What are the steps?

Implementing building energy codes and standards

Buildings: Session 7

Buildings energy efficiency sessions in partnership with:

BEEP

INDO-SWISS BUILDING ENERGY EFFICIENCY PROJECT

IFC International Finance Corporation WORLD BANK GROUP

WORLD RESOURCES INSTITUTE

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Energy Efficiency Training Week: Buildings Program

1. **Where to start:** Energy use in buildings
2. **Where to start:** Energy efficiency potential in buildings
3. **Toolkit:** Energy efficient building design
4. **Toolkit:** Energy efficient building technologies

   Where do I get help? IEA's Technology Collaboration Programmes
5. **Toolkit:** Energy efficiency policies and target setting
6. **What are the steps?** Enabling investment with energy efficiency policies
7. **What are the steps?** Implementing building energy codes and standards
8. **What are the steps?** Building operations and procurement

   Special session. The multiple benefits of energy efficiency
9. **Did it work?** Evaluation and energy efficiency indicators

   Where do I get help? International and regional energy efficiency initiatives
10. **Energy efficiency quiz:** Understanding energy efficiency in buildings

7. What are the steps?: Implementing codes and standards

Trainers: Brian Dean and Pierre Jaboyedoff

Purpose: To teach the fundamentals of building energy codes and standards. This course will include discussions of regulation types (e.g. mandatory, voluntary and stretch codes) and compliance paths (e.g. prescriptive, performance and outcome-based).

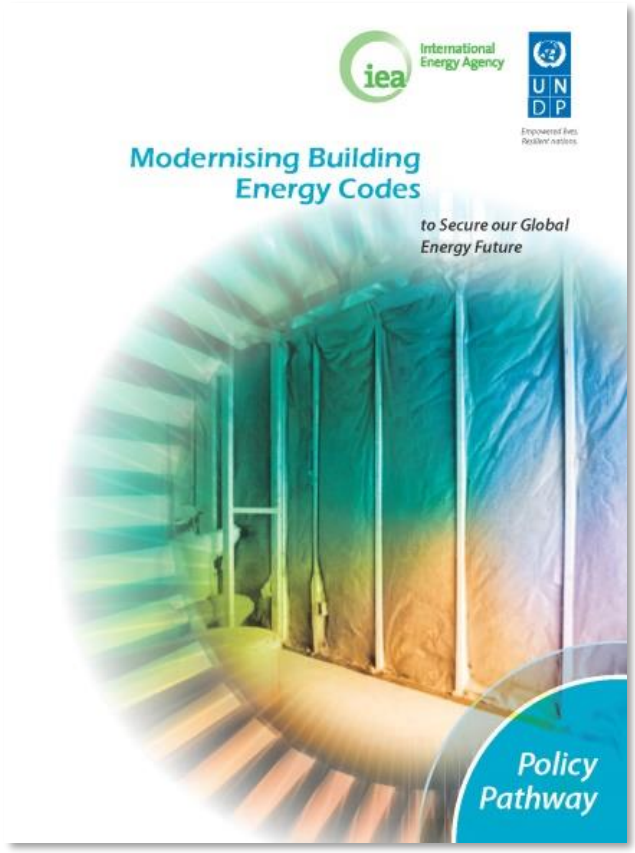
Scenario: A respected industry association claims that the building energy codes are out of date. *How do you advance building energy codes in your jurisdiction?*

