Developing an Energy Conservation Building Code Implementation Strategy in India

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ABSTRACT

Commercial building sector in India is expanding rapidly at over 9% per year spurred largely by the strong growth in the services sector. It has been estimated that 70% of building stock that will be there in the year 2030 is yet to come up in the country – a situation that is fundamentally different from developed countries. Under the Energy Conservation Act 2001, Government of India launched Energy Conservation Building Code (ECBC) on a voluntary basis. ECBC sets the minimum energy performance standards for "large commercial buildings" after taking into account the five major climatic regions of India. The Bureau of Energy Efficiency, a statutory body, has taken initiatives in implementing capacity building programs and in developing several technical documents and training material to raise awareness about ECBC and to enhance the professional skills of building design professionals.

Once made mandatory, the state governments will be responsible for enforcing ECBC through local municipal authorities, which also enforces building bye laws. Incorporation of ECBC specifications in the existing bye laws, National Building Code and in Central Public Works Department Schedule of Rates will be critical in ensuring effective nation-wide adoption. Capacity building of human resources in municipalities and development of compliance procedures and software right from the design to commissioning of the buildings will also be needed. Availability of appropriate and cost effective building materials and equipment and facilities to test the performance of these materials and equipment is being addressed through the establishment of testing centers in the country. Nation-wide capacity building efforts for practicing architects and engineers, as well as for students are also ongoing.

This paper, for the first time, addresses the above issues and proposes several options and strategy to accelerate the implementation of ECBC in the country.

Introduction

In the rapidly growing economy of India, the energy requirements are increasing at a fast pace. The Government of India, at the highest level, is giving top priority to the attainment of nation's long-term energy security. India currently ranks sixth in the world in terms of primary energy demand. As per the Planning Commission's Integrated Energy Policy Report (Planning Commission 2006), if India perseveres with sustained economic growth rate of 8% of GDP per annum through 2031-32, its primary energy supply will need to grow by 3 to 4 times, and electricity generation capacity by 5 to 6 times compared to 2003-04. It is estimated that by 2031-32, the country's power generation capacity would be 800,000 MW from a current level of 160,000 MW. Central Electricity Authority (CEA) has estimated that the country is currently facing electricity shortage of 9.9% and peak demand shortage of 16.6% (CEA 2009).

While it is essential to add new power generation capacity to meet the nation's growing energy requirements, it is equally important to look out for options that will help in reducing energy demand for various end-use sectors. Since buildings account for approximately 33% of electricity consumption and is the fastest growing sector, it is critical that policy interventions are put in place to improve energy efficiency in both new construction as well as existing buildings.

Energy Conservation Act, 2001

To give impetus to energy conservation in the country, Government of India enacted the Energy Conservation Act (EC Act), which came into force on 1st March 2002. Under the Act, Government of India established the Bureau of Energy Efficiency (BEE) in March 2002, a statutory body under the Ministry of Power (MoP), Government of India. The EC Act directs BEE to spearhead improvement in energy efficiency through various regulatory and promotional measures and implements the provisions of the act (MoP 2001).

The EC Act has empowered the Government both at the Central as well as at the State level to put in place a legal framework that could help in creating an institutional set-up that promotes energy conservation in the country, and also helps in monitoring the efforts to meet the energy saving targets and energy intensity of the economy.

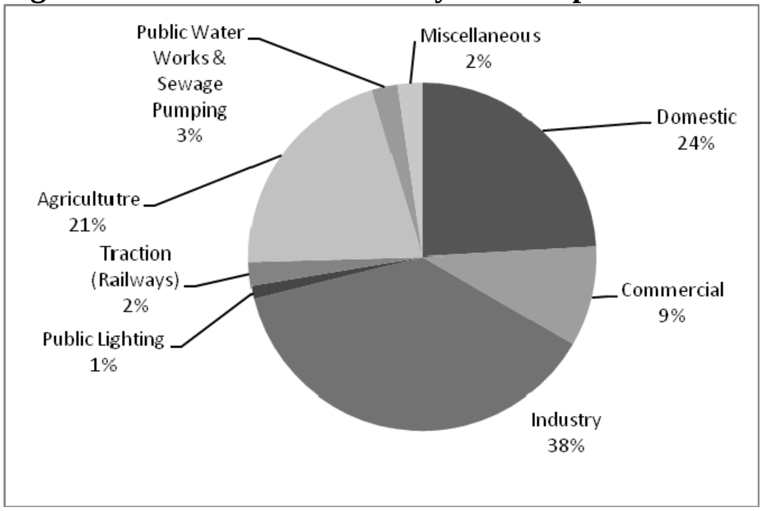
Overview of the Indian Commercial Buildings Sector

According to Energy Information Administration, any building that is not used for residential, manufacturing and agricultural purposes is termed as a 'Commercial Building'. However in India, CEA classifies electricity end use sectors broadly into several categories (e.g. industrial, residential, agricultural, commercial, etc.), primarily based on the tariff charged by the Distribution Companies that is approved by the state Electricity Regulatory Commissions. Figure 1 shows the electricity consumption in various sectors in India.

