International Energy Agency

Building planning and design

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The trainers

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Introductory roundtable

Introduce yourself !
Name, country, organisation

State one buildings policy or technology you think is the most promising for your region

State the most interesting thing you learned from the previous session

Over the next 3 days:
Speak up and engage with others
Ask questions, give answers

How the session will work

1. Introduction to the subtopics
2. Setting the level of ambition: what are we trying to achieve?
3. Identifying Technology Gaps
4. Identifying Policy Gaps
5. Identifying the “Enablers”
6. Identifying the Key Actions

Fill in templates for:

- technology timeline
- policy timeline
- key actions

Roadmap for Buildings and Construction

Global Alliance for Buildings and Construction

Current 8 strategic priority areas:

1. Urban planning: use urban planning policies to enable reduced energy demand, increased renewable energy capacity and improved infrastructure resilience.
2. New buildings: Increase uptake of new buildings with net-zero operating emissions.
3. Building retrofits: Increase the rate of building energy renovation and increase the level of sustainability in existing buildings.
4. Building operations: Reduce the operating energy and emissions through improved energy management tools and operational capacity building.
5. Systems: Reduce the energy and emissions needed for equipment, appliances, lighting and cooking.
6. Materials: Reduce the environmental impact of materials and products in buildings and construction by taking a life-cycle and circular economy approach.
7. Resilience: Reduce building risks related to climate change through building design, selection of materials and improving resilience to structural, water and heat risks.
8. Clean energy: Increase secure, affordable and sustainable energy and reduce the carbon footprint of energy demand in buildings.

1. Introduction to the subtopics

New buildings and retrofits

Buildings don't use energy, people do:

How to **design** buildings so that their systems need the **least** amount of energy possible to operate?

This module will cover measures to improve the design of new buildings, and to increase the energy efficiency of existing buildings through retrofits.

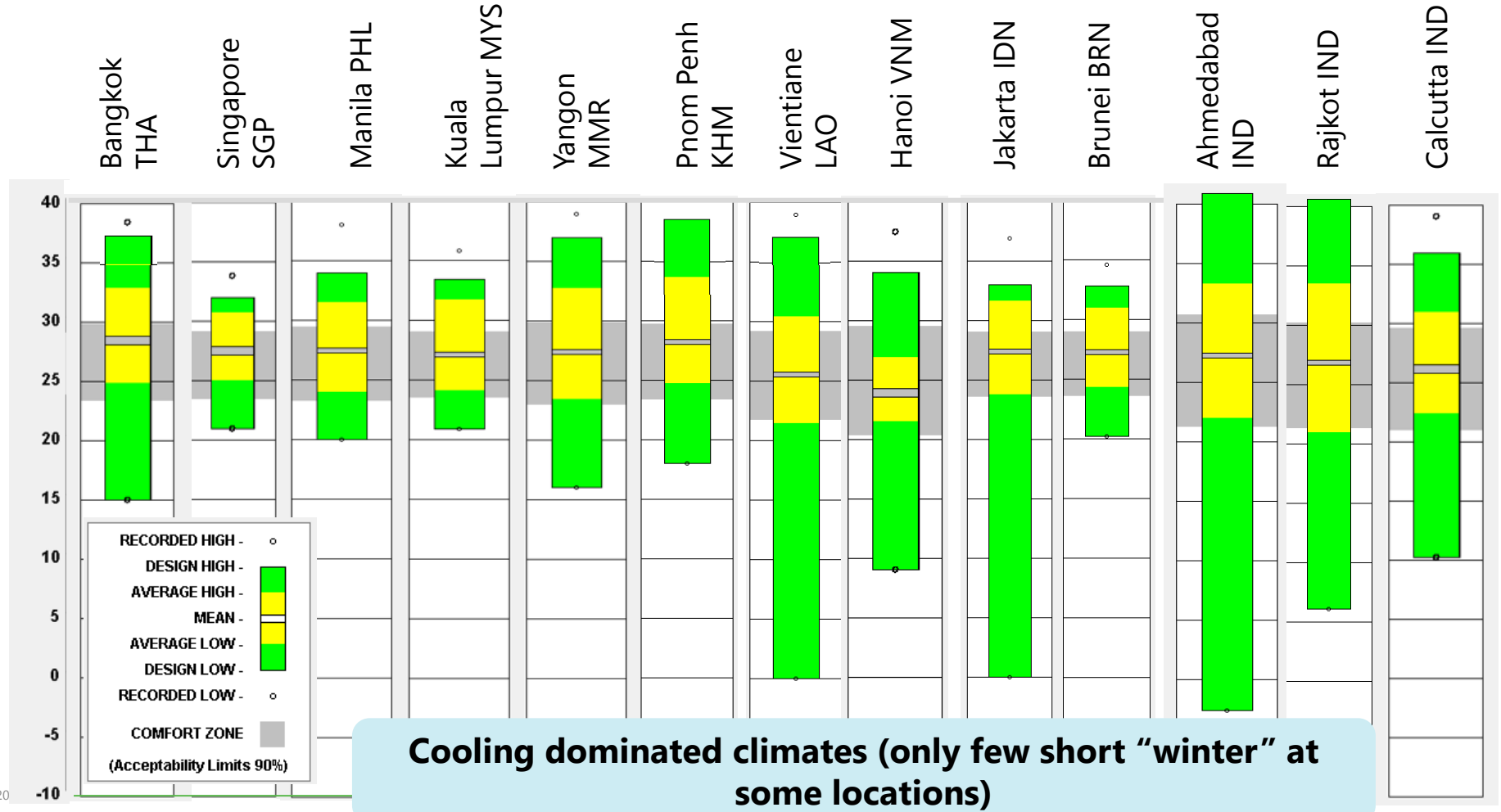
Typology differences

Comparison	Office buildings	Residential buildings
Heat gains in summer	Internal gains and HVAC are generally dominant	Envelope heat gains are dominant
Occupation	Mostly day time	Mostly night time and week-ends
Envelope area ratio to floor area	Higher HVAC needs for deeper floor plates	2-4 times higher than commercial buildings
Peak temperature	Controlled by HVAC	Controlled by building envelope quality (and decentralised AC)
Energy for cooling	Depends essentially on internal gains and HVAC system	Depends essentially on envelope quality
Comfort expectations	Adaptive cooling difficult to apply	Mostly adaptive

Systems critical (Module 2)

Passive measures critical

Temperatures (annual variations)



Cooling dominated climates (only few short "winter" at some locations)

Roadmap for Buildings and Construction

Global Alliance for Buildings and Construction

Set targets for:

- Urban planning
- New buildings
- Building retrofits
- Building operations
- Systems
- Materials
- Resilience
- Clean energy

All new buildings to achieve:

- (Nearly) net zero operating emissions
- Energy system-level net zero emissions

Achieve these through:

- Decarbonisation targets
- Thermal regulations
- Incentives
- Mixed use buildings
- Building passport
- Building and system commissioning
- Technology and knowledge transfer

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Set targets for:

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- Clean energy

Existing building physical improvements:
- Increased renovation rates
- Deep energy renovations
- Public building renovations

