Roadmap for Energy Efficiency in Buildings

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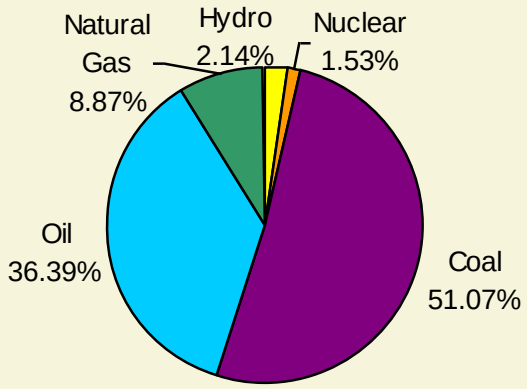
Energy Scenario in india

- Installed Capacity in India – Approx. 160,000 MW
- Projected Capacity in 2030 – 800,000 MW
  - 600 MW capacity addition each week for the next 20 years
- Capital Investment Needed – Approx. $1 trillion
- Capacity Added by China in last two years – 180,000 MW
  - More than total installed capacity in India
- Capacity Added by India in 10th Five Year Plan – 22,000 MW
  - Situation improving in 11th Five Year Plan but only marginally
- Consumption per Capita of 600 kWh in 2009
  - Assuming 25% T&D Loss
- US consumption per Capita is 13,000 kWh

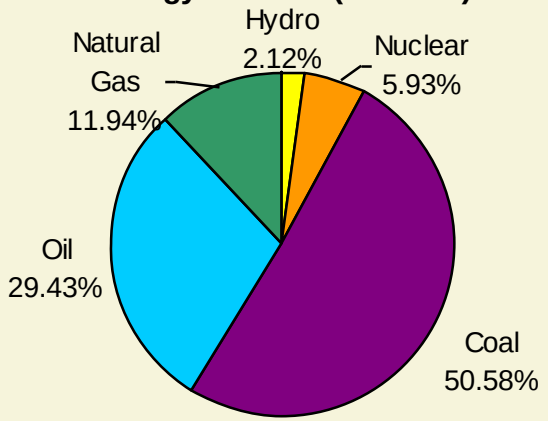
Indian Energy Sector

Total Primary Commercial Energy Demand (2003-04)



327 Mtoe

Total Primary Commercial Energy Demand (2031-32)



1858 Mtoe

Energy requirement to increase at a CAGR of 6.4% (2004-2032) and coal to remain the mainstay

Source: Planning Commission, 2006

Energy Efficiency Potential and Outcome

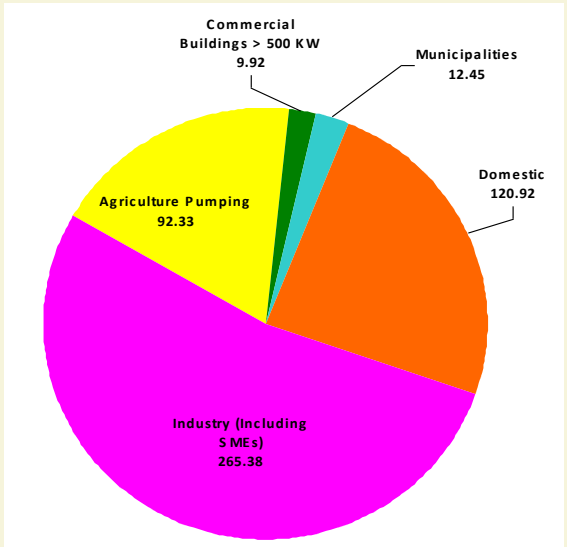
Energy Conservation potential assessed as at present (IEP) (15% by DSM and 25% overall)	-	**20000MW**
Verified Energy Savings :		
During X Plan period	-	**877 * MW**
During 2007-08 and 2008-09		**2127 MW**
Target for 2009-10		**2600 MW**
-Target for XI Plan period (5% reduction of energy consumption)	-	**10000 MW**

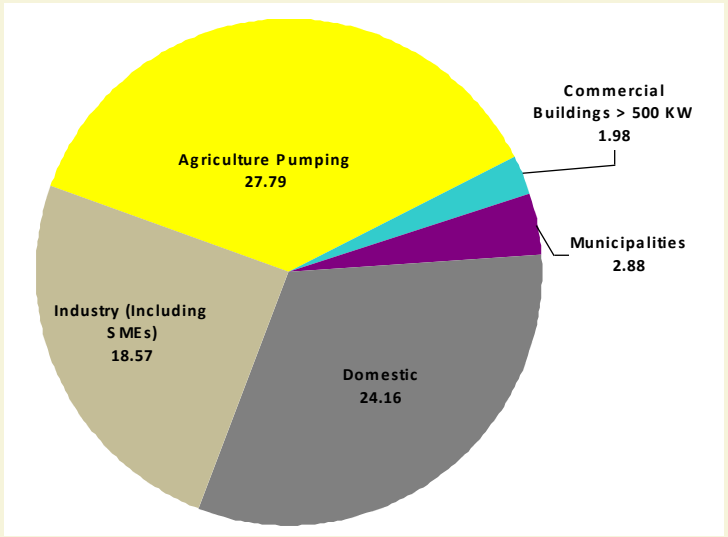
** Only as indicated by participating units in the National Energy Conservation award scheme, for the previous five years.*