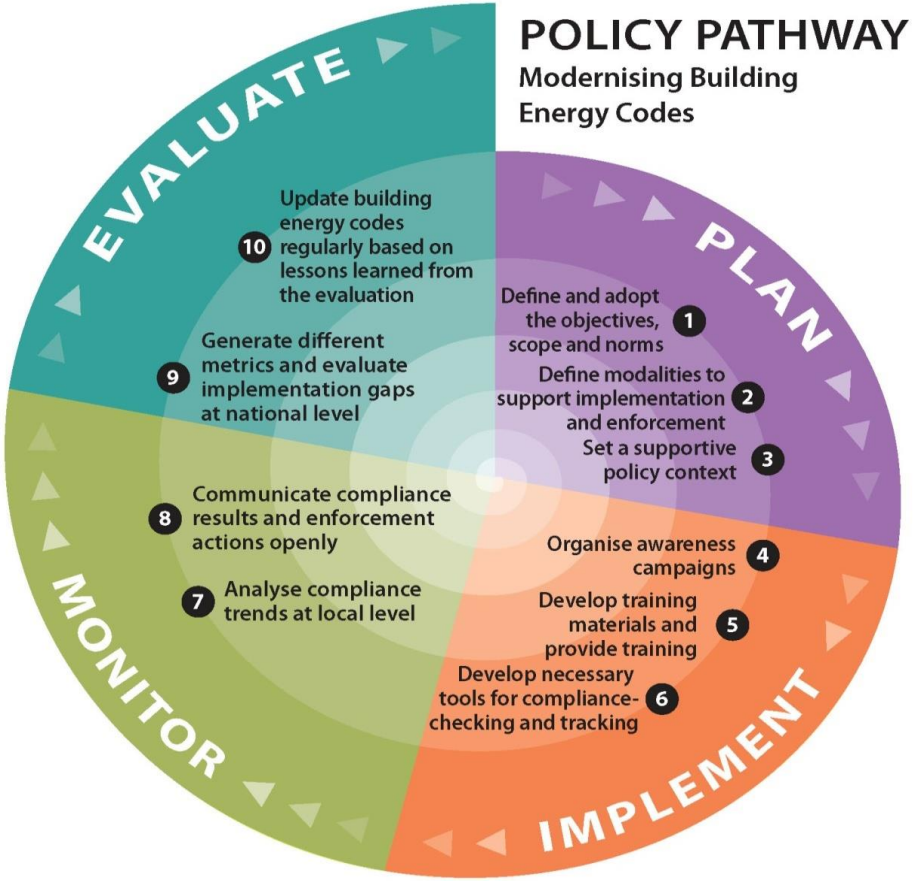
Building energy code vision

Review IEA's Policy Pathway

Set a strategy

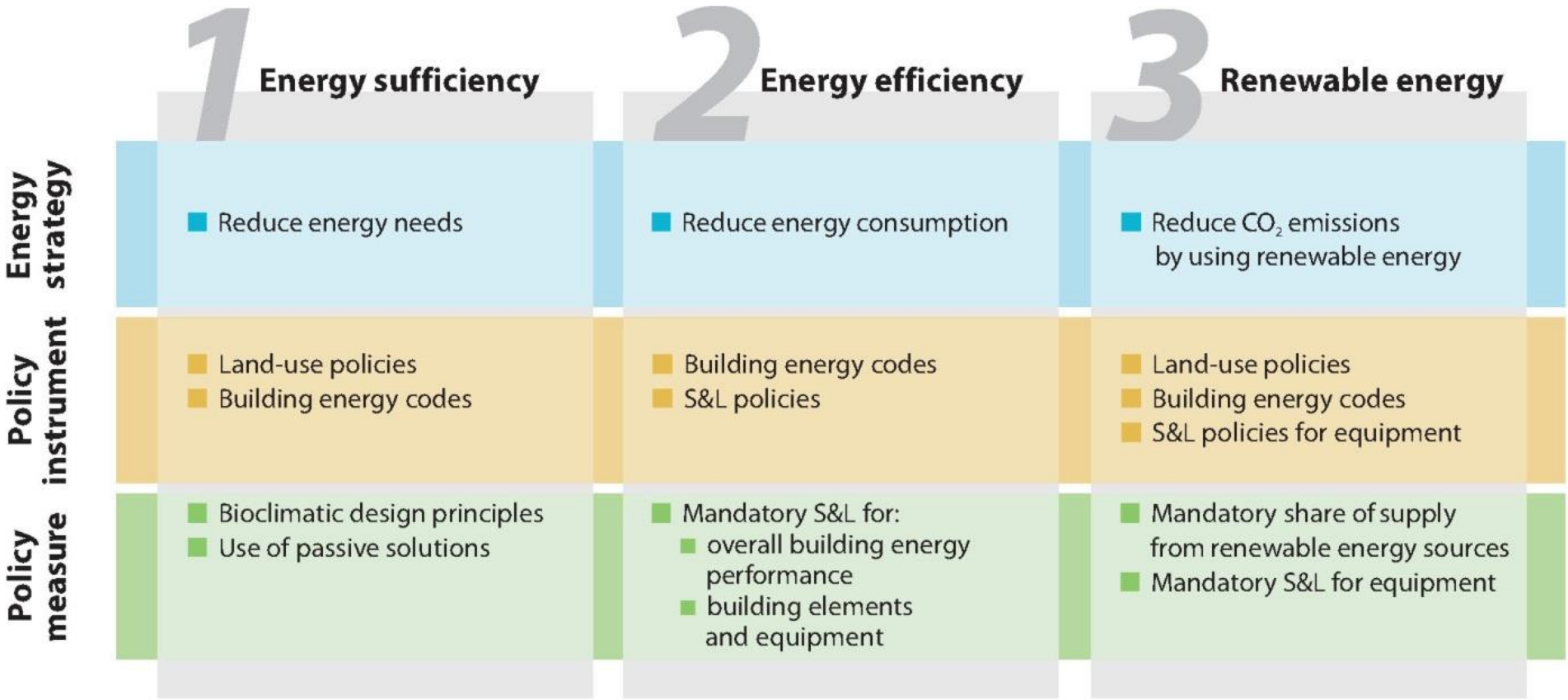
Building energy codes: policy pathway





www.iea.org/publications/policypathwaysseries/

Building energy codes: policy pathway



Building energy code types

Prescriptive

Simple trade-off

Performance

Outcome-based

Building energy code types

1. Prescriptive Codes:

- Specify requirements for key elements such as wall and ceiling insulation, window and doors, roofs, foundations, heating, ventilation air-conditioning, equipment efficiency, water heating, lighting fixtures, and controls.
- Compliance with these codes is commonly assessed by checking the list of prescribed requirements.

2. Simple Trade-Off Codes:

- Allow for trade-offs between similar building components. For example, less efficient insulation for more efficient windows in the building envelope.

3. Performance Codes:

- Specify a minimum required level of energy consumption or intensity for the whole building. They require energy modelling to be conducted at design stage.
- Compliance is commonly checked by comparing the modelled energy performance of the design with a reference building of the same type.

4. Outcome-based Codes:

- Demonstration of performance during the operation of buildings.
- Compliance is typically possible through energy performance certificates or with energy disclosure policies.

Building energy code process

Set roles with stakeholders

Create a roadmap timeline with targets

Understand the steps of implementation

Achieve continuous improvement

Building energy codes: 4-part governance

ASSESS, DEVELOP & IMPROVE

- **Technical Lead**: TBD
- **Policy Lead:** TBD
- **Support**: Stakeholders

1. Plan & Development

2. Adoption & Adaptation

- **Lead**: Implementing jurisdiction
- **Technical Support**: TBD
- **Policy Support:** TBD

IMPLEMENT

4. Review & Update

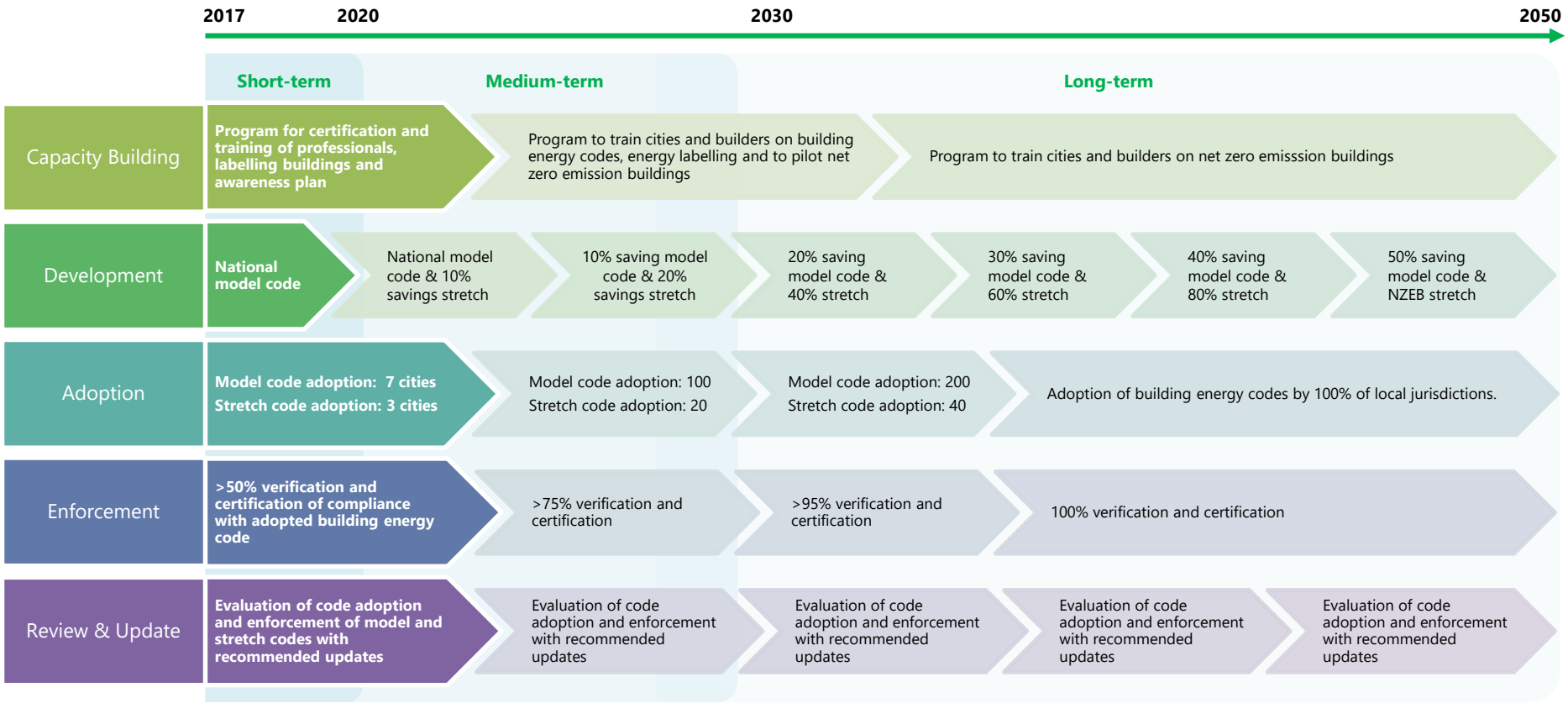
- **Lead**: TBD
- **Support**: Stakeholders

