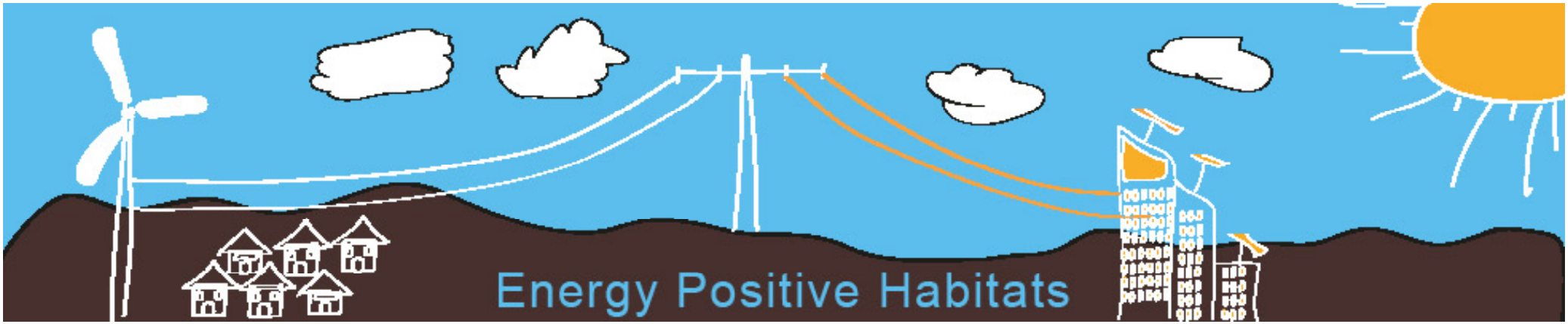
Auroville Green Practices

A Hands-on-Workshop
30 Aug to 1 Sept, 2012
Auroville (near Pondicherry)



‘Human Habitats today have become centers of energy consumption. By conserving energy with appropriate building design, reducing energy by efficient energy management and producing energy with decentralized systems that allows feeding surplus energy into the grid, we can create a shift towards energy positive habitats. Essential to this movement is the fact that humans have to change their life styles to consume less energy.‘

htpp://agp.aurovilleconsulting.com

Energy Efficiency in Building Sector: Practice ,policies and programs

Mili Majumdar,
Director, Sustainable Habitat Division, TERI
Secretary , ADaRSH (Association for Development and Research on Sustainable Habitats

Conference on Energy Positive Habitats, Auroville
August 30, 2012

GRIHA

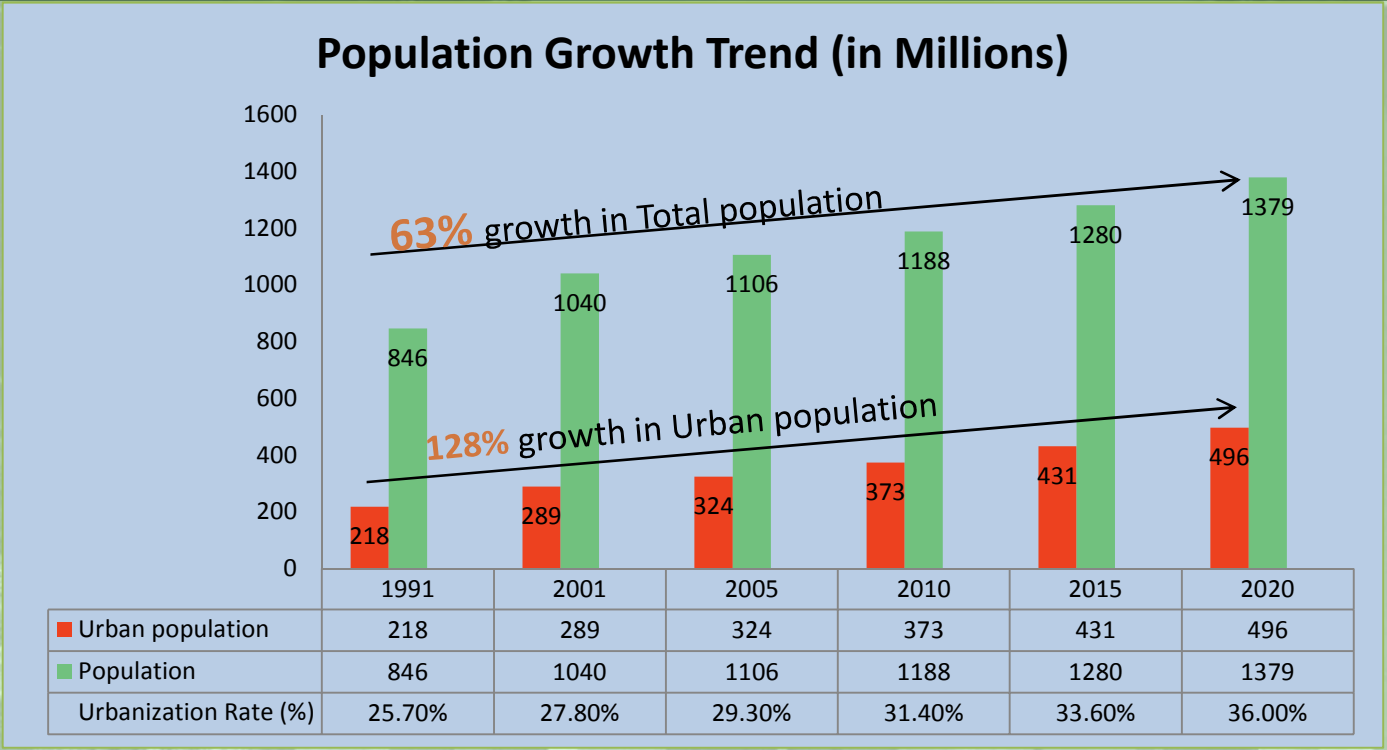
Background

Globally, buildings account for :

- 40% energy use
- 42%water consumption
- 40% solid waste
- 50% raw material use
- 50% of air pollution
- 42% GHG emission
- 50% water pollution

Total energy use in buildings is growing rapidly owing to economic development, increasing urbanization and improved lifestyles, predominantly due to increased space conditioning load

Population and GDP-:drivers that influence energy demand from all the sectors in a country



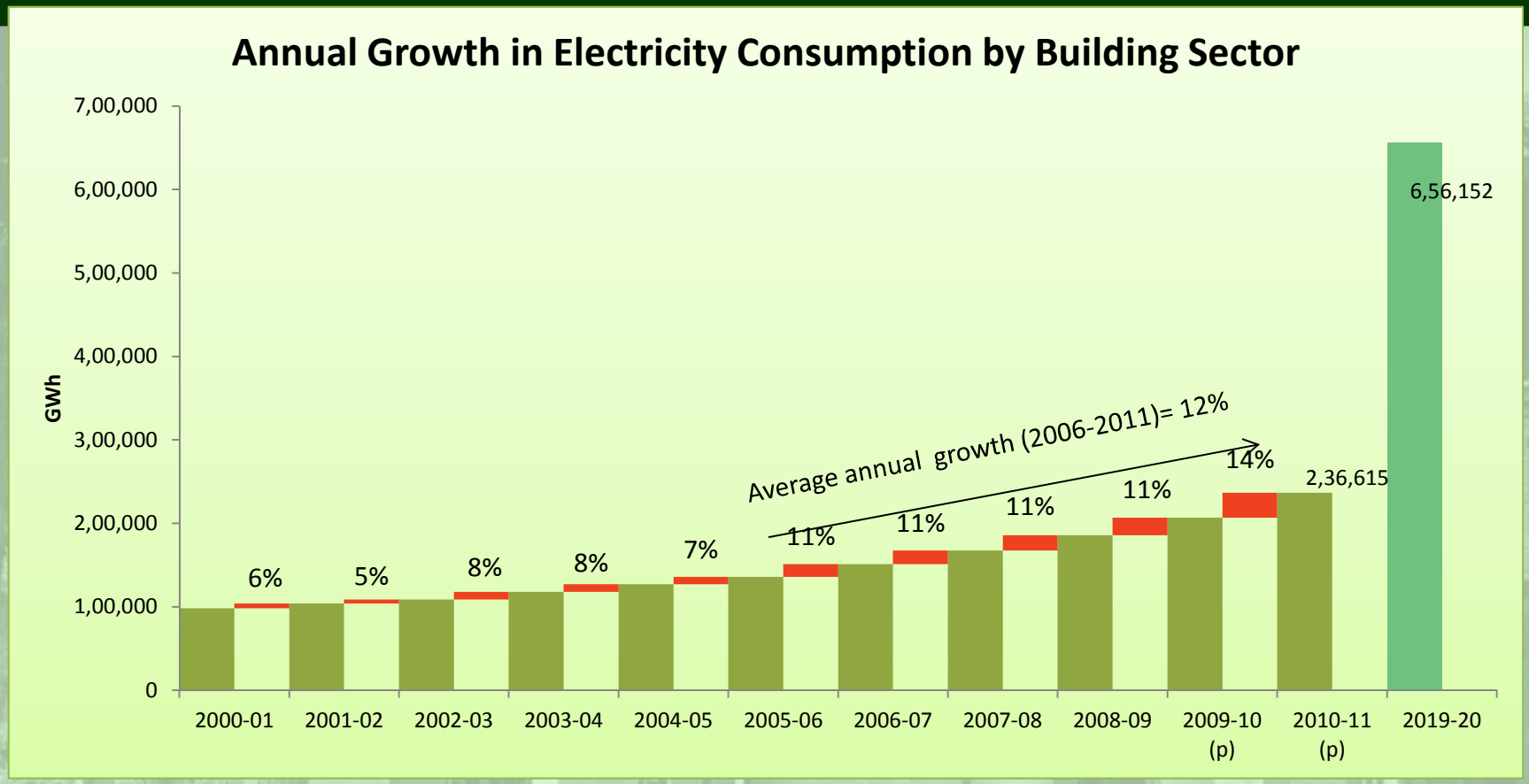
	1991	2001	2005	2010	2015	2020
Urban population	218	289	324	373	431	496
Population	846	1040	1106	1188	1280	1379
Urbanization Rate (%)	25.70%	27.80%	29.30%	31.40%	33.60%	36.00%

(Source: RICS Research, Real Estate and Construction Professionals in India by 2020- A demand and supply assessment of specialized skill-sets in built environment)

In 2020 almost **500 Million** people will be living in Urban India

Present World population **7000 Million**

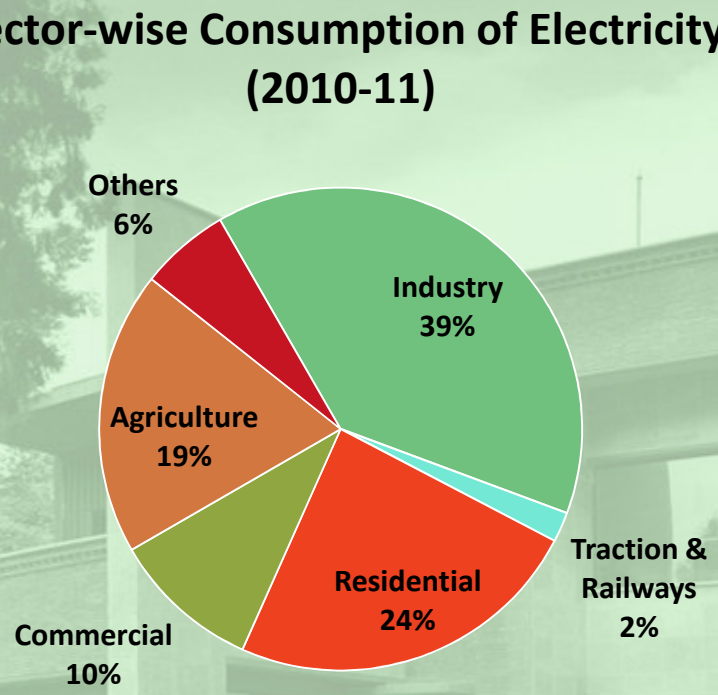
Growth in Electricity Consumption by Building Sector



At a 12% growth rate electricity consumption of building sector will increase almost **3 times** by 2020

(Source: Central Electricity Authority)

Sector-Wise Electricity Consumption in India (2011)



Residential & Commercial sector contributed to **34%** of total electricity consumption

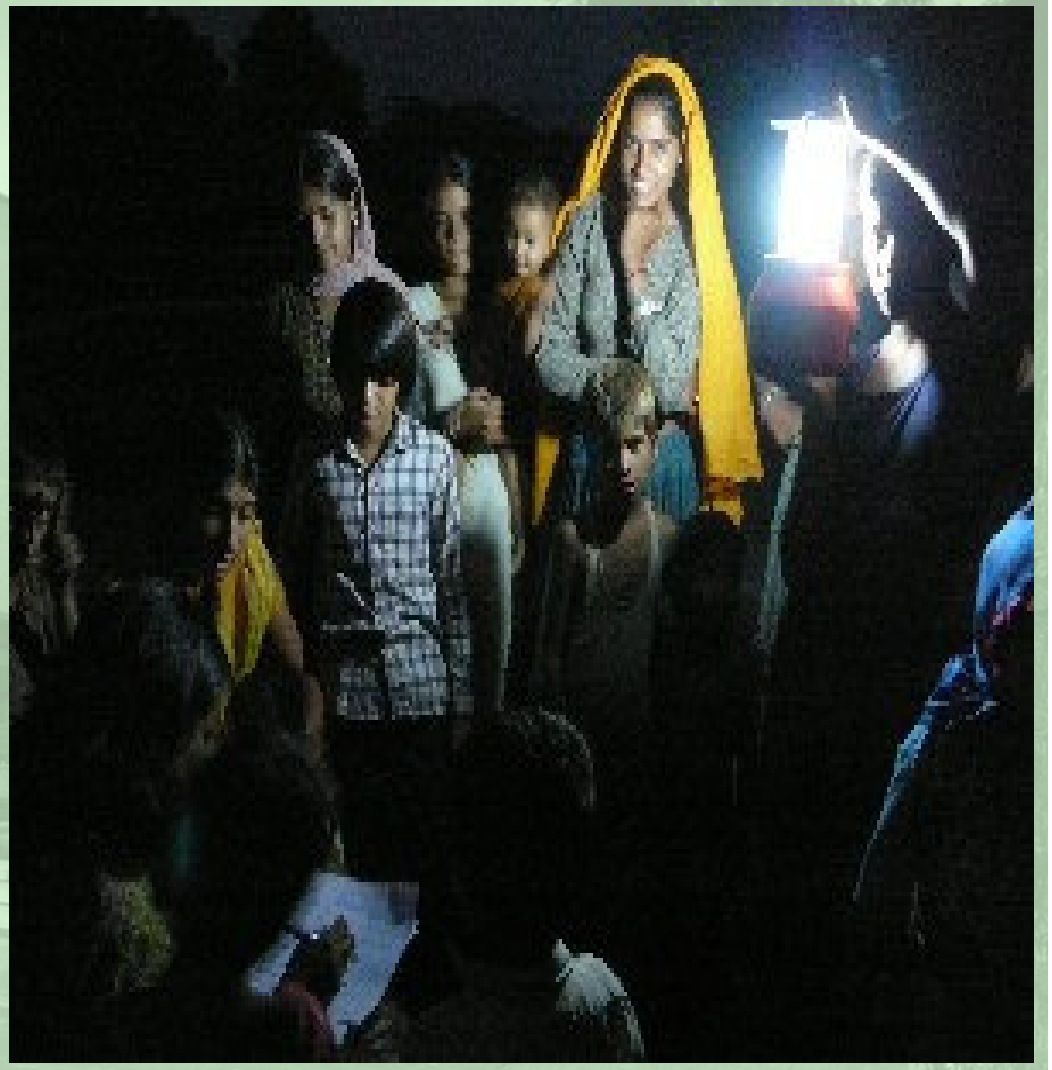
(Source: Energy Statistics 2012, Central Statistics Office, MOSPI)

