Energy Code Enforcement for Beginners: A Tiered Approach to Energy Code in India

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ABSTRACT

In the next 18 years, India will add 67% of the floor space projected for 2030, or about 2.3 billion square meters. Buildings consume 33% of total energy in India and this is growing at 8% per annum. For a large scale market change, the Bureau of Energy Efficiency developed the Energy Conservation Building Code (ECBC). Through mandatory ECBC compliance, India can achieve an annual energy saving of 1.7 billion kWh. The rate of compliance with ECBC is forecasted at 10% until 2013, 35% in 2015 and 65% by 2017. To achieve this, ECBC must be adopted by the states and barriers to enforcement by local governments must be overcome.

Shakti Sustainable Energy Foundation funded a study to develop a tiered approach to compliance, with evaluation of individual ECBC measures for energy savings, incremental cost, and ease of enforcement. The findings were peer reviewed and the measures were then bundled in to tiers. Lower tiers include ECBC measures that are easy for market adoption, and are enforceable through the current building permit process. This will help build capacity over time and allow developers to get experience with building energy efficiency. It will help enforce ECBC and build capacity at same time without reducing stringency of the code. This approach can be enforced more effectively given the current construction and real estate practices.

This paper summarizes the analysis and presents the policy case for the Tiered approach.

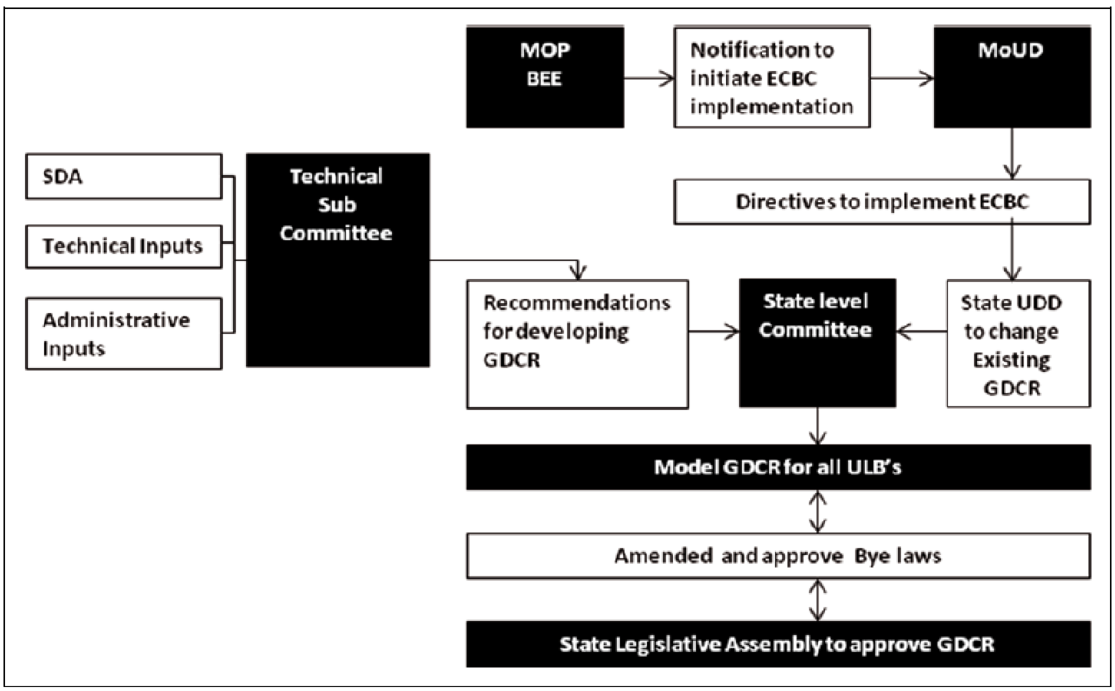
Introduction

Background

Indian cities house approximately 340 million people presently, which is estimated to grow to approximately 540 million, or about 40% of the population by 2030 (McKinsey 2010). Rapid urbanization increases the demand for commercial work places. The commercial building sector is expanding at approximately 9%. The Central Electricity Authority estimates that India experiences a shortage of 9.9% and peak demand shortage of 16.6% (CEA 2009). Out of total floorspace of 2030, only 33% exists in India presently and another 67% will be added in next 18 years (Kumar 2010). The need for office space is also rising with 5.5 million square meters of office space added annually in the top seven Indian cities, with total office floor space rising to more than 28 million square meters (CBRE 2011). Increasing internal loads and thermal comfort aspirations of the occupants also add to the electricity demand. Presently, over 33% of overall energy is being consumed by buildings and this is growing at 8% per annum. Given this growth, ensuring that each new building development is energy efficient must become a top priority of policymakers.

