Commercial Buildings and Energy Conservation Building Code of India

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INTRODUCTION

Energy has become the vital force fueling the life on earth and also plays a significant role in the economic development of any country. Energy is required in every aspect of life, from making various equipment and products to charging our phones. Energy systems in India have evolved over the past six decades along with India's economic development, and the aspiration of 1.2 billion people. Ever increasing urban populations and the improved quality of life in cities have resulted in greater demand for energy. This situation has posed tremendous pressure on India's limited energy resources and has necessitated optimum use of its resources.

The primary energy consumption in India is the third largest after China and USA with 5.6% global share in 2017(BP Report, 2018). The energy consumption in India is derived from various sources such as crude oil (221.1 Mtoe; 29.34%), natural gas (46.6 Mtoe; 6.18%), coal (424 Mtoe; 56.26%), nuclear energy (8.7 Mtoe; 1.15%), hydroelectricity (30.7 Mtoe; 4.07%) and renewable power (21.8 Mtoe; 2.89%), with a total of 753.7 Mtoe (excluding traditional biomass use) in the calendar year 2017. The present and future growth for primary energy in India and the percentage share of the various resources are shown in Fig. 1 (BP Report, 2018).

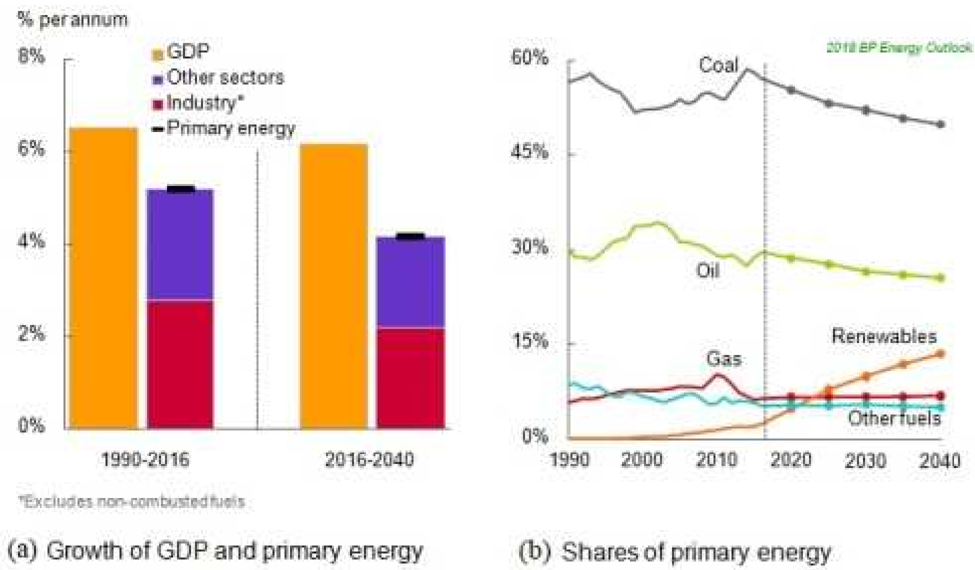


Fig. 1 India's energy consumption from various sources-current and projected demands

Fig.2 shows the current and projected energy demand of different fuels for various regions, including India. As per Mr. Bhaskar Sarma of the Bureau of Energy Efficiency, energy demand in India will increase by a factor of 1.5 to 2.5 by 2030.

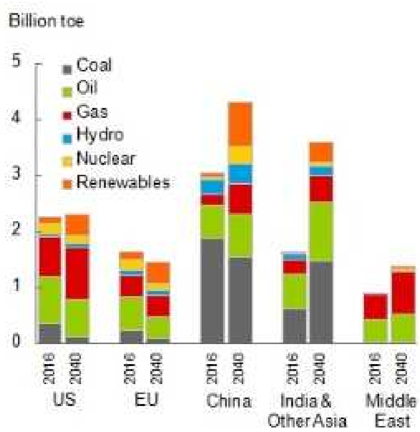


Fig. 2 Primary Energy demand by fuel and region (BP Review, 2018)

It has to be noted that in India, industrial and commercial consumers pay electricity and petroleum product prices that are amongst the highest in the world. Household consumers pay electricity and petrol prices that are highest in the world relative to their incomes. While India's per capita energy consumption will remain much lower than that of industrialized countries, India's total energy consumption is expected to increase significantly, due to its huge population. Due to this threat of energy crisis, various strategies to conserve the available energy, and harness renewable energy from all possible sources have been considered by the government. Efficient energy use reduces costs, energy imports, GHG emissions, and also pollution.