The Commercial building sector includes office buildings, hotels, hospitals, educational institutes, retail malls, etc. According to CEA, electricity consumption in the commercial sector in India at present accounts for about 9% of the total electricity consumption in the country. The electricity consumption in this sector has experienced an average growth of 13.5% over last four years (Fig. 2). This growth is attributed to the ever increasing energy consumption in existing buildings as well as increasing energy intensity of newly constructed commercial buildings such as multi specialty hospitals, luxury hotels, retail malls, data centers, etc. which are being built all over the country.

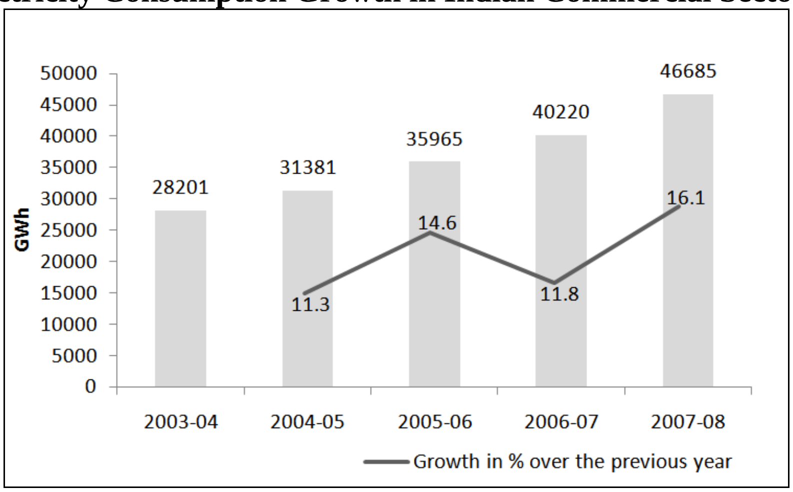
A demand for Information Technology sector and related services has been mainly driving rapid growth of commercial buildings in major cities in India. In the absence of non-availability of data on commercial buildings, several organizations have been currently making attempts to estimate the floor-space of existing commercial building stock in India. Recent study by McKinsey (McKinsey 2009) has estimated built up area of one billion m^2 of commercial buildings that is expected to grow to four billion m^2 in 2030. Estimates based on the building sector data analyzed by the ECO-III team also predicts that 70% of building stock that will be there in 2030 is yet to come up in the country – a situation that is fundamentally different from developed countries – requiring a carefully crafted set of policy interventions to encourage energy efficiency through a combination of regulatory and market mechanisms.

Figure 1: Sector-Wise Electricity Consumption in India



Source: CEA 2009

Figure 2: Electricity Consumption Growth in Indian Commercial Sector (2003-2008)



Source: CEA 2005 and CEA 2009

BEE launched its first energy efficiency program for existing government buildings in 2002, shortly after its creation. Under the first phase of the program, nine prestigious Government Buildings in New Delhi were covered. Energy assessment studies identified, on an average, energy/electricity savings potential of approximately 30%.

In order to accelerate the energy efficiency activities in the commercial buildings, BEE has recently developed a Star Rating Program for office buildings, which is based on actual energy performance of the building, in terms of Energy Performance Index (EPI) measured in terms of annual electricity usage per unit of built up area (in kWh/m^2/year). Under the program, office buildings having a connected load of 500 kW or greater are being rated on a 1-5 star scale taking into account building type, climate and percentage of building area that is air-conditioned, with a 5-star rating being the most energy-efficient.

Energy Conservation Building Code

The EC Act empowers the Central Government to prescribe Energy Conservation Building Code (ECBC) in the country. BEE with technical assistance from USAID supported Energy Conservation and Commercialization Project (ECO-II Project), a Committee of Experts finalized ECBC in consultation with various stakeholders. In May 2007, MoP formally launched ECBC for its implementation in commercial buildings on a voluntary basis.

ECBC sets minimum energy performance standards for commercial buildings that have an electrical connected load of 500 kW or greater or a contract demand of 600 kVA or more. The Code focuses on building envelope, mechanical systems and equipment including heating, ventilating, and air conditioning (HVAC) system, interior and exterior lighting systems, service hot water systems, electrical power and motors, and takes into account five climates zones present in India (BEE 2008). Several members of the ASHRAE 90.1 committee participated in the development of the ECBC. The structure of the ECBC is patterned after the ASHRAE Standard (ASHRAE 2004), and offers two compliance approaches: Prescriptive or Whole Building Performance Method. A Trade-Off Option allows greater flexibility to designers while designing the building envelope. *The EC Act specifies that through ECBC compliance, the overall aim is to develop energy norms and standards for eligible commercial buildings, expressed in terms of energy consumption per* m^2 *of area.*

Per the EC Act, the Central Government can prescribe ECBC for adoption in all the states of India, the State Governments have the power to amend ECBC to suit regional and local climatic conditions and direct the building owners and occupiers to comply with ECBC.

BEE and ECO-III Partnership

Since 2007, BEE has been actively involved in promoting ECBC awareness through nation-wide workshops and capacity building programs for stakeholders. ECBC Program Committee (EPC) constituted by BEE in 2008, addresses all issues related to ECBC. BEE, on the recommendation of the EPC and with support from USAID ECO-III Project, brought out a revised version of ECBC in May 2008 to make the document consistent across various sections and rectify typographical errors (BEE 2008).

