

The role of Energy Conservation Building Code 2017 in Indian Energy Policy

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Abstract: With the advancement in technology and the need for development by both developed and developing countries, energy plays a vital role in the whole process of sustainability. India's security score has been declining since 2000 due to decrease in energy storing capacity, scarcity in primary energy supply sources and to much dependency on import. The World Energy Council's latest Energy Trilemma Index covering 128 countries shows how energy policies are changing around the world. India's energy policies and infrastructure are rated among the worst in the world with 109th rank with overall score of 50.3. India scores high on Energy Security but struggles on sustainability and equity indicators giving clear indication on revisiting ECBC 2017. This paper reviews and compares ECBCs between two versions of the code titled ECBC 2007 and ECBC 2017 and identify the role of human behavior as a missing link. This paper suggest Low Cost Energy Conservation Measure focused on sustainability and environment.

Keywords: Energy Conservation Building Code (ECBC) 2017, Energy Conservation, Energy Conservation Act 2001, Human Behavior, Indian Energy Policy, Sustainability.

I. INTRODUCTION

The world today is moving away from fossil fuels. The global energy policy is increasing focus on the environment and sustainability. The pressing concern for many regions around the world are affordable access to energy and stable infrastructure (Iftikhar Fatima et al., 2015). The developed countries have ensured affordable energy access today and also taken steps to ensure future demands can be met (Ahuja and Tatsutani, 2009). The Government of India also has introduced two-way tactic to meet the energy mandate while safeguarding minimum increase in CO₂ emissions. Firstly, encouraging more use of alternate energy mainly through wind power and or solar energy in the generation side. At the same time replacing the old technology with the new and energy efficient technology in power plants using fossil. Secondly, the efficient utilisation of energy in DSM application the opportunities provided in ECA 2001. BEE came into existence as a statutory body in 2002 under the Ministry of Power for implementation of ECA 2001 and achieve energy independence by 2020 as the national vision given by the then president of India Dr. APJ Abdul Kalam. The "Trilemma Index" evaluates countries on their capability to deliver maintainable energy through three extents. These extents are security of energy, energy availability and affordability and environmental sustainability (Indriyanto et al., 2010). India's position on the energy security index is high. It is because of dropping in position almost every year since 2000 mainly due to the reasons like storing capacity reduction, non-availability of primary energy supply sources and to much dependency on import.

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It is the truncated energy equity and sustainability prevalent with the current realities make India a score of Fifty, which is a mid-point in sustainable energy index (ET, 21 October 2019). According to the Government of India in the "Integrated Energy Policy" document, energy security includes three important features. These three features are: (a) to meet and sustain the countries increasing energy demand due to an estimated yearly economic growth of 9% by the year 2031-32, (b) to meet the energy demand and sustain the overall social development including health and safety and (c) to ensure the availability and usage of energy is sustainable (Planning Commission, 2006). India's rank is 136 on human development index amongst 186 countries (UNDP, 2013). India lags behind in terms of developing sufficient infrastructure and services. As and when developed that will call for higher energy usage (Gauri 2018). It is also important to ensure energy security and sustainability for both short term and long term in applications like environmental requirements and socio-economic conditions (Nawaz and Alvi, 2018). Optimal usage of available energy and conserving the same wherever it is possible, be it building sector, manufacturing, agriculture and transportation, will lead to sustainability of energy resources in India (Gauri, 2018).

ECBC is a game changing policy initiative (ECBC, 2017; Yu and Evans 2014). "ECBC" spells out the minimum requirements of standards for design and construction of domestic and commercial buildings in India. It promotes the energy efficient design or retrofitting of the buildings without affecting their functions, comfort, health and productivity (Rawal et al., 2018). The building sector in India consumes 35% of total generated energy. These are commercial buildings, residential buildings in domestic usage and various other types of buildings used in various other purposes. As per Central Electricity Authority (CEA) annual report of 2017 commercial buildings consume 9 % and domestic buildings consume 24 % of the total of 35 % consumed by building sector as highlighted in Fig. 1.