Recognizing the importance of energy conservation and efficiency, the Government of India enacted Energy Conservation Act in 2001. The Bureau of Energy Efficiency (BEE) was established in 2002 to develop policy with an emphasis on self–regulation and market principles. The primary objective of BEE is to reduce energy intensity of the Indian Economy providing leadership in buildings and eleven identified industries. BEE launched the Energy Conservation Building Code (ECBC) in 2007, which prescribes a minimum standard to achieve energy efficiency in buildings. ECBC has the potential to reduce average energy consumption by 30-40% in new commercial buildings across all five climate zones. The Government of India launched eight national missions, which are part of the core National Action Plan on Climate Change (NAPCC), committing to significant goals in the context of climate change. One of the missions, the National Mission on Sustainable Habitat (NMSH) will bring various central government departments, state level departments, non-governmental voluntary organizations and civil society under one aegis to work towards implementation and enforcement of ECBC at the urban local body (ULB) level. Various bi-lateral, multi-lateral collaborative programs with United States Agency for International Development, United Nations Development Programme and Swiss Agency for Development and Cooperation are working with BEE to build capacity within India for ECBC. Targets set for the 12th Five Year Plan, starting from April 2012 to March 2017 are expected to drive ECBC adoption, implementation and enforcement across India. It is forecasted that the ECBC compliance rate for commercial buildings would be at 65% in 2017, at the end of 12th five year plan (UNDP 2011).

Figure 1. ECBC Implementation Process



Similar to other federal republic countries, local governments in India have powers to implement national policies at local levels (see figure 1). To implement national level initiatives, both bottom up and top down approaches are used. However, the top down approach is predominant. In reality, this means that ECBC will be mandated by the state level urban development departments (UDD) on the recommendation of the Ministry of Urban

Development. States need to adopt ECBC and have it enforced at the ULB level. ECBC offers flexibility for states to amend the code to suit regional or local climatic conditions. Upon amendment, the state UDD needs to notify all ULBs to adopt ECBC in their jurisdictions. At various stages of implementation, these processes get approval from the state legislative assembly as well as the local government. In every state, each ULB is responsible for city level development by following the state level General Development Control Regulation (GDCR). GDCR outlines the framework for land use and building bye laws. It is essential for a ULB to clarify the enforcement mechanism to the citizens. Each ULB needs to develop capability to address ECBC implementation and enforcement procedures. Although these procedures may be the same for all ULBs, their institutionalization is crucial.

Code Compliance Challenges

ECBC interlinks standards and guidelines of various standard setting bodies like Bureau of Indian Standards, National Building Council, ISO 15009, ASHRAE, etc to integrate best practices. BEE projects that India can achieve 1.7 billion kWh of energy savings annually through mandatory ECBC compliance. ECBC is specific to 5 climate zones of India and applies to new buildings with connected load of 100 kW or greater or a contract demand of 125 kVA or greater (BEE 2007). Code compliance is achieved through two methods: Prescriptive Method and Whole Building Performance (ibid).

In 2005, India's National Building Code (NBC 2005) was revised with respect to regulating building and plumbing services to be consistent with international practices. However, mandatory building energy performance standards are not part of the code. Despite some success stories, implementation of NBC is not common and enforcement of structural, plumbing and electrical codes is almost non-existent. Although the NBC defines seismic zones and contains construction measures for structural systems, these measures are not enforced uniformly. ECBC contains a set of requirements for energy performance of building systems that include building envelope, lighting, electrical and HVAC systems. Building codes in India are adopted by amending the local bye-laws and ULBs are responsible for their enforcement. ULBs are short-staffed and their technical personnel include mainly civil engineers who do not possess the building science knowledge needed to enforce the performance requirements in ECBC. Thus energy code enforcement in India is a significant challenge, similar to other developing countries (Deringer 2004). Many buildings in India are built in the speculative real estate sector, where lighting and HVAC items are added in by the tenants. Under the current building permitting process, permits for occupancy are issued by the ULBs at the time of construction completion when tenant improvements are not completed. Indeed, in most cases, tenant leases are only signed after the ULB issues the occupancy certificate. Given this, it will be impossible for ULBs to check for compliance with all ECBC requirements under the current practice. Figure 2.1 shows a conceptual state of the current building energy efficiency market; figure 2.2 shows the market transformation that would occur as a result of perfect enforcement; and 2.3 shows the market transformation that might occur with the significant barriers to enforcement that have been identified here.