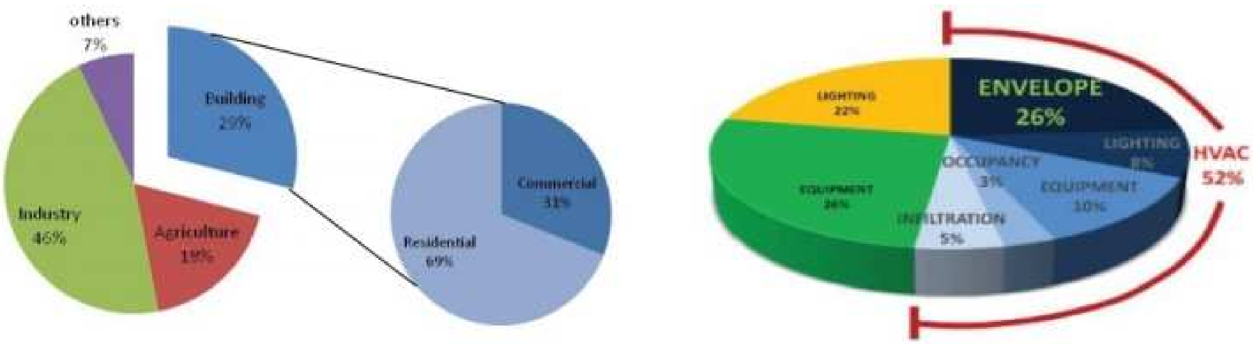
Considering the vast potential for energy savings, the Government of India enacted the Energy Conservation Act (EC Act), in 2001. The Act provides for the legal framework, institutional arrangement, and a regulatory mechanism at the Central and State levels to achieve energy efficiency. The Bureau of Energy Efficiency (BEE) was established in March 2002 under the Ministry of Power (MoP) to implement the EC Act 2001. BEE is the statutory body for development of energy efficiency policy and strategies based on self-regulation and market principles. It also facilitates coordination of energy efficiency at the central level while "state designated agencies" (SDAs) do the same at the state level in 30 states. The EC Act 2001 further mandates BEE to work with designated consumers and other agencies to enforce the provisions of the act. However, there are no provisions in the budget of the central government at present to enforce checks and compliance to the Act.

The Energy Conservation Building Code (ECBC) was introduced in 2007 to guide the design of new commercial buildings – where there is largest scope for energy efficiency improvements. This was revised in 2017(The Government is considering to revise and update ECBC every 5 years).

THE ENERGY CONSERVATION BUILDING CODE

Under its statutory authority, the Bureau of Energy Efficiency (BEE) with the support of the Ministry of Power (MoP) launched the Energy Conservation Building Code (ECBC) in 2007, to establish minimum energy performance standards for buildings in India. The ECBC was developed by the International Institute for Energy Conservation (IIEC) under contract with the United States Agency for International Development (USAID) as a part of the Energy Conservation and Commercialization (ECO) Project providing support to the (BEE) Action Plan. The process of development of ECBC involved extensive data collection and analysis regarding building types, building materials, and equipment. ECBC started as voluntary, but made mandatory by Gazette notification of the Ministry of Power on 13th February 2018. The code is applicable to all new building that has a connected load of 100 kW or higher or a contract demand of 120 kVA or higher. The code is also applicable to all buildings with air conditioned floor area of 1,000 m^2 or higher. The structure of ECBC is patterned against that of the ASHRAE Standard 90.1-2004. It has to be noted that the BEE/GRIHA Star Rating System exists independently of the code- It evaluates buildings based on operational energy use and is the only energy-use-specific building label used in India (Williams and Levine, 2012).

The building sector is the second largest employment provider next to agriculture. The building sector contributes to about 5% of the India's GDP, which is expected to rise to 6% in the next 4-5 years. Consequently, the building industry is also one of the biggest emitter of GHGs in India. Buildings account for about 29% of India's electricity consumption and are second only to the industrial sector in emitting greenhouse gases [see Fig. 3(a)]. In addition, the building sector is growing at 8-10% annually. Of the building sector, commercial building space accounts for 31%, with breakdown of energy consumption as shown in Fig. 3(b). Hence, the purpose of this code is to provide minimum requirements for the energy-efficient design and construction of buildings.