Considering the growing need for developing better understanding of ECBC in the country, ECO-III, in association with BEE, developed ECBC User Guide (USAID ECO-III Project 2009a), which aims to assist the building designers, architects and all others involved in the building construction industry to facilitate implementation of ECBC in real situations. In addition, ECBC Tip Sheets on Building Envelope, HVAC Systems, Lighting Design and Energy Simulation have been developed by the ECO-III project and disseminated widely in the country to create awareness about the Code and the major building systems that will be affected by it.

In India, the first national level initiative to collect and analyze standardized building energy use data (currently for 760 commercial buildings) has been carried out by BEE in partnership with the USAID ECO-III Project. This is especially relevant in the context of linking performance of ECBC-compliant buildings with an area-weighted normalized electricity index as specified in the EC Act. The average benchmarking indices for different building types (along with sub-classifications) are shown in Table 1 below (Kumar et. al. 2010).

Table 1: Benchmarks for Different Commercial Buildings in India

Number of Buildings	Building Type	Floor Area (m^2)	Annual Energy Consumption (kWh)	Mean Benchmarking Indices	
OFFICE BUILDINGS				**kWh/m²/year**	**kWh/m²/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/m²/year**	**kWh/bed/year**
128	**Multi-specialty Hospitals**	8,721	24,53,060	**378**	**13,890**
22	**Government Hospitals**	19,859	13,65,066	**88**	**2,009**
HOTELS				**kWh/m²/year**	**kWh/room/year**
89	**Luxury Hotels (4 and 5 Star)**	19,136	48,65,711	**279**	**24,110**

Source: Kumar et. al. 2010

The USAID ECO-III project, with assistance from US Department of Energy (Pacific Northwest National Laboratory) is developing the first generation ECBC Compliance Check (ECONirman) tool and a standard ECBC training program to assist BEE with the mandatory implementation of ECBC.

Institutional Set Up for Code Implementation

Implementation of ECBC involves various stakeholders at national as well as at the state level. The responsibility for the implementation of codes pertaining to buildings lies with the State level Urban Local Bodies (ULBs).

In India, Standards and Codes are developed at the Central Government level. Subsequently the Central Government advises all the State Governments and the stakeholders for their voluntary or mandatory adoption at the State level. This is applicable for implementation of ECBC as well.

Under the Prime Minister's *National Action Plan on Climate Change* (NAPCC), the Ministry of Urban Development (MoUD) at the Centre owns the overall responsibility of implementing ECBC under the *National Mission of Sustainable Habitat*, which is under development currently by MoUD. Keeping Climate Change issues in perspective, the mission envisages several mitigation measures including enhancement of energy efficiency in buildings.

MoUD has the responsibility of broad policy formulation and monitoring of programs in the areas of urban development, urban water supply and sanitation. These are essentially State subjects but the MoUD plays a coordinating and monitoring role and also supports these programs through schemes funded by the Central Government. MoUD addresses various issues of urban sector through policy guidelines, legislative guidance and sector-specific programs. The

Town and Country Planning Organization is a technical advisory and consultancy organization of the MoUD on matters concerning urban and regional planning and development strategies, research, monitoring and appraisal of Central Government schemes and development policies. This organization provides its technical and policy inputs to the concerned state level Urban Development Department(s), the apex body overseeing the activities of ULBs (ULBs include Municipal Corporations, Municipalities and Nagar Panchayats). In 2001, there were about 3,636 ULBs in the country.

ULBs regulate urban development and are responsible for town planning, regulation of land-use and construction of buildings, roads, bridges, etc. Each ULB in a state governs these developments at the town/city level through its General Development Control Regulation (GDCR) - a document which lays down the framework for individual plot level building regulations called building bye laws. GDCR covers all aspects of building construction including structural integrity, fire safety, seismic design, lighting, electrical, plumbing, sanitary facilities, ventilation, etc. GDCR generally incorporates broader issues of development and construction, whereas finer details get finalized by ULB’s in building bye laws depending upon context and situation. For each ULB, the formulation process of GDCR and contents of GDCR may vary although they all tend to follow a model template or language. The State Legislative Assembly approves GDCR on the recommendation of ULB’s Committee constituted for the purpose. Once any code or standard gets incorporated in GDCR document and is approved by the State Legislature, concerned ULB directs its Town Development Office to incorporate the provisions of the code or standard judiciously in the existing building bye laws and enforces its mandatory implementation in real situations.

In the context of ECBC implementation, general institutional arrangement discussed above is also likely to be adopted by the States, though variations from one state to another can be expected.

Other Building Codes and Rating Programs

Apart from ECBC, there are a few other building codes and building rating systems currently in use in India. These have been developed by different organizations for promoting energy efficiency and environmentally sustainable systems in buildings. These are as under:

National Building Code (NBC)

Bureau of Indian Standards (BIS) develops the National Building Code of India (BIS 2005). It is a comprehensive building Code, that provides guidelines for all building construction activities across the country. NBC serves only as a Model Code and not a mandatory Code for adoption by all organizations and agencies involved in building construction works. It covers limited guidelines on energy conservation in building systems. However a few provisions of the NBC have been incorporated in the ECBC.

Environment Clearance of Large Construction Projects

Ministry of Environment and Forest (MoEF) undertakes the Environment Impact Assessment and Clearance (EIA) for large building and construction projects (MoEF 2007). Builders and developers need to obtain an EIA clearance before construction. Per the stipulations, any building and construction project with built up area between 20,000 to 150,000 m^2, require EIA clearance from MoEF. While all township and area development projects covering more than 50 hectare (500,000 m^2) and built up area more than 150,000 m^2 in the states are required to get environment clearance from the State Environment Impact Assessment Authority.

