Energy Conservation Building Codes-Overview

Two day Intensive Training Program on ECBC

UNDP-GEF-BEE and EMC Kerala

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Director Vke environmental
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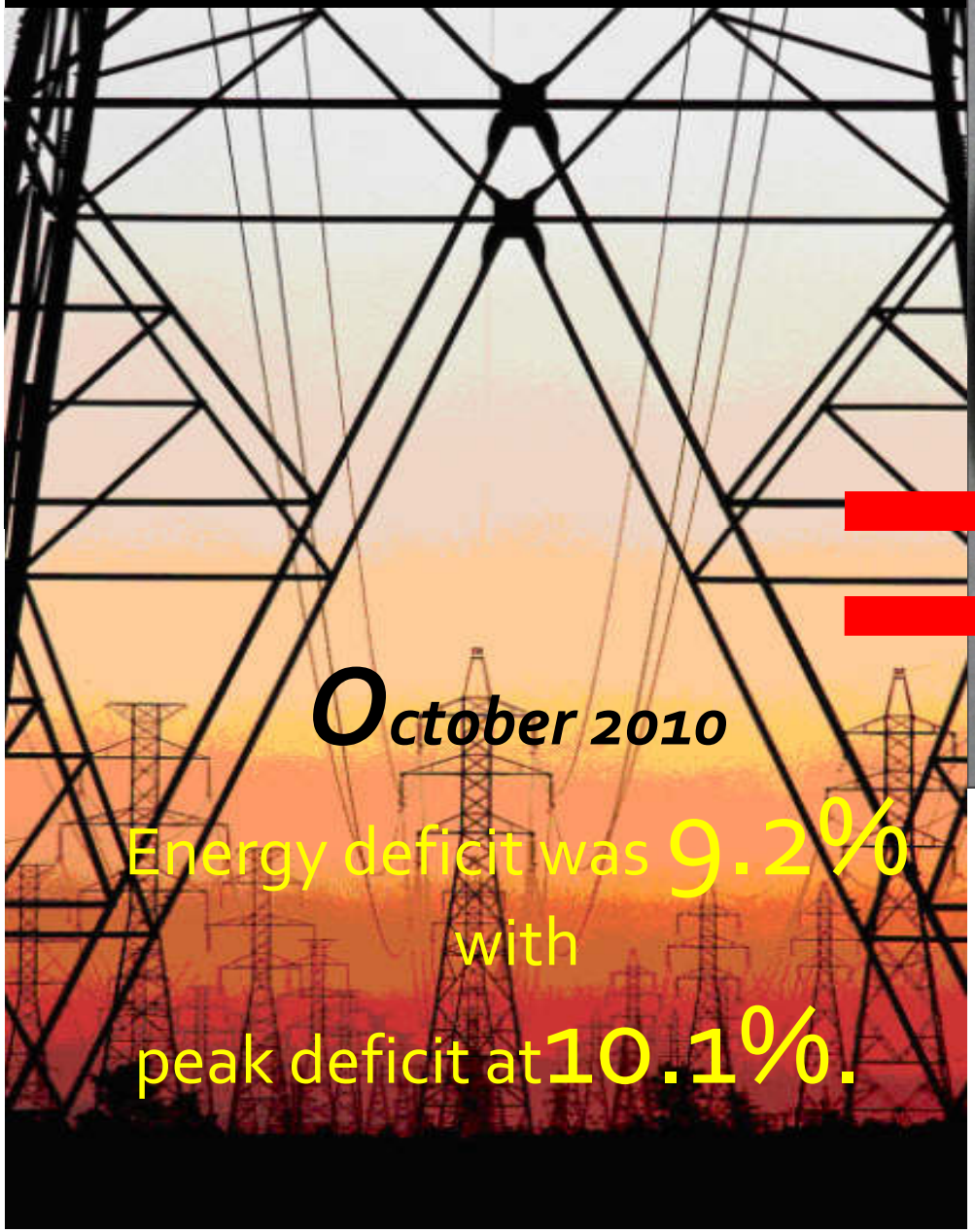
Energy Consumption



October 2010

Energy deficit was 9.2%

with

peak deficit at 10.1%.

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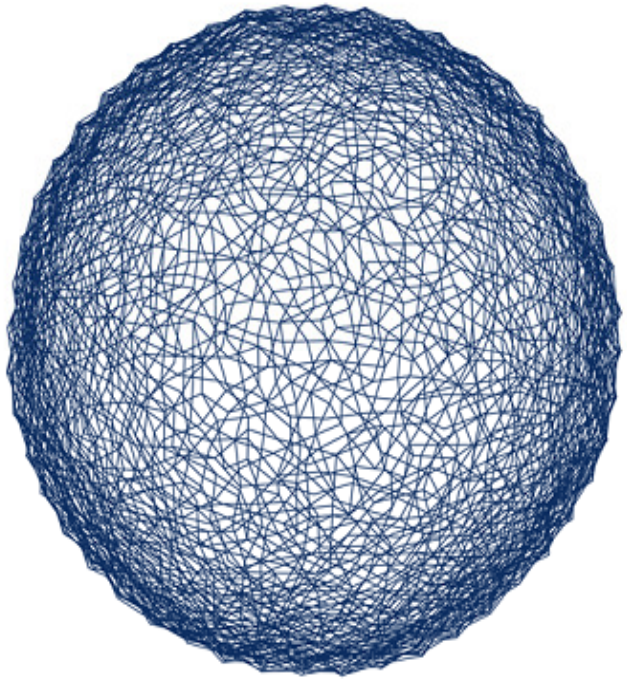
Economic Growth

Climate Change and India



COP15
COPENHAGEN
UN CLIMATE CHANGE CONFERENCE 2009

- India matched the global strides towards CLIMATE CHANGE as well as took its first step towards energy security through
  - The Energy Conservation Act in September 2001
  - Followed by the Electricity Act in 2003
- In June 2008, PM Dr Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC), highlighting 8 major sectors

The National Policy Framework

- **The Energy Conservation Act, 2001**
  - The Act provides for institutionalizing and strengthening of delivery mechanisms for ***Energy Efficiency*** services in India and
  - Provides a much needed ***Coordination*** between the various allied agencies