Electrical Energy Consumption and Conservation Potential




S. No.	Sector	Consumption (KWh)	Saving Potential (KWh)	% Savings
1.	Agriculture Pumping	**92.33**	**27.79**	**30.09**
2.	Commercial Buildings/ Establishments with connected load > 500 KW	**9.92**	**1.98**	**19.95**
3.	Municipalities	**12.45**	**2.88**	**23.13**
4.	Domestic	**120.92**	**24.16**	**19.98**
5.	Industry (Including SMEs)	**265.38**	**18.57**	**6.99**
	Total	**501.00**	**75.36**	**15.04**





Source: BEE/ NPC Study 2009

Growth Profile of Indian Commercial Sector




- Demand for OFFICE SPACE in India is driven by the increasing share of the services sector in the Indian economy
  - Office space supply shifting from Central Business Districts to secondary centers (office and IT parks)
  - Modern office buildings in newly developed areas enable the higher quality standards that are essential for IT services
  - All India office market
    - 70% by IT Services companies (more than 7000 No.) in India
    - 15% by financial service providers & pharmaceutical sector
    - 15% by other sectors
    - Office stock must increase nearly 20 million sf/year in New Delhi, Mumbai, Bangalore to keep pace with growing demand
    - Conservative estimate (for India): Approx. 55 million sf/year
- SHOPPING CENTRES/MALLS
  - By the end of 2008, space of 79 million sf in 257 centers are estimated in 15 largest cities of India

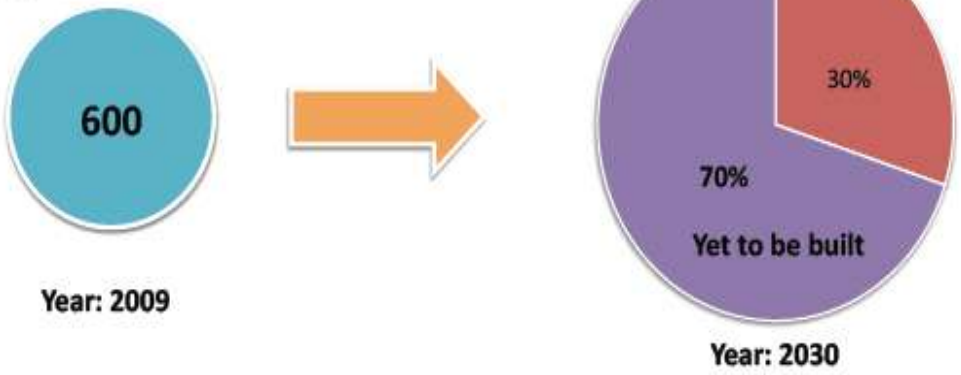
ENERGY IS LIFE

BEE

CONSERVE IT

Growth of Building Sector : Case for Energy Code

- Commercial Buildings Growth Forecast
- Currently, 600 million m^2 (USAID ECO-III Internal Estimate Using CEA and Benchmarked Energy Use data, LBNL, McKinsey)
- In 2030, 2,300 million m^2 (estimated)
  - 70% building stock is yet to be constructed
- Opportunity for the government - 50% of the new construction in the public sector



Typical Building Energy Use

Average Energy Consumption

HVAC	55%
LIGHTING	14%
Electronics	27 %
Others	4%

Standard Setting Bodies

- Bureau of Energy Efficiency, Ministry of Power
  - ECBC, Standards and Labeling Program for Appliances
- Bureau of Indian Standards
  - NBC,
  - Standards for equipment and appliances
- International Code Council
  - Model Energy Code (Residential and Commercial)
- International Standards Organization (ISO)
- Illuminating Engineers Society of North America
  - Lighting Standards
- ASHRAE
  - Commercial and Residential Building Energy Standards
  - Standards on Ventilation Rate
  - Thermal Environmental Conditions for Human Occupancy
  - Data Centers and Clean Rooms
- American Refrigeration Institute (ARI)
  - HVAC Equipment Standards (Chillers, RTU, etc.)
- American Society of Mechanical Engineers
  - Boiler standards
- American Society for Testing and Materials
  - Properties of Materials (e.g. thermal insulation, etc.)