3. Enforcement & Certification

- **Lead**: Implementing jurisdiction
- **Support**: TBD

Source: Mexico and IEA

Building energy codes: 4-part governance roadmap



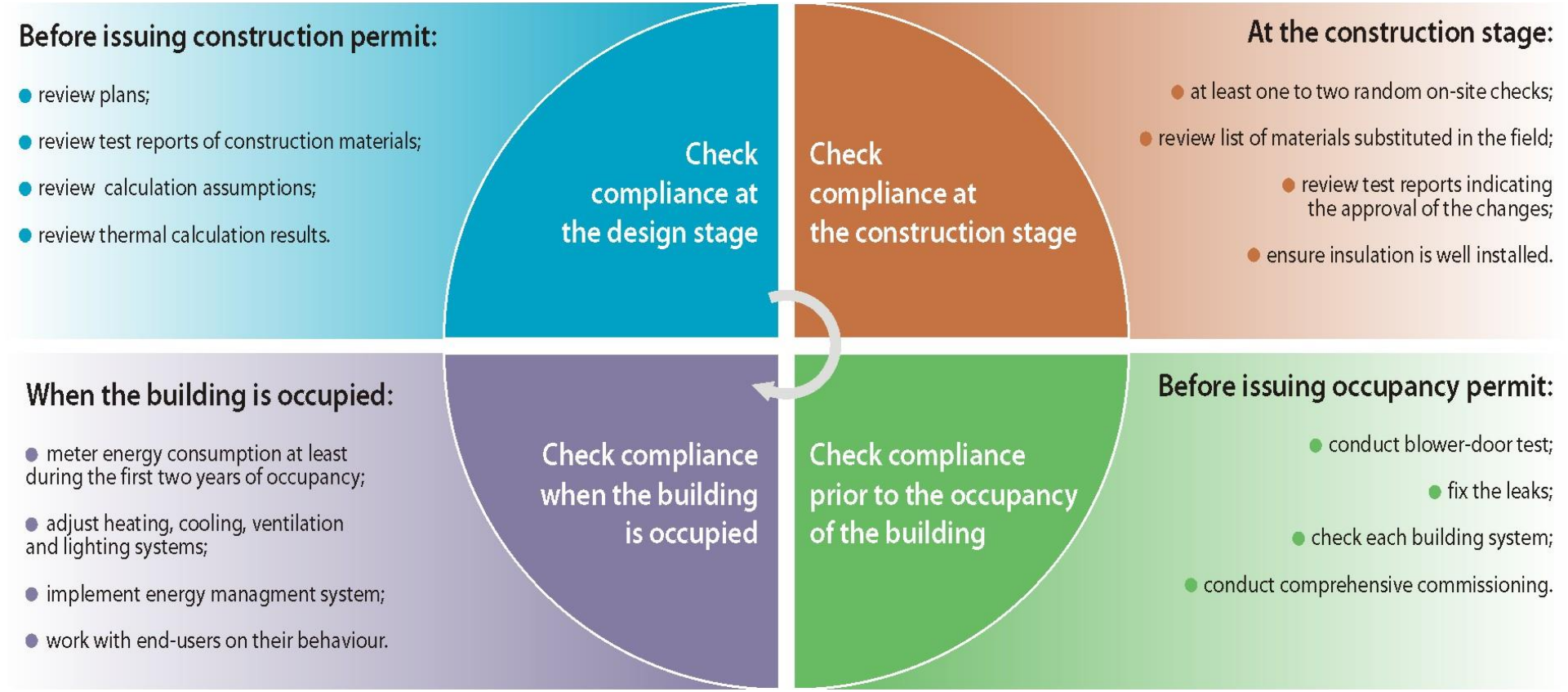
Source: Mexico and IEA

Achievable and aspirational building energy codes

- **Model code:** a code that is used as a basis for multiple jurisdictions to adopt and implement

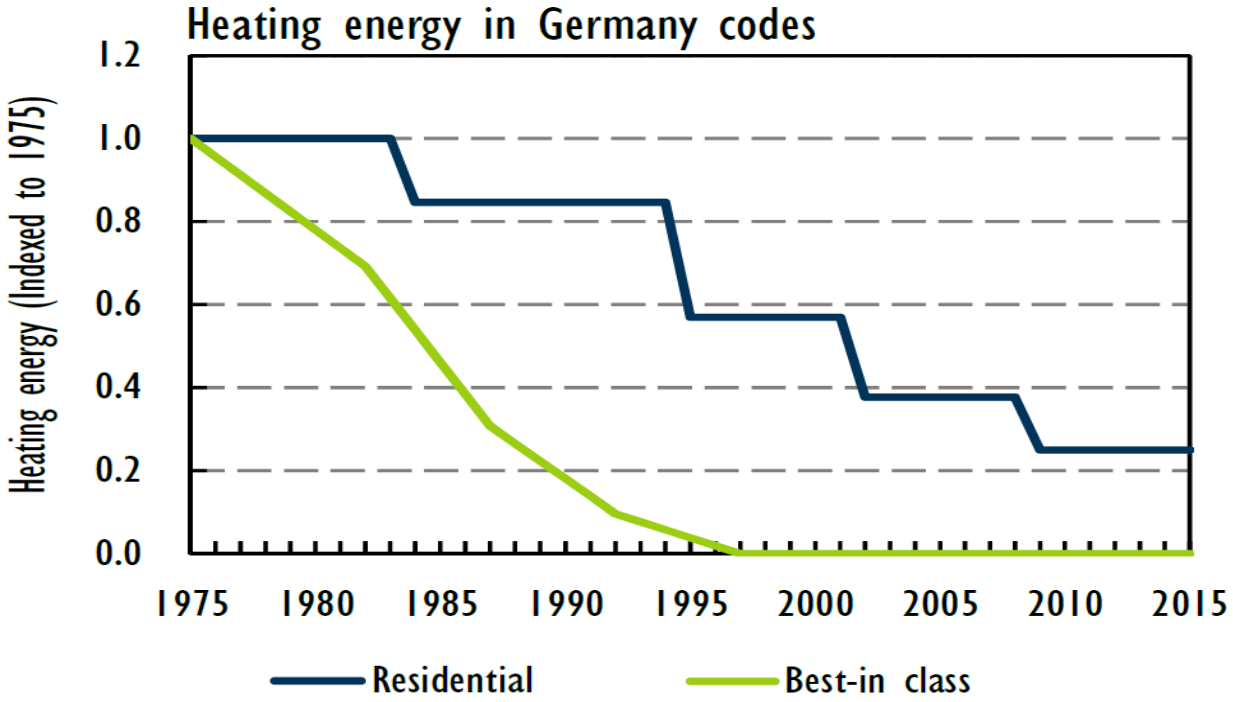
- **Stretch code:** a code that has higher energy efficiency requirements than the base model code.
  - To allow local jurisdictions to adoption higher energy efficiency requirements
  - To enable incentive programs tied to higher efficiency levels

Building energy codes: implementation



Building energy code continuous improvement - Germany

Germany has used increasing **regulation** and increasing **technology R&D** to achieve a 75% reduction in heating energy use from 1975-2015



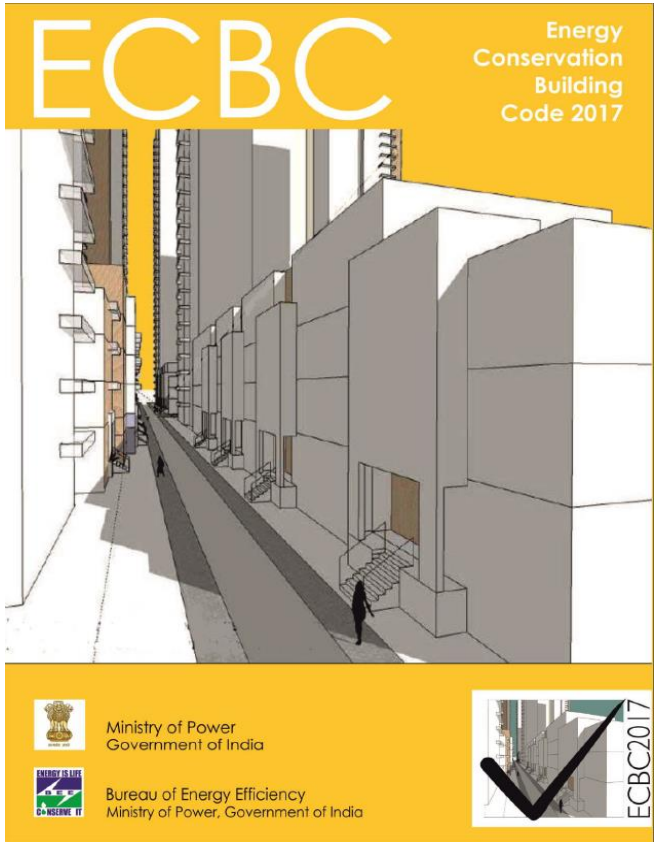
Source: IEA Energy Efficiency Market Report

Building energy codes:

India's Energy Conservation Building Code

India's Energy Conservation Building Code - Residential

India's Energy Conservation Building Code 2017

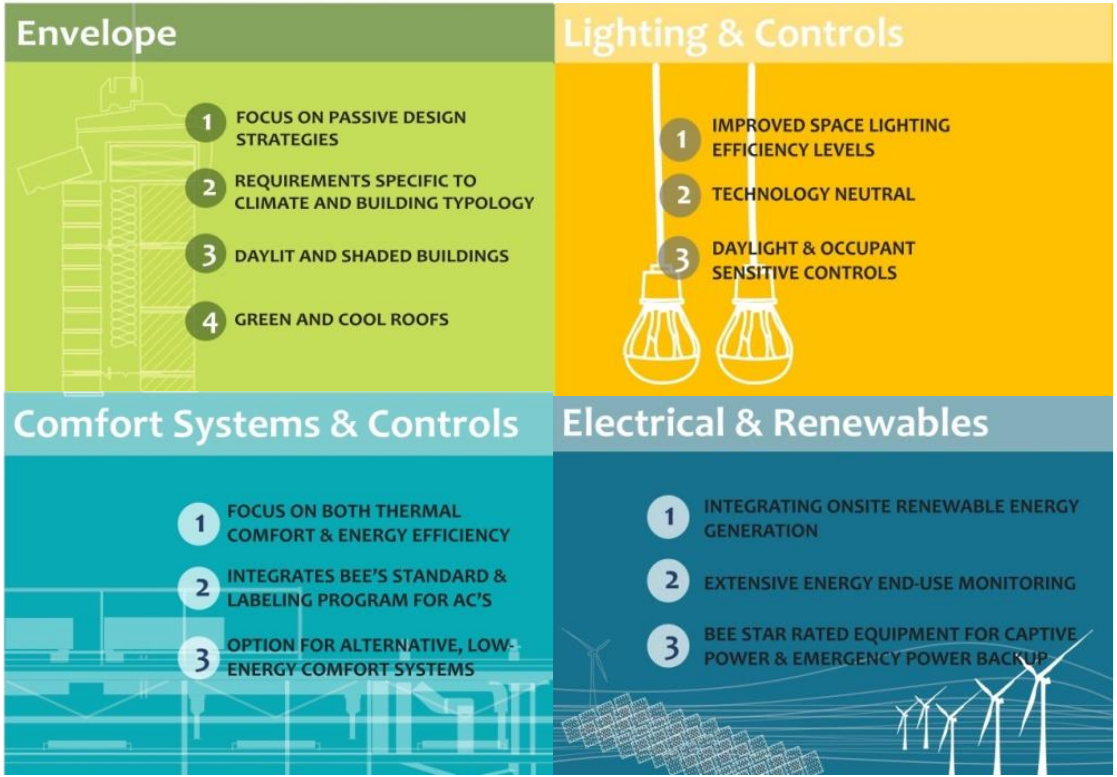


Code update process:

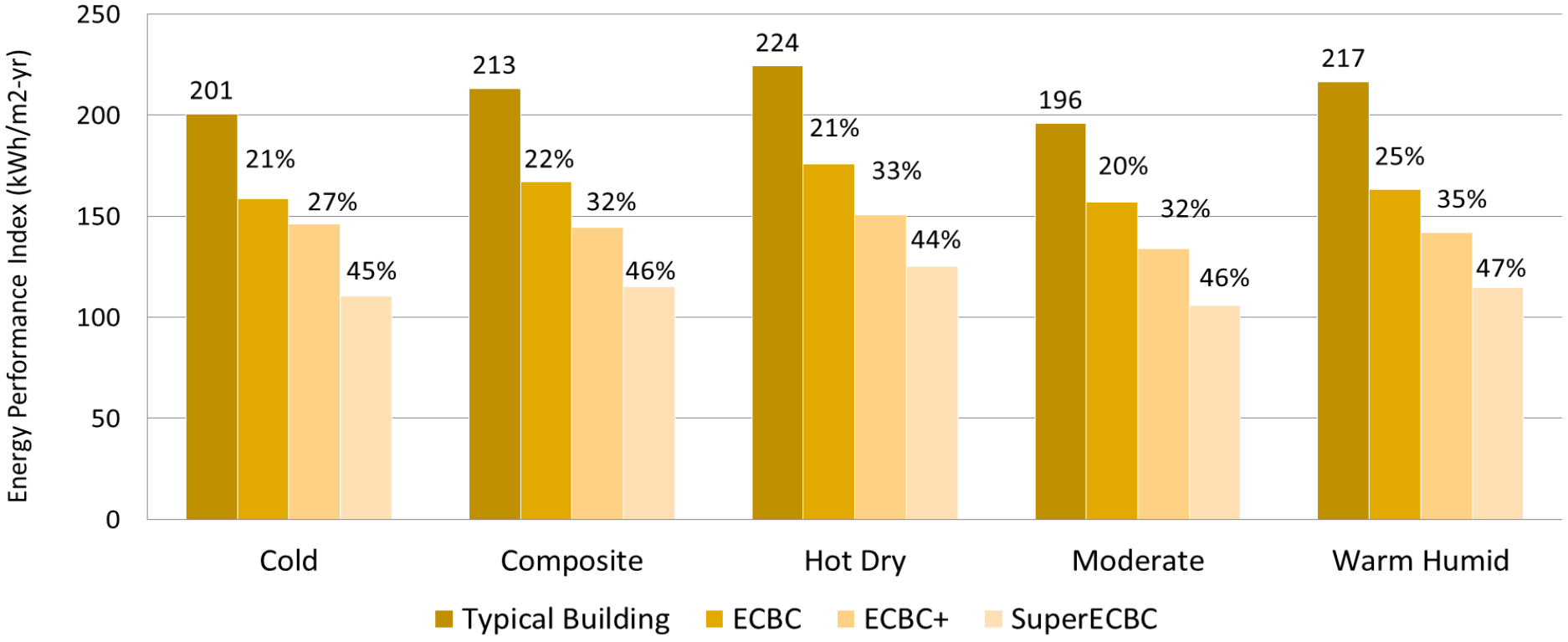
- **Working Groups**
  - Market Assessment
  - Technical Analysis
  - International Best Practice
  - Expert Comments
- **Technical Committee**
  - Regional and National Workshops
  - Public Consultation
- **Steering Committee**
  - Overall Review and Guidance

India's Energy Conservation Building Code 2017: Objective

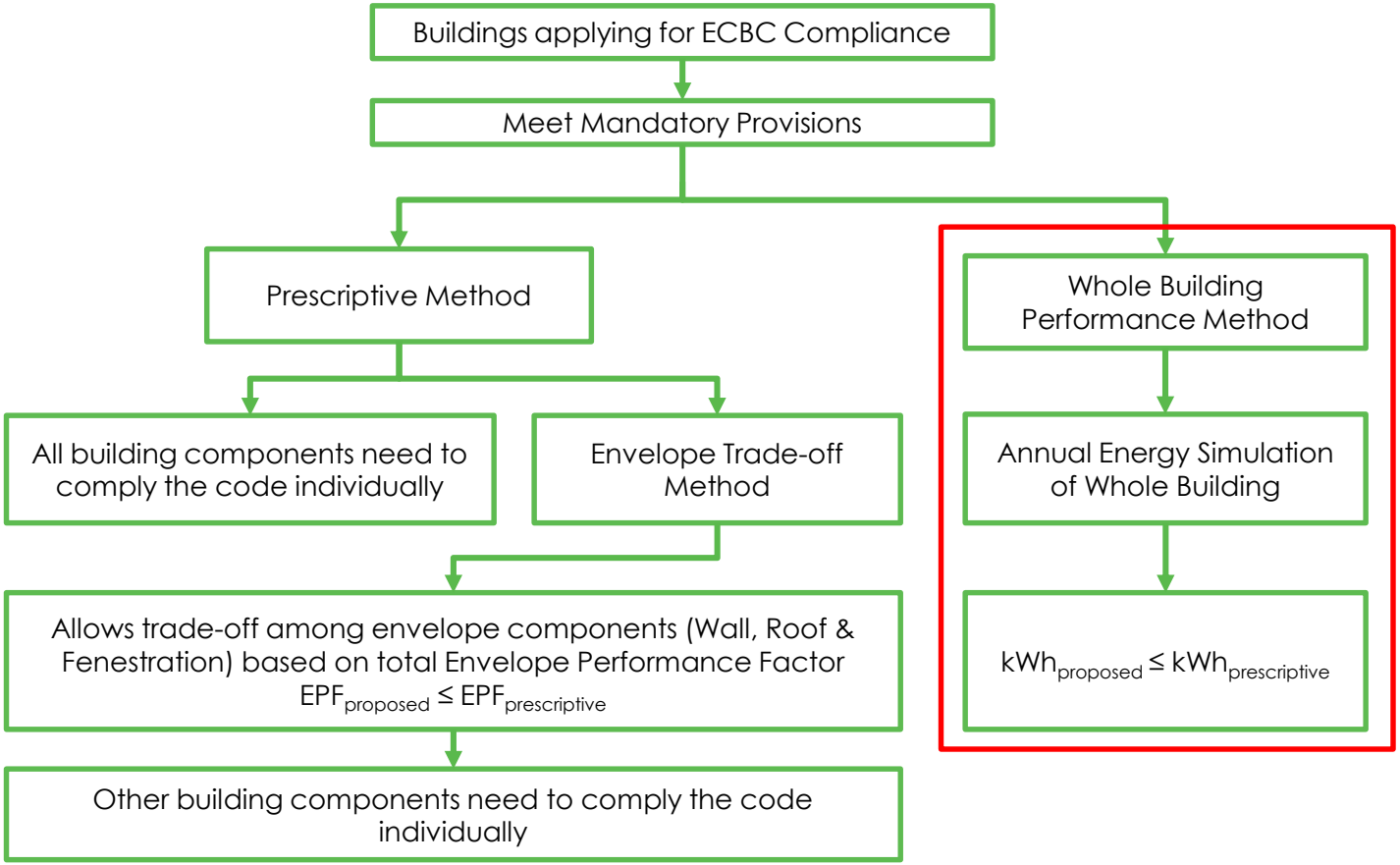
- Systematic implementation and enforcement
- Strong push towards energy efficiency
- Net Zero Energy Building Vision by matching both energy efficiency and renewable energy
- Response to recent technological advancements
- Applicable to various categories of buildings and passive design strategies
- Technology neutral