After the introduction of ECBC by the Government, MoEF has started asking for ECBC compliance while undertaking EIA for all projects falling under their purview. At present, there are around 300 such projects, which have been given clearance by MoEF, and are under various stages of development.

Leadership in Energy and Environmental Design, LEED-India

Similar to the LEED rating system, developed by the U.S. Green Building Council (USGBC), LEED-India promotes a whole-building approach to sustainability by addressing performance in the following five areas: (1) sustainable site development, (2) water savings, (3) energy efficiency, (4) materials selection and (5) indoor environmental quality.

The LEED India rating system is managed by Indian Green Building Council (IGBC), promoted by Confederation of Indian Industry (CII) Godrej Green Business Centre. IGBC is comprised of key stakeholders in the construction industry, including government, companies, architects, product manufacturers, and research institutions. At present, 73 buildings in India are LEED certified (http://www.igbc.in).

Green Rating for Integrated Habitat Assessment

Having recognized that the LEED rating system largely focuses on air-conditioned buildings, while most Indian buildings are not air-conditioned, The Energy and Resources Institute (TERI), developed Green Rating for Integrated Habitat Assessment (GRIHA) — a rating system for new commercial, institutional and residential buildings (http://www.grihaindia.org/).

GRIHA rating system has incorporated the provisions of the NBC 2005, ECBC, and other Indian Standard codes. In 2008, GRIHA has been launched by the Ministry of New and Renewable Energy, the Government of India, The rating criteria includes extent of commercial energy use, renewable energy use, water use and recycling, waste management, etc. Presently two buildings have been rated under GRIHA.

In summary, ECBC has been developed as India’s first building energy code that focuses specifically on the compliance of minimum energy efficiency standards for commercial buildings. The National Building Code of India (2005) had been previously put in place as a comprehensive document to provide guidelines for regulating building construction activities across the country. However, the content says little about energy efficiency and focuses mainly on building design to prevent failure in the wake of a natural calamity. It is expected that both GRIHA and LEED-India voluntary rating systems will incorporate ECBC once it is made mandatory by the Government of India.

Table 2: ECBC with other Voluntary and Mandatory Programs for Buildings

Program	Organization	Framework	Building Type	Key Building Characteristics	Scope
ECBC	Ministry of Power/ BEE	Voluntary	Commercial	Connected load 500 KW ≥ or Contract Demand ≥ 600 kVA	Energy Efficiency
Environmental Clearance	Ministry of Environment and Forests	Mandatory	Commercial	Built up Area: 20,000 - 150,000 m^2	Environmental Impact
LEED - India	CII - IGBC	Voluntary	Commercial, Institutional, Residential	-	Sustainable design/green building
GRIHA	Ministry of New and Renewable Energy	Voluntary	Commercial, Institutional, Residential	-	Sustainable design/green building

Major Barriers to and Recommendations for Implementing ECBC

Implementation of ECBC is currently in a voluntary compliance phase since May 2007. No specific study so far has been carried out by BEE or any other organization to establish barriers towards its implementation. However while interacting with various stakeholders at various forums, following barriers and challenges (Table 3) have been identified by the authors of this paper, and corresponding recommendations have been developed as under:

ECBC Implementation Strategy

Development of a most suitable implementation strategy by the Government relies on several perceptions and the prevailing scenario. A few strategic options and focus areas, in the opinion of authors, which need to be considered by the Government in the development of an implementation strategy are discussed here:

Table 3: Barriers and Challenges for Implementation of ECBC

Barriers/Challenges	Recommendation
Design and Technical Barriers	
Technology and Aesthetics Integration: Energy efficient buildings are designed by incorporating several technical/engineering measures and their integration with aesthetics. Conventional design practice lacks close collaboration between architects and engineers.	Building designers need to restructure their working process to understand ECBC requirements and make concerted efforts to incorporate load reduction strategies and energy-efficient systems in the building design.
Newer Professional Requirements: Motivation among architects, consultants, and developers to familiarize with ECBC requirements can impede widespread acceptance and implementation of ECBC in real practice.	ECBC compliance is likely to be made mandatory in due course by the Government. It will be in construction industry's own interest to understand newer professional requirements and adapt these as part of standard professional practice.
Understanding of Building Physics and Energy Simulation: Incorporation and optimization of load reduction strategies and energy efficiency features in building design requires basic understanding of building physics and ability to model and interpret results from energy simulation tools in case of large buildings.	Initiatives are required both at educational and professional level to enhance the understanding of students and professionals in the field of Building Physics and Energy Simulation. Trained professionals can assist architects in energy analysis in an integrated design process
Lack of Domain Expertise: Designing for energy efficient HVAC and lighting systems are highly specialized areas. There is dearth of experts with requisite domain knowledge in the country forcing building designers to rely heavily on rules of thumb and vendors' views.	Development of unbiased expertise in specialized areas in educational and 'not for profit' institutions/bodies is needed on priority basis. Technically sound, unbiased and easy to use information related to energy-efficient design should be made available in the public domain.
Improving Skills of Building Trade Professionals: Lack of integrated design approach and good project and construction management practices reduce the final impact of energy-efficient design because of poor workmanship during building construction.	Focusing on skills development among various building trades professionals will lead to good workmanship that will improve the energy efficiency. Active involvement of vendors in skills development of service providers for energy efficiency needs to be promoted extensively.
Infrastructure Challenges	
Split Incentives/Principal Agent: The classic problem faced by the construction industry is a huge barrier in India. Developers don't want to invest in better infrastructure (e.g. energy-efficient buildings) if they are not confident of commanding a premium on such buildings.	To persuade/force developers/builders to finance, construct, and promote energy-efficient buildings, it is necessary to create market incentives, and policy/regulatory mechanisms that will lead to visible results. Better financing terms, mandatory disclosure of energy benchmarks, along with an awareness program can help address this issue.
Design Expertise: When faced with new building regulations, it may be difficult for builders/owners to understand the criteria they need to use to select an architect that assists them in designing ECBC compliant building.	Assistance from the authorities or authorized institutions to the building owners/users can include selection criteria and recommendations for determining expertise and experience of architects in executing ECBC compliant buildings.
Product Performance Specifications: Lack of availability of appropriate building materials, newer equipment and technologies to meet ECBC compliance	To transform market for energy efficient products, building designers need to demand products' technical specifications from vendors for ECBC compliance. Such