Role and Implications of Codes and Standards

CODES

- National Building Code
- Energy Conservation Building Code
- International Energy Conservation Code
- California Title 24

STANDARDS

- BIS Standards
- ISO Standards
- ASHRAE Standards
- ASME Standards

» Ensures Minimum Performance (not best practice)

» Can be used as a baseline document

» Harmonization of Code

» Remove ambiguity/inconsistency to assist in code compliance

» Code is NOT a Design Guide

» Code compliance is an ongoing exercise

- Education and Awareness is key
- Incentives and Fines have also been effectively used

Protocol and Voluntary Guideline Setting Bodies




- US Green Building Council
  - LEED-NC, LEED-EB, etc.
- India Green Building Council
  - LEED-NC (India), LEED-EB, etc.
- Ministry of New and Renewable Energy (MNRE)
  - GRIHA (Maintained by TERI)
- Energy Star (Environmental Protection Agency and DOE)
  - Efficiency Levels of Equipment and Appliances
  - Existing Buildings
  - Benchmarking Framework (uses Commercial Buildings Energy Consumption Survey CBECS)
- Efficiency Valuation Organization
  - International Performance Measurement and Verification Protocol

Inter-linking Standards and Guidelines

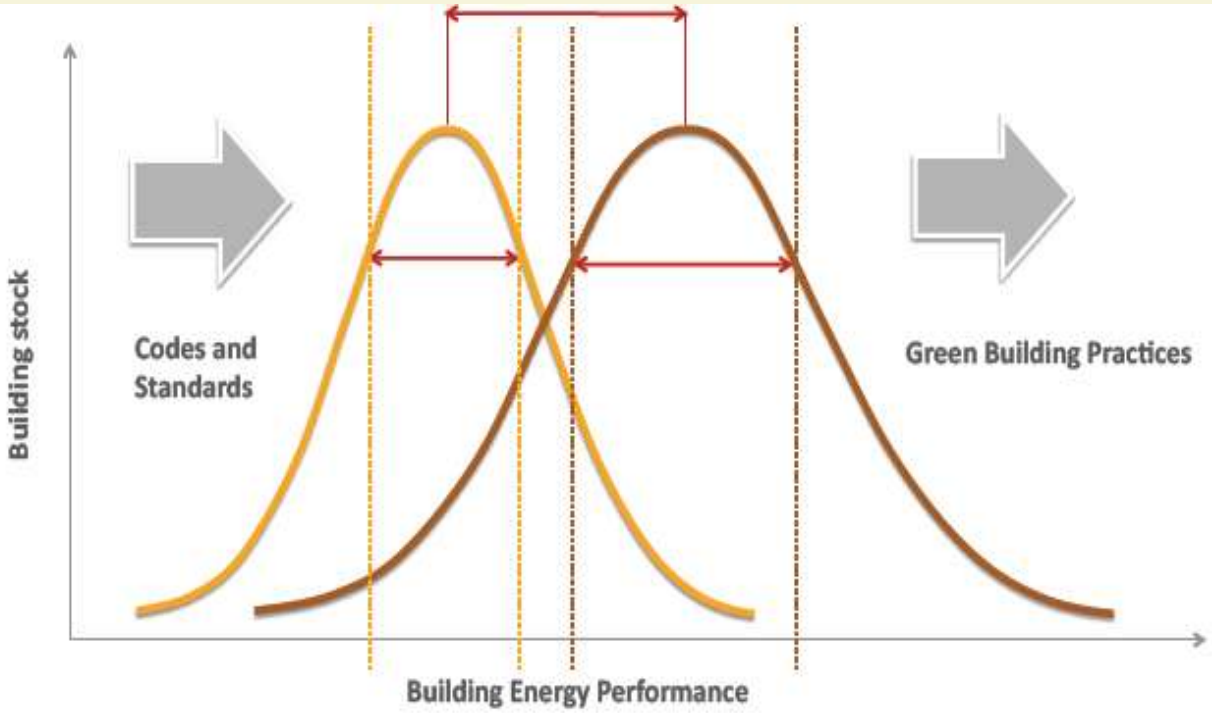
LEED-NC	LEED-EB	ECBC
• ASHRAE 90.1 • ASHRAE 62 • ASHRAE 55 • IPMVP	• Energy Star • CBECS • IPMVP • Indian Benchmarked Data Missing	• BIS • NBC • ISO 15099 • ARI • ASHRAE • Compliance Specs missing

Inter-linking Standards and Guidelines




Program	Organization	Compliance Required	Building Type	Building Covered	Scope	Linkage to ECBC
ECBC	Ministry of Power/BEE	Voluntary	Commercial/ Residential	Connected Load>= 500kW Contract Demand >= 600kVA	Energy Efficiency	NA
LEED-NC	Indian Green Business Center	Voluntary	Commercial/ Institutional	-	Sustainable design/green building	Refers to ECBC for energy efficiency credits
GRIHA	MNRE	Voluntary	Residential/ Commercial/ Institutional	-	Sustainable design/green building	Refers to ECBC for energy efficiency credits
Environmental Clearance	Ministry of Environment & Forests	Mandatory	Commercial/ Residential	Built-up area 20,000 to 150,000 m^2	Environmental Impact	Refers to ECBC

Role and Effectiveness of Codes & Standards



Codes and standards are effective tools for "pushing up the low end" of design and construction practice; they are most effective when accompanied by programs that demonstrate more efficient construction practice.

Role and Effectiveness of Codes & Standards

Prescriptive Standards

- checklists of minimum standards for particular measures
- easier to develop and enforce
- may stifle innovation and circumvent cost-effective ways of achieving performance objectives

Performance Standards

- establish overall energy efficiency targets on a whole-system basis
- more difficult to enforce

» Standards must be supported by education and outreach programs if they are to be widely understood and applied.

