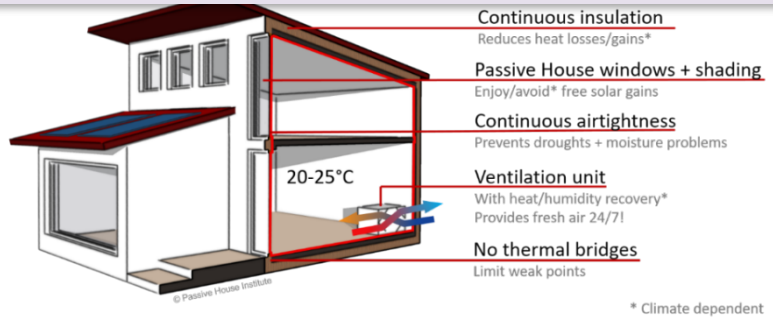
- Replicable Design Catalogue of EE Homes
- Energy Efficient Building Materials Directory
- ECONIWAS Web-Portal
- Smart Home Program
- Eco-Niwas Samhita (ECBC-R) Part -II

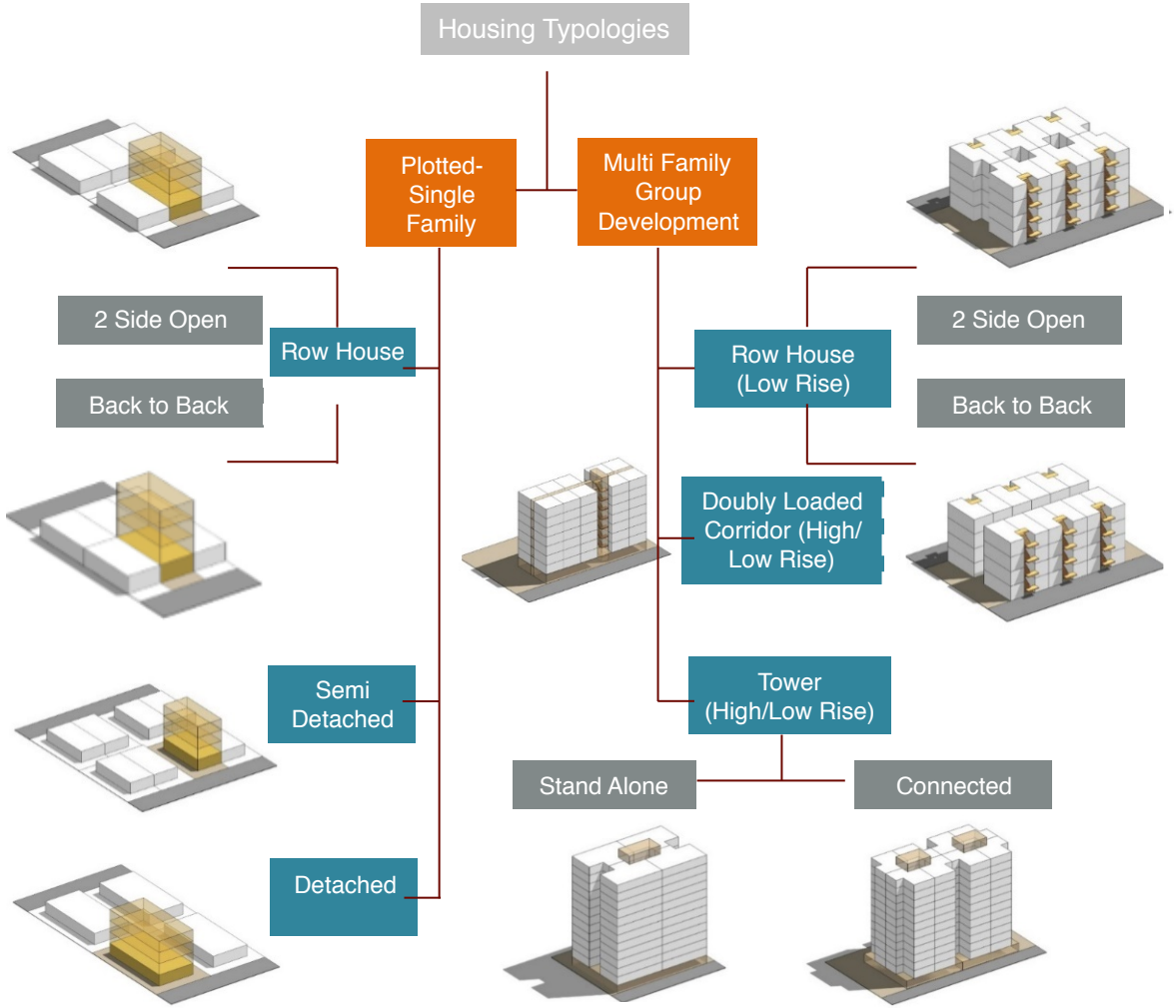
Replicable Designs for Energy Efficient Residential Buildings

- The project aims to develop a **Design Template** for building energy efficient homes, catering to:
  - Various residential types
  - Across different house sizes
  - In different climatic zones across India

- The focus of the project is to **enable the user/ builder/ designer** to easily **adopt energy efficiency** measures into the construction **with immediate impact**.

- The Catalogue will consist of about **7000-10000** Design Typology, considering each climate zone.



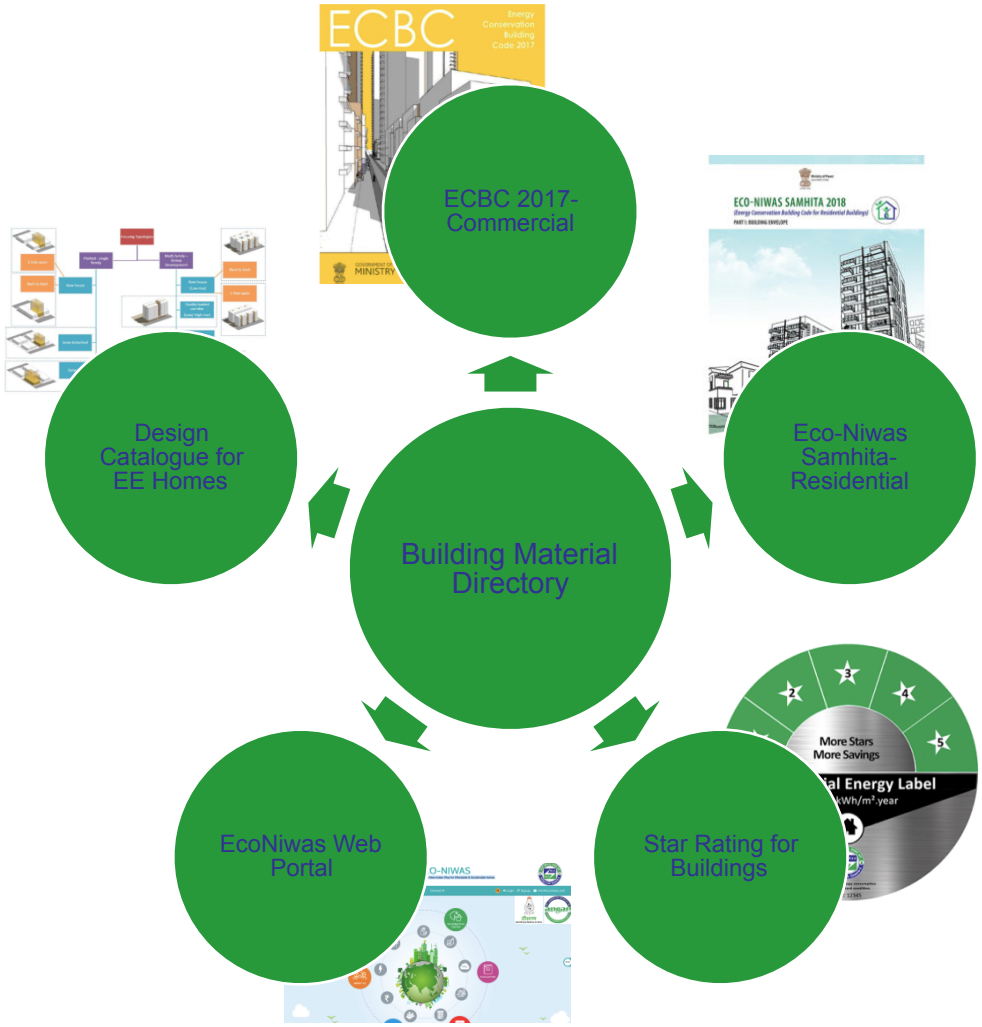


Typology Matrix

Energy Efficient Building Materials Directory for India

Objective of this project :

- To create a national directory of energy efficient building materials.
- To augment the use of energy efficient building materials
- To encourage manufacturers to register their products in the directory
- To enhance energy efficiency and create awareness
- To make effective policies and regulations



What will this Accomplish?