Barriers/Challenges	Recommendation
in buildings is a major barrier.	practices will eventually facilitate improved products' availability and their cost effectiveness.
Product Testing Facilities: There are many mandatory provisions in ECBC, which require testing facilities. In reality, very few government or 3rd-party testing facilities to evaluate performance of building materials and equipment exist today. This hinders the deployment of such products in the construction of ECBC compliant buildings.	Extensive testing infrastructure is urgently needed to evaluate performance of indigenously available building materials, insulation, glazing, window frames, HVAC equipment, lighting systems, etc. The Government needs to identify existing laboratories/institutions and strengthen them to facilitate testing requirements.
Educational Institutions: Lack of specialized courses and curriculum on energy and environment subjects in architectural schools in India along with inadequate availability of faculty members have been identified (Kumar et. al. 2009a). This leads to unavailability of qualified professionals to meet growing needs of energy efficiency in the building industry.	Several initiatives are needed to overcome these barriers in the prevailing scenario. Capacity building programs are needed for upgrading expertise of faculty members (educators and trainers) on energy efficiency in building designs. Simultaneously academic institutes are encouraged to introduce newer courses or undertake revisions in existing curriculum.
Policy and Enforcement Barriers	
Effective Compliance Mechanism: Enforcement of ECBC lies with the State Governments. The existing institutional set up and administrative mechanism in each state is ill- equipped to enforce ECBC compliance. There is also a need to mobilize stronger coordination between Central Government and the State Government, and proper delegation of responsibilities to the ULBs to enforce ECBC compliance.	There is an urgent need to strengthen the existing administrative mechanism both at the Center as well as at the State level by allocating higher level of financial and professional resources. Development of ECBC compliance tools, certification of ECBC experts who can review design specs and inspect construction of new buildings will assist enforcement authorities to initiate, regulate and monitor ECBC implementation program more effectively.
Recognition and Awards: Since ECBC compliance is presently on voluntary basis, there is no specific motivation for the building owners, building designers, building developers to follow ECBC requirements in the projects. This is leading to general complacency for energy efficiency in the construction industry.	Setting up an appropriate program for giving national and state level recognition to reward exemplary work in new construction that rigorously enforce ECBC can help in raising the profile of ECBC before it becomes mandatory.

Strengthen Administrative and Institutional Set-Up

The Prime Minister's National Action Plan on Climate Change (NAPCC) assigns the implementation of ECBC to the Ministry of Urban Development (MoUD) under the National Mission of Sustainable Habitat, which is under development presently. Figure 3 and Figure 4 illustrate the ECBC institutional set up and compliance process that may be needed at the state level, using state of Gujarat as an example. These have been developed keeping in mind the existing process for bye laws approval and how ECBC can be integrated with that process. Following steps are being proposed to implement ECBC at the State Level:

1. Ministry of Power or BEE notifies MoUD to initiate the process of ECBC implementation in the states through a Government Notification;