» Codes and standards that are not frequently updated may reinforce obsolete rules of thumb based on outdated assumptions about energy prices and technology.

Energy Conservation Building Code (ECBC)

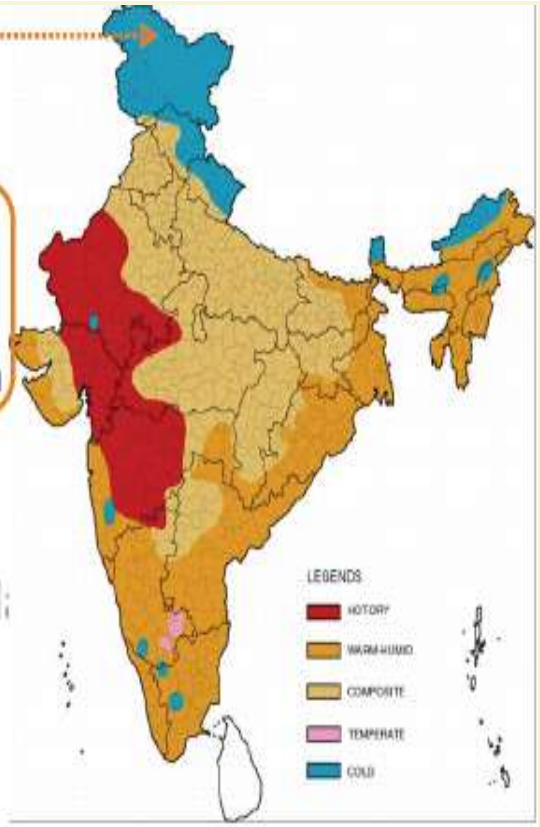
» Covers new commercial buildings

» Building components included

- **Building Envelope (Walls, Roofs, Windows)**
- Lighting (Indoor and Outdoor)
- Heating Ventilation and Air Conditioning (HVAC) System
- Solar Water Heating and Pumping
- Electrical Systems (Power Factor, Transformers)

» Potential to save 1.7 billion units annually on mand

» Expected reduction in XI plan 500 MW



Energy Conservation Building Code

- ECBC covering the following components prepared:
  - Building Envelope (Walls, Roofs, Windows)
  - Lighting (Indoor and Outdoor)
  - Heating Ventilation and Air Conditioning (HVAC) System
  - Solar Hot Water Heating
  - Electrical Systems
- ECBC finalized after extensive consultation
- Voluntary introduction of ECBC in May 2007; mandatory after capacity building and implementation experience
- Impact of ECBC - Reduced Energy Use for buildings
  - National Benchmark ~ 180 kWh/m^2/year
  - ECBC Compliant building ~ 110 kWh/m^2/year

Road to ECBC Implementation

- Introduction of ECBC in the existing municipal bye-laws in the States
- Strengthening or restructuring of existing organizational set up in municipalities/urban local bodies in the States
- Development of compliance tools to facilitate enforcement and monitoring of ECBC implementation by the concerned agencies
- Capacity building of building designers on ECBC, energy simulation programs, energy efficient construction practices, etc.
- Promoting availability and usage of energy efficient building equipment and systems (glazing, windows, roof and wall insulation products, efficient HVAC and lighting systems and controls, etc.)
- Introduction of a carrot and stick approach
  - suitable fiscal incentives to promote ECBC compliance and market transformation
  - Stiff penalty and fine for non-compliance

ONGOING INITIATIVES ON ECBC

- **CAPACITY BUILDING / TRAINING**
- 25 training programmes/ workshops involving about 1500 professionals have been conducted till date
- **PANEL OF ECBC EXPERT ARCHITECTS**
- Support to Government Agencies for ECBC like MH&FW, NPTC and Haryana
- **Baseline survey of Government buildings**
- Survey completed in 27 States and 712 Government Buildings. Wide Variation on the energy use found 50-700 units /sq.mt/Year .
- A potential saving of energy in Government buildings of around 1.2 billion units annually resulting in avoided capacity of 137 MW.