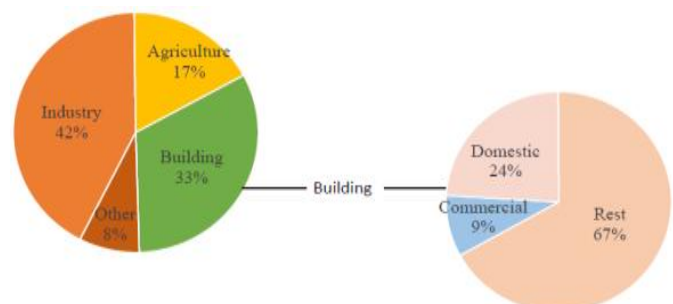


Fig. 1. Sector wise Electricity Consumption in India (2015 - 2016) Source: CEA annual report, 2017

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India is a big country with five different climatic conditions such as hot, cold, composit, humid and moderate. (ECBC, 2017) spanning from north to south and east to west. As per the climatic conditions loads connected in any building are light, air-conditioner, fan, water heater, fridge, washing machine, microwave oven, various receptacle mount loads used in daily domestic or commercial purposes etc. However, the primary loads of domestic and commercial buildings are mainly lighting and air-condition loads and consume 59 % and 31 % respectively as shown in Fig. 2.

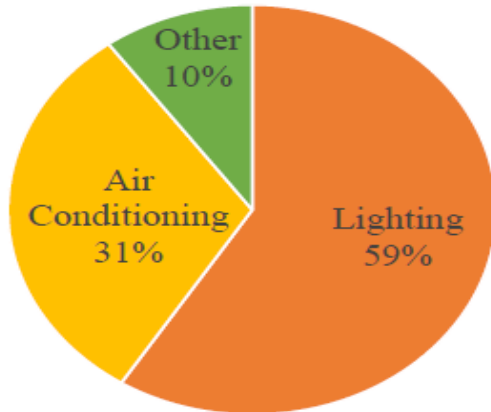


Fig. 2. Load distribution in buildings Source: CEA annual report, 2017

Construction in building sector in India is growing steadily with the growth of economy and business activities. There is a surge in migration of educated young professionals from rural to urban locations due to the economic growth and career opportunities. Construction of new buildings is the reality to keep pace with the increasing demand from residential and commercial sectors. It is estimated that the existing buildings in India will grow from 1.4 billion m² in 2017 to 2.2 billion m² in 2037 as shown in Fig. 3. and 30 % of that building stock is yet to be constructed.

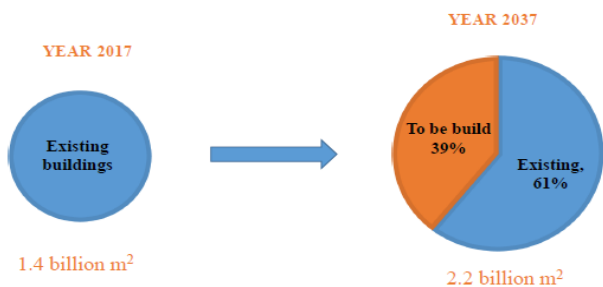


Fig. 3. Expected growth in buildings from 2017 to 2037 Source: AEEE report on buildings, 2017a

The average annual growth rate of electricity consumption in Indian commercial buildings is 9-10% from 2006-07 (CEA) as highlighted in Fig. 4. It is projected to grow further with the construction of buildings, leading to more consumption of electricity, by 2037 (AEEE, 2017a) accordingly.



Fig. 4. Growth Rate of Energy Consumption in Indian Commercial Building Source: CEA, 2017

Therefore, there is a need to ensure that the future buildings in India are energy efficient. Air-conditioning systems, lights, water heating systems, receptacle mount loads etc. used in the building should be energy efficient. On site electricity generation either from solar or wind or bio-fuel should have the priority. Usage of natural light should be given priority while ensuring the thermal integrity of the building by an efficient building design to maintain the highest standard for building envelop. Water is becoming a scarce commodity in many cities in India and therefore, water recycling and water harvesting must be a key feature in every new building construction. Features of such energy efficient building should be zero wastage, self-sustainable, high in efficiency etc. as described in Fig. 5.