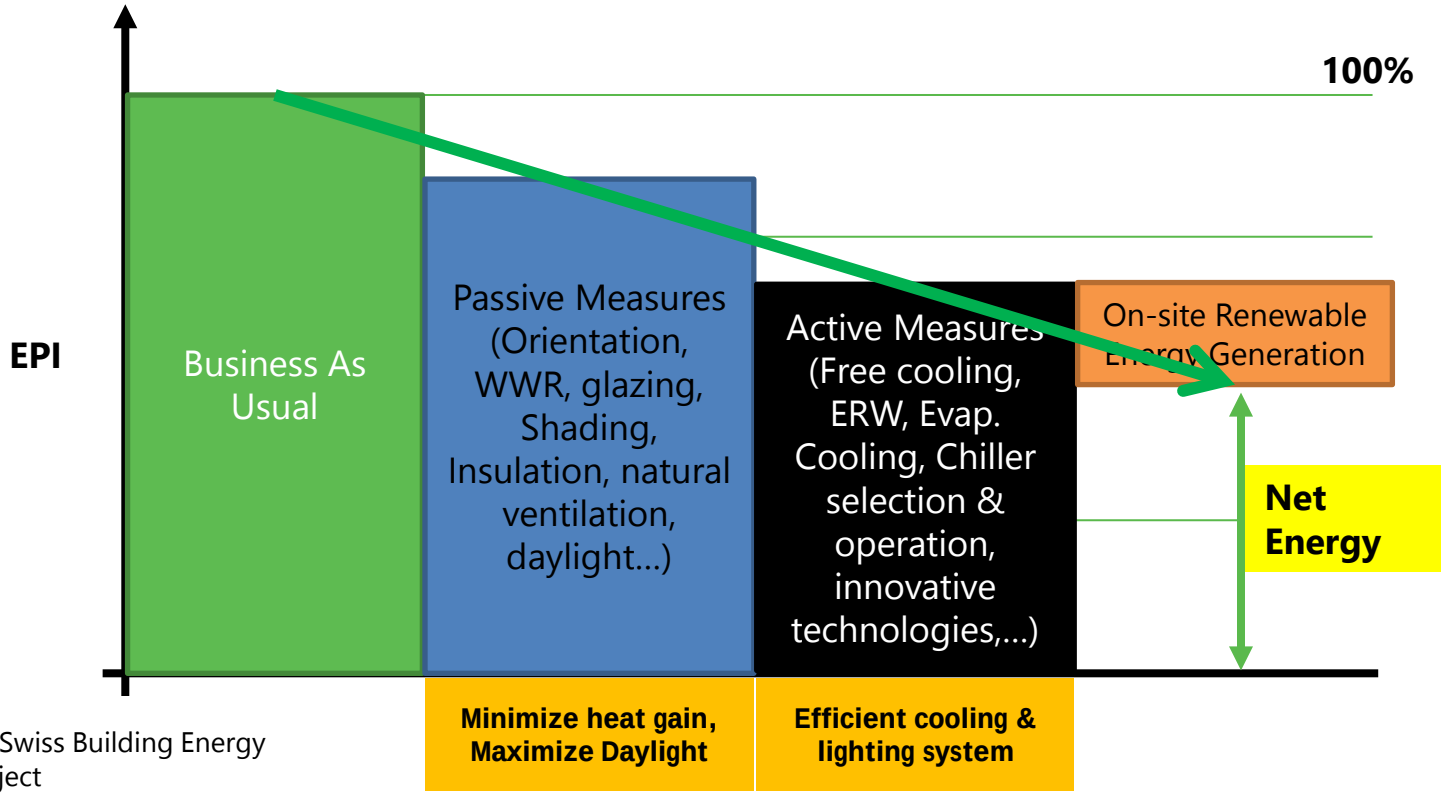
Achieve these through:
- Decarbonisation targets
- Envelope improvements
- System improvements
- Incentives
- Better access to finance
- Renovation passports
- Technology and knowledge transfer

2. Setting the level of ambition: what are we trying to achieve?

New buildings and retrofits

What are we trying to achieve	What are the factors	How might we measure that ?
• **Low energy needs** • **Low capital cost** • **Comfortable** • Easy to maintain • Resilient • Low emission	• Climate • Form • Area of glazing • Materials of building envelope • Ventilation openings • Does the building have AC?	• If no AC: Hours of thermal comfort • If AC: HVAC loads and capacity of cooling system required

Refresher: Integrated Design Charrette Approach



Source: Indo-Swiss Building Energy Efficiency Project

Refresher – passive measures

- **Minimise heat gain**
  - Building envelope
  - Shading
  - Window to Wall Ratio
  - Orientation and shape
  - Surface finish and colour (interior and exterior)
  - Cool roofs
- **Maximise air flow**
  - Ventilation openings
  - Night ventilation
  - Orientation and space massing
- **Maximise daylight**
  - Surface finish and colour
  - Protect from solar gains through external shading

Example of a measured flat in a low cost housing in Rajkot, India

Monitoring of Smart Ghar III, 1200 dwellings, no AC

- Low cost housing without additional cost as compared to the business as usual projects
  - Low Window to Wall Ratio
  - Partly opaque windows/shutters
  - Casement windows with large natural ventilation openings

Source: BEEP

Example of a measured flat in a low cost housing in Rajkot, India

Monitoring of Smart Ghar III: Base flat

- During hot summer in Rajkot (40-41°C max every day)
- Inside temperature between 30-32°C → 8-9°C below outside without any cooling
- Compliant with the National Building Code thermal comfort of India with ceiling fan