However, it is essential to start implementing code without waiting for all capacity building to be ready first. Early learning from code implementation will help to develop alternative enforcement approaches; and ULBs will be able to save energy during this early implementation of ECBC. Vaidya et. al. (2010) recognized these challenges and proposed the formation of Tiers of ECBC. Tiers prepare the industry towards ECBC compliance during the timeframe that ECBC moves from being voluntary to mandatory; and the proposed approach will build capacity and allow developers to get experience with energy efficient design and construction and in turn will help to implement ECBC in the long term. Shakti Sustainable Energy Foundation funded the background research, peer review process, and the formulation of the ECBC Tiers.

The Tiered Approach

In a tiered approach for compliance with ECBC, Tier 1 can include those requirements of ECBC that are easy for market adoption, have high return on investment (ROI), and are enforceable through the current building permit process. Tiers 2 and 3 can include additional measures that are more difficult to implement or enforce. Figure 2.4 shows the market transformation that could be achieved through such a tiered approach.

Figure 2.1. Business As Usual Case

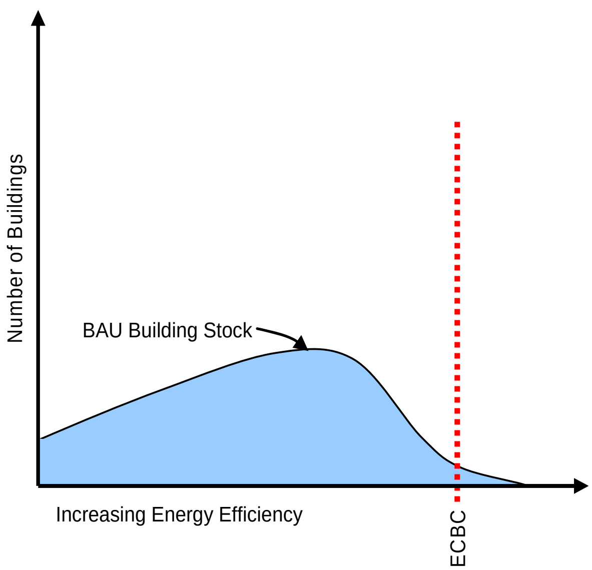


Figure 2.2. Market Transformed with Perfect Enforcement

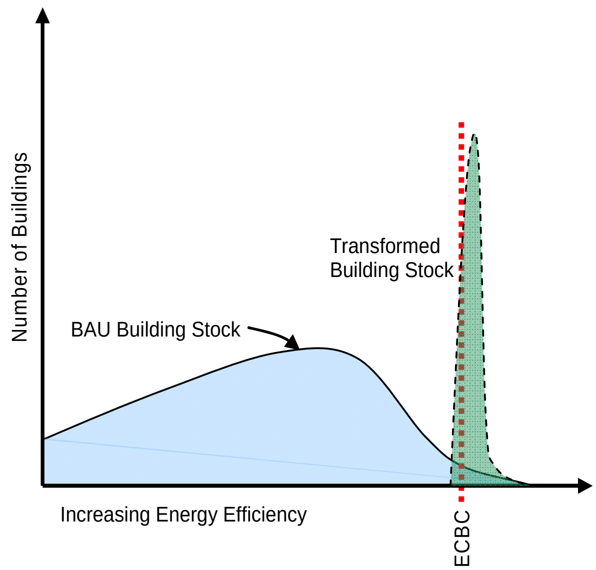


Figure 2.3. Market Transformed with Expected Enforcement

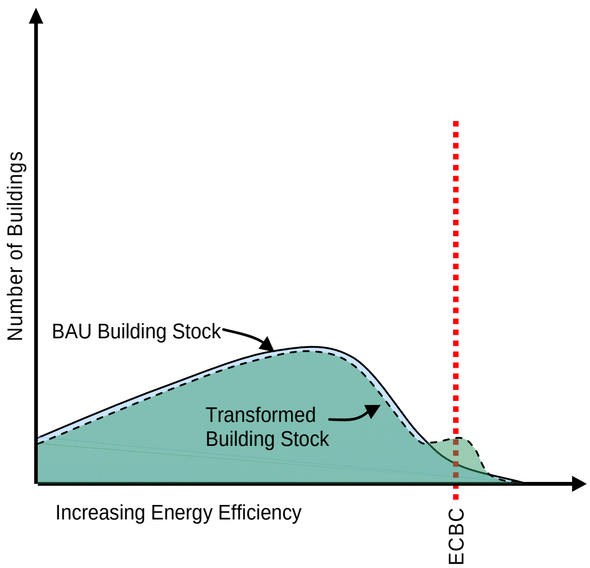
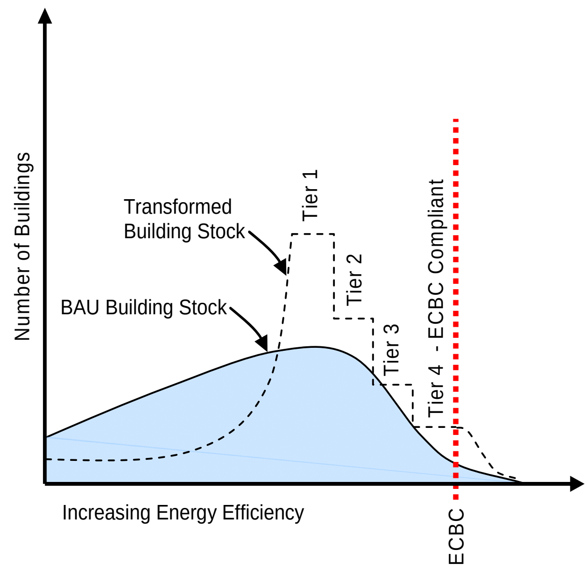


Figure 2.4. Market Transformed with Voluntary Packages with Incentives



By keeping Tier 1 easier for market entry, the compliance rates for Tier 1 can be higher, with significant energy savings.

Since the requirements of the Tiers are made explicit, there will be no need for local flavors of interpretation of the ECBC requirements to make them easier for the local market. A building owner that attempts Tier 1 will be recognized for completing a set of requirements, as opposed to being penalized for not completing the requirements in the higher tiers. This builds success stories and encourages builders and developers to attempt the higher tiers in subsequent building projects. The tiered requirements can be incorporated in to the local building bye laws more easily for mandatory compliance. The tiers are formed based on evaluation of each Energy Conservation Measure (ECM) in ECBC for