Benefits for Manufacturers

- Enhance Visibility of Manufacturers in the market
- Network Integration of Industries
- Materials can be registered at free of cost

Benefits for Developers

- Informed Choices of Materials while building EE Homes
- Cost information and comparison
- Climate Specific **Decision Support** for Informed Choices

Benefits for Government/Policy Makers

- Awareness
- Making Effective Policies
- Availability of **credible data** in the **public domain**

Benefits for the End consumer

- Access to **Manufacturer's contact details**
- Availability of **credible data** in the **public domain**
- Access to curated list of **locally available products**
- Climate Specific **Decision Support** for Informed Choices in Building Materials/ products
- Facilitate **quick comparison** between different Building Materials/ products based on relevant properties
- Identify **Economically Viable** options as per user requirement.
- Facilitate **green procurement**
- *Ultimately lead to Energy Efficient and Thermally Comfortable Buildings for India*

ECONIWAS Web-Portal

GOVERNMENT OF INDIA
MINISTRY OF POWER

ECO-NIWAS
Energy Conservation – New Indian Way for Affordable & Sustainable homes

BUREAU OF ENERGY EFFICIENCY
Government of India, Ministry of Power

Home | About Us + | ECO-NIWAS + | Information Center + | Publications | Updates + | Connect + | Login | Signup | info@econiwas.com

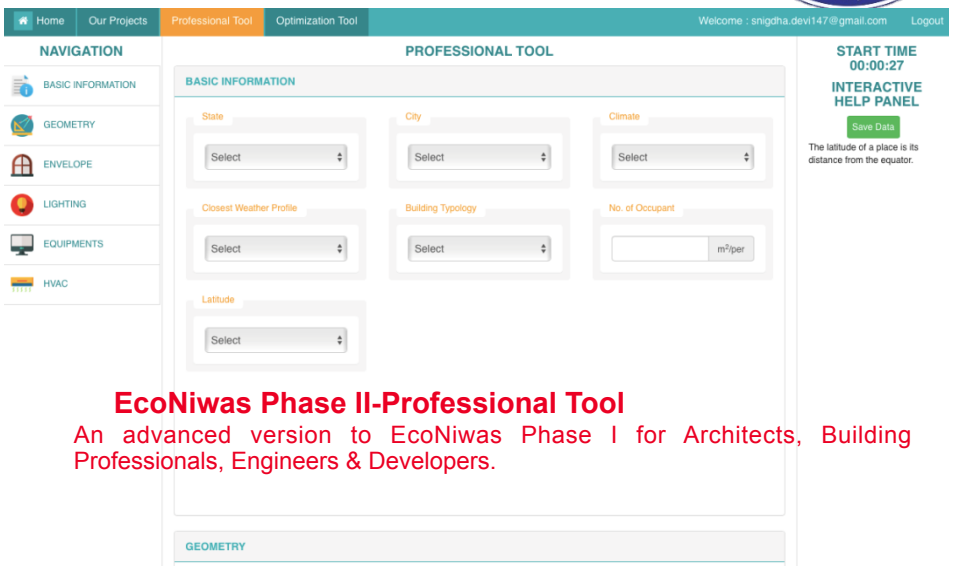
- **Digitalization can support in converting construction boom into an energy savings boom**
- **One stop solution, Awareness raising and empowering website www.econiwas.com**
- **Basic Tool, Professional tool, Compliance tool, Plugins, Prototypes and many more**

सौभाग्य

One stop solution for energy efficient homes

ECONIWAS Web-Portal

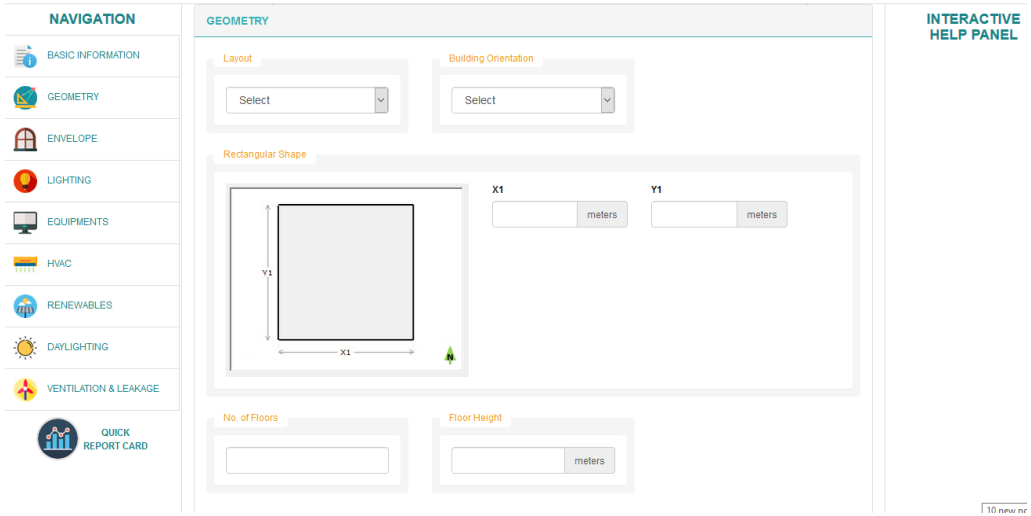
Basic Tool-EcoNiwas Phase I



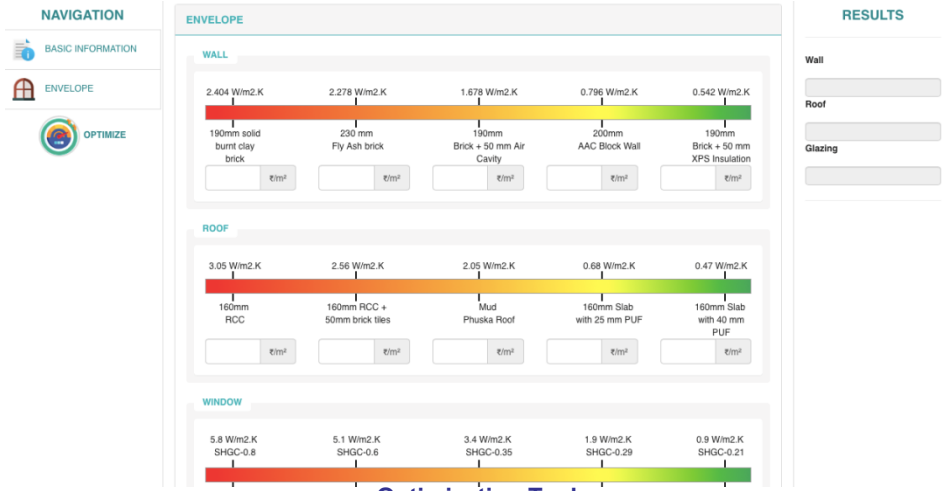
EcoNiwas Phase II-Professional Tool

An advanced version to EcoNiwas Phase I for Architects, Building Professionals, Engineers & Developers.

Professional Tool



Online simple to use tool for simulation and analysis

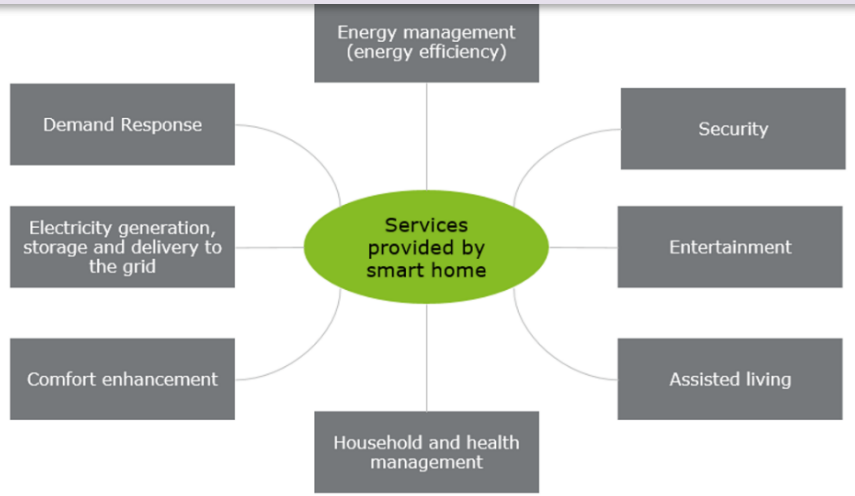


Optimization Tool

Smart Home Program - Technology Assessment Study and Pilot Design

Objective :-

- Home automation Technologies
- Application potential in India,
- Optimal approach for informing demand response.
- Home automation centric energy efficiency policies in future.



•Preparation of Database and Adaptive Model for Thermal Comfort of occupancy in residential building

Objective :-

To develop a single nation-wide adaptive thermal comfort model.
Residences of various types located in different climatic zones of the country, spread over major economic and social categories covering major typologies are targeted.