(a) Energy consumption by various sectors in India

(b) Break down of energy consumption of commercial buildings in India

Fig.3 Energy scenario in India (Bano and Kamal, 2016)

ECBC code takes into consideration the climatic condition of the building's location, while suggesting various strategies. As per the code, India is divided into 5 distinct climatic zones as shown in Fig. 4 and the design of building envelop should take into account these climatic zones.

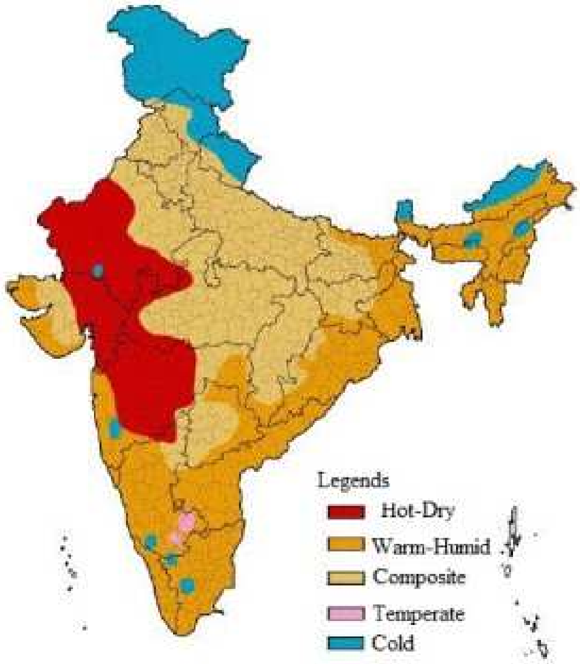


Fig. 4 Climate zone map of India

ECBC is considered as an essential regulatory tool to curb the energy footprint of large commercial buildings. Energy efficient technologies and materials that were not available in the years preceding the launch of ECBC are now commonly available in Indian markets. Hence, ECBC was revised in 2017 to incorporate advanced technologies.

ECBC sets minimum energy performance standards for the design and construction of new commercial and public buildings. As per ECBC Commercial Buildings are divided into various sub categories; i.e., offices, hotels, hospitals, and shopping centers or malls. The components in the buildings which are considered in the ECBC include:

1. Building envelope (walls, roofs, and windows),
2. Heating, ventilation and air conditioning,
3. Water heating and pumping (including solar water heating for at least 1/5 of design capacity, unless systems use heat recovery),
4. Interior and Exterior Lighting and controls,
5. Electrical and renewable energy systems (transformers, motors, and power distribution systems),

In the 2017 version of ECBC there are three levels of energy performance standards: ECBC, ECBC + and SuperECBC. The adherence to the minimum requirements as per ECBC level of efficiency is enough to comply with the code. Other two efficiency levels are of voluntary nature. This feature was added to prepare the building industry for meeting energy efficiency standards in coming years and give sufficient time to the market to adapt.

Thus the minimum requirements of ECBC lists specific maximum and minimum limitations on a number of key building features that affect building energy use. ECBC has both prescriptive and performance-based compliance paths. The prescriptive path calls for adoption of minimum requirements for the building envelope and energy systems (lighting, HVAC, service, water heating, and electrical). The performance-based compliance path requires the application of Whole Building Simulation Approach to prove efficiency over base building as defined by the code.

To comply with the Code, buildings should (a) have an Energy Performance Index Ratio (EPI Ratio) less than or equal to 1(EPI is defined in the code) and (b) meet all mandatory requirements mentioned under Clauses 4.2, 5.2 , 6.2, and 7.2. For example, Table 4-1 of the code lists the minimum daylight area requirements for ECBC Buildings. Row 1 of the table specifies that all business and educational buildings having more than 3 stories above the ground should have a minimum of 40% of its floor area exposed to daylight in range of 100 – 2,000 lux for at least 90% of the year. Similarly, Table 4-10 and Clause 4.3.3 lists the U-factor (with lower numbers indicating better insulating properties), Solar Heat Gain Coefficient (SHGC) and Visual Light Transmittance (VLT) requirements for vertical fenestration for ECBC compliant buildings. Thus, for a building located in New Delhi, which falls under the composite climate (as per Appendix B, Table 11.1), the prescriptive requirements are: Window to Wall ratio ≤ 40%, SHGC ≤ 0.27, U-factor ≤ 3.0 W/m^2.K, and VLT ≥ 0.27. Most of the commercial buildings have energy performance index (EPI) of 200 to 400 kWh/m^2/ year. Energy-conscious building design, using ECBC, can reduce EPI to 100 to 150 kWh/m^2/ year in India (Bano and Kamal, 2016). By judicially designing the building envelope parameters i.e. orientation, shape, walls, fenestrations, shading device and roof, the HVAC load can be reduced in commercial buildings.