- The energy savings potential over the Equipment Useful Life of the ECMs
- Enforceability and implementability given current market conditions
- The Return-on-investment (ROI) value to the building developer

Research Methodology

Energy Analysis

Energy analysis to evaluate the savings potential for each ECM in ECBC was done with DOE2 simulations. A total of 75 individual ECMs were identified through a detailed review of the ECBC (The Weidt Group 2011b). Office as a building type was found to be the most common building type coming up in India. The office building was considered with three building area sizes[1], five climate zones, two building operation schedules and three building plan geometry aspect ratios. Table 1 summarizes these conditions. An exhaustive combination of these conditions result in ninety different building scenarios. The Business-as-usual (BAU) models and the ECMs are simulated for each of the 90 building conditions resulting in over 5,000 simulation runs. Each building plan shape was developed as a realistic architectural design.

Table 1. (Building Cases Analyzed)

Climate	Hot Dry	Cold	Warm Humid	Temperate	Composite
Building size (m^2)	500	1000	2500		
Floor plan aspect ratio	1:1	1:2	2:1		
Building operation Hours	24	8			

Baseline or Business as Usual (BAU) Definition

A BAU scenario was defined as the characteristics of a building that represented current construction practices. It was identified through ground level research for each climatic zone. This included building system characteristics, building use schedules, thermal comfort set-points, schedule for enabling cooling and heating systems, fuel types, and electricity rates.

Cost estimation

The BAU scenario and the improved efficiency scenario costs were estimated in detail to arrive at the incremental cost for each ECM (The Weidt Group 2011b). This exercise included cost calculations for each component of the system to arrive at the total assembly cost for each system. Cost of raw material at site, installation cost, taxes and prevailing business practices for profit margins were included to arrive at cost of each ECM. Quantity estimates for each building configuration were derived from the energy model, and overall costs for each measure were calculated accordingly. These costs were then normalized to the floor area.