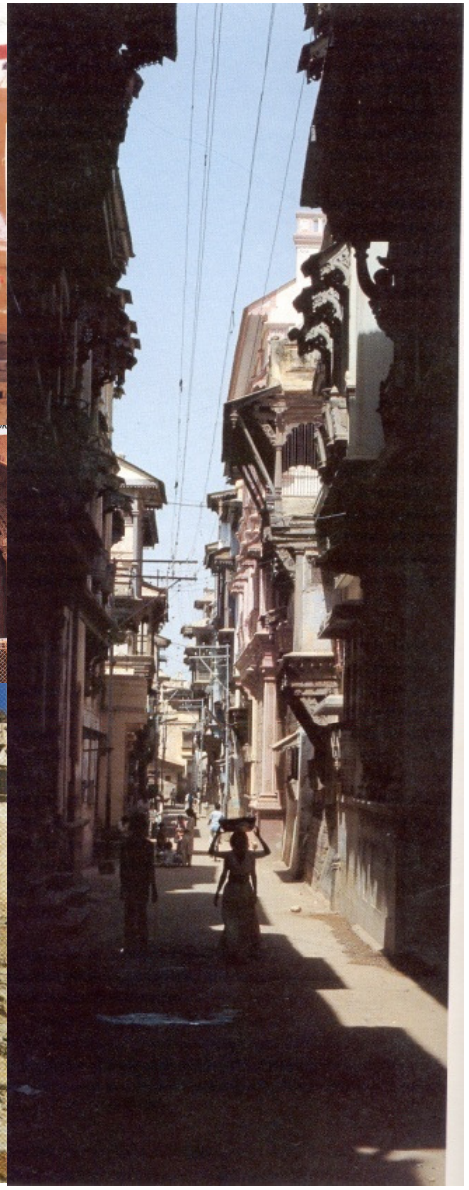
The National Policy Framework

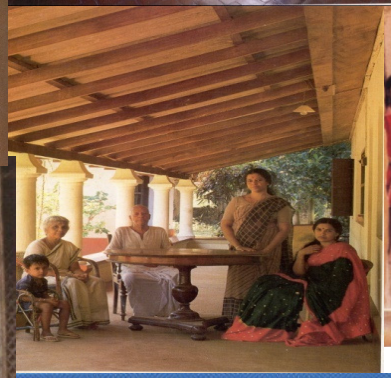
The important Features of the Energy Conservation Act, 2001 are:

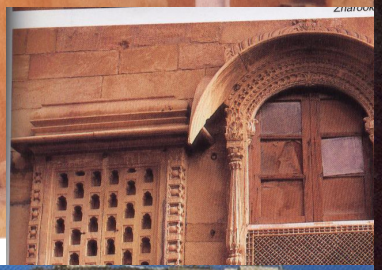
- Standards and Labeling - *for electrical equipment*
- Designated Consumers (DCs) – *to instill energy auditing and monitoring for energy intensive DCs*
- **Energy Conservation Building Codes – *for new buildings exceeding the connected load of 100 kW***
- Establishment of the Bureau of Energy Efficiency (BEE) to monitor and implement the EC Act, 2001

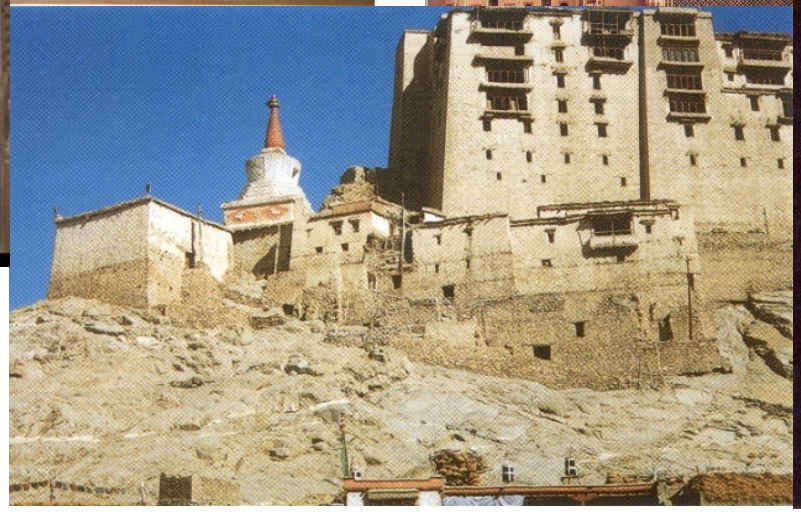
Why

Look for energy efficiency in buildings?









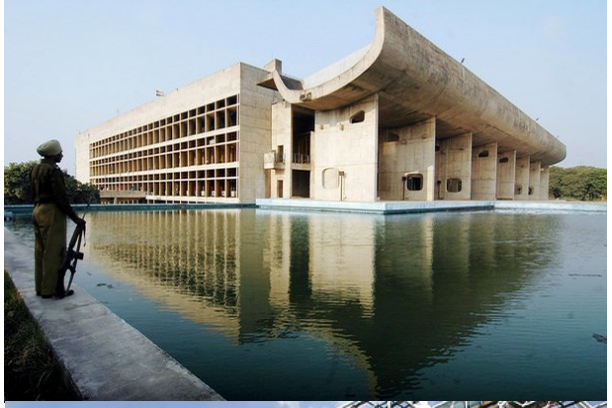
Precedent.....

Precedent

Form generated from

- ✓ Climate
- ✓ Function
- ✓ Availability of materials
- ✓ Culture

Respecting Nature !



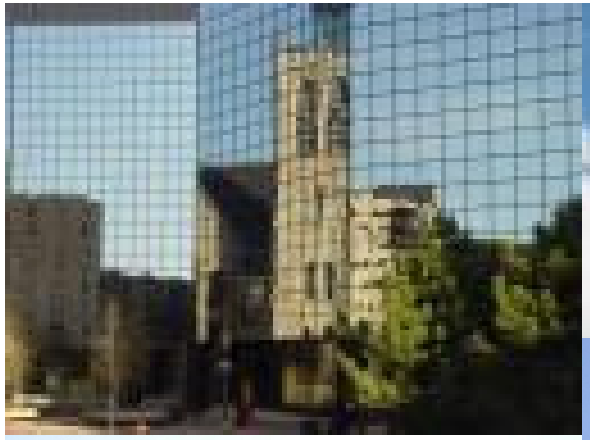
Modern Movement

Modern Movement

Form generated from

- ✓ Technology to serve man
- ✓ Urbanization

Controlling Nature !!