Figure 3: Proposed ECBC Implementation Process at the State Level

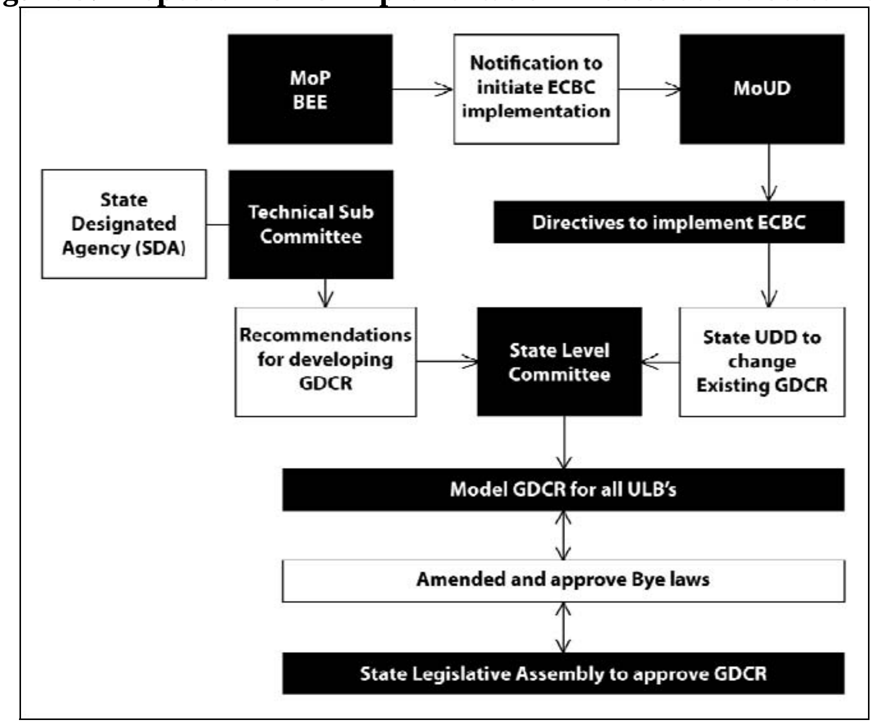
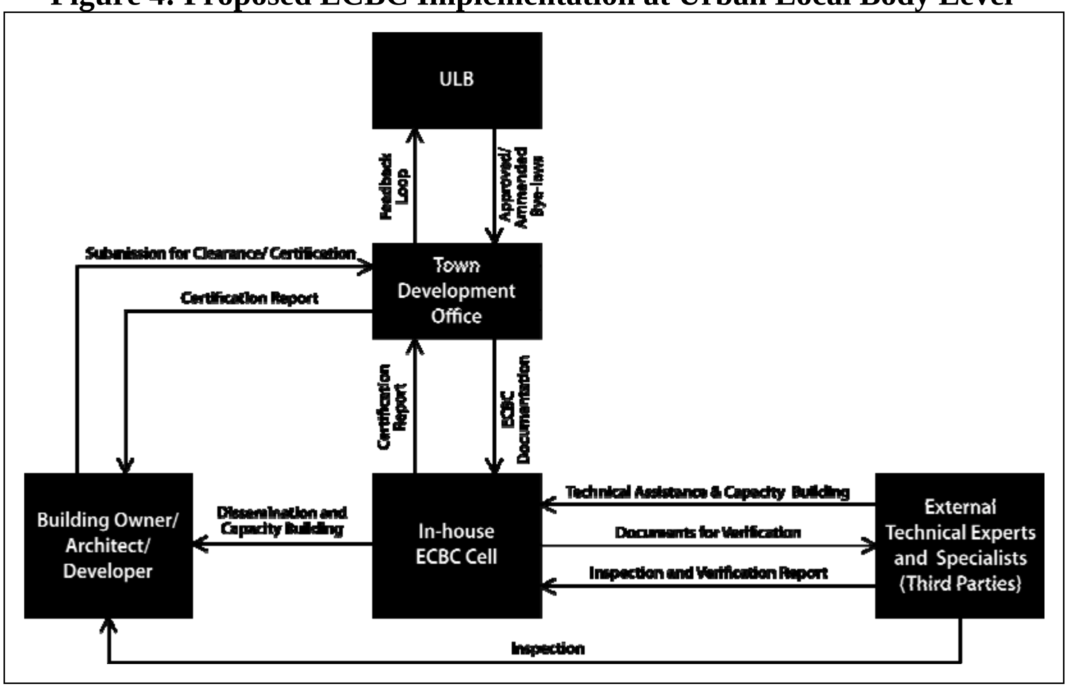


Figure 4: Proposed ECBC Implementation at Urban Local Body Level



2. MoUD issues directives to the State Government's Urban Development Department (UDD, the apex body for all the ULBs in the state) to adopt ECBC in the existing bye laws of various ULBs in the state.
3. UDD refers the matter to a state level committee to review and integrate ECBC provisions in existing General Development Control Regulation (GDCR), which governs

the bye laws of ULBs;

4. A Technical Sub-committee provides technical and administrative inputs pertaining to the integration of the ECBC clauses into GDCR;
5. UDD produces the revised “Model GDCR document” including ECBC integration clauses and submits the document to the State Legislative Assembly for approval;
6. The approved Model GDCR is circulated to ULBs for appropriate action and modification of bye laws, if needed.
7. The modified bye laws are kept at the Town Development Office (TDO) which is responsible for enforcement and compliance of the bye laws;
8. TDO can set up an in-house ECBC Cell with adequate number of specialists and build their capacity to deal with all issues associated with ECBC compliance;
9. TDO identifies, appoints and authorizes special institutions (as third-parties) within the state to facilitate periodic inspection and certification of ECBC compliance;
10. UDD monitors the compliance programs at the state level and reports to MoUD, MoP and BEE on a periodic basis.

