Energy Conservation Building Code-Residential (ECBC-R) as a tool for Energy Efficiency

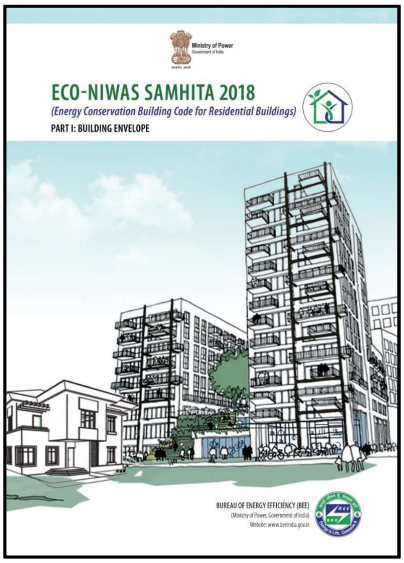
28th September 2019

Green Building Congress

Hyderabad

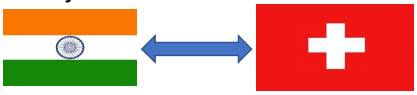
Outline of the presentation

- About BEEP
- Current context
- ECBC-R code & scope
- Provisions under the ECBC-R code
- Code compliance check tool
- Example
- Way Forward



About Indo-Swiss Building Energy Efficiency Project (BEEP)

- **BEEP** is an Indo-Swiss bilateral co-operation project on Building Energy Efficiency.
- **GOAL:** To reduce energy consumption in new commercial, public and residential buildings in India through energy-efficient and thermally comfortable (EETC) designs.
- Project duration: **2011 to 2021**

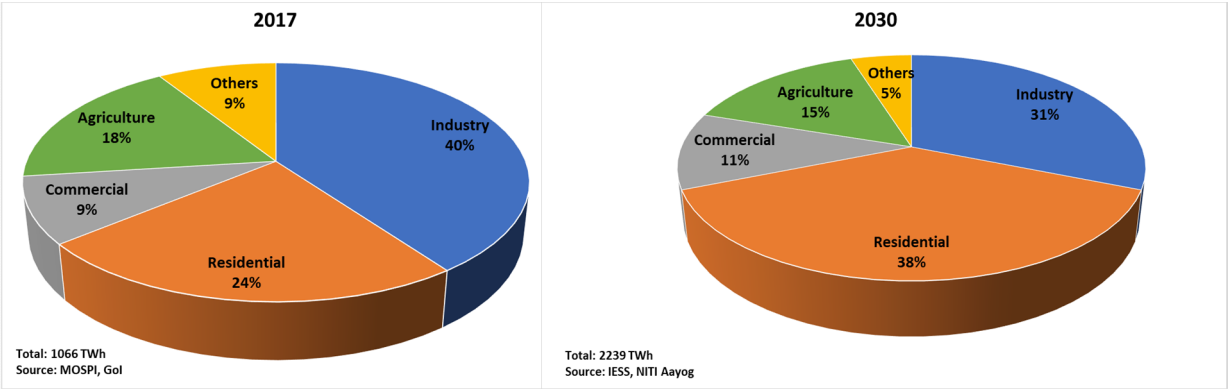


https://www.beepindia.org/

Elements of BEEP

- Building Design ← Working on building projects and builder's team to make buildings energy efficient and thermally comfortable
- Building Technology
- Building Policy ← Technical support for development of Eco-Niwas Samhita 2018: Part I (Building Envelope)
- Outreach

Electricity consumption scenario in residential buildings



Thermal Comfort - Health & Socio- Economic Impacts

- **~90%** of the households does not have access to air-conditioning
- Maximum air temperature limit for thermal comfort (with fan) is **32-34ºC** [NBC]
- As room air temperature and the wall surface temperatures approach 35ºC, then the ability of the human body to loose heat reduces drastically.
- Thermal discomfort results in
  - Loss of concentration, nausea or irritability, muscle cramps or weakness, headache, fatigue, etc.
  - Negative impact on health of the occupants, children unable to study, loss of income due to poor productivity

Eco-Niwas Samhita 2018

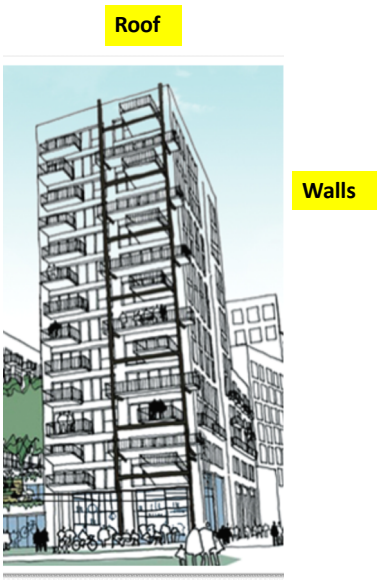
- Eco-Niwas Samhita 2018 (Part I-Building Envelope); the new Energy Conservation Building Code for Residential Buildings.

