



# Buildings and Environment: The big picture



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**URBANSAPES: *how  
sustainable are our buildings  
and cities?***

**Fellowship Media Briefing  
Centre for Science and  
Environment**

**New Delhi, May 1-2, 2014**





Beginning of a conversation.....



# Spotlight: Cities



## Urban explosion

- By 2025 around 65 per cent of the world's population is projected to live in cities – equal to the global population in 1986.
- A billion more will be added over the next three decades in Asia – almost adding a whole new India. More than half of them will be living in cities

India's urbanisation is still modest at 30 per cent and is expected to be 40 per cent by 2030. But this is more than the population of the United States.

## India's urban mosaic

**Skewed growth:** 70% of urban population are in about 400 cities. The rest in about 4000 towns and cities. About one third of the total urban population in the megacities..

**Shadow growth:** Top rung cities show strong trend towards suburbanisation.

**Slow growth at the bottom:** Lower rung towns stagnating. Some have grown due to infrastructure investments and rural to urban migration.

The Hindu/New Delhi/June 27, 2012

## Greening the urban jungle

**U**rbalisation took centre-stage at last week's Rio+20 conference for good reasons. Cities collectively consume 75 per cent of world's natural resources, generate 50 per cent of waste and emit about 70 per cent of the greenhouse gas. With no slowing down of urbanisation in sight, this consumption is bound to increase. It is now abundantly clear – as UNEP's recent report on sustainable cities convincingly demonstrates – that unless cities become resource efficient and reduce waste generation, national and global sustainable development would be impossible to achieve. This is a warning bell to Indian policymakers, who have so far focused on the economic growth of cities and ignored their environmental performance. Consuming 40 billion tonnes of raw material every year has its consequences. The first visible challenge is the staggering waste cities produce. Conventional wisdom has been to find more landfill sites. This approach would demand more land over time and cities cannot endlessly appropriate the resources of their region. It would lead to potential conflicts and the loss of productive agricultural land would partly offset the economic benefits provided by the cities. Pursuing standard solutions and treading the beaten path of town planning would not help. Only a radical change in course will create zero-carbon, zero-waste habitats, which is imperative.

It would be impractical to cap the growth of cities. Neither is it the objective of the current debate. The question is how to transform them. Certain cities have taken the lead and shown a way forward. For instance, Copenhagen recycles most of the waste it generates and lets only 3 per cent go to the landfill. Extending the idea of recycling, Kitgum town in Uganda traps used water from houses and utilises it to grow food in grey-water gardens. Cities in Malta have opted for a smart bi-directional grid system to regulate their power consumption. There are more inspiring examples. With the Central government dithering on commitments to reduce emission levels and the National Mission on Sustainable Habitats failing to offer anything substantial, Indian cities can no more rely on centrally directed policies and projects. They have to adopt best practices on their own and launch projects with clear green benchmarks. A good beginning would be to promote non-motorised transport. Even in larger cities such as Chennai, the share of bicycle trips, despite poor arrangement, is as high as 12.5 per cent of the total trips. Building dedicated bicycle tracks would significantly reduce transport related emissions. If Indian cities are keen to improve the quality of life and remain economically competitive, they have to leapfrog to become desirable green places to live in.



## **City: The focal point of climate mitigation and energy security discussions**



**Cities: the central focus of discussion in the Rio+20 conference ....**

**Energy Outlook 2009 tracks cities for the first time**

Already two-third of world's energy is consumed in cities – by half of world's population.

By 2030 cities will be consuming 73% of world energy.

Globally cities account for 70% of CO<sub>2</sub> emissions.

Big increase in global CO<sub>2</sub> from increase in floor space in buildings of various types, -- especially in non-OECD countries.

Massive increase expected in ownership of household appliance

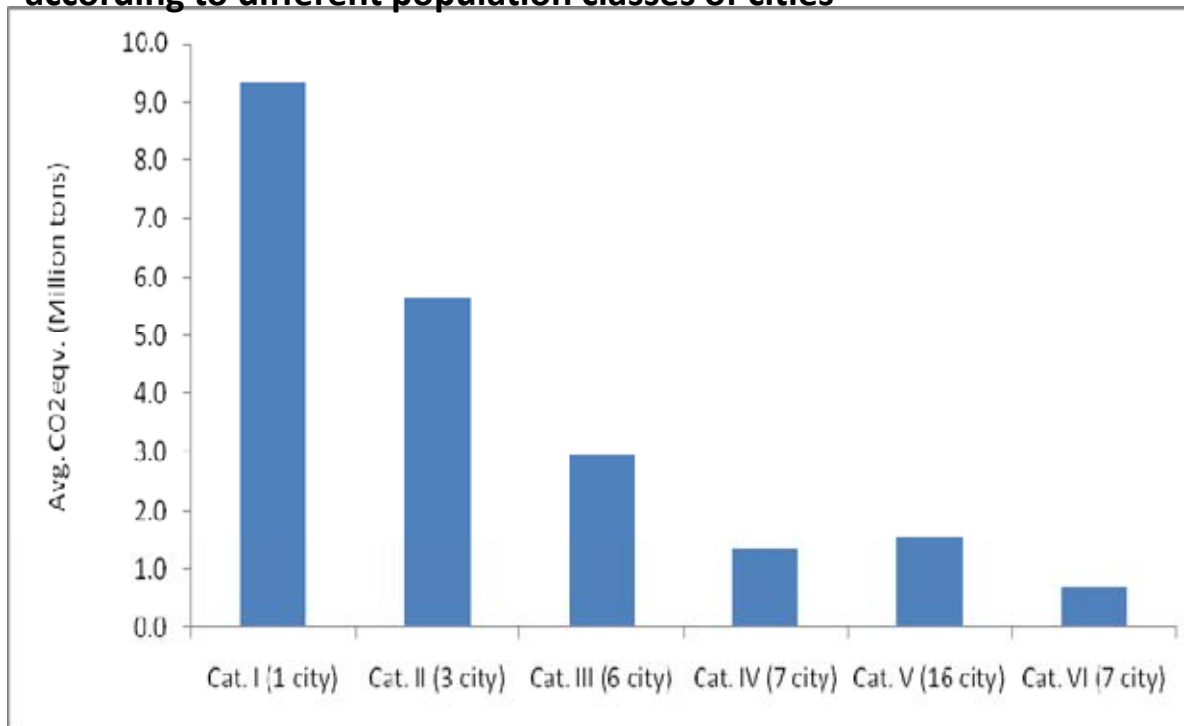
**Cities collectively consume 75% of world natural resources, generates 50% of waste, and emits 70% of greenhouse gases.**



## Cities: Energy guzzlers

**Bigger Indian cities guzzle more fuel**

**Total CO2 equivalent emissions (million tons/ annum) classified according to different population classes of cities**



Source: Based on data provided in 'Energy and Carbon Emission Profile of 53 South Asian Cities', published by ICLEI, British High Commission and Census of India 2001 for city population data

**Global cities under pressure to mitigate setting targets and deadlines for CO2 reduction.....**

London – 60% by 2025

Paris: -- 25% by 2020

Toronto – 30% by 2020;  
80% by 2050 from 1990 level

Tokyo – 25% by 2020 from 2000 levels

**Indian cities to frame climate mitigation plan and targets**

**Energy security challenge**



## Lifestyle pressure amidst poverty



### **Middle class growing rapidly:**

The 2010 McKinsey study on urban infrastructure estimates that the seeker class (with household income of 200,000 – 500,000 per annum) will be the most dominating income class and is expected to be half of all urban households by 2025

About 16% households fall in mid-high to rich income class. (Jones Lange 2010)

Cities will see more concentrated buying power, transformation of lifestyle and aspiration for high end resource intensive comfort level.

### **Urban poverty remains high**

Nearly 21% of urban population -- but 40% to half in Delhi and Mumbai, live in slums. All low income groups are not necessarily in the slums. 75% of the urban population in the bottom rung of income level – Rs 80/day (USD 1.8). (Mckinsey 2010)

19% households cannot afford any housing (Jones Lange 2010)



# Track and record building typologies for better planning



## **Very poor data base on trends in building spaces in India:**

Ministry of housing and poverty alleviation tracks demand for housing but not other built up areas. Planning commission and others on trends in the construction sector. But buildings are a very small component of the construction industry.....

Real estate service providers, investment banks, and research foundations are the principal source of information.....But very opaque and not verifiable.....

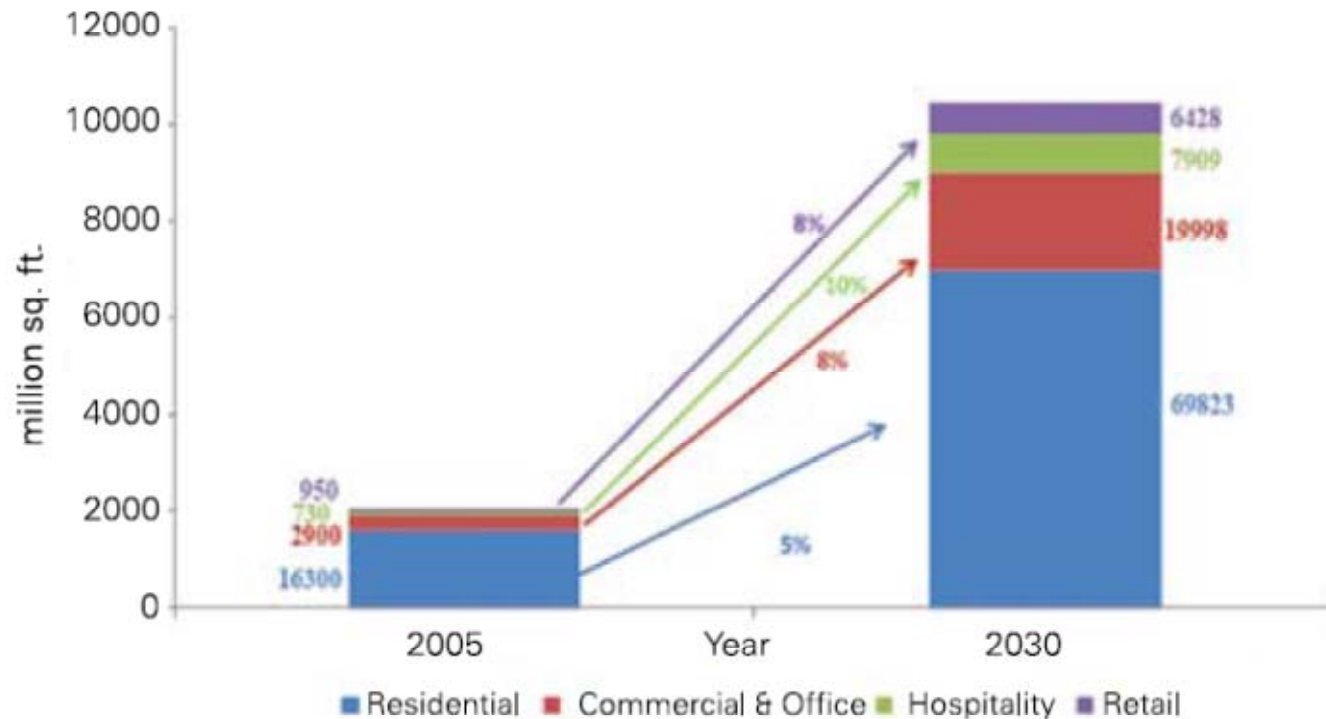
A few cities – Hyderabad, Bangalore, Chennai, Delhi, Mumbai have a little better data due to new growth etc.

**Disparate estimates make a curious jigsaw ..... But indicative of an explosive trend: Eg.** Constructed area in 2005: close to 25 billion square feet. Expected to be 5 times and reach to approximately 104 billion square feet by 2030. A CAGR between 5 to 10 percent to be achieved ..... Hospitality and Retail to achieve higher CAGRs -- 8–10%. By 2030, -- 7 to 11 times of the level in 2005. Maximum growth in residential and commercial sector -- four to five times of 2005 figures. (EDF)

**Very poor data on building typologies:** No data on numbers, type, size, use of construction material, natural ventilation, etc. Need good data base for better planning and targeted reduction in energy consumption



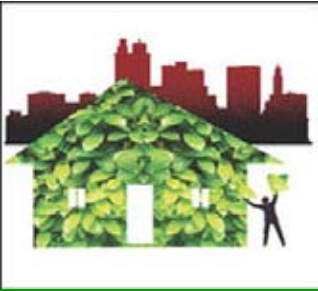
## Building sector: explosive growth



Source: Planning Commission - Environmental Design solutions 2010/CW

**India's challenge:** The ECO-III forecasts - 70% of building stock that will be there in 2030 is yet to come up in the country.