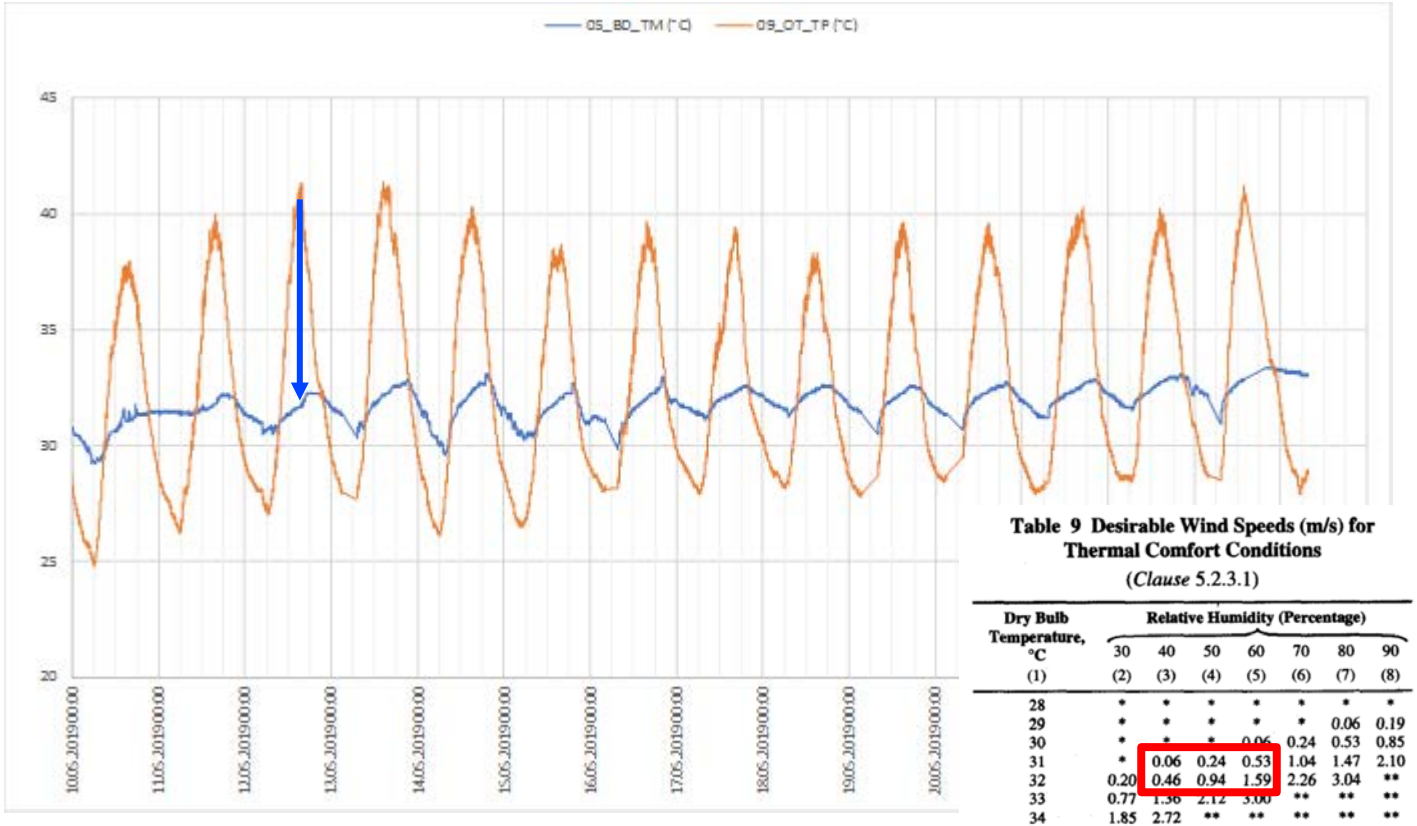


Table 9 Desirable Wind Speeds (m/s) for Thermal Comfort Conditions

(*Clause* 5.2.3.1)

Dry Bulb Temperature, °C	Relative Humidity (Percentage)						
	30	40	50	60	70	80	90
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
28	*	*	*	*	*	*	*
29	*	*	*	*	*	0.06	0.19
30	*	*	*	0.06	0.24	0.53	0.85
31	*	0.06	0.24	0.53	1.04	1.47	2.10
32	0.20	0.46	0.94	1.59	2.26	3.04	**
33	0.77	1.36	2.12	3.00	**	**	**
34	1.85	2.72	**	**	**	**	**
35	3.20	**	**	**	**	**	**

* None

** Higher than those acceptable in practice.

Source: BEEP

3. Technology gaps

- Let's try and think of all the **technologies** that are relevant to building design and planning in your regions.

Building envelope	Window systems:	Design tools:
- Insulation - Thermal mass - Reflective coatings - Wall constructions - Roof constructions	- High performance glass (solar and/or thermal) - External moveable shading - Static shading	- Thermal and energy dynamic simulation - Computer Fluid Dynamics - Design charrettes
	Ventilation:	**Other:**
	- Openings - Natural ventilation strategies	- Low embodied energy or recycled materials

- Some things to think about:

- which are available locally? Which are currently affordable? Expensive? Are specially skilled workers or tools required?

Technology refresher – the building envelope

Difference in strategy fundamentals for non AC buildings and cold climates:

Cold climates

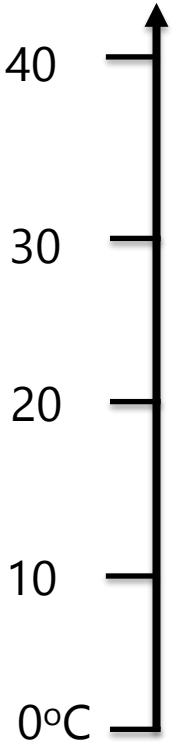
- **Temperature is stable**, cold: **static** behaviour
  - Must minimize heat losses.
  - The more insulated and tight the building, the better.

Hot and dry climates

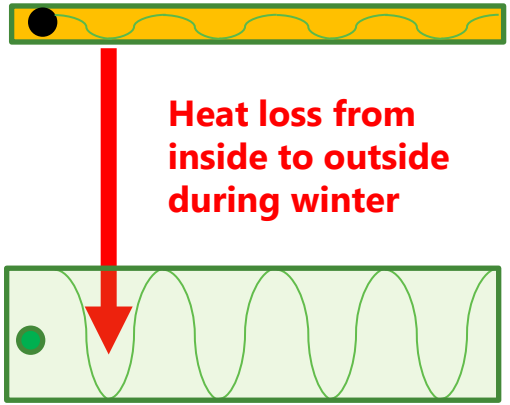
- **There are heat gains and losses over 24 hours:** mostly **dynamic** behaviour
  - Heat ingress during the day («no natural ventilation», and/or active cooling), windows closed, maximum solar protection
  - Heat losses during the night (removing the day heat gains)
  - Balancing day heat gains and night heat losses is necessary to avoid progressive overheating
  - At night the «cooling machine» is either natural ventilation or active cooling

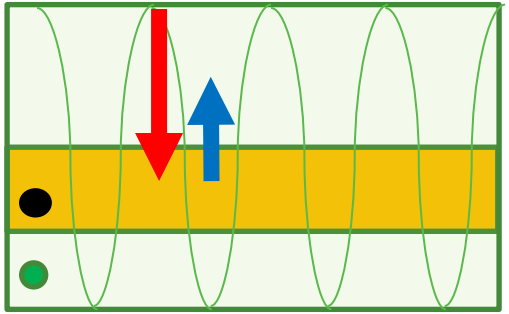
Drivers of building energy use: climate

Building physics is the same everywhere, but, buildings in cold and hot climates have different dynamics depending on typical temperatures profiles



North in Winter





South in Summer

Heat is incoming during the day

and

outgoing during the night

- T inside
- T outside

Sources: BEEP India

Envelope heat gain per unit envelope area

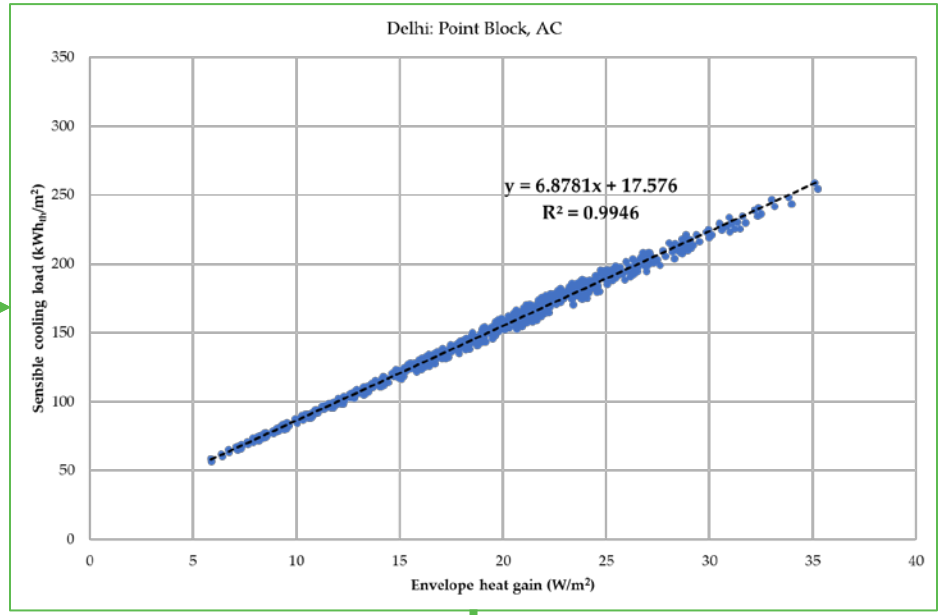
Residential Envelope Thermal Transmittance RETV, a.k.a Envelope Thermal Transfer Value ETTV (W/m2)