Findings of a recent study

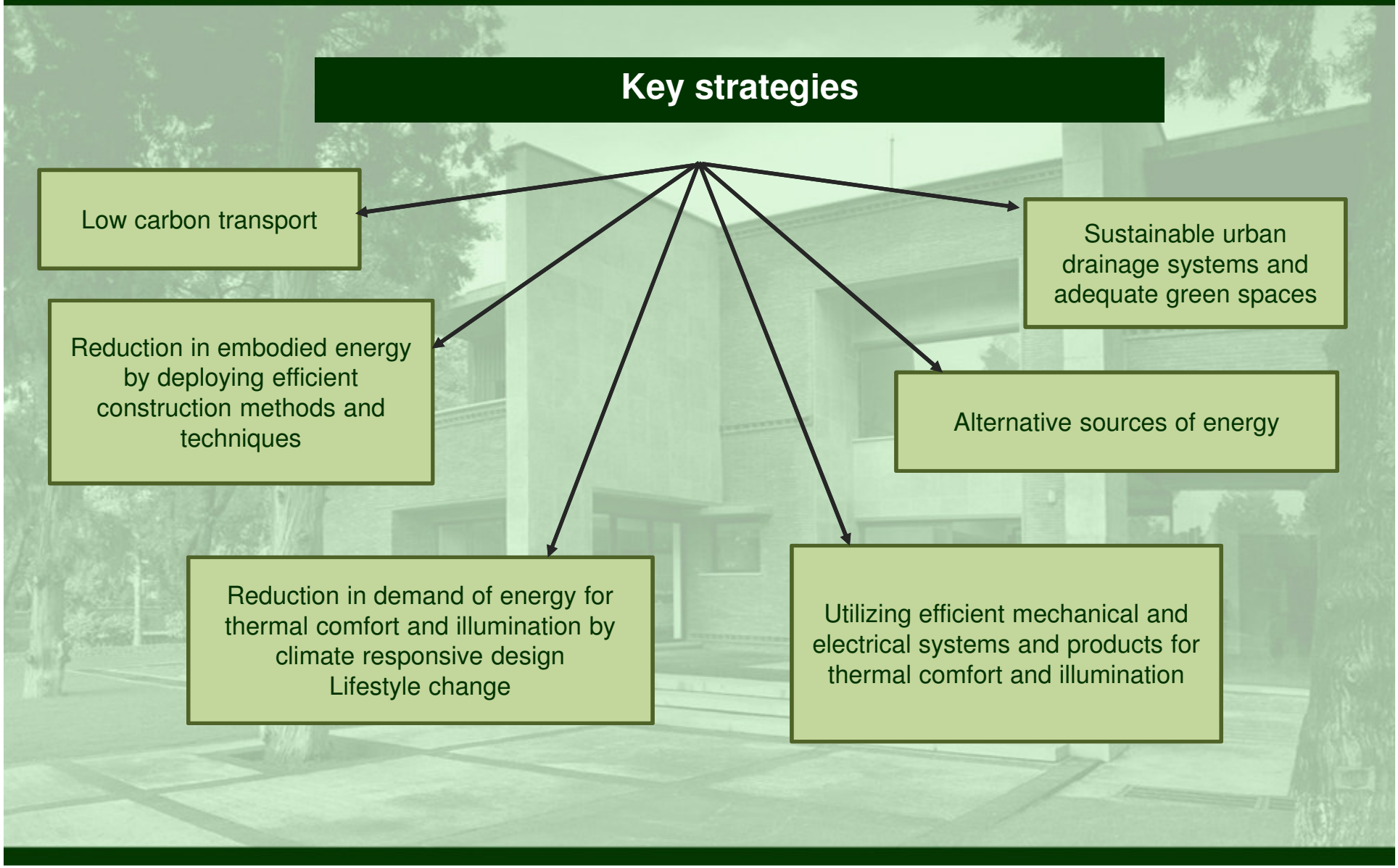
- The average household is likely to consume **five** times more electricity in 2020 than in 2000.
- If commercial buildings, continue to be built and operated in the conventional manner, their electricity consumption may increase by more than **3.5 times by 2021**
- There is a huge potential for electricity savings by buildings sector in India
- 20% of the total electricity consumption by residential sector in 2021 can be saved by using energy efficient appliances and **Lighting alone has 50%** electricity saving potential
- **42,370 MW of power plant can be avoided in 2021 through building energy efficiency**

Equity and access ……key challenge

Around 1.5 billion people in the world lack access to electricity; about a quarter of them live in India.



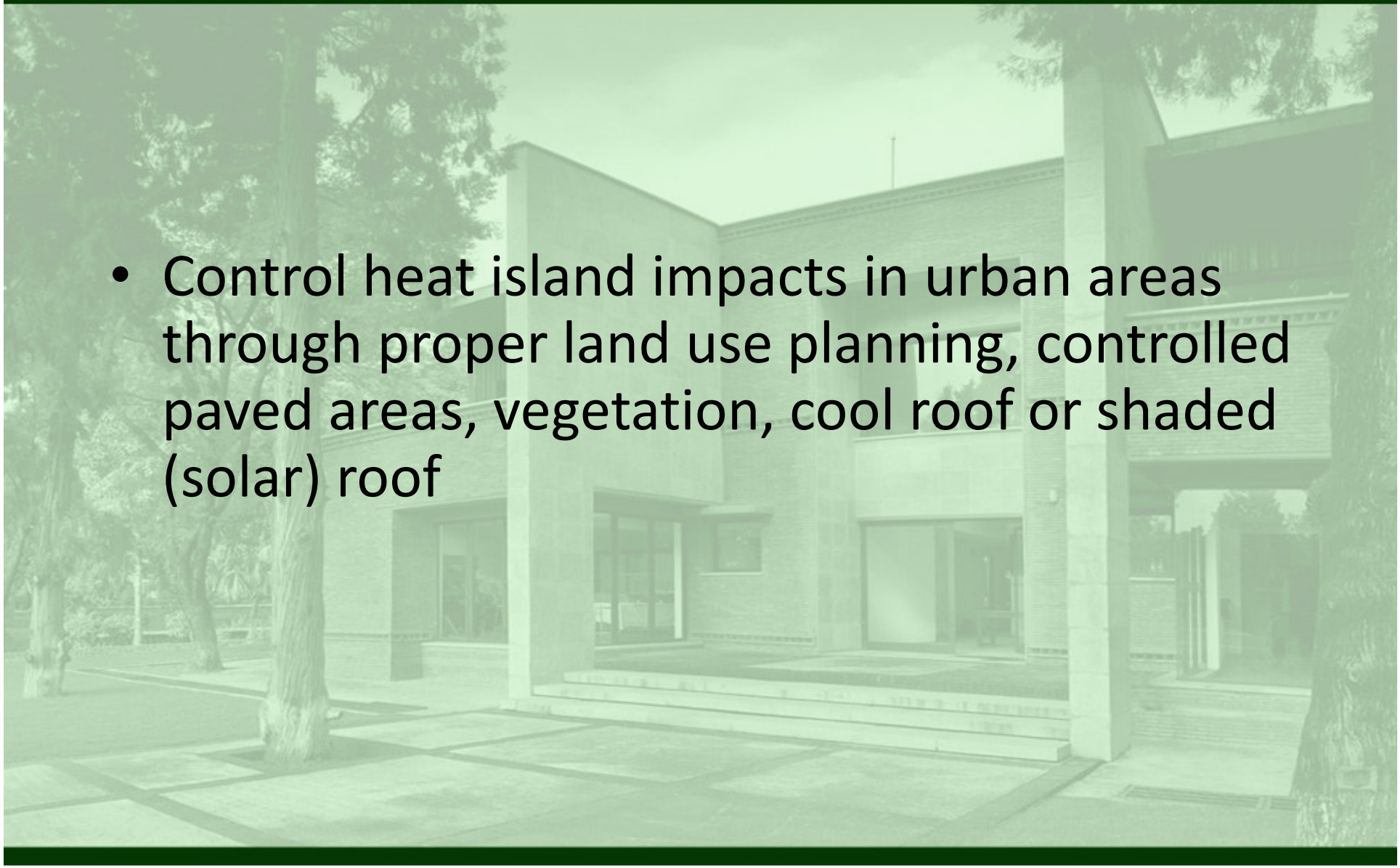
Energy efficiency strategies: Urban settlements and buildings



Buildings: GHG emissions reduction potential for buildings stock in 2020

Economic region	Countries/country groups reviewed for region	Potential as % of national baseline for buildings[b]	Measures covering the largest potential	Measures providing the cheapest mitigation options
Developed countries	USA, EU-15, Canada, Greece, Australia, Republic of Korea, United Kingdom, Germany, Japan	Technical: 21%-54%[c] Economic (<US$ 0/tCO_2-eq): 12%-25%[d] Market: 15%-37%	1. Shell retrofit, inc. insulation, esp. windows and walls; 2. Space heating systems; 3. Efficient lights, especially shift to compact fluorescent lamps (CFL) and efficient ballasts.	1. Appliances such as efficient TVs and peripherals (both on-mode and standby), refrigerators and freezers, ventilators and air-conditioners; 2. Water heating equipment; 3. Lighting best practices.
Developing countries	Myanmar, India, Indonesia, Argentine, Brazil, China, Ecuador, Thailand, Pakistan, South Africa	Technical: 18%-41% Economic (<US$ 0/tCO_2eq): 13%-52%[g] Market: 23%	1. Efficient lights, esp. shift to CFLs, light retrofit, and kerosene lamps; 2. Various types of improved cooking stoves, esp. biomass stoves, followed by LPG and kerosene stoves; 3. Efficient appliances such as air-conditioners and refrigerators.	1. Improved lights, esp. shift to CFLs light retrofit, and efficient kerosene lamps; 2. Various types of improved cooking stoves, esp. biomass based, followed by kerosene stoves; 3. Efficient electric appliances such as refrigerators and air-conditioners.

Strategy 1



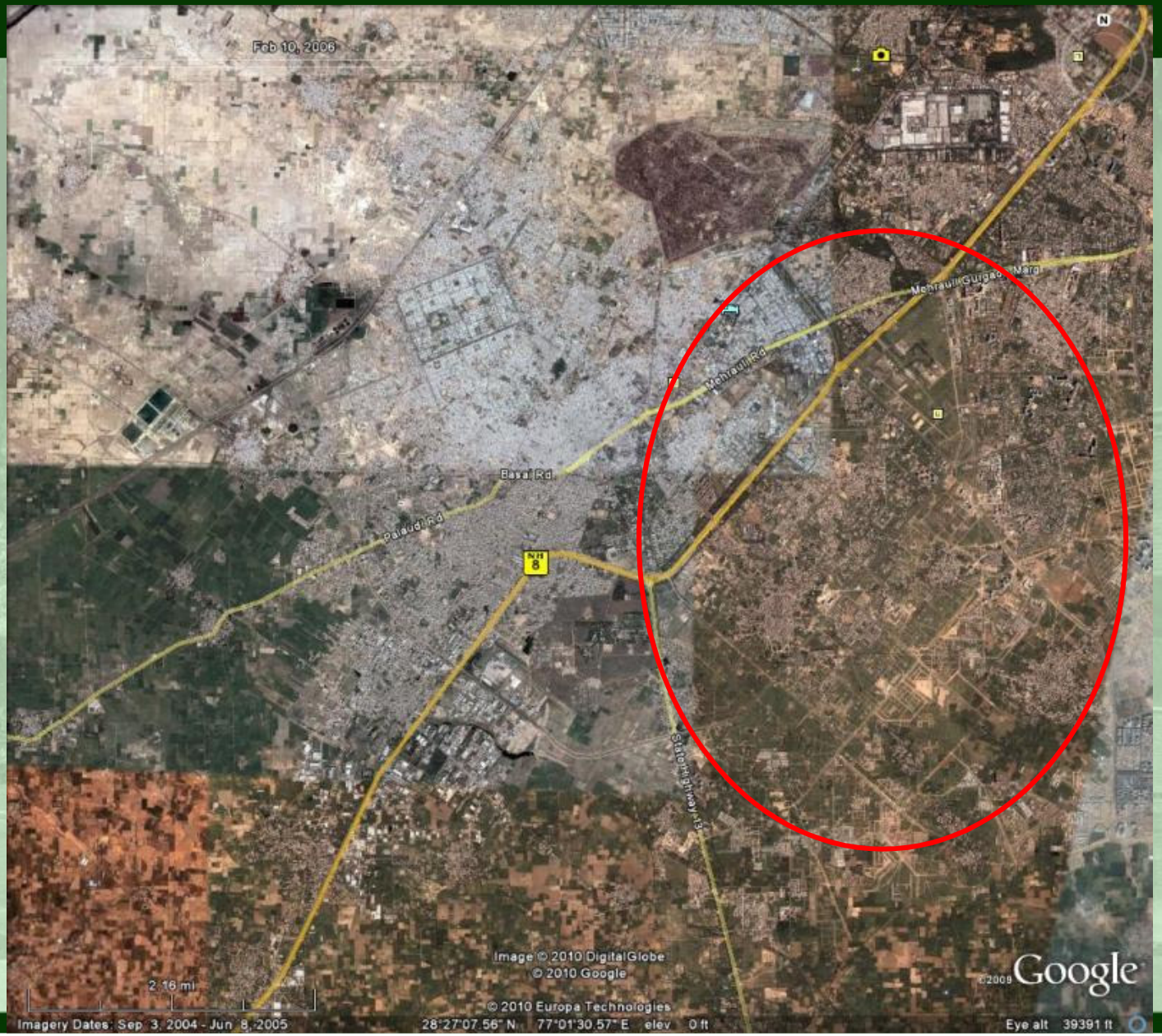
- Control heat island impacts in urban areas through proper land use planning, controlled paved areas, vegetation, cool roof or shaded (solar) roof

Urban Sprawl and heat island

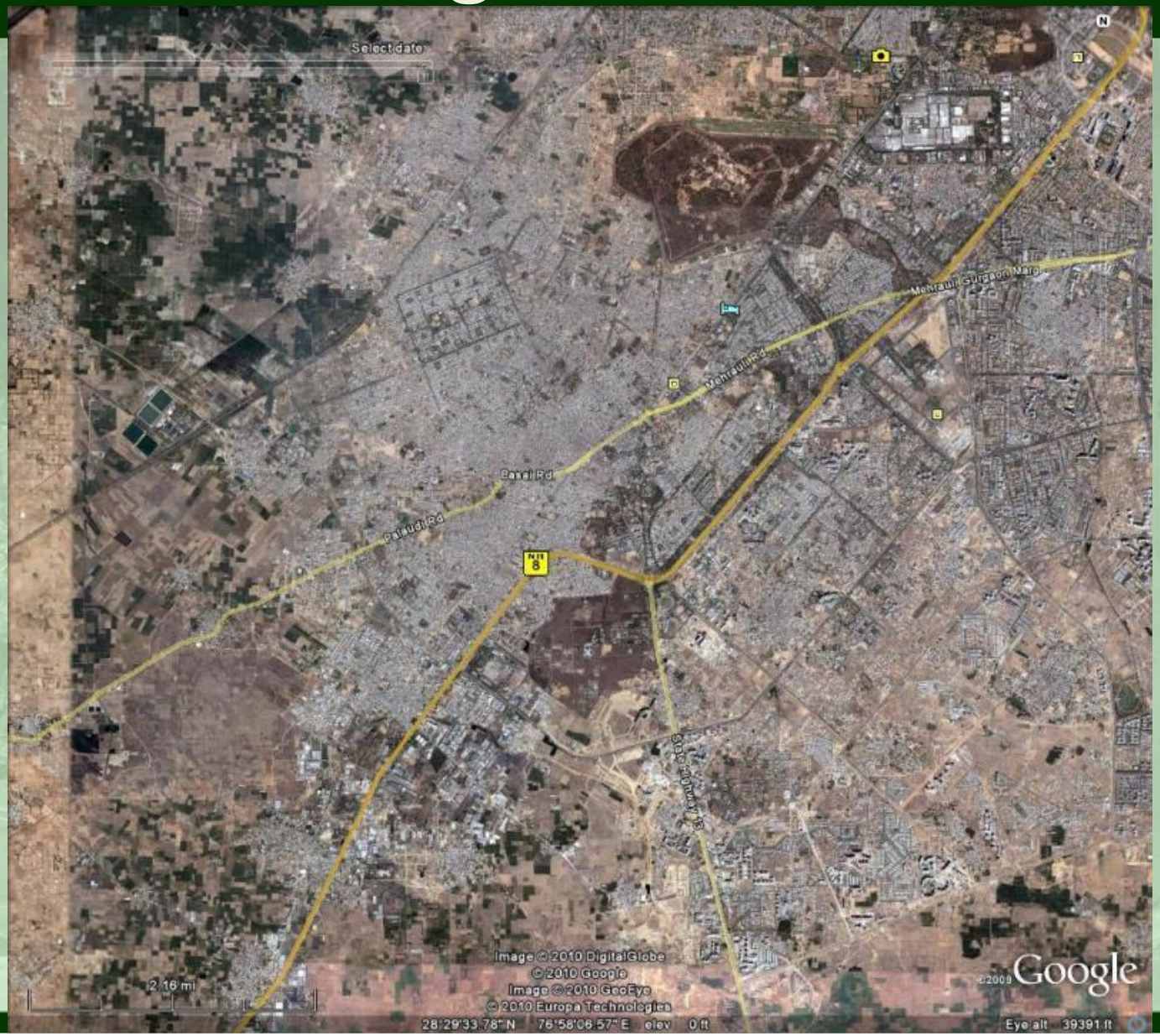
Key Impacts:

- Urban heat island (increasing temperature impacts energy use)
- Urban flooding

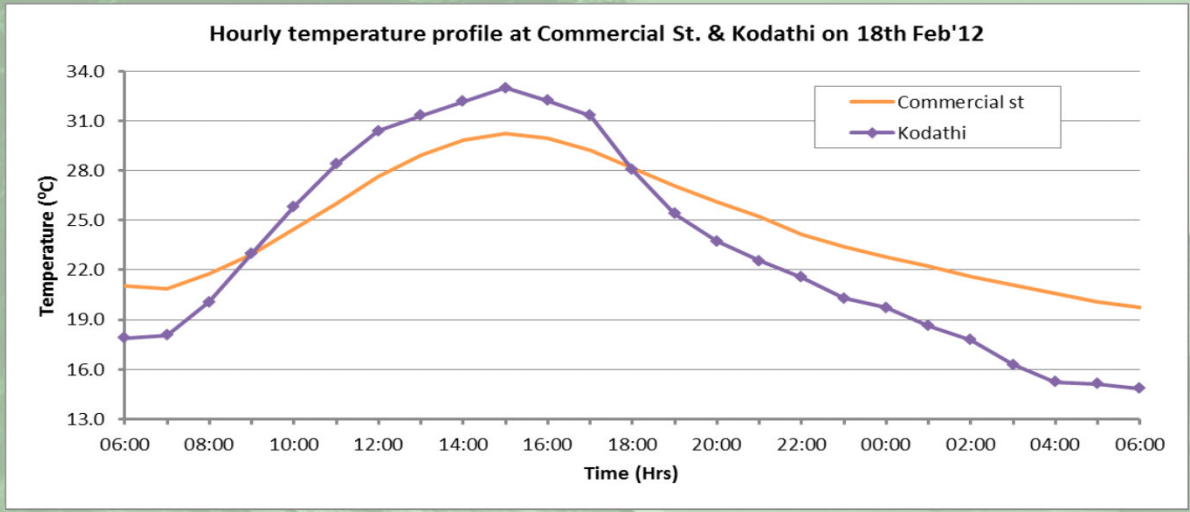
Gurgaon 2006

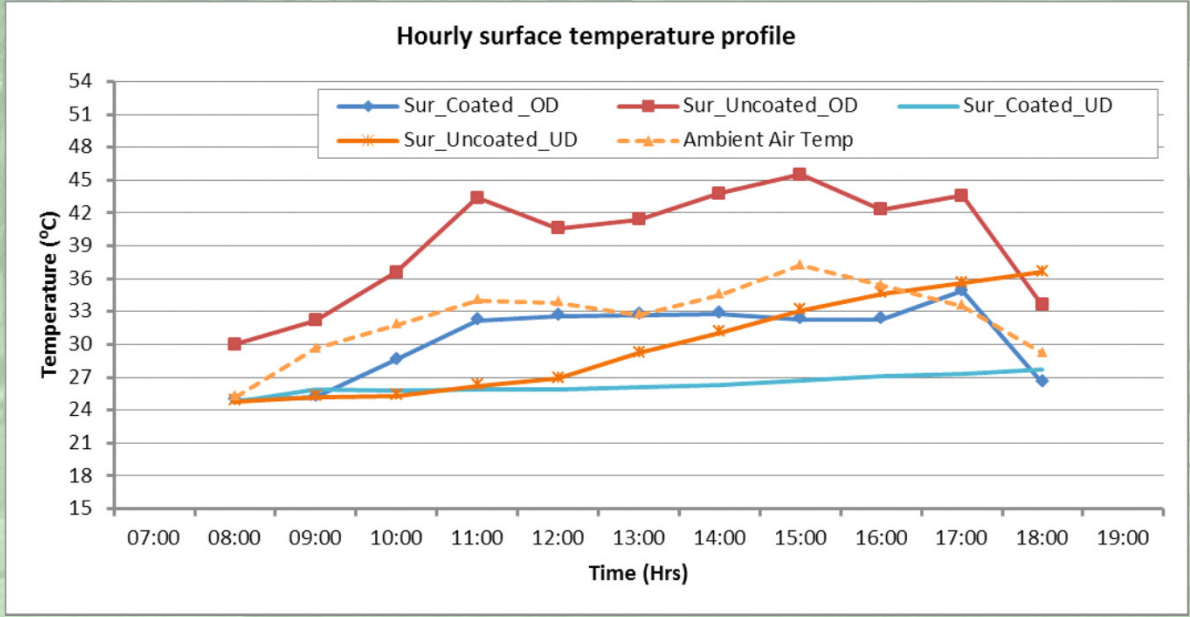


Gurgaon 2010



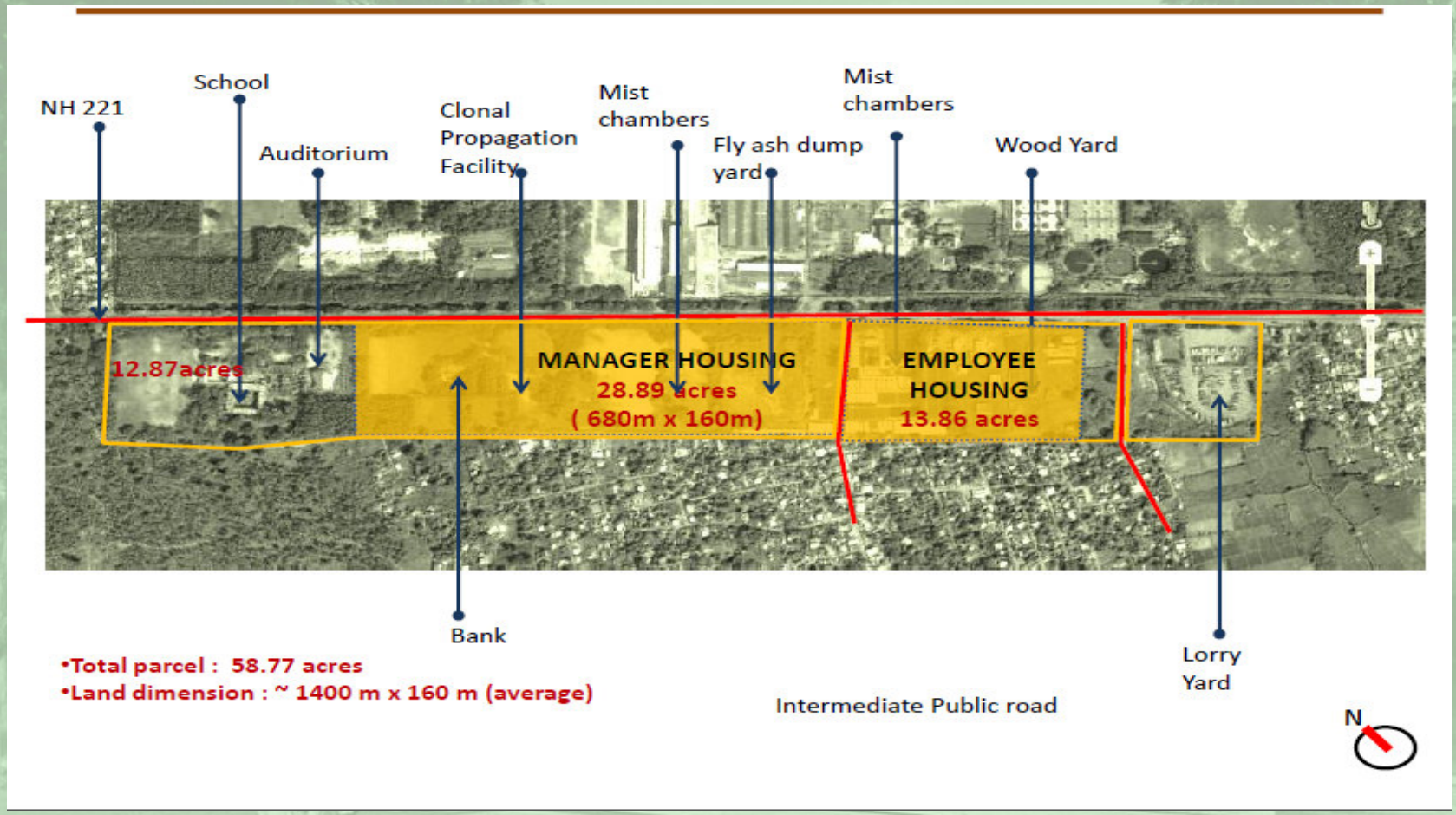
Urban Heat Island Study in Bangalore





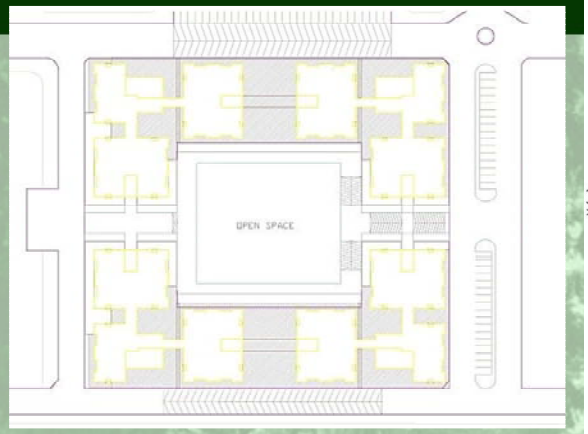
- Significant difference(upto 5 deg C)in temperature (both day and night) recorded in urbanised areas and greener areas
- Cool roof surface temperature can be cooler by 15 deg C than uncoated roof during daytime
- Dense vegetation and dense canopy areas have higher night time temperature than vegetated areas with lesser canopy area
- UHI have significant impact on energy consumption in cities

Mitigating heat island impact using good design strategies:ITC Bhadrachalam Township, Andhra Pradesh

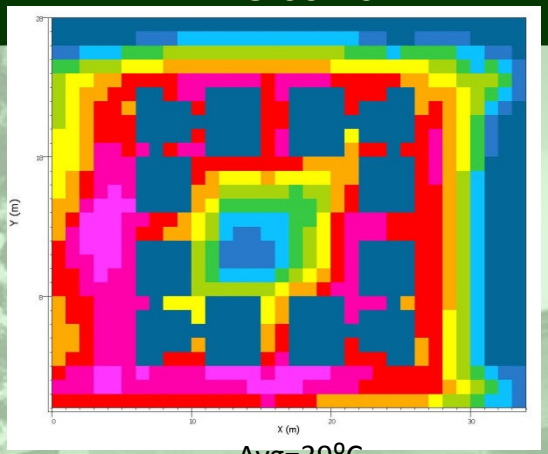


UHI Study- Air Temperature at 1.2m lvl on a typical day during March

Base Case- Asphalt Roads & Cement concrete paving

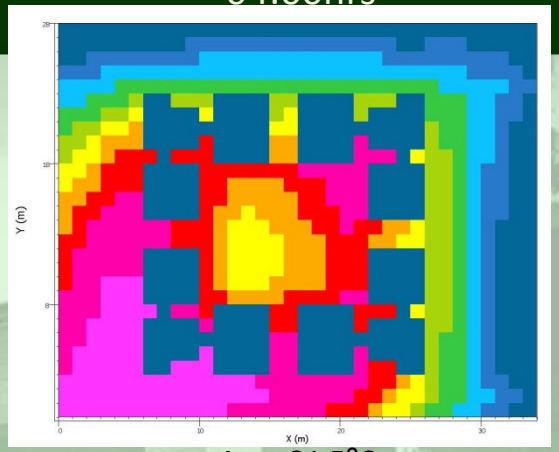


15:00hrs



Avg=39°C

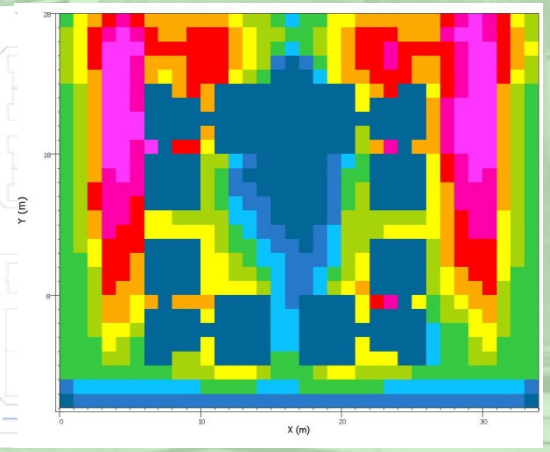
04:00hrs



Avg =31.5°C

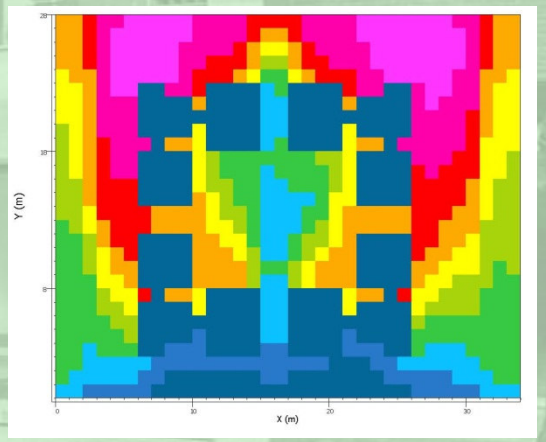
Design Case- with vegetation and landscape elements recommended

15:00hrs



Avg=36°C

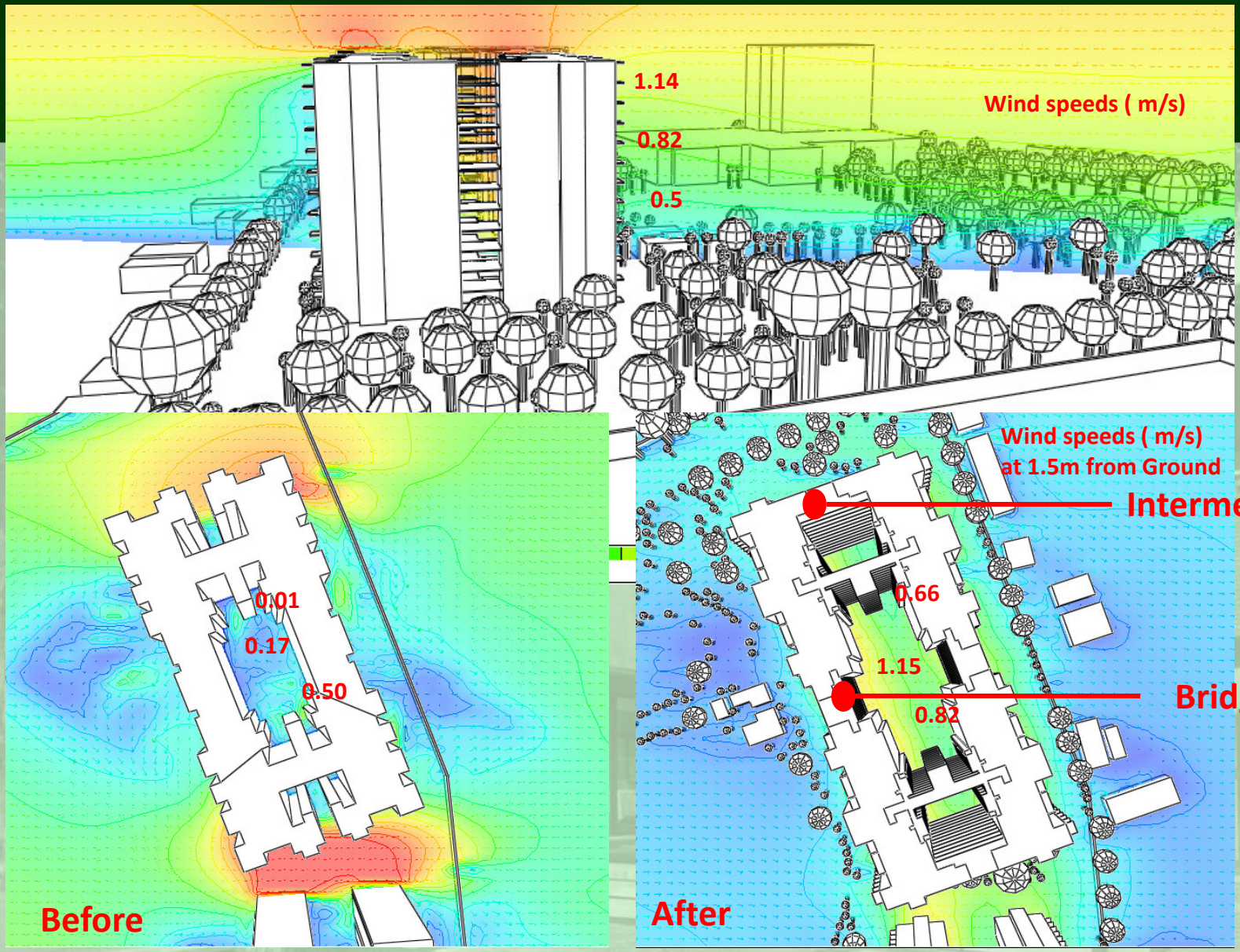
04:00hrs



Avg =27.5°C

- Adding vegetation and landscape elements reduces air temperature by 3 to 4 deg C