Present

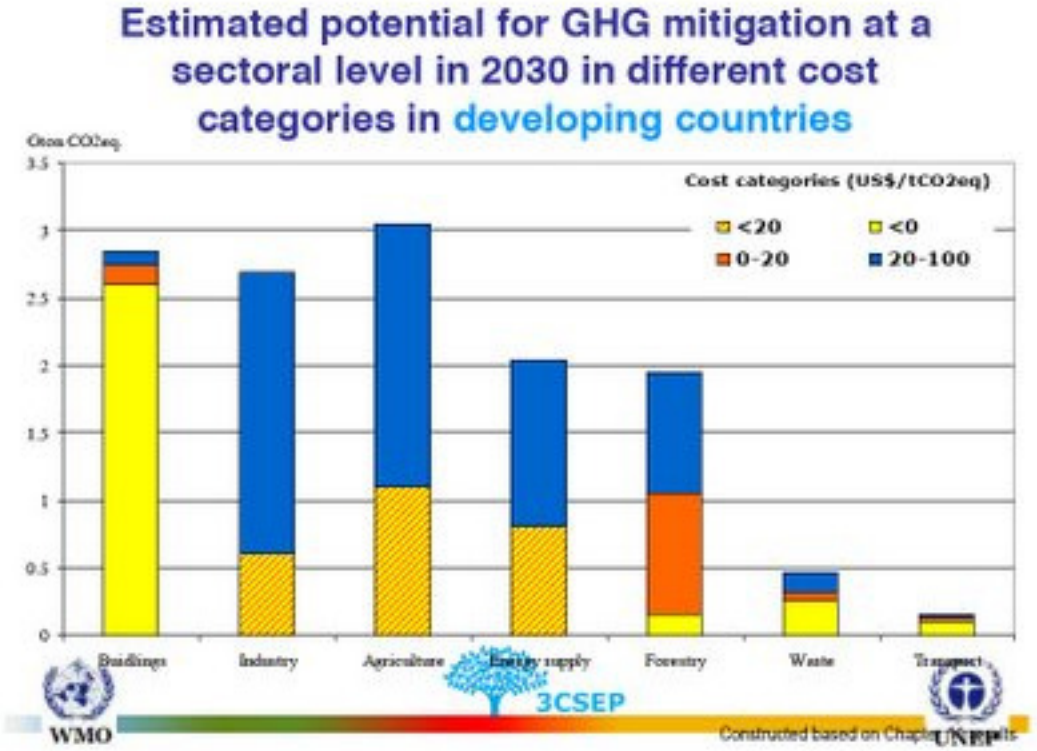
Contemporary Architecture

Form generated from

- ✓ “WANT” and not the “NEED”
- ✓ Ultra Urbanization

Exploiting Nature !!

Why Buildings?

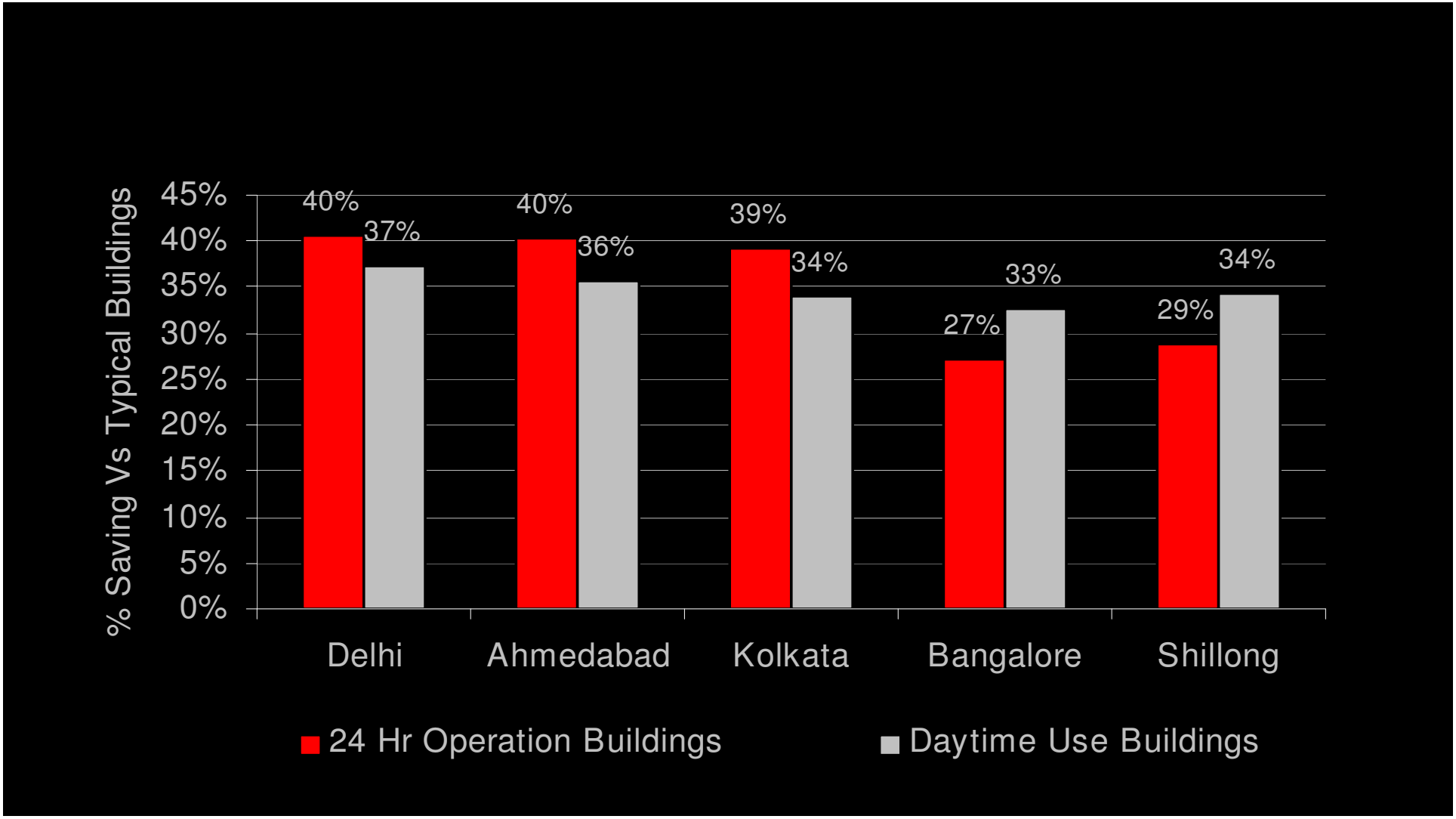


IPCC Fourth Report observes that the building sector has the greatest potential amongst all sectors for energy savings resulting in reduction of GHG emissions