Calculated for the cooling period, excluding roof by dynamic simulation → Envelope heat gain*Tcooling=Sensible cooling

- Multi-linear regression → Coefficient of the RETV formula (***A, B, C***)

Net heat gain rate through all the building envelope components divided by the total envelope area of the exposed envelope

$$\text{Envelope heat gain}, \frac{W}{m^2} = \frac{Q_{wall.cond}\ (kWh) + Q_{win.cond}\ (kWh) + Q_{win.rad}\ (kWh)}{T_{cooling}\ (h) * A_{envelope}\ (m^2)}$$



$$RETV = A * (1 - WWR) * U_{wall} + B * WWR * U_{win} + C * WWR * SHGC_{effective}$$

Shading & the SHGC

- **Solar Heat Gain Coefficient (SHGC)**
  - SHGC is the successor to the shading coefficient used in the United States and it is **the ratio of transmitted solar radiation** to **incident solar radiation of an entire window assembly**. It ranges from 0 to 1 and refers to the solar energy transmittance of a window or door as a whole, factoring in the glass, frame material, sash, divided lite bars and screens (if present).

- **G-value**
  - Sometimes also called a Solar Factor or Total Solar Energy Transmittance, the G-value is the coefficient commonly used in Europe to measure the **solar energy transmittance of windows**. Despite having minor differences in modeling standards compared to the SHGC, the two values are effectively the same.

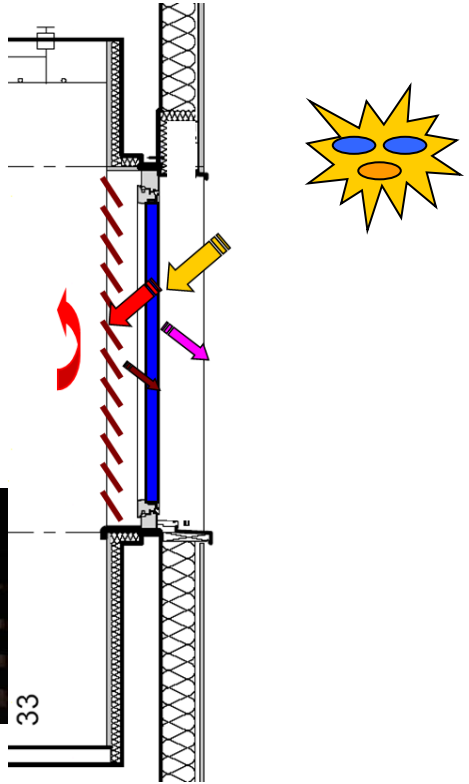
The lower the SHGC or G-value, the less heat from solar radiation is transmitted to the space

Solar Heat Gain Coefficient (SHGC)

- SHGC is the ratio of transmitted solar radiation to incident solar radiation of an entire window assembly. It ranges from 0 to 1 (g-value~in Europe).

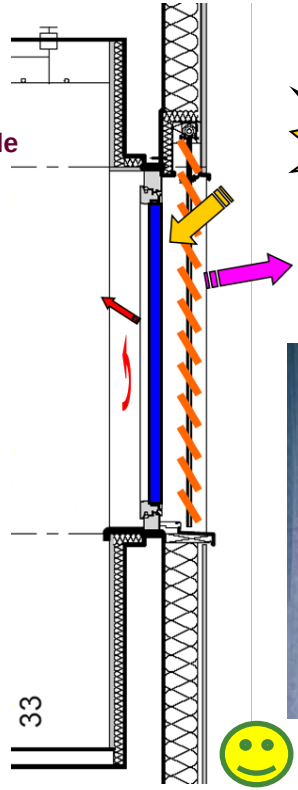
Interior blinds

SHGC > 50%



External movable blinds

SHGC < 15%



Integrated Design Process: Tier 1 – Building Design -

Building envelope is often the main source of heat gain/loss

- Walls, windows, roof, uncontrolled air infiltration
- There is a wide variation in the quality of building envelopes:

U ~ 3.5 W/m^2.K
Monolithic concrete wall

35% Windows with inadequate shading

U ~ 0.5 W/m^2.K

10% Windows with shading

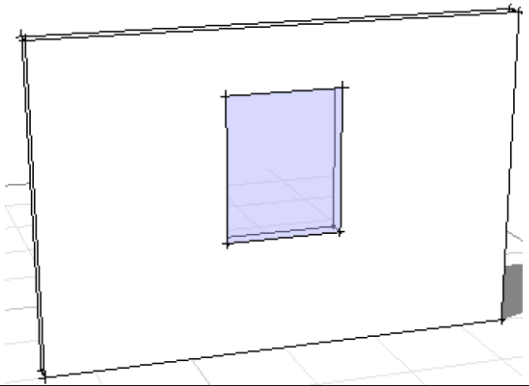
Source: Adapted from Lechner, Norbert: Heating, Cooling, Lighting : Sustainable Design Methods for Architects

Refresher on controlling heat gains in hot dry and humid climates by external shading lamella blinds (or shutters)

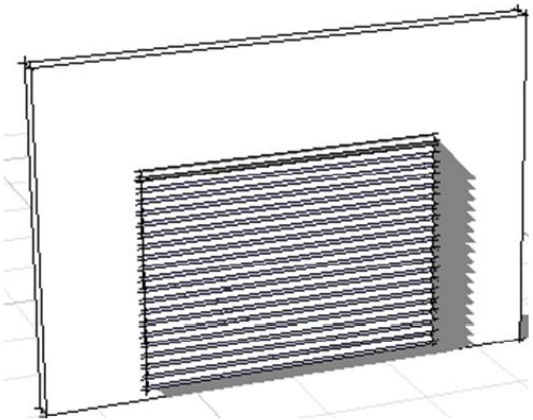
- Comparison of trade-off for the Window to Wall Ratio
- 1.5x1.2 m2 window
  - No shading
  - SHGC = 0.88
- 2.1x3 m2 windows
  - External movable lamella blind
  - SHGC 0.15
- Same heat gain