**Developed countries,** a very small addition is made to the building stock each year. In the UK, at least 80% of the homes to stand in 2050 have already been built. In France buildings constructed before 1975 thermal regulations will represent over 50% of the building stock in 2050



## Metro cities: explosive trend



**Office stock** must increase nearly 20 million sf/ year in New Delhi, Mumbai, Bangalore to meet growing demand;

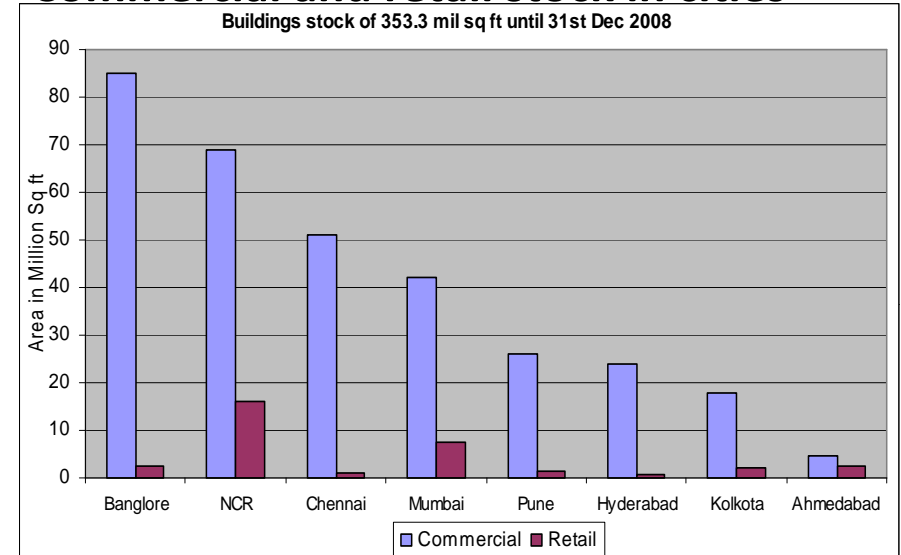
**Commercial floor space to increase 5-6% a year:** Space of shopping malls 79 million sf in 257 centers are estimated in 15 largest cities of India (BEE)

Energy intensity will increase due to higher levels of lighting and equipment in commercial spaces.

**Suburbs: new growth and resource conflict areas**

- 95% of new residential projects in suburbs
- 60% of operational office spaces in metro cities in suburbs
- More than half of retail spaces in suburbs (J Lange)

### Commercial and retail stock in cities





# Challenge of residential space

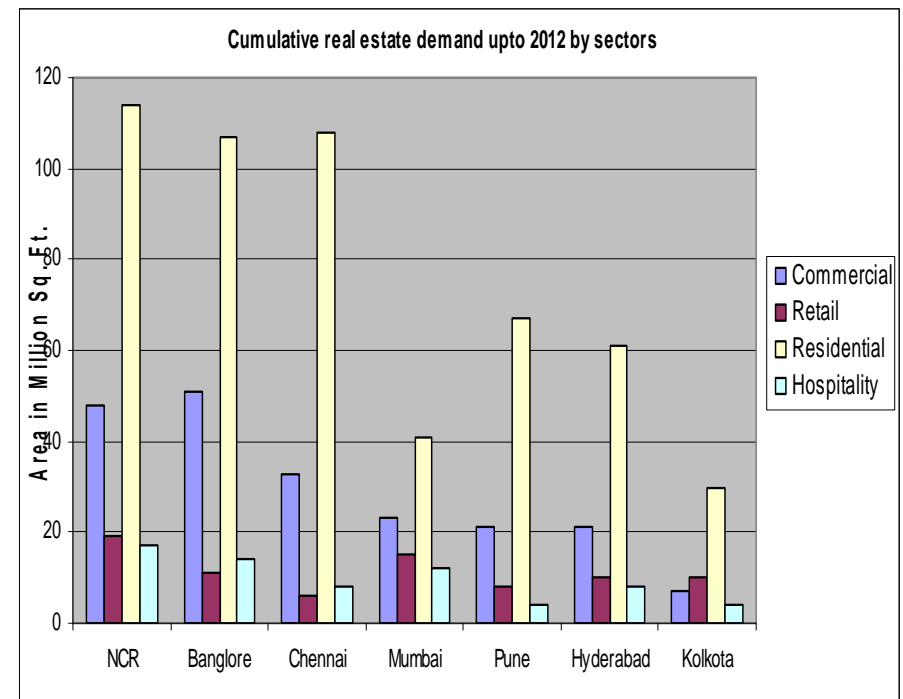


**Residential space:** Enormous housing shortage – Official estimate for affordable housing 18.6 million units; Unofficial estimate – 40 million! Demand growing at 10% annually

**Government to focus on EWS and LIG:** RAY – policies to boost affordable housing – mandate like 15-25% of developed land in all housing projects for EWS/LIG with cross-subsidization or extra FSI etc.

**Middle and high income housing:** More private players. Eg. CREDAI - association cover 80% of the real estate development in 13 states.

**Self constructed housing for the poor**





# Towns made to order

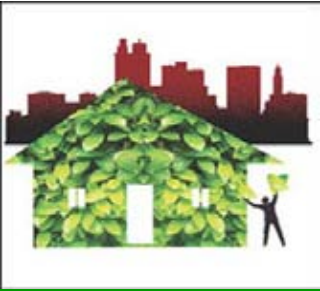
**Town boom:** IDFC's India Infrastructure report 2009:  
-- the size of private 'integrated' townships ranges from 100 to over 1000 acres.  
More than 200 such townships planned -- especially around the metros.

Touted as Walk to Work Green Towns – without green benchmark

## Urban planning in existing towns: an opportunity

- Support sustainable infrastructure
  - Public transport connectivity
  - Metered water and electricity supply
  - Decentralized waste water management
  - Decentralized, sustainable energy management
- Increase permissible density especially in areas with infrastructure.
- Higher density along transport corridors



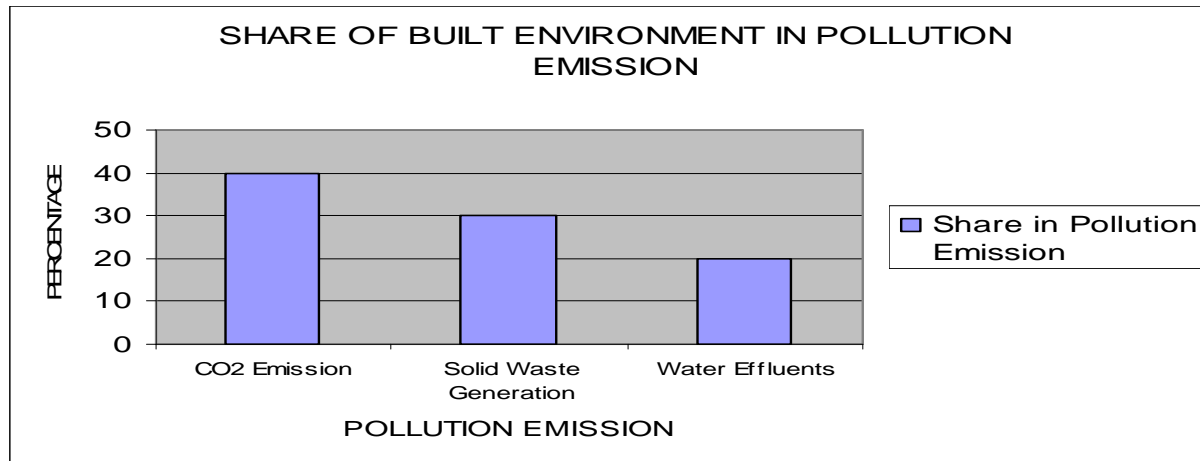
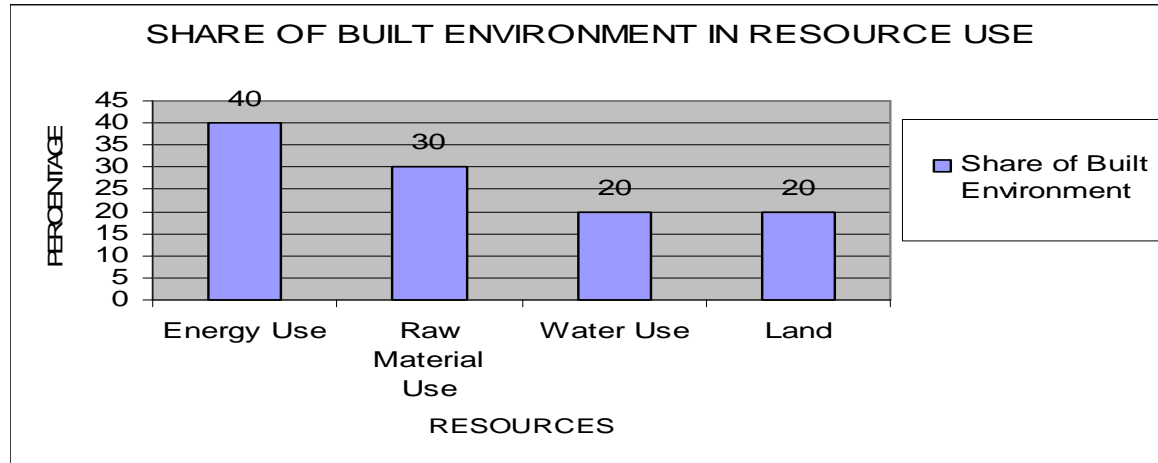


**Green worries?.....**

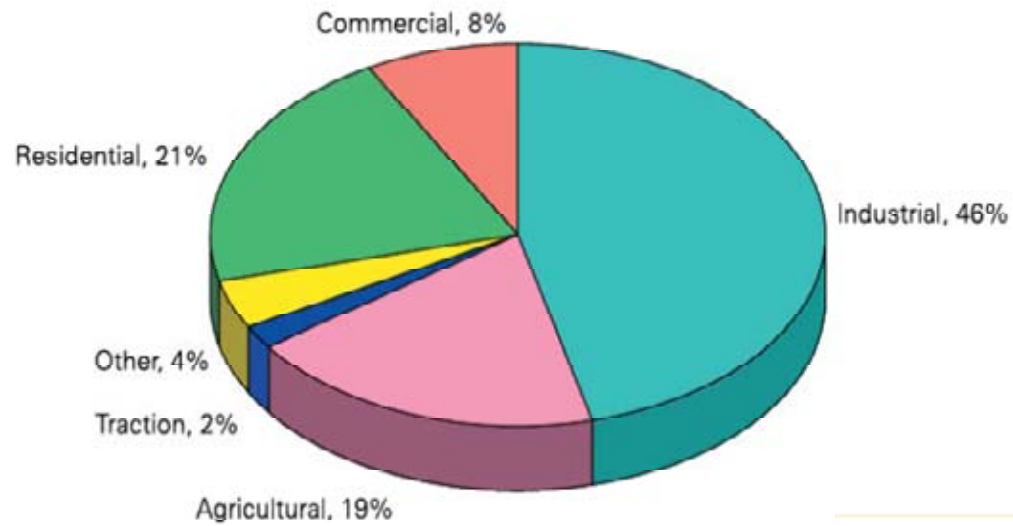


# Buildings: earthscrapers

## Burden of Built Environment

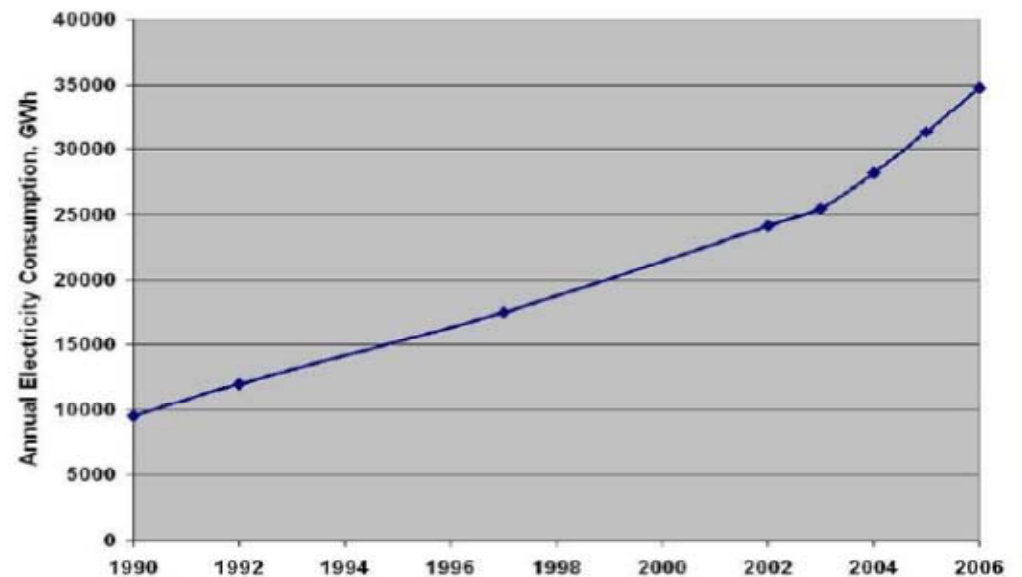


Source: Anon, 2008, Green Buildings – an overview, Capacity Building Series (2008-2009), June 2009, TARA Nirman Kendra, New Delhi



Residential sector consume nearly the highest

Electricity Use in the Commercial Sector is exploding. climatic zone-wise and building-use-wise





# Emerging policy opportunities.....



## **Integrated Energy Policy 2006:** Demand side management in buildings

NBC should be amended to facilitate efficient buildings

Publicise innovative approaches

Make energy audits compulsory for all load above 1 MW

Initiate benchmarking; Amend building byelaws to enable solar water heaters

**ECBC:** Sets minimum energy performance standards. Has legal back up from the Energy Conservation Act; Voluntary, to become mandatory

## **Star rating of buildings and appliances**

**National Habitat Standard Mission:** Acknowledges Building energy consumption increasing from a low of 14% in 1970 to 33% in 2004-05. That mandatory ECBC can save 1.7 billion units of electricity per year....