Launched by Ministry of Power (MoP) on 14 December 2018.

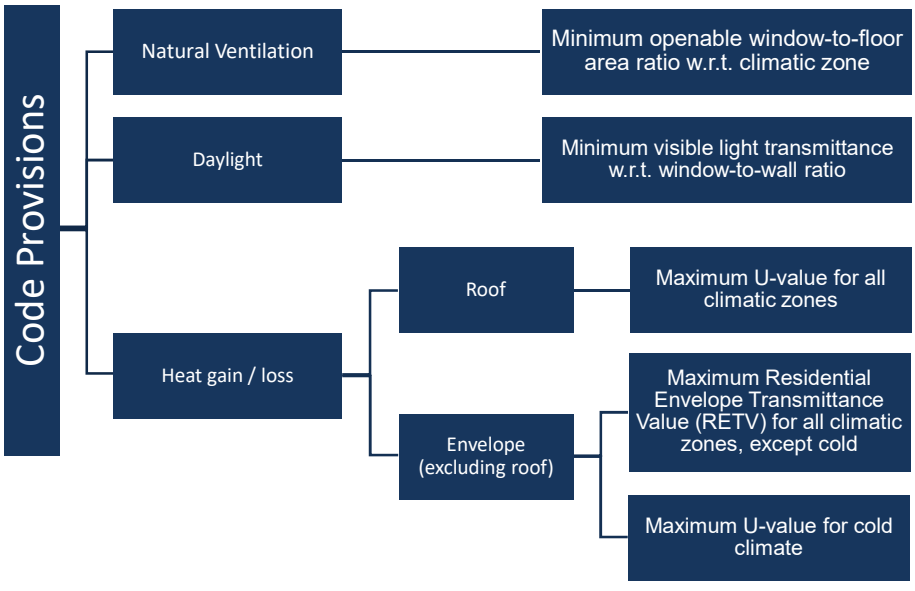
Building envelope provisions to improve thermal comfort and reduce energy consumption

Eco-Niwas Samhita (ENS) 2018: Scope

- Code is applicable to:
  - 'Residential buildings' built on a plot area ≥ 500 m^2
- Building envelope (roof, walls, windows and outside openings)
- Sets minimum building envelope performance standards to
  - Limit heat gains / heat loss
  - Ensuring adequate natural ventilation potential
  - Ensuring adequate daylighting potential.



Eco-Niwas Samhita (ENS) 2018: Code Provisions



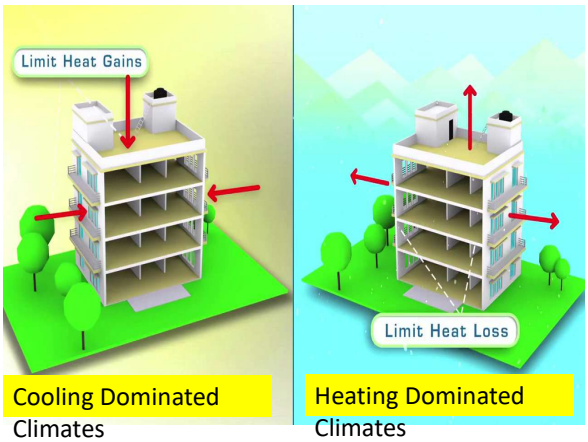
Reducing Heat Gains/ Loss

Roof

- Thermal transmittance of roof (U_{roof}) shall comply with the maximum value of 1.2 W/m^2.K.

Building Envelope (excluding roof)

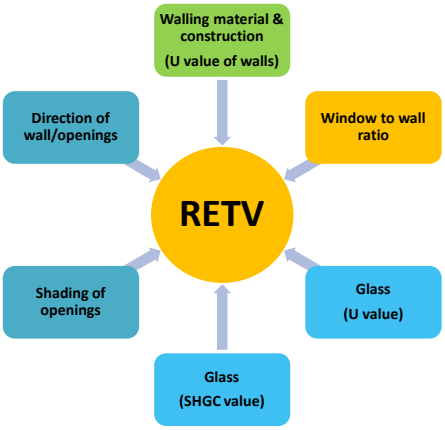
- Residential Envelope Transmittance Value ($RETV$) shall comply with the maximum value of 15 W/m^2 (Except Cold).
- Thermal transmittance of the building envelope ($U_{Envelope}$) for cold climate shall comply with maximum of 1.8 W/m^2.K



Cooling Dominated Climates | Heating Dominated Climates

Residential Envelope Transmittance Value (RETV)

- RETV is the **net heat gain rate** (over the cooling period) through the **building envelope** (excluding roof) of the dwelling units divided by the **area of the building envelope** (excluding roof) of the dwelling units.