T_ext	42	°C
T_in	26	°C
I_sol_facade	500	W/m2

height_no_shade	1.5	m
width_no_shade	1.2	m
area_no_shade	1.8	m2
U_window_no_shade	2.8	W/m^2-K
SHGC_window_no	0.75	
Q_solar_gain	675	W
Q_trm	81	W
Q_gain_tot	756	W



height_ext_shade	2.1	m
width_ext_shade	3	m
area_ext_shade	6.3	m2
U_window_with_shade	2.8	W/m^2-K
SHGC_window_with	0.15	
Q_solar_gain	473	W
Q_trm	282	W
Q_gain_tot	755	W

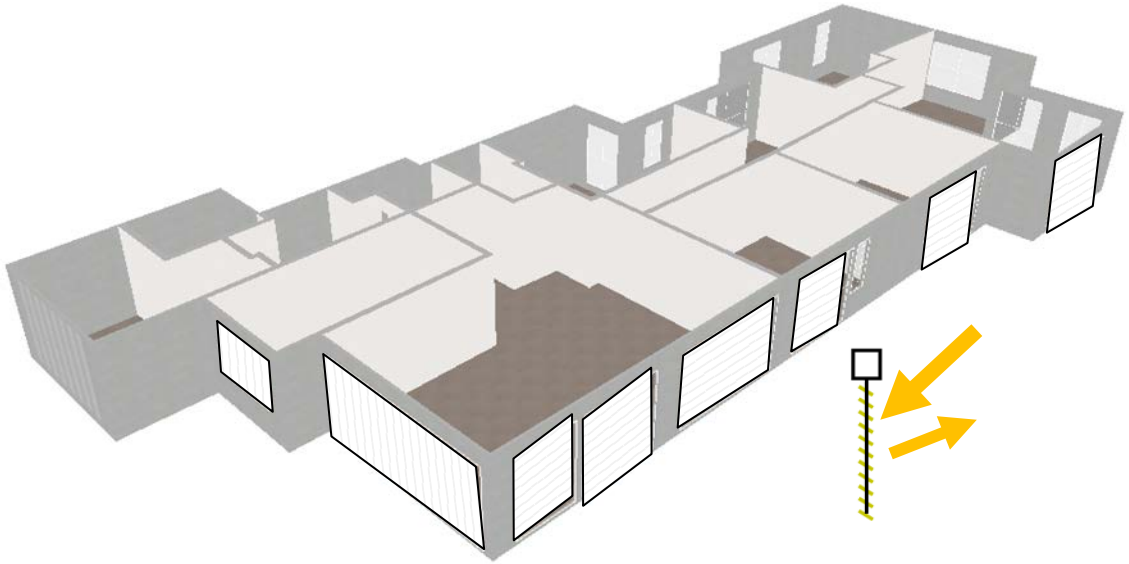


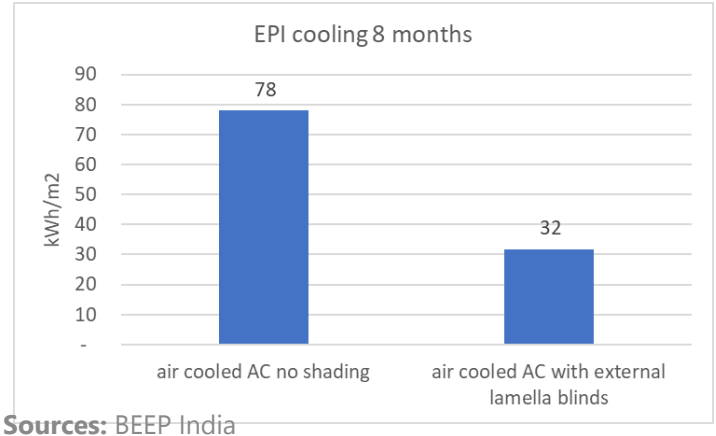
Sources: BEEP India

Refresher on controlling heat gains in hot climates

-> Reduce heat gains by external movable shading

- Example of the external shading impact on a high end residential apartment
- The reduction in cooling energy demand is about 50% lower with the external shading.
- It is equivalent to the gain of poor AC to a high performance water cooled VRF.

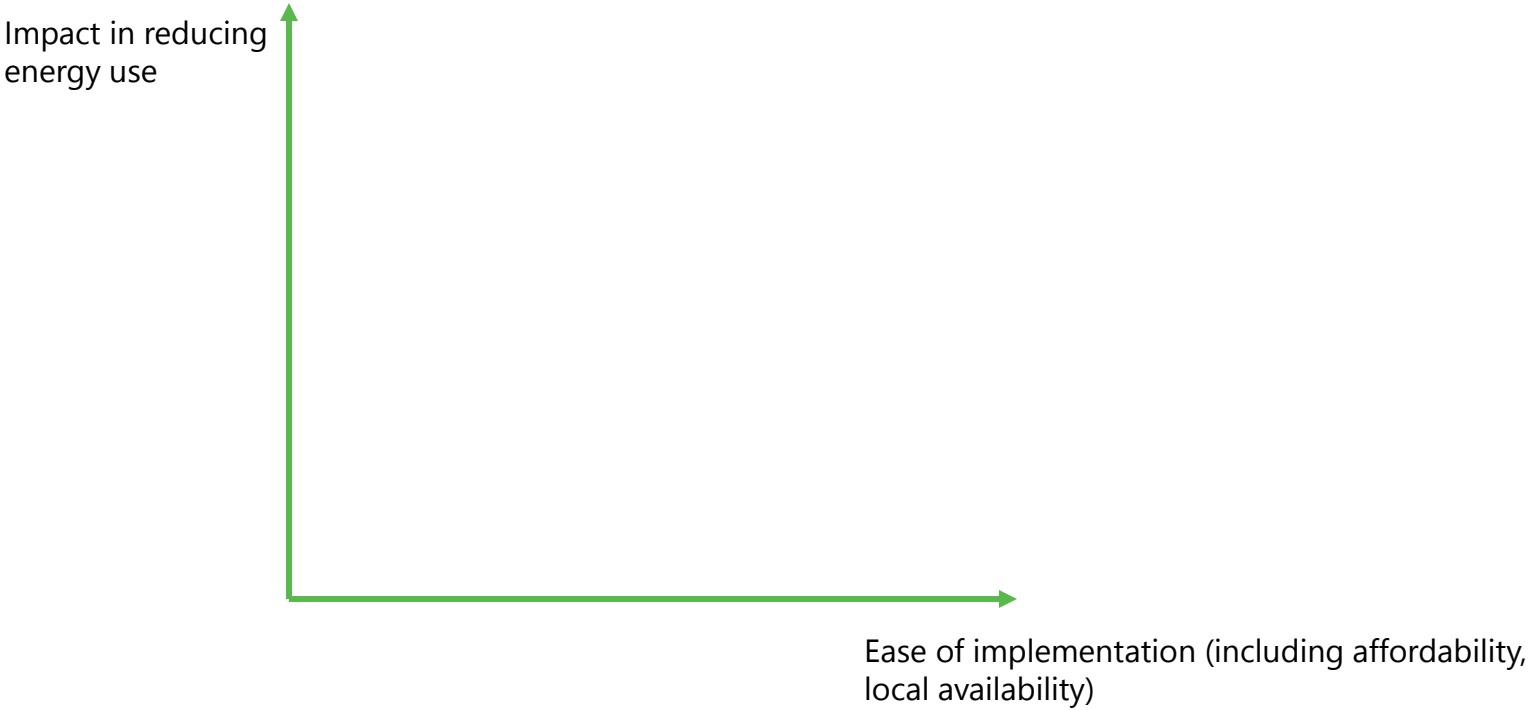




For high WWR, external shading (simple shutters or external movable covering) can save as much as a new generation high performance air conditioners → Combination of passive and active → 50-75% electricity bill reduction for new and retrofit

Sources: BEEP India

Mapping impact vs availability - technology



Setting targets

- On your flipcharts, set targets for the key technologies in this format:

- List any of the key barriers you can think of for achieving this timeline.