Bureau of Energy Efficiency

Bureau of Energy Efficiency

- Energy Efficiency in Government Buildings was the first step
  - **Rashtrapati Bhawan,**
  - **Prime Minister's Office and Defence Ministry blocks in South Block,**
  - **Rail Bhawan,**
  - **Sanchar Bhawan,**
  - **Shram Shakti Bhawan,**
  - **Transport Bhawan,**
  - **R&R Hospital,**
  - **Terminal I, Terminal II and Cargo Sections of Delhi Airport, and**
  - **AIIMS.**
- Energy savings potential between 23 to 46 % was identified in the above buildings.

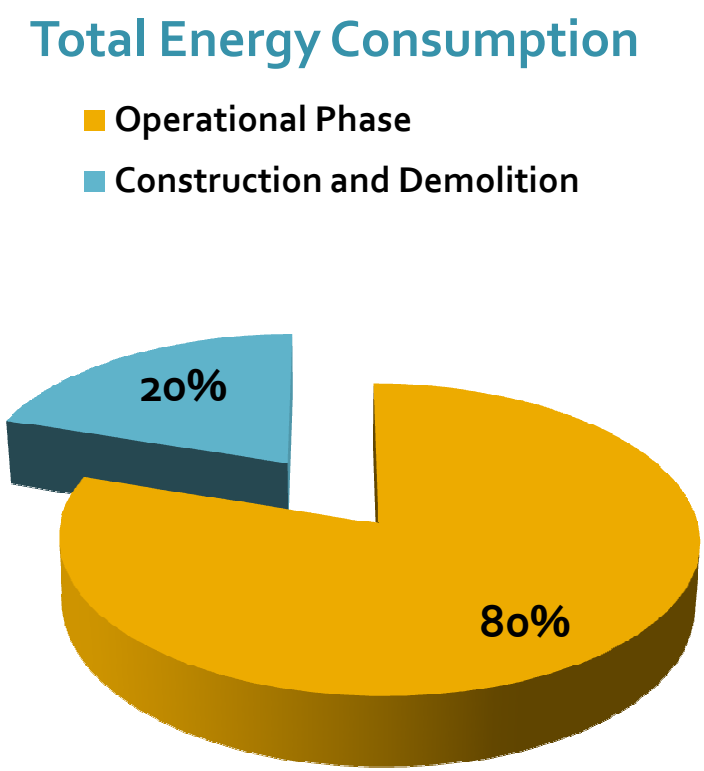


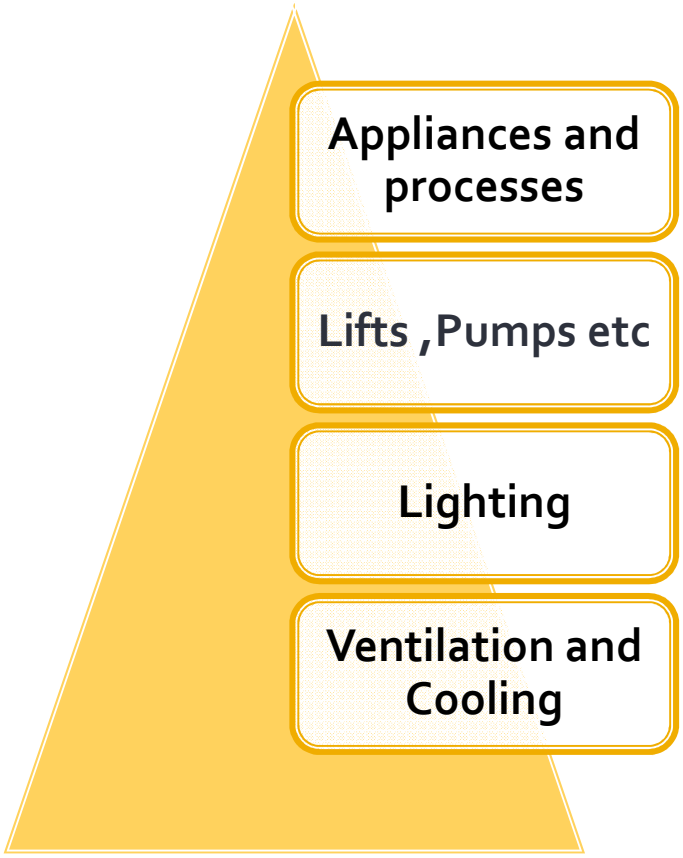
National Energy Savings = Code Stringency X Level of Compliance X Adoption Rate