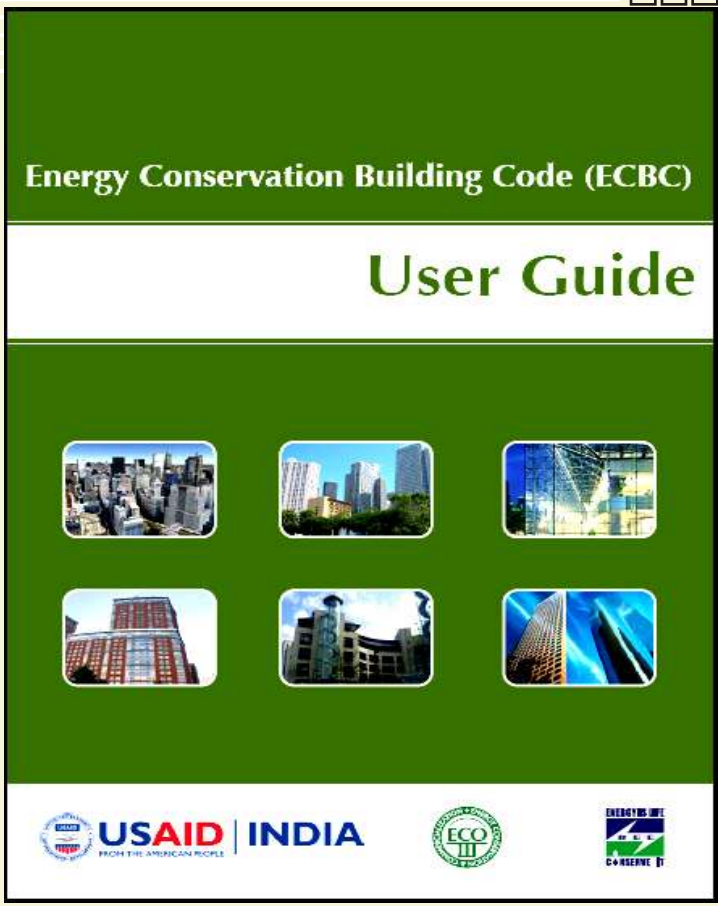
ONGOING INITIATIVES IN ECBC

- **DEVELOPMENT OF TECHNICAL REFERENCE MATERIAL**
- Tip sheets on envelope design, lighting, HVAC and energy simulation have been developed
- **CURRICULUM DEVELOPMENT**
- 20 architectural/ engineering colleges have committed to develop architectural and engineering courses for energy efficient and sustainable building design.
- **ECBC PROGRAMME COMMITTEE**
- To facilitate development of ECBC complaint building design
- Credible implementation of few demonstration project
- Setting up compliance and evaluation procedures by creating appropriate institutional mechanism .

ECBC User Guide

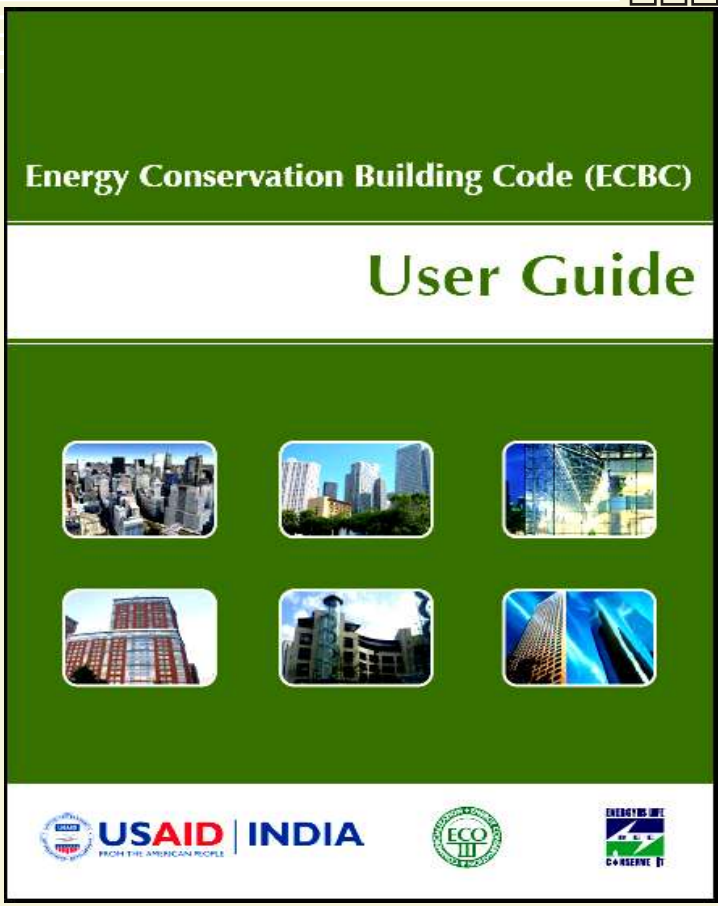



- Contains information related to
  - Purpose
  - Scope
  - Administration and enforcement
  - Building envelope
  - Heating, ventilation, & air conditioning
  - Service water heating & pumping
  - Lighting
  - Electrical power
  - Appendixes
    - A: ECBC definitions, abbreviations, and acronyms
    - B: whole building performance method
    - C: climate zone map of India
    - D: Supplemental material
    - E: Comparison of international building energy standards
    - F: References
    - G: ECBC compliance forms



ECBC User Guide

- Administrative Guidance
- Technical Guidance
- Compliance/ Checklist
- Case Studies/Examples
- References



Why is User Guide Important?

- ECBC Compliance & Implementation
  - Prescriptive option
  - Tradeoff option
  - Whole building performance option
- Fills essential gaps in ECBC (revised version - 2008)

Why is User Guide Important?