RETV Formulation

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

- Dependent on wall properties
- Dependent on window properties
- Dependent on window properties & shading

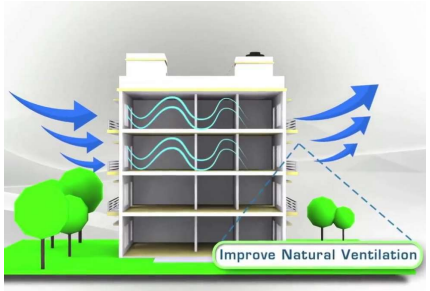
a, b, c: coefficients, based on climatic zone
$A_{envelope}$: envelope area (excluding roof) of dwelling units (m^2)
A_{opaque_i}: areas of wall / opaque part (m^2)
$A_{non-opaque_i}$: areas of glass / non-opaque part (m^2)
U_{opaque_i}: thermal transmittance values of wall / opaque part ($W/m^2.K$)
$U_{non-opaque_i}$: thermal transmittance values of glass / non-opaque part ($W/m^2.K$)
$SHGC_{eq_i}$: equivalent solar heat gain coefficient values of glass / non-opaque part
ω_i: orientation factor

Climate zone	a	b	c
Composite / Hot-Dry	6.06	1.85	68.99
Warm-Humid	5.15	1.31	65.21
Temperate	3.38	0.37	63.69

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

- Provision: **Minimum openable window-to-floor area ratio** (WFR_{op}) with respect to the climatic zone.
- It is the ratio of openable area ($A_{openable}$) to the carpet area (A_{carpet}) of dwelling units.

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



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

Visible Light Transmittance (VLT)

- **Minimum VLT** of the glass used in non-opaque building envelope components (transparent/translucent panels in windows, doors, etc.) **with respect to the window-to-wall ratio (WWR)**
- WWR is the ratio of the area of non-opaque building envelope components of dwelling units to the envelope area (excluding roof) of dwelling units.

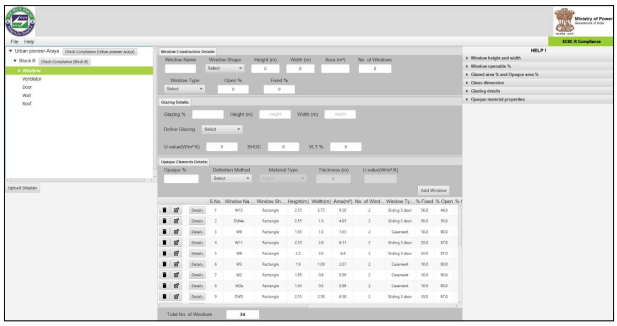
$$WWR = \frac{A_{non-opaqu}}{A_{envelope}}$$

It is advised that:
a) the WWR ≤ 0.15, minimum VLT should be 40% and
b) the WWR in residential buildings may not exceed 0.40

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

About the Tool and hardware / software required

- Offline application; tool along with it's user manual and tool demonstration video, can be downloaded from:
  BEE website or BEEP website
- Runs directly; no need to install



Input

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

Outcome

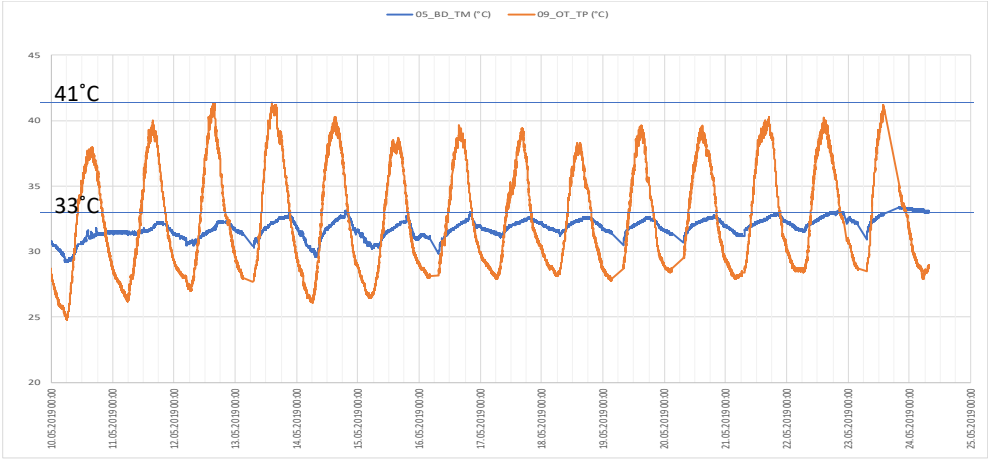
- Code Compliance check
- RETV
- Comparison of different design alternatives