Out door Wind Flow analysis for High-rise structures



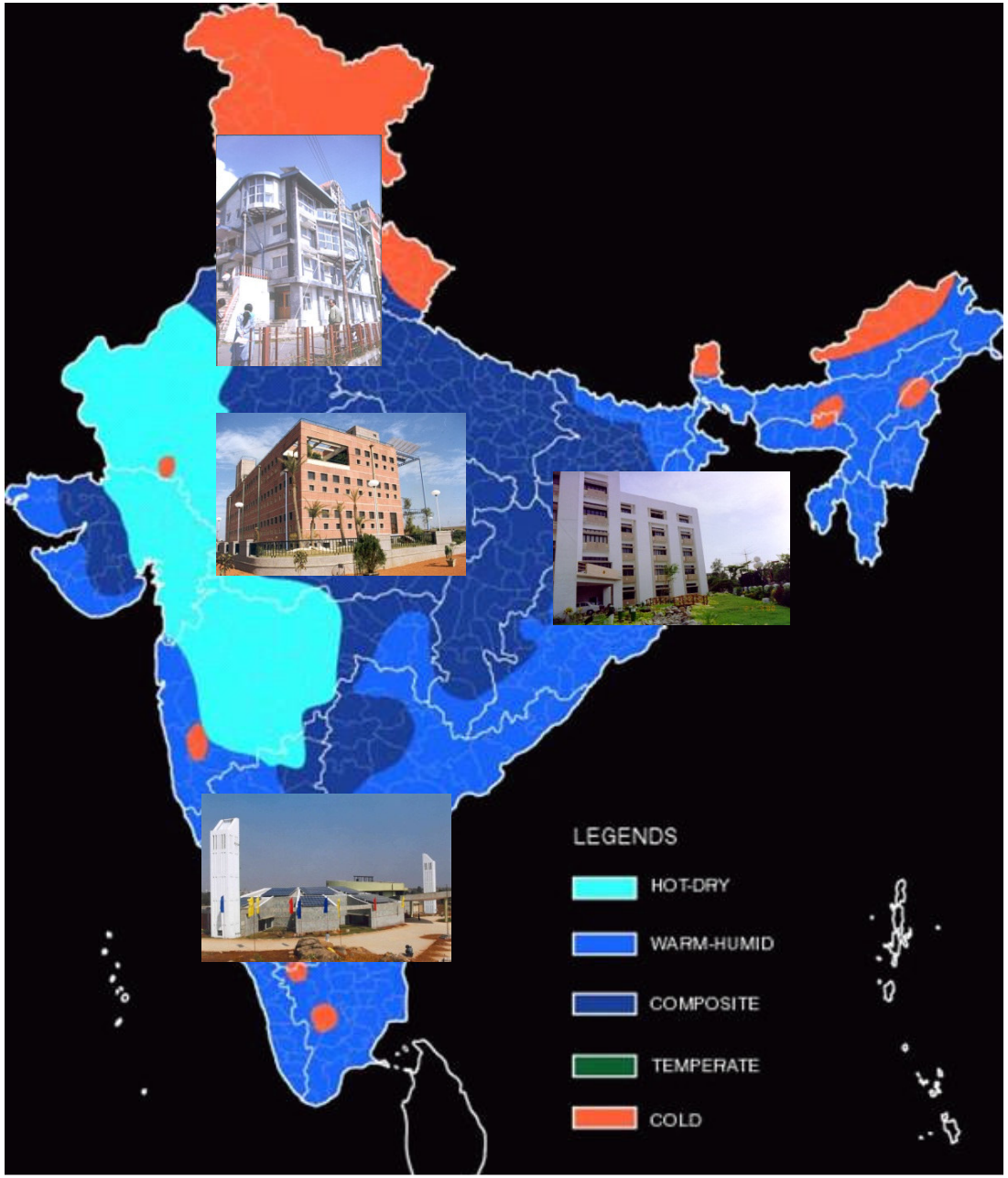
- Higher wind speeds for better comfort in outdoor ,semi outdoor and courtyard spaces and by adding a stilt, bridges and intermediate courts and landscape elements

Strategy 2

- Promote buildings that are climate responsive, have suitable interventions of energy efficient envelope, systems and controls (Use of Energy conservation building code);
- Integration of renewable energy systems
- Lifestyle change (adaptive comfort)

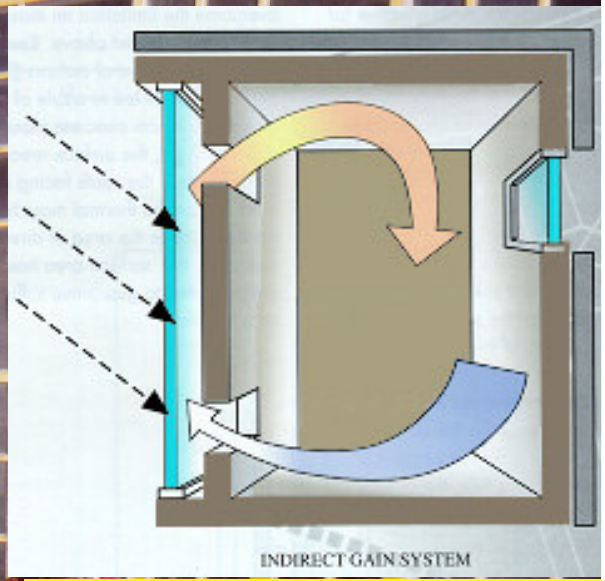
Architecture does not reflect climate responsiveness

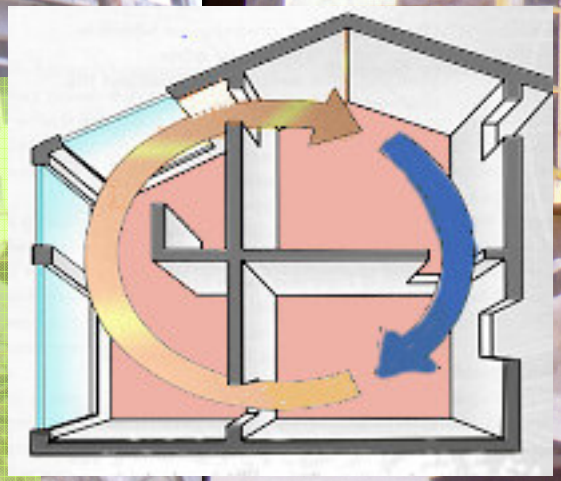
Bioclimatic response: solar passive design



Architectural design to harness solar potential in cold climate

Sarai of Tabo Gompa, Spiti
Ar Subhendu Kaushik





Himurja building,Shimla

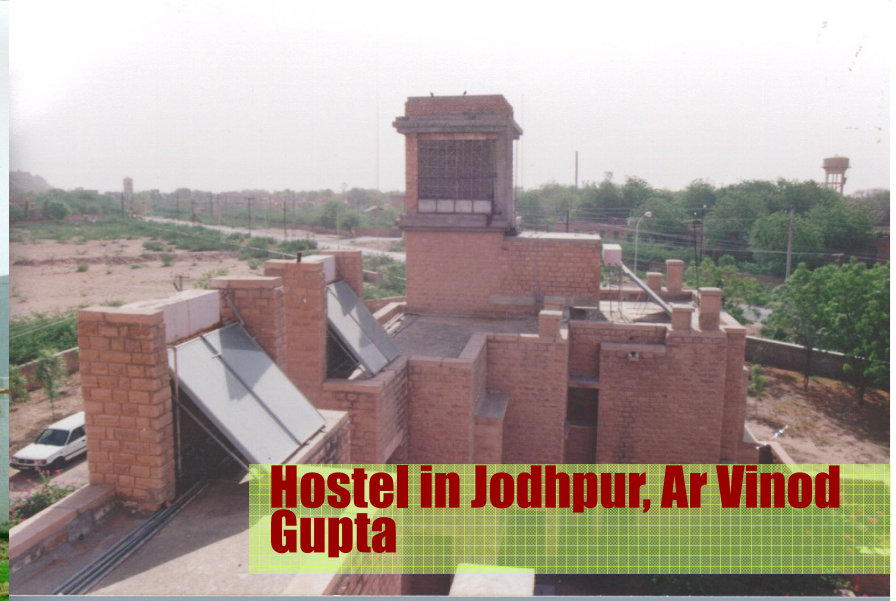
Ar Arvind Krishan:

Indoor temp range of 18-28 deg C with corresponding ambient condition of 9-15 deg C.No auxiliary heaters

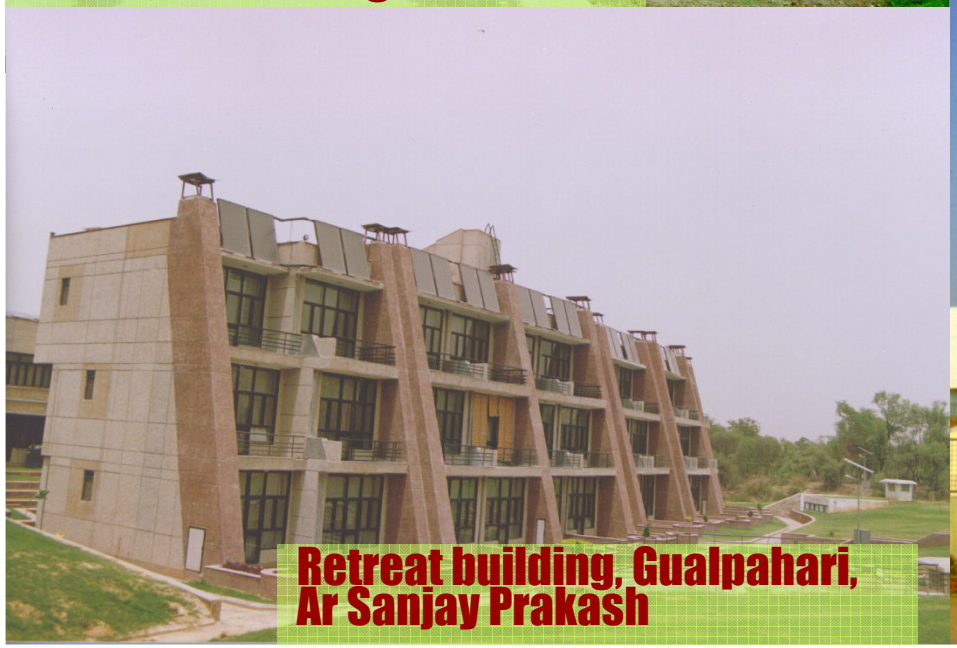
Sunspaces and trombe wall for cold climate in India to reduce auxiliary heating need

Solar passive devices for hot climate: solar chimneys and wind towers

Residence at Panchkula
Ar Siddharth Wig



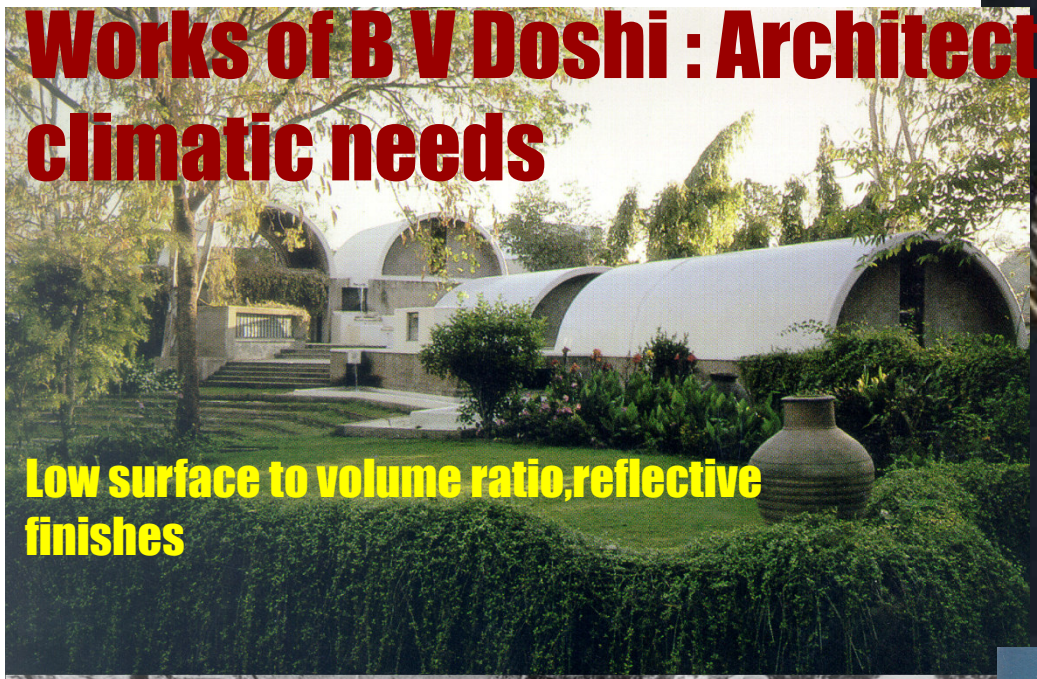
Hostel in Jodhpur, Ar Vinod Gupta



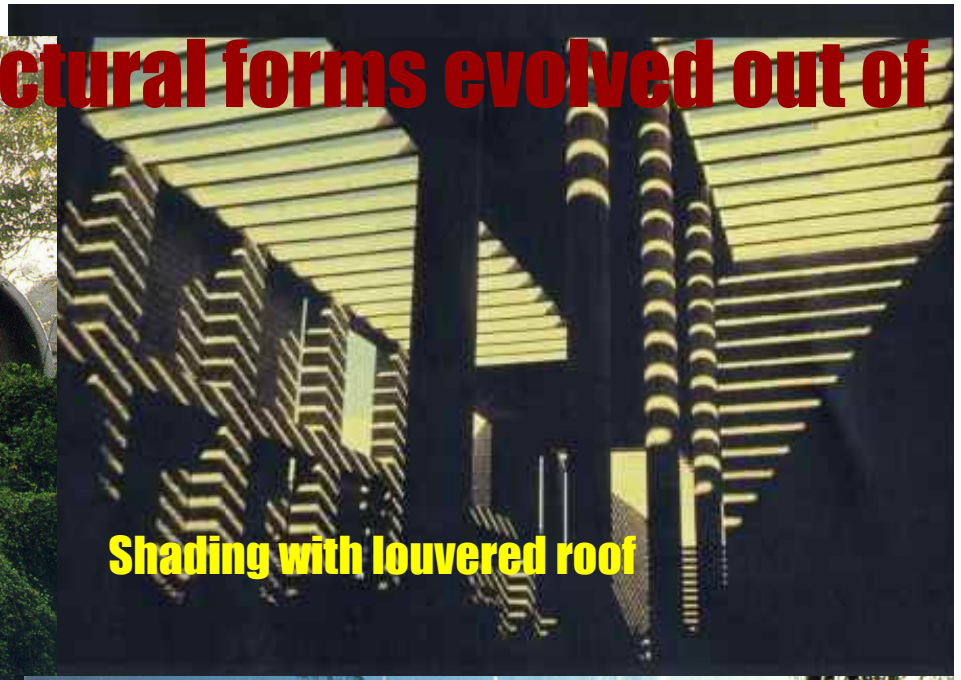
Retreat building, Gualpahari, Ar Sanjay Prakash