Building System

- Envelope
- HVAC
- Lighting
- Electric Eqpt & Systems
- Service Hot Water and Pumping

Mandatory Provisions (required for most compliance options)

Compliance Options

- Prescriptive Option
- Trade Off Option
- Whole Building Performance

Energy Code Compliance

ECBC – Tasks ahead




- **Promotion of ECBC**
- Conducting atleast 5 workshops in each climatic zones
- Workshop with manufacturers
- **Prototype buildings**
- ECBC architects to come up with design prototyes for various building types, climatic zones etc.
- **Amendment of Building By-laws**
- Review of state by laws by ECBC expert architects for incorporating ECBC provisions
- **Capacity building**
- Broaden the existing database of existing ECBC expert architects
- **Situation Analysis of ECBC compliant buildings**
- Database of ECBC compliant buildings in India

ECBC – Tasks ahead




- **Compliance tools**

Developing compliance procedures based on:

- i) Component based (prescriptive)
- ii) System- based approach
- iii) Whole building approach
- **Compliance Test procedures**

set up a mechanism for check testing of compliance for ECBC compliant buildings at various stages:

- Design Stage
- Construction Stage
- Completion Stage

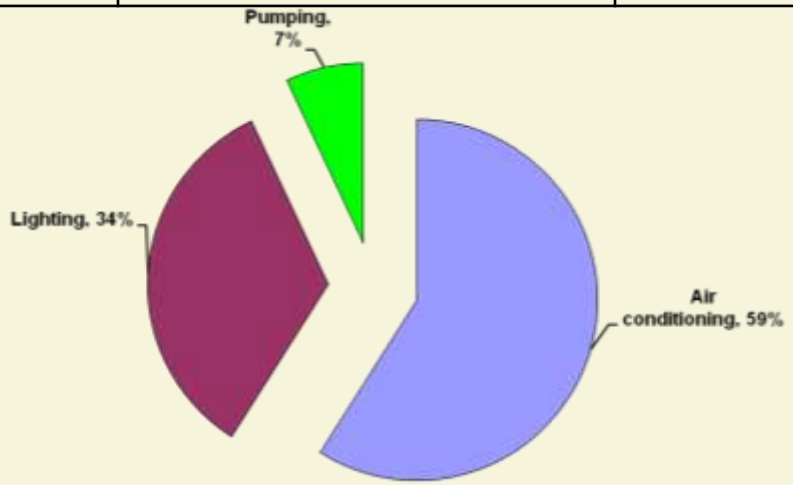
Energy Efficiency in Existing Buildings/ facilities

- There is vast scope for energy efficiency improvement in buildings/ existing facilities.
- Energy Audit Studies have revealed a savings potential to the extent of 40% in end use such as lighting, cooling, ventilation, refrigeration etc.
- Audits identify the Energy baselines in existing facilities along with Energy Efficiency Measures.

Energy Efficiency Improvements at Rashtrapathi Bhawan

EEMs at Rashtrapati Bhawan

Energy Saving Measure	Electricity savings (kWh/ year)	Savings in lakh Rupees per year
Air conditioning	5,54,266	35.3
Lighting	3,25,028	20.7
Pumping	54,140	3.45
Total	9,33,434	59.45



ONGOING INITIATIVES

- An exercise for expanding the number of existing ESCOs through an open invitation and evaluation process was taken up by BEE.
- In order to create a sense of credibility amongst the prospective agencies that are likely to secure the services of an ESCO as well as the financial institutions, a process of rating ESCOs was taken up through CRISIL and ICRA.
- Rating was carried out in terms of success in implementation of energy efficiency projects based on performance contracting, availability of technical manpower, financial strength, etc.
- 80 ESCOs empanelled with BEE after accreditation by CRISIL/ ICRA. 50 of the 80 accredited ESCOs are at levels 1 to 3 (Above Average)