India's Energy Conservation Building Code 2017: Estimated impact



India's Energy Conservation Building Code 2017: Compliance



India's Energy Conservation Building Code 2017: Compliance

- If all requirements of the prescriptive path are met, then the building is deemed to have an EPI ratio of 1
- For performance path and EPI ratio of ECBC compliant building = 1 [mandatory]
- EPI ratio of ECBC+ and SuperECBC buildings varies based on table for different building types in different climate zones

$$EPI\ Ratio = \frac{EPI\ of\ the\ Proposed\ Building}{EPI\ of\ the\ Standard\ Building}$$

Building Type	Composite		
	ECBC	ECBC+	SuperECBC
Hotel (No Star and Star)	1	0.91	0.81
Resort	1	0.88	0.76
Hospital	1	0.85	0.77
Outpatient	1	0.85	0.75
Assembly	1	0.86	0.77
Office (Regular Use)	1	0.86	0.78
Office (24Hours)	1	0.88	0.76
Schools and University	1	0.77	0.66
Open Gallery Mall	1	0.85	0.76
Shopping Mall	1	0.86	0.74
Supermarket	1	0.81	0.70
Strip retail	1	0.82	0.68

Energy Conservation Building Code: Implementation status

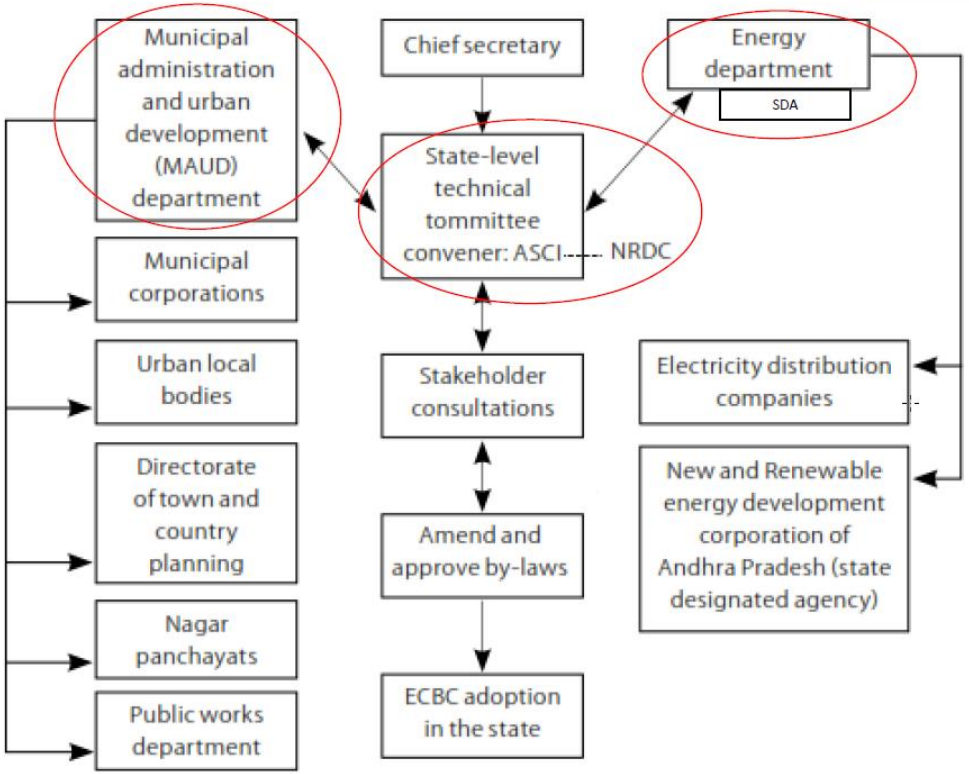
- Status of implementation
- Update ?
- Present status ?
- Towards unified by-laws at State level ? E.g. Gujarat, Rajasthan

State/UT	Andhra Pradesh	Arunachal Pradesh	Assam	Bihar	Chandigarh UT	Chhattisgarh	NCT of Delhi	Goa	Gujarat	Haryana	Himachal Pradesh	Jammu and Kashmir	Jharkhand	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Manipur	Meghalaya	Mizoram	Nagaland	Odisha	Puducherry UT	Punjab	Rajasthan	Sikkim	Tamil Nadu	Telangana	Tripura	Uttar Pradesh	Uttarakhand	West Bengal
ECBC Amendment	✓	✓	✓	✓		✓	✓		✓	✓	✓			✓	✓	✓	✓					✓	✓	✓	✓		✓	✓		✓	✓	✓
ECBC Notification	✓									✓				✓	✓							✓	✓	✓	✓			✓			✓	✓
Notification in state bye-laws	✓									✓																		✓				
Notification at Municipalities	✓																											✓				
Enforcement	✓																											✓				
Schedule of Rates -PWD														✓																		
ECBC Cell	✓			✓		✓	✓			✓	✓			✓	✓	✓	✓					✓		✓				✓		✓		
Training & Capacity Development	✓	✓				✓								✓	✓		✓							✓				✓				
Energy Simulation Software						✓				✓				✓					✓					✓						✓		