**National Habitat Standards:** In the making to guide action in cities

**National building code adding a chapter on and sustainability**

**Environment Impact Assessment (EIA).....**



## First generation action in Delhi



Initiated and proposed

- Cool roof programme initiated
- Implementation of ECBC in government buildings
- Revision of master plan
- Fulfill the targets of Enhanced Energy Efficiency Mission to retrofit 100 existing buildings with area above 10,000 sq ft
- Delhi secretariat to be converted into a green building. About 15 more government buildings identified
- Solar water heater system mandatory in industries, hotels, hospitals, nursing homes, and residential buildings with 500 sq meter area. Subsidy for purchase of solar water heater etc
- Proposal for a solar city in the NDMC area



## Cool roof: Low hanging fruit



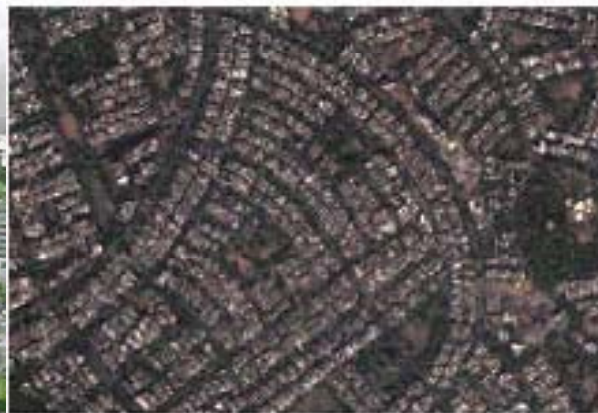
### **Need cool roof programme – Light reflective surface; vegetative cover; etc**

LBNL and IIIT-H study found annual energy savings in range of 13-14 kWh/m<sup>2</sup> with cool roof in a commercial building in Hyderabad. For a building with 150 sqm roof area this saving can be worth Rs. 14,700.

### **Assess methods –**

- Most paints are toxic and do not last more than four years. Consider white tiles etc.
- The glare from the reflective roofs can annoy nearby high rise buildings.

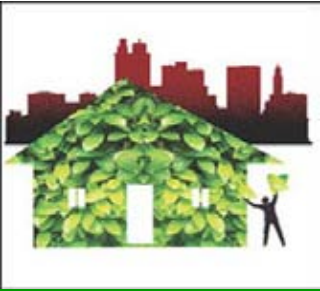
### **How rooftops of two cities differ**



Dark rooftops in Delhi



White rooftops in Jaisalmer



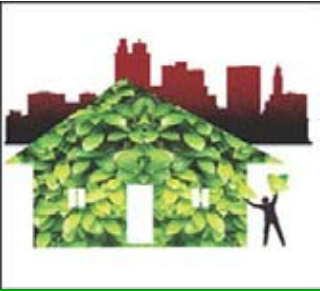
**Second generation challenge.....**



## Change the practice.....



- **Scalability:** The challenge is not to have a small number of high performance sustainable buildings, but to raise the sustainability of the entire stock of buildings in active use.
- **Effective reduction in new stock:** The challenge of including not just a few top end large buildings but mass construction. Ensure much larger aggregate savings. Need low cost energy saving measures
- **Retrofit existing stock**
- **Improve the performance of appliances** to maximise savings.
- **India still has a large stock of very low-energy homes:** Leverage this to achieve much better energy targets. Do not lock up more energy by design



## **Can we have targets?**



**Can all/large new buildings have energy performance targets by 2020?**

**Can substantially large number of buildings be energy positive by a targeted date, -- generate more energy than they consume?**

**Can existing buildings reduce energy consumption by certain percentage by a targeted date?**

**Are these questions premature?**

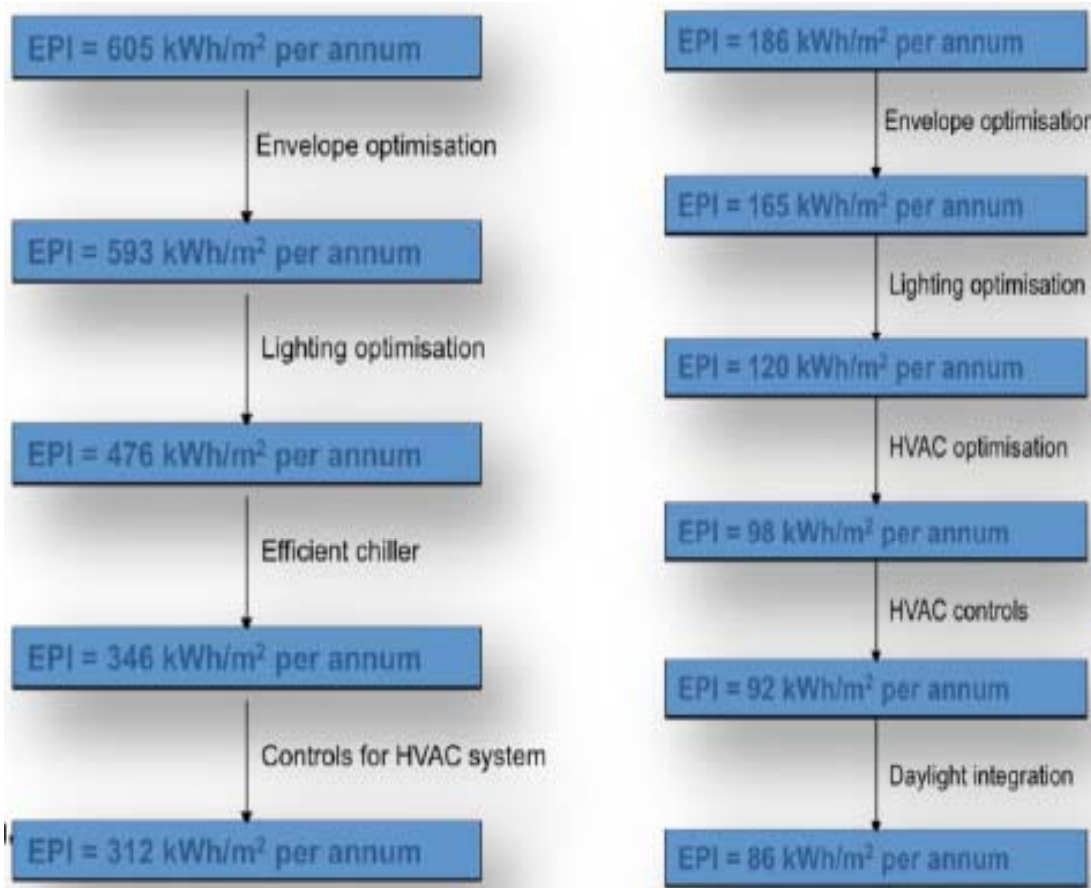
**How will ECBC help to make the second phase of transition?**



# Building code: A beginning



Impact of energy efficiency measures on the EPI of commercial buildings (office and hospital buildings)



Source: EDS, 2010

**Energy Conservation Building Code – for five climatic zones**

**The energy audits of buildings by the BEE** shows that existing buildings have 30 to 50 percent energy savings potential.

**Low carbon strategy of the Planning Commission**  
Possible to make massive cuts in energy usage



## **A shot in the dark..... What is ECBC targeting to achieve?**



### **According to BEE:**

An average commercial building in India has electricity consumption of 180-200 EPI. ECBC compliance can bring this down by 20 to 25 per cent. An ECBC compliant building will be 3-star on BEE's building star rating scale.

But not verifiable as no credible sample survey or scientific study

There is no data on record of number of buildings that have voluntarily implemented ECBC.

Buildings rated by IGBC and GRIHA green building rating systems claim to comply with ECBC but neither of the agencies have shared any sort of performance data with nodal agency.



## ECBC – possible approaches....



**Prescriptive method:** Provides step by step directions for all sections – building envelop, lighting, HVAC etc -- and set the minimum requirements. This is a rigid system

**The whole building method** uses the simulation models of buildings to verify that the total integrated design is ECBC compliant. This allows innovation and creativity

Cities find it easier to implement prescriptive method.

**Where do we want to take this?**



## Challenge of the AC paradigm.....

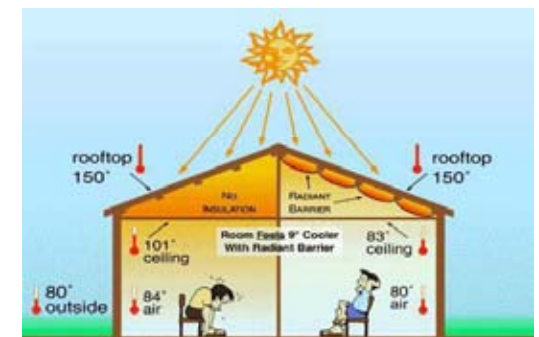


**Code sets the limit for level of heat transfer through the building envelop; Sets energy performance standards for heating, cooling etc**

**High performance buildings will require good insulation. Poorly insulated buildings severely affect the efficiency of air conditioning units, cause high energy losses.**

**Needs high performance insulation products: Code has fixed high insulating capability norm (R-value) to ensure rapid uptake of high performance insulating material in air conditioned buildings.**  
Increasing demand of air conditioned building increasing demand for high performing insulation. ....

--Insulation materials -- mineral wool, rock wool, vermiculite, foams expanded polystyrene, extruded polystyrene among others





## But why should we assume 100% AC requirement?



**ECBC standards are designed assuming that 100% of India's commercial building stock will be fully air conditioned** requiring both cooling and heating.

But the commercial floor space is forecasted to become only 60% air conditioned by 2030 (McKinsey). Most of our residential buildings are not air conditioned.

**Prescriptive requirements are relevant only for air conditioned building.** Therefore, mandates performance of individual components

**Buildings without HVAC systems will need whole building performance method.** But Code mandates sealing of enclosed building envelop to minimize air leakages from all fenestrations – thus blocks scope of natural ventilation needed for thermal comfort of non-air conditioned space.

**Under ECBC it is not possible to simulate partially or completely unconditioned buildings**

**Other concerns.....**Increased use of expensive, imported and environmentally inappropriate materials. Environmental lifecycle effects not accounted for: Glass wool, rockwool are bad for health. Thermocol (polystyrene) is less stable, releases gases through process of degradation

.....



## Too cool for comfort

**AC performance is directly linked to its temperature setting**  
ECBC has not set thermostat standards., lower temperature means more electricity.

The National Building Code puts the desirable indoor temperature during summers at 27.5° C.

CEPT study: reducing a temperature of thermostat below 26°C leads to increase in cooling load at the rate 10 per cent per degree centigrade. AC's efficiency could drop by 3% to 10% with every degree lower than this.

### Global good practice

South Korea and Japan have regulation that forbids commercial units to reduce their temperature settings below 26°C and 28°C respectively. Sri Lanka has set it at 26°C

Bushirt Rule in Japan





## Ensure total energy performance of buildings ....



**System approach for thermal comfort -- using natural and passive cooling methods.** – orientation, sun shades, ventilation, insulation for cool and comfortable structures. Ceiling fans for low energy cooling

**Creative passive cooling designs and methods.** to reduce to solar heat gain. Innovative/alternative designs -- filler slabs, double roofs, cavity/filler walls, composite walls, shading and many others.

**Let many methods and material bloom:** autoclaved aerated concrete (AAC) blocks, hollow blocks, thermocrete or other building materials with inherent higher R-values can also improve buildings' insulation..... etc

**Balance high cost technology** –complex technological package requiring high investment ...Eg. Special glazing technology

**Low cost simple Technology** for enhanced environmental and functional performance



*Cavities in the walls insulate an apartment in Bellary, Karnataka (Photo by Ashok B Lall)*

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**What is this paradigm?**



Chandigarh



Mumbai



Kolkatta



Gurgaon



Noida



Chennai



Bangalore



**Where does this belong?**

## Where does this belong?

Shillong



Gauhwati



Gauhwati



FRONT VIEW OF THE BUILDING

Agartala





**Northeast is different from other climatic zone...**





## Five climatic zones .... Why should all buildings look same!

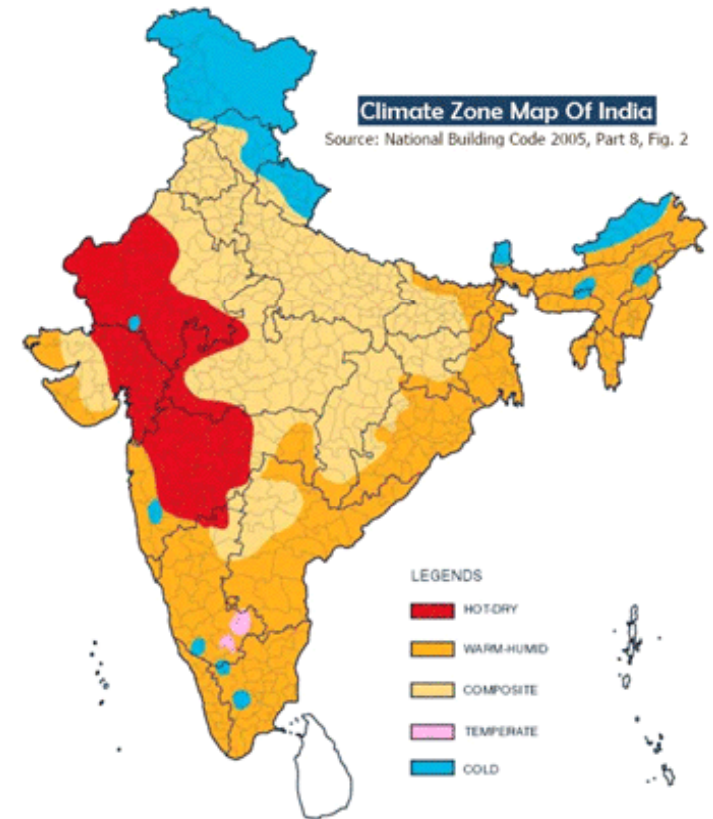


**Five climatic zones defined under ECBC**

**Yet for some critical parameters it prescribes the same norms for all zones.....**

Eg.  
The prescribed R-values for the overall roof and wall assemblies are the same for four of the five climatic zones. It allows 60% WWR in all climatic zones

**What is the regional climate?**





# Dazzled by Glass ■■■■■■■■■■



**Uses....** sense of open space. Allows natural light. Keeps dust away...Reduces the need for artificial light; aesthetics etc

**But..... Traps heat...** the principle of greenhouse. Increase energy use for cooling.

**Why so much glass in tropical climate of India** that needs to control heat gain and high glare.

Eg. Delhi receives 2,688 hours of sunlight annually London only 1,480 hours.