Example of RETV Compliant Building: SmartGHAR-3, Rajkot

- PMAY project by the Rajkot Municipal Corporation
- Wall made of AAC blocks (light weight and good thermal insulation) to reduce heat gains.
- Reflective property (china mosaic) to reduce heat gains
- Adequate window size for natural ventilation
- Proper design and shading of windows to reduce heat gains

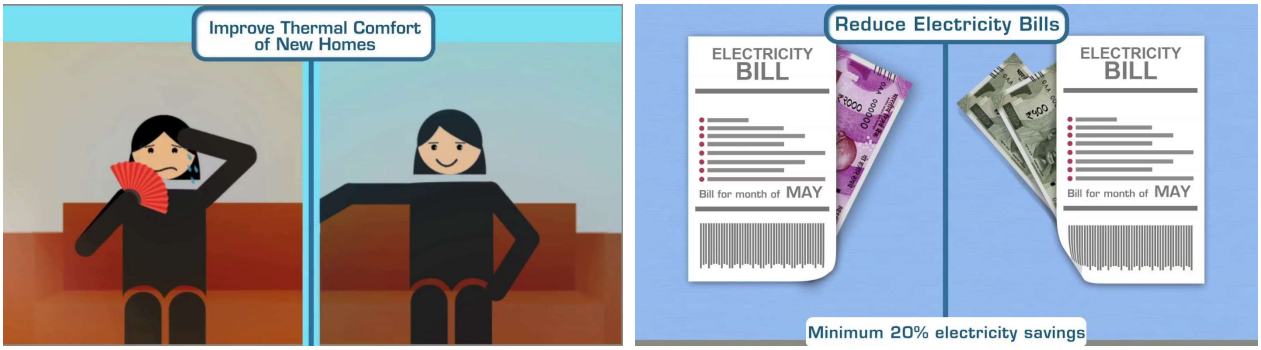



Monitoring of Smart GHAR III: Indoor temperature in Summer



- Improved design helped to reduce RETV from 18.34 W/m^2 to 9.5 W/m^2
- RETV of 9.5W/m^2 helped in keeping the indoor temp below 33ºC even in summer days.

Expected Impacts of ECBC-R Part I (Building Envelope)



- Impact of ECBC-Residential during 2018-2030
  - Minimum 20% energy saving (in cooling) as compared to a typical building
  - 125 billion kWh of electricity saving
  - 100 million tonnes of CO_2 equivalent abatement
  - Improved thermal comfort and daylighting for the residents

Way Forward

- Residential building sector is set to double in 15-20 years with 3 to 4 fold increase in electricity consumption.
- Thus there is a need for the residential building stock to be Energy Efficient, Thermally Comfortable and overall GHG Emission Reduction.
- Effective and quick implementation of simple ECBC-R code with governments at central, state/cities level, holds the key to mainstream energy efficiency in residential buildings.
- Adoption of ECBC-R as the baseline scenario in green rating systems.

ECBC-R Resources

- Code document: https://www.beepindia.org/wp-content/uploads/2013/12/ECBC_BOOK_Web.pdf
- https://beeindia.gov.in/content/ecbc-residential
- Brochure: https://www.beepindia.org/wp-content/uploads/2013/12/Brochure.pdf
- Compliance check tool: https://www.beepindia.org/wp-content/uploads/2013/12/EcoNiwasSamhita_ComplianceCheckTool.zip
- Film: English short version (https://www.youtube.com/watch?v=zg515mlU0dc)
- Film: English long version (https://www.youtube.com/watch?v=EG44gdSuWNE)
- Film: Hindi short version (https://www.youtube.com/watch?v=nyweHmqAPxw)
- Film: Hindi long version (https://www.youtube.com/watch?v=LEAb-iviwRc)
- ECBC-R Compliance tool video tutorial: https://www.youtube.com/watch?v=2SQyKekxpiM
- Support email: pmtu@beepindia.org

Thank you !

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