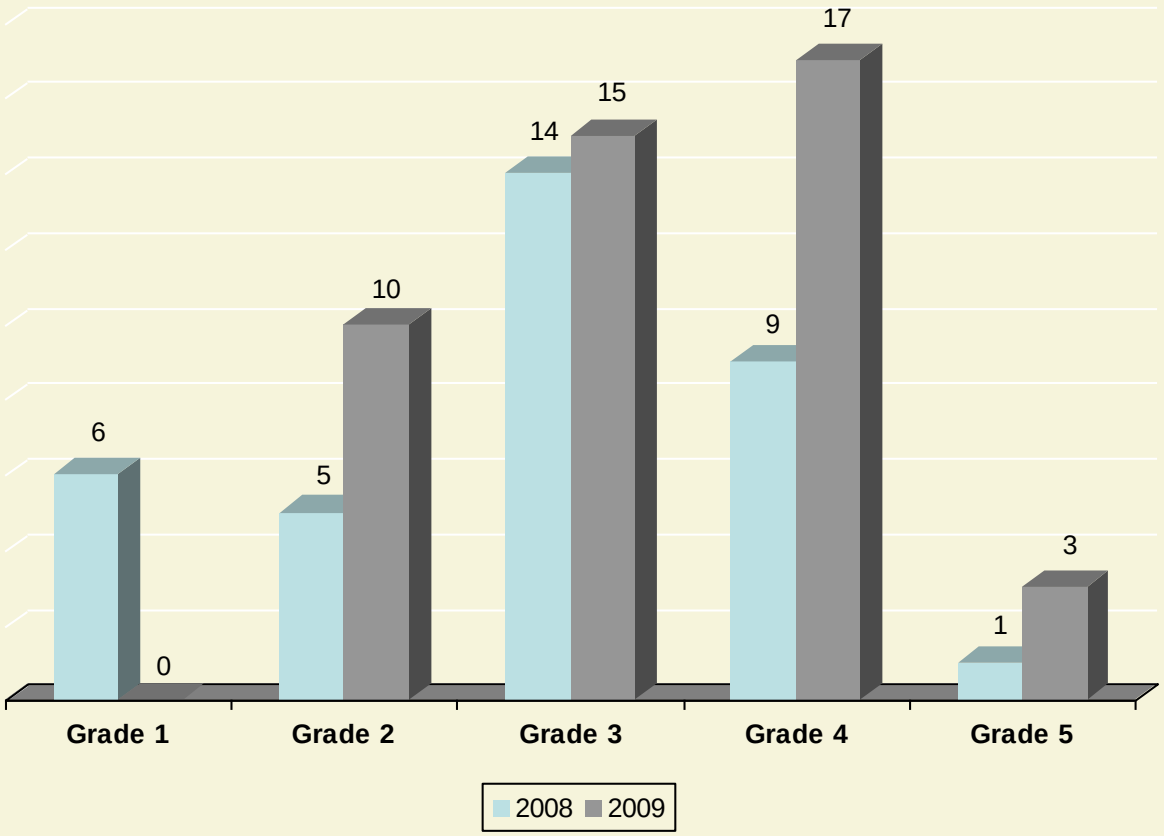
Grading Scale

ICRA / CRISIL-BEE Grading	Definition	Score
GRADE 1	Very High	85 and above
GRADE 2	High	70-84
GRADE 3	Good	55-69
GRADE 4	Below Average	40-54
GRADE 5	Poor	0-39

ESCO Grading Distribution




55 per cent of the graded entities have above average execution capability in 2009 against 70 per cent in 2008.



STAR RATING FOR OFFICE BUILDINGS

- Large potential for energy savings both in government and commercial office buildings.
- The regulation, promotion and facilitation of energy efficiency in commercial buildings is one of the key thrust areas of BEE.
- Energy Conservation Building Code (ECBC)

• specifies standards for new, large, energy -efficient commercial buildings.

- Energy Service Companies (ESCOs)

• upgrade the energy efficiency of existing government buildings through retrofitting on performance contracting mode.

SCHEME FOR RATING OF BUILDINGS

- The Star Rating Program for buildings is based on actual performance of the building in terms of specific energy usage (kWh/sq m/year).
- This programme would rate office buildings on a 1-5 Star scale with 5 Star labeled buildings being the most efficient.
- Five categories of buildings - office buildings, hotels, hospitals, retail malls, and IT Parks in five climate zones in the country have been identified.
- Office buildings in the following 3 climatic zones for air-conditioned and non- air-conditioned:
  - Warm and Humid
  - Composite
  - Hot and Dry
- It will be subsequently extended to other climatic zones and building types.

BANDWIDTHS- LESS THAN 50% AIR CONDITIONING




Composite

EPI(Kwh/sqm/year)	Star Label
80-70	1 Star
70-60	2 Star
60-50	3 Star
50-40	4 Star
Below 40	5 Star

Warm and Humid

EPI(Kwh/sqm/year)	Star Label
85-75	1 Star
75-65	2 Star
65-55	3 Star
55-45	4 Star
Below 45	5 Star

Hot and Dry

EPI(Kwh/sqm/year)	Star Label
75-65	1 Star
65-55	2 Star
55-45	3 Star
45-35	4 Star
Below 35	5 Star

BANDWIDTHS- MORE THAN 50% AIR CONDITIONING




Composite

EPI(Kwh/sqm/year)	Star Label
190-165	1 Star
165-140	2 Star
140-115	3 Star
115-90	4 Star
Below 90	5 Star

Warm and Humid

EPI(Kwh/sqm/year)	Star Label
200-175	1 Star
175-150	2 Star
150-125	3 Star
125-100	4 Star
Below 100	5 Star

Hot and Dry

EPI(Kwh/sqm/year)	Star Label
180-155	1 Star
155-130	2 Star
130-105	3 Star
105-80	4 Star
Below 80	5 Star

Bandwidths for the BPOs




- BPOs, which primarily focus on providing service to IT related activities such as application management and application development, date centre operations or testing and quality assurance.
- BPOs may have varied hours of operation e.g. 24x7/ 24x5, 18x7, 16x7 or 16x5 etc.
- Those BPOs having a connected load of 100 kW and above and a minimum built up area of 500 Sq m would be considered for BEE star rating scheme
- Average Annual Hourly Energy Performance Index (EPI) i.e. **(AAhEPI) in (Wh/hr/sqm/)** will be considered for rating the BPO.
- This programme targets BPOs located within the following 4 climatic zones ie (Warm and Humid, Composite, Hot and Dry, Temperate)