Glass environmentally harmful. Unsafe, fire hazard

**Yet... ECBC** allows a maximum wall-to-window ratio (WWR) of 60 per cent.

Make its use strategic . Different orientations require varying WWR.



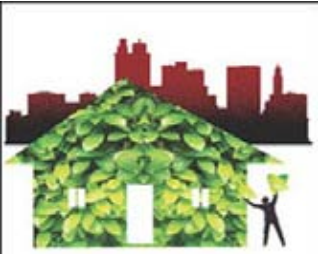
# Ask why?



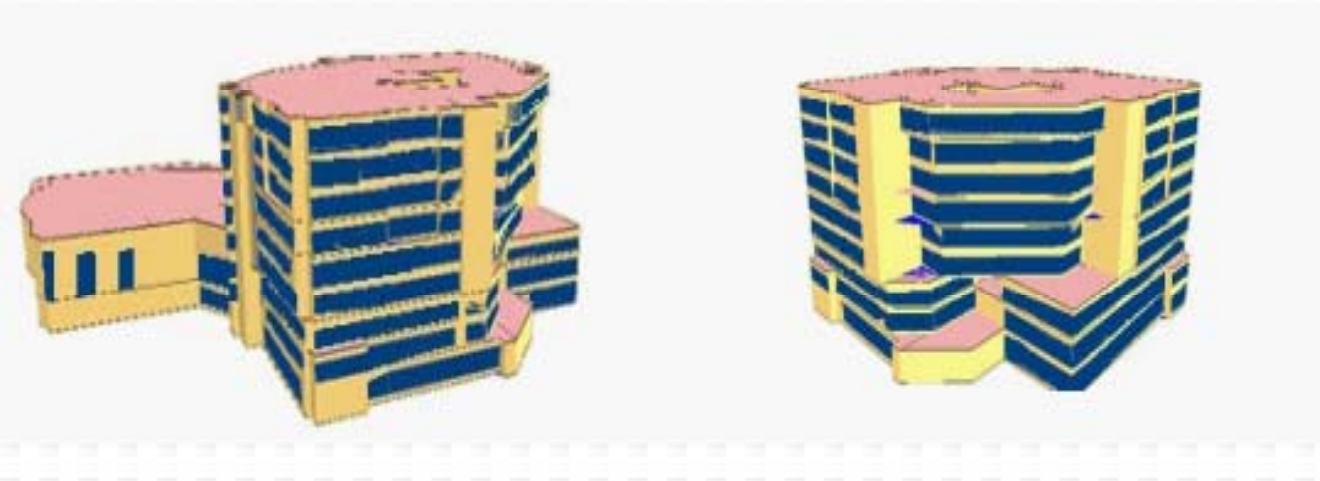
**Air tight glass building in hot and humid climate of Chennai**

**Why?.....?**

**Anna Centenary Library Building**



# Ask why?



Electrical Use Summary

Alternative	Lights	Equipment	Cooling	Tower/Heat Reject.	Pumps/Aux.	Fans	Total
Electrical End-use Totals (kWh)							
Base Case	2,243,820	132,491	1,401,766	471,594	45,991	315,098	4,610,760
Proposed Case	1,141,850	132,491	1,801,046	0	26,631	201,021	3,303,039
Incremental Electrical Savings (kWh) (compared with previous alternative, negative savings represent increases)							
Proposed Case	1,101,970	0	-399,280	471,594	19,360	114,077	1,307,721

**-399,280 kWh**

Even the consultant point out in their report the power consumed for cooling the building is more than a conventional building.

**Then Why so much glass? And how come Gold rated?**



## Ignoring local wisdom



Dakshinachitra



### Chettinad Houses of Tamil Nadu

For hot-humid climate

**SOLAR ACCESS:** Solar radiation is helpful in January and February. Other months -- only wind can give comfort.

**VENTILATION** -- A deep arcaded area is a transition space ....Provide shade and also ventilation

**Allow summer breezes to ventilate and cool.....** Windows designed to provide shade from south sun but allow southern breezes.

**Need local science for strong modern identity**

# Eastern region's own wisdom



(Photographs: Courtyards Houses of Kolkata: Bioclimatic, Typological and Socio-Cultural Study by Nibedita Das)



## Courtyard Houses in East

For hot-humid climate of the region

**SOLAR ACCESS:** Solar radiation is helpful in January and February. Other months -- only wind can give comfort.

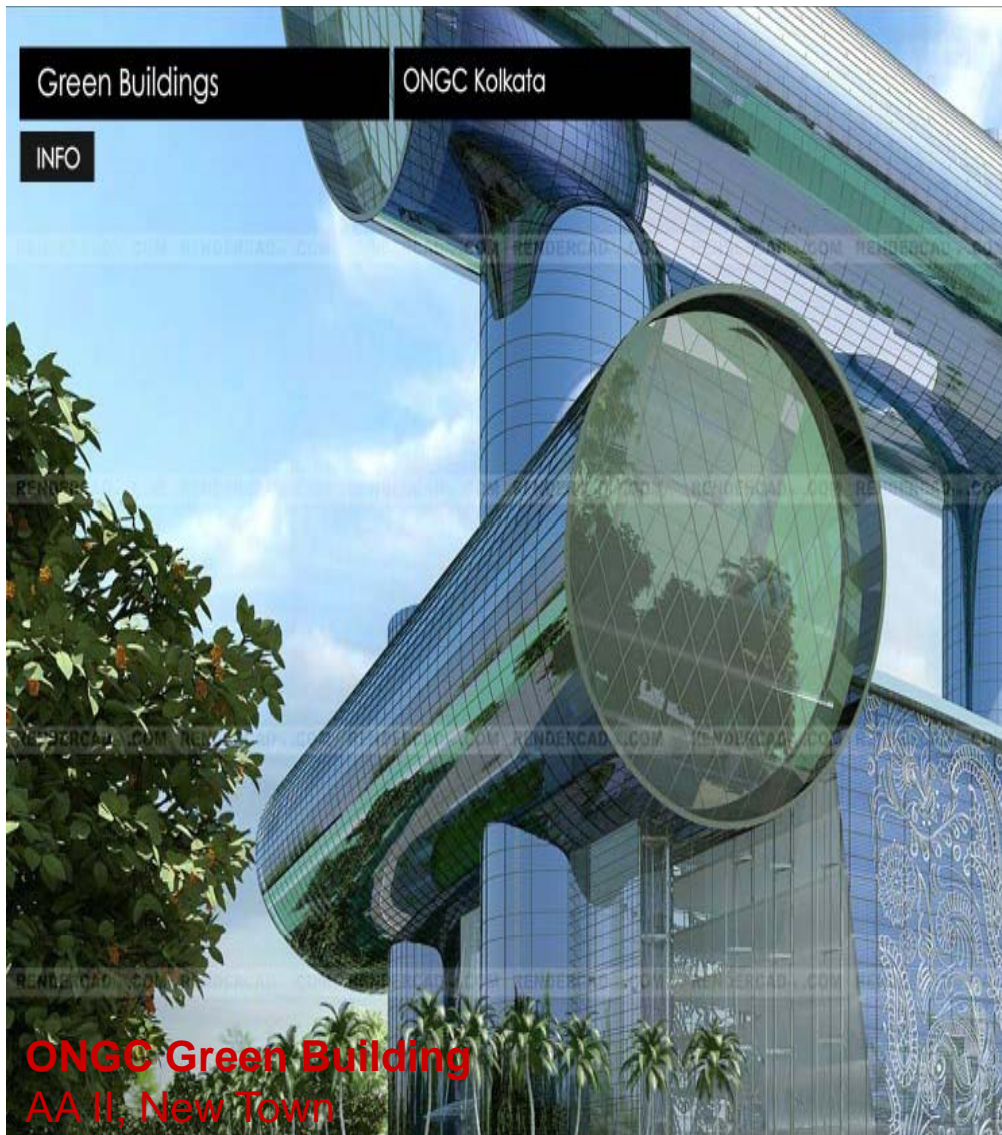
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(Source N Das)

**Need local science for strong modern identity**



# Ask why?



**Air tight glass building in hot and humid climate**

**Why?.....?**

# Tell why?



## Kolkata Museum of Modern Art (Herzog & de Meuron)

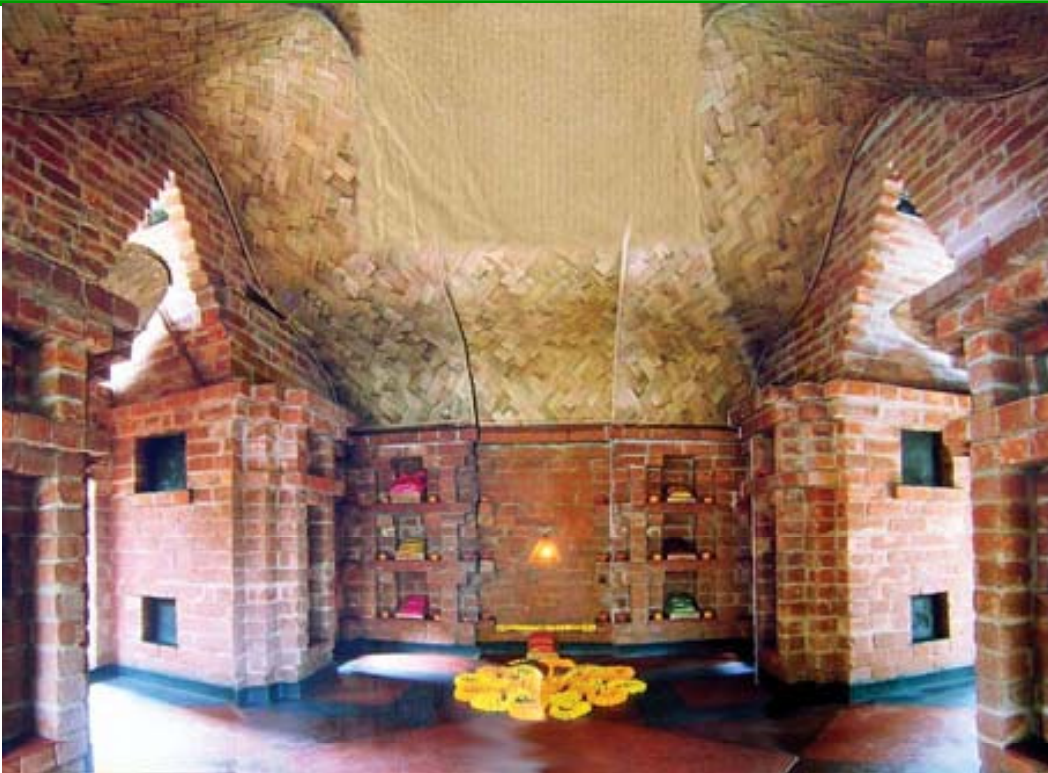
**It provides the logic.....**

-- Kolkata has a tropical wet and dry climate, experiencing hot and humid summers and high levels of precipitation.....

-- This uses **passive methods** where feasible **to control the climate in and around the building,**

-- The urban scale spaces are shaded and **offer natural cross ventilation through careful planning.... etc.....**"





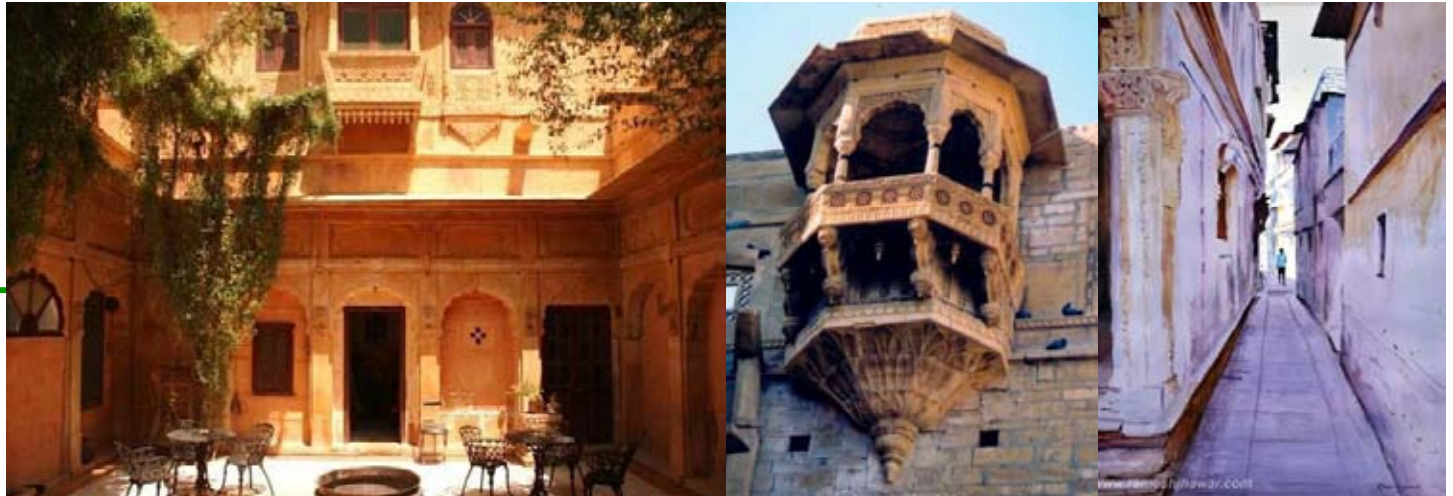
## Meditation room for Asha Niketan: -- Laurent Fournier