Implementability and Enforceability

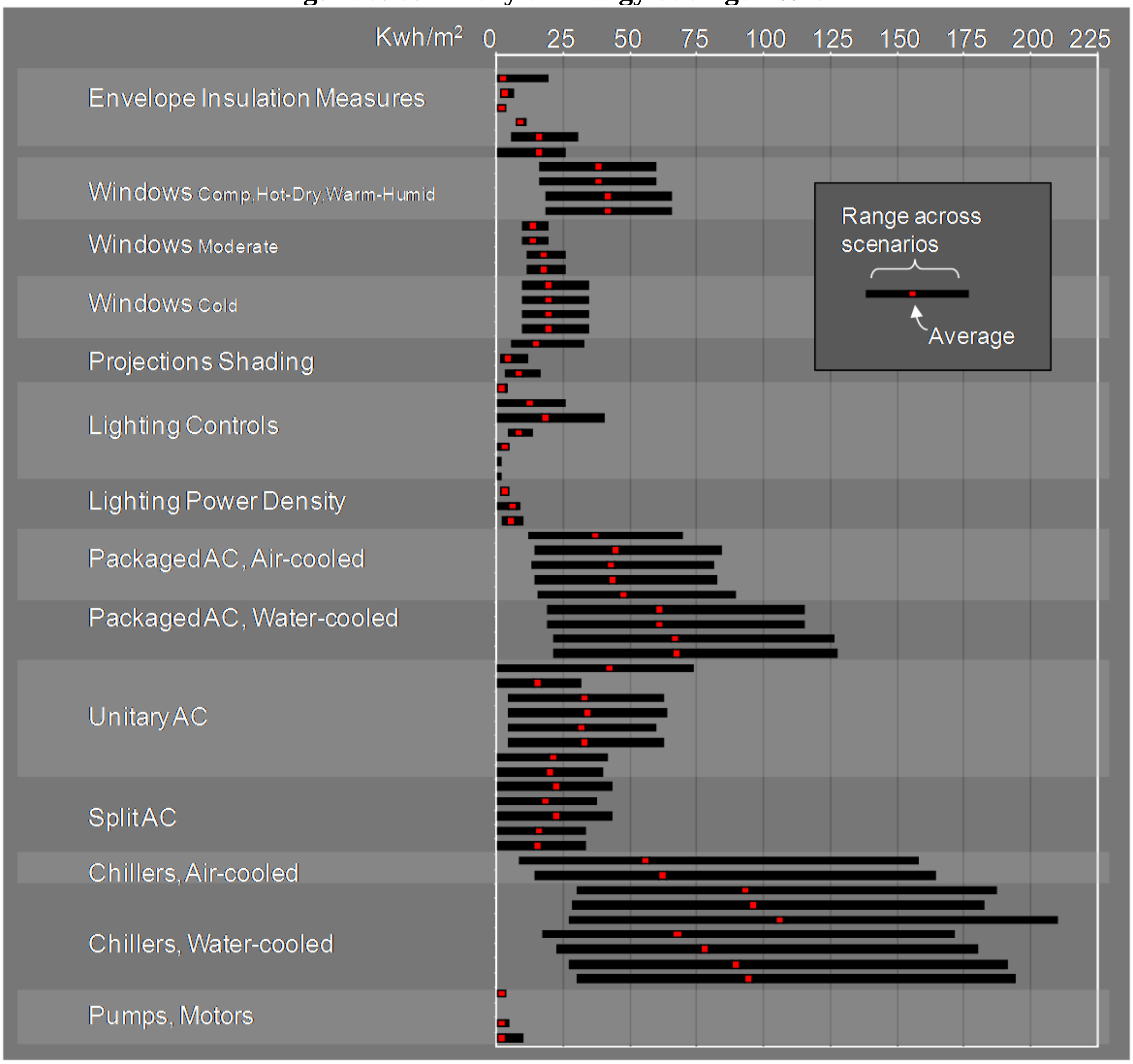
Each ECM was further evaluated for implementability and enforceability on a scale of one through five with one being very easy and five being very difficult. Implementability was evaluated for the current level of expertise in the industry (designers and contractors). Enforceability was evaluated for the local government officials' ability to check the ECM in construction documents and also for their ability to check the ECM on-site (The Weidt Group 2011b).

[1] Market research indicated that these building sizes would be especially challenged in terms of ECBC implementation and enforcement. These sizes come under the purview of the ECBC and are common in second and third tier cities where enforcement would be especially challenging. Smaller buildings are designed and constructed by developers with less wherewithal and sophistication to hire adequate industry expertise.

