Improving Building Sector Energy Efficiency in India: Strategies and Initiatives

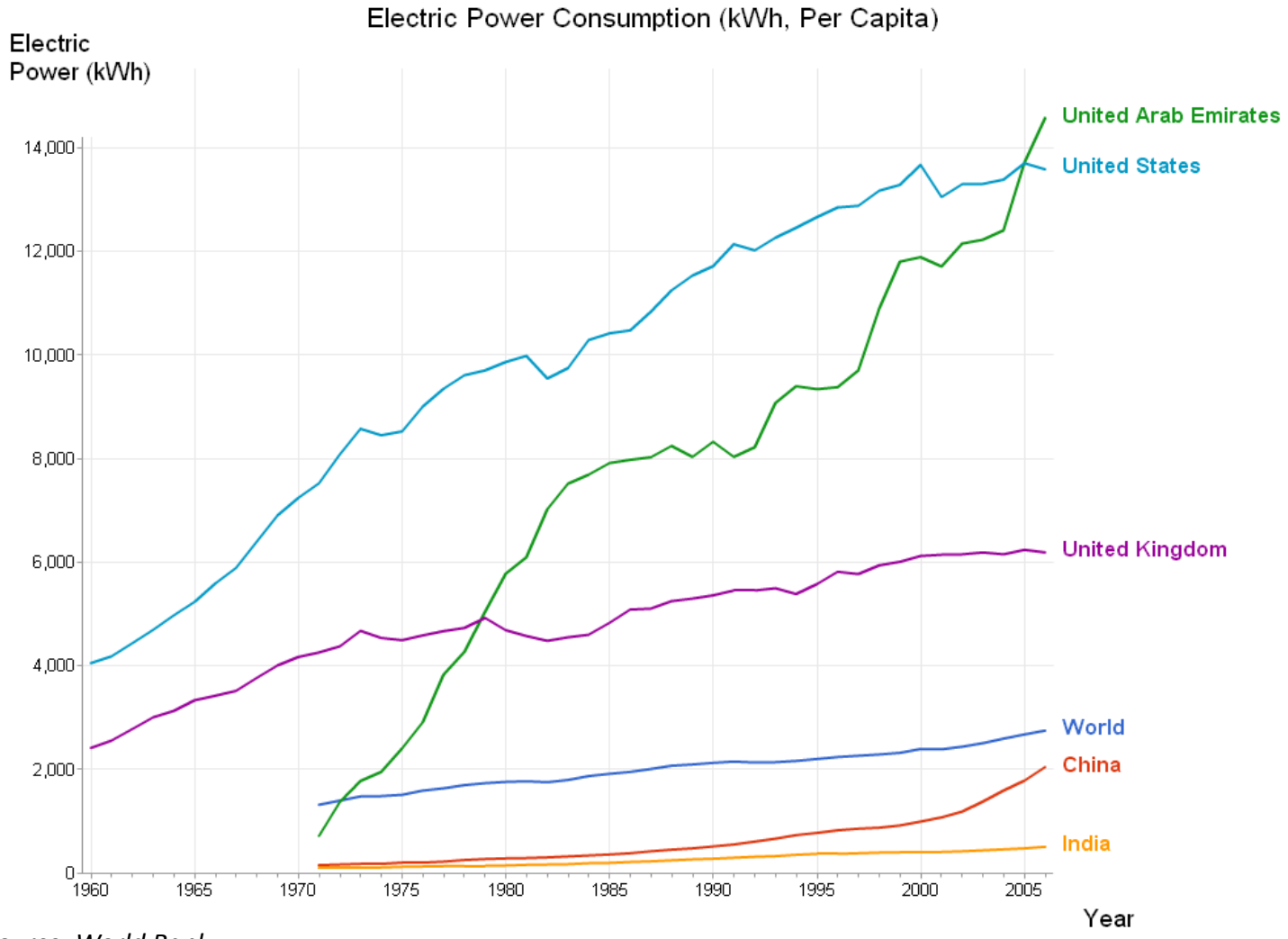
Satish Kumar, Ph.D.
Chief of Party, USAID ECO-III Project
International Resources Group

TOT Workshop, Infosys Mysore Campus
2nd August, 2010

Presentation Outline

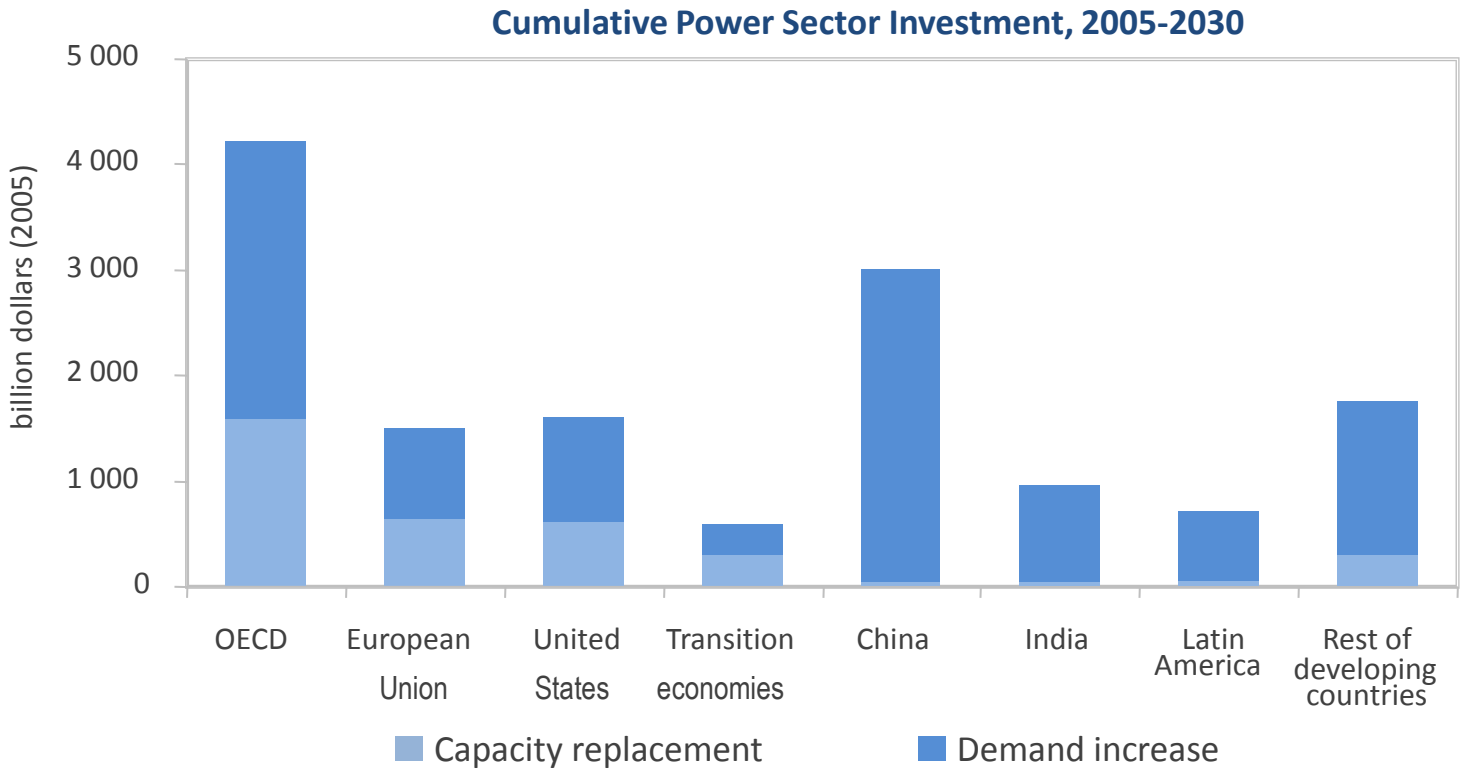
- Electricity Scenario – Macro Situation
- Why Buildings?
- India's Building Sector
- Current Programs and Policies
- ECO-III Activities and Contributions
- Path Forward

World Energy Scenario



Source: World Bank

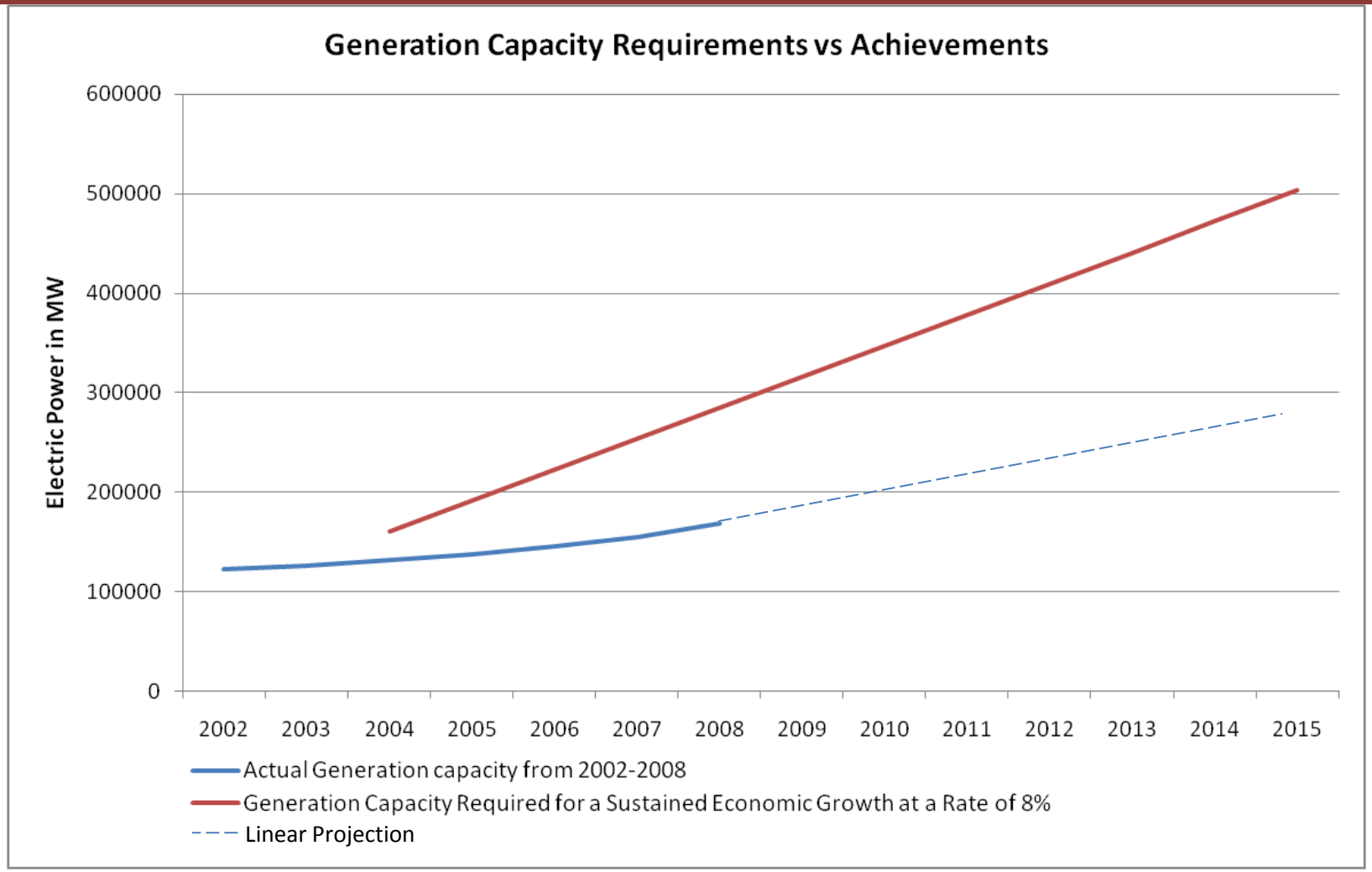
World Energy Scenario



The largest investments are needed in developing countries – especially countries like China and India – mostly to meet surging demand

Source: International Energy Agency (IEA), International Energy Annual 2006 (June-December 2008)