Roadmap for Buildings and Construction

Global Alliance for Buildings and Construction

Set targets for:

- Urban planning
- New buildings
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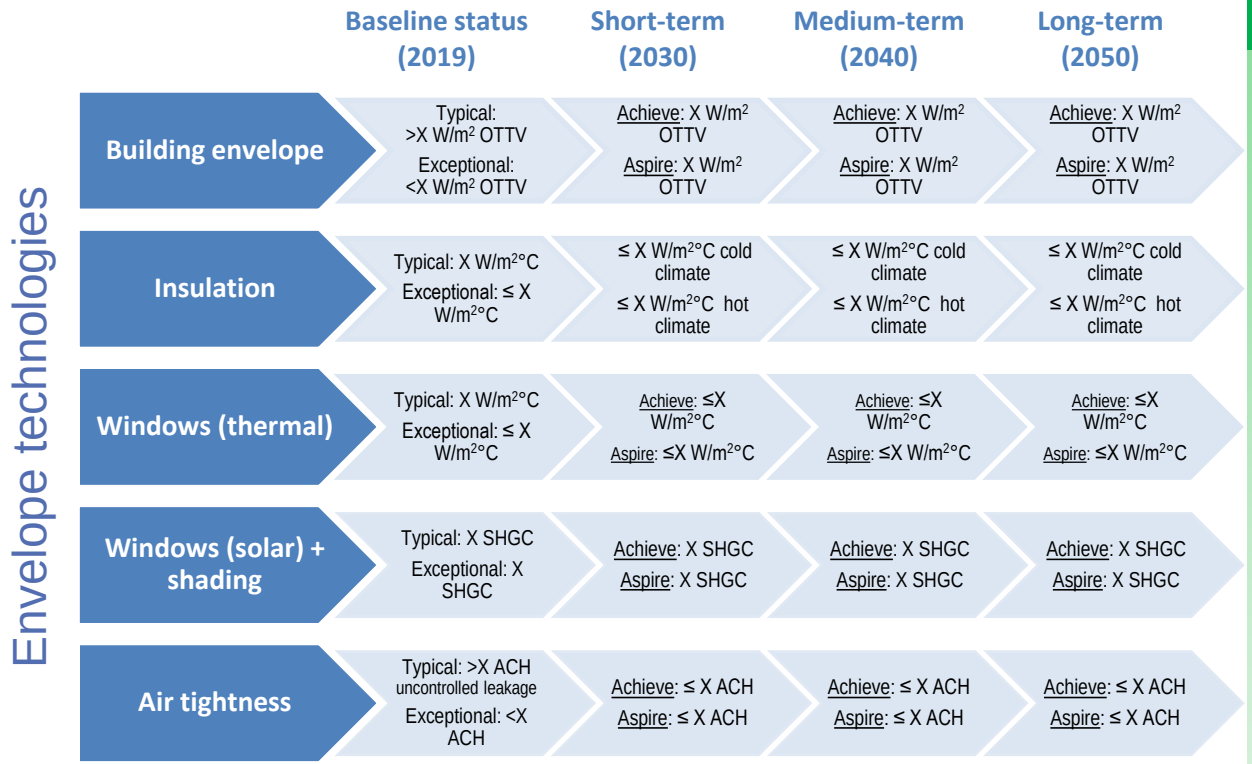

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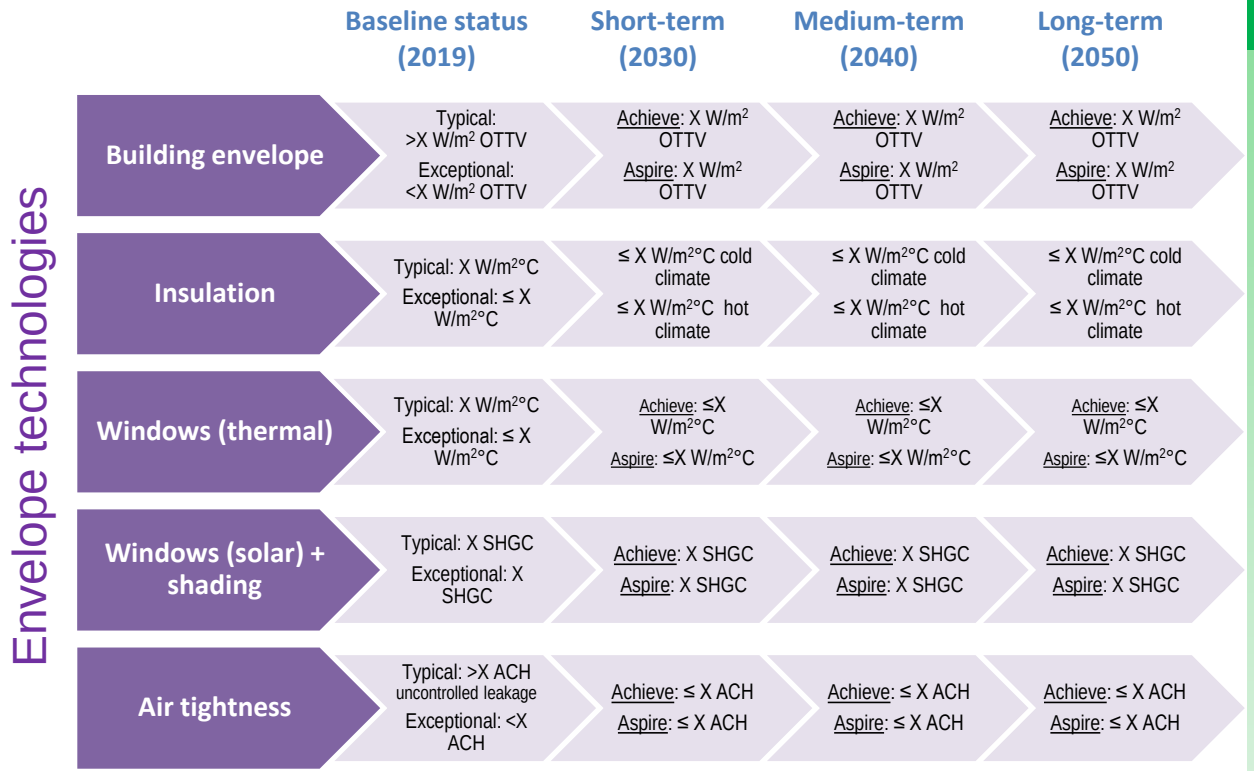


Coffee break

4. Policy gaps

- Let's try and think of all the **policies** that are relevant to building planning and design in your regions.