Exposed bricks and bamboo mesh arches:

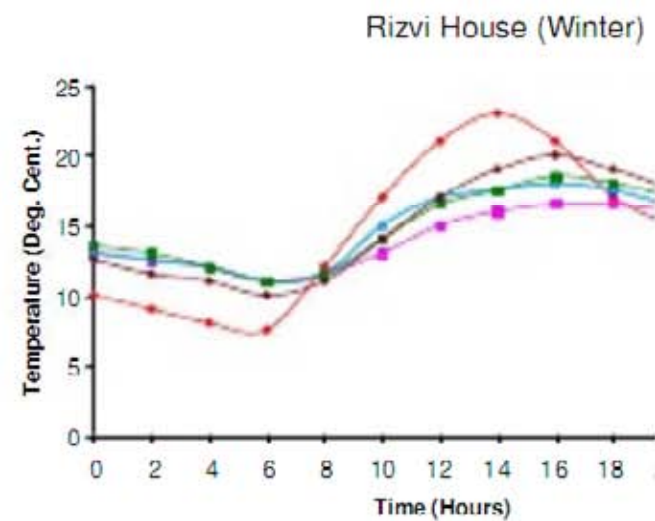
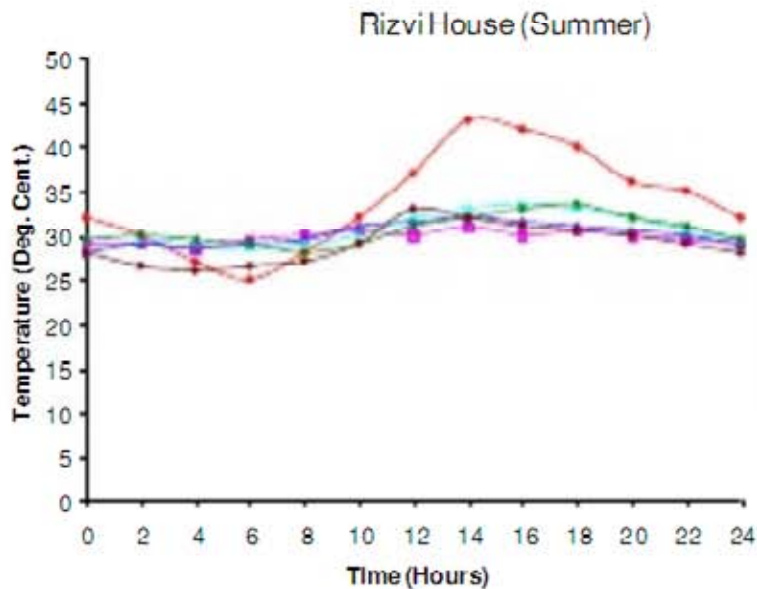
- High ceilings, Arches and big window openings for better ventilation and lighting
- Local materials
- Less use of steel and concrete
- Reviving and improvement in local building techniques

## Rizvi house

- NE-SW orientation.
- Openings and the entrance on windward side
- Absence of the openings on exterior surfaces facing southeast and southwest
- Main entrance opens into the narrow shaded street inducing cool air from the street.
- Courtyard facilitates shaded spaces and ventilation through openings facing the courtyard.
- The projection of the courtyard provides shade from direct solar radiation
- The *jharokhas* catch wind and allow air circulation.
- Massive walls and heavy roofs offer greater thermal resistance and increase the time lag.
- The exterior of the building is white washed which helps in reflecting solar radiation.



# Lucknow





**Cold desert.....**

# Integrate traditional wisdom to reduce energy impacts of new buildings



**Rammed earth** is an ancient technique used for hundreds of monasteries, castles and forts around Ladakh. These structures have survived, unprotected and exposed harsh nature for hundreds of years.

- **Abundantly available material is earth**, -- principal building material for walls, roofs, and floors.
- **In dry climate compacted earth walls are durable, mud-plastered surface requires little maintenance**
- **Three or four storied mudwall structures in Ladakh**, and some even higher. Roofs are generally flat and are constructed
- **Sometimes there is an enclosed yard on the ground floor where cattle is kept**
- Since glass was not available until recently, **windows are fitted with solid timber shutters**
- **letting in light as well as cold air, or of keeping both out.**
- **The window openings are limited to the sunny sides of the building**, and the sides exposed to cold winds have no openings

# Integrate local wisdom



Rebuilding of Druk White Lotus school:  
combines local wisdom

Source: SECMOL – The Students'  
educational and Educational and Cultural  
Movement of Ladakh



Insulation it does not need to be very  
expensive modern materials. The wood  
waste generated during the construction is  
filled in the ceiling to stop heat loss through  
the roof.

## Encourage locally appropriate technique and material



**Local techniques:** Top layer of the floor is lined with slates from the nearby mountains. This reduces the use of cement.

Slates also become a thermal mass or heat bank as they are now cut off thermally from the cold ground.

Source: SECMOL



Outer walls insulated by a jacket wall outside the main structural wall. Six inch gap between the walls - filled with low cost insulation: saw dust, wood shavings or sometimes paper and plastic garbage. Sometimes use cow dung as an insulating plaster. Right mix of earth and clay, it makes a strong and thermally effective plaster. 1 ft mud wall = 2 ft concrete = 4 ft stone = 1.5 inch of saw dust. = 1 inch of Thermocol, rockwool etc.

# Learn from locally proven energy efficiency measures

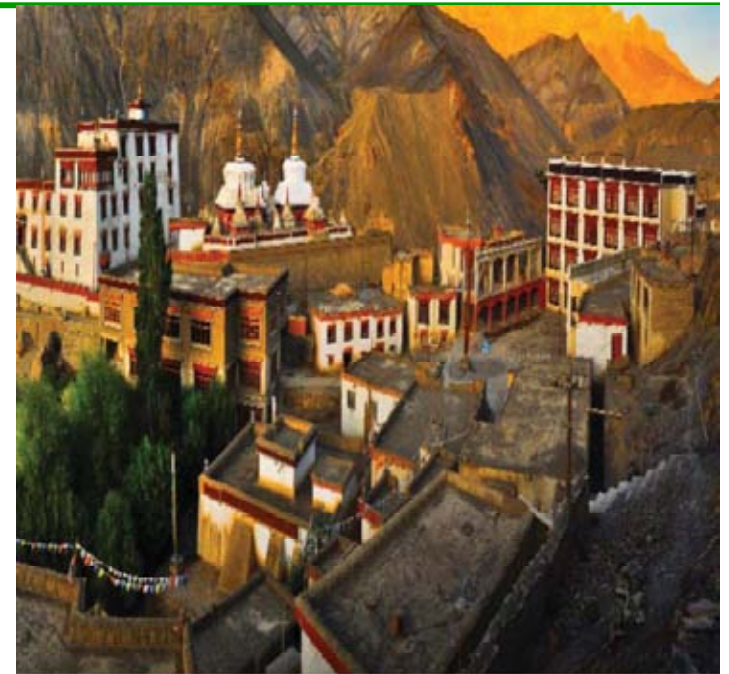


**Passive Solar Architecture** – Link energy conservation with clean energy

- **Conventional methods of room heating** -- use of kitchen stove fuelled with dung, wood and kerosene.
- **Trombe wall built on the principle of passive solar gain** and minimization of heat loss through various design and insulation techniques.
- **Trombe house can reduce reliance on heating fuels by about two-third, besides reducing indoor air pollution and health hazards.**
- **Installation of 75 solar retrofitted houses** in 1984, in collaboration with Ladakh project.  
(Source: HBF study)

Windows and skylights ensure that no place in the building needs electric lights in the day.

**Sources: Buildings of SECMOL – The Students Educational and Agricultural Movement of Ladakh**



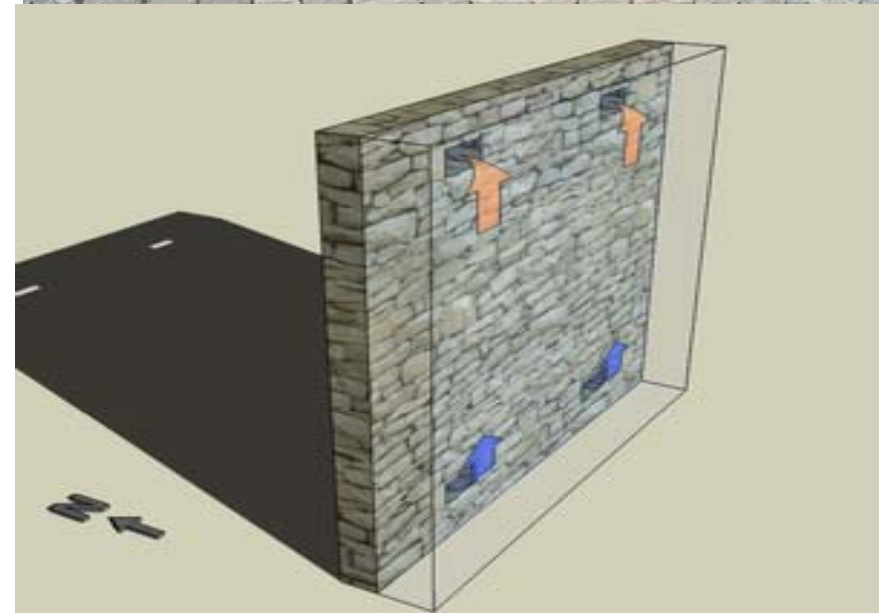
# Good examples of modern buildings built sensibly.....



## **Example of good practices: LE DeG Trainees' Hostel: Architect: Sanjay Prakash and Associates**

Traditional materials and methods modified and adapted for energy efficiency  
South exposure with no overhangs for maximum winter gains. Entrance lobby designed as solarium on south side. Bedrooms with Trombe walls for direct heat gain and for passive heating.

**Result: Temp inside sleeping room above 8 degree C when outside temp was - 17 degree C in moderate winter**



# Tradition under pressure...



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## Studies show:

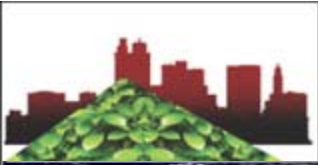
- **Timber is in short supply and even good building stone is not easily available.**
- **Glass can be used effectively for solar passive heating of buildings, but more commonly it is seen that this new material is not used judiciously:** So the resulting buildings are thermally inferior to the unglazed ones, though they may be better lit. for educational facilities, hotels, factories, and other functions which did not exist earlier.
- **New buildings designed by architects and engineers** – Not all are sensitive to and aware of the local practices. It is not uncommon to find buildings in the mountains similar to those in the plains
- **Advent of new material and technique:** Since galvanized iron sheets were introduced in Srinagar, earth roofs disappeared. Helped in roof waterproofing. But has little insulation value. Add to this indiscriminate use of glass in walls – Result -- buildings are hot in summer and cold in winter. --- Newer buildings require more heating than traditional buildings. Thermal comfort and energy savings are compromised

**Source: ISIC Survey – Eco friendly guidebook for Jhelum city**  
Galvanized iron roofs can be insulated with a variety of materials and the insulation value of glazed walls can be improved. But these increase cost and increase dependence on import.

## Drawing lessons from our local wisdom



**Create opportunities for** – more creative use of building orientation, positioning of interior spaces according to direction, variation in glazed area according to orientation of façade, combination of appropriate building material etc



*Model building design that helps save energy and money by leveraging sun's movement*



Shell roof and the 25 kWp solar photovoltaic plant



## Paradigm shift in building material



**Promote locally appropriate, locally available material with low embedded energy.....**

The new policy expected to incorporate measures to promote the use of green materials to create sustainable buildings.

This may be looked at as an opportunity to use alternate building materials.

Availability of appropriate material as listed in schedule of rates difficult to source....

Thermal properties of most of the local material not always known



## Implementation challenges



Design stage scrutiny for ECBC compliance

Checks during construction, at construction site or at the time of giving completion certificate.

How building commissioning system can ensure that it is built according to the planned design and is ready to perform ....

Need continuous monitoring system

Need indicators for performance



## **Best practice in South Asia region**



### **Sri Lanka**

- Covers all commercial buildings, industrial facilities and large scale housing developments – with any of the four features -- four or more stories, floor area 500 m<sup>2</sup> or more, air-conditioning cooling capacity of 250 kW or more apart, electrical power demand of 100 kVA or more
- The energy code compliance expires every 3-5 years and needs to be revalidated. This ensures maintenance throughout their life-span.
- CPEEB also prescribes efficiency standards for the mechanical equipment and appliances. But for building envelop it seeks relative efficiency of the complete envelop measured by the Overall Thermal Transfer Value (OTTV). This makes is relatively easier to adopt at large scale and less complex capacity development.
- Mandates temperature setting at 26 degree centigrade for design of HVAC systems. It even takes into account the adaptive comfort conditions.
- Energy audits and energy data reporting



# EIA: A lost opportunity

**Only comprehensive legal instrument** that addresses environmental and resource impacts of **high impact buildings** comprehensively – land, water, energy, waste, pollution, etc

**Legally binding under the Environment Protection Act**

**Influence much larger built up area than any other:** Eg -- from energy stand point compare -- EIA and ECBC.

Only in Haryana, -- about 927 buildings reviewed for environmental clearance between 2008-2011. The area data for 446 buildings shows -- 8,29,89,836 square meters.

In contrast, according to the BEE website the ECBC registered buildings nationwide accounted for 829,787 sq meter until 2010.