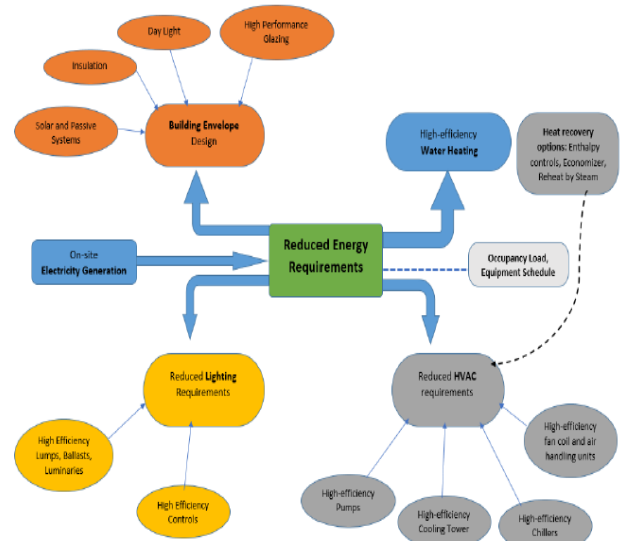


Fig. 5. Features of Energy Efficient Building Source: AEEE Conference Presentation, 2018

Govt. of India mandated the requirements for future energy-efficient building design and construction through ECBC. The code also recommends two additional categories of design for buildings namely ECBC+ and Super ECBC to achieve higher levels of energy efficiency. However, these two categories are not obligatory and go beyond the minimum requirements. The road map as explained in Fig.6 is for a smooth implementation.

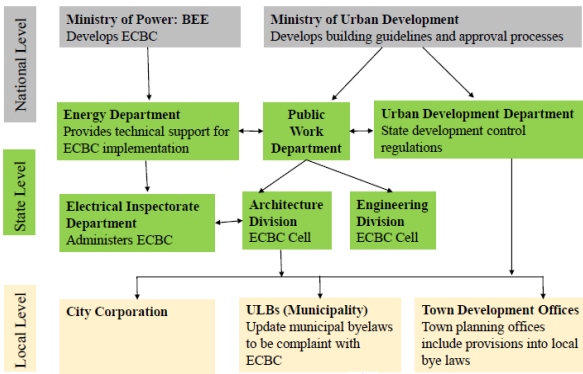


Fig. 6. ECBC implementation road map
Source: AEEE, 2017c

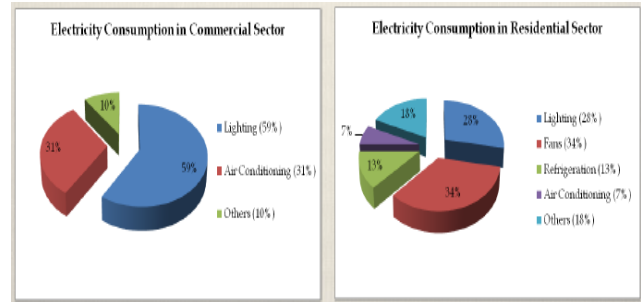


Fig. 7. Break-up of electricity consumption
Source: BEE presentation on ECBC, 2017

II. “ENERGY CONSERVATION BUILDING CODE (ECBC)”

The Government of India introduced ECBC in 2007 for construction of new buildings. It was constituted under ECA 2001 for strengthening “BEE” to implement the Act successfully. The purpose of “ECBC” is to make the Indian Domestic and commercial buildings energy efficient. The energy consumption in Indian building sector is about 33% of which commercial buildings consume 9% and residential buildings consume 24% (CEA). ECBC compliant buildings are expected to consume 40% - 60% less energy compared to any conventional buildings based on computer simulation model. **It is estimated that nationwide annual savings of approximately 1.7 billion kWh is possible if “ECBC” implementation is made mandatory (CEA).** Introduction of “ECBC” was the beginning of series of actions for promoting energy conservation in Indian commercial and domestic sector buildings. One such action is the introduction of “Eco-Niwās Samhita” in 2018.

While “ECBC” was introduced at the Central level but the responsibility for implementation lies with the States “Ministry of Urban Development”. Central Government or State Governments can give necessary suggestions to “Urban Development Authorities (UDA)” for implementing “ECBC” for optimal utilisation and conservation of energy. Main features of revised “ECBC 2017” are:

- To set a long term vision for Indian building sector energy conservation.
- To ensure all existing and new buildings are under the preview of the act.
- To ensure energy efficient building design for reducing energy usage.
- To establish a baseline of energy consumption for comparison and endorse buildings that surpass the minimum requirements of the code.
- To ensure the ease of compliance and enforcement of the code.