Source: ://www.phsc.co.uk/thermal-comfort-in-your-workplace/

User Benefits of New Govt. Initiatives

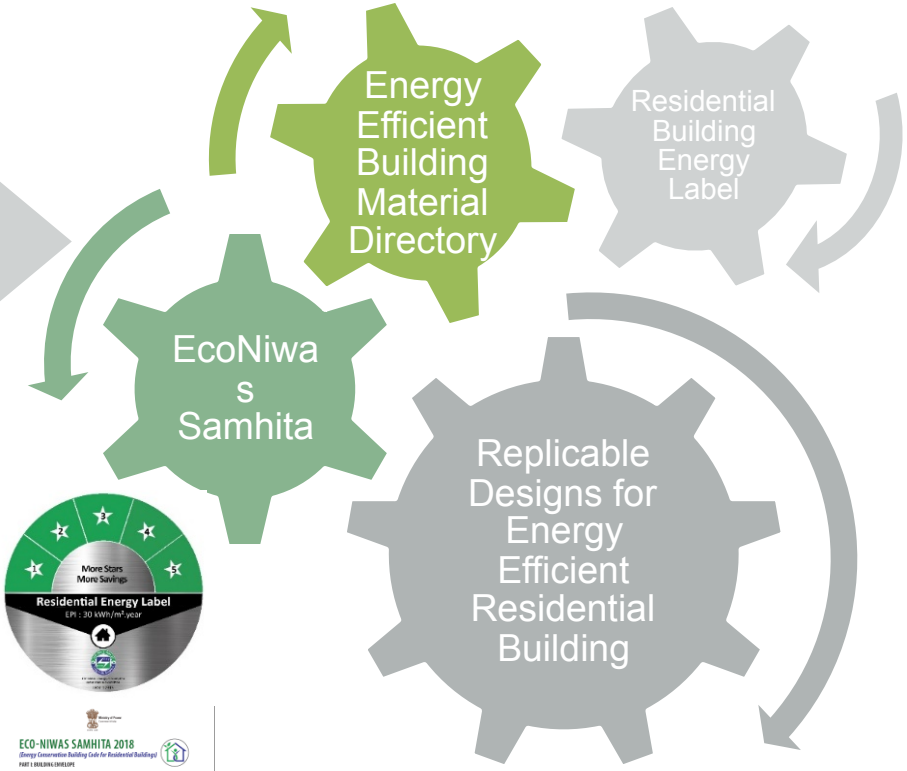
Policies & Regulations-Residential

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

Supporting Initiatives

- ECONIWAS Web-Portal
- Energy Efficient Building Materials Directory
- Replicable Design Catalogue of EE Homes

Building Material Directory -*5000+ Materials*
Replicable Building Model -*7000+ Models*



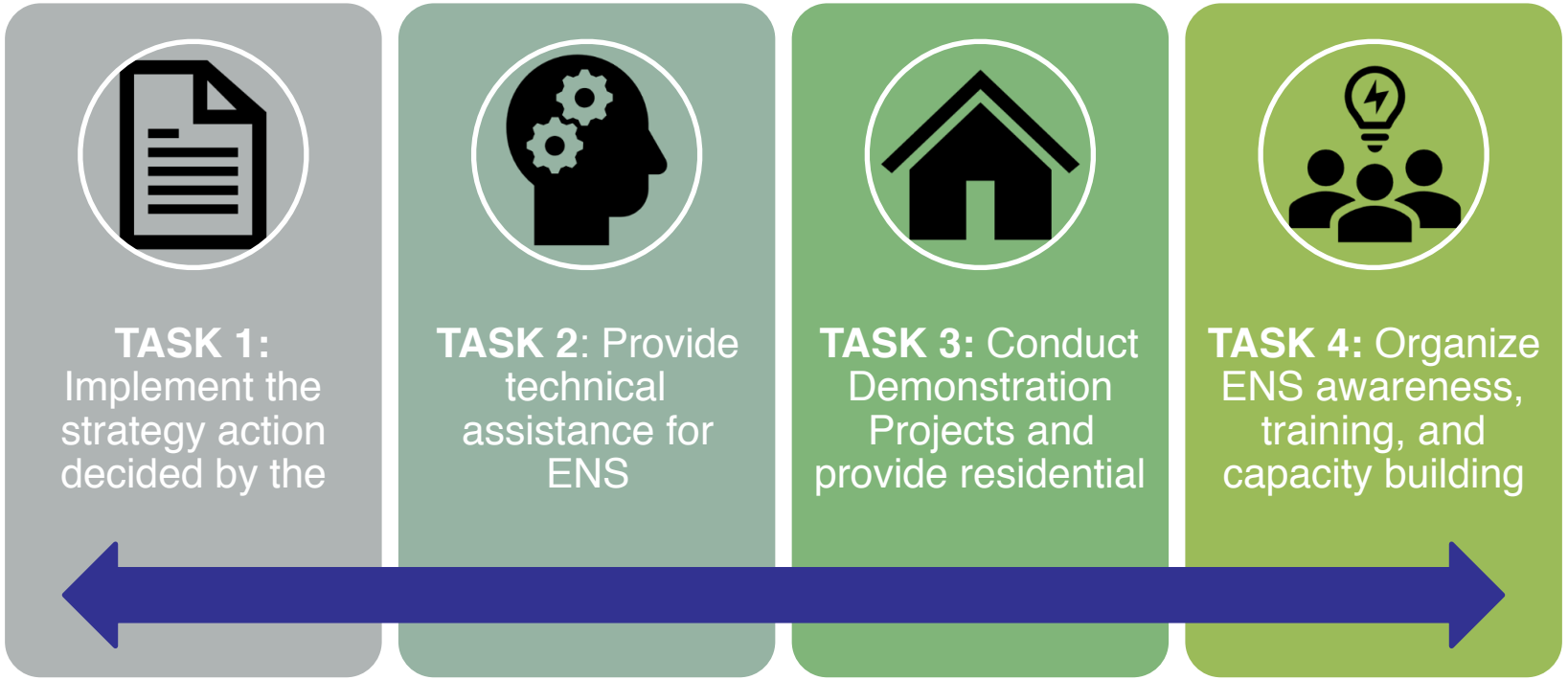
User Benefits

- ***Major energy and cost savings*** for climate responsive design and effective use with the help of ***Energy Efficient Building Materials***
- Evaluation, endorsing building design drawings for ***EcoNiwas Samhita compliance***, ***Residential Building Energy Label*** and assessment of EPI based on building simulation.
- to **enable the user/ builder/ designer** to easily **adopt energy efficiency** measures into the construction **with immediate impact**.
- This will ensure that the relevant information on sustainable buildings is available in easy to use format and has a wide reach.
- To provide ready to use database for further making energy efficient policies

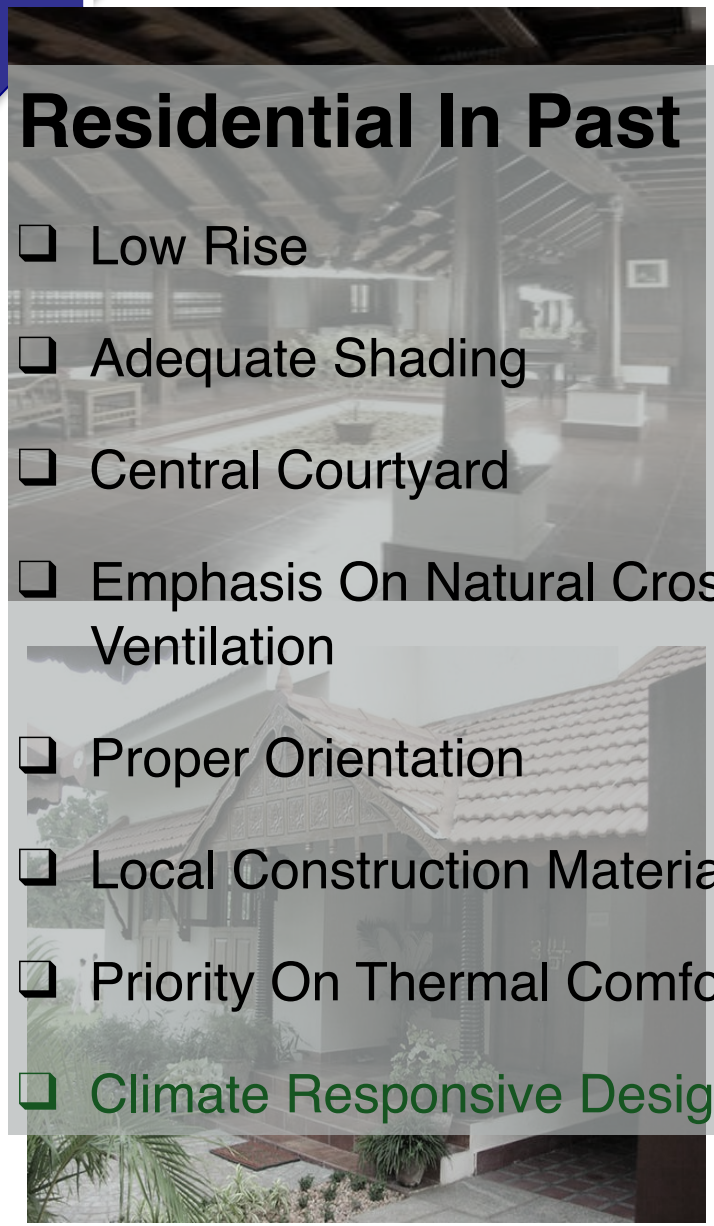
About Eco-Niwas Samhita

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:



Have you observed buildings in past & present



Residential In Past

- Low Rise
- Adequate Shading
- Central Courtyard
- Emphasis On Natural Cross-Ventilation
- Proper Orientation
- Local Construction Materials
- Priority On Thermal Comfort
- Climate Responsive Design

Residential In Present

- Mid & High Rise
- Shading Limited By Bye-laws
- Clustering Around Central Greens
- Limited Natural Ventilation – Single Sided
- Low Or No Emphasis On Orientation
- Global Construction Materials
- Priority On Speedy Construction
- Poor Climate Responsive Design