To increase the efficiency of new buildings and retrofits:	To increase the demand for efficient buildings:	To increase the affordability and availability of efficient technologies:
- Mandatory building codes - Standards	- Building certification - Information and awareness - Incentives - Resource sharing	- R&D - Incentives

- Some things to think about:
  - Mandatory or voluntary policies ?
  - How will they be enforced?
  - How stringent should the mandatory code be?

Example: Indian Energy Conservation Building Code

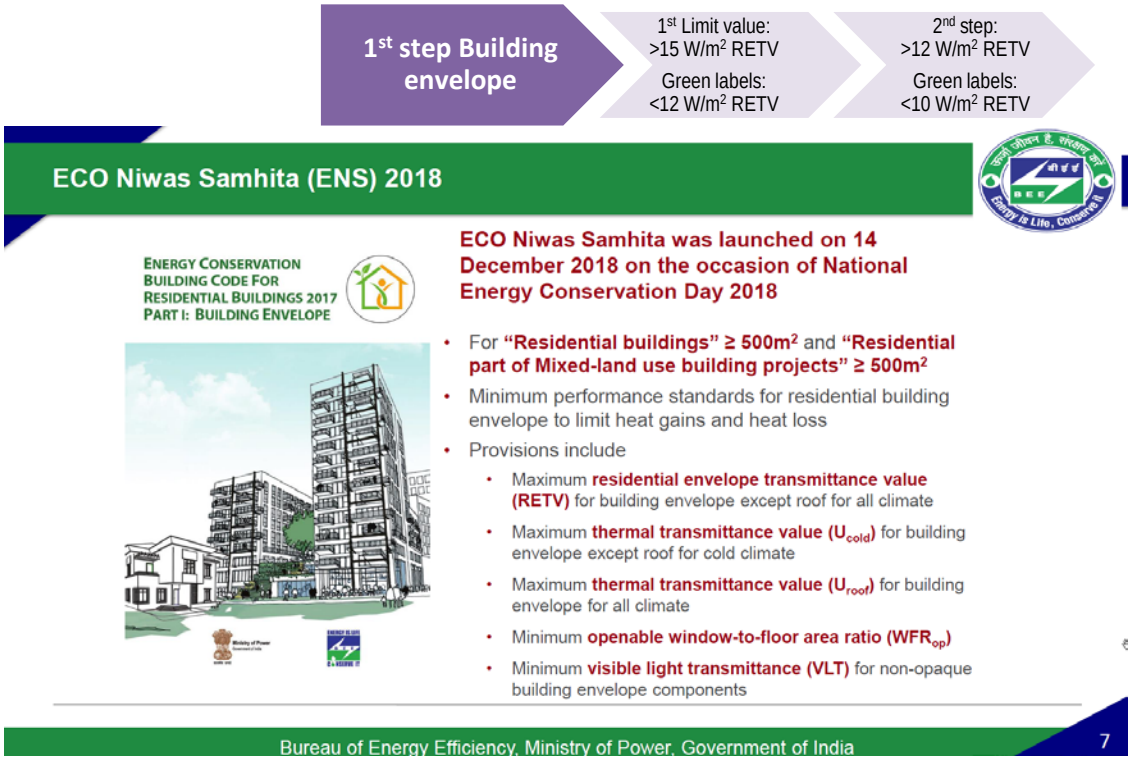
Indian Energy Conservation Building Code for Residential buildings (ECBC-R)

- India did not have any Energy Conservation Building Code until 2018
- Brief history: ECBC commercial
  - 2007 Energy Conservation Building Code for commercial buildings launched
  - 2017 revised version
  - Issues:
    - Only 12 States have adopted and made it mandatory by now
    - Human resources devoted insufficient for code compliance at project and commissioning level
    - The complexity of the code made it slow to adopt
- Residential:
  - 2017, Indian Government asked the Bureau of Efficiency (BEE, Ministry of Power) to develop and launch rapidly an Energy Conservation Building Code for residential buildings
    - The technical development was performed within 6 months (Building Energy Efficiency Project (BEEP)), with national level technical and steering committees, as well as web and regional consultation.
    - The code was launched in December 2018 after all consultation were completed successfully

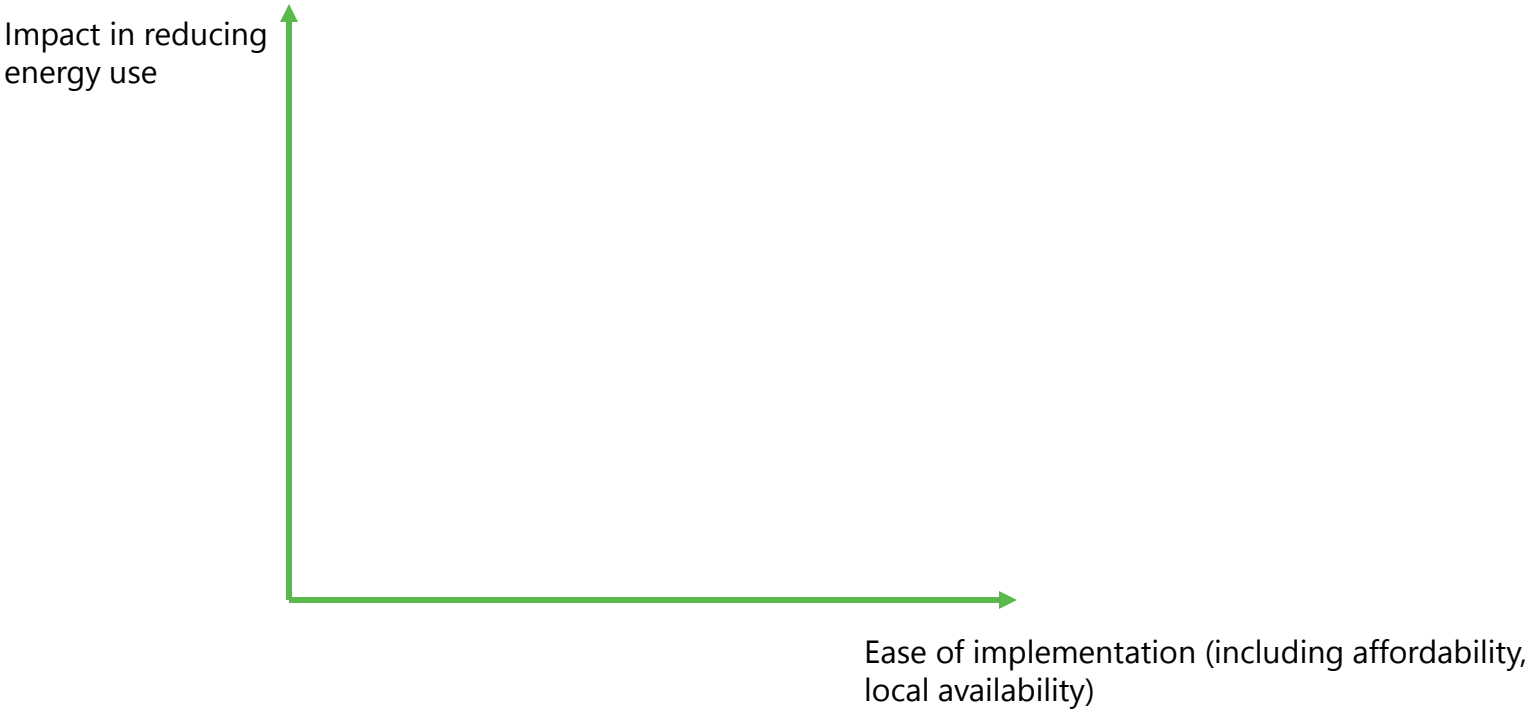
Next steps for the roadmap progress for residential building codes

- → Information campaign with the Central government (BEE) are now ongoing with the technical support of SDC (BEEP) and GIZ in various states
- → bring the urban ministry of the States to make compliance mandatory for building permit clearance
- → need of a full chain of human resources to ensure this process.