**How can we realise the full potential of this instrument?**



## Promising tool... but a blunt tool.....



### Why EIA is not working effectively for buildings?

Form 1 and 1A are not as exacting as the detailed EIA for industrial and mining projects

Construction can precede consent ... blunts the edge

Escape routes ... the phenomenon of 19,999 sq mt.....

No clear siting policy ..... Very weak post construction monitoring

No follow up on compliance reports

No public consultation

Inadequate resources and staff ..... and many more....



## **Weakens sectoral interventions.....**



For each sector Form 1 and Form 1A demand some information.....

**Eg – on Energy it demands to know --**

- Power requirement
- Application of glass in buildings
- Renewable energy application
- Passive solar architectural features
- Lighting, ventilation, space conditioning
- Thermal characteristics of the building envelop
- Impact on micro climate
- safety etc

**No formal linkage with ECBC**

**But can this make a difference?.....**

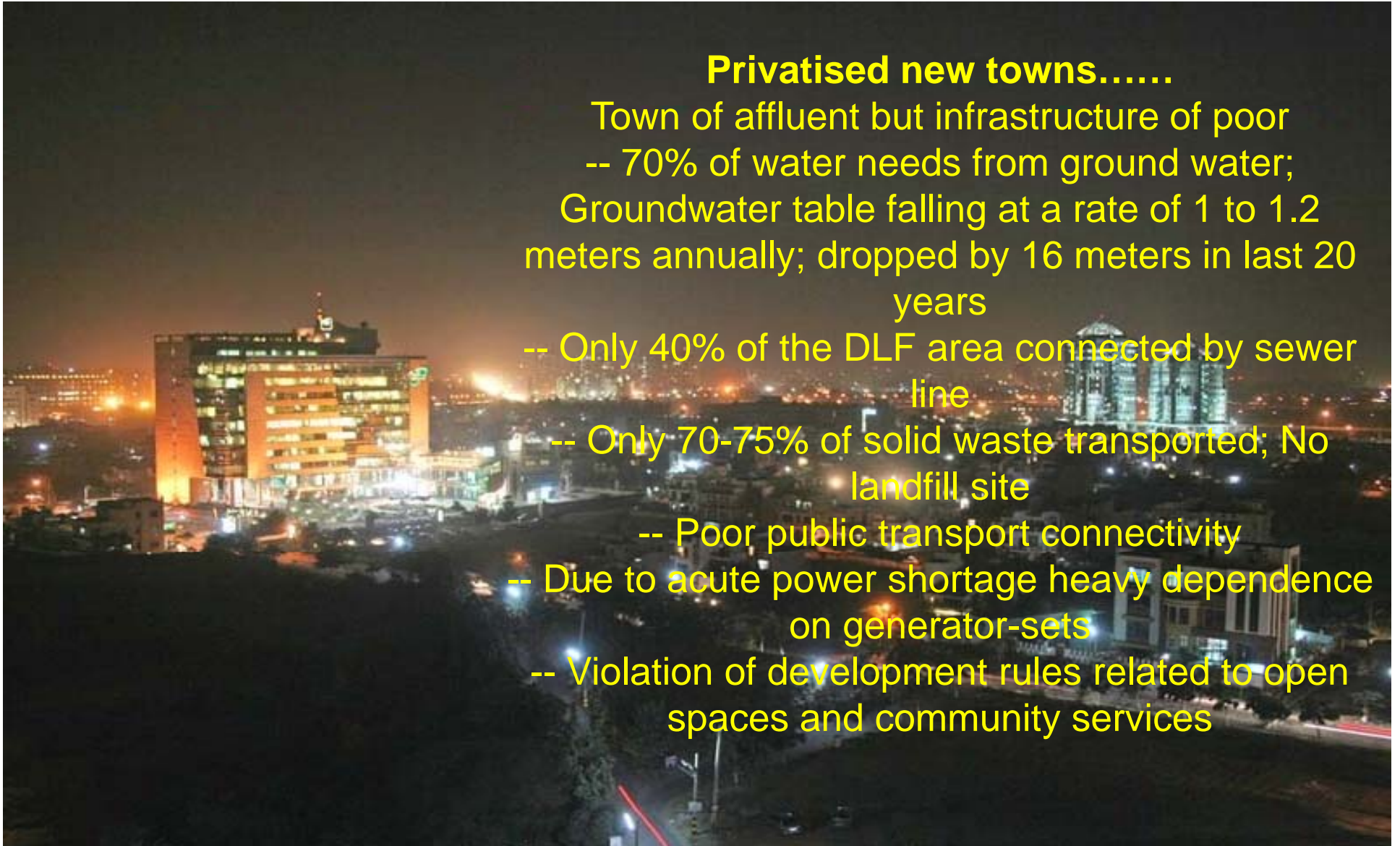
**No clear numbers and benchmark;** Sometime response as generic as – “All relevant features like orientation of building, shading effect will be incorporated...” On thermal characteristics of buildings — “in accordance of ECBC,,,”

# EIA could not prevent Gurgaon dilemma.....



## Privatised new towns.....

- Town of affluent but infrastructure of poor
  - 70% of water needs from ground water; Groundwater table falling at a rate of 1 to 1.2 meters annually; dropped by 16 meters in last 20 years
  - Only 40% of the DLF area connected by sewer line
  - Only 70-75% of solid waste transported; No landfill site
  - Poor public transport connectivity
  - Due to acute power shortage heavy dependence on generator-sets
  - Violation of development rules related to open spaces and community services





# Green rating of buildings

Voluntary green rating schemes growing in popularity in globally.

Country	Rating system
United States	Leadership in Energy & Environmental Design (LEED-United States)
	The Green Globe Rating System
	Energy Star (United States Environment Protection Agency)
Canada	Leadership in Energy & Environmental Design — Canada (LEED-Canada)
Australia	Green Star
	Australia Greenhouse Building Rating (AGBR)
United Kingdom	Building Research Environment Assessment Method Consultancy (BREEAM)
Europe	European Environment Agency rating
Hong Kong	Building Environment Assessment Method- Hong Kong (HK-BEAM)
Japan (CASBEE)	Comprehensive Assessment System for Building Environment Efficiency
Taiwan	Ecology, Energy Saving, Waste Reduction and Health (EEWH) (Taiwan)
Singapore	BCA Green Mark
Philippine	Philippine Green Building Council
South Korea	Green Building Council (Korea)
India	GRIHA
	Indian Green Building Council



# Greening of building spaces



## Details on green rating systems in India

Heads	LEED/IGBC	GRIHA
Inception year	2001	2007
Total buildings registered	2,111	375
Total buildings rated	362	NA
Square ft registered	1,450 million	118 million
Square ft rated	NA	NA

Source: IGBC and GRIHA website

Yet another estimate shows that about 730 million sq ft. have been rated. That is a mere 3 per cent of the existing built up area of 25 billion sq ft. Miniscule!



## Why voluntary green rating under scrutiny today?



Voluntary rating schemes work on reputation advantage. It stimulates market and speeds up market uptake of green features. But as private voluntary schemes these remain outside the pale of regulations.

But now the voluntary rating programmes are getting linked with official incentive programmes.

**Bhubaneswar grants extra 0.25 floor area ratio as an incentive to developers for ECBC compliance**

**Maharashtra government:** Increased floor space index; reduced consent fee; rationalisation of property tax; reduction in state taxes etc. Pimpri Chinchwad

**NOIDA, UP:** NOIDA authority awards 15 per cent extra FAR (floor area ratio – extra built up area) to projects which commits for LEED gold rating.

**Ministry of Renewal Energy** incentives for on-site renewal system

**Union Environment Ministry** allows separate queues for environmental clearance for fast track clearance to buildings that are pre-certified for GRIHA and LEED.

**This demands performance monitoring**



## CSE review of the rating system



**Opaque system:** There is no data and information on the performance of the green rated buildings. Even in cases where rating systems have been promoted with government back up and incentives there is no record of the actual performance of the buildings.

**No performance monitoring and reporting:** The Government of India as well as state/ local governments are beginning to give incentives for rated buildings. But no official system for regular monitoring, reporting of information on actual performance of buildings.

**No strategy to improve public acceptance of the green rating systems:** Documentation of the efficiency measures in buildings and their performance is essential to build public support and acceptance of these programmes. But there is very poor level of information on the applications, costs and pay backs in the public domain.



## Globally rating systems are being made more accountable.....



**CSE review: without proper performance monitoring green rated buildings perform sub-optimally and sometimes worse than the standard buildings.**

**Eg. In the US** the US Green Building Council -New Buildings Institute study of 2008 showed wide variability in LEED energy performance which was a cause for concern.

**In Canada** study by the National Research Council Canada, in 2009 shows that on average, LEED buildings used 18-39 per cent less energy per floor area than their conventional counterparts. But, 28-35 per cent of LEED buildings used more energy than their conventional counterparts.

**This demands performance based green rating**



## Do it differently.....



### **Instead of FAR bonus grant fiscal incentives:**

- Incentive in the form of additional space allowance has the potential to create substantially more additional built up area.
- If the developers are non-compliant, it will lock up enormous resource inefficiency in the new structures that cannot be reversed. This is a serious risk.
- Or a post facto penalty at the market rate of FAR will only legalise the deviation and non-compliance and perpetuate business as usual practices.
- Global best practices indicate that fiscal incentives can work more efficiently. Immediate tax benefits can encourage the developers to build green. Grant fiscal incentives in the form of concessions in corporate tax, license fee or income tax levied on corporations etc. This can go as direct benefit to the developer.
- Fiscal penalty in case of non compliance can be three to four times the tax/license fee concession thus granted.



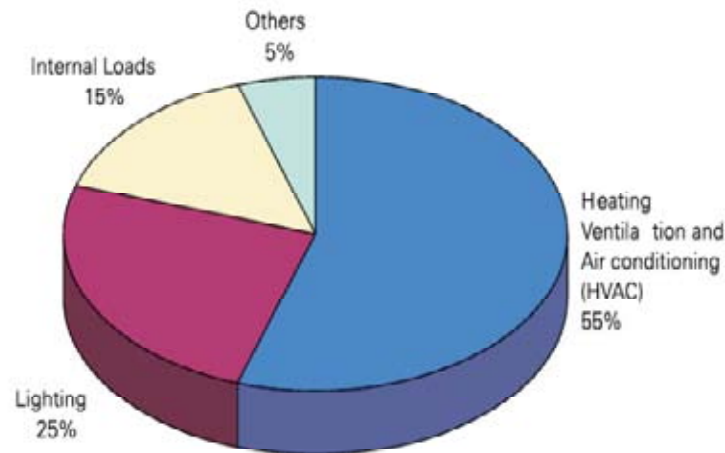
**Appliances and behaviour ..... An opportunity**



## Varying pattern of end use of energy .....



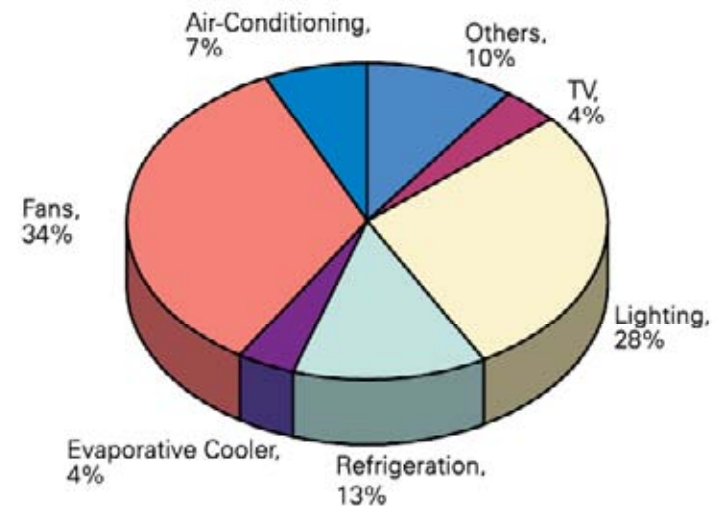
**HVAC use up maximum energy in commercial buildings**



Lighting and AC use up 80 per cent of the energy in a commercial building.  
AC market is growing at 25% a year