Conclusions

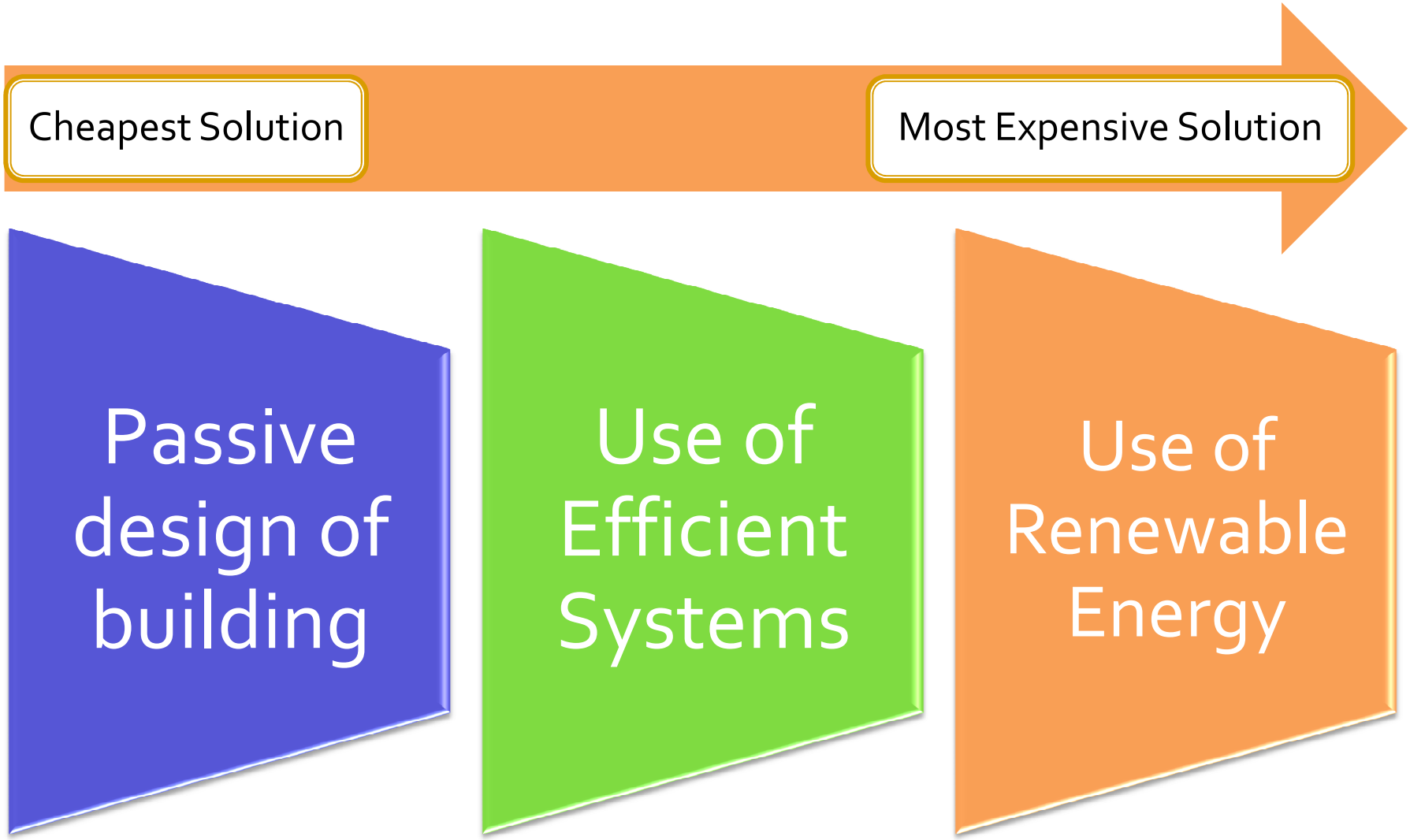
- Similar savings can also be expected in modern high-rise urban buildings.
- The average energy use for typical commercial building is 200 kWh/sq. meter/year.
- Mandatory enforcement of ECBC can reduce the energy use by 30-40% to 120-160 kWh/sq. meter/year.
- Nationwide Mandatory enforcement of ECBC will yield a saving of 1.7 billion kWh for 2005-2006.

Energy consumption in Buildings

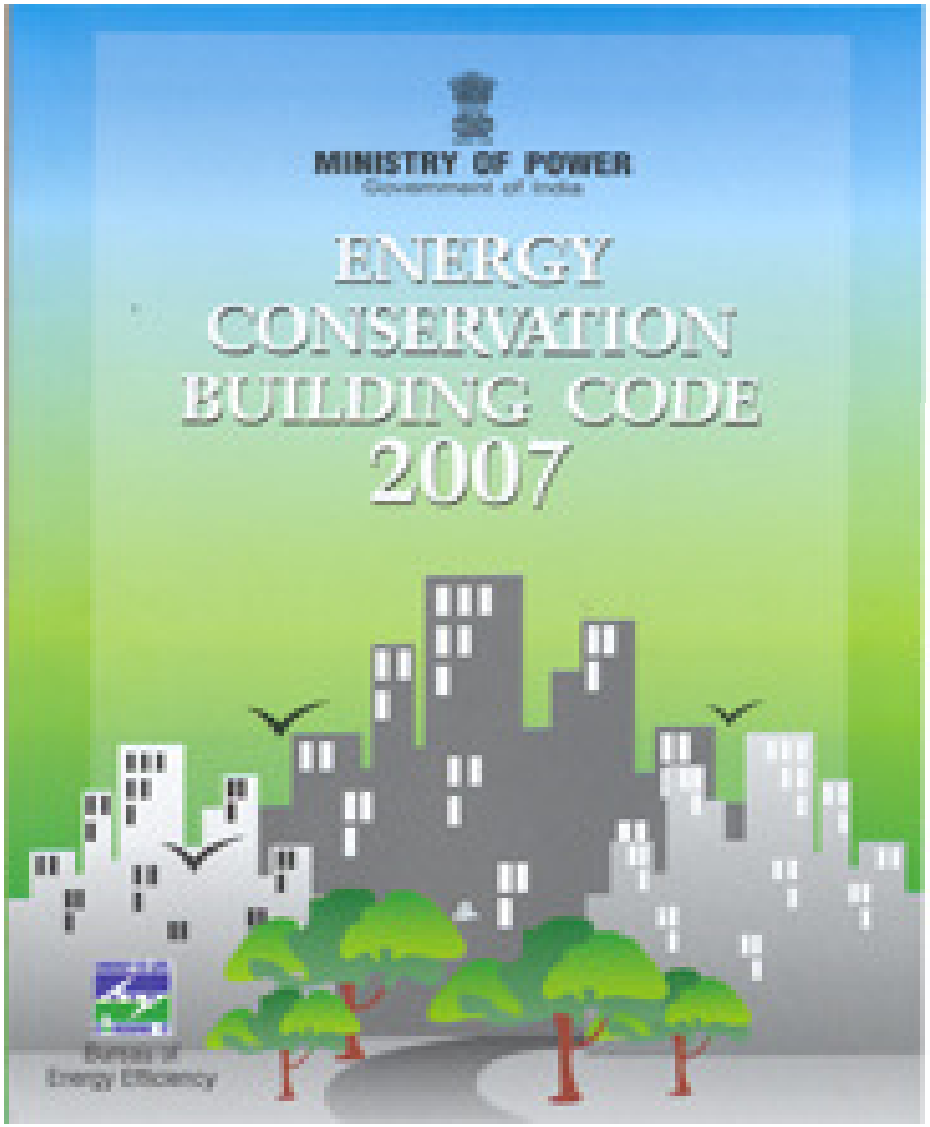




Energy Efficiency Measures



Purpose of ECBC



- To provide **minimum** requirements for the energy efficient design and construction of buildings