Private residence , New Delhi

Works of B V Doshi : Architectural forms evolved out of climatic needs



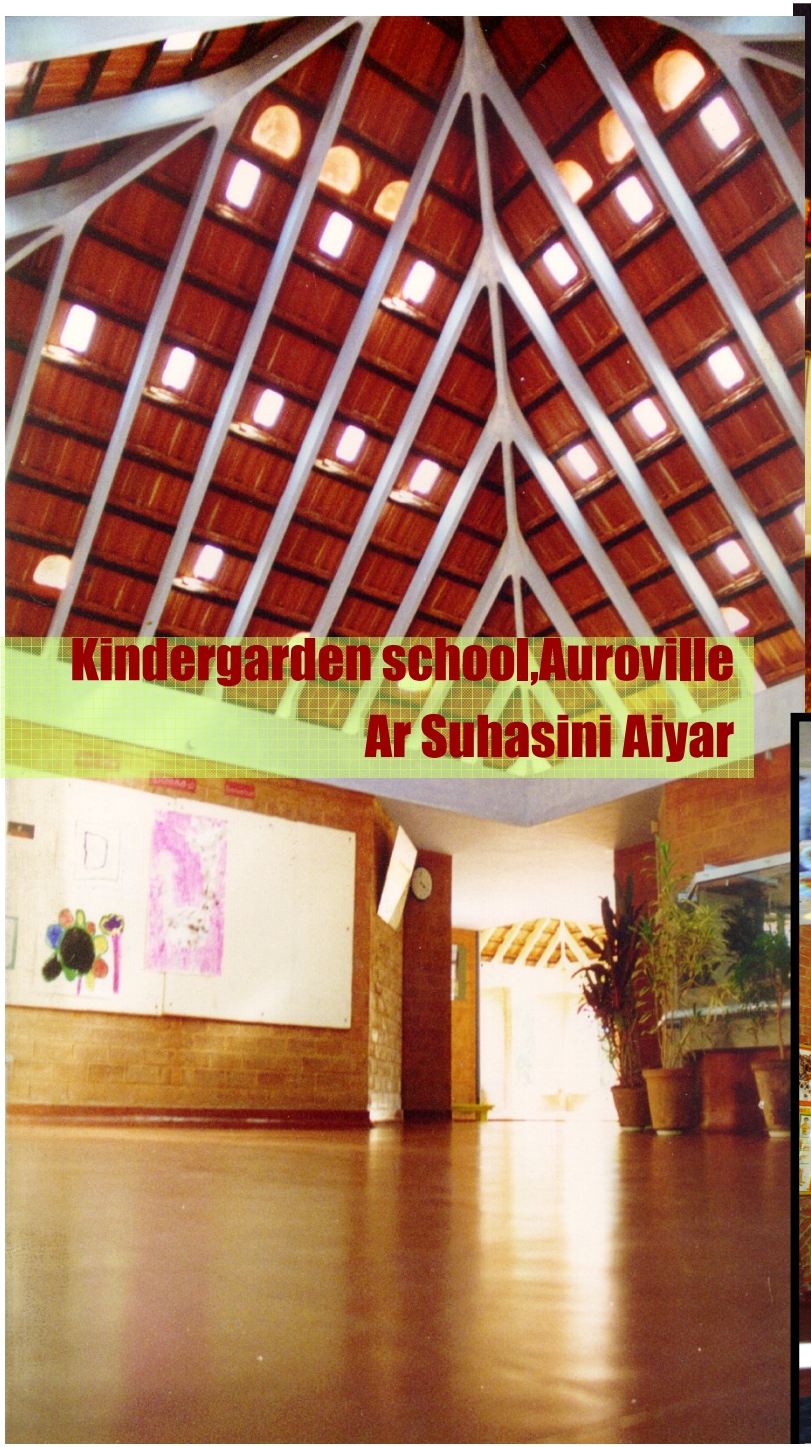
Low surface to volume ratio,reflective finishes



Shading with louvered roof

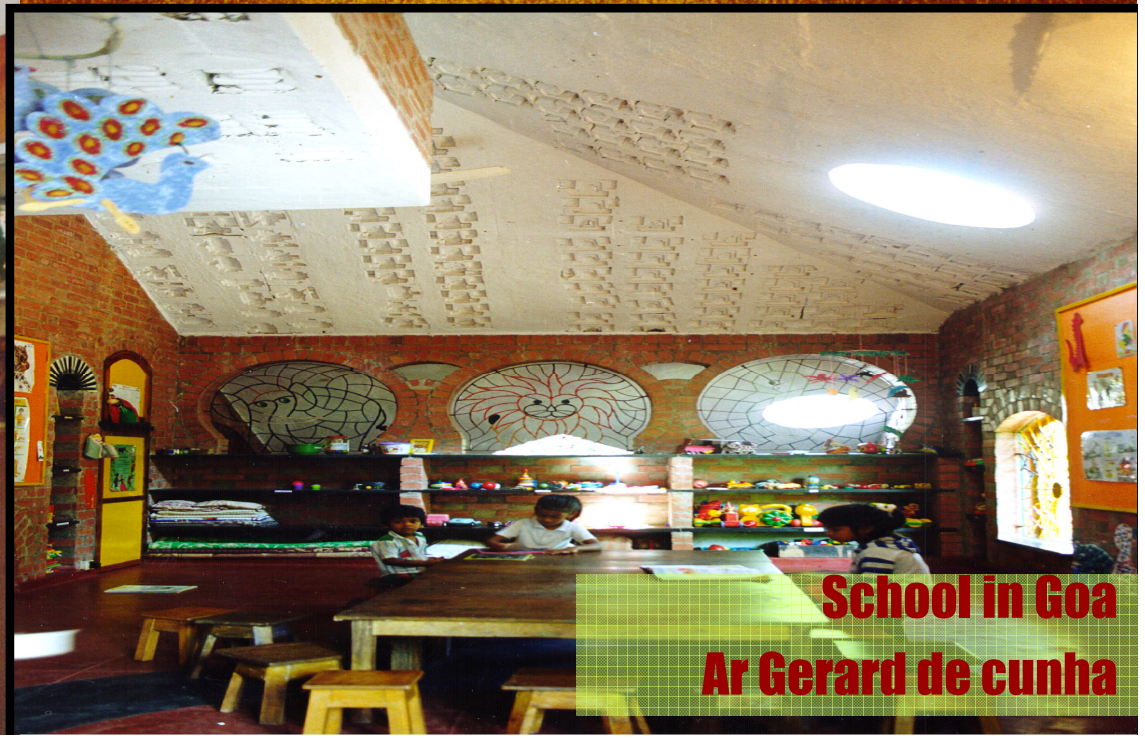
Use of low cost insulating techniques

Water as microclimate modifier



Kindergarden school,Auroville
Ar Suhasini Aiyar

Torrent research center
Ar Nimish Patel



School in Goa
Ar Gerard de cunha

Emphasize on “cost-effective” strategies for making green buildings and effecting construction of efficient buildings

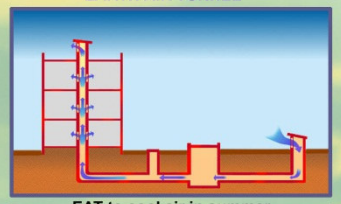
Passive design of building

Use of Efficient Systems

Use of Renewable Energy

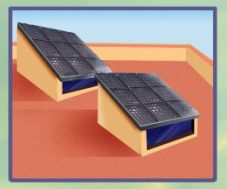
ENERGY EFFICIENT SUSTAINABLE HABITAT

EARTH AIR TUNNEL



EAT to cool air in summer and heat it in winter

PHOTOVOLTAIC MODULES

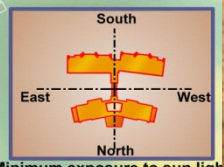


Utilisation of solar radiation

LANDSCAPE

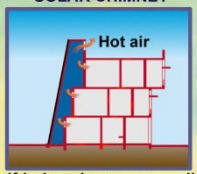
High trees on east and west side to block solar radiation
Deciduous trees on south side to allow winter sun

SOLAR ARCHITECTURE

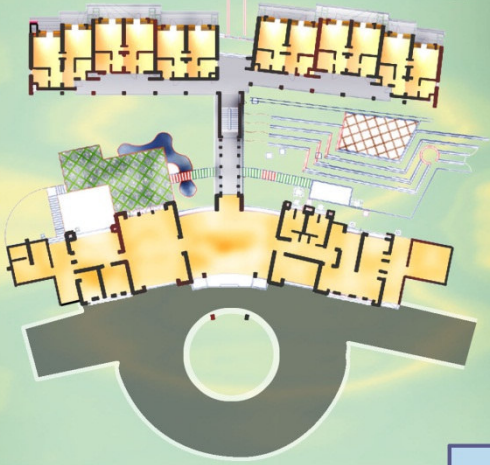


Minimum exposure to sun ligh

SOLAR CHIMNEY



Self-induced passage cooling



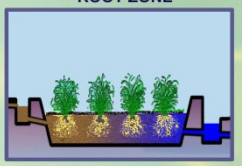
HOT WATER SOLAR PANELS

Utilisation of solar radiation

DAY LIGHTING

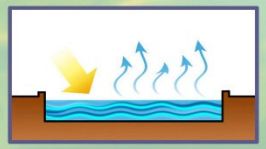
Diffused sun-light allows light but not heat

ROOT ZONE



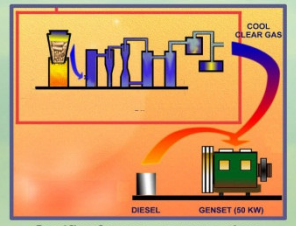
Waste water treatment process

WATER BODIES



Absorb heat and cool air by evaporation

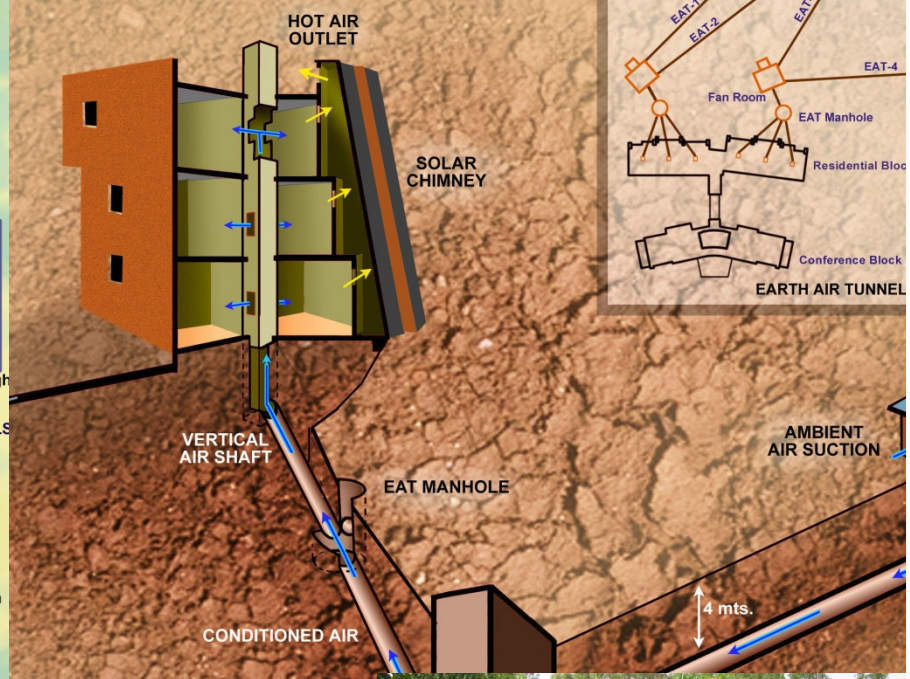
GASIFIER



Gasifier for power generation

SUSTAINABLE HABIT
AT GUAL

PASSIVE SPACE CONDITIONING



HEATING OF AIR IN WINT
AND COOLING OF AIR IN
BY CONDITIONING AIR TI
NETWORK UNDER

TERI-Retreat, Gurgao

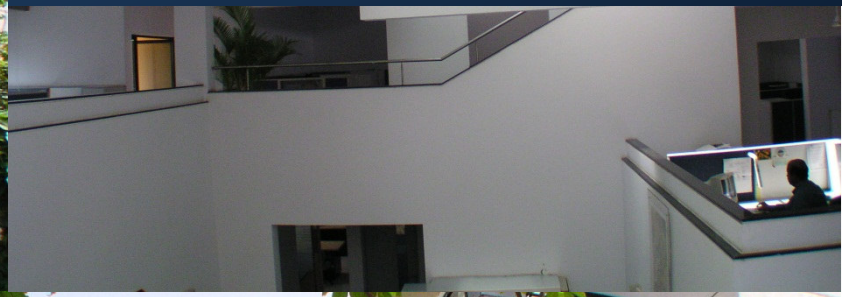
TERI-Bangalore

Solar Wall

Solar Water Heating

Non Airconditioned

Daylit



Building consumes only 30kWh/sqm/annum

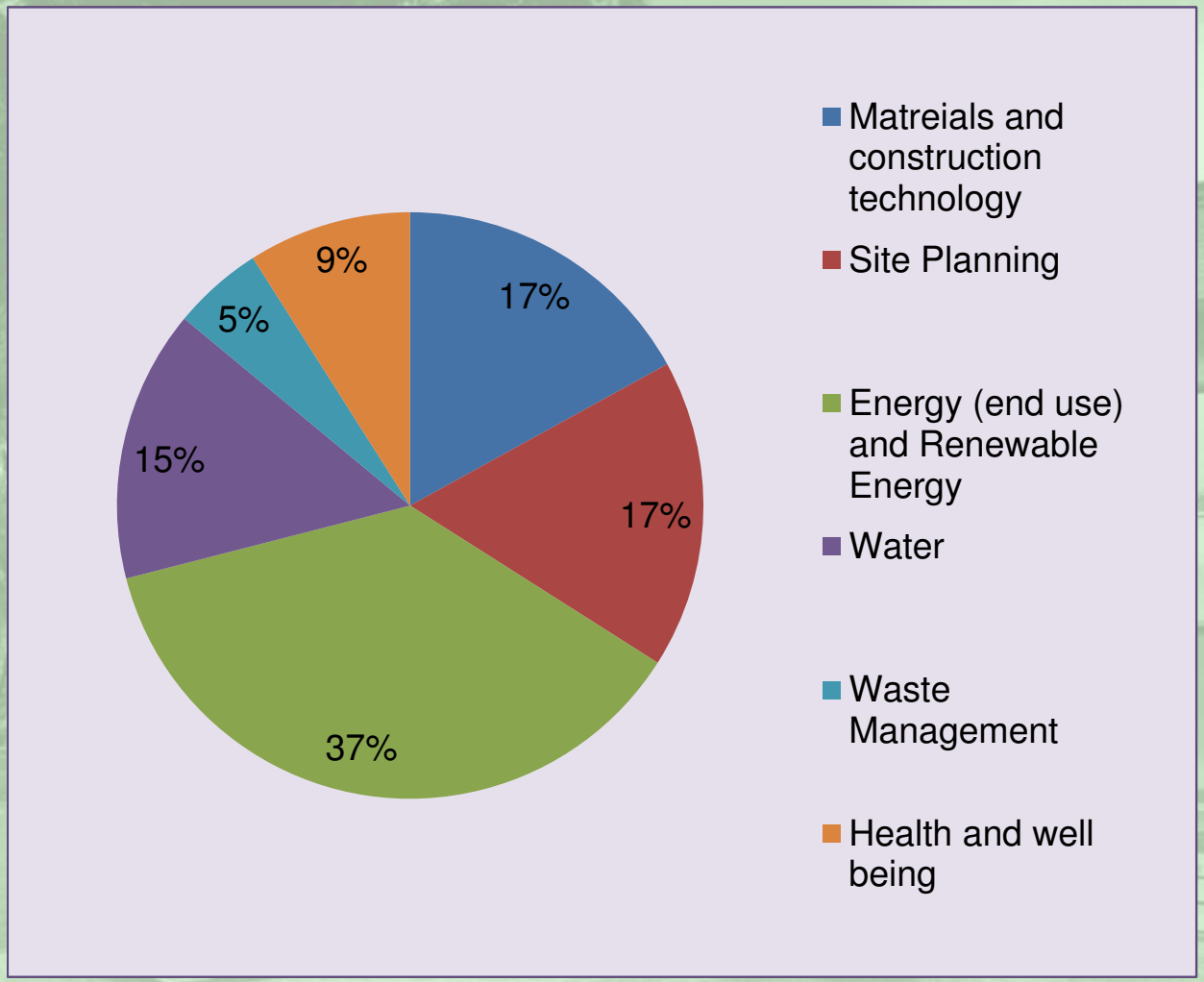
GRIHA-Green Rating for Integrated Habitat Assessment

Tool to facilitate design, construction, operation of a green building ,and in turn ….measure “greenness” of a building in India