Role of Government and other Stakeholders

Long-term success of the ECBC will depend heavily on the collaborative roles various stakeholders would play towards the development, adoption, implementation, and updating process of building code. These are briefly as under;

- **BEE:** The proposed role for BEE is as a continued facilitator and hub of supporting activities both at the Central and State Level. BEE may have to review its coordination role once the Ministry of Urban Development develops the ‘National Mission on Sustainable Habitat’ and the Mission becomes operational for implementation.
- **States:** Without adoption by the states, the ECBC will continue to be implemented in the government buildings only, and in a small number of additional private buildings through voluntary participation. Extensive state adoption is crucial for spreading wider acceptance of the ECBC in commercial buildings in the private sector.
- **Design professionals:** Architects and engineers will need to be directly involved in efforts to expand knowledge and understanding of ECBC and energy-efficient buildings. They will also need to be consulted on the type of technical assistance that must be developed for them. Documenting and sharing best practices on ECBC implementation in real situations could be beneficial.
- **Academic institutions:** Once architects get involved in professional practice, the time to learn and develop new skills is scarce, clients dictate project costs and time schedules, and integrating new approaches becomes difficult. Therefore integrating concepts of energy-efficient design and technology into architecture and engineering curriculum in professional colleges becomes essential. If this is taught at university level, along with other basic skills, upcoming professionals can use the skills as a guiding principle in designing all buildings.
- **Technical consultants:** Substantial expertise exists in the international energy efficiency field, related to building design, technical requirements, education, policy and program delivery. Drawing on international experience through a collaborative framework can lead to capacity building and knowledge transfer to Indian energy efficiency

professionals leading to a more sustainable approach where more buildings can benefit from the guidance of building energy efficiency consultants/experts. Technical consultants can develop specific resources needed for supporting ECBC implementation, drawing from their international experiences.

- **Industry:** Manufacturers of building materials, lighting, and MEP systems have the technology that can facilitate in designing and constructing energy-efficient buildings. It is in their business interest to provide accurate, reliable, and easy to use information so that their products are operated and maintained correctly to achieve maximum energy efficiency. Industry can also become a major player in Public Private Partnerships to develop the infrastructure and R&D facilities (e.g. Building Energy Performance Laboratory at CEPT University, Ahmedabad) that can benefit the entire sector.

Introduce Standard & Labeling Program for Building Materials and Systems

After meeting the mandatory requirements of the Code, there are mainly two approaches for complying with ECBC – one is a *Prescriptive Approach* that specifies performance requirements while selecting and installing building materials and equipment (insulation, windows, lighting, HVAC systems, etc.); the other is the *Whole Building Performance Approach* that allows flexibility in design but requires specialized energy simulation expertise. The primary benefit of the prescriptive path is its simplicity. Unfortunately, at present government or third-party laboratories cannot certify all the products and equipment necessary to comply with the ECBC. Therefore for the prescriptive path to be effective, a Standards and Labeling program for building materials and systems, similar to what has been initiated by BEE for home appliances, will be critical in promoting ECBC compliance.

Provide Technical Support

Energy codes may appear to be complex and difficult to decipher, particularly when these are being adopted for the first time. However, whether these are existing Code requirements or an update to existing Code, building professionals and consultants require assistance to ensure that buildings be built in accordance with the Code. Useful resources can include in-person training, how-to manuals/guides, and case studies, as well as enforcement checklists and compliance forms. In this context, BEE has organized several awareness programs nationwide for building professions. ECO-III has supported these initiatives and has developed a number of ECBC Tip Sheets and ECBC User Guide in association with BEE. Computer based ECBC Compliance tool is under development to assist designers and enforcement authorities in promoting ECBC implementation.

Build Capacity of Academic Institutions

Current academic training on energy-efficient design and construction techniques in India appears to be insufficient to support widespread implementation of ECBC requirements.

A survey on architecture educational curriculum conducted by the ECO-III Project brought forth many inadequacies of the education structure vis-à-vis the issues of energy efficiency, environment and sustainability (USAID ECO-III Project 2009b). Most institutes have indicated the lack of professional expertise to teach such courses as one of the major barriers.

Lack of good quality reference material in terms of books and research publications is also a major hindrance towards generating interest in building science subjects among students and teachers. It is also observed that adequate infrastructure in the form of diagnostic equipment, simulation labs and software is not available in most of the institutes.

It is essential to incorporate the fundamentals of building science, related to energy use, into typical architecture-related curriculum to build understanding and expertise.

Develop ECBC Network

To ensure a positive impact of ECBC at the national level, it is necessary for each state to adopt it as early as possible. Determining the best local administrative process for adoption and the most effective infrastructure for enforcement may not be an easy task, but it is one that can be supported through good networking of institutions and dissemination of useful information to the stakeholders. In going through the process, states will uncover effective strategies to support ECBC implementation and be in a position to share their best practices and lessons learned amongst various States and stakeholders. An *ECBC Best Practices Network* can be a web-based resource, but care should be taken to also support the distribution of the information in-person to assure widespread dissemination and include those who are without internet access. A Best Practices Network should be specific to the needs and circumstances of the state.

Move the Market towards High Performance Buildings

In a developing economy with improved energy efficiency as a primary goal, the ECBC needs to be implemented gradually and made increasingly stringent with time. Experience shows that design and construction techniques, as well as new products, are first implemented in a small handful of buildings as progressive efficiency measures. As understanding of the process and awareness increases, the cost of related products falls due to rising demand, and these practices become more widespread. Many measures become more cost-effective and can be used for improving the stringency of the code. Without programs to push new developments in building energy efficiency, the code enhancement would progress at a very slow pace, leading to limited improvement in energy efficiency of the buildings. Therefore it is important that ECBC implementation plan should encourage and support newer developments, which promote higher performance in the buildings.