Scope of ECBC

- Applicable to buildings or building complexes that have a connected load of 100 kW or greater
- Generally, these building have more than 1000 sq m of conditioned space
- Provisions of ECBC apply to:
  - *Building Envelopes*
  - *Mechanical systems and equipment*
  - *Service Hot Water Heating systems*
  - *Interior and Exterior Lighting systems*
  - *Electrical Power and motors*
- National Building Codes (NBC) is the reference document for ECBC

ECBC Administration and Enforcement

- Compliance Requirements
  - Mandatory Requirements
  - New Buildings
    - *Compliance with Section 4 to 8 or whole building performance Method*
  - Additions to Existing Buildings
    - *When additions plus the existing building exceeds the 1000 sq m*
    - *Only the additions can comply, or both the additions and the existing building can comply*
    - *Existing conditioning systems need not comply, but all additional equipment and systems must comply*

ECBC Administration and Enforcement

- Alterations to Existing Buildings
  - Where existing building exceeds 1000 sq m., any alterations need to comply
  - The entire building can be made compliant, as if it were a new building

Exemptions under ECBC

- The provisions of this code do not apply to:
  - Buildings that do not use either electricity or fossil fuel
  - Equipment and portions of building systems that use energy primarily for manufacturing processes and
  - Multi-family buildings of three or fewer stories above grade, and single-family buildings.

ECBC-Compliance Approach

Mandatory

Section 4.2Envelope
Section 5.2 HVAC
Section 6.2 Service Hot Water and Pumping
Section 7.2 Lighting
Section 8.2 Power

Prescriptive

Section 4.3Envelope
Section 5.3 HVAC
Section 7.3 Lighting

OR

Tradeoff

Section 4.4 Envelope

OR

Whole Building Performance Method

Section 4-Envelope
Section 5 - HVAC
Section 7 - Lighting
Section 8 - Power

Compliance Documents

Building Envelope

- *insulation materials and their R values,*
- *fenestration U factors,*
- *solar heat gain coefficients (SHGC),*
- *visible light transmission and air leakages,*
- *overhangs and sidefins,*
- *building envelope sealing details*

Heating, Ventilation and Air Conditioning

- *Systems and equipment types*
- *Sizes, efficiencies and controls*
- *Economizers*
- *Variable speed drives*
- *Piping insulation*
- *Duct sealing, insulation and location*
- *Requirement for balance report*

Service Hot Water Systems

- *Solar Water Heating System with detailed calculations to meet 20% hot water demand*
- *Heat Recovery system details*
- *Gas heater system details*

Lighting Systems

- *Lighting schedule, showing types, number and wattage if lamps and ballasts*
- *Automatic lighting shut off*
- *Occupancy sensors and other lighting controls*
- *Lamp efficacy for exterior lamps*

Electrical Power

- *Electric Schedules showing transformer losses*
- *Motor efficiencies*
- *Power factor corrections devices*
- *Electric check metering and monitoring systems*

Impact of Energy Efficiency measures on costs

Built up area is 4240 sqm of which 1912 sqm is air conditioned

- **Key energy efficiency features that added to cost (35 lacs)**
  - High performance glazing (Incremental cost of Rs 12.5 lacs)
  - Roof insulation(Incremental cost of 7 lacs)
  - Efficient lighting with controls(incremental cost of 9 lacs)
  - High efficiency chillers/pumps/fans (about 34 TR which is 30% of total tonnage was saved, hence there was a decrease in cost by about 4 lacs)
  - Earth air tunnel (11 lacs)
- **Annual energy savings : 18.5 lacs..simple payback of 2 years**

Optimization-building material

Initial energy consumption: 240 kWh/m^2 yr

Building envelope

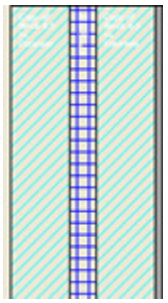
- Brick wall
- RCC roof without insulation
- Single clear glass for windows

240 kWh/m^2 per annum

- Cavity brick wall with insulation
- Roof insulation with fiber glass
- Shading on roof
- Double glass for windows

208 kWh/m^2 per annum

13% energy savings



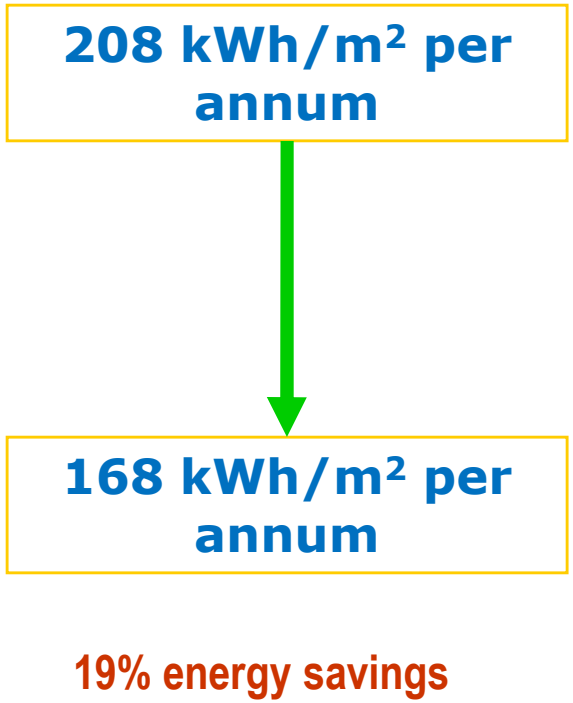
Optimization of Lighting Design

Lighting optimization

- Efficient fixtures
- Efficient fixtures & lamps
- Efficient layout
- Daylight integration