Peer Review

The evaluation for energy savings, costs, ROI, implementability and enforceability was peer reviewed at a workshop by industry experts (SSEF 2011).

Figure 3. Summary of Energy Savings kWh/m²

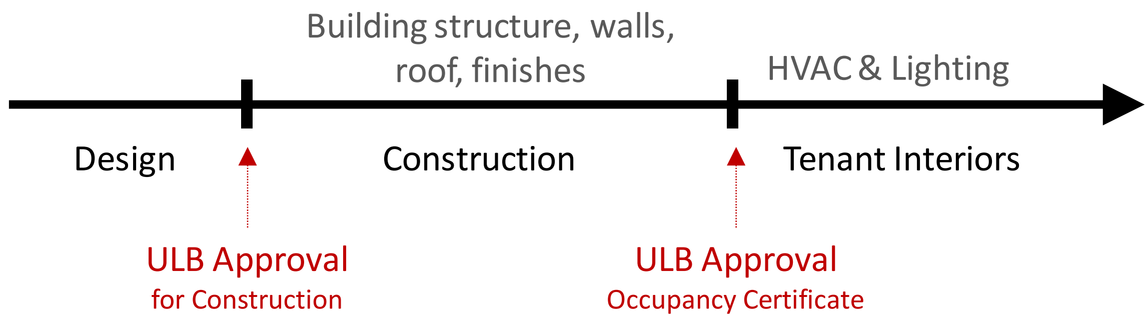


Individual ECM Energy Results Summary

Annual energy consumption of business-as-usual buildings ranges between 140 and 633 kWh/m² with an average of about 360 kWh/m². The results indicated that measures show a wide range of potential energy savings compared to business-as-usual scenarios. The energy savings for an individual measure are as high as 40%. The incremental construction costs for an individual measures are as high as 5500 Rs/m^2. See Figure 3 [2] for a summary of the energy savings observed across all ninety scenarios that includes all building configurations, use schedules, and climate zones.

The results across these measures were analyzed to identify consistent patterns in energy savings by climate zone, size of building, and use schedules. The most consistent changes in savings for the measures were observed based on climate zones. The Tiers were thus customized for each climate zone.

Figure 4. (Typical Process for Design, Construction and ULB Approvals)[3]



Tier Formulation

The consensus during the peer review workshop was that the Tiers would need to be customized by ECBC climate zones. The research team reviewed the ECBC measures analysis results and discussed the issues of implementation and enforcement given the current building approval process in typical ULBs. Two approaches for the Tiers were proposed:

Approach 1

Under this approach the Tiers are arranged so that the highest energy savings are included in the first Tier. ECMs with high energy savings are in Tier 1, followed by moderate energy savings in Tier 2 and those with lower energy savings in Tier 3. This rational ensures that high energy savings are achieved even when only first Tier is implemented.

Approach 2

This approach takes into consideration the current process of building design construction, permitting and real estate leasing (Figure 4). The Tiers in this approach are developed so that the requirements are in sync with the building systems that have been completed at the time of occupancy certificated. This approach relies on the BEE's appliance labeling program for enforcing the HVAC efficiency measures and a potential third party check for lighting measures. Tier 1 contains ECMs that can be checked when the building shell is

[2] Figure 3 is included to provide a very high level summary of the energy results of the individual ECMs across all scenarios. The exhaustive analysis of the patterns of savings is not included here in the interest of brevity.

[3] Figure 4 shows that within the current permitting process where energy codes don't exist, in most buildings HVAC and Lighting are installed after the ULB has given an occupancy certificate. Given this process, the ULB has no leverage to enforce the code for HVAC and lighting equipment.

completed and ready for approval given the current construction approval process of most ULBs. Tier 2 contains ECMs that could be implemented by the developer/owner with labeling programs as the mode of enforcement. Tier 3 contains measures may require an independent Third Party Assessor to do the compliance check, or may require a change in the way ULBs currently provide building completion approvals. With this approach, the compliance check process is aligned with current building permitting process, making it easier for enforcement compared to Approach 1. The arrangement of the Tiers in this approach also results in the highest cumulative lifetime energy savings based on Equipment Useful Life (EUL) for measures in Tier 1; measures in Tier 2 and 3 have lower cumulative lifetime savings (see Figure 5).

In each case, the Tiers are additive, i.e. Tier 2 contains all the measures in Tier 1 in addition to those identified for Tier 2; Tier 3 contains all the measures in Tier 2 in addition to those identified for Tier 3.