Successful implementation of “ECBC” is expected to reduce electricity consumption by 25% -30% in India as shown in Fig. 7 in both commercial and residential building sectors.

A. Expected Outcome of ECBC

“ECBC” was created under Energy Conservation Act to strengthen “BEE” for driving energy independence initiative across India and to educate public in general about the efficient usage of energy. Initially drafted “CEBC” had the following key features for energy conservation in building sectors in India.

- Applicable only to new commercial buildings that will have 100 kW and more as connected load or 120 kVA or more as contract demand.
- Daylight harvesting and shading provisions were introduced as passive design features of the new buildings.
- Introduction of installing all possible renewable energy systems .
- Implementation of energy efficient building design.
- Encouraging energy efficient design to modify the existing buildings.
- Target to reach a milestone of near zero energy buildings.

This ECBC was further modified in approach and expanded in reach during 2017 with better clarity and redefined target as highlighted in Fig. 8. It is estimated that 50% energy savings which in monetary terms will be about Indian Rs. 35,000 Crore (350 Billion Rupees) is possible by the year 2030. And if that happens then it will mean 15 GW reduction in peak demand and abatement of 250 Mt CO₂e of GHG.

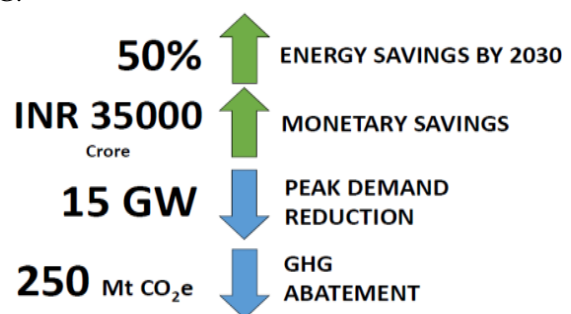


Fig. 8. Potential National Impact of ECBC 2017
Implementation Source: Government of India report on ECBC, 2017

BEE forecasted the impact of an effectively implemented ECBC across the regions and all five climatic conditions will result into an overall energy saving in the range of 20 – 25 % as shown in Fig. 9. It will be possible because human behaviour has a positive impact on energy consumption by any equipment / machines used in buildings on daily basis (Khan et al., 2016).

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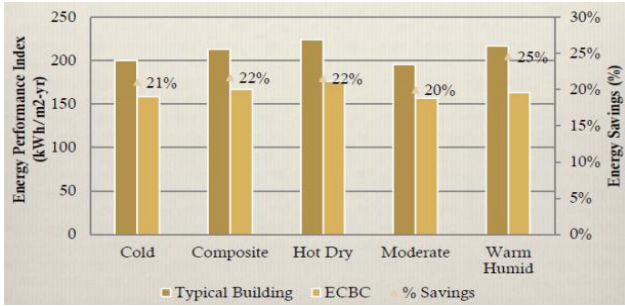


Fig. 9. Expected Impact of ECBC

Source: BEE

B. ECBC Action Plan

BEE designed and introduced an action plan as shown in Fig. 10 to roll out ECBC for implementation in 2017. The whole plan can be summarized in nine steps for better understanding and planning. These are designating the core team, giving the vision statement, finalizing the implementation methodology, base line for buildings in all five climatic zones, finalization of stringency analysis method, identifying consultants for all four geographic sides namely east, west, north and south, code development after due considerations of all suggestions / comments, approval of the code by core team and BEE and finalizing the ECBC 2017 code.



Fig. 10. ECBC Implementation Process Plan

Source: BEE

As explained the action plan in Fig. 10 the same was targeted to be executed meticulously with eight mile stones in 2012, 2013, 2014, 2015, 2016 and 2017, with three mile stones namely 5, 6 and 7 to be achieved in 2016 alone. Milestones were reached, roll out action plan was finalised and the final ECBC was launched by BEE in 2017 as planned initially. Various milestones of that journey are highlighted in Fig. 11.