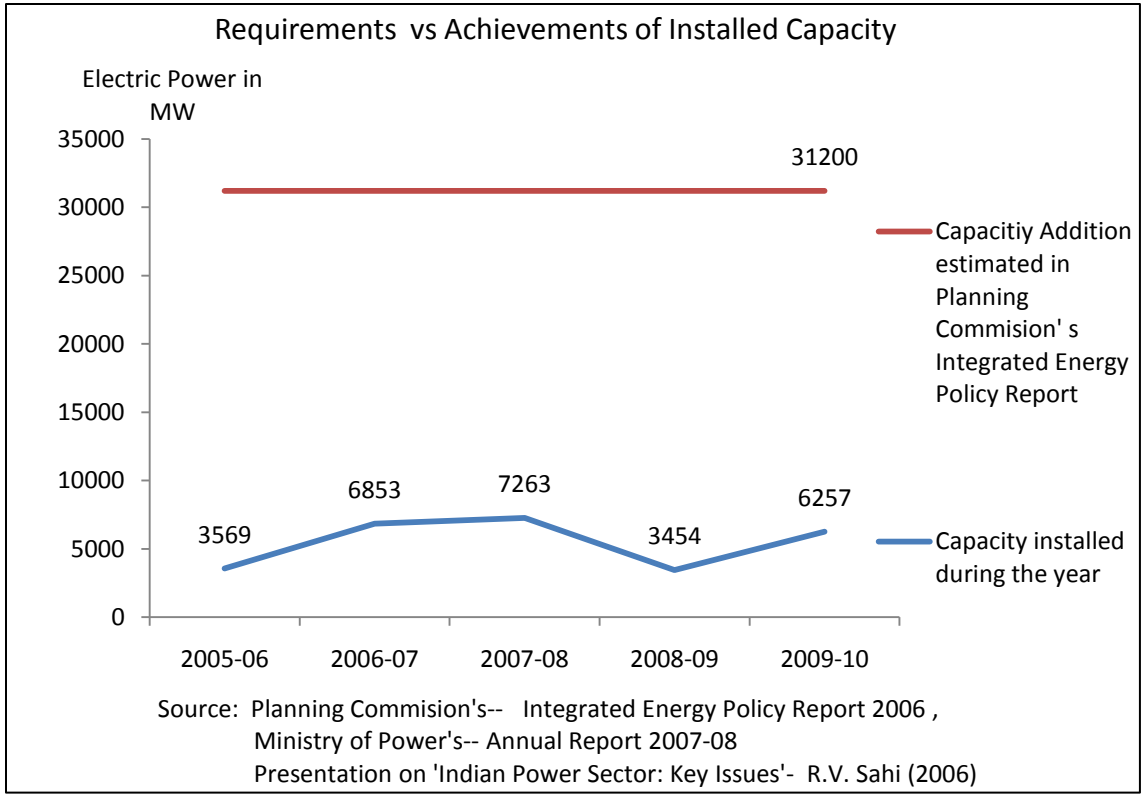
Energy Scenario in India



Source: Central Electricity Authority General Review 2006 & 2009 and Planning Commission's Integrated Energy Policy Report 2006

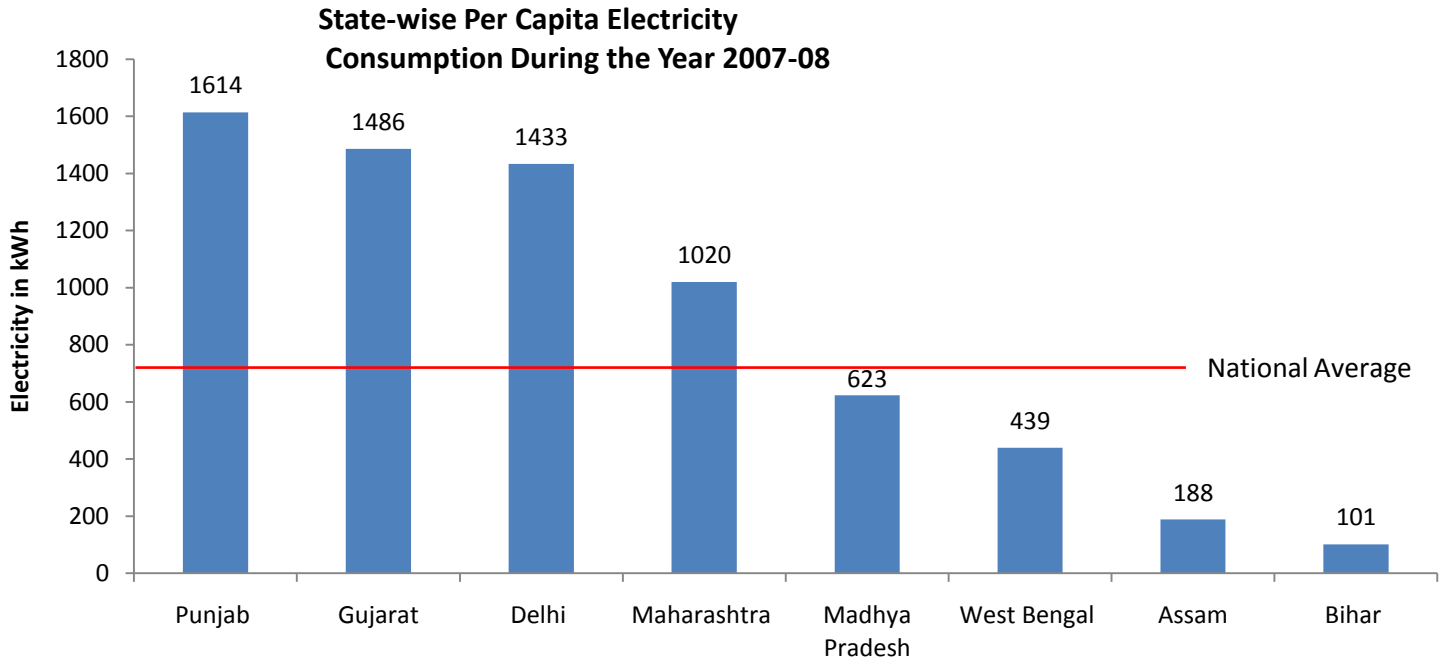
Energy Scenario in India

- Installed Capacity in India – Approx. 160,000 MW
- Projected Capacity in 2030 – 800,000 MW
  - 600 MW capacity addition each week
- Continued deficit supply in 2007-08 (MOP)
  - Peak power deficit of 16.6%
  - Energy Deficit of 9.9%
- Capacity Added by China in last two years – 180,000 MW



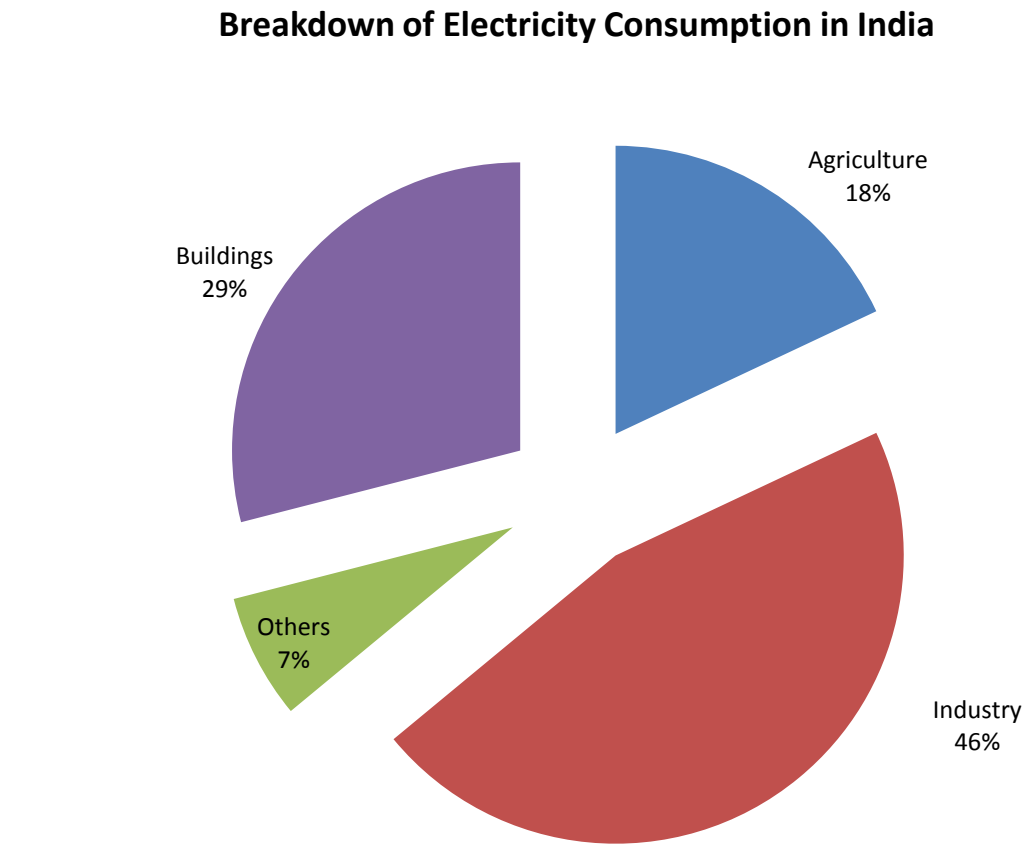
Source: Planning Commision's-- Integrated Energy Policy Report 2006 ,
Ministry of Power's-- Annual Report 2007-08
Presentation on 'Indian Power Sector: Key Issues'- R.V. Sahi (2006)

Electricity Scenario in India



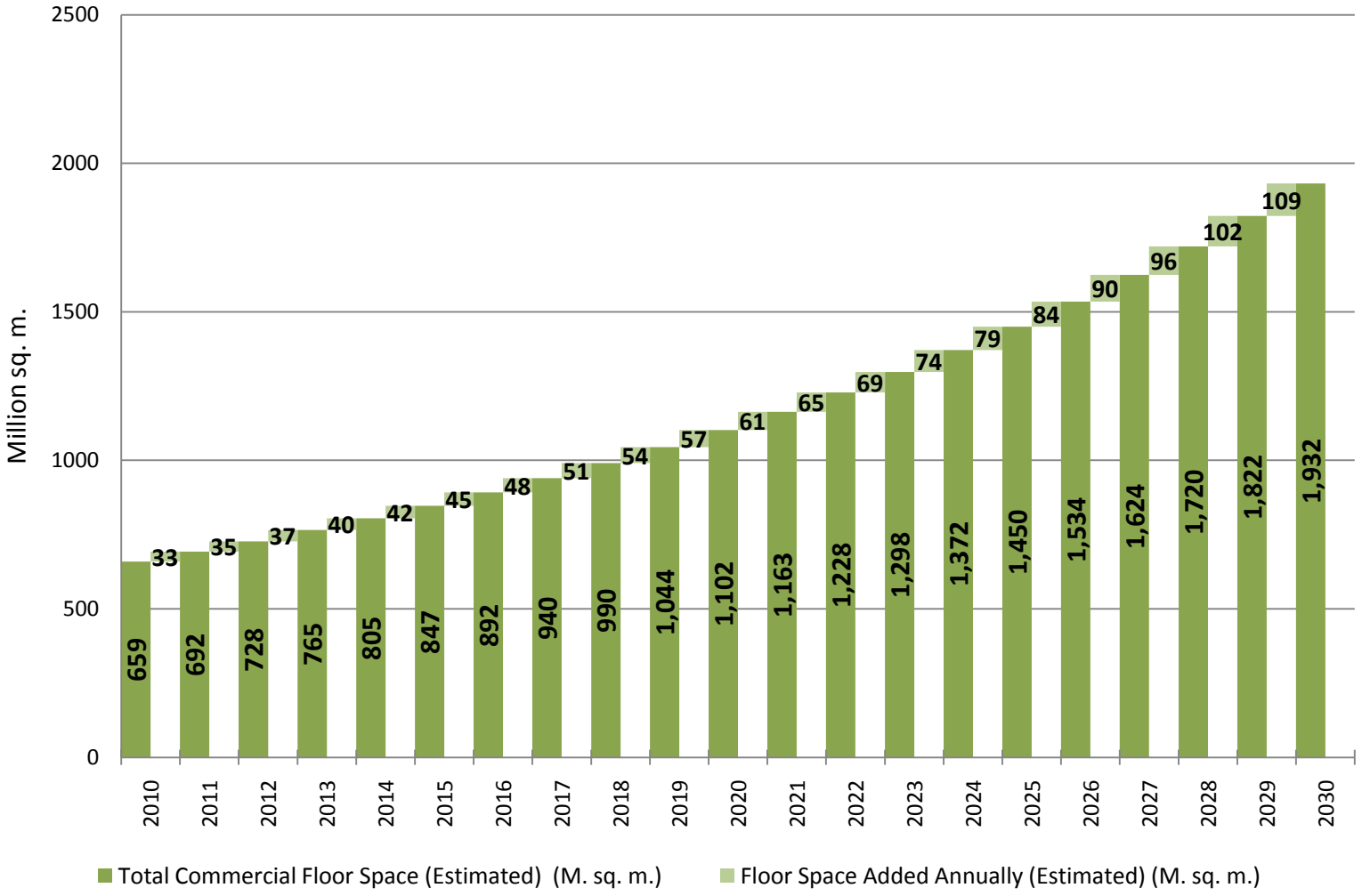
Source: Central Electricity Authority's 'Year End Review 2007-08'

Why Buildings?