Source: UNDP-GEF-BEE, 2017

Energy Conservation Building Code State level governance map

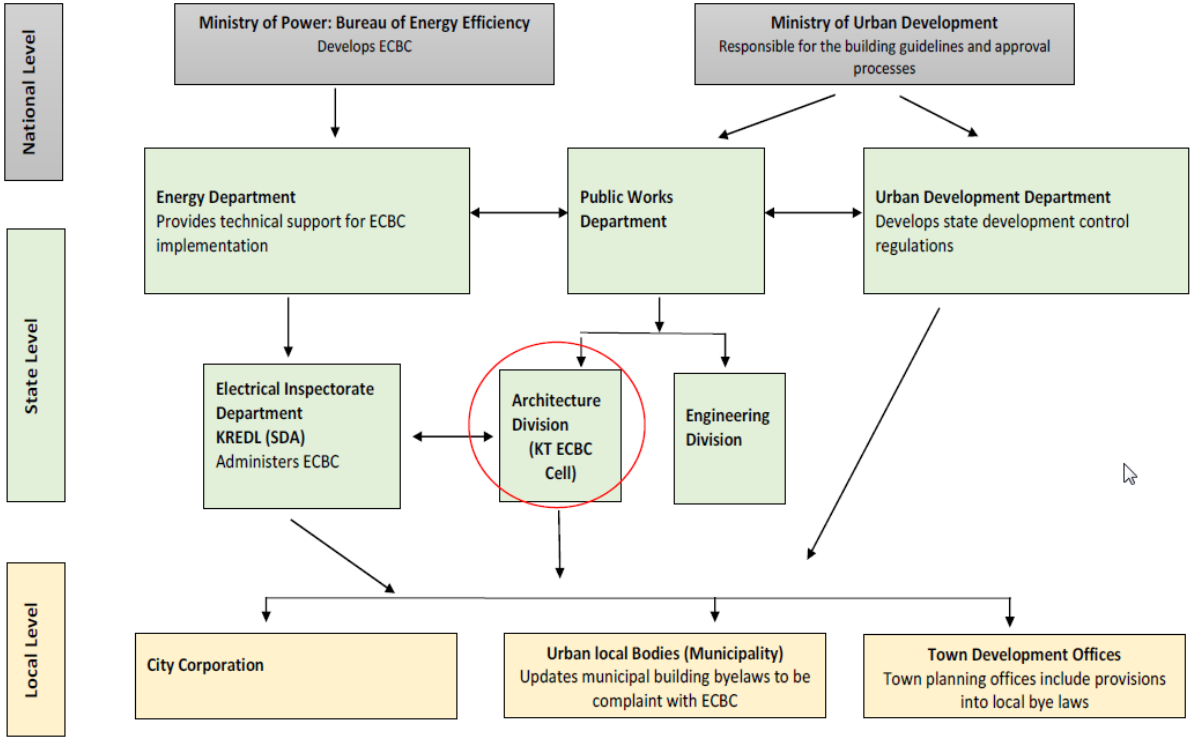
ANDHRA PRADESH & TELANGANA: Illustrative ECBC governance map



Source: Khosla, 2016

Energy Conservation Building Code State level governance map

KARNATAKA: Illustrative ECBC governance map



Source: Khosla

Energy Conservation Building Code

- Questions (text taken from ECBC Delhi 2018)

- *3.1.2.3 EPI Ratio for Core and Shell Buildings*
  - *EPI for core and shell buildings shall be calculated for the entire building based on the final design of the common areas and the relevant mandatory undertaking(s) in the tenant lease agreement for the leased areas, as per §3.1.2.1 or §3.1.2.2.*

- *HVAC Definition ?*
  - *As per drawings ?*
  - *Actual construction ?*
  - *Tenant freedom ?*
  - *Contract with tenants ?*

India's Energy Conservation Building Code - Residential

- Proposed draft ECBC-R development & consultations
  - The approach, the development and the code draft has been reviewed by the Steering Committee, the Technical Committee, by a consultation on the web site of BEE and by consultations in cities like Chennai, Delhi, Calcutta, Mumbai
  - All comments have been taken into account and included in the draft code in consultation with BEE
  - Final draft has been submitted to BEE

COP 24 Indian Pavillion
Monday 10th December at Katowice

Building Energy Efficiency

Energy Conservation Building Code for Residential Buildings

(ECBC-R)

Dr Sameer Maithel

Indo-Swiss Building Energy Efficiency Project (BEEP

ECBC-R application

1.7. The code is applicable to all residential buildings and residential parts of 'mixed land-use projects', both built on a plot area of ≥500 m^2.

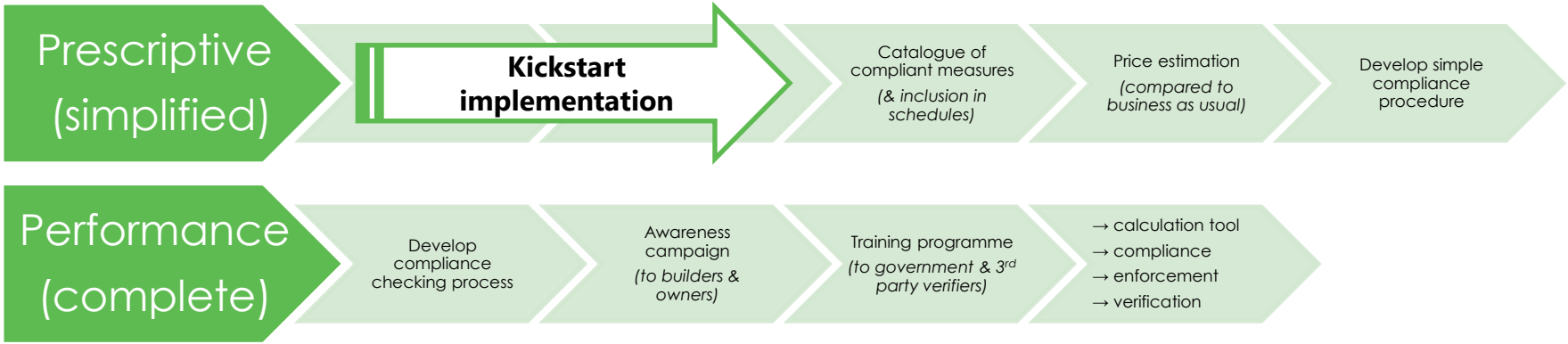
However, states and municipal bodies may reduce the plot area based on the prevalence in their area of jurisdiction.

This provision is kept to take into account the prevalent plot sizes and housing types in different states, enabling the inclusion of a greater percentage of new multi-dwelling unit residential buildings within the scope of this code.

Applicable to all residential buildings built on a plot area of ≥500 m^2

ECBC-R: a simplified two tier process

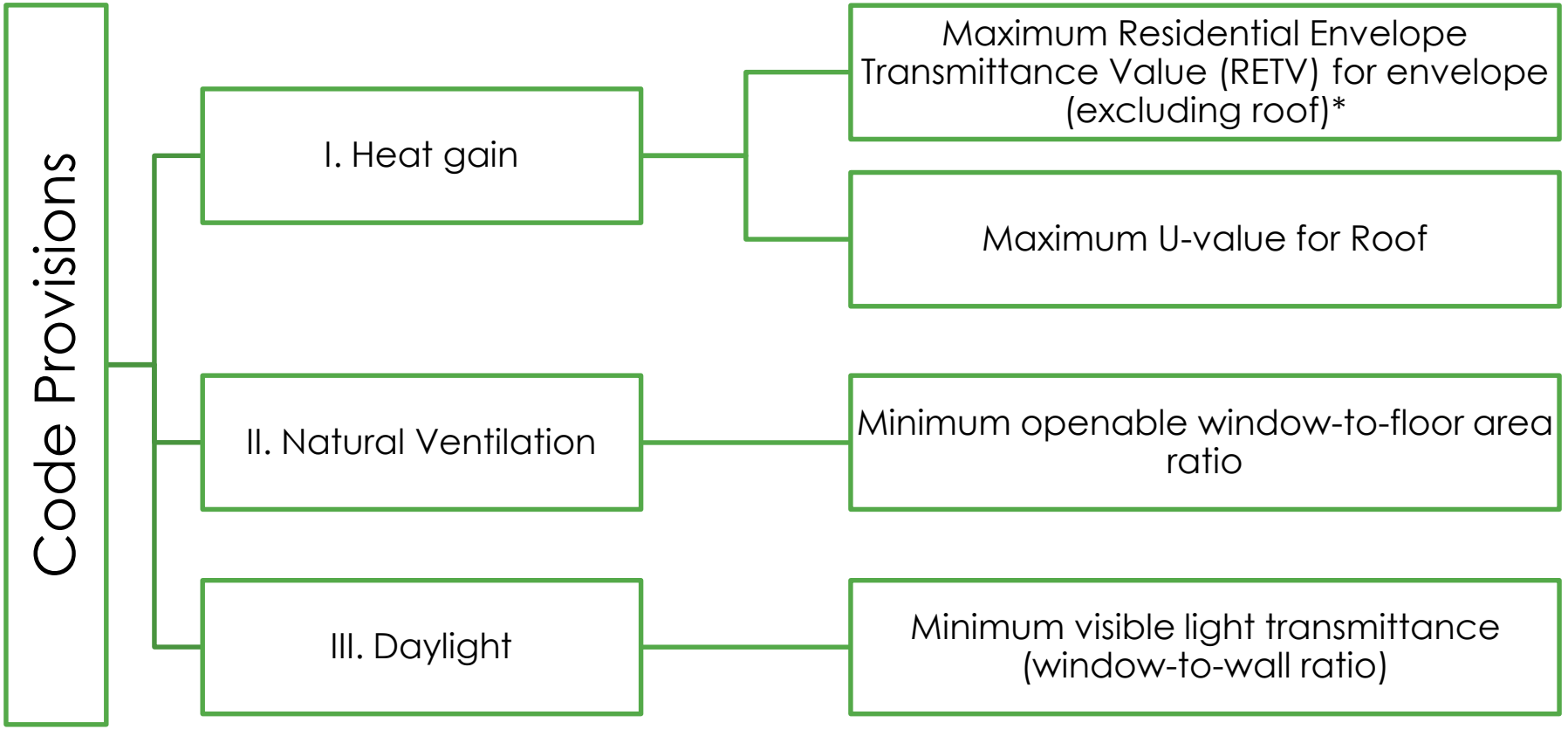
- **Development:** Review experience in the region Singapore, Hong Kong, others…
  - Buildings survey, representative buildings, > 20,000 Energy Plus simulations across climates