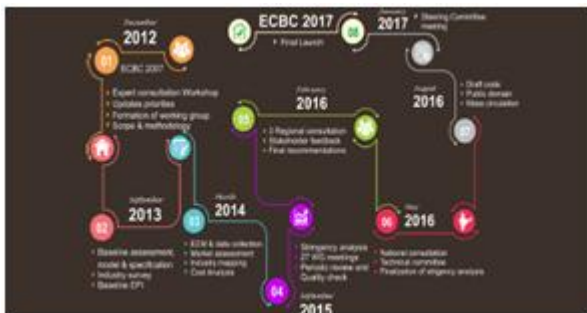


Fig. 11. ECBC Journey for Implementation

Source: BEE

C. Application Area

“ECBC” action plan is for the buildings and the equipment / machines used in the buildings as listed below to make these energy efficient so the energy index is kept within the acceptable limits. The same is also highlighted in Fig. 5 and 6. for better understanding (ECBC). These are mainly as follows:

- Envelop of the building.
- Indoor and outdoor lightings.
- Central air-conditioning system.
- Water heater using solar energy.
- All low power electrical loads.

Application by whom and what

Execution and implementation of “ECBC” initiatives call for a well-coordinated action plan involving all stakeholders at various stages. Implementation and execution responsibility of “ECBC” is with the state governments and its local bodies. It is expected that there will be unambiguous communication amongst all stakeholders to bridge the gap, if any, and can be summarised as follows:

- “ECBC” is enacted by Central Government and its implementation and execution is by state government through departments like urban development and urban local department popularly known as UDD and ULB.
 - ECA 2001 authorizes BEE and the state governments for the followings activities:
 - Do the necessary changes in ECBC to match the requirements of the respective states and notify through the state gazette.
 - Help and guide the building owners so that they can comply with ECBC code.
 - Constitute government watch dog who can ensure the implementation through proper coordination.
- (Source: AEEE, 2017b)

Therefore, the role of state governments and their local bodies are very crucial for an effective implementation of ECBC in true letter and spirit as explained in Fig. 12. Central Government gives a vision with the approved code to achieve the successful implementation. It is the State Government’s responsibility to provide all help and support to its Local Governing Bodies with necessary statutory and infrastructural requirements.

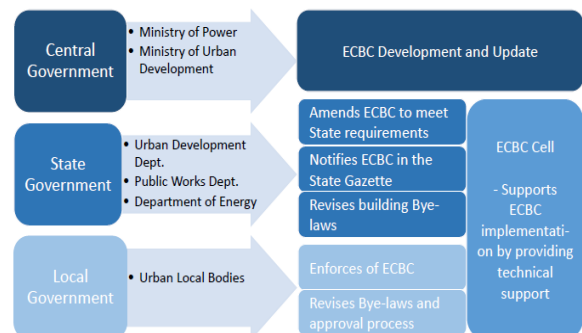


Fig. 12. Role of Stakeholders

Source: AEEE, 2017a

As per the “Electricity Act 2003” the objectives of “Central Advisory Committee” and “State Advisory Committee” are well defined and can be summarised as follows:
The central advisory committee to advise the central commission on the followings.

- i) All important questions related to the policy.
 - ii) All issues related to the responsibilities of the licensees such as continuity, quality and extent of service.
 - iii) Licensees to comply with the requirements and obligations of the license.
 - iv) Consumer interest is to be safeguarded.
 - v) Responsibilities of utilities such as supply of power and overall performance standard.
- (Source: AEEE, 2017b)

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- (Source: AEEE, 2017b)

Further clarification for “ULB” is explained below:

State commission shall act according to section 108 of state government directives when it comes to public interest to guide ULBs. In case of any ambiguity the authority to take the final decision is with the state government.

To make the “ECBC” execution more real and outcome oriented the following programs of the central government are also linked with the “ECBC”.

Building to be rated for energy consumption in India and the reference will be “ECBC” for evaluating the energy efficiency of the building but voluntary in nature:

- i) GRIHA scheme.
- ii) Star ratings of equipment by BEE.
- iii) IGBC scheme.
- iv) LEED) scheme.

Indian building sector is expected to not only meet but also to exceed the minimum requirements of “ECBC” with the inclusion of these green building programs / schemes.

D. What Is Expected To Be Implemented

“ECBC” compliance options are as per the applicable building systems as shown in Fig. 13 and 14. It highlights the options available and the systems / equipment covered. “ECBC 2017” modifies the “building systems” to “building envelop” consisting “building design”, HVAC, water heating, lighting and receptacle mount loads, building trade-off process and the complete building performance process to meet the Energy Code Compliance as least prerequisite.