Source: CEA 2009

Commercial Floor Space Projection for India



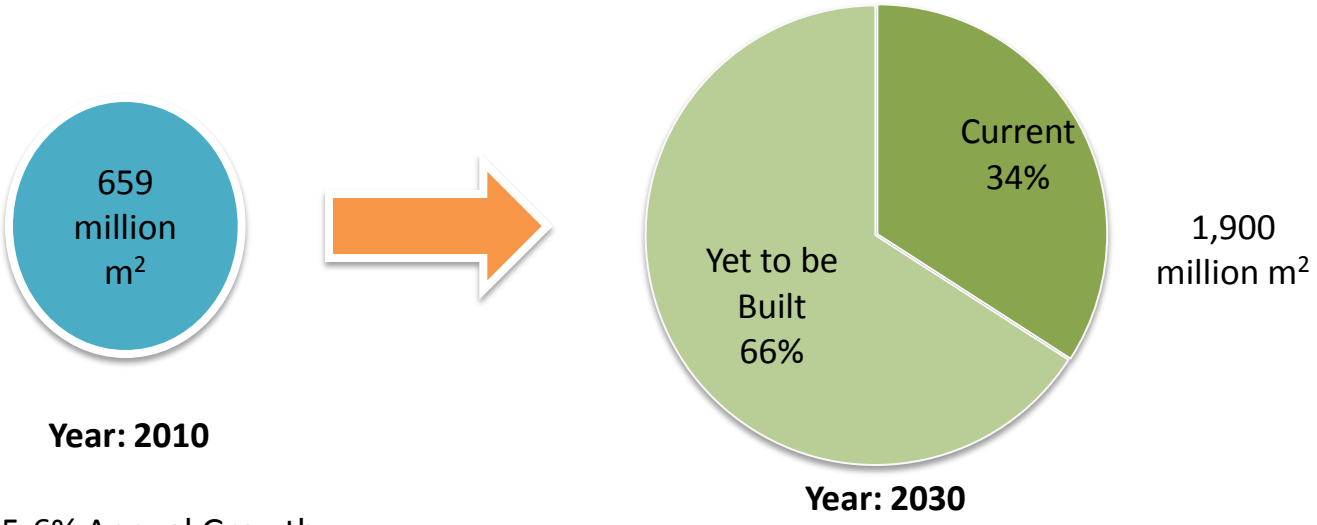
Source: USAID ECO- III Project

* Assuming 5-6% Annual Growth

Growth in the Indian Building Sector

Commercial Buildings Growth Forecast

- Currently, ~ 659 million m^2 (USAID ECO-III Internal Estimate Using MOSPI, CEA and Benchmarked Energy Use data)
- In 2030,~ 1,900 million m^2 (estimated) *
  - 66% building stock is yet to be constructed

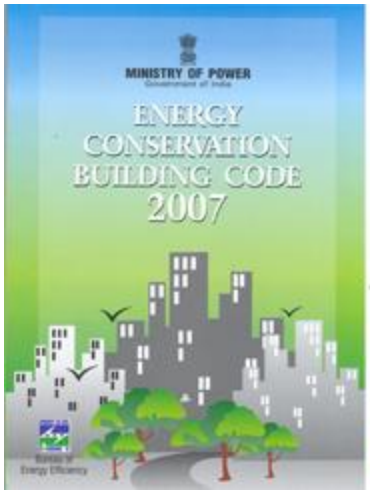


* Assuming 5-6% Annual Growth

Source: USAID ECO- III Project

Energy Conservation Building Code (ECBC)

- Covers new buildings and ensures minimum energy performance requirements
- ECBC launched by Govt. of India on 27th May,2007
- 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)



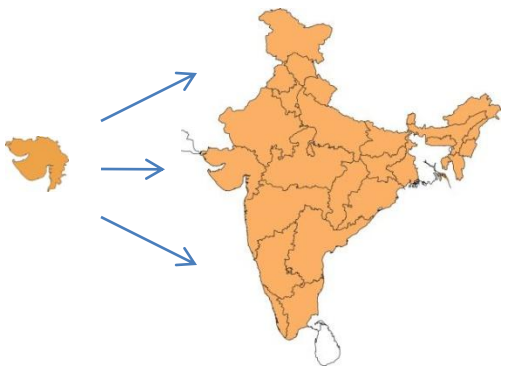
Energy Conservation Building Codes (ECBC)

Energy Conservation Building Code Implementation

Moving From Technical Content Development and Capacity Building to Implementation

ECBC Implementation Roadmap

- Framework to test ECBC implementation in one state
- Replicate the model



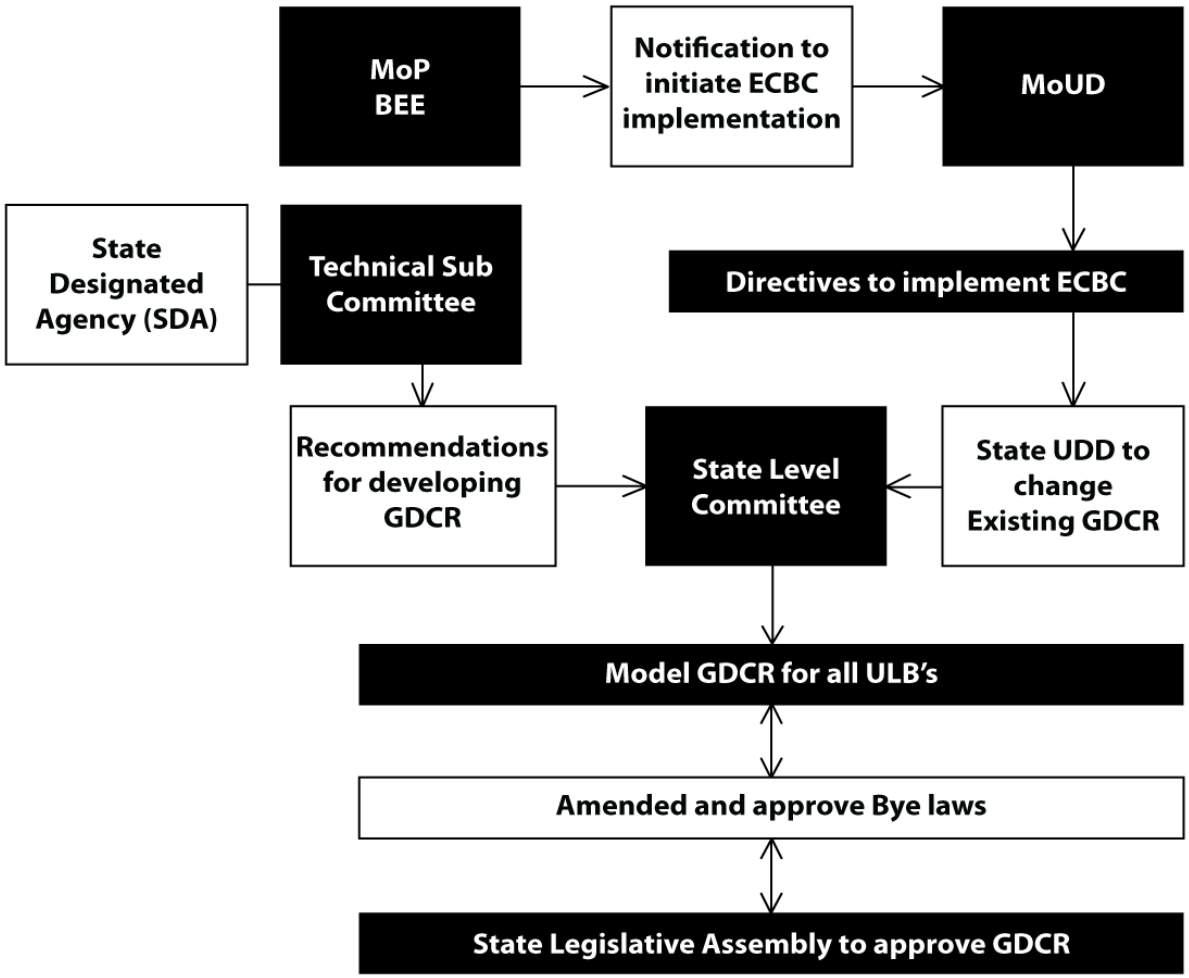
ECBC Compliance Check Tools

- ECONirman to check perspective and trade-off compliance

Certified Building Energy Professionals

- Introduce rigor through a BEE-Certified program
- Fully conversant with ECBC clauses and specifications
  - Basic understanding of building physics
- Training and certification for ECBC Evaluators/Code Compliance officials

ECBC Implementation Framework – Central and State Govt. Level



Legend:

1. Notification to initiate ECBC implementation in the states
2. Directives to start ECBC implementation process
3. Existing General Development Control Regulation (GDCR) Document
4. Administrative Inputs
5. Technical Inputs
6. Recommendations for developing Model GDCR
7. Model GDCR for all ULBs

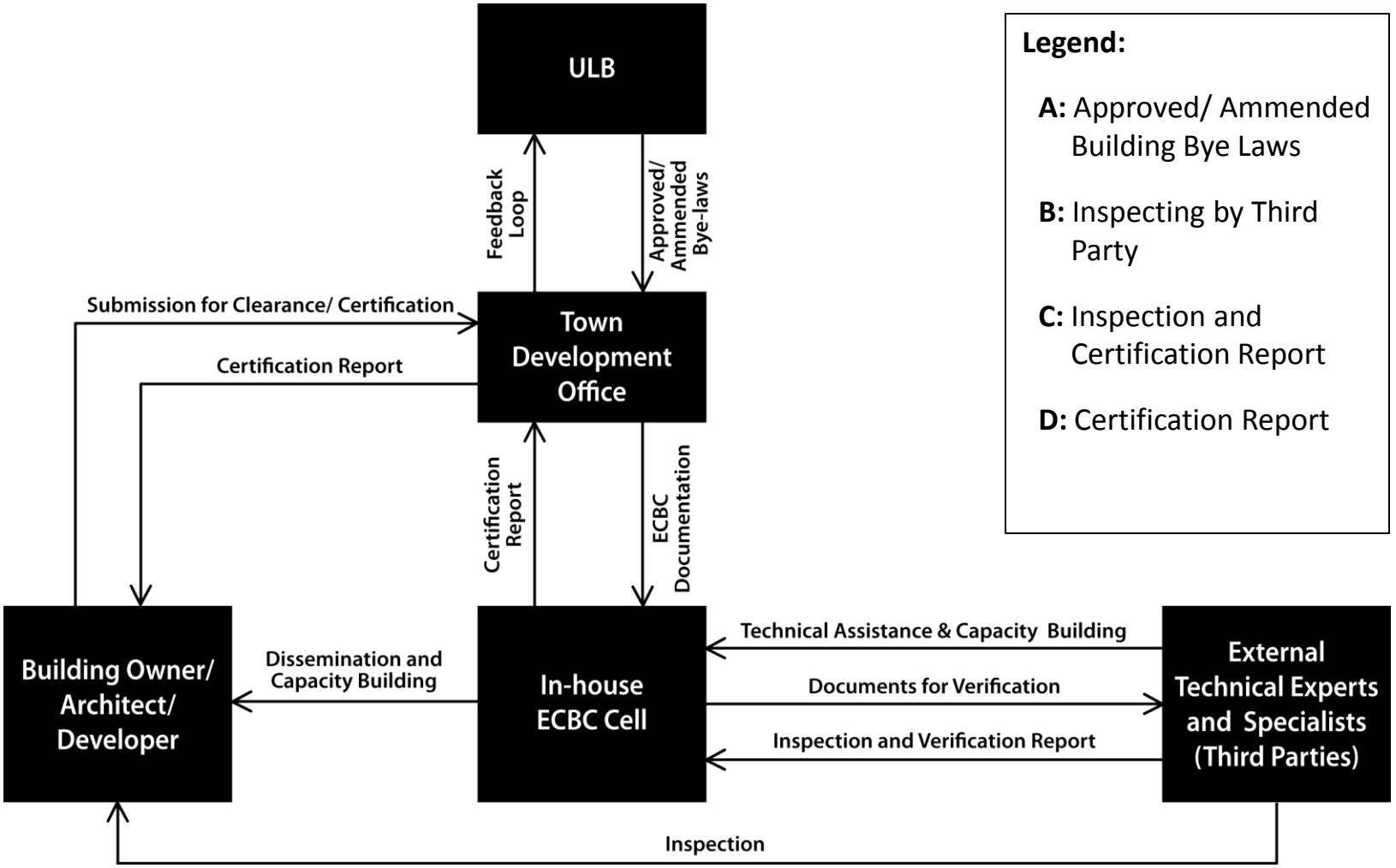
8, 9, and n: Amended building Bye Laws for approval of State Legislative Assembly

8*, 9*, and n*: Approved Bye Laws for ULB's to enforce

Abbreviations:

MoP : Ministry of Power
BEE : Bureau of Energy Efficiency
SDA : State Designated Agency under EC Act
MoUD : Ministry of Urban Development
UDD : Urban Development Department
ULB : Urban Local Body

ECBC Implementation Framework – Municipal Level



Legend:

A: Approved/ Ammended Building Bye Laws

B: Inspecting by Third Party

C: Inspection and Certification Report

D: Certification Report

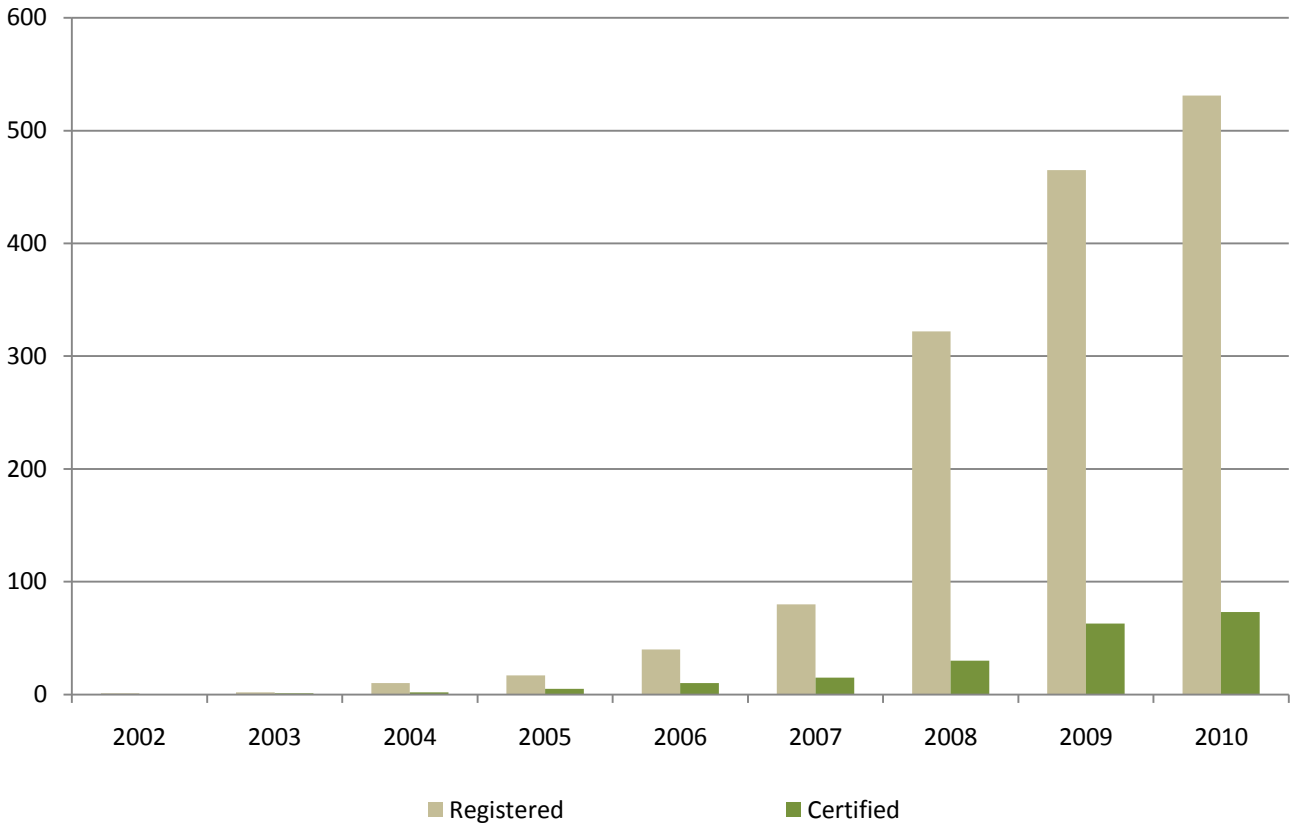
LEED India rating from Indian Green Building Council (IGBC)

- A voluntary, market-driven building rating system based on UGBC's LEED rating system.
- Evaluates environmental performance from a whole building perspective over a building's life cycle.
- Covers five environmental categories:
  - Sustainable Sites
  - Water Efficiency
  - Energy & Atmosphere
  - Materials & Resources
  - Indoor Environmental Quality

Rating	New Construction (NC)	Core & Shell (C&S)
LEED Certified	26-32	23-27
LEED Certified Silver level	33-38	28-33
LEED Certified Gold level	39-51	34-44
LEED Certified Platinum level	52-69	45-61

- Currently 618 buildings are registered under LEED and 97 buildings are certified

Growth of Green Buildings
"LEED India" from Indian Green Building Council (IGBC)



All types of buildings, all over the country :

IT Parks, Offices, Banks, Airport, Convention Centre, Institutions, Hotels, Residential, Factories . . .

Green Rating for Integrated Habitat Assessment (GRIHA) From MNRE

Set of 34 criteria

100 (+4 innovation points) point system with differential weightage on various criteria

- 51 - 60 ★
- 61 - 70 ★★
- 71 - 80 ★★★
- 81- 90 ★★★★
- 91- 100 ★★★★★

GRIHA Rating

Total Projects	Number of Buildings	Total Area, Sq.ft
Certified Buildings	2*	6,00,867
Registered Buildings	40*	2,19,29,769

* As of June 2010

- GRIHA is the National Rating System
- Central Public Works Department (CPWD), the construction arm of Govt. of India has adopted it as its Green Building Standard
- Govt of India has decided to build all its new buildings to meet minimum of GRIHA 3 Star rating.

Eco- Housing India

Focus Areas	Points
Site Planning	260
Environment Architecture	80
Efficient Building Materials	200
Energy Efficient Lighting	50
Solar Water Heaters	50
Water Conservation	200
Solid Waste Management	80
Other Innovative Measures	80

Range	Rating
500	*
501 – 600	**
601 – 700	***
701 – 800	****
>800	*****

Eco Housing
Building a Better Tomorrow

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

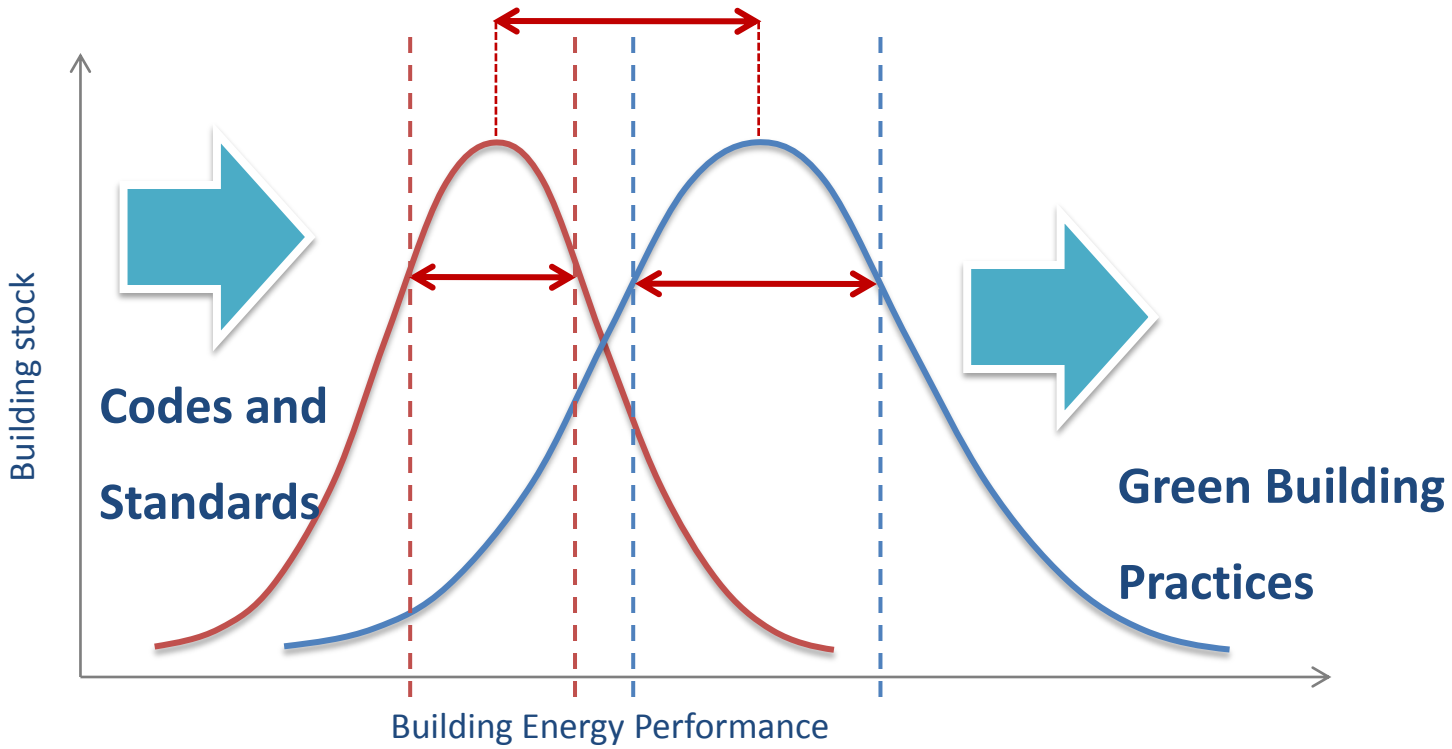
» Code compliance is an ongoing exercise

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

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

Role of Codes and Standards and Green Building Ratings in Improving Energy Efficiency



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.

Relationship of ECBC With Other Programs

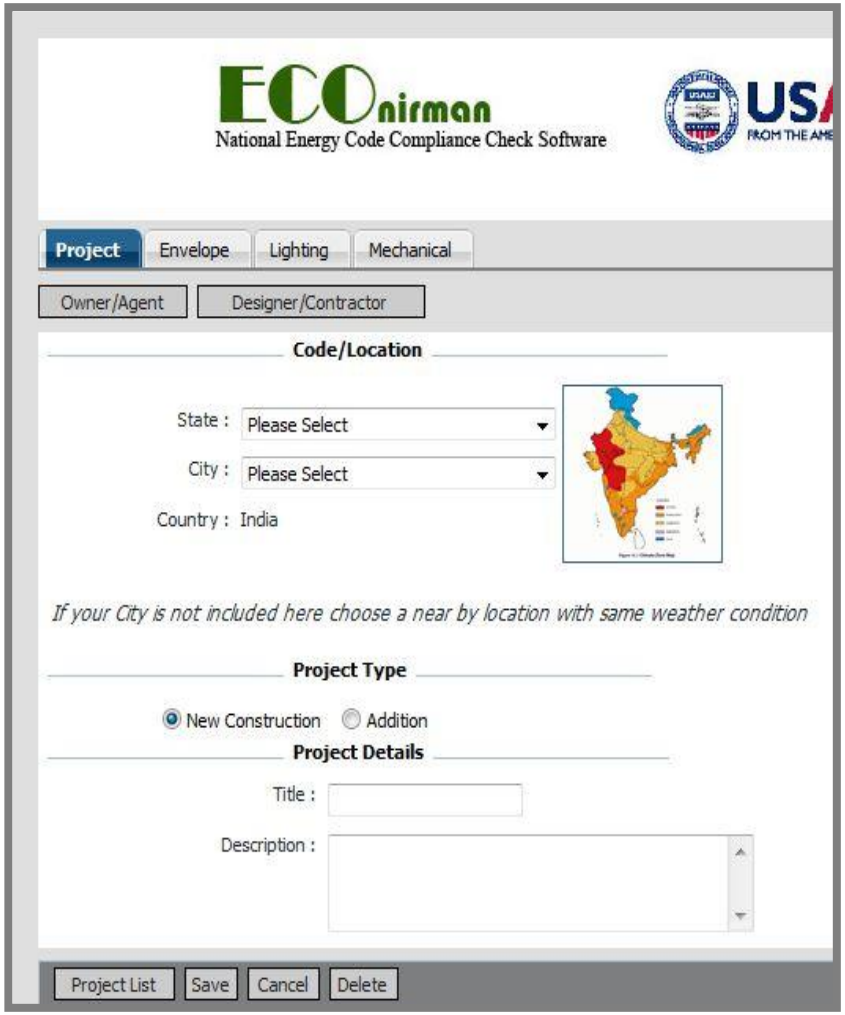
Program	Organization	Compliance Required	Building Type	Building With	Scope	Linkage to ECBC
ECBC	Ministry of Power/BEE	Voluntary	Commercial	Connected Load>=500kW Contract Demand >=600kVA	Energy Efficiency	NA
LEED-India	CII-Green Business Center	Voluntary	Commercial/ Institutional	-	Sustainable design/green 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 Impact Assessment (EIA)	Ministry of Environment and Forests	Mandatory	Commercial/Residential	Applicable to Large Projects	Environmental Impact	ECBC and Environmental Clearance requirements are related