- **Adoption and enforcement:** Model bye-laws developed at the national level can be adopted by the states to implement the building code.
  - Rajasthan: www.dnaindia.com/jaipur/report-rajasthan-gets-unified-building-bylaws-2553952

- **Review and update:** Further improvement could be achieved:
  - 15 W/m^2 can be lowered to 12 W/m^2

ECBC-R: building envelope requirements



* The RETV provisions are for all climates except the cold climate.

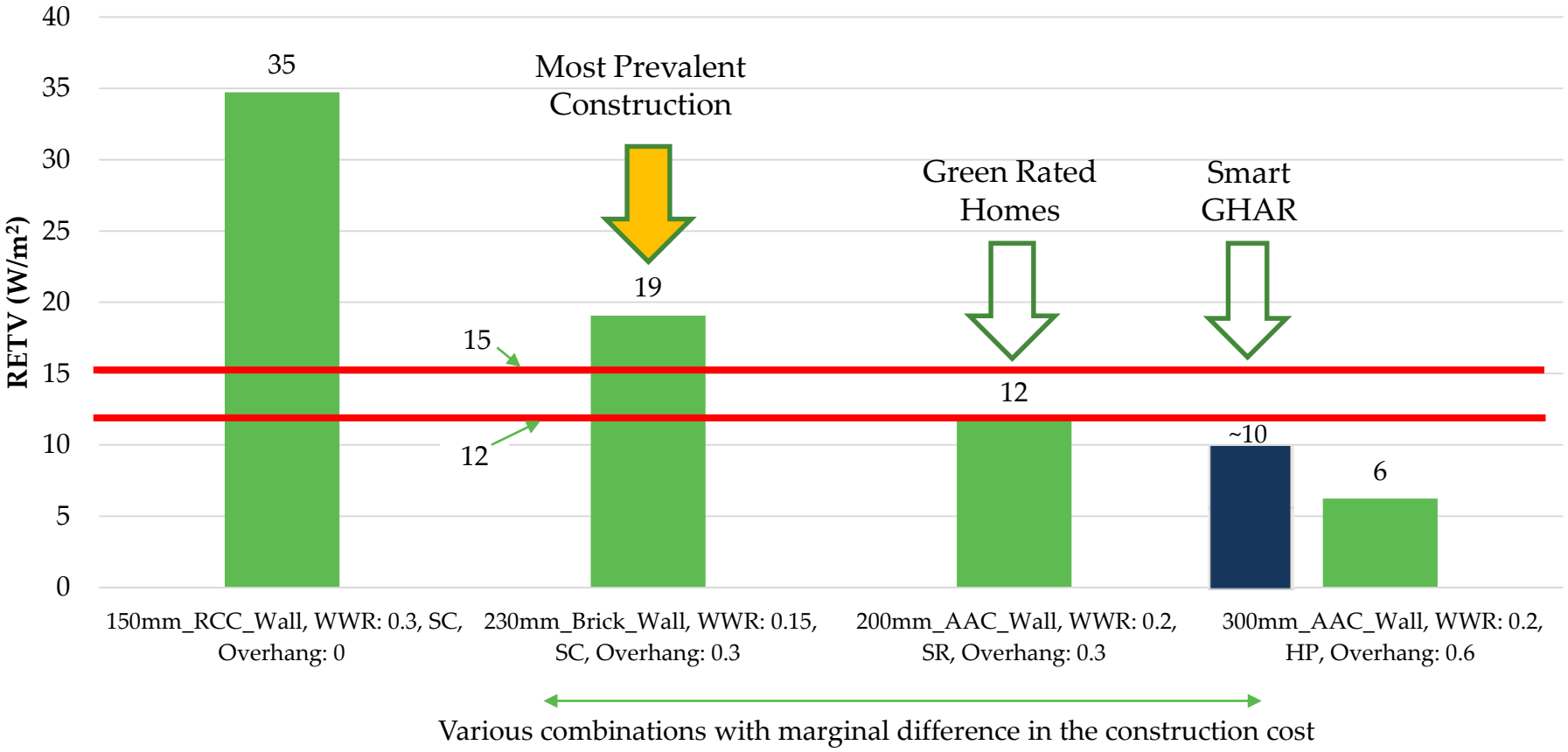
Reducing Heat Gain: Code objective & provisions

To limit the heat gain/loss from the building envelope, the code specifies:

Maximum value of thermal transmittance of roof (U_{roof}= 1.2 W/m^2.K) for all climate zones

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

Typical RETV for different construction types (Threshold = 15 W/m²)



Process for Energy Simulation

Pre-processing

- Selection of floor plan and building typology; geometric modelling - Template model
- Parameter for simulation cases (Cooling, Wall type, Glass type, Shading, WWR, Operable window to floor area ratio, Orientation, Wind)
- Generation of multiple EnergyPlus simulation input files

Energy Simulation

- One of the most advanced, widely used and accepted simulation program for whole building energy simulation
- All simulations are done using "EnergyPlus"

Post-processing

- Extraction of selected results (heat conduction from each exposed wall & window, transmitted solar through windows, hourly operative temperatures, sensible (thermal) heat loads, cooling by ventilation, etc.)
- Customized programming (automated) to collect and process simulation results to calculate key indicator (heat gains per unit exposed envelope area, DDH wrt IMAC, sensible cooling load per unit floor area)

Group discussion

Scenario:

A respected industry association claims that the building energy codes are out of date.

How do you go about testing this claim, and what do you do if this information is correct?

- ***What indicators are important in your state?***
- ***What code types?***
- ***How would the process work for you?***

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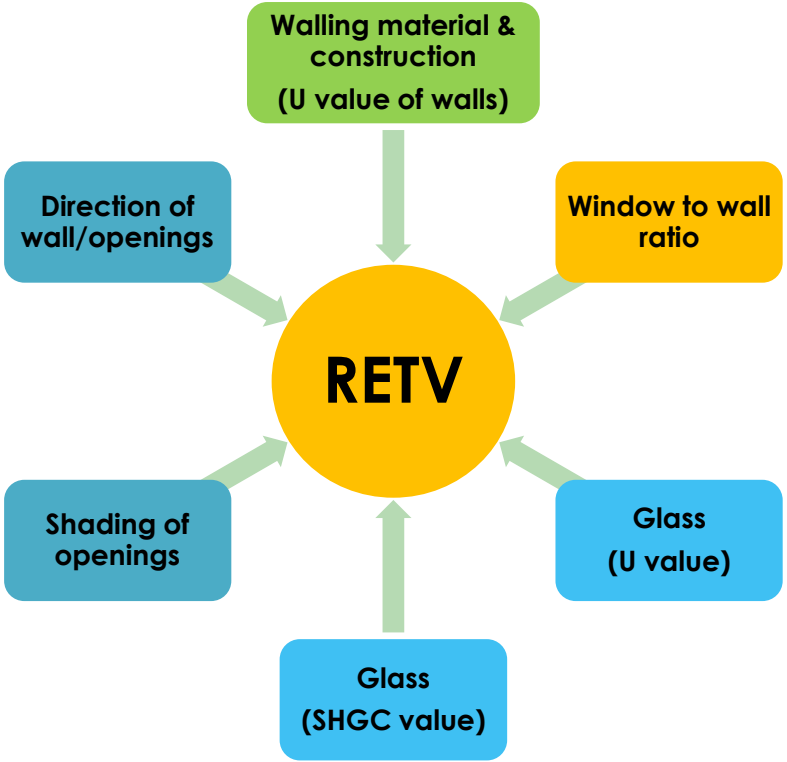
Residential Envelope Transmittance Value (RETV): Design Parameters



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

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

Maximum RETV for all climates (except cold climate) is 15 W/m²

Openable area for natural ventilation

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

$$WFR_{op} = \frac{A_{openable}}{A_{built-up}}$$

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

From draft proposed ECBC-R

RETV Formula

3.4.3 The RETV calculation of the building envelope shall be carried out separately for each orientation of the building, using Equation 3 or 3.1 as shown below. The RETV of all orientations shall be combined as per the relative envelope areas in each orientation to get the total RETV of the building (See Annexure 8 Example 1).