Reason behind the shift in design…

- Rapid Urbanization

⇨ Need for Mass Affordable Housing

Higher Real-Estate Value

Availability & Abuse of Technologies

Acceptance to Global Design Philosophy

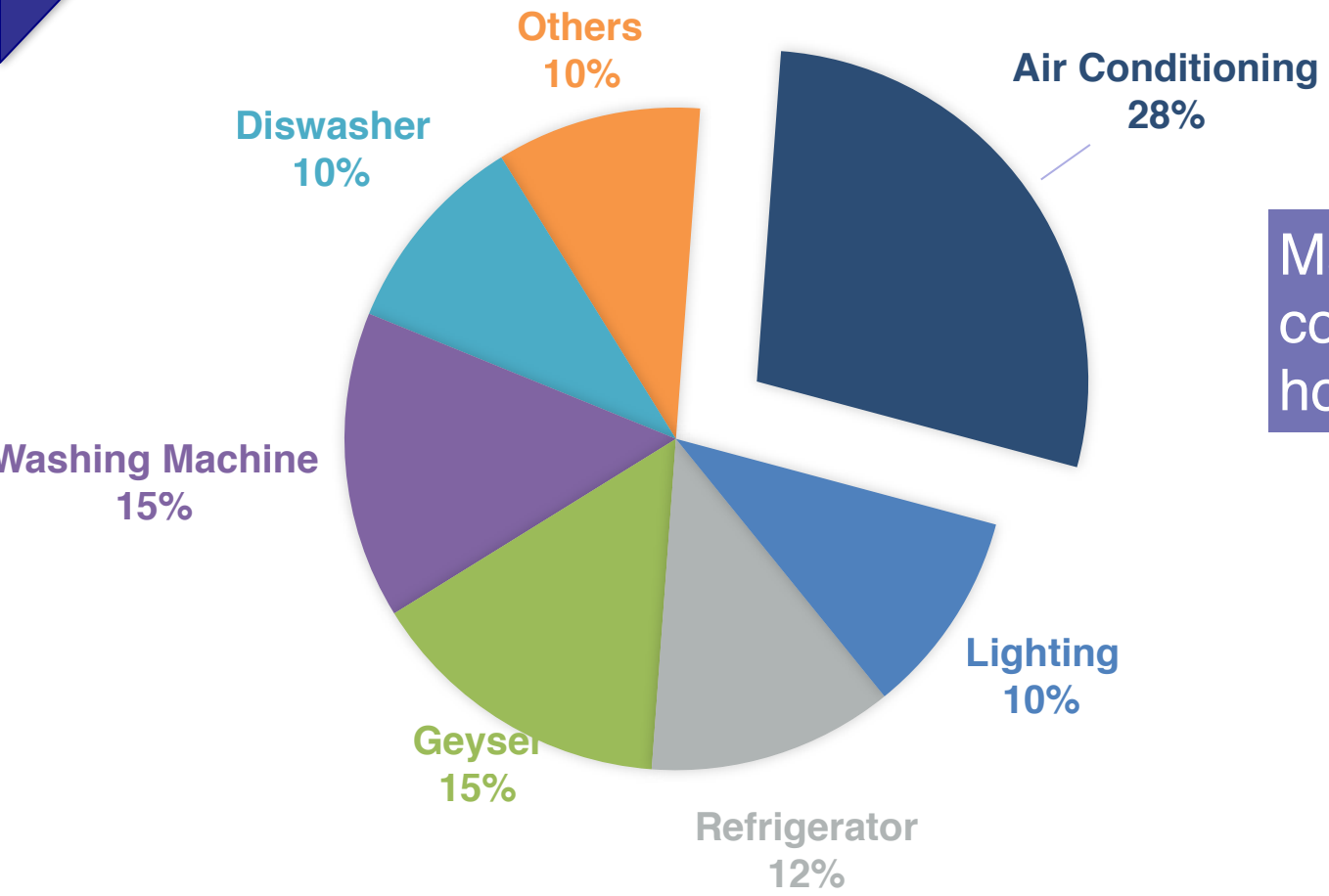
Effect of the transition in design

- **Increased** electricity consumption

- Dependency on **Mechanical systems**

- Thermal **Discomfort**

Energy distribution pattern in typical home



Maximum energy consumption in a typical home is from Air conditioning

Source: IGBC Green Homes

Now it is time to CHANGE, ENERGY EFFICIENT BUILDINGS are the need of the hour

Ways to reduce the energy demand of a building

- **Climate Responsive Building Design**
- **Efficient Building Envelope Design**
- **Energy Efficient Appliances** (5 Star A/C, Fridge, LED Lights Etc)
- **Proper Maintenance of Electrical Appliances**

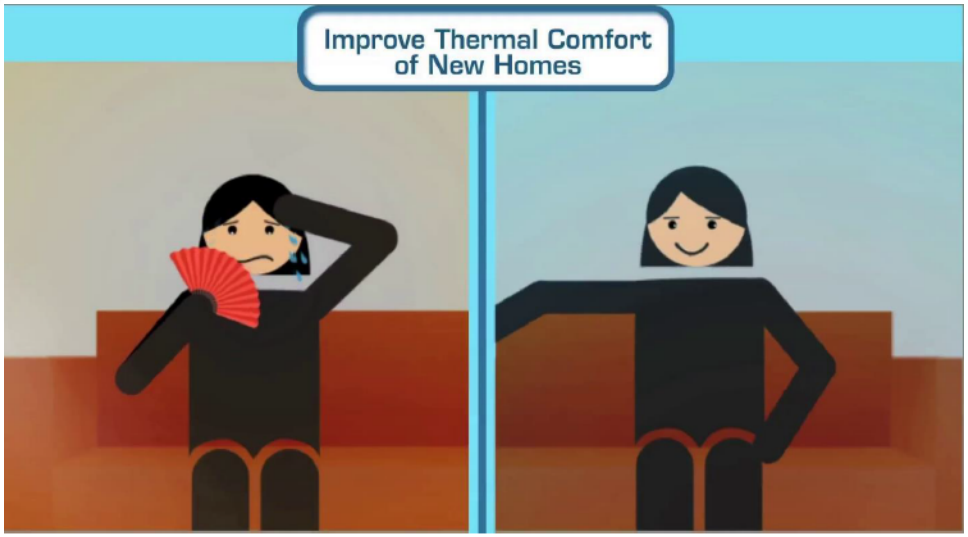
To Address The Above Factors

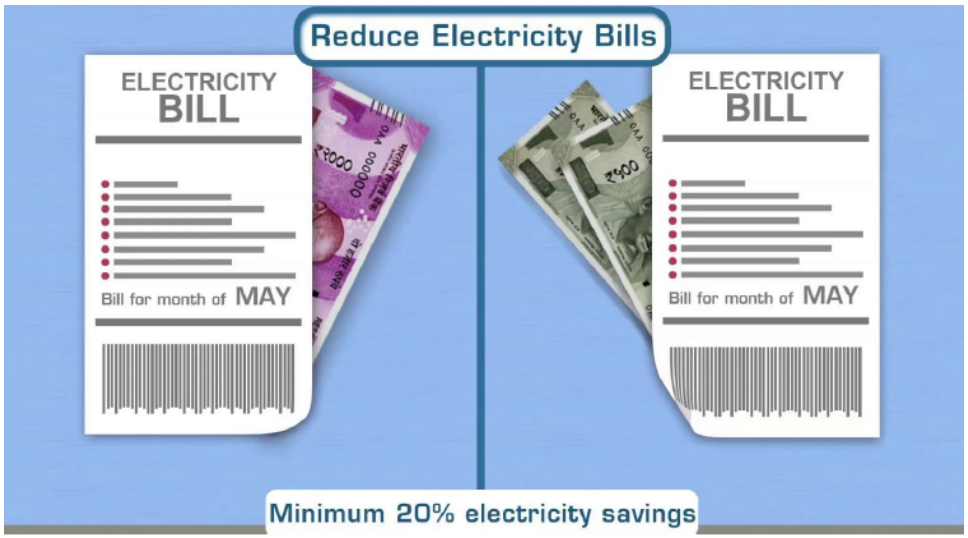
Eco Niwas Samhita Was Created

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 1





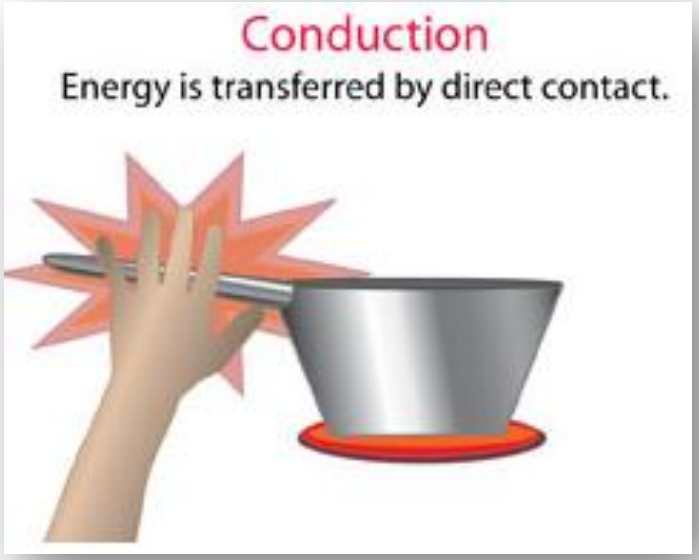
Estimated Savings 2018 – 2030

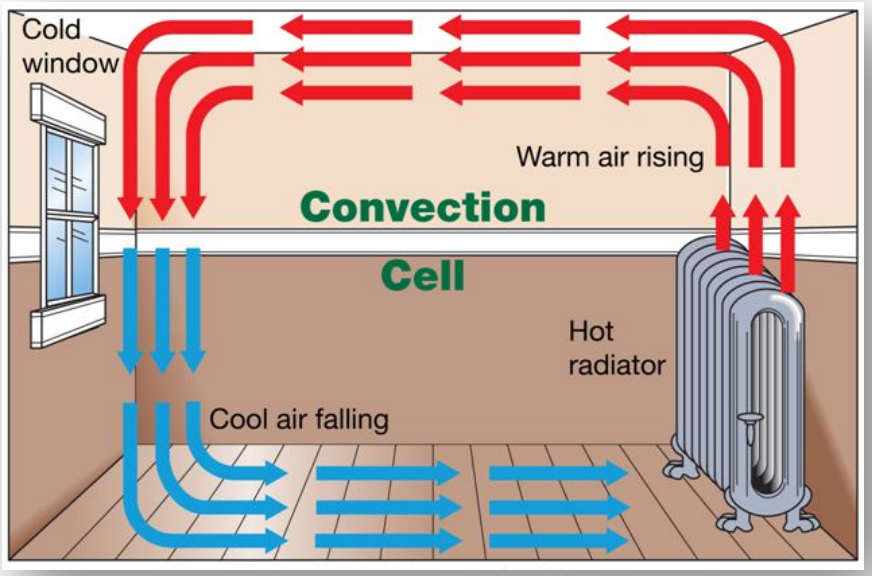
- 20% Cooling Energy
- 25 billion kWh Electricity
- 100 million Tons of CO_2 Equivalent