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

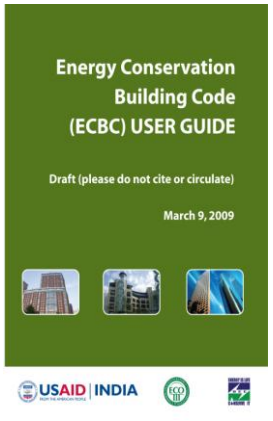
Road to ECBC Implementation

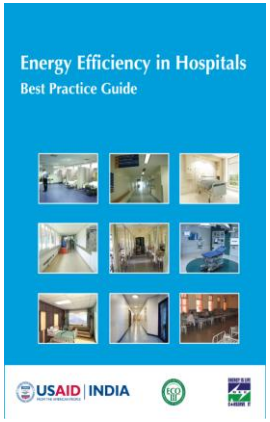
- Introduction of ECBC in the existing municipal bye-laws in the States
- Strengthening or restructuring of existing organizational set up in municipalities/urban local bodies in the States
- **Development of compliance tools to facilitate enforcement and monitoring of ECBC implementation by the concerned agencies**
- Capacity building of building designers on ECBC, energy simulation programs, energy efficient construction practices, etc.
- Raising awareness of building developers on energy efficiency and ECBC
- 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 suitable fiscal incentives to promote ECBC compliance and market transformation

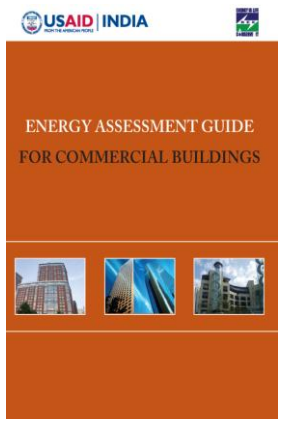


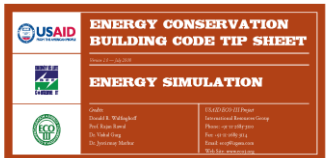
Road to ECBC Implementation

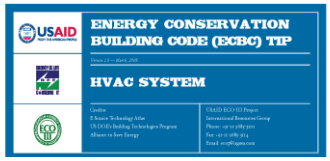
- Introduction of ECBC in the existing municipal bye-laws in the States
- Strengthening or restructuring of existing organizational set up in municipalities/urban local bodies in the States
- Development of compliance tools to facilitate enforcement and monitoring of ECBC implementation by the concerned agencies
- **Capacity building of building designers on ECBC, energy simulation programs, energy efficient construction practices, etc.**
- Raising awareness of building developers on energy efficiency and ECBC
- 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 suitable fiscal incentives to promote ECBC compliance and market transformation

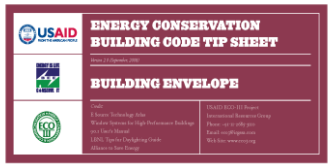


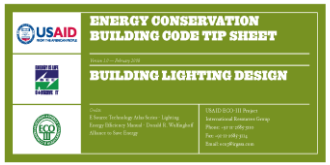












Benchmarking

- Need for benchmarking effort:
  - Energy consumption data is largely unavailable for the Indian building sector,
  - Lack of standardized approaches to data collection and analysis,
  - Absence of performance benchmarks based on actual energy consumption.
- Key Partners: BEE, LBNL, ICMQ
- Impacts:
  - Worked with BEE to initiate data collection,
  - Created standardized format for collecting building energy consumption data,
  - Started in December 2008; 861 buildings in database so far.

Challenges

- Little or no reliable data available in public domain - on actual energy consumption in different types of commercial buildings
- No systematic data collection and analysis of building energy data
- Limited scope to compare the individual building performance against peers
- Limited understanding about what are the key parameters influencing the energy consumption in a building
- Limited understanding on the role of energy efficiency professionals, statisticians, public and private sector organizations (data providers)

What is Quality

Quality is never an accident.

It is the result of high intention, sincere effort, intelligent direction and skillful execution.

- Willa A. Foster

Benefits of Benchmarking

»Designers, Owners and Users

- Designers/ESCOs – Building performance targets for new and existing buildings
- Owners/Users – Measure the performance of their buildings
- Building portfolio managers can compare the performance of individual facilities to others

»Building Developers and operators

- Helps to assess the potential savings
- Use of appropriate products and technologies

»Policy Makers

- Reward/Incentivize exemplary building performance and penalize/discourage poor building performance
- Starting Point for Energy Audits and Building Retrofits

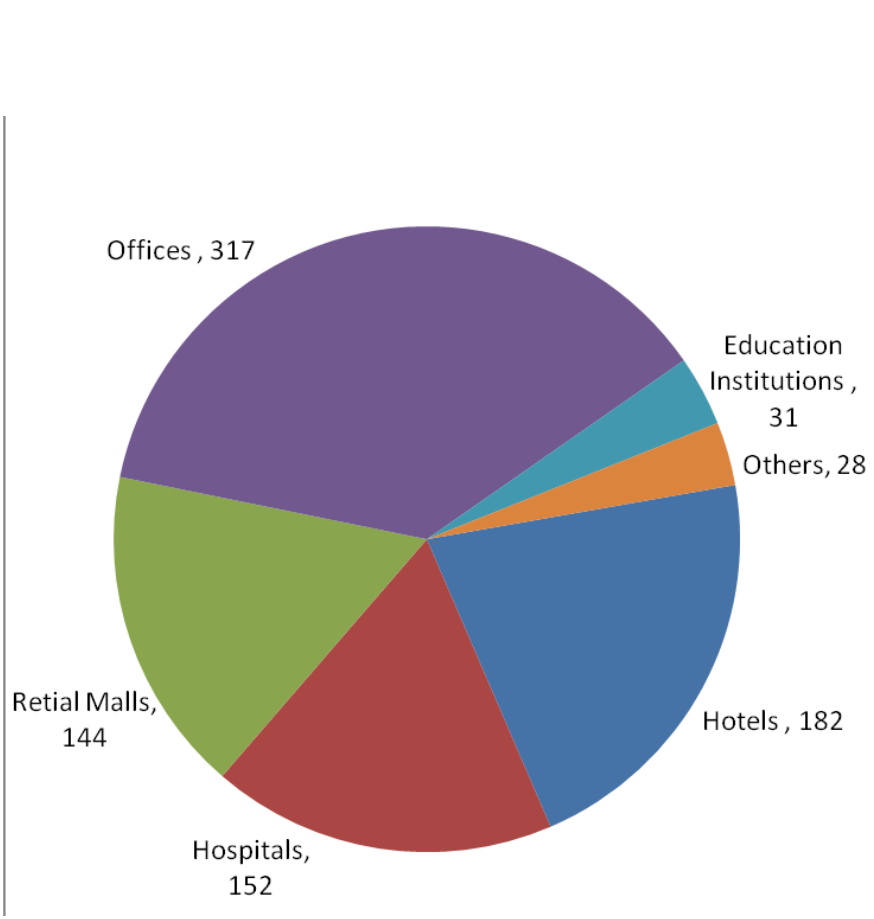
Benefits of Benchmarking – Indian Context

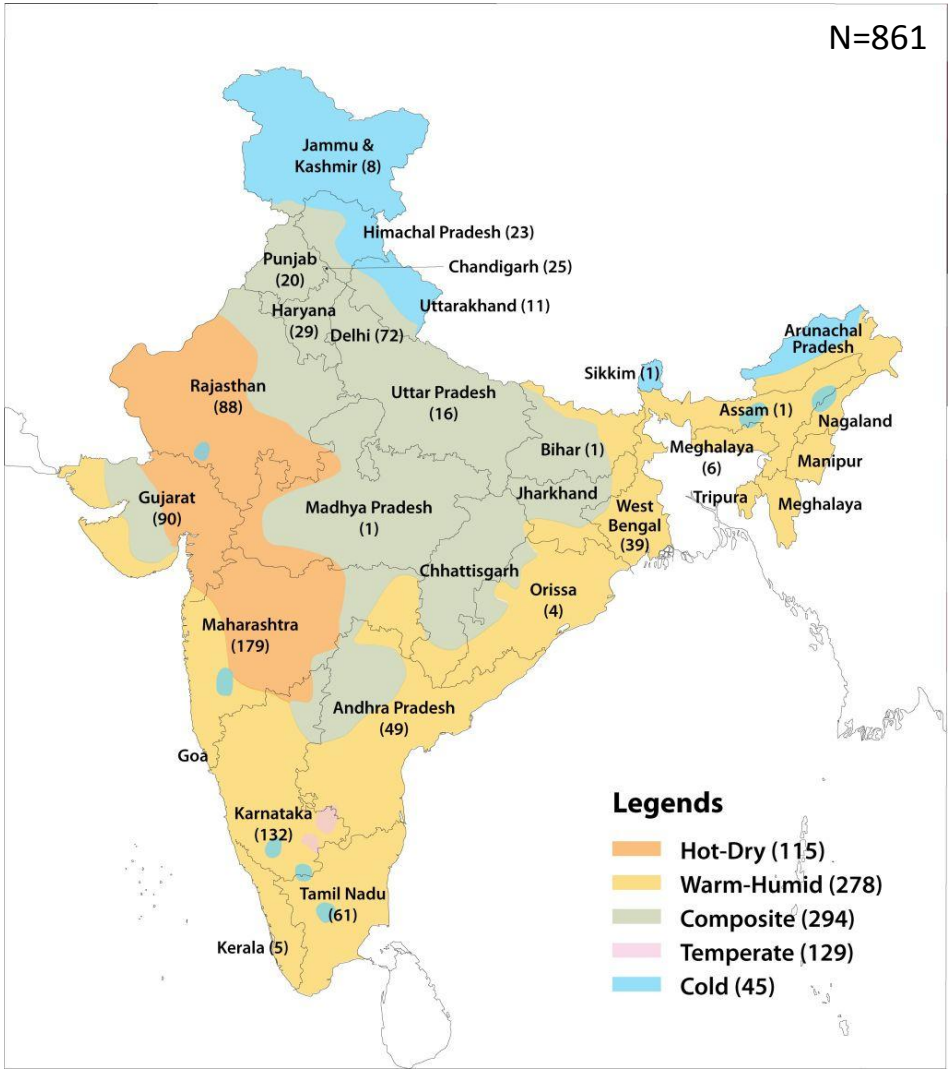
- Introduce Sanity in Building Energy Audit Process
  - No need to start with "Investment Grade Audits"
  - Help in developing a graduated response to building performance issues
- Provide a Framework for Meeting ECBC Related Stipulations in the EC Act
  - Help in quantifying energy savings from ECBC
- Can be Used to Provide Performance Briefs to Design Teams
  - System-Level Benchmarking Needed
- Can be Used as the Basis for Existing Building Rating Programs

Milestones – Benchmarking Exercise

- Design of the Standardized Form for Data Collection (December 2008)
- First Round of Data Collection from ECO-III Project (Jan – March 2009)
- Launch of Star Rating for Office Buildings (March 2009)
- Data Collection for BPO, Hotel, Hospitals by ICMQ (Apr – Sep 2009)
- Development of Mutli-Variate Regression Model and Recommendations for Improving Star Rating Program (Feb – June 2010)