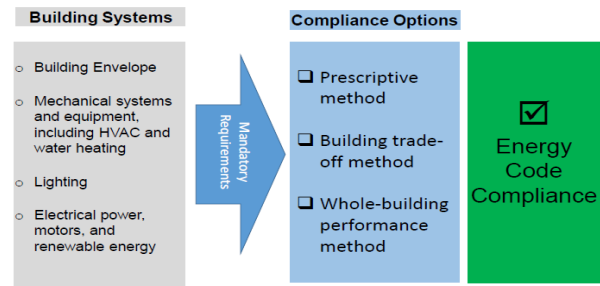


Fig. 13. ECBC Compliance Options
Source: BEE

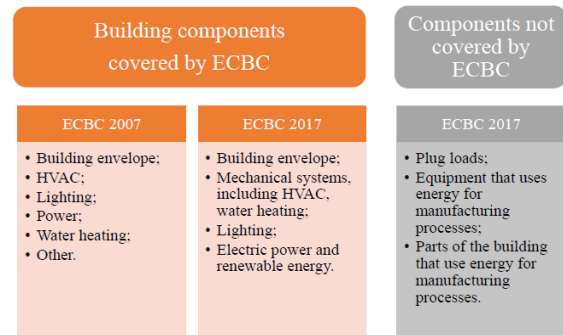


Fig. 14. Applicable Building Systems
Source: BEE

There is a modification in “ECBC 2017” compared to “ECBC 2007” in terms of equipment that need to be covered. In “ECBC 2007” distinction was not drawn between buildings used for residential / commercial and manufacturing purposes. All receptacle mount loads and equipment used for manufacturing purposes are kept out of the preview of “ECBC 2017” when the building is partially used for manufacturing in any residential / commercial location. As per the latest code the equipment to be covered for “ECBC 2017” compliance are “building envelop” consisting “building design”, HVAC, water heating system, lighting system, receptacle mount loads and renewable power system, if any.

Government of India also initiated the following programs to ensure the implementation and success of “ECBC” in its true letter and spirit.

- i) Hon’ble Prime Minister of India launched efficient lighting program for household on 5 January, 2015.
- ii) Radio programme once a week for 15 minutes highlighting the benefits of star labelling and energy efficiency requirements.
- iii) TV advertisements to showcase energy conservation opportunities that can be practiced in homes, schools and workplaces on daily basis.
- iv) Hon’ble Central Minister for Power launched the following programs on 14 December 2014 celebrated as National Energy Conservation Day.
 - a. “Energy Savers Portal for schools”.
 - b. “Consumer awareness campaign for energy efficiency”.
 - c. “Interactive session with students from schools across the country through video conference”.

- v) Advertisements on energy conservation and energy efficiency in print media.

III. IDENTIFYING THE MISSING LINK

“ECBC” envisaged plan as designed and implemented by the Govt. of India in building sectors is explained earlier. Since the “ECBC” plan is in practice for a very short period of time, therefore, the data available may not be enough to draw a convincing conclusion.

It is also important to evaluate the outcome and suggestions of research done on the same subject in the past in different part of the world for comparison. The findings and suggestions of few researches are summarized below that are relevant to this article for better understanding.

- i) Robert K et al., (2010) finds that application of energy conservation practices across all sectors in USA was one of the cost effective measures to reduce import of energy, deficit in trade and adverse environmental impact due to burning fossil fuels. Therefore, energy conservation is an essential element in US energy policy. If the energy policy is designed and implemented correctly then it can be an effective tool in any countries energy conservation movement.
- ii) End users at the community level need to walk the talk and think not as consumer but as citizen who is equally responsible for reducing the impact on environment. It is possible to measure and evaluate their respective impacts on environment and can be further improved by further research which can help in fine tuning the energy policy. Application of hybrid solutions like combining more than one source of energy through the energy policy can make each consumer as stand alone unit for better management of the resources available at the community level (Eva H et al., 2010).
- iii) Ron Lawrence (1982) found students community can be made part of any energy conservation policy and program by providing energy conservation training and integrating the same as part of their daily routine provided they feel equally important for energy conservation.
- iv) I Khan et al., (2016) recommended a model for energy conservation with human behavior and attitude as the core element and termed it as KABP model (Knowledge, Attitude, Behavior and Practice). Also suggested spreading awareness to public and motivating through energy policy can be more effective.
- v) India is one of the leading energy consuming countries in the world. To have an efficient energy management system it is important to understand the energy demand and an action plan through the energy policy (IAE; 2014).
- vi) Azizi et al., (2015) found in their study that it is possible to influence consumers about the efficient way of using energy. This can be done by providing proper awareness of correct usage of energy and further improved by giving feedback. The study also found consumers in green building consume less energy compared to conventional building mainly because of design of the building and consumer