Achievement
LPD=1.3W/ft2

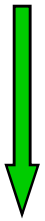
Illumination levels as per standards:
Laboratory: 400 lux
Corridors: 200 lux
Work plane (faculty room): 300 lux



Optimisation of HVAC system

HVAC system

- Air-cooled chiller



168 kWh/m² per annum

- *Water-cooled chiller CoP=4.88 (complying with minimum efficiency requirements of the Energy Conservation Building Code)*

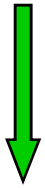
133 kWh/m² per annum

21% energy savings

Optimisation of HVAC design

HVAC system

- No controls used in HVAC system



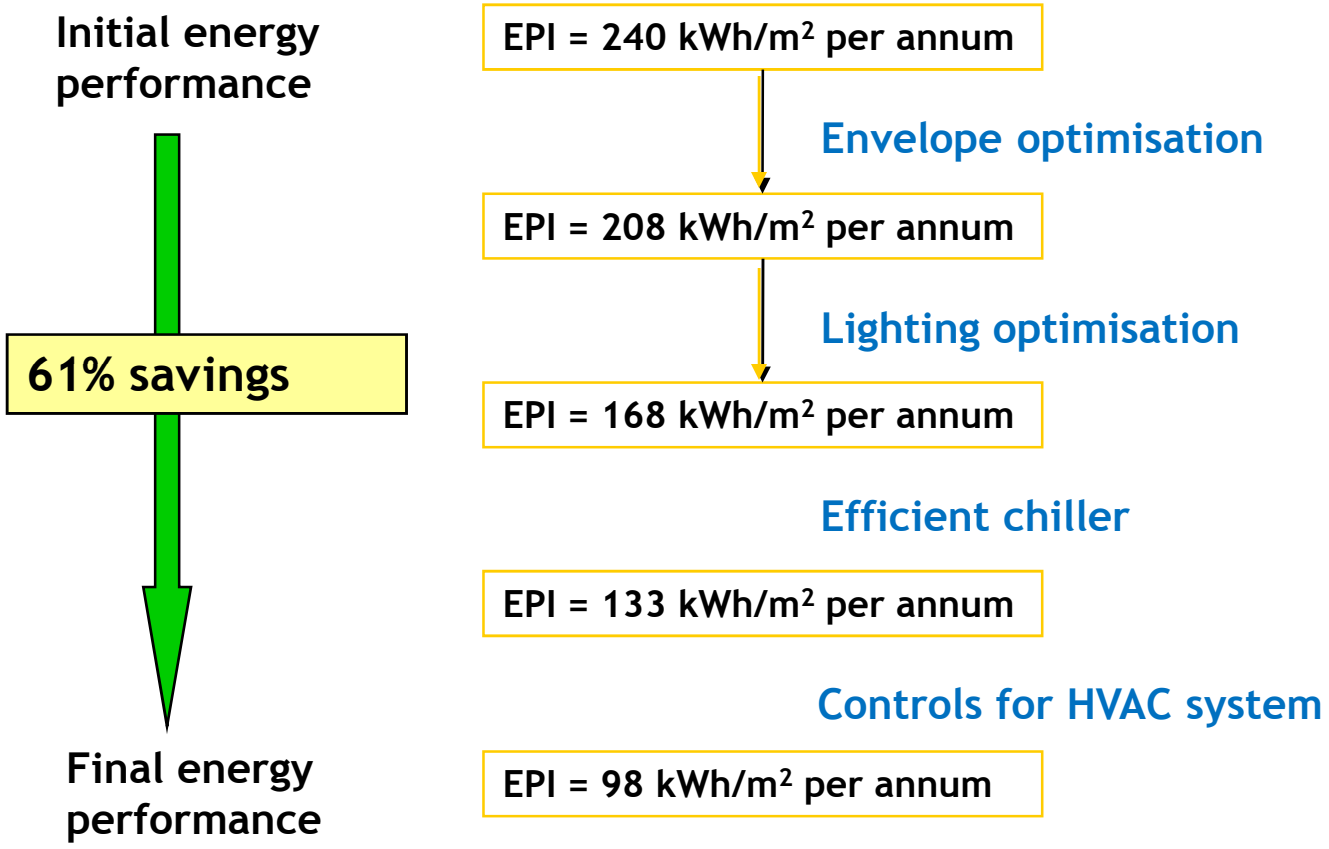
- *Controls used in HVAC system*
  - *Variable speed drives for chilled water pumps*
  - *Efficient load management*
  - *Earth air tunnel for fresh air treatment*