Benchmarking: Macro Analysis: Building Population



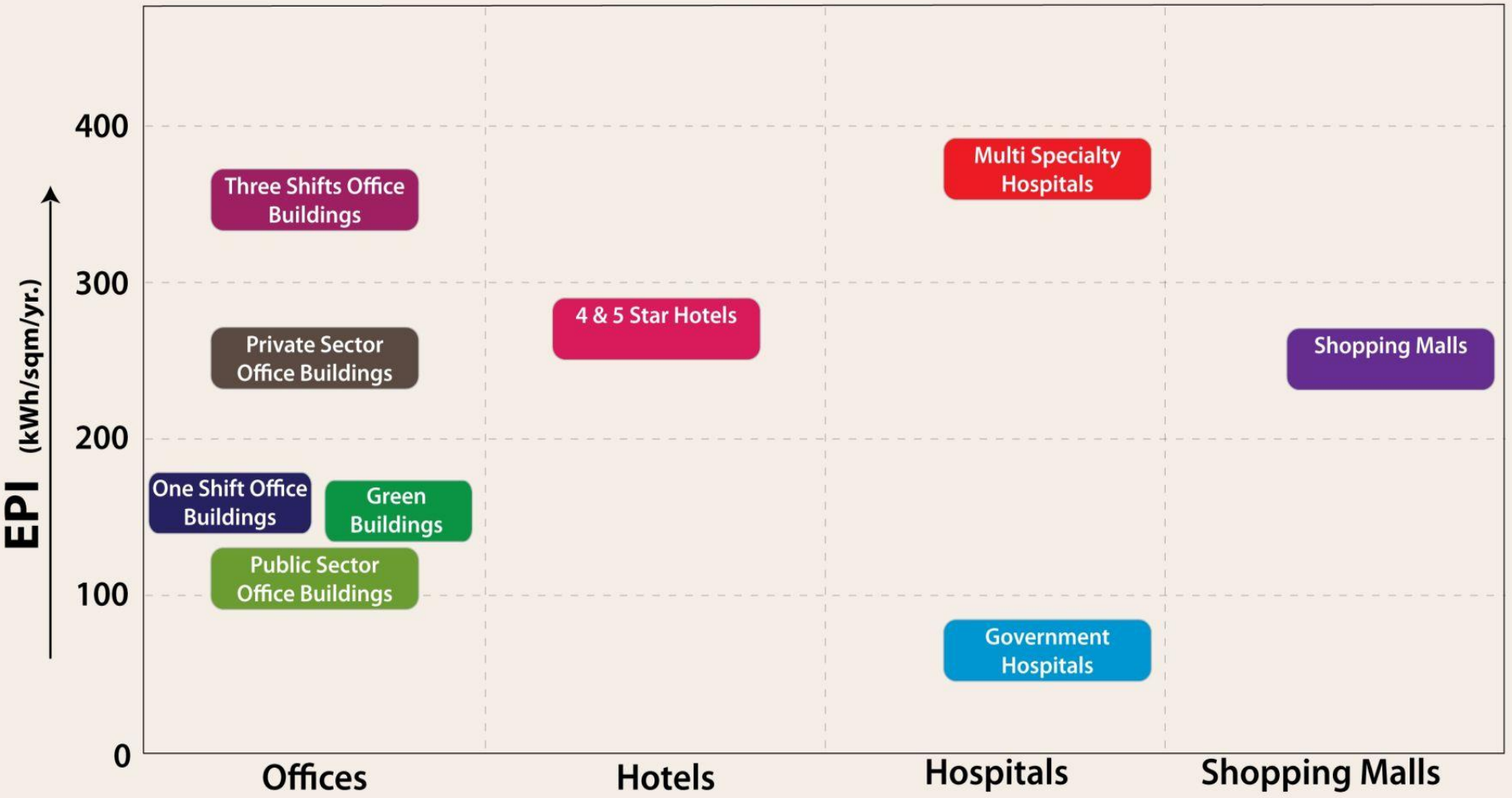


Benchmarking

Number of Buildings	Building Type	Floor Area (m^2)	Annual Energy Consumption (kWh)	Benchmarking Indices	
OFFICE BUILDINGS				**kWh/m^2/year**	**kWh/m^2/hour**
145	**One shift Buildings**	16,716	20,92,364	149	0.068
55	**Three shifts Buildings**	31,226	88,82,824	349	0.042
88	**Public Sector Buildings**	15,799	18,38,331	115	0.045
224	**Private Sector Buildings**	28,335	44,98,942	258	0.064
10	**Green Buildings**	8,382	15,89,508	141	-
HOSPITALS				**kWh/m^2/year**	**kWh/bed/year**
128	**Multi-specialty Hospitals**	8721	24,53,060	**378**	**13,890**
22	**Government Hospitals**	19,859	13,65,066	**88**	**2,009**
HOTELS				**kWh/m^2/year**	**kWh/room/year**
89	**Luxury Hotels (4 and 5 Star)**	19,136	48,65,711	**279**	**24,110**
SHOPPING MALLS				**kWh/m^2/year**	**kWh/m^2/hour**
101	**Shopping Malls**	10,516	23,40,939	**252**	**0.05642**

Averages for different commercial buildings *(Source: Building Energy Benchmarking study undertaken by the USAID ECO-III Project)*

Energy Intensity Level for different Building Types



BEE Star Rating Program for Buildings

- Rating based on bands of performance (Energy Performance Index – kWh/sq. m./year)
  - Based on preliminary results from BEE/ECO-III benchmarking study
- Launched Star Rating Program for:
  - Office Buildings in February 2009
  - Business Process Outsourcing (BPO) Buildings (3-shift office buildings) in December 2009
- Under development:
  - Retail Malls
  - Hotels
  - Hospitals

Star Rating - New Methodology Proposed to BEE

- Estimate the energy consumption of a benchmark building: The benchmark building represents a representative building with similar use type, physical and operating characteristics and located in same climatic zone. This estimate is derived by applying regression techniques to a large dataset of surveyed buildings.

- Compute a statistic called Building Performance Index (BPI): It is calculated as the ratio of actual electricity consumed to estimated electricity consumed by the benchmarked building

Use of Benchmark Numbers

- Building Level Benchmarks – First Step, Less Costly
  - Energy consumption per employee in an office
  - Energy consumption per bed in a hospital
  - Energy consumption per room in a hotel
- System Level Benchmarks – Requires Metering Infrastructure, More Costly and Data-Intensive
  - Lighting System: 5 Watts/m2
  - Equipment Power: 10 Watt/m2
  - HVAC System: 50 m2/Ton of Refrigeration; 25 Watts/m2
    - Chilled and Condenser water pumps: 10 Watts/GPM
    - Air Handling Unit: 0.75 Watts/CFM

Factors influencing the energy consumption

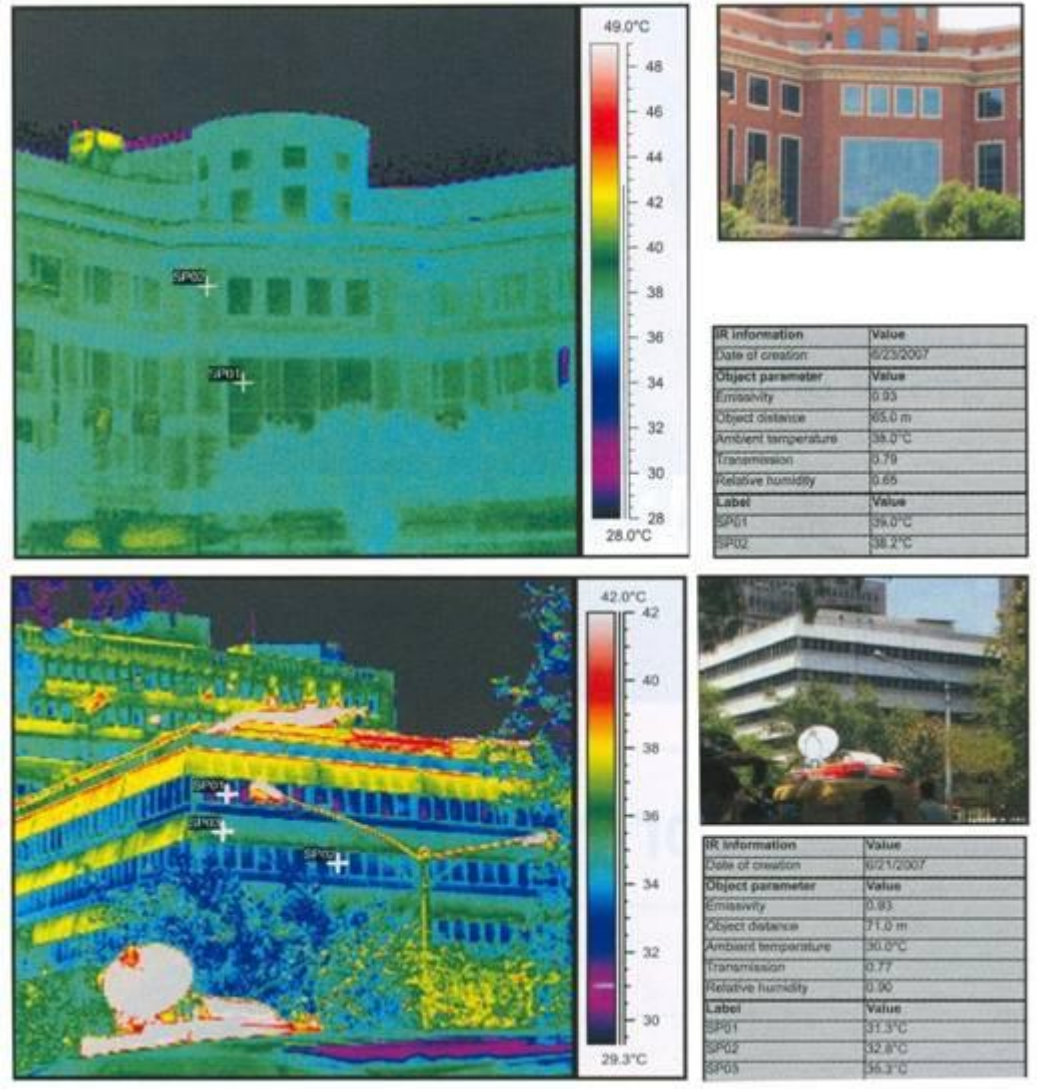
Building type	Independent variables
	▪ Built up area ▪ Hours of operation ▪ Percent conditioned space ▪ Number of employees ▪ Climate
	▪ Built up area ▪ Number of beds ▪ Small / Large category ▪ Climate
	▪ Built up area ▪ Number of rooms ▪ Climate

Well & Poorly Designed Building Envelope (Building Auditing)

Uses/ Benefits

- **Building Diagnostics**
- **Locate HVAC problem areas**
- **Detect building moisture issues**
- **Locate Electrical Problems**
- **Easy non-invasive/non-destructive testing**
- **Detect plumbing problems**

Source: Greenpeace



Delivering Building Performance

Activities	Implementation	Next Steps
Quality Assurance in Energy Assessment	Building Energy Assessment Guide	Standardize Executive Summary of Energy Audits and Require Quality Assurance
Benchmarking Energy Use at Building Level	Standardize Energy Use Survey Collected and Analyzed Data Develop a rigorous methodology Launched a Benchmarking Tool	Data Collection Form: To be refined based on feedback Work with BEE in refining the Star Labeling program
Three-Legged Approach to Address Credibility Gap and Minimize Unintended Consequences	Statistical: Good Start with 860 buildings data and conducting a rigorous multi-variate regression approach (Energy Star Approach) Technical: Reasons behind high performance Policy: Continuous tightening of the Star Labeling program (Learning from DECs, NABERS, and Energy Star)	Rope in more companies to contribute to online database; Partner with IGBC and GRIHA and ask them to base performance using BMT and contribute to database Undertake 20-30 building energy assessments after constituting an expert panel to learn about the success behind exemplary energy performance and high user satisfaction

Gujarat DSM Load Research Survey Results

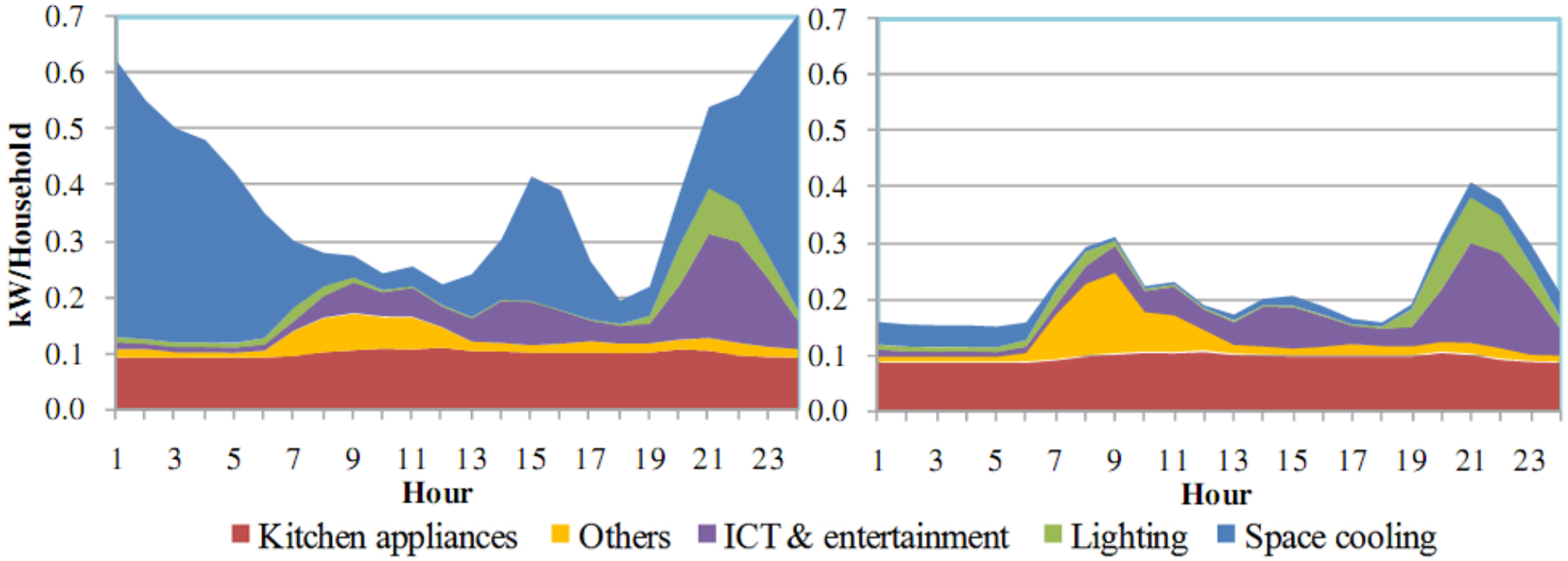


Figure 14: (a) Load curve for end-use categorization during summer (b) Load curve for end-use categorization during winter