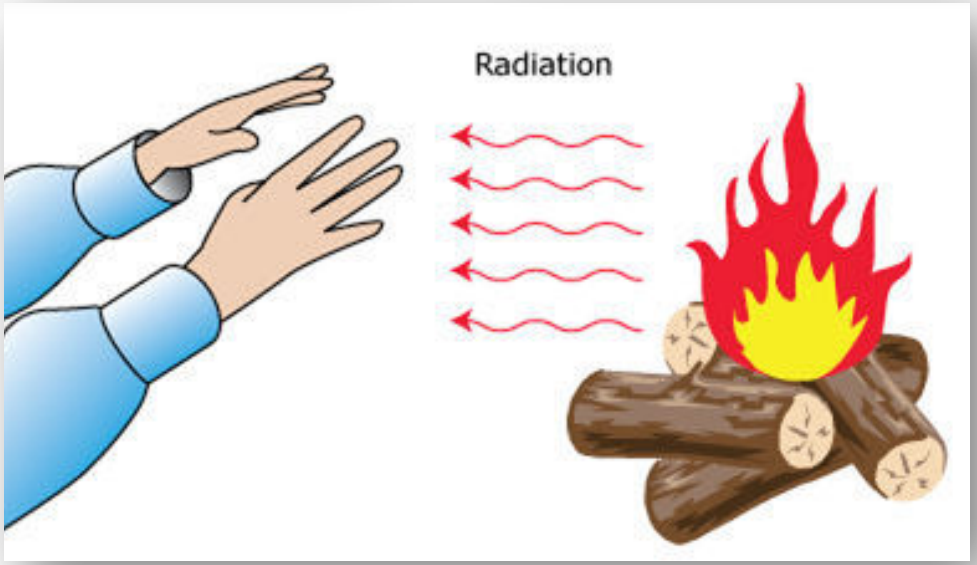
Building Envelope

Building Physics & Concepts

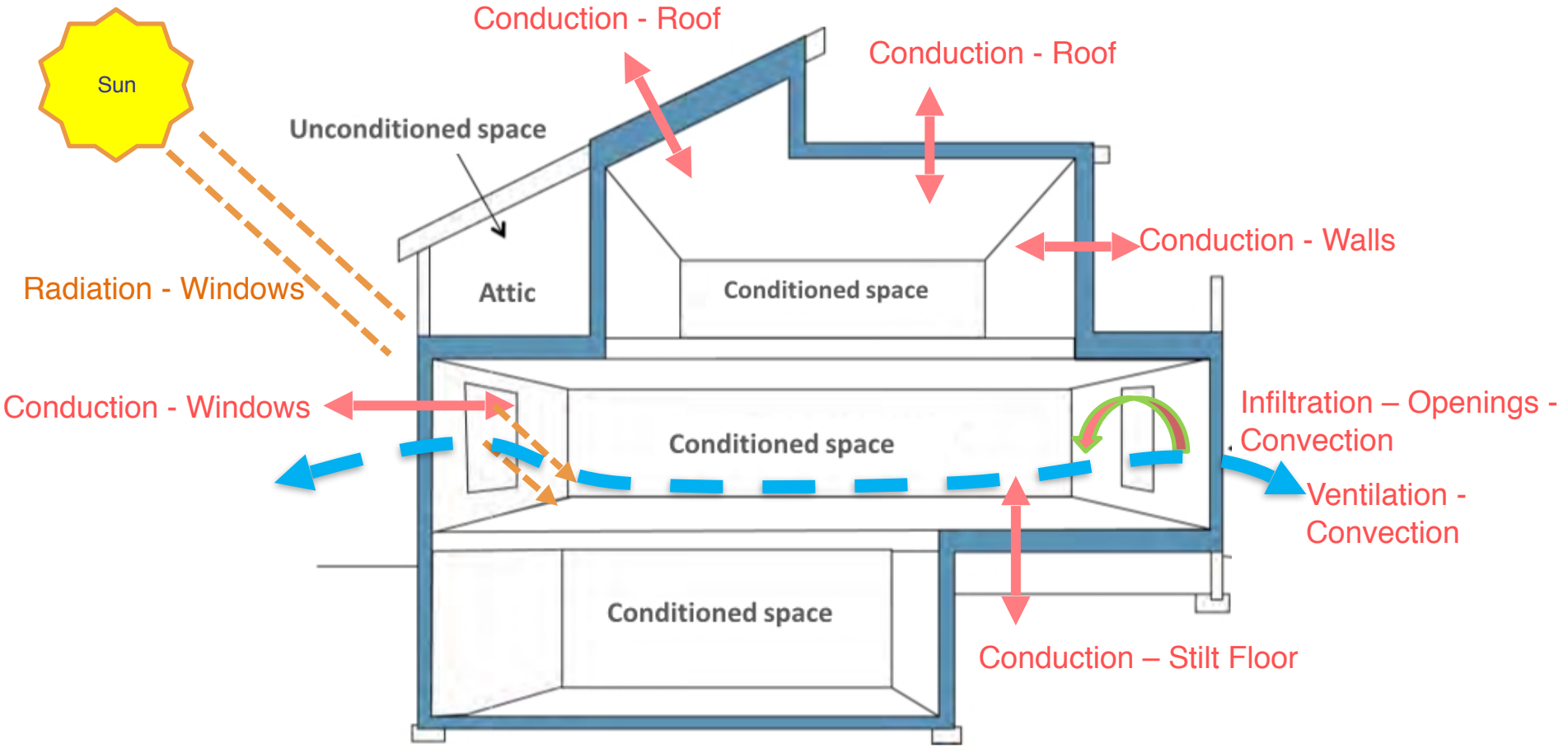
How Heat Travels…







Sources for heat gain in a building



Building Envelope Design Is The Key Of Energy Efficient Residential Buildings

What is U- Value ?

Definition:

Thermal transmittance is the rate of heat transfer through materials

Unit of U-Value : $W/(m^2K)$

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

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

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

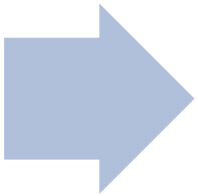
The lower the U-value, the lower is the heat gain/loss in the building.

Types of wall & their U Value

150 mm RCC (No plaster) U Value 3.77 W/m²K → Block with 15 mm plaster on both sides – → with 15 mm plaster on both sides U Value 1.72

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

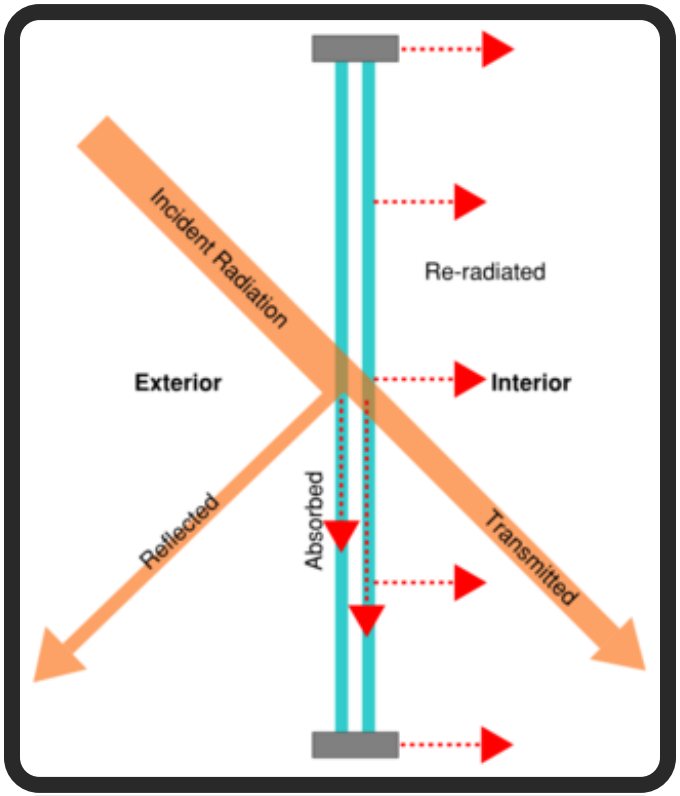
What is SHGC

Solar Heat Gain Coefficient

Definition:

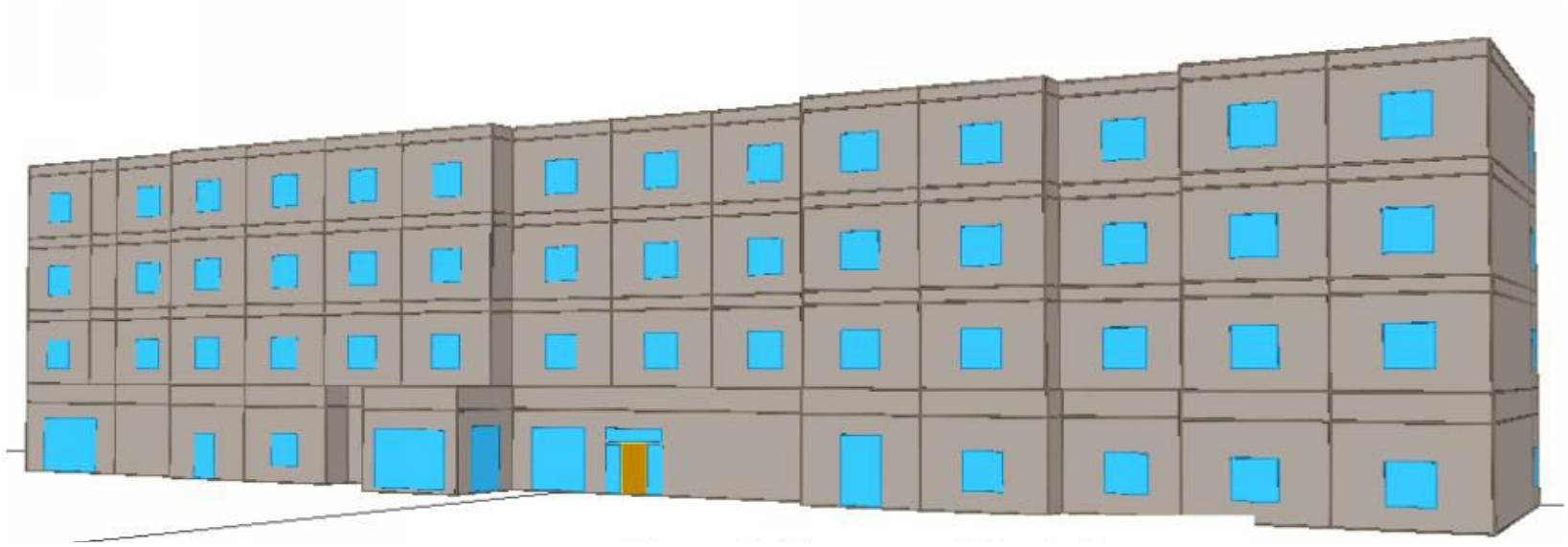
SHGC is the fraction of incident solar radiation admitted through a window, both directly transmitted and absorbed and subsequently released inward.

The value of SHGC varies from 0 - 1



What is Window to Wall Ratio (WWR)

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



WWR Sample calculation

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

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

$$WWR = 0.6$$

$$= 60\%$$

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

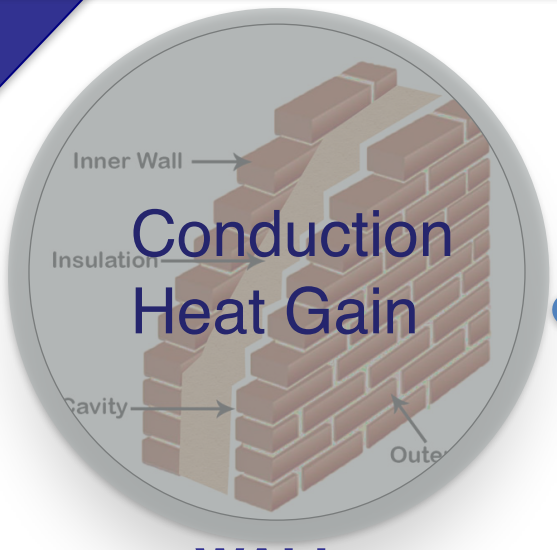
From where can we obtain the VLT, SHGC & U-Value of the Glass?

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

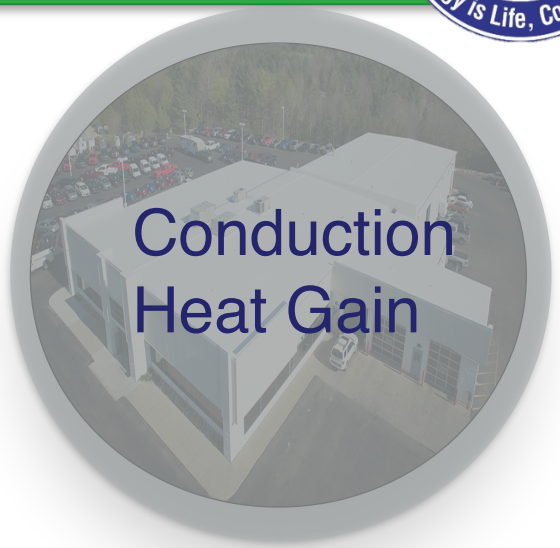
ENS Part 1- Building Envelope and It's components