GIZ	Uttar Pradesh	199
GIZ	Maharashtra	112
GIZ	Karnataka	61
GIZ	Punjab	27
SDC	Gujarat	60
SDC	Rajasthan	68
SDC	Andhra Pradesh	49
	Total population	576



Mapping impact vs availability - policy



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Policies

	Baseline status (2019)	Short-term (2030)	Medium-term (2040)	Long-term (2050)
Building codes	X countries with voluntary or mandatory codes	Achieve: X% net zero ready code Aspire: X% net zero code	Achieve: X% net zero ready code Aspire: X% net zero code	Achieve: X% net zero ready code Aspire: X% net zero code
Building certification	X countries with voluntary or mandatory certification	Achieve: X% mandatory Aspire: X% mandatory	Achieve: X% mandatory Aspire: X% mandatory	Achieve: X% mandatory Aspire: X% mandatory
Building passports	Widespread voluntary and silo information collection	Achieve: X% buildiing passports Aspire: X% buildiing passports	Achieve: X% buildiing passports Aspire: X% buildiing passports	Achieve: X% buildiing passports Aspire: X% buildiing passports
Resource sharing	Minimal resource sharing buildings and communities	Achieve: X% sharing policies Aspire: X% sharing policies	Achieve: X% sharing policies Aspire: X% sharing policies	Achieve: X% sharing policies Aspire: X% sharing policies
Incentives	Leading jurisdictions provide incentives	Achieve: X% non-fiscal incentives Aspire: X% fiscal and non-fiscal	Achieve: X% non-fiscal incentives Aspire: X% fiscal and non-fiscal	Achieve: X% non-fiscal incentives Aspire: X% fiscal and non-fiscal

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Policies

	Baseline status (2019)	Short-term (2030)	Medium-term (2040)	Long-term (2050)
Building codes	X countries with codes	Achieve: X% mandatory codes Aspire: X% net zero code	Achieve: X% net zero ready codes Aspire: X% net zero codes	Achieve: X% net zero ready codes Aspire: X% net zero codes
Building certification	X countries with certification	Achieve: X% mandatory Aspire: X% mandatory	Achieve: X% mandatory Aspire: X% mandatory	Achieve: X% mandatory Aspire: X% mandatory
Building passports	Widespread voluntary and silo information collection	Achieve: X% buildiing passports Aspire: X% buildiing passports	Achieve: X% buildiing passports Aspire: X% buildiing passports	Achieve: X% buildiing passports Aspire: X% buildiing passports
Circular economy	Minimal circular economy decisions	Achieve: X% plan circular economy Aspire: X% plan circular economy	Achieve: X% plan circular economy Aspire: X% plan circular economy	Achieve: X% plan circular economy Aspire: X% plan circular economy
Incentives	Leading jurisdictions provide incentives	Achieve: X% non-fiscal incentives Aspire: X% fiscal and non-fiscal	Achieve: X% non-fiscal incentives Aspire: X% fiscal and non-fiscal	Achieve: X% non-fiscal incentives Aspire: X% fiscal and non-fiscal

5. The “enablers”

- Discuss the barriers identified previously
- Classify them:
    - Capacity/knowledge
    - Financial
    - Technical
    - Innovation

5. The “enablers”

- Some “enabling” strategies

Capacity building	Finance	Multiple benefits
• Government training • Professional training • Educational training • Awareness and information • Institutional coordination	• Urban development funds • Infrastructure funds • Dedicated credit lines • Guarantees • Green bonds • Preferential tax, grants and rebates • EPCs • Procurement purchase or lease • On-bill/ tax repayment	• Emissions savings, air quality • Energy savings, energy security, energy prices • Economic, productivity, employment, asset value • Poverty alleviation, health and wellbeing, safety and security

6. Key actions

- Now list the key actions, drawing on all we've identified as crucial do advancing energy efficiency in buildings in your region.
  - Policy
  - Technology
  - Capacity building
  - Finance
  - Innovation

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	Baseline status (2019)	Short-term (2030)	Medium-term (2040)	Long-term (2050)
New buildings	<X% net zero ready buildings	Achieve: X% net zero ready Aspire: X% net zero buildings	Achieve: X% net zero ready Aspire: X% net zero buildings	Achieve: X% net zero ready Aspire: X% net zero buildings

Key actions

Develop and implement mandatory codes. Transition from voluntary to mandatory codes that set the minimal efficiency in new buildings.

Strengthen building codes. Ensure that there is a building code improvement cycle that strengthens the performance requirements every 3-5 years with aspirations of achieving zero emission and net zero energy codes.

Integrate renewable energy in new building design. Achieve net zero emissions or net zero energy through the integration of renewable energy.

Enable sustainable building investments. Enable increasing design and construction of sustainable buildings by increasing access to and use of finance to enable private investment.

Governments lead by example. Develop policies that ensure all new government buildings are low-emission and efficient.

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	Baseline status (2019)	Short-term (2030)	Medium-term (2040)	Long-term (2050)
Building retrofits	<X% buildings renovated each year to be sustainable	Achieve: X% renovation Aspire: X% renovation	Achieve: X% renovation Aspire: X% renovation	Achieve: X% renovation Aspire: X% renovation

Key actions

Increase renovation rates. Renovation rates in industrialised countries to reach 2% on average of the existing stock per year by 2025 and 3% by 2040. Renovation rates in developing countries reaching 1.5% by 2025 and 2% by 2040.

Increase the depth of renovation. Enable deep energy renovations that reduce energy consumption of existing building by at least 50%.

Enable renovation investments. Enable increasing renovation rates by increasing access to and use of finance to enable private investment in renovations.

Governments lead by example. Develop policies that ensure existing government buildings are renovated to be low-emission and efficient.

Thank you!

Reminder: meet at hotel lobby at 9am tomorrow for site visit!

Instructions for group presentation

- Divide into two even groups:
    1. New buildings
    2. Building Retrofits

- Using your individual templates you have been filling out throughout the training, compile the following to present to the other groups in **3 minutes**:
    - **Technology timeline:**
        - current status, 2030, 2040 and 2050 targets for up to 5 key technologies
    - **Policy timeline:**
        - current status, 2030, 2040 and 2050 targets for up to 5 key policies
    - **Enablers**
    - **Key actions**

Use what you learned from Policy Action too!