Field data to inform DSM Program Design

Gujarat DSM Load Research Survey Results

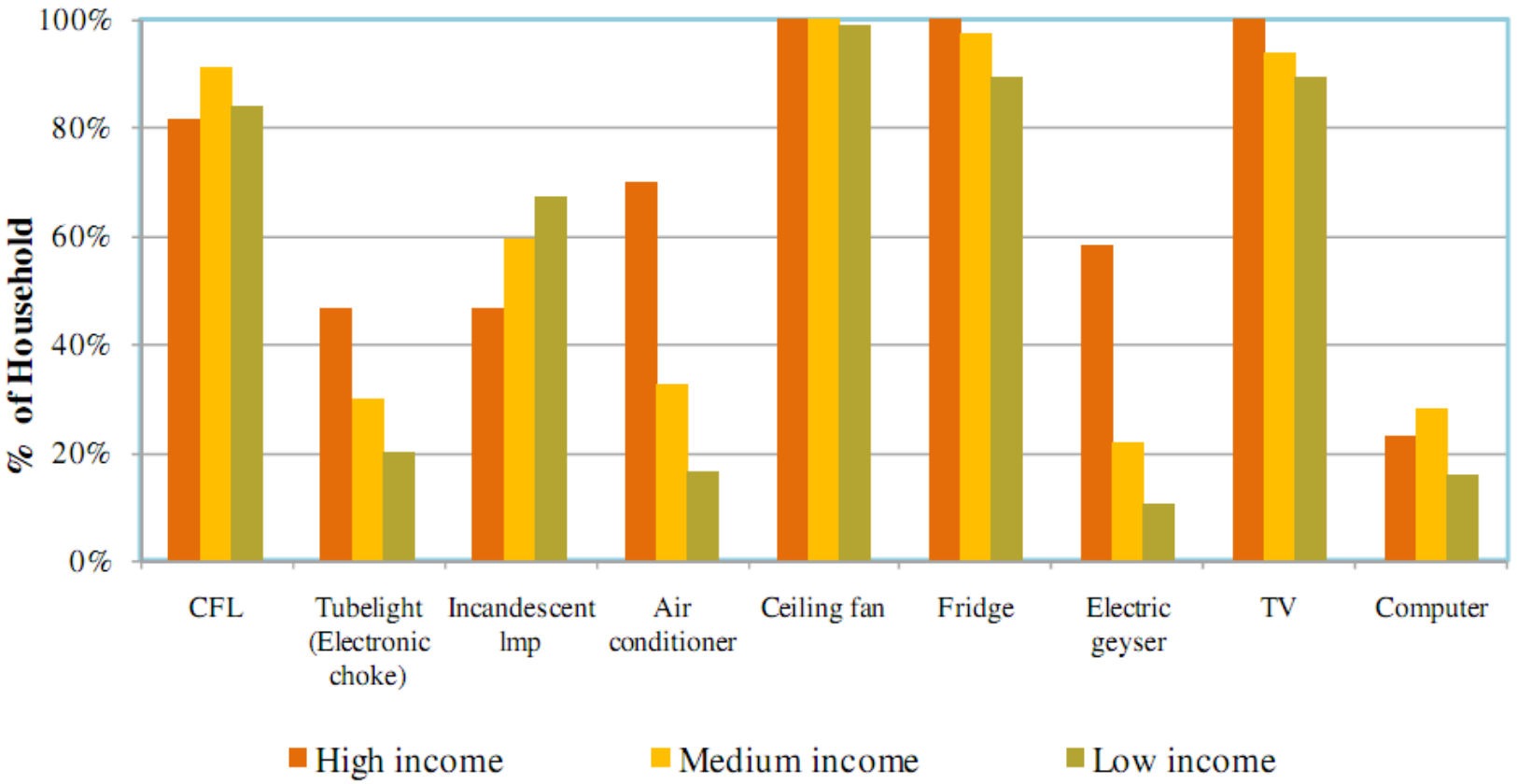
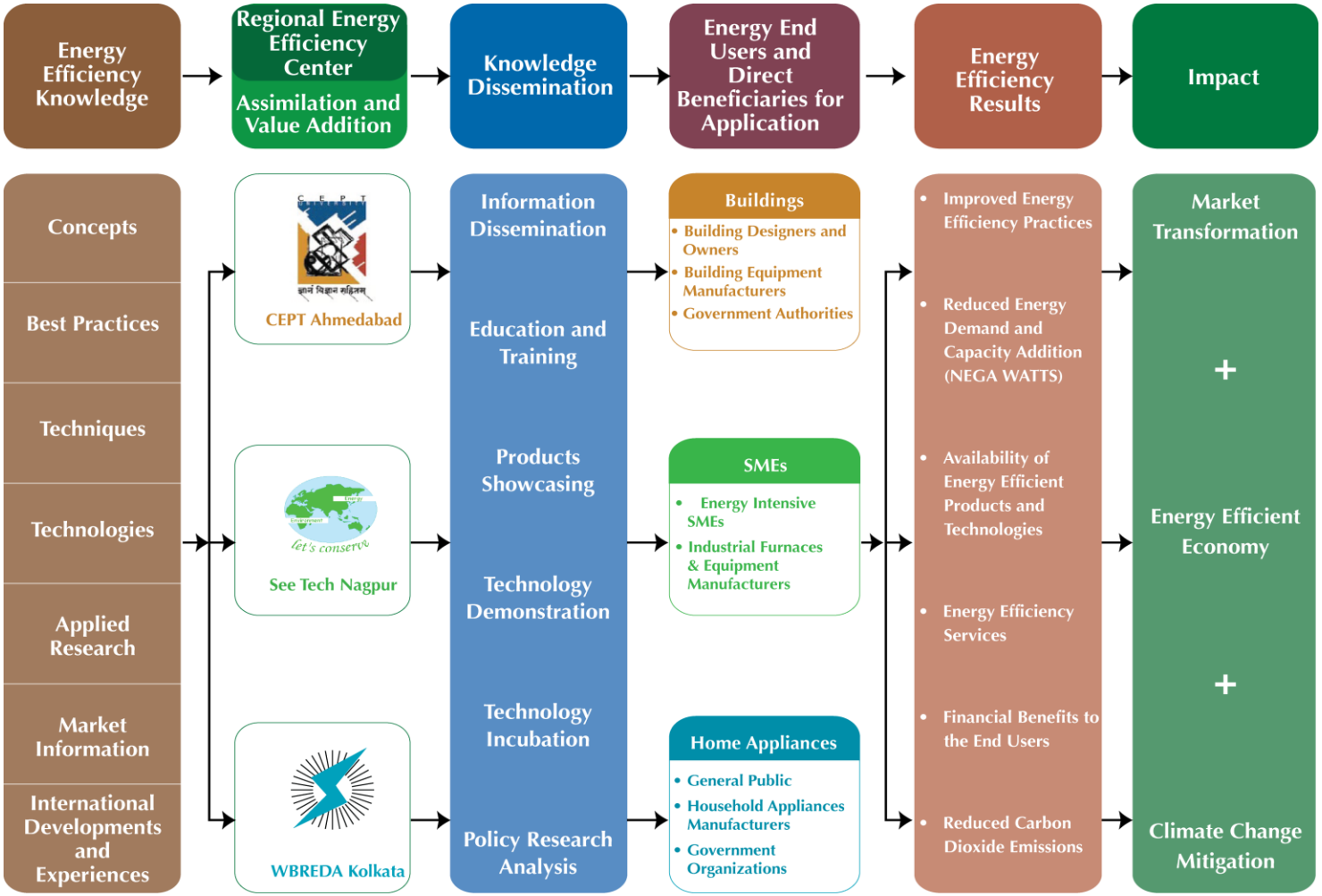


Figure 2: Income category wise appliance ownership for residential establishments in Gujarat

Real-world insights for effective Program Design

Strengthening/Creating EE Institutions: Regional Energy Efficiency Centers



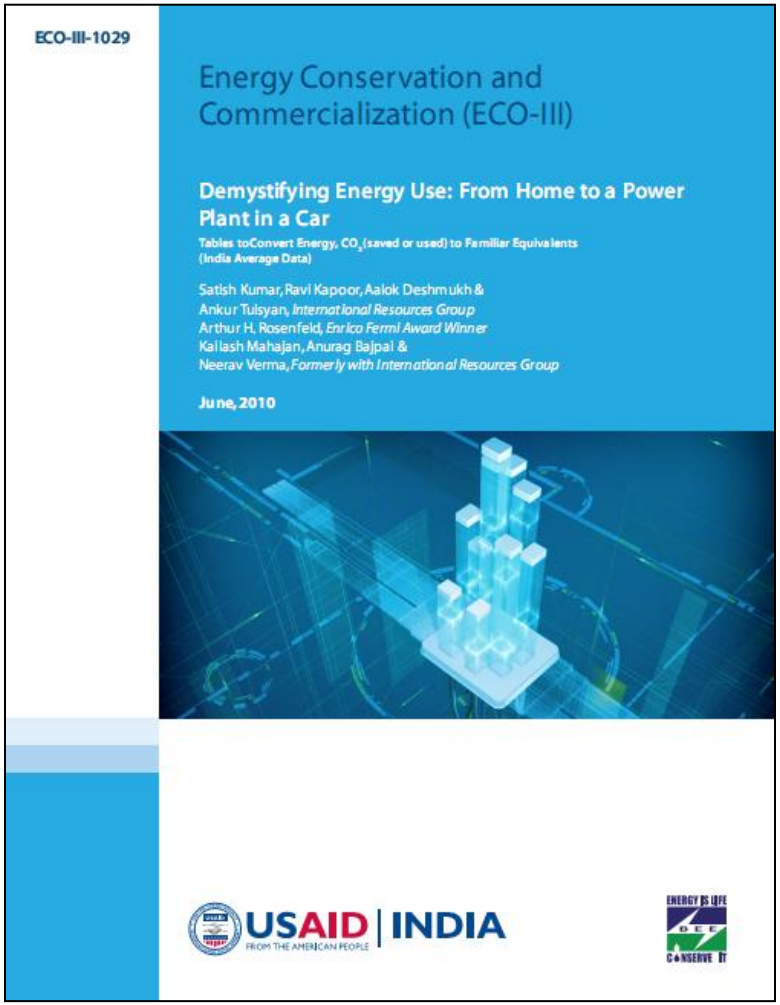
REEC at CEPT, Ahmedabad: Buildings & Energy Simulation

- Objectives:
  - Establish simulation training facilities, envelope performance lab, fenestration testing, certification & labeling program,
  - Assist State Govt. to adopt ECBC.
  - Create a PPP by leveraging USAID's resources
- ECO-III Assistance ($250k):
  - Seed Funding, Technical Assistance
- Partners:
  - Glazing Society of India ($350k):
    - –Spectrophotometer, staffing of REEC, Labeling program.
  - Ministry of New & Renewable Energy ($160k):
    - –Solar Calorimeter.
  - Government of Gujarat ($225k):
    - –For construction of a "Net Zero Energy Building for REEC".

Outreach and Extension Activities

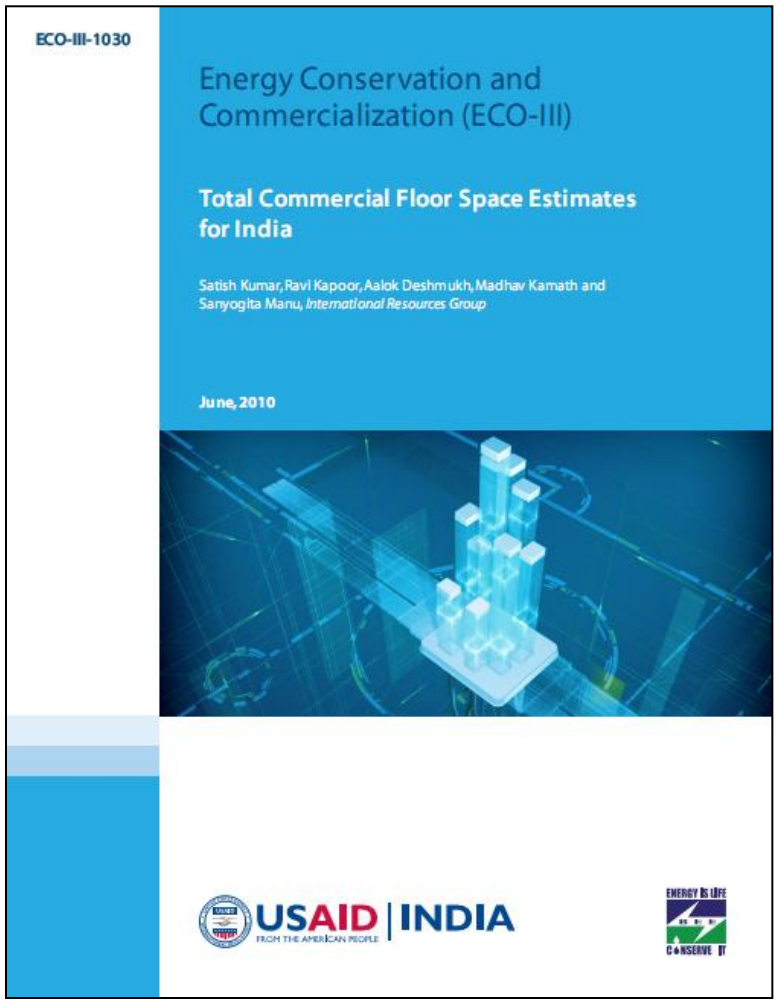
- Two Study Tours to US Institutions & Energy Centers
  - Provided exposure to Indian energy professionals (from MOP, BEE, REECs, GEDA, PEDA, AEEE, GSI, NPC) on energy efficiency programs of US government, and services provided by Energy Centers of US
- Monitoring & Verification workshops with support from EVO and AEE
  - Three Level-II Training workshops
  - First Certified M&V Professional workshop
- Helped with the organization of US – India 2nd Energy Efficiency Technology Cooperation Conference
- Total Professionals Trained: More than 1,500
- Created and maintaining a dedicated project web site (www.eco3.org)
  - Continuously updated and modified
  - Widely used by EE Community for technical documents and resources