Figure 5. Lifetime Energy Savings with Approach 2

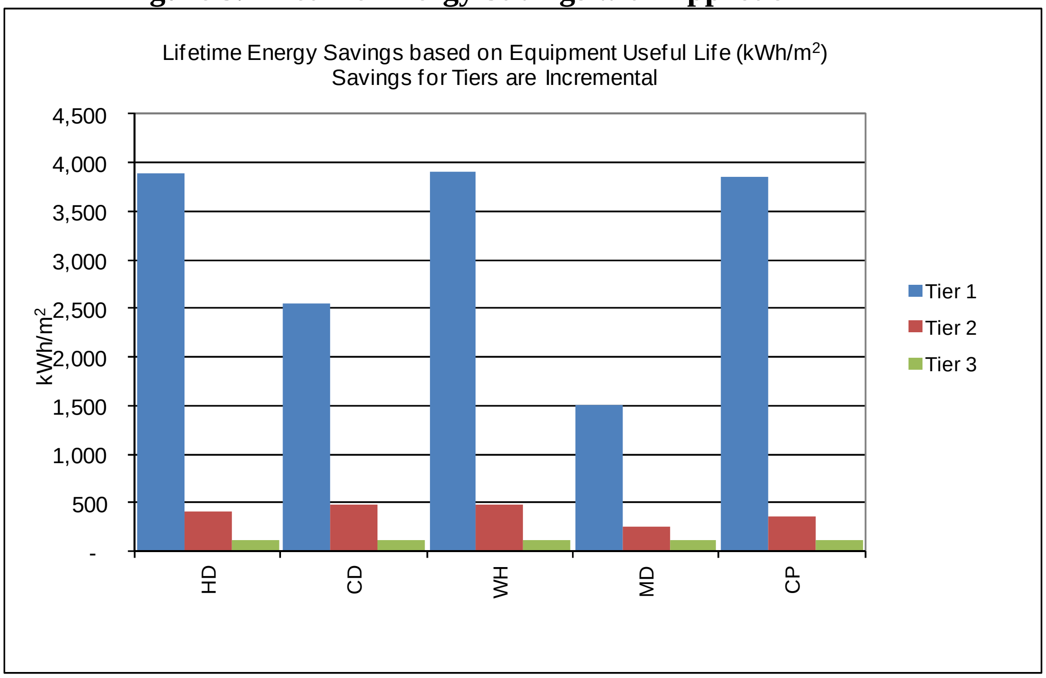


Table 2. Tiers Formulated with Approach 1 – Annual Energy Savings Potential

Climates	Tier 1	Tier 2	Tier 3
		Includes all measures of Tier 1 (respective climate) and the following	**Includes all measures of Tier 2 (respective climate) and the following**
Composite	HVAC equipment efficiency measures, Vertical Fenestration Measures, Window Shading measures, Opaque Wall and Roof assembly measures	-	Lighting Control measures and Interior Lighting Power measures
Hot-Dry	HVAC equipment efficiency measures, Vertical Fenestration Measures, Window Shading measures	Opaque Wall and Roof assembly measures	Lighting Control measures and Interior Lighting Power measures
Warm-Humid	HVAC equipment efficiency measures, Vertical Fenestration Measures, Window Shading measures	Opaque Wall and Roof assembly measures	Lighting Control measures and Interior Lighting Power measures
Moderate	HVAC equipment efficiency measures, Vertical Fenestration Measures, Window Shading measures	Opaque Wall and Roof assembly measures	Lighting Control measures and Interior Lighting Power measures
Cold	HVAC equipment efficiency measures, Vertical Fenestration Measures, Window Shading measures, Opaque Wall and Roof assembly measures	-	Lighting Control measures and Interior Lighting Power measures

Table 3. Tiers Formulated with Approach 2– Enforcement Method

Climates	Tier 1	Tier 2	Tier 3
		Includes all measures of Tier 1 (respective climate) and the following	**Includes all measures of Tier 2 (respective climate) and the following**
Composite	Vertical Fenestration Measures, Window Shading measures, Opaque Wall and Roof assembly measures	HVAC equipment efficiency measures	Lighting Control measures and Interior Lighting Power measures
Hot-Dry	Vertical Fenestration Measures, Window Shading measures, Opaque Wall and Roof assembly measures	HVAC equipment efficiency measures	Lighting Control measures and Interior Lighting Power measures
Warm-Humid	Vertical Fenestration Measures, Window Shading measures, Opaque Wall and Roof assembly measures	HVAC equipment efficiency measures	Lighting Control measures and Interior Lighting Power measures
Moderate	Vertical Fenestration Measures, Window Shading measures, Opaque Wall and Roof assembly measures	HVAC equipment efficiency measures	Lighting Control measures and Interior Lighting Power measures
Cold	Vertical Fenestration Measures, Window Shading measures, Opaque Wall and Roof assembly measures	HVAC equipment efficiency measures	Lighting Control measures and Interior Lighting Power measures