awareness and behavior. Need of the hour is to integrate such activities in the energy policy.

- vii) Jennifer A Senick (2015) found in her study that it is a challenge for any green building to perform as intended due to various reasons. The study suggested that there is a need to align the energy conservation measures deployed in the building with the usability by the occupants.
- viii) Yun et al., (2011) suggested an energy saving empirical model for domestic sector buildings where energy usage behavior by the occupants play the major role for its success.
- ix) Government of India initiated a study in 2014 to understand the energy consumptions patterns in Indian homes. Report presented by Prayas Energy Group in 2016 suggested that consumer’s response to energy conservation policies implemented by the government plays vital role in its success. Policy need to be balanced from both sides, i.e. utilities and consumers. Advance technology and improved tariff alone may not give the desired result. Consumer’s behavior and understanding about the energy conservation concept also play an important role. Therefore, not only technology, information and tariff but also educating the consumers about the judicious utilization of energy through a balanced policy is need of the hour.

As per the ECBC 2017 the Central Government will give the policy and action plan (Code) with a vision for the State Governments to implement that action plan with the help of ULBs in true letter and spirit so that the buildings can be made energy efficient and energy index of each building can be brought within the acceptable limits. However, the human behavior part is left optional and the energy efficiency program in India is mostly focused on technology excellence, minimum price and digital information (Aditya Chunekar et al., 2016). On the other hand studies in recent past suggested that human intervention can further increase the energy efficiency of any building no matter how energy efficient the equipment / technology may be (Geun Young Yun et al, 2011; Jennifer A. Senick, 2015; Eva Heiskanen et al., 2010). Studies show that two identical equipment with same rating operating in two different buildings by two different sets of people can consume unequal amount of energy for giving the same output / doing the same job (Nurul Sakina Mokhtar Azizi et al., 2015; I Khan et al., 2016). This happens only because of the way how an individual uses the equipment to meet his / her requirements. Therefore, it is ambiguous to claim that a building is energy efficient if the technology is advanced and the equipment installed are energy efficient.

Any energy saving program can give better result if the human intervention is made mandatory and not optional besides implementing the energy efficient equipment / technology and system. This is a missing link in the present “ECBC 2017” policy that needs to be addressed.

The present “ECBC” Policy implemented in India is giving encouraging results. Main thrust of the implementation is mainly on designing the new buildings and technology.

Human intervention is limited to some painting competition on energy conservation by school children and some scattered, unorganized efforts by individual groups without any recognition by the “ULBs”.

Expected annual energy saving of 1.7 billion units in India is possible provided implementation of “ECBC” is mandated in the energy conservation policy (CEA). The human behavior part is left optional and the energy efficiency program in India mostly focused on technology, price and information (Aditya Chuneekar et.al., 2016). To involve the public for making the energy conservation a movement in India it will be advisable to make the human intervention obligatory under ECBC by the ULBs from the optional mode.

IV. CONCLUSIONS

Research shows human intervention to use the equipment / system judiciously requires a paradigm shift in attitude towards energy usage from “If not me, to why not me?”. Perhaps that is how the human psychology works and accepted by the majority as the norms. With the advancement in automation in life style human intervention for better management seems to be the things of the past and forgotten. ECBC 2017 is a good policy towards bringing energy efficiency in building sectors which otherwise is not the priority area to the business community as it is seen as an expenditure towards operations. If the human intervention is mandated as an obligatory factor under ECBC 2017 by the ULBs it will not only make the buildings energy efficient, but will also bring a socio-cultural change about the way energy is being used and also the consequences of abuse / misuse of energy which is the greatest gift to the mankind by the mother nature.

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