ECO-III New Publications – Energy Equivalence Matrix



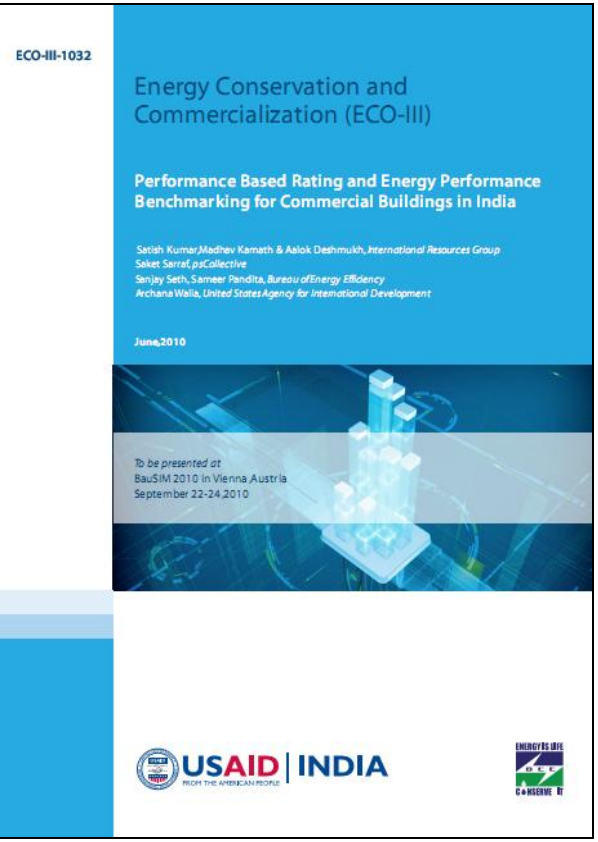
- Tables to easily convert used or avoided energy use or emissions to familiar metrics such as homes and cars.
- Updated with latest available data for India.
- Estimated savings for ongoing programs such as ECBC Implementation, Bachat Lamp Yojana
  - ECBC implementation will allow the equivalent of powering approximately 11 lakh typical urban Indian homes.
  - Bachat Lamp Yojana will free up capacity for approximately 23 typical thermal power plants.

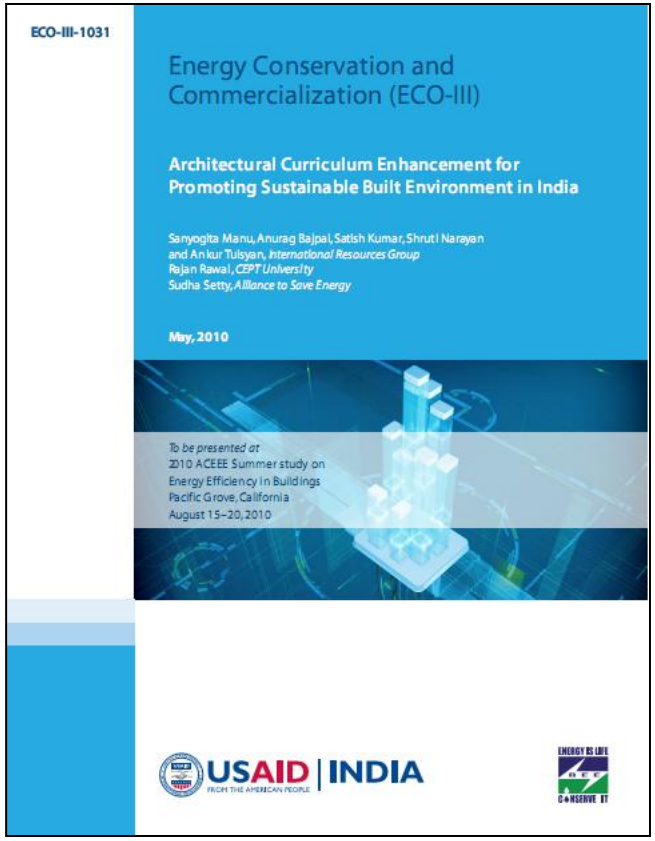
ECO-III New Publications – Commercial Floor Space Estimate

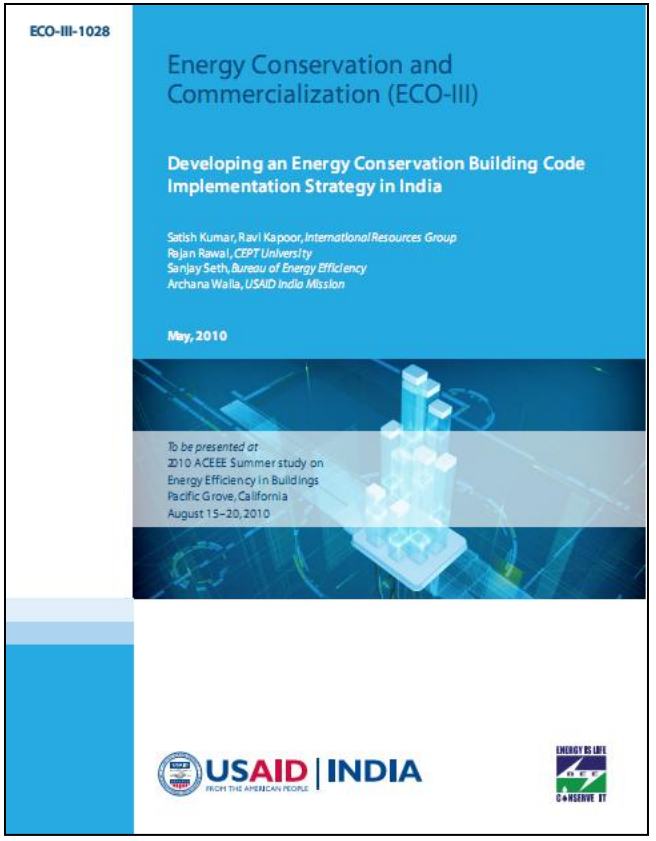


- Aimed at putting out transparent estimates to raise the quality of discussion around the issue.
  - Press for consensus on important numbers that can guide policy decisions and strategic framework
- Based on:
  - LBNL's India Energy Outlook,
  - MOSPI Economic Census 2005,
  - CEA's General Electric Review 2009
- Compared with estimates by:
  - McKinsey & Company
  - LBNL
  - Climate Works Foundation
- Current (2010) estimate for commercial floor space in India: 659 M sq. m., growing at ~4-5% p.a.

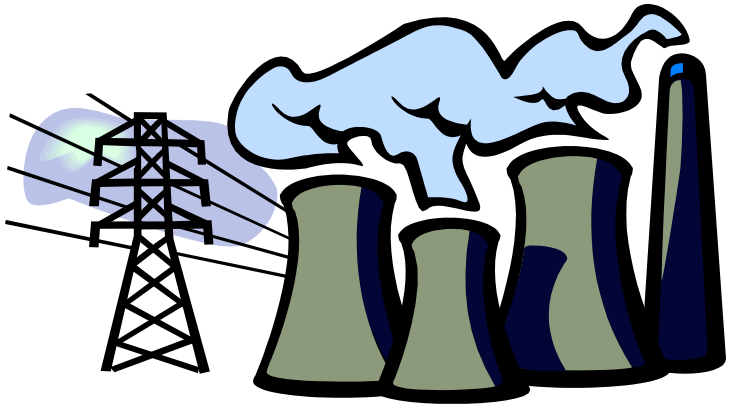
ECO- III New Publications – Conference Publications





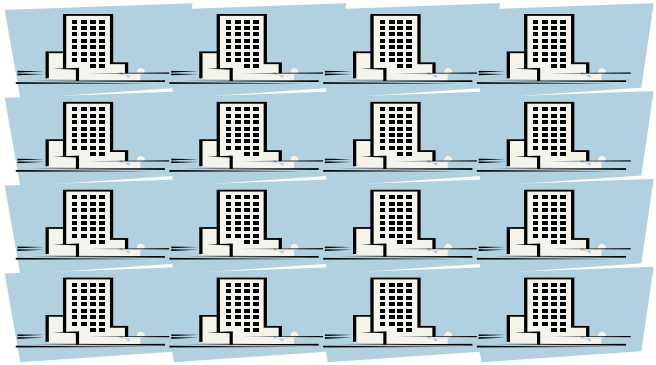


Concept of Energy Equivalence Matrix



One typical Thermal Power Plant
(Capacity of 600 MW=3.09 billion kWh)

=



1500 typical Office Buildings
(2 million kWh per building per year)

=

1.8 million typical Urban Homes
(1.7 thousand kWh per year)

=

0.689 million typical Cars

Energy or Carbon?

Primary Energy Use	**1 Lakh (100,000) Cars =**	**358,000 Homes**
CO_2 Emission	**1 Lakh (100,000) Cars =**	**76,000 Homes**
~ 5 times variation		

Selection of Reporting Metric Can Alter the Results Significantly

Building Energy Efficiency: Path Forward

- Net Zero Energy Building Goals
  - Integrate Energy Efficiency with Renewable Energy
- Develop a framework for separate residential energy code
  - Target "best bang for buck" sub-sectors
    - High-rise residential development
    - Public housing sector
  - Keep it simple – develop an 80% solution
  - Integrate Standards and Labeling program
- Skills development and enhancement program for building trade professionals
  - Preserve and pass on traditional knowledge
  - Vocational training
- Invest in the future
  - Work with architecture and engineering colleges
  - Prepare the next generation of building design professionals

Work with Govt. and Industry to Inspire "Game Changing" Technologies and Policies

- India should embrace and require "adaptive" thermal comfort standards that is based on sound science and takes into account thermal preferences of people in tropical climates.
- Challenge the Air-conditioning industry to come up with "game-changing" technology"
- How to Make Promising and Innovative Energy-Efficient Technologies Into Mainstream Technologies
  - Solar Cooling, Radiant Cooling, Vapor Absorption, Direct-Indirect Evaporative Cooling, Ground-Source Heat Pump
- Challenge the Industry to Reduce HVAC efficiency from 0.75 to 1.25 kW/ton of refrigeration to 0.4 to 0.6 kW/ton (50% reduction)
- Use de-centralized system (energy-efficient, better controls, etc.)
- Identify technologies that provide comfort conditioning and show 50% energy reduction
- IT Industry Placed India on Global Map; CET Industry Can and Should Make India Global Leader

Scope for massive improvement

if you use the multiplier effect. For example:

BE LEAN - Halve the demand

Review standards, reduce losses, avoid waste.

times

BE MEAN - Double the efficiency

Buy efficient equipment, use it efficiently, avoid system losses, tune it all up.

times

BE GREEN - Halve the carbon in the supplies

With on-and off-site measures

equals

You're down to one-eighth of the CO_2

BUT YOU NEED TO TAKE ALL THE STEPS!

ECO-III Project Partners - Key to Success

Public Sector Partners

- Bureau of Energy Efficiency
- International Partners: US DOS, US DOE, LBNL, EVO, AEE, N FRC
- Reserve Bank of India
- GUDC, GEDA, PEDA and WBREDA
- World Bank

Industry Associations

- CII Green Business Center
- NASSCOM, ISHRAE
- Glazing Society of India

Private Sector Partners

- Alliance to Save Energy, NPC, Econoler, DSCL Energy Services, CEPT, Conzerv, NISST, See-Tech, AEEE
- Infosys
- DLF
- E-Source, Colorado, USA
- DesignBuilder, UK

Academic Institutions

- 20 Architecture/Engineering Colleges CEPT, IIT-KGP, IIT-R, IIIT, MNIT
- IIM Ahmedabad
- IIT Roorkee
- Technical University of Vienna

Thank You

Contact Information

Satish Kumar, Ph.D.
Chief of Party, USAID ECO-III Project
Phone: +91-11-2685-3110
Email: skumar@irgltd.com
URL: www.eco3.org

Online Benchmarking Tool Demonstration

Please standby for the demonstration