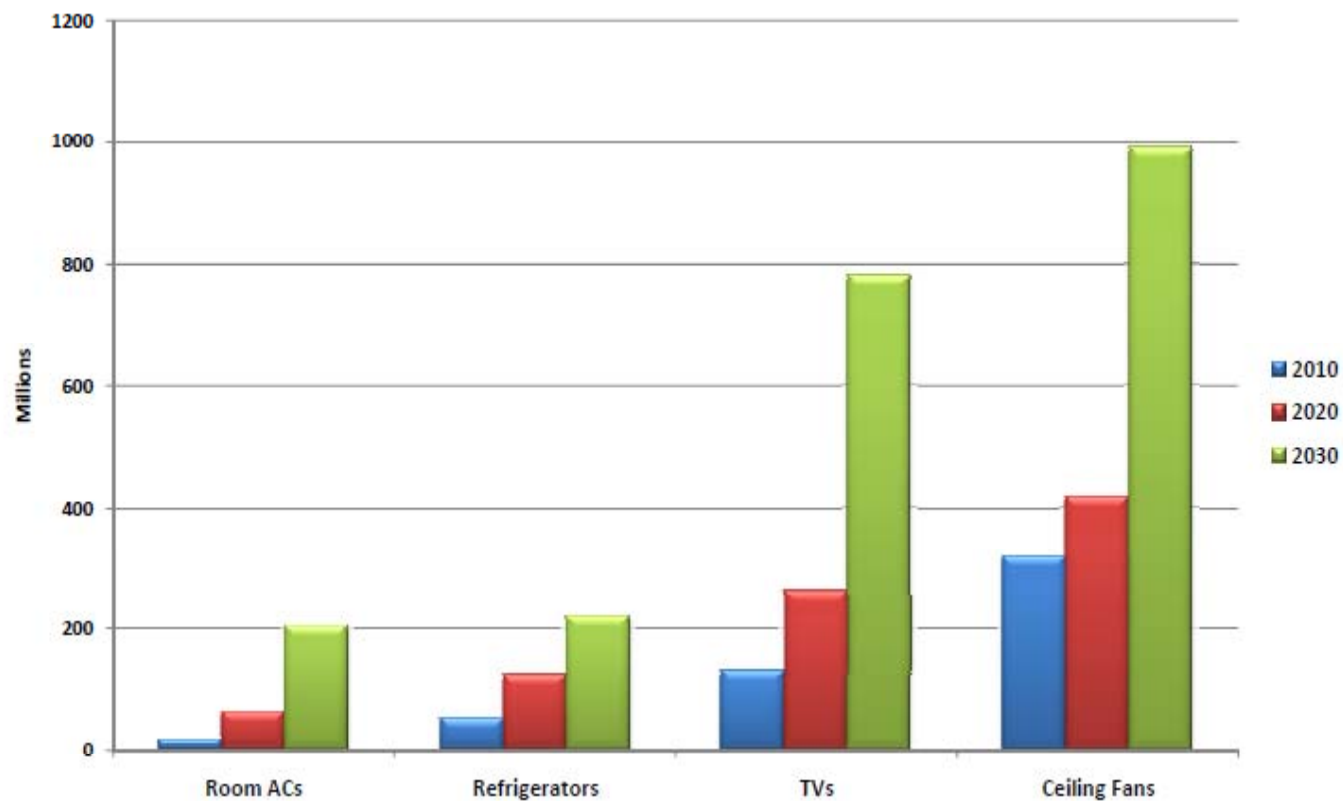
Source: Bureau of Energy Efficiency

**Fans and refrigerators use maximum energy in residential buildings**





## Ownership of Appliances in India Growing Rapidly



Estimates From  
Daljit Singh 2011,  
Prayas

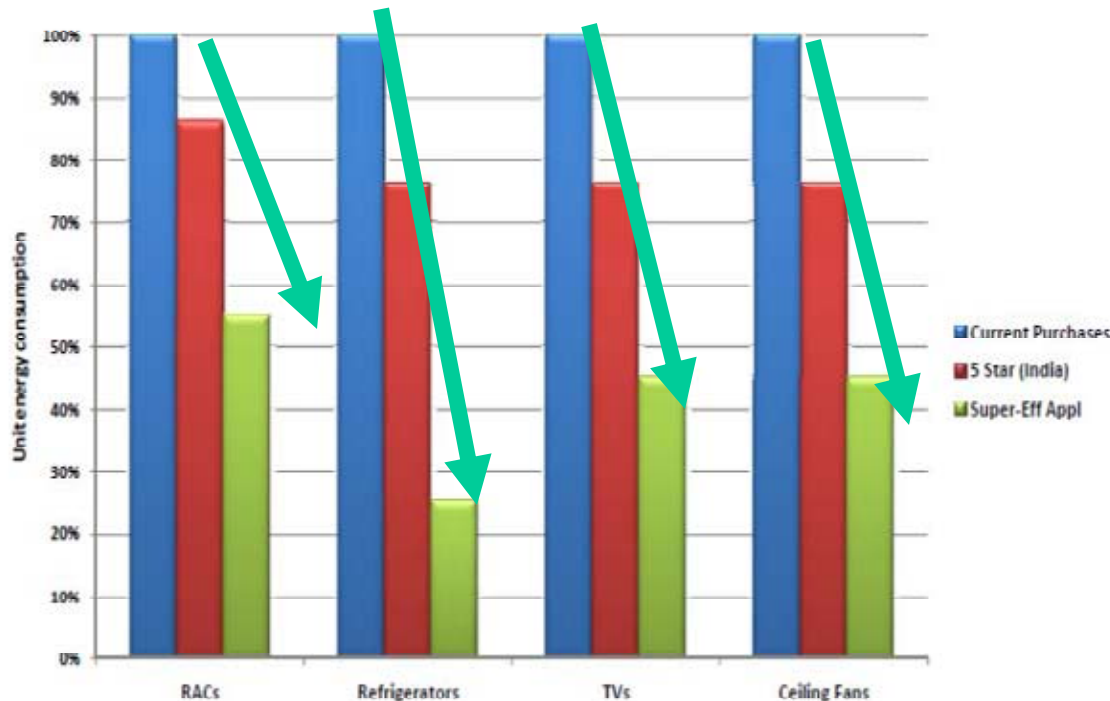
*By 2030, more than 70% of the stock of appliances will have been added just after*



# Can we have energy prudent society?



## Comparison of Consumption of Current Purchases and Highest Rated in India with Best World-Wide



*Large gap between average current purchase and highest rated model (5-Star), and even larger gap between highest rated and best commercially available world-wide.*

## Impacts

Labelling is encouraging shift to efficient models in some categories

In 2009-10 and 2010-11, 85-90% of labeled frost free refrigerators were 4 or 5 Star

But room ACs, -- only 15-20% are 4 or 5 Star, but increasing.

Appliances without mandatory labelling, -- large fraction are unlabeled.-- Only 2% of ceiling fans are labeled.

Estimates From Daljit Singh 2011, Prayas



# But.....

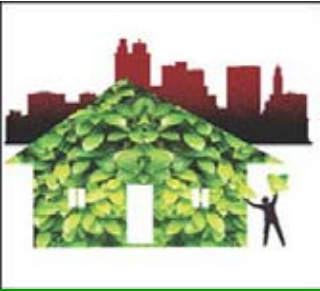
## Energy losses from rebound effect



- Multiple ownership of efficient appliances use more energy than a single inefficient one – like refrigerator; -- Retailers increase lighting use even after meeting specifications -- total energy use increases
- Study (WBCD) -- people may increase usage after installing efficient lights -- Lose up to 12% of the expected energy savings by leaving them on longer. Efficient furnace lose up to 30% because people raise the thermostat.
- Use a range of energy indicators -- absolute total usage; Per person per year; Per square meter per year -- to track change.
- **Need policies to influence behaviour – Change billing practices to make users pay specifically for the energy used.** --- Global studies show that when tenants are billed for actual consumption, energy use for heating typically drops by 10 to 20%.  
  
**Eg. China** – Consumption based pricing and billing system covers 317 million square of built up area; Public disclosure of energy consumption (already 6000 buildings); energy database for 33,000 buildings... etc
- **Special challenge of captive power generation – Solar and gen sets**



**Poor persons home are not energy guzzlers. But need design innovation and habitat management to improve comfort.....**



# Affordability.....

**Affordable and low cost housing:** Massive housing deficit

- Official estimate -- close to 20 million housing units
- Unofficial estimate – 40 million housing units. Demand growing at 10% a year.

**Several states have framed favorable policies to boost affordable housing – mandate; FSI relaxation etc**

**Challenge of affordability**

**Poor people's self constructed housing**

**Challenges**

- Land availability and tenurial security
- Exclusion from formal finance system
- Poor design and quality construction
- Private developers lack interest
- Low priority to rental housing



# Greening of poor people's home



Not just resource efficiency in rich person's home. Green measures needed to improve comfort and efficiency of poor peoples' home

Good practices -- Design innovations in low cost homes

Eg. SAM-BKL project of IGSS: In 2008 'Micro Home Solutions' –  
**Night shelters:** designed comfortable shelter with canvas, chicken mesh, bamboo and ropes

Source: Micro  
Home Solutions



DHS- Design  
Home Solutions



## Need high density development: Cities to set norms



Source: [Kolkataskyline.wordpress](http://Kolkataskyline.wordpress.com)

**Nationally policy is expected to incentivise high-density development** for optimal use of urban space and resource efficiency.

**Higher FAR do not automatically result in densification.**

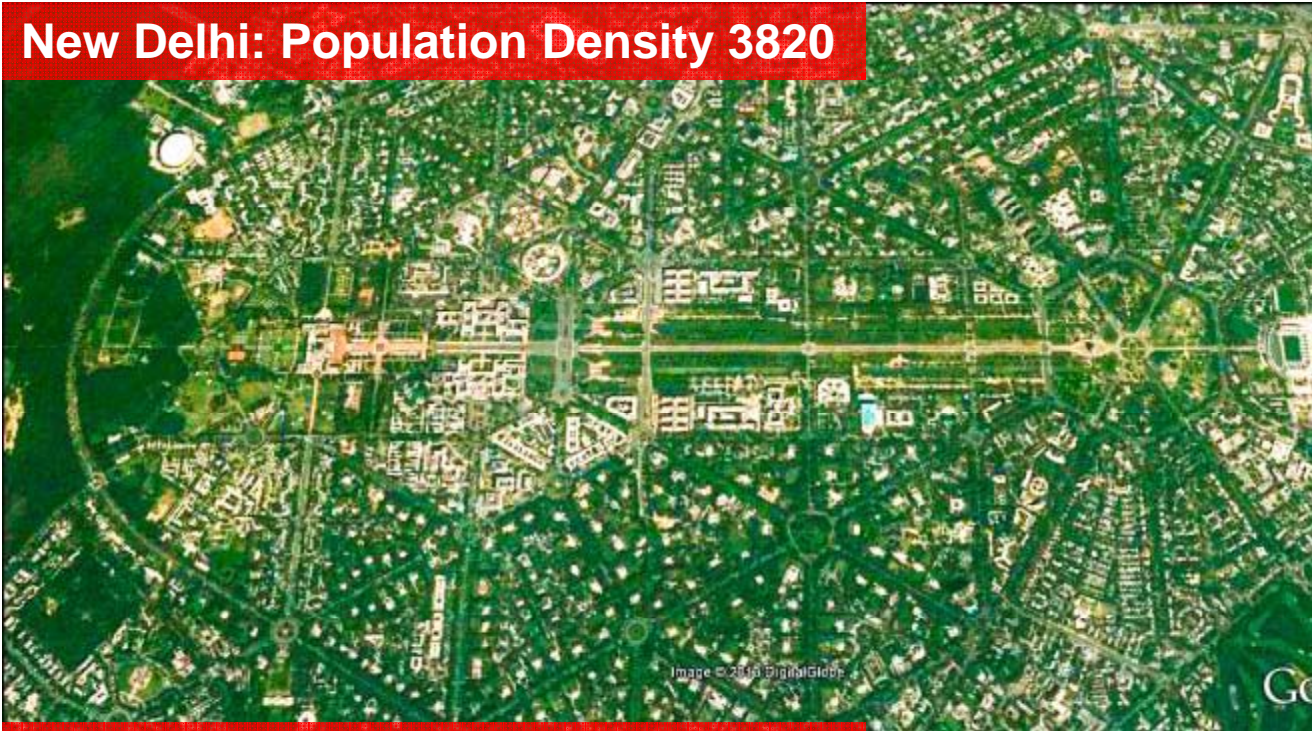
-- Provision of large unit-sizes defeat the purpose of densification.

**Link the FAR threshold with a minimum density requirement.**

-- Maximum permissible FAR and densities to be based on the capacity of public transport, circulation network and the physical infrastructure thresholds of the area.

**Provide a variety of mixed-use, mixed-income housing, employment and recreation options** within walking/cycling distance of each

## New Delhi: Population Density 3820



## 'Half of Delhi's population lives in slums'

(Hindustan Mahapatra, TNN On 2, 2012, 10:45:00 AM)

Tags: Supreme Court

NEW DELHI: Delhi may be one of the biggest metropolises in the world with a population of around 18 million, but nearly half its people live in slums and unauthorized colonies without any civic amenities.

In a note filed before the Supreme Court on management of municipal solid waste, the capital's civic bodies said, "About 49% of the total population of Delhi lives in slum areas, unauthorized colonies and about 860 jhuggi jhonpi clusters with 4,20,000 jhuggies."



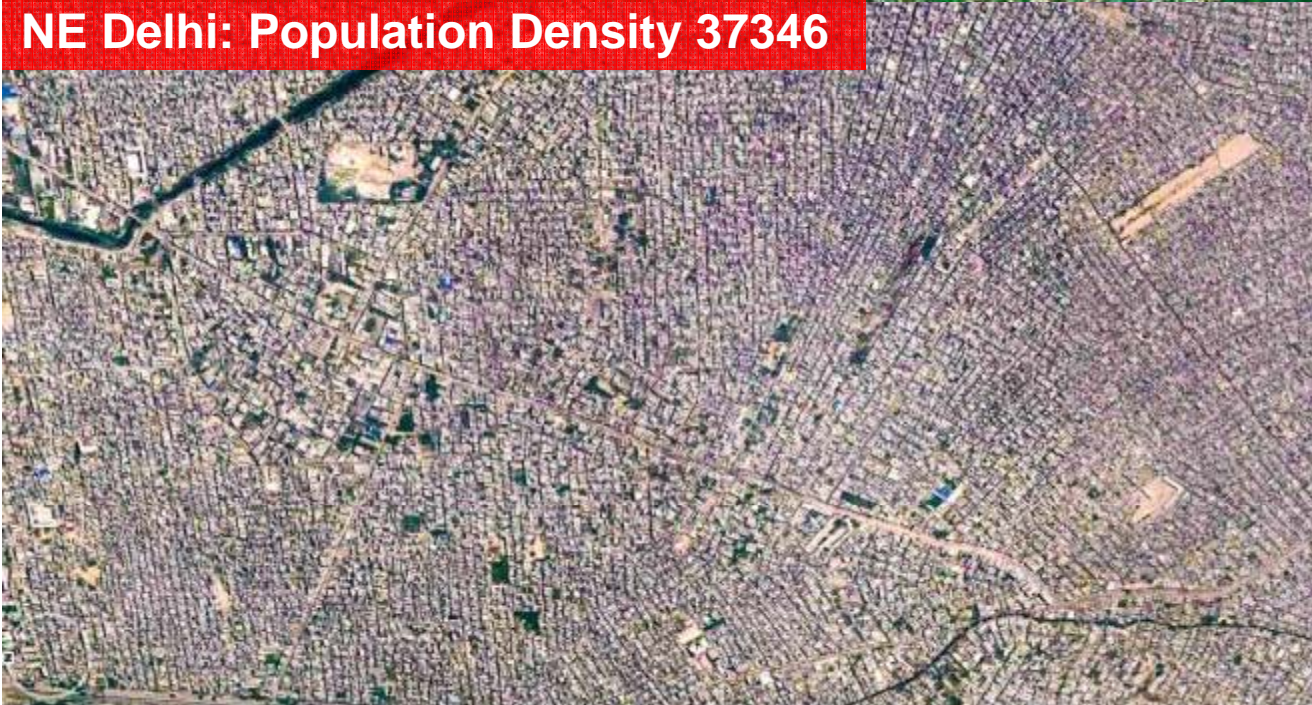
Only 1 per cent of Delhi's population live in Lutyen's Delhi.