Encourage Partial Compliance as an Intermediate Implementation Strategy

On this note, it may also be worthwhile to consider carrying out Code implementation in a phased manner. Instead of trying to drive Code implementation in its entirety, which can be daunting, technical support may be provided in a step-by-step manner. Under this approach, easy-to-understand guidance and training can be provided for specific systems and components, one at a time. For example, early efforts may focus on building capacity for professionals, vendors and compliance authorities solely on bringing current building practices up to the envelope requirements stated in the ECBC. This may even be broken down into smaller efforts such as insulation, glazing, etc., that may be carried out either sequentially or concurrently. Subsequently, the focus can then be shift to, say, lighting systems, HVAC system, etc.

Conclusions

Ministry of Power, Government of India and BEE under EC Act has taken major initiatives to improve energy efficiency in new commercial buildings through the development of ECBC and announcing its adoption on voluntary basis in the country. Though the adoption and implementation of ECBC lies with the State Governments, BEE has been promoting awareness on ECBC amongst the building designers and the concerned state level authorities through nationwide awareness workshops and training programs. Since 2007, USAID supported ECO-III Project has been assisting BEE in this national task and has developed ECBC User Guide and number of ECBC Tip Sheets to raise capacity of professionals in the building construction Industry. However implementation of ECBC at the State level and incorporation of ECBC provisions in real building designs continue to pose several challenges. Though no in-depth study has been undertaken so far by BEE or any other organization to analyze and document problems associated with the implementation process, several barriers have been identified through interactions with the stakeholders. These include the following:

- Lack of clarity in the institutional and administrative set up and compliance mechanism at the state levels to enforce ECBC;
- Inadequate in-depth knowledge and expertise amongst majority of practicing architects, engineers and consultants, to incorporate ECBC provisions in the building design;
- High cost of energy efficient building equipment and building materials in the market as a result of low demand;
- Inadequate products and material testing labs to meet mandatory provisions of ECBC;
- Absence of market forces and lack of awareness among building owners/users on the long term financial benefits of Energy Efficient/ECBC compliance buildings;
- Inadequacy of faculty and trainers with specialized knowledge and expertise in existing academic architectural/engineering and professional institutions to educate/train students and professionals on energy efficiency aspects in buildings.

Considering that the construction sector will experience rapid growth over the next twenty years, BEE with support from Ministry of Power and Ministry of Urban Development, need to take the lead in developing an ECBC Implementation Roadmap, which should include the following components:

- Strengthening of institutional/administrative set up and creation of in-house ECBC compliance cells in municipal authorities in states;
- Identification and authorization of institutions and organizations to function as third party certification agencies for ECBC compliance in buildings;
- Selection of institutions to enhance capacity of building designers, consultants, educators, etc. through nationwide training programs on ECBC and building energy efficiency;
- Enhancement of educational curriculum for upcoming architects and engineers in selected academic institutions to meet growing needs of energy efficiency in buildings;
- Identification and strengthening of existing labs to meet building products' testing and certification requirements of ECBC;
- Creation of forums to interact with building materials and equipment manufacturers to create market pull for efficient products;

- Introduction of a scheme that promotes compliance of a few specific easy to implement ECBC prescriptive provisions as transient strategy in the on-going voluntary compliance phase of ECBC adoption;
- Recognize/reward building developer/designer for undertaking exemplary work for implementing measures to meet ECBC compliance partially/fully in buildings.

References

ASHRAE. 2004. "**Energy Standard for Buildings Except Low-Rise Residential Buildings**", www.ashrae.org, Atlanta, GA, USA

[BEE] Bureau of Energy Efficiency. 2008. "**Energy Conservation Building Code 2007**". New Delhi, India.

[BIS] Bureau of Indian Standards. 2005. "**National Building Code**". New Delhi, India.

[CEA] Central Electricity Authority. 2005. "**All India Electricity Statistics, General Review 2005**". New Delhi, India: Ministry of Power

[CEA] Central Electricity Authority. 2009. "**All India Electricity Statistics, General Review 2009**". New Delhi, India: Ministry of Power.

Ministry of Power (2001): "**The Energy Conservation Act 2001**". New Delhi, India.

[MoEF] Ministry of Environment and Forests. 2007. "**Manual on Norms and Standards for Environment Clearance of Large Construction Projects**". New Delhi, India.

McKinsey & Company. 2009. "**Environmental and Energy Sustainability: An Approach for India**". Mumbai, India.

Planning Commission. 2006. "**Integrated Energy Policy, Report of the Expert Committee**". New Delhi, India.

Satish Kumar, Anurag Bajpai, Rajan Rawal, and Sudha Setty. 2009. "**A Need for Curriculum Enhancement in Architecture Education to Promote Sustainable Built Environment and Mitigate Climate Change**", International Conference of Education, Research and Innovation (ICERI), Madrid, Spain.

USAID ECO-III Project. 2009a. "**Energy Conservation Building Code User Guide**", ISBN Number: 978-81-909025-3-3. New Delhi, India: Bureau of Energy Efficiency

USAID ECO-III Project. 2009b. "**Background Paper on Architecture Curriculum in India**". New Delhi, India.

Satish Kumar, Madhav Kamath, Saket Sarraf, Sanjay Seth. 2010. "**Benchmarking Energy Use in Indian Commercial Buildings – A Preliminary Report**". New Delhi, India.