133 kWh/m² per annum

98 kWh/m² per annum

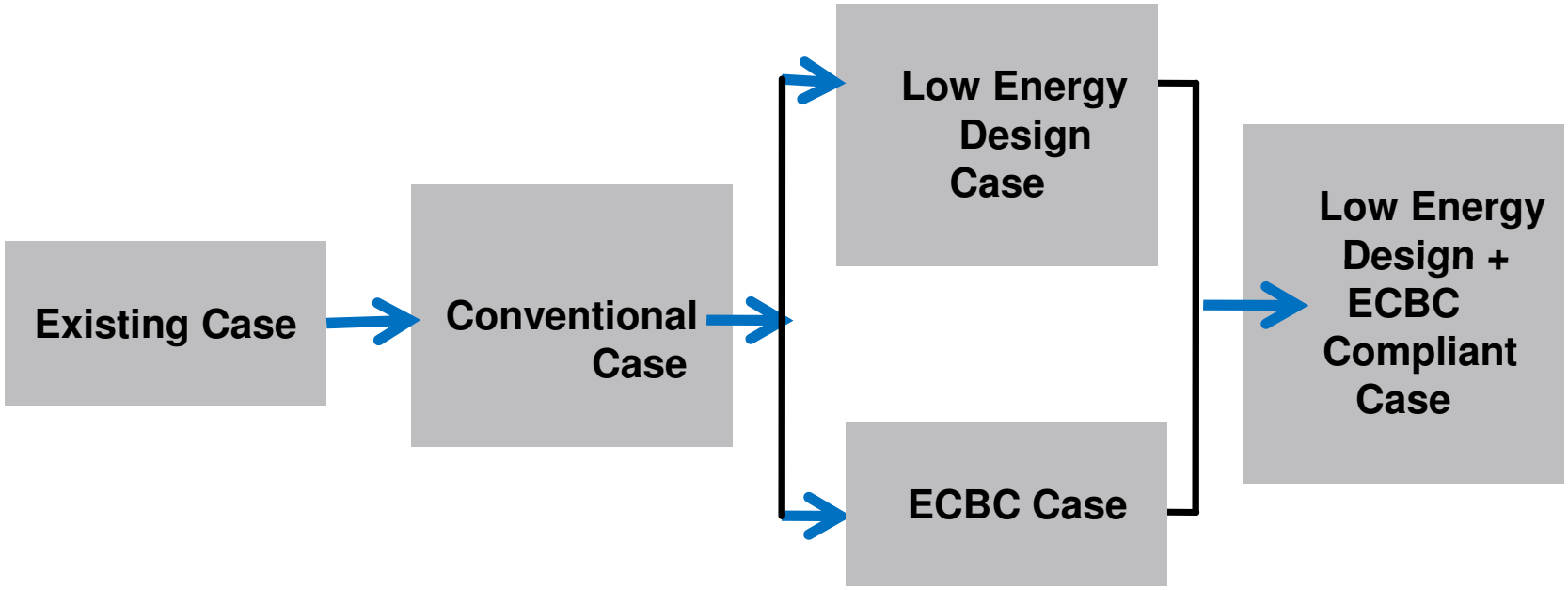
26% energy savings

Annual Energy Savings



Thankyou

Relevance and impact of low energy passive strategies and ECBC strategies



Reference: High Performance Commercial Buildings in India,TERI and White Box Technologies,USA

Microsoft Building, Hyderabad

1. *Built up Area 55741 m2,consisting office spaces, multi purpose rooms, cafeteria, meetin g rooms, conference halls and atrium space.*

2. *Conditioned space 45057 m2 with 10 hr use and 5 working days*

Building Design

1. Longer façade inclined to NE-SW
2. Wall and roof not shaded
3. WWR 70%

Building Envelope

1. Wall U value 1.85W/m2k
2. Roof U value 0.232W/m2k
3. Glass U Value 1.66W/m2k
4. Glass SHGC 0.18

Building Lighting System

1. LPD 8.15 W/m2
2. No daylight Sensors
3. No Occupancy Sensors
4. Visual Comfort-NBC2005

Building HVAC System

1. Water Cooled Centrifugal Chiller
2. COP 6.6
3. Variable Air Flow System
4. VFD in AHUs
5. Thermal Comfort –NBC 2005

Building Performance	
Cooling Demand	2210 TR
Electric Load	2830 kW
Energy Performance Index	150 kWh/m2/year

What if the building had been designed as a conventional building?

Building Design

1. Longer façade inclined to E-W
2. Wall and roof not shaded
3. WWR 70%

Building Lighting System

1. LPD 20 W/m2
2. No daylight Sensors
3. No Occupancy Sensors
4. Visual Comfort-NBC2005

Building Envelope

1. Wall U value 1.98 W/m2k
2. Roof U value 1.78W/m2k
3. Glass U Value 6.17W/m2k
4. Glass SHGC 0.61

Building HVAC System

1. Unitary System(split window Ac)
2. COP 2.9, EER 8.4
3. Constant Air Flow System
4. Thermal Comfort –NBC 2005

Building Performance	
Cooling Demand	2340 TR
Electric Load	4710kW
Energy Performance Index	208 kWh/m2/year

WHAT IF THE MICROSOFT BUILDING HAD ONLY ECBC FEATURES?

1. Building Envelope as per ECBC
2. LPD As ECBC
3. Chiller COP and controls as per ECBC
4. Other features remain same as in conventional case

Building Performance	
Cooling Demand	1770TR
Electric Load	3070 kW
Energy Performance Index	145 kWh/m2/year

WHAT IF THE MICROSOFT BUILDING HAD ONLY LOW ENERGY DESIGN FEATURES

1. Best Building Orientation
2. Wall and roof shaded
3. Other features remain same as in conventional case

Building Performance	
Cooling Demand	1880 TR
Electric Load	3910 kW
Energy Performance Index	173 kWh/m2/year

What if the building had both ECBC and Low Energy Features/

Building Design

1. Longer façade inclined to N_S
2. Wall and roof shaded
3. WWR 40%

Building Lighting System

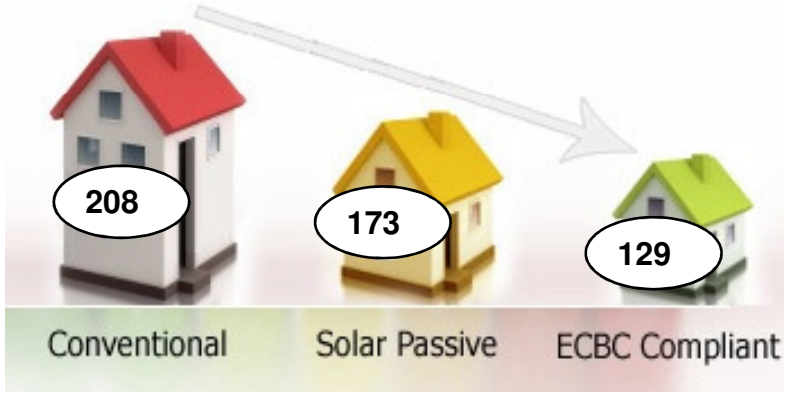
1. LPD 10.8 W/m2
2. Day and artificial light integration
3. Dimming Sensors and occupancy sensors
4. Visual Comfort-NBC2005

Building Envelope

1. Wall U value 0.44W/m2k
2. Roof U value 0.261W/m2k
3. Glass U Value 3.3W/m2k
4. Glass SHGC 0.20

Building HVAC

1. Centrifugal Chiller
2. COP 6.3
3. Variable Air Flow System
4. Variable frequency drives in pumps and AHU fans
5. Thermal Comfort –NBC 2005



Building Performance	
Cooling Demand	1560 TR
Electric Load	2760 kW
Energy Performance Index	129 kWh/m2/year