The National Building Code of India 2016 (NBC) is the reference standard for lighting levels, heating, ventilating, and air conditioning (HVAC), thermal comfort conditions, natural ventilation, and any other building materials and system design criteria addressed in this ECBC.

CONCLUSIONS

The ECBC has the potential to transform the way commercial buildings are constructed and to have significant energy savings. Tremendous potential exists for using materials and equipment, such as heat-resistive paints, fly-ash blocks, insulation materials, energy-efficient windows, energy management control systems, and lighting controls. Constructing more efficient buildings will also assist India’s strategy to achieve climate target of reducing emissions intensity of its Gross Domestic Product by 33% to 35% from 2005 levels by the year 2030 as part of the Paris Agreement. The use of ECBC is estimated to save 25% to 40% of energy use in buildings. Based on scenarios (high, medium and low) for code compliance, the Administrative Staff College of India (ASCI) and the Natural Resources Defense Council (NRDC) estimated that with a combination of ECBC compliance and voluntary rating programs, India can potentially save more than 3,000 terawatt-hour (TWh) of cumulative electricity by 2030.

However, the impact of ECBC depends on the effectiveness of its enforcement and compliance. Currently, the majority of buildings in India are not ECBC-compliant. Even the National Building Code provisions are not implemented in several buildings in India, as evidenced by building failures during earthquakes, cyclones, and floods. The State Governments, which are the implementation agencies, do not have proper mechanisms to check the implementations. In addition, due to corrupt officials or professionals, it is difficult to ascertain whether the buildings actually adopted the provisions of the code properly. But, it has to be appreciated that the Central Government is taking the right steps. It is hoped that the code will result in energy efficient buildings in future, reducing the energy requirements of our country.

REFERENCES

1. Bano, F. , and Kamal, M.A. 2016. "Examining the Role of Building Envelope for Energy Efficiency in Office Buildings in India", *Architecture Research*, Vol. 6, No. 5, pp. 107-115.
2. BP Review, 2018 *BP Statistical Review of World Energy*, 67th edition, June 2018, https://www.bp.com/en/global/corporate/energy-economics/energy-outlook.html
3. ECBC:2017, *Energy Conservation Building Code of India*, Ministry of Power, Govt. of India, New Delhi, India, 2007, 75 pp. (also Energy Conservation Building Code 2017, Bureau of Energy Efficiency, New Delhi, India, 2017, 200 pp).
4. *Energy Conservation Building Code (ECBC) -User Guide*, Bureau of Energy Efficiency, New Delhi, July 2009, 173 pp.
5. Tulsyan, A., Dhaka, S., Mathur, J., and Yadv, J.V., 2013. “Potential of energy savings through implementation of Energy Conservation Building Code in Jaipur city, India”. *Energy and Buildings*, Vol. 58, pp.123-130.
6. Williams, C. and M. Levine. 2012. “Gauging Improvements in Urban Building Energy Policy in India”, *Proceedings of the 2012 ACEEE Summer Study on Energy Efficiency in Buildings*, Pacific Grove, CA pp. 4414-4425.

About the author: Dr. N. Subramanian, a consulting engineer now living in Maryland, USA, is the former chief executive of Computer Design Consultants, India. A doctorate from IITM, he also worked with the TU of Berlin and the TU of Bundeswehr, Munich for 2 years as Alexander von Humboldt Fellow. He has more than 40 years of professional experience which include consultancy, research, and teaching. Serving as consultant to leading organizations, he designed several multi-storey concrete buildings, steel towers, industrial buildings, and space frames. Dr Subramanian has contributed more than 250 technical papers in National and International journals & seminars and published 25 books. He has also been a reviewer for many Indian and international journals. He is a Member/Fellow of several professional bodies, including the ASCE, ACI, ICI, ACCE (India) and the Institution of Engineers (India). He also served as vice president of the Indian Concrete Institute and Association of Consulting Civil Engineers (India). He is a recipient of several awards including the 2013 ICI - L&T Life Time Achievement award of the Indian Concrete Institute.