1st Term

2nd Term

3rd Term

$$RETV = a \times (1 - WWR) \times U_{opaque} \times \omega + b \times WWR \times U_{non-opaque} \times \omega + c \times WWR \times SHGC_{eq} \times \omega$$

where,

RETV : residential envelope transmittance value (W/m²)

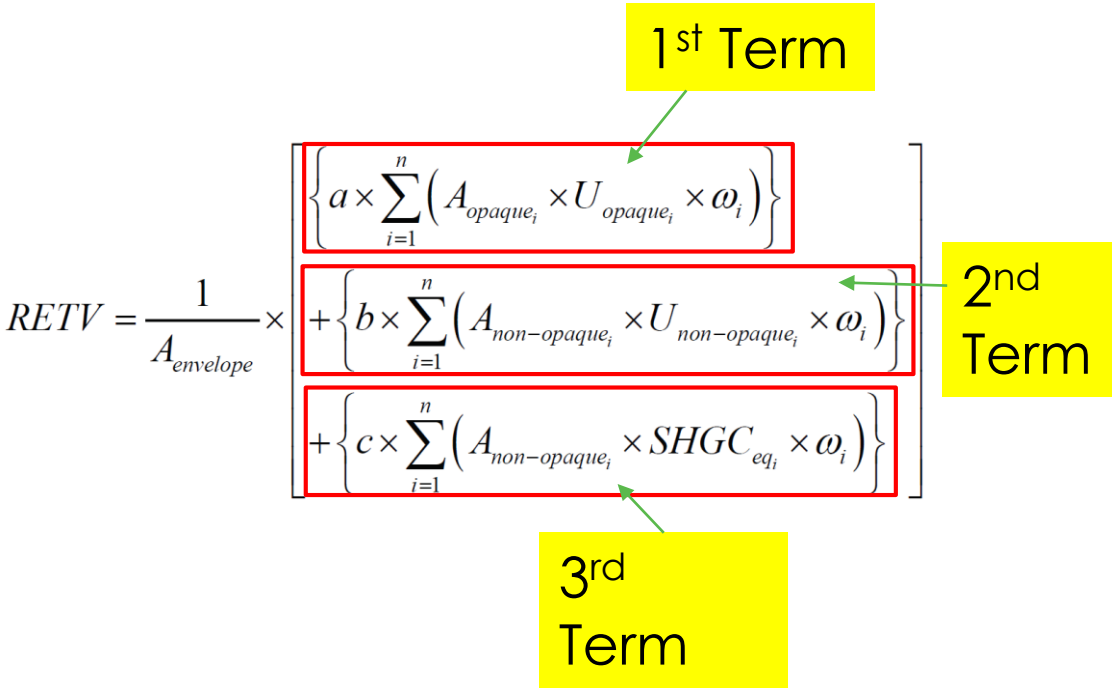
WWR : window-to-wall ratio; it is the ratio of the non-opaque building envelope components area of dwelling units to the envelope area (excluding roof) of dwelling units

---

14 BEE plans to improve the RETV norm to 12 W/m² in the near future and the building industry and regulating agencies are encouraged to aim for it.

Characterizing the performance of the building envelope

Residential Envelope Transmittance Value (RETV) (W/m2) is the net heat gain rate (over the cooling period) through building envelope (excluding roof) divided by the area of building envelope (excluding roof). Its unit is W/m².



a, b, c: coefficients, based on climatic zone
$A_{envelope}$: envelope area (excluding roof) of dwelling units (m²)

A_{opaque_i}: areas of wall / opaque part (m²)

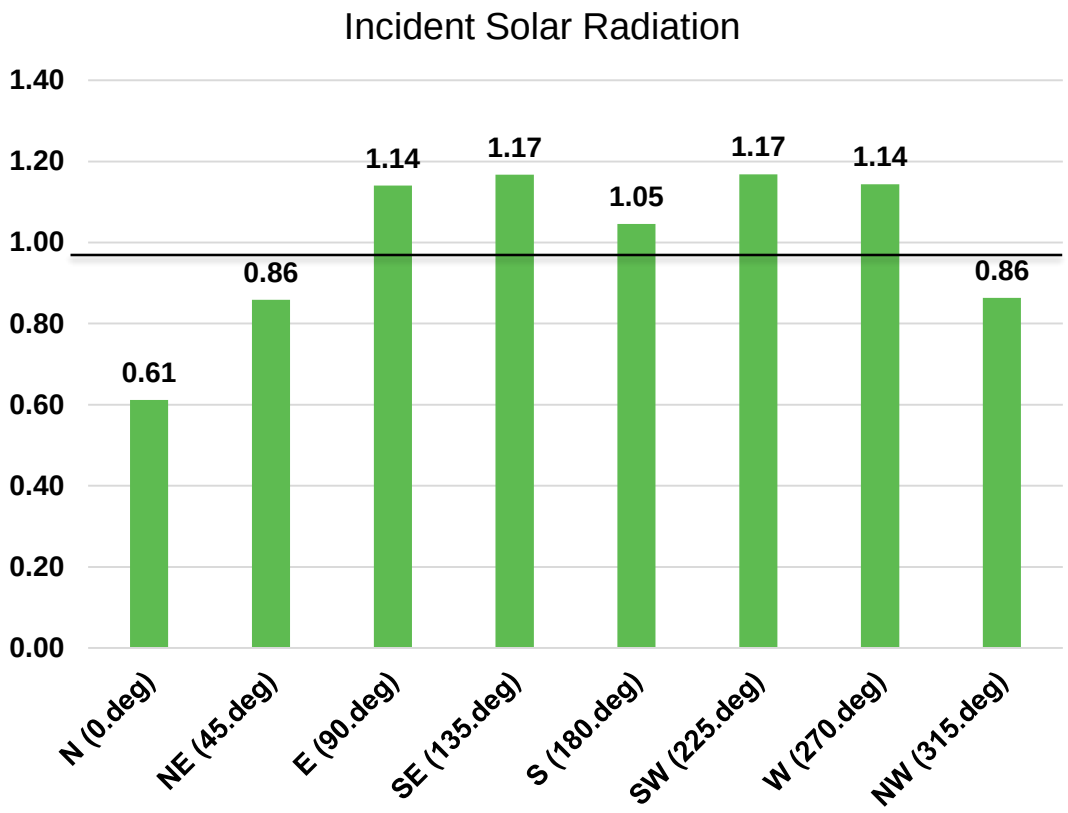
U_{opaque_i}: thermal transmittance values of wall / opaque part (W/m².K)

$A_{non-opaque_i}$: areas of glass / non-opaque part (m²)

$U_{non-opaque_i}$: thermal transmittance values of glass / non-opaque part (W/m².K)

$SHGC_{eq_i}$: equivalent solar heat gain coefficient values of glass / non-opaque part
ω_i: orientation factor

Orientation Factor



Accounts for variation in incident solar radiation falling on walls with different orientations

Solar radiation falling on "South-West" orientation is almost "Double" as compared to "North" orientation.

Worst orientations must be treated first

ECBC-R: a simplified two Tiers road map

Hypothesis

1. After BEE releases ECBC-R
2. MoUD via the TCPO include it (all or part) in the model Bye-laws
3. Model Bye-laws can be used by the States in some states which have unified Building Bye Laws)

- http://mohua.gov.in/cms/Model-Building-Bye-Laws.php