What gets measured gets managed

GRIHA-Green Rating for Integrated Habitat Assessment

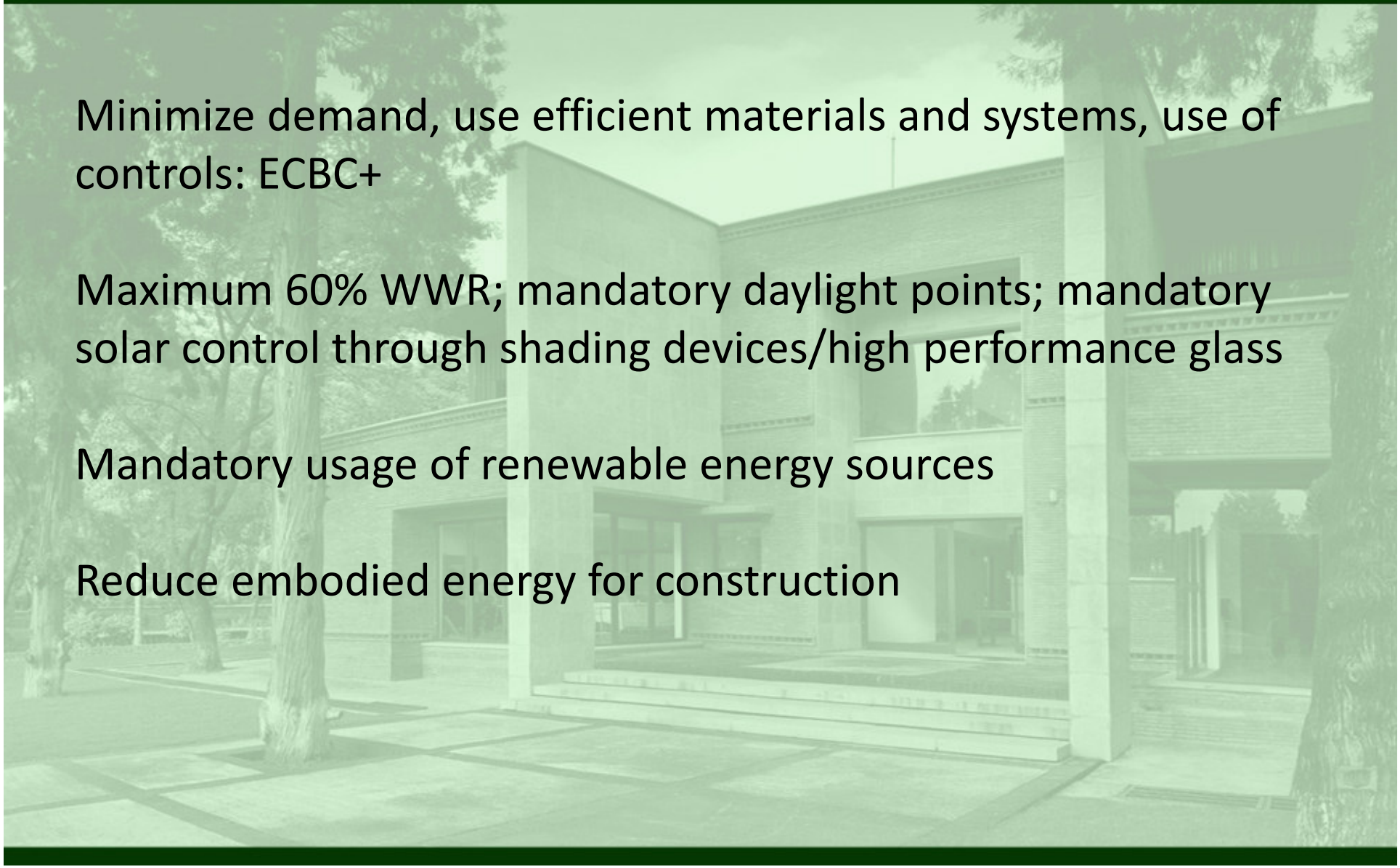
(for new construction) enables achievement of all key policy initiatives and enables market transformation



Tool to facilitate design, construction, operation of a green building ,and in turn ….measure "greenness" of a building in India

What gets measured gets managed

GRIHA: Some key drivers to rethink design approach



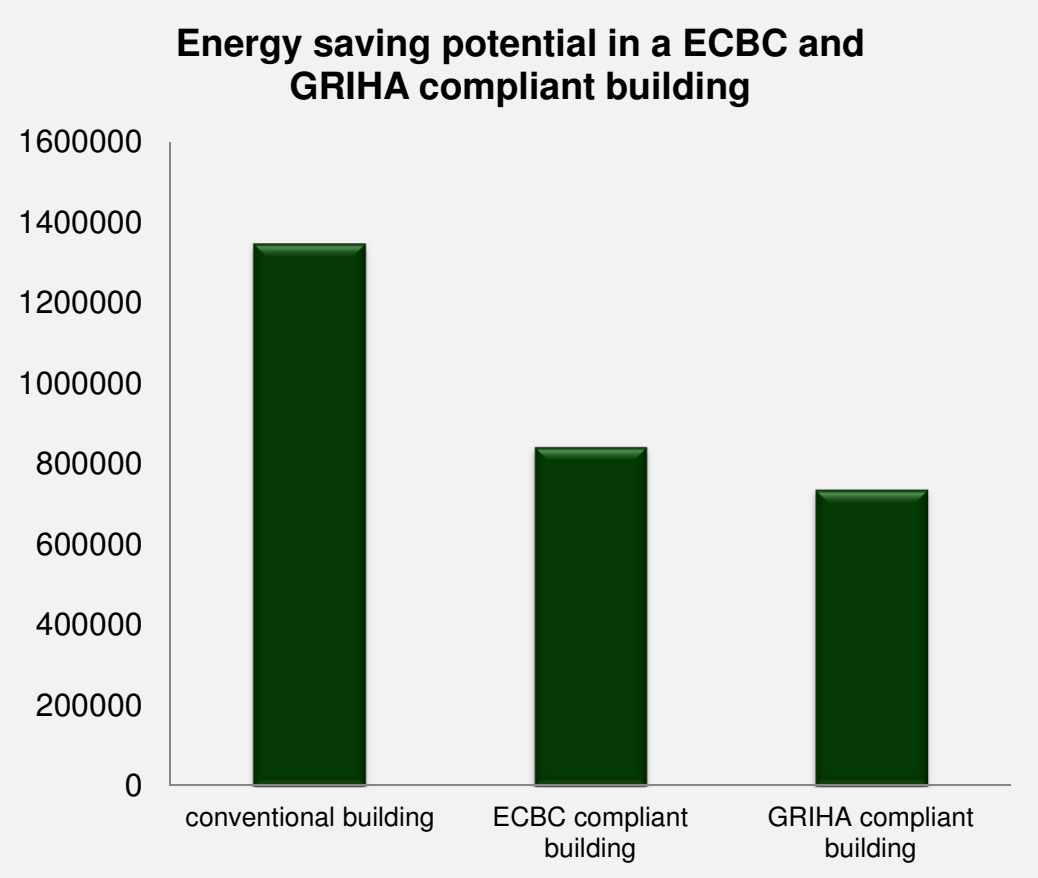
Minimize demand, use efficient materials and systems, use of controls: ECBC+

Maximum 60% WWR; mandatory daylight points; mandatory solar control through shading devices/high performance glass

Mandatory usage of renewable energy sources

Reduce embodied energy for construction

GRIHA Compliant Building: ECBC +



ECBC Compliance:

- Insulation
- High Performance glass
- Controls
- Efficient electrical , mechanical and lighting systems

Incremental cost: 15%

Payback period < 5 years

GRIHA Compliance:

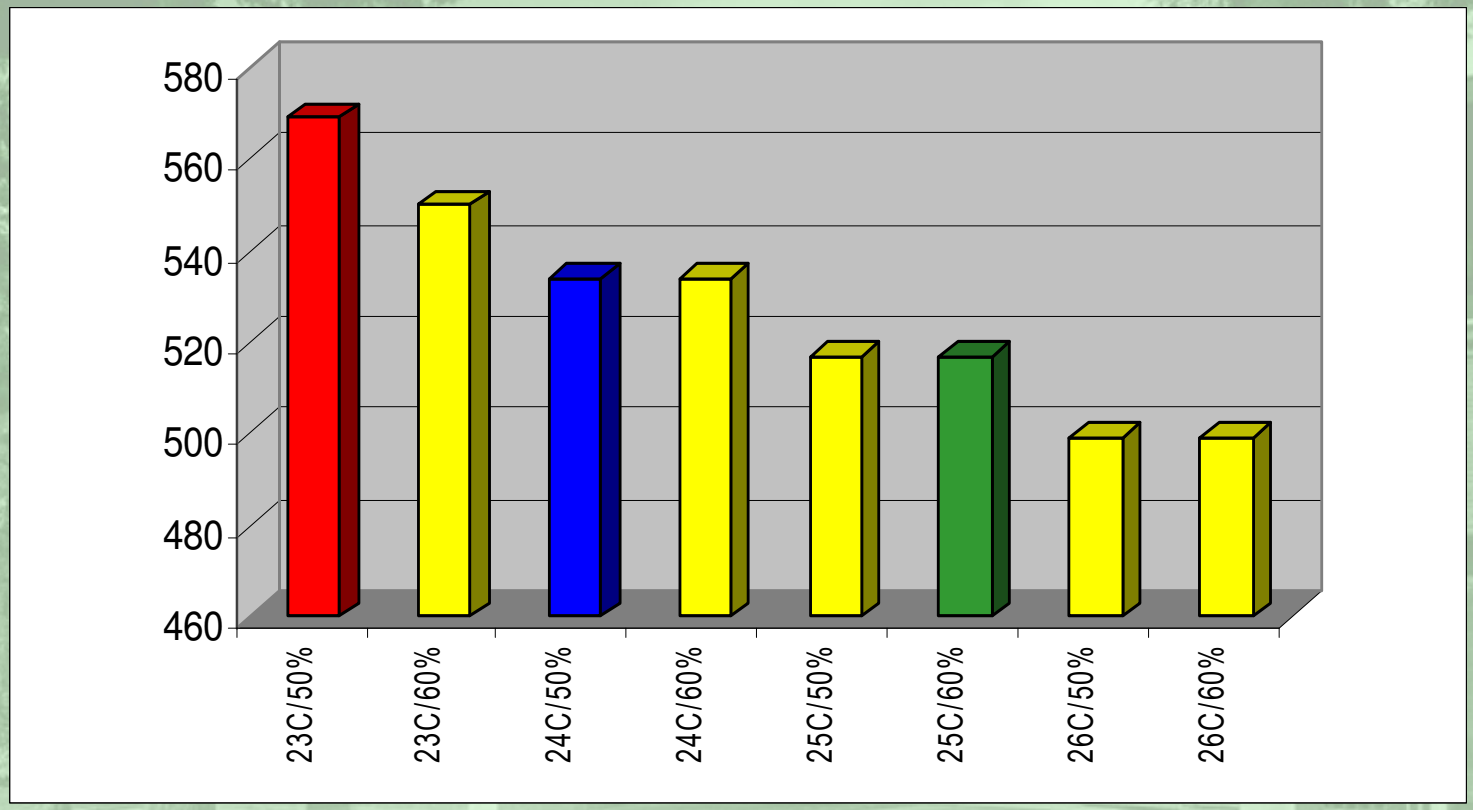
- ECBC +
- Passive principles (shading, orientation, controlled glass area)
- Higher indoor design conditions (higher by 1 deg C)
- Optimized lighting design

No further incremental cost

Payback period: < 4 years

Adaptive comfort and energy savings

Indoor Design Conditions



1 0 C decrease in temperature increases cooling load by 3.5%

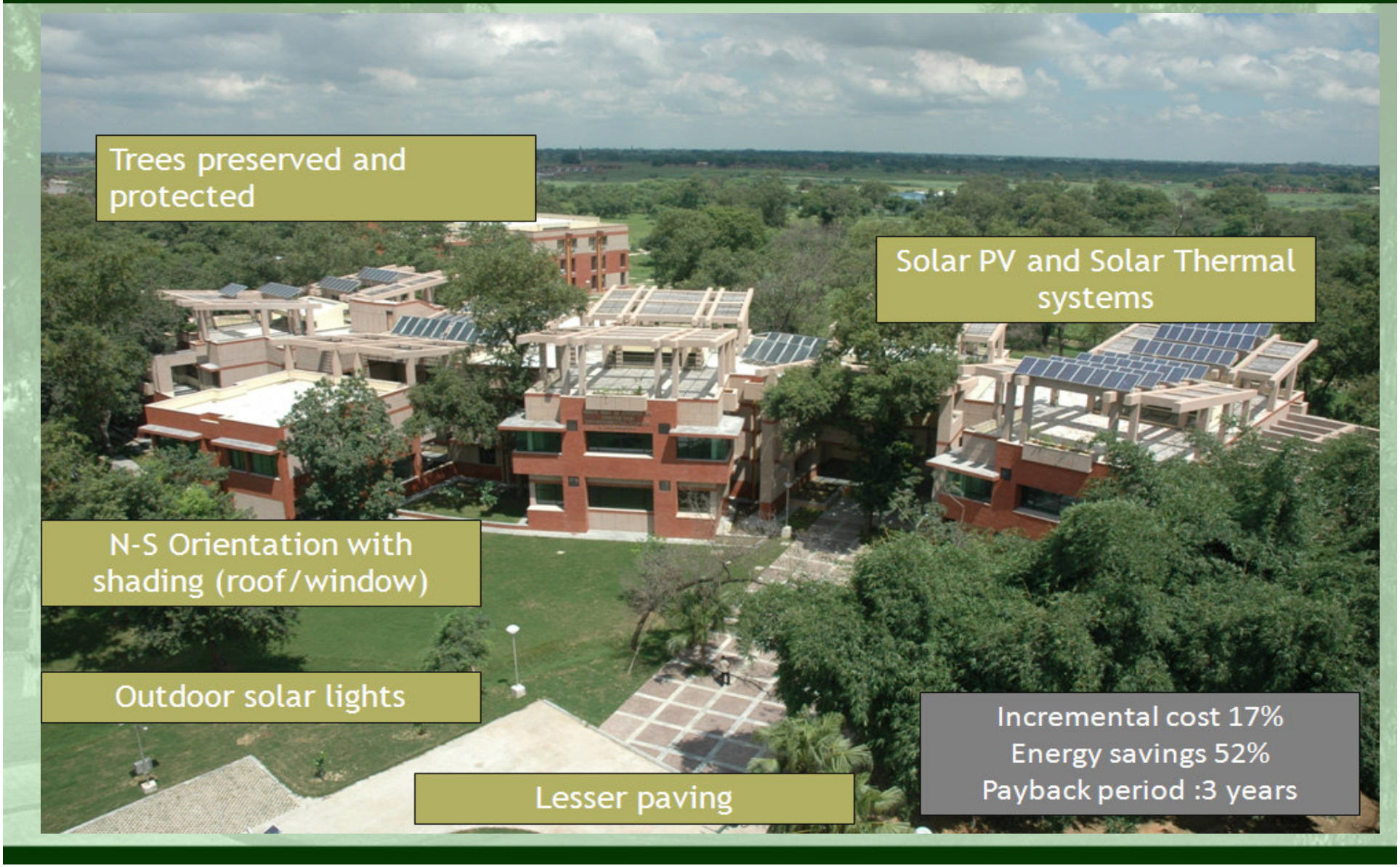
Adaptive comfort in Non AC buildings

- Indians have a higher tolerance threshold for heat and cold because we live in non AC homes and in hotter climates.
- Adaptive comfort is now being given priority internationally as well, so as to reduce AC energy requirement, which comprises the highest percentage in commercial and residential building energy consumption

Table 9: Desirable Wind Speeds (m/s) for Thermal Comfort Conditions							
Clause 5.2.3.1							
Dry Bulb Temperature	Relative humidity percentages						
°C	30	40	50	60	70	80	90
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							

Corporate office of Unilever, Mumbai

First 5 star rated GRIHA building in IIT Kanpur (RE integration)



Suzlon One Earth Campus, Pune

- Visibility of green building through implementation of RE
- Installed 13.44kWp of SPV & 18 windmills @4.75 kW each
- Generate approximately 250000 units of electricity through RE
- Energy consumption reduction compared to GRIHA benchmarks: 47%