Tables 2 and 3 summarize the types of measures that are included in each Tier for each approach. Table 4 summarizes the cumulative savings compared to the BAU case, and Table 5 summarizes the simple payback for implementing the Tier in a building compared to BAU. Both approaches lead to Tier 3 achieving the same final result.

Table 4. Tier Annual Energy Savings in % kWh/m2

Climate	Approach 1: Based on Energy Savings Potential Tier 1	Approach 1 Tier 2	Approach 1 Tier 3	Approach 2: Based on Enforcement Method Tier 1	Approach 2 Tier 2	Approach 2 Tier 3
Composite	29%	29%	36%	22%	29%	36%
Hot-Dry	22%	28%	35%	21%	28%	35%
Warm-Humid	25%	29%	36%	20%	29%	35%
Moderate	15%	17%	27%	10%	17%	27%
Cold	25%	25%	32%	15%	25%	32%

Table 5. Tier Payback Period in Years

Climate	Approach 1: Based on Energy Savings Potential Tier 1	Approach 1 Tier 2	Approach 1 Tier 3	Approach 2: Based on Enforcement Method Tier 1	Approach 2 Tier 2	Approach 2 Tier 3
Composite	7.5	7.5	6.7	10.2	7.5	6.7
Hot-Dry	7.3	6.0	5.7	8.1	6.0	5.7
Warm-Humid	6.5	5.8	5.5	8.4	5.9	5.5
Moderate	11.5	11.1	8.6	19.0	11.1	8.6
Cold	9.4	9.4	8.0	15.4	9.4	8.0

Conclusions and Policy Recommendations

Deconstructing ECBC in to tiers will help the implementation of ECBC at the state and local levels. ULBs officials are conversant with building activities which relate to the building bye-laws they have checked in the past. These include building structure, envelope and plumbing, and within ECBC they relate to the envelope measures. Since these measures have a very long EUL, the cumulative lifetime energy savings due to these measures are large. ECMs pertaining to walls, roof and fenestration can be more easily enforced by ULBs and have the largest impact on savings. From a policy perspective, the tiers formulated using approach 2 (enforcement method) described above are likely to result in higher compliance rates for Tier 1 and result in larger cumulative lifetime energy savings.

Within the Tiered Approach to ECBC, the occupancy certificate will be issued by the ULB for compliance with Tier 1 of ECBC. HVAC systems efficiencies will be enforced through an expanded labeling program. Lighting system installations will be checked by independent Third Party Assessors.

ECBC implementation can realistically be done only by integrating it in to building bye laws. Bye-laws currently are prescriptive in nature. Integrating ECBC through the Tiered approach in building bye laws is a realistic goal, and will add minimal burden on ULBs. It will also allow building developers and the UBL to follow prevailing system of building permit approvals.

Under the guidance of BEE and Ministry of Urban Development, Shakti Sustainable Energy Foundation is meeting with the policy makers related to ECBC adoption and enforcement. To assist with the mandatory compliance of ECBC, the requirements of the ECBC Tiers could be incorporated in to the model bye-laws at the central government, and in to the local bye-laws by the ULBs. The ULBs include Municipal Corporations, Development Authorities, Town and Country Planning Authorities etc. BEE's State Designated Agencies (SDA) will play a coordinating role and provide technical assistance to the ULBs. Further, to achieve this in the various regions of India, a dialogue between technical experts, BEE, experts in governance and government officials is essential. The SDAs which are responsible for ECBC implementation in each state, will need to step in aggressively to bring all stakeholders for the dialogue. Over the short term, BEE has a significant role to play for ECBC implementation and enforcement. During this time frame, BEE will continue to be the nodal agency that sets the technical and quality standards for how ECBC is implemented in buildings and the level and mode of enforcement that is done. As the market gains momentum in these areas BEE can focus on updating ECBC to achieve higher levels of energy efficiency in buildings in India.

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