Bandwidths for the BPOs




Climatic Zone - Composite

Average Annual hourly EPI AAhEPI (Wh/hr/Sqm)	Star Rating
45-40	1 Star
40-35	2 Star
35-30	3 Star
30-25	4 Star
Below 25	5 Star

Climatic Zone - Warm and Humid

Average Annual hourly EPI AAhEPI (Wh/hr/Sqm)	Star Rating
50-45	1 Star
45-40	2 Star
40-35	3 Star
35-30	4 Star
Below 30	5 Star

Climatic Zone - Hot and Dry

Average Annual hourly EPI AAhEPI (Wh/hr/Sqm)	Star Rating
35-30	1 Star
30-25	2 Star
25-20	3 Star
20-15	4 Star
Below 15	5 Star

Climatic Zone - Temperate

Average Annual hourly EPI AAhEPI (Wh/hr/Sqm)	Star Rating
40-35	1 Star
35-30	2 Star
30-25	3 Star
25-20	4 Star
Below 20	5 Star

Present status of the Scheme & Future Initiatives




- **158** applications have been received under day use office building category.
- **92 Buildings** have been found eligible for issue of a star Label under this scheme till date . (RBI, SBI, ADB ,CPWD, Railways, kalpataru)
- **22** applications have been received under BPO category, out of which 12 BPO buildings found eligible.
- Bandwidths for IT buildings , Hospitals , Hotels and Shopping Malls under development .

Summary

- Building Energy Code is the MOST EFEECTIVE POLICY tool in India
  - Especially important because of expected growth in new construction
- Codes and standards development is very expensive and time consuming
  - Build on existing code and standards
  - Adapt/modify international code and standards where possible (do not go by rhetoric)
    - Lot to learn from the experiences of other countries
- Ensuring code compliance can be even more expensive and difficult
  - Develop tools and supporting documents (specs to help in proper installation at site, etc.)
  - Education and awareness should be combined with inspection and fine for improved enforcement (based on other countries experience)
- Standards are becoming stricter everywhere; enforcement is getting stronger
- Use codes to strongly discourage poor design
  - 100% glazed façade without high performance glazing in hot climate
- Significant potential for further improvement
  - Less than an optimal cost-benefit ratio in standards
  - Enforcement can always be improved

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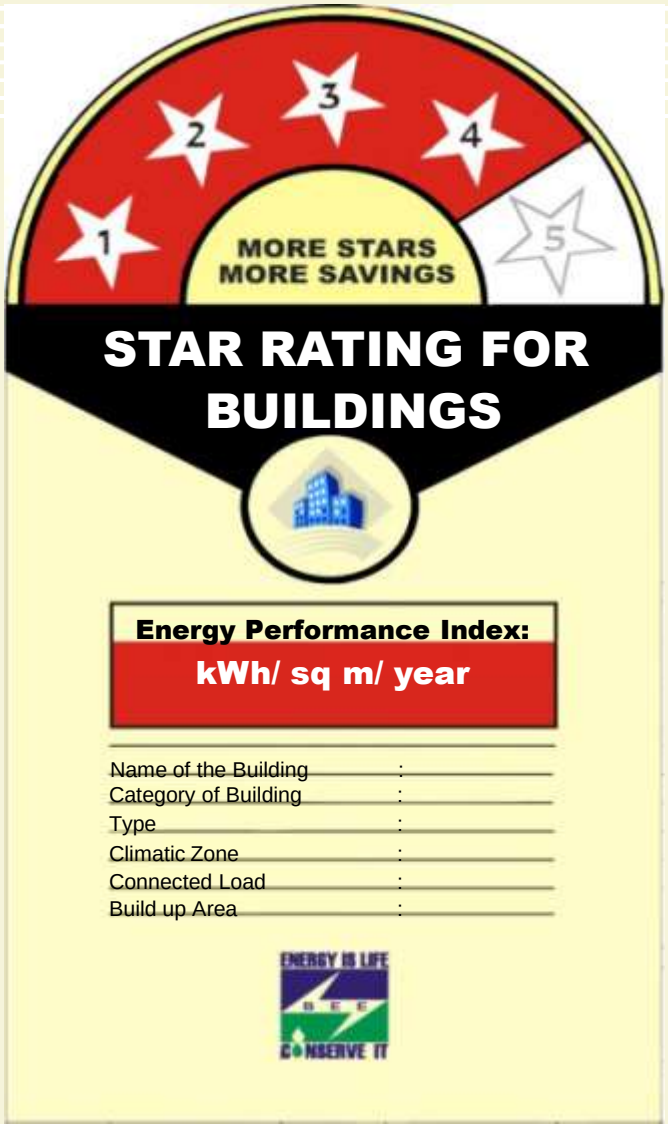
1
2
3
4
5
MORE STARS
MORE SAVINGS
STAR RATING FOR BUILDINGS
Energy Performance Index:
kWh/ sq m/ year
Name of the Building :
Category of Building :
Type :
Climatic Zone :
Connected Load :
Build up Area :

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