GRIHA Rated

Police Training School, Turuchi, Tasgaon

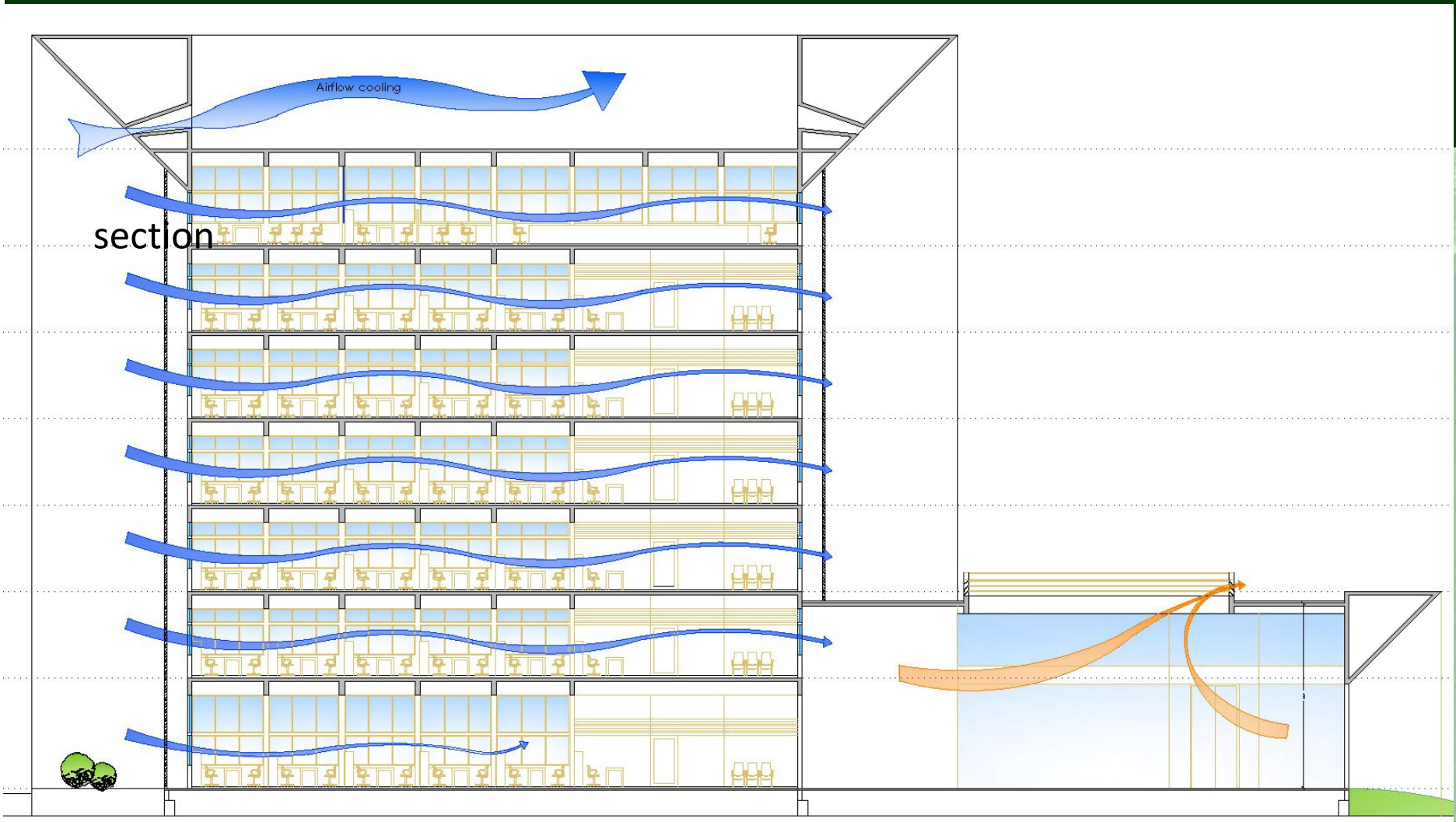
- Visibility of green building through implementation of RE
- 21.5% of internal lighting annual energy requirements met by renewables.
- 28,105 kWh electricity generated from 1kVA of solar power and 13 windmills with power capacity of 5.5kW each.
- Energy savings compared to GRIHA benchmark: 31%

★★★★

GRIHA Rated

Pimpri Chinchwad New Town Development Authority (PCNTDA) Pune

- ECBC compliant envelope and systems
- Well shaded envelope with 75% areas day lit
- Efficient water fixtures and recharge of ground water
- Efficient lighting with controls
- 100% electricity through Solar PVs


Airflow cooling
section

AIRCONDITIONING

In a conventional office building 100% carpet area is covered by airconditioning.

Conventional building:

Carpet area to be airconditioned	=63072 sft
Required capacity of Airconditioning (@140sqft/TR)	=460 TR
Average power consumed in 8 hr cycle	=460X1.2X8 hrs
(mean of summer, monsoon and winter	=4416 units
Cooling load)	
Net power consumption for 270 working days	**=11,92,320 units**
(1.2 million kWH)	

Only 20% space airconditioned: Saves 80% energy in space conditioning

Solar PV integration to meet 100% demand

- Payback period came down to 2.5 years from 9 years by accounting for
  - MNRE subsidy of 30%
  - Transformer eliminated (LT connection could suffice)
  - HT metering kiosk, synchronizing panels, UPS ,battery back up, one DG set eliminated

EAST SIDE ELEVATION

PCNTDA Pune

100% Renewable energy (SPV) installed on site- 100 KW

HAREDA Akshay Urja Bhawan Chandigarh

- Roof insulation
- High performance glazing meeting GRIHA SHGC requirements
- Building Management System (BMS)
- VRV systems
- 42 KW of RE (SPV)
- Efficient lighting with controls

How does GRIHA make a difference?

Typical office building- 8 hr use

200kwhr/sq m/annum

↓

100kwhr/sq m/annum

- Passive architectural design
- Daylight integration
- Shaded windows
- Roof insulation
- RE integration
- Solar water heaters

45 lpd

↓

31.5 lpd

- Low flow fixtures

- 30% - 50% reduction in energy consumption compared to GRIHA benchmarks
- 40 - 65 % reduction in building water consumption compared to GRIHA base case
- At no/negligible incremental cost

Potential impact

9 million sqm of GRIHA 5 star certified project can save

- Enough electricity to power about 90,000 urban homes
- Enough water to meet needs of 21000 urban homes
- Monitored data to ensure compliance
- 6MW PV installation to enhance supply

Strategy 3

- Use materials and technologies with low embodied energy, recycled content or that are reusable

Building materials

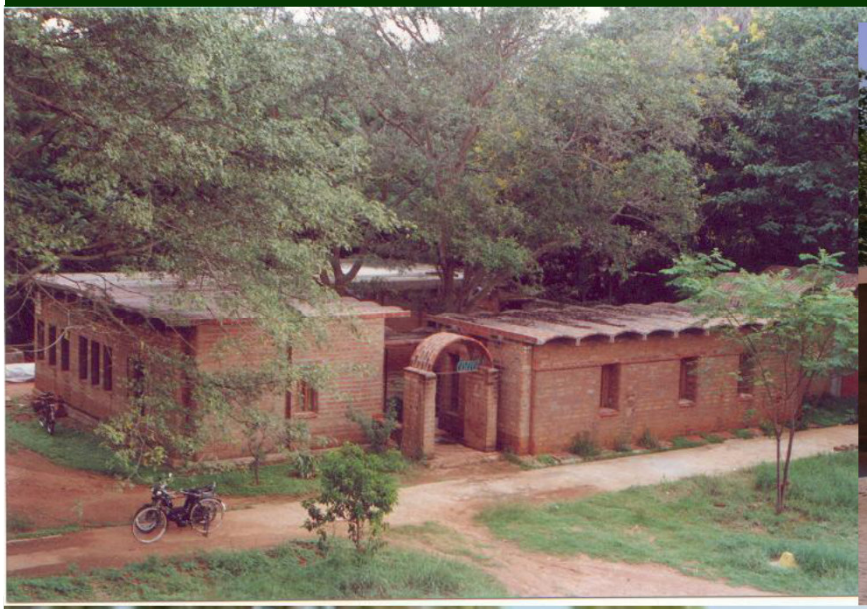
Materials consumed in bulk quantities

Type of material	Annual consumption
1. Burnt Clay Bricks	150×10^9
2. Cement	220×10^6 t
3. Steel	45×10^6 t
4. Coarse aggregates	300×10^6 m^3
5. Fine Aggregates	350×10^6 m^3

Indian construction Industry:
In terms of Vol. of materials produced: 1.25 billion t/year
Per capita consumption of Construction materials : 1.10 t
Food grains : 0.20 t

Slide Courtesy:
Prof BVB Reddy
: IISC, Bangalore

Use of low embodied energy technologies



Source: Pandya, Y. (2009). Footprints EARTH

Source: Lad, J.(2009). SriAurobindo Society

Policies and programs

Current approaches to enable sustainable buildings

- Policy and regulatory approaches/National programs and plans
  - Environmental clearance
  - Energy Conservation building code
  - Mandates on green rating
  - National mission on sustainable habitats
- Voluntary and market driven approaches
  - Green building rating systems
  - Appliance labeling (partly mandatory)

Lack of integration and uniformity and clarity on application domain (e.g. ECBC does not talk about residential buildings); Environmental clearance is a nightmare for many builders; piecemeal approach results in islands of excellence in a sea of environmental chaos; implementation challenges

GRIHA meets objectives of key government policies and programs

Ministry of New and Renewable Energy

- Solar buildings program for energy efficient buildings
- GRIHA- national building rating system (partly mandatory)
- Solar cities programme
- Incentives for integration of renewable energy & GRIHA

Bureau of Energy Efficiency, Ministry of Power

- Energy Conservation Building Code (voluntary)
- Appliance labeling (partly mandatory)
- Star rating programme for existing buildings (rates commercial buildings on energy performance)

Ministry of Environment & Forests

- Environmental Clearance (Mandatory)
- Resource (energy, water) efficiency integral part of clearance
- ECBC mandatory

Ministry of Urban Development

- National Mission on Sustainable Habitats
  - energy efficiency in buildings
  - management of solid waste
  - accelerating modal shift to mass transport

Pimpri Chinchwad Municipal Corporation, Maharashtra

- Partly mandatory to comply with GRIHA
- Incentives for GRIHA

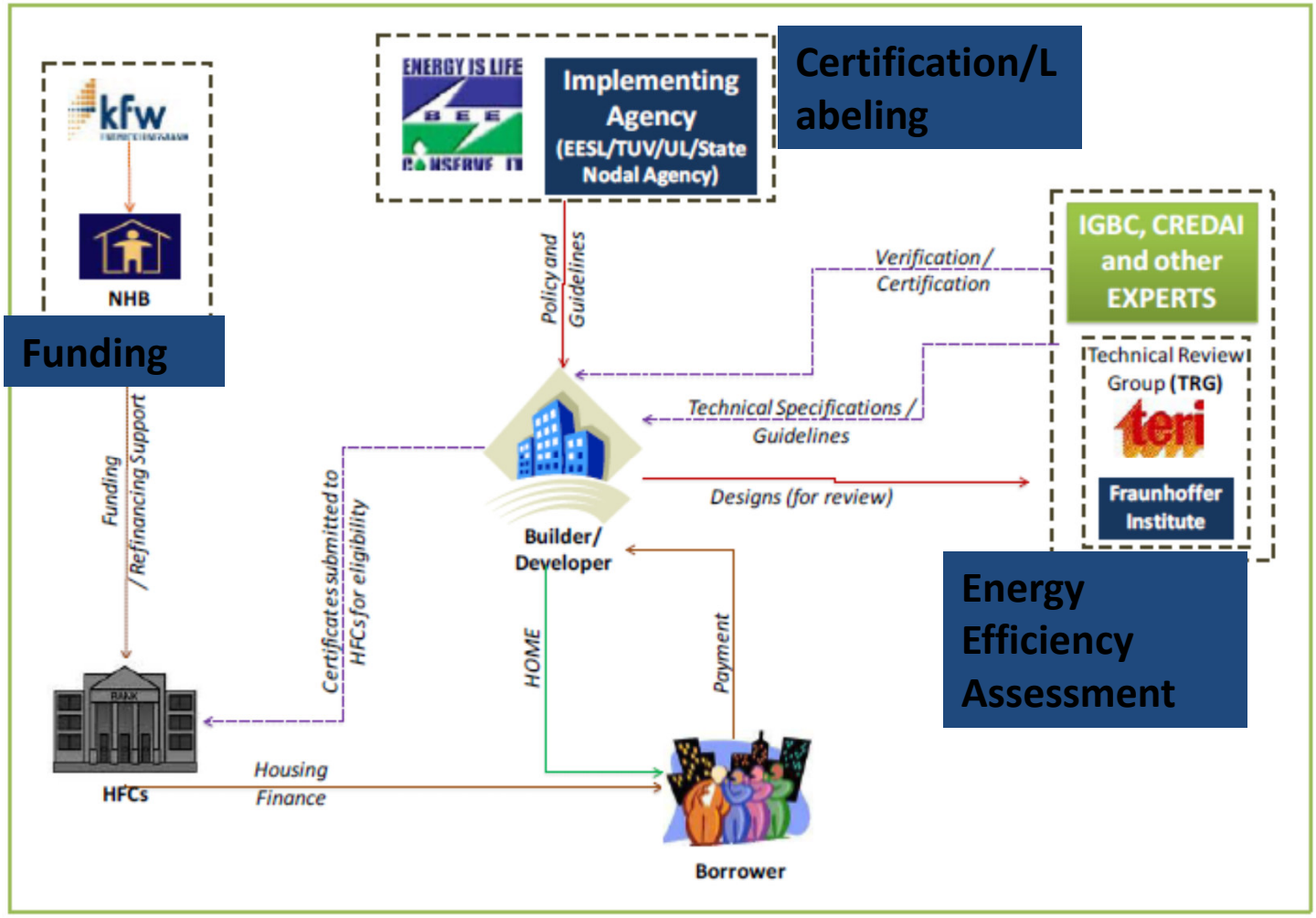
Central Public Works Department/ Thiruvanantha-puram PWD

- Mandatory to comply with GRIHA
- Revised specification, schedules and plinth area rates