Typical Heat Gain From Building Envelope



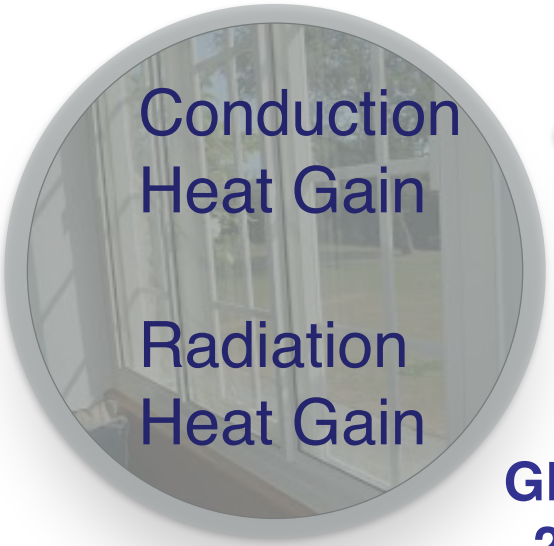
Conduction Heat Gain

WALL
15-25%



Conduction Heat Gain

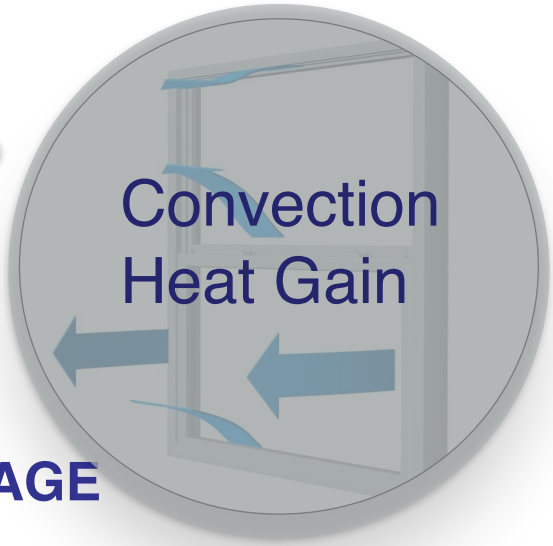
ROOF
25-35%



Conduction Heat Gain

Radiation Heat Gain

GLAZING
25-35%



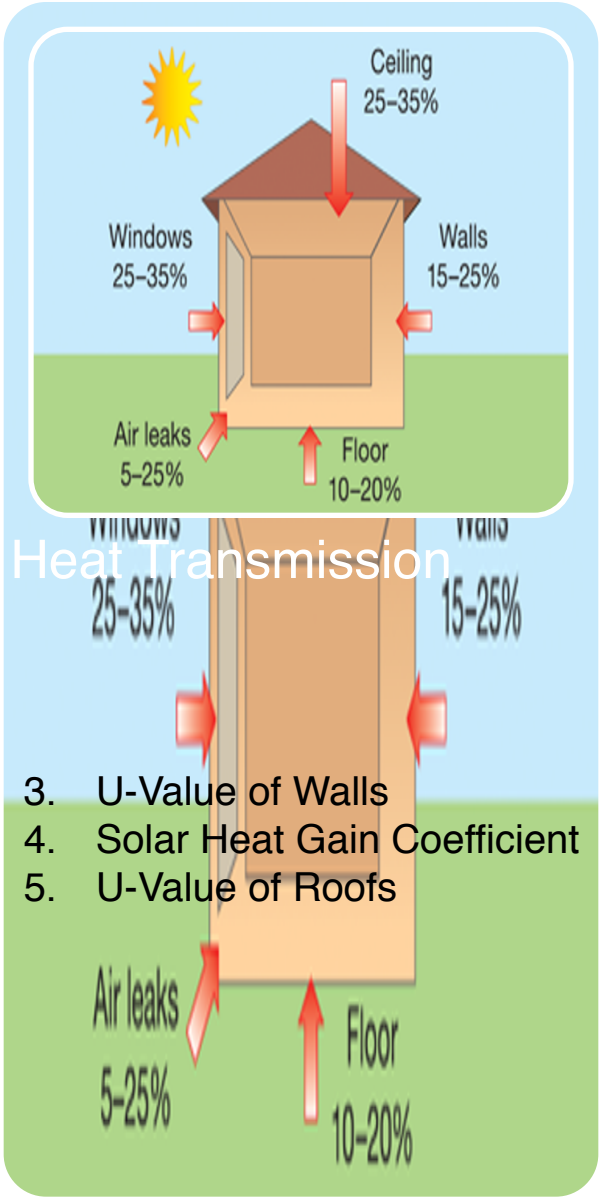
Convection Heat Gain

AIR LEAKAGE
5-10%

Code Compliance Requirements - Envelope

Transparency

1. Window to Wall Ratio
2. Visual Light Transmittance



Heat Transmission

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

Ventilation

6. Window to Floor Area Ratio

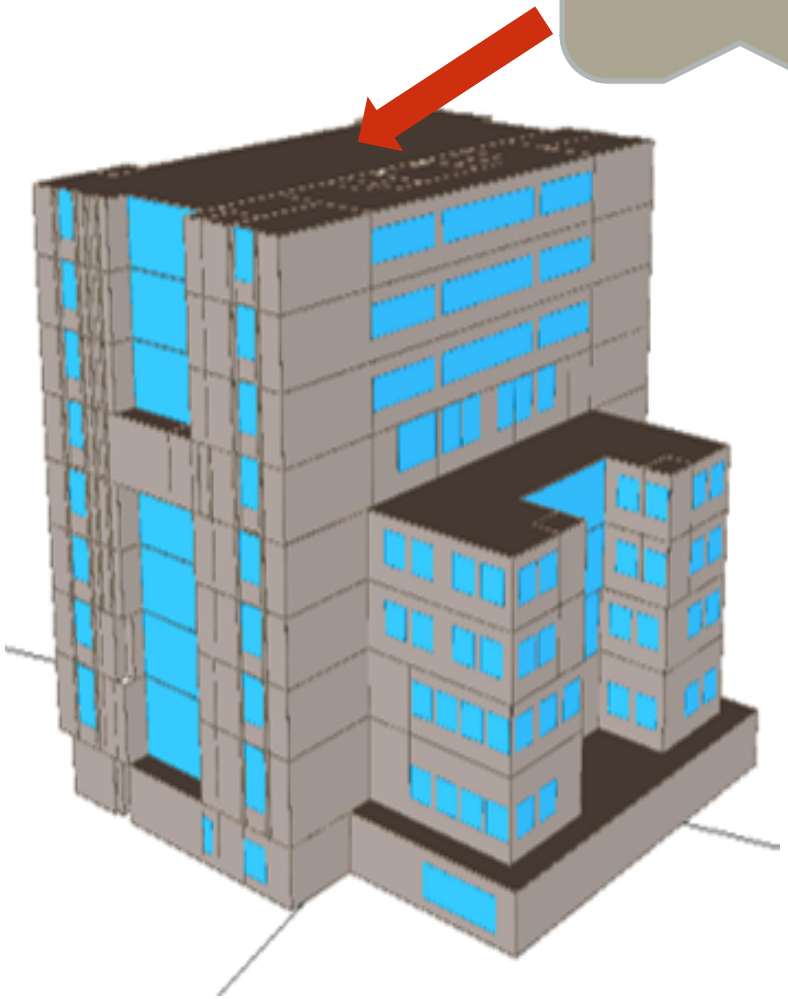
Code Compliance : VLT & WWR

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

Thermal Transmittance of Roof (U_{roof})

Thermal Transmittance of Roof (U_{roof})



Thermal transmittance (U_{roof}) characterizes the thermal performance of the roof of a building.

Maximum U_{roof} : **1.2 W/m²K.**

Residential Envelope Transmittance Value (RETV)

RETV can be calculated by using the following formula:-

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

Wall Conductive Heat Gains

Window Conductive Heat Gain

Window Radiation Heat Gain

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**

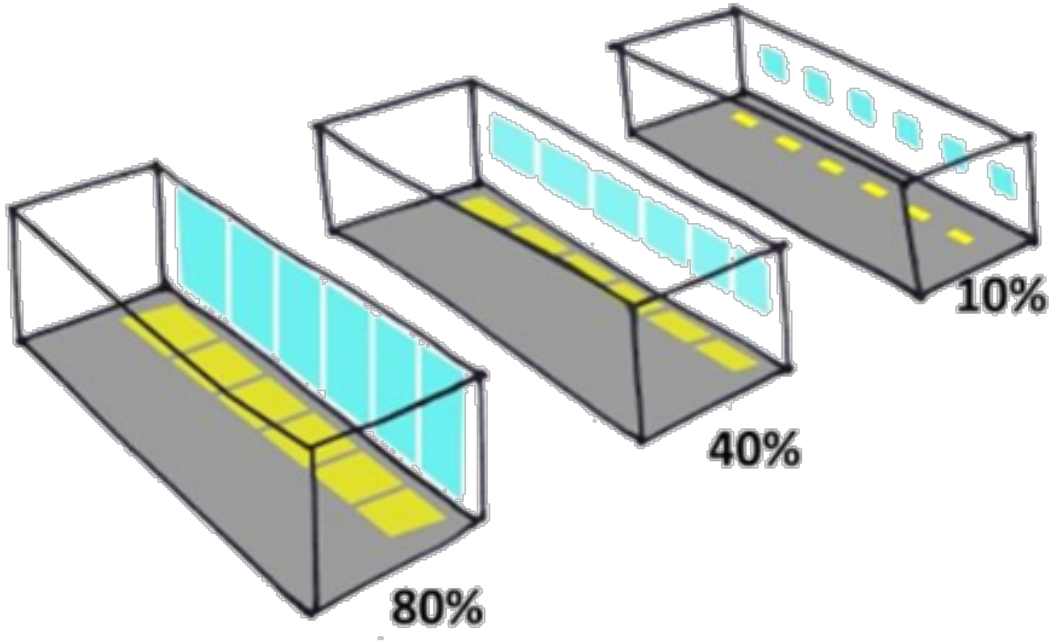
Window to Floor Area Ratio

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.

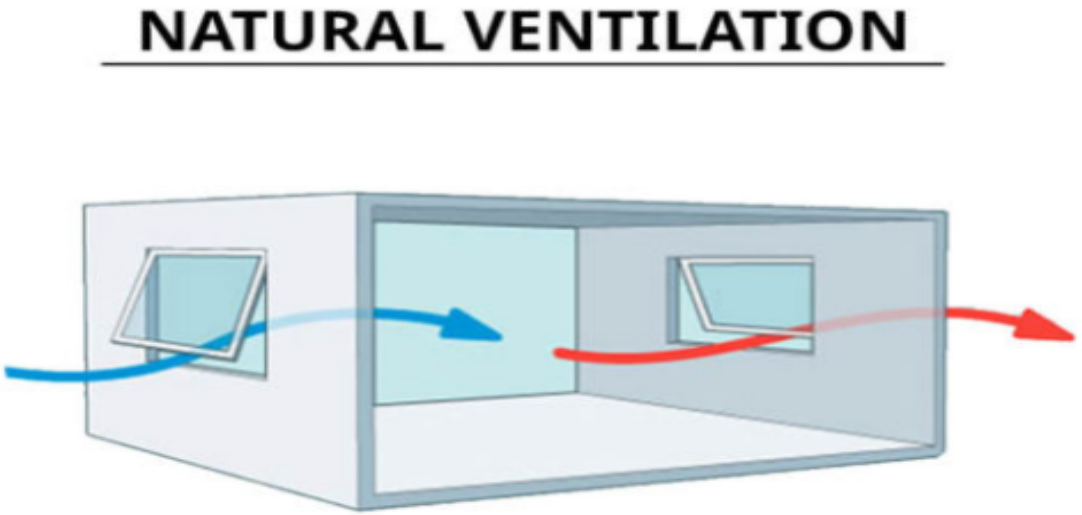
$$WFR_{op} = \frac{A_{openable}}{A_{Carpet}}$$



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

Higher WFR_{op} helps in enhancement in

- Natural Ventilation
- Thermal comfort
- Cooling Energy Savings



WFR Sample Calculation

Calculation:

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

$$WFR = 0.54$$

$$= 54\%$$

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

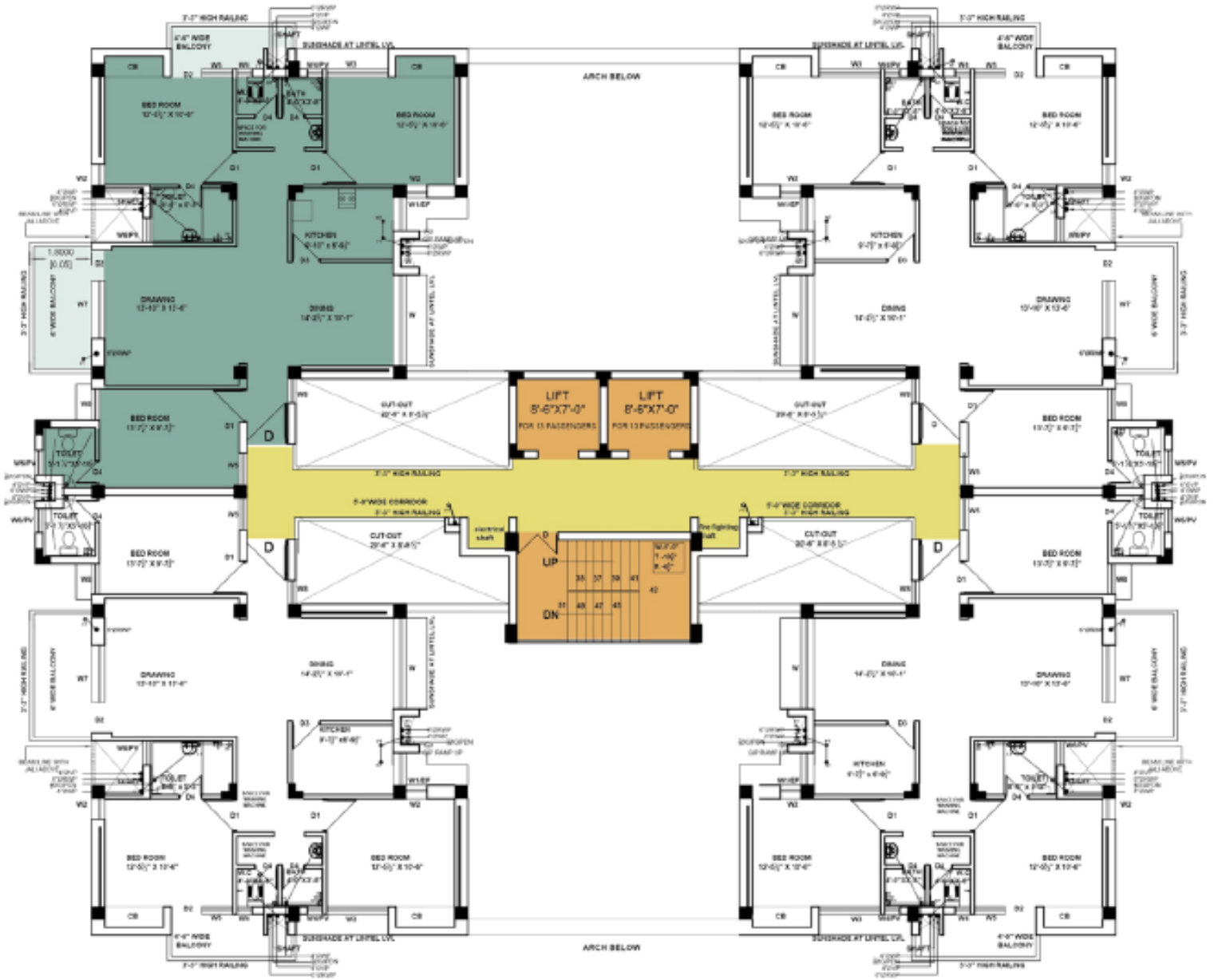
Climatic Zone	Minimum percentage (%) of WFR_{op}
Composite	12.50
Hot-Dry	10.00
Warm - Humid	16.66
Temperate	12.50
Cold	8.33

Eco-Niwas Samhita - Case Study

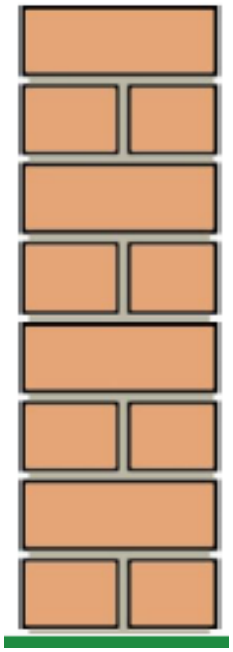
Case study project details

- 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

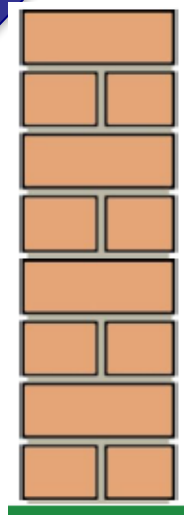


	RETV Wall conduction	RETV Window conduction	RETV Window Radiation	RETV (TOTAL)
Case.1 • Brick Wall • No Shading • Single clear glazing • WWR: ~14%	10.1	1.8	9.6	**21.5**

230mm Normal Brick wall with U value – 2 w/m²k

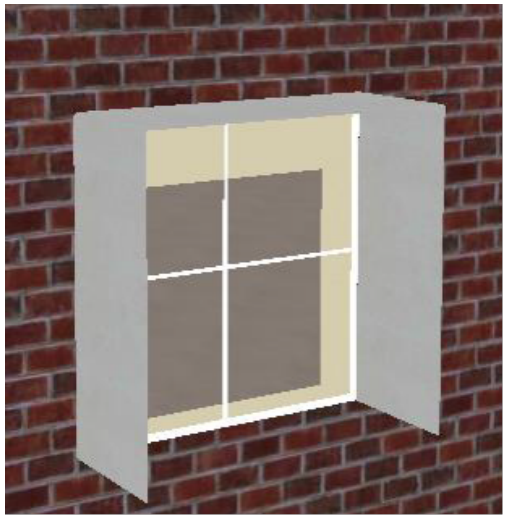
- **RETV: 21.5 W/m² higher than 15 W/m² (Non compliant)**
- **Heat conduction through wall is high and high heat gain through windows with no shading**

Case II: Case I + Proper Shading of Windows



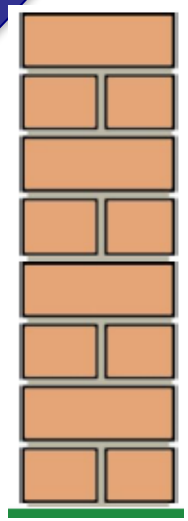
230mm Normal Brick wall with U value – 2 w/m²k

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



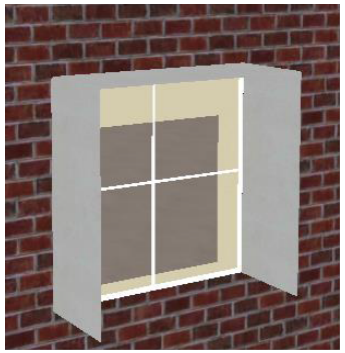
- **RETV = 18.6 W/m²**
- **Shading helps in reducing heat gain through windows**

Case III: Case II+ Single reflective glass



230mm Normal Brick wall with U value – 2 w/m²k

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



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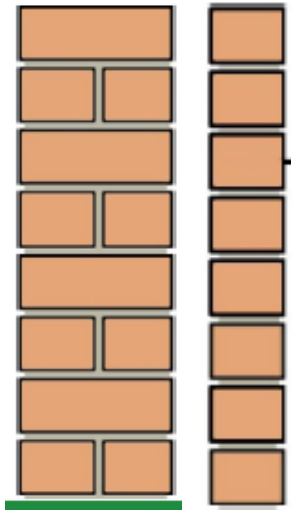
- **RETV = 16.3 W/m²**
- **High Reflective Glass also helps in reducing heat gain through windows**

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^2k

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

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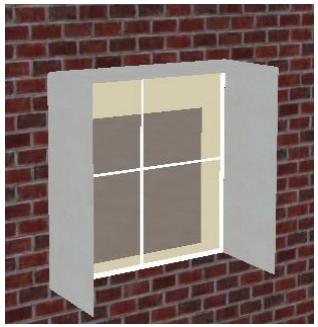

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- **RETV = 12.8 W/m^2**
- **Cavity in Brick reduces the conduction heat gain**

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

200 mm AAC block with U value – 0.7 w/m²k

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

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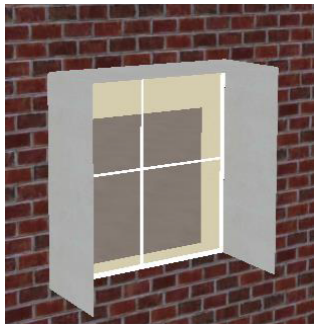

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- **RETV = 10.9 W/m²**
- **AAC Walls further reduced thermal conduction from walls as compared to cavity brick wall**

Key Envelope Parameters & it's impact on RETV

	RETV Wall conduction	RETV Window conduction	RETV Window Radiation	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 • **Cavity 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**

Eco-Niwas Samhita Compliance Approach

Eco-Niwas Samhita (ENS) Compliance Tool

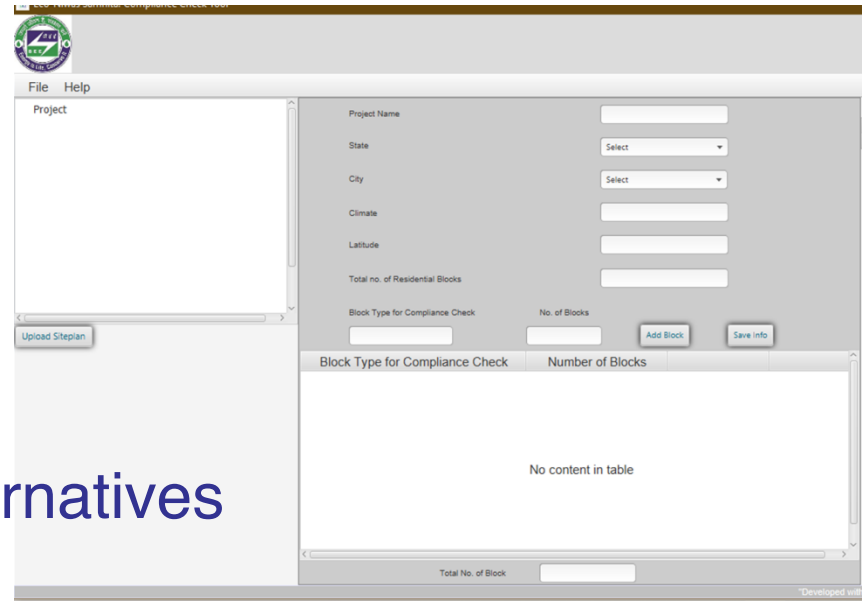
- Offline application tool along with it's user manual and tool demonstration video can be downloaded from **BEE website**

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**

THANK YOU