Most part of urban boom – housing and commercials have been pushed to the sides and periphery

Delhi has not maximised the use of land to provide for its teeming million – Delhi needs 70,000 houses a year to meet the housing deficit

Massive illegality: About 49% lives in slums, unauthorized colonies -- 860 jhuggi-jhonpris

## NE Delhi: Population Density 37346





## Why this difference in urban form?



**Kolkata city**



**New Town Kolkata**

# Low density can lead to sub optimal use of metro

## Metro Corridor – Density disparity – The Yellow Line



- Chawri Bazar

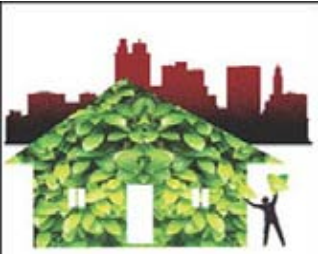


- Race Course



- Green Park





**Avoid car feeders to buildings –  
Public transport to define the urban form**



**1a) High Density Mixed Use within 5-min walk of stations...**



**Reason for success of BRT in Curitiba:**

**Maximum people Live, Work & Play  
within 5-min walk of *RAPID TRANSIT* Stations**



## Delhi setting norms for high density requirements



Delhi framing Transit Oriented Development Policy (DDA/UTTIPEC)

Density minimums as per the table below:

Gross FAR (site)	Minimum permissible density (with $\pm 10\%$ variation)	
	Residential dominated project (Residential FAR $\geq 50\%$ )	Predominantly non-residential (Residential FAR $\leq 30\%$ )
Below 1.0	Under-utilization of FAR (not permitted)	Under-utilization of FAR (not permitted)
1.1 - 2.0	200- 400 du/ha	100 - 200 du/ha
upto 3.0	400 - 600 du/ha	250 - 400 du/ha
3.1 - 4.0	600 - 800 du/ha	400 - 600 du/ha

\* Site level FAR shall be based on Approved TOD Influence Zone Plan.

- **Mixed land-use norms:** At least 30% residential and 20% Commercial & Institutional use of FAR is mandatory within the Influence Zone
- **Several other cities including Surat, Pimpri Chinchwad .are incentivising densification along transit corridor. Linking up green building requirements**



# Build compact city .....Devil is in detail



## ***National Habitat Standard Mission of the Ministry of Urban Development***

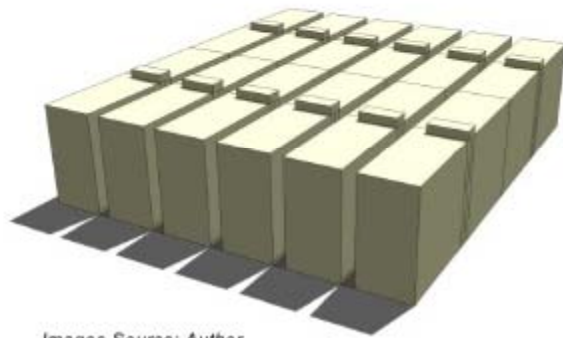
### ***Guidelines for compact mixed land use***

- **95% of residences should have daily needs** retail, parks, primary schools and recreational areas accessible **within 400m walking distance.**
- **95% residences should have access to employment and public and institutional services by public transport or bicycle or walk or combination of two or more.**
- **At least 85% of all streets to have mixed use development.**
- **Need small block size with high density permeable streets etc**

### **UTTIPEC guidelines**

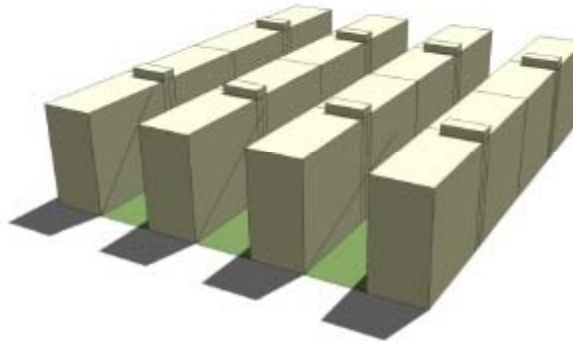
<b>Hierarchy of Facilities</b>	<b>Accessibility Standard from each home/ work place.*</b>
MRTS Station	Approx. 800 m or 10 min walk
Metro feeder/ HOV feeder Stop	Approx. 400 m or 5 min walk
Bus Stop	Approx. 400 m or 5 min walk
IPT/ auto-rickshaw Stand	Approx. 250 m or 3 min walk
Cycle Rickshaw Stand	Approx. 250 m or 3 min walk
Cycle Rental Stand	Approx. 250 m or 3 min walk
Shared private parking garage	Approx. 500 m or 6 min walk

## High rise vs high density.....

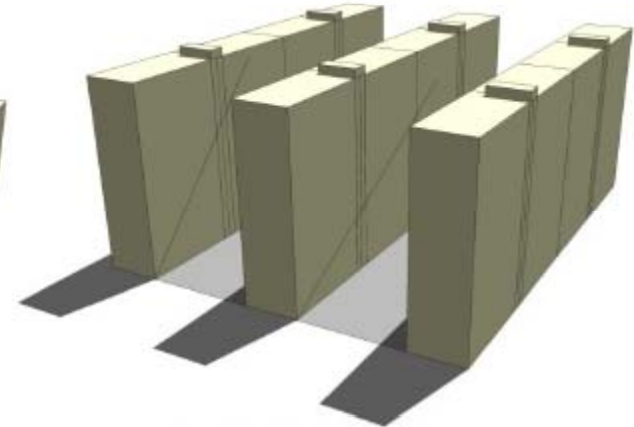


Images Source: Author

Net block level FSI = 6.5  
Density = 2600 units/Ha @ 25sq.m. each



Net block level FSI = 4.4  
Density = 1750 units/Ha



Net block level FSI = 6.0  
Density = 2400 units/Ha



Image Source: Google Earth

### UNDESIRABLE OPTION

Current low-income housing complexes being constructed all over Mumbai Region.



Image Source: Kate Dunham

### DESIRABLE OPTION

Midrise housing with optimal spacing between buildings allowing daylight and airflow through public spaces and homes.



Image Source: Kate Dunham

### UNDESIRABLE OPTION

Taller buildings, when designed in rows, require larger spacing in between for adequate daylight access – creating an undesirable urban experience.



**Enable change through design.....**



**Need guidelines for orientation.....**



**Proposed UTTIPEC guidelines for building orientation:** All dwelling units should get minimum 2-hour solar access in at least one habitable area (living room, bedroom or private open space) on the shortest winter day of Dec 21 (Winter Solstice).



# Building and the neighbourhood.....



# Mitigate traffic impacts of buildings



**Eg EIA provides for traffic impact assessment of buildings. But rarely assessed....**

**But --- There is no provision for demand management to mitigate traffic impact in the surrounding areas.**

**Cumulative impact of the construction on the carrying capacity of the surrounding areas not addressed.**

**Self reported plans provided by the project proponents are not cleared by any assigned authority**

**Make traffic related clearances from competent authorities mandatory**





**But.....**



**Poor walking access**



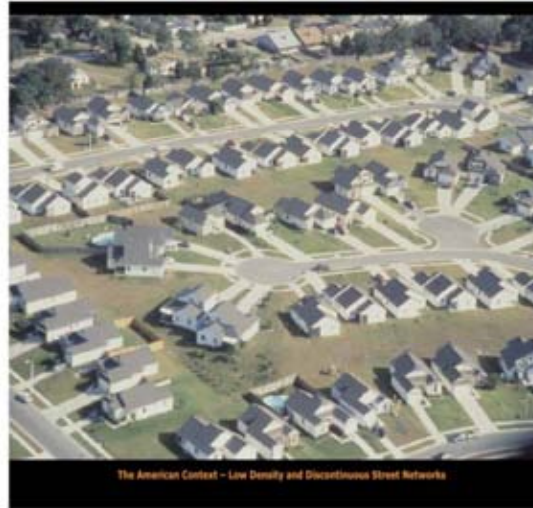
**Footpaths for beautification**



**Source: CSE** **No mid block crossings for pedestrians – Advantage to vehicles**



## Low density car centric growth: wasteful use of valuable urban land



The American Context - Low Density and Discontinuous Street Networks

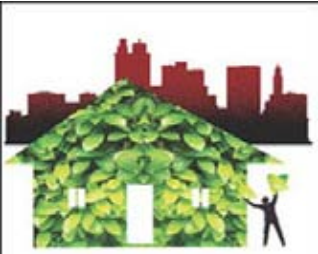


The American Context - Extreme Auto-Centriam

Car centric infrastructure in the US

**This kind of road and transport infrastructure will lock up more energy and undermine building efficiency gains**

- **In Sri Lanka – buildings also report transport energy use**



**California: SB 375 law** -- Bringing back that urban form -- requires jobs, recreation and housing planned in a way that people can live and work closer together, and drive less.

**Safety, Freedom & Respect for  
Women – in Delhi.**

## **FEW ACTION POINTS**



Dec 2012  
DRAFT Prepared by the  
Team of UTTIPEC, Delhi  
Development Authority



Supported by:



## **Safety and urban planning...**



### **Excerpts:**

**Initiate planning and road design schemes where unwatched streets can be transformed... to make safe urban areas:**

- **Get rid of walls and setbacks. Add street edge uses -- for road safety at night, Transparent fencing** shall be used above 300 mm high toe wall from ground level.
- Add planned hawker zones.

- Adhere to IRC 103:2012 for Street Design.
- Introduce planned mixed-use housing ...along road edges of major vulnerable roads.

### **Slow down vehicles on Roads :**

- No more signal free corridors- signalize existing ones.
- Remove gates on public streets from gated colonies from vulnerable areas.



**To ensure Safety of Pedestrians:**



# Need financial mechanism..



Financial mechanisms can make energy savings more valued by those involved in the development, operation and use of buildings.

Need transparency in energy use and cost in the building value chain

- Split incentives between building owners and users -- the returns on energy efficiency investments do not go to those making the investment

Inexpensive loans for green buildings and retrofitment (Eg. France – Zero Rate Eco loan to property owner to improve energy performance of buildings)

Buildings	City	Area (Sq ft)	Hike in cost (in%)	Payback on cost premium (in years)
CII Sobrabji Godrej GBC	Hyderabad	20,000	18	7
ITC Green centre	Gurgaon	170,000	15	6
Spectral Services	NOIDA	150,000	8	4
WIPRO	Gurgaon	175,000	8	5
Technopolis	Kolkata	72,000	6	3



## **Lessons from first generation action**

**Cities need clear roadmap and targets on green building construction and operations**



### **Legal framework**

- Enforce building energy codes. Make them progressively more stringent
- Need measurable results from post-occupancy valuation of buildings –Audit energy performance.
- Sub-metering controls and charging according to use; Incentive based billing
- Labeling systems

### **Incentives and subsidies for green buildings**

**Capacity building** for architects, engineers, developers; understanding of code requirements; technical tools for execution

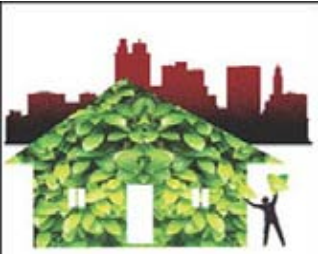
- **Introduce process incentives for developers for integrated design approaches to urban planning**

**Need integrated approach to zoning laws and town building norms**

**Peoples' participation in planning** (eg. Global best practices -- Friedburg, Germany).

**Renewable energy application** -- Onsite renewable generation for buildings.

- Feed-in tariffs for on-site generation



# Deepen public and policy understanding for the big change



## Need people as partners

Tell people what “works” and what “doesn’t work” in terms of energy-saving strategies for homes.

Tell them about the rate of return on costs for energy-efficiency and products and appliances. People must know where to find information on options, prices and suppliers

Deepen understanding -- how individual decisions to conserve energy add up to overall savings that benefit the community.

Resource efficient city development without compromising economic growth (eg. Global best practices -- Vaxjo, Sweden – 30% decline in city GHG but 20% increase in regional GDP).



•Chitra Vishwanath's house is made of compressed stabilised earth blocks excavated from the site itself (Photo: Chitra Vishwanath)



**Let's begin the discussions...**