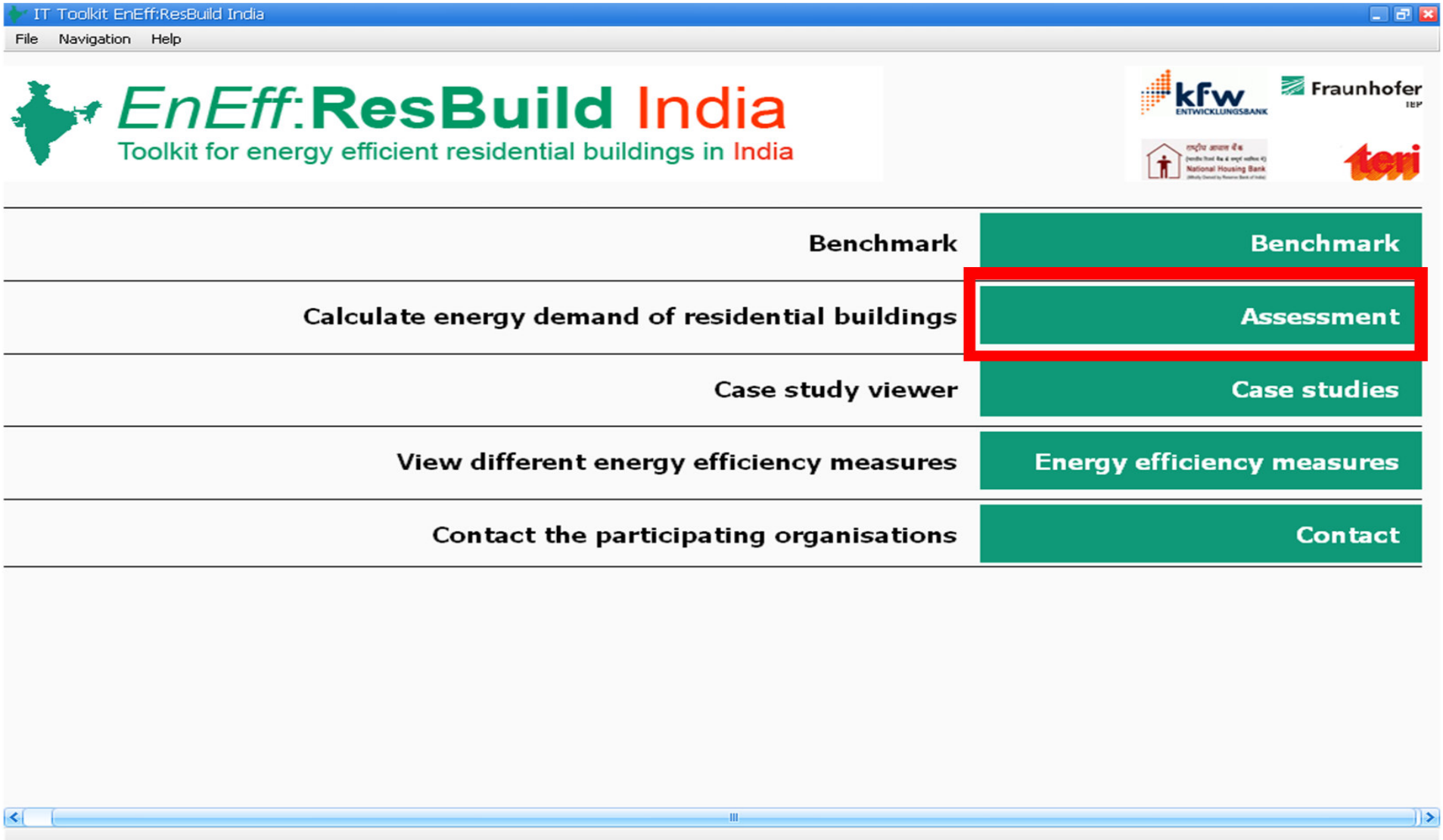
Financing energy efficient housing

Innovation for India: Funding and Certification System

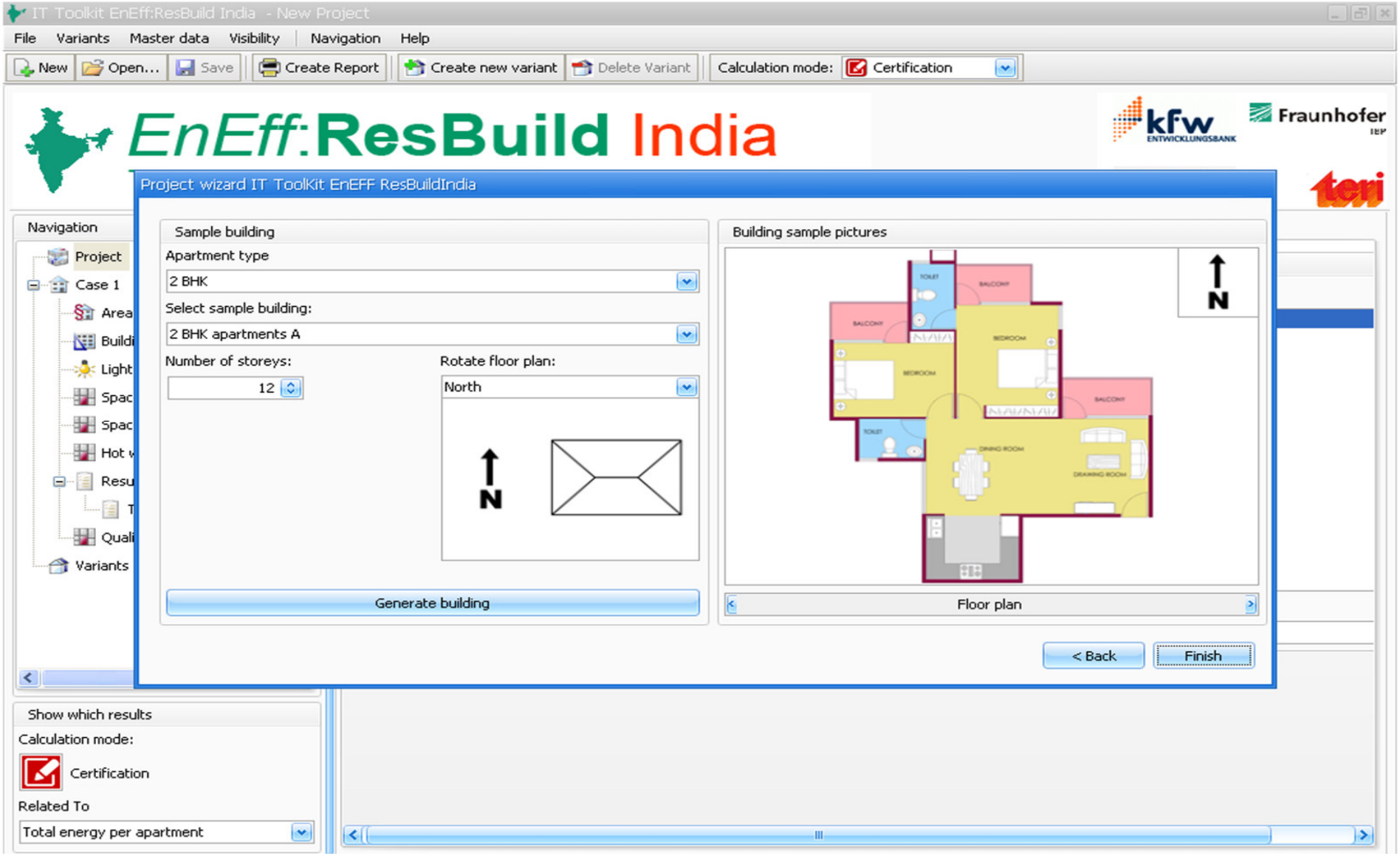
Stakeholder Dialogue/Policy Development



IT Toolkit : Select Assesment



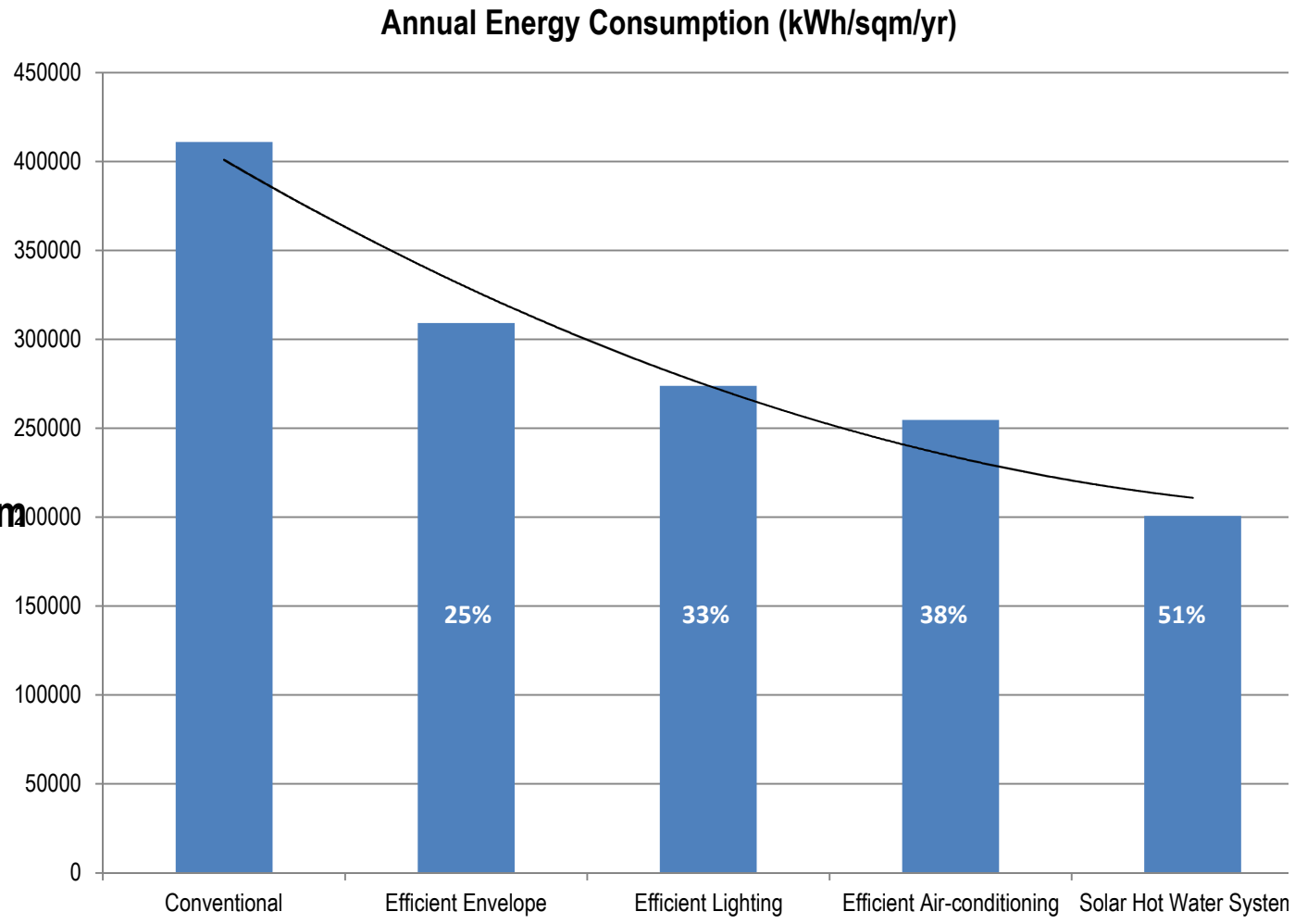
Sample Building



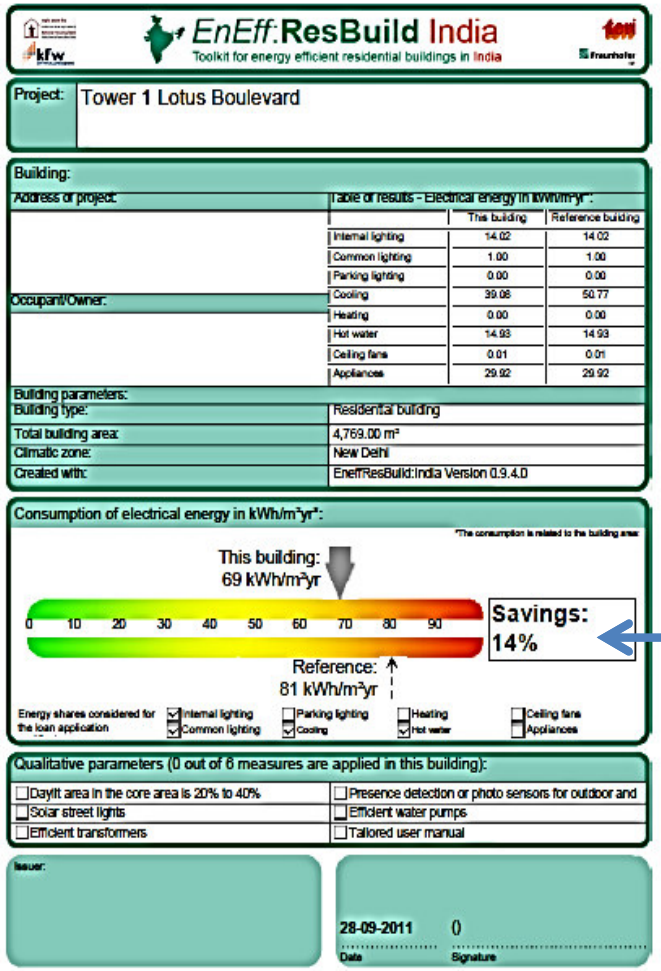
Energy Conservation Measures

Energy Conservation Measures –

- **Efficient Envelope Materials**
- **Efficient Lighting System**
- **Efficient AC system**
- **Solar Hot Water System**



Certificate



EnEff:ResBuild India
Toolkit for energy efficient residential buildings in India

Project: Tower 1 Lotus Boulevard

Building:

Address of project:

Occupant/Owner:

Table of results - Electrical energy in kWh/m²yr*:

	This building	Reference building
Internal lighting	14.02	14.02
Common lighting	1.00	1.00
Parking lighting	0.00	0.00
Cooling	39.08	50.77
Heating	0.00	0.00
Hot water	14.93	14.93
Ceiling fans	0.01	0.01
Appliances	29.92	29.92

Building parameters:

Building type:	Residential building
Total building area:	4,769.00 m²
Climatic zone:	New Delhi
Created with:	EneffResBuild:India Version 0.9.4.0

Consumption of electrical energy in kWh/m²yr*:

*The consumption is related to the building area

This building: 69 kWh/m²yr

0 10 20 30 40 50 60 70 80 90

Savings: 14%

Reference: 81 kWh/m²yr

Energy shares considered for the loan application: Internal lighting, Common lighting, Parking lighting, Cooling, Heating, Hot water, Ceiling fans, Appliances

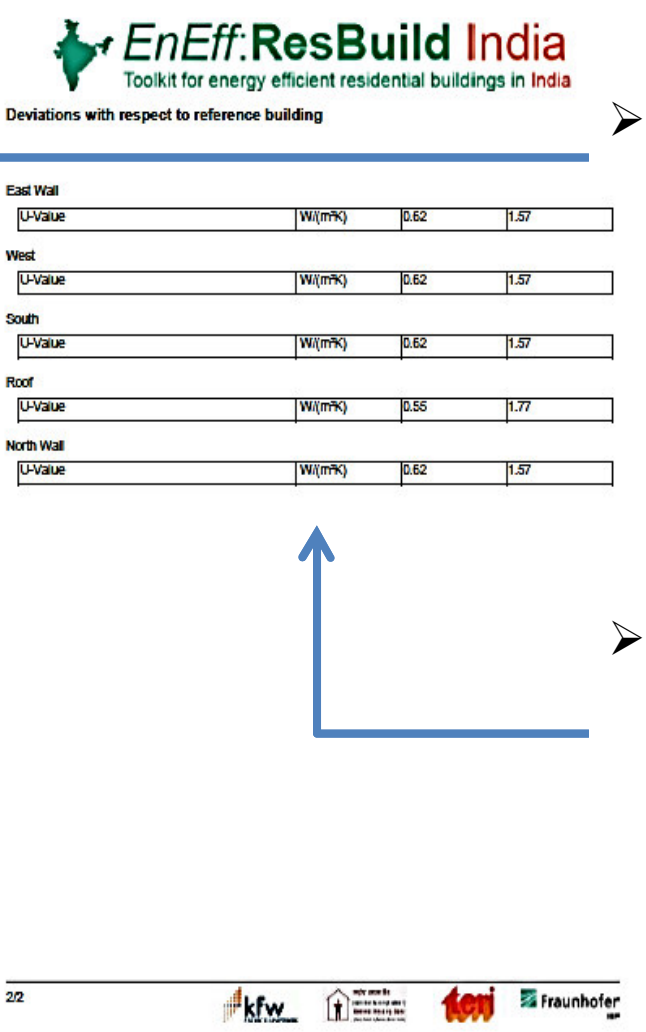
Qualitative parameters (0 out of 6 measures are applied in this building):

Daylit area in the core area is 20% to 40%	Presence detection or photo sensors for outdoor and
Solar street lights	Efficient water pumps
Efficient transformers	Tailored user manual

Issuer:

28-09-2011 ()

Date Signature



EnEff:ResBuild India
Toolkit for energy efficient residential buildings in India

Deviations with respect to reference building

East Wall

U-Value	W/(m²K)	0.62	1.57

West

U-Value	W/(m²K)	0.62	1.57

South

U-Value	W/(m²K)	0.62	1.57

Roof

U-Value	W/(m²K)	0.55	1.77

North Wall

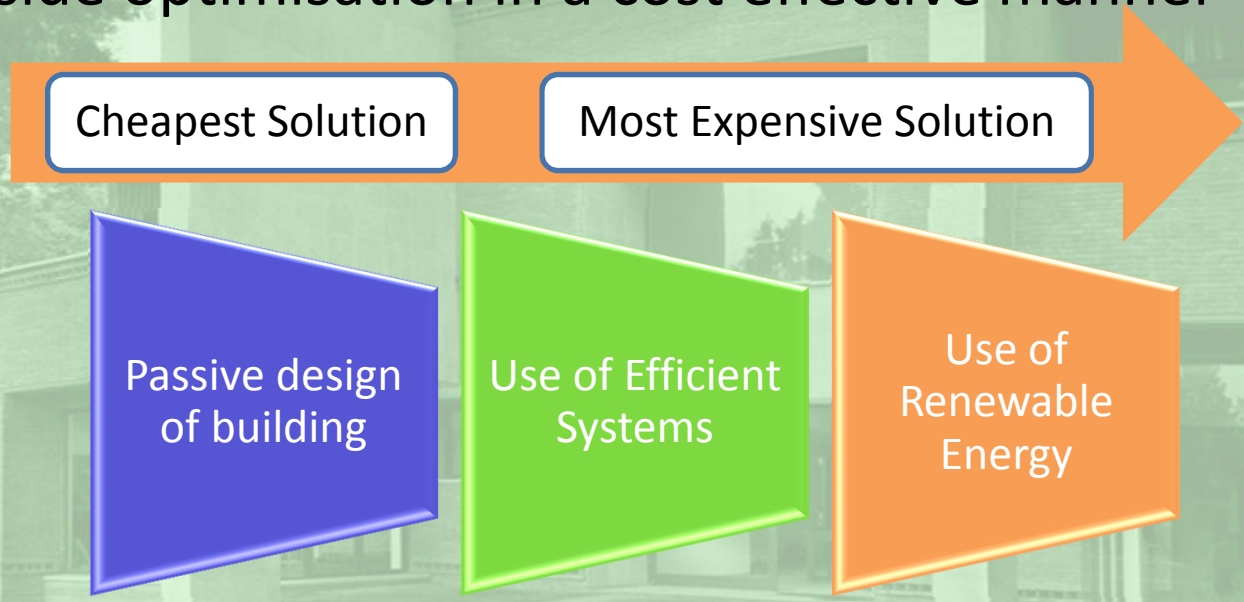
U-Value	W/(m²K)	0.62	1.57

2/2

- **% Saving with respect to the reference case**
- **A short report on parametric variations with respect to reference case**

Energy Efficiency in buildings: A driver to Green Economy

- Climate change mitigation
- Energy and natural resource security
  - Demand side optimisation in a cost effective manner



- Job creation
- Market transformation

Thank you