

Measuring and Reducing Residential Building Energy Demand in India

Neha Yadav

Abstract— India has one of the fastest developing economies, yet it isn't anticipated to arrive at the degree of vitality utilization seen in other significant economies. It is the 2nd largest population, 3rd largest economy and 4th largest energy consumer in the world and soon would become 3rd. This growth in population has increased the demands for building services and comfort level leading it to increasing energy demand in the country. As this growth of energy consumption has raised concerns over exhaustion of resources and supply difficulties and adverse environmental impacts, now is the high time that these energy consumption and demand should be regularised and reduced via assessing the and measuring the same in India. Although India has the fastest economy but it is not able to reach the projection level of energy consumption like other such economies.

According to EIA's International Energy Outlook 2017 (IEO2018), Buildings energy consumption in India is expected to increase faster than in other regions. It also projects that among all regions of the world, the fastest growth in buildings energy consumption through 2040 will occur in India. Main contributor to this demand and consumptions would be residential sector adding to which as per as per Central Electricity Authority ,India's domestic energy consumption has increased from 80 TWh in 2000 to 186 TWh in 2012, and constitutes 22% of total current electrical consumption.

This research focuses on analysing how India has been a major contributor in increasing residential energy demand and addressing the opportunities and challenges of building energy consumption through identifying various measures and initiatives for reduction of energy demand.

I. INTRODUCTION: BUILDING ENERGY DEMAND AND CONSUMPTION

Residential and commercial sectors in developed countries contributes up to 30% in overall energy consumption throughout all the developed countries. The percentage has even increased in other sectors such as industrial and transportation.

Growth in population, increasing demand for building services and comfort levels, together with the rise in time spent inside buildings, assure the upward trend in energy demand. The rapidly growing world energy use has already raised Concerns over supply difficulties, exhaustion of energy resources and heavy environmental impacts. (International Energy Outlook, 2017) India, China and Africa are projected to be three of the fastest growing and most populous regions in the IEO2018 Reference case.

As per U.S. Energy Information Administration, International Energy Outlook 2017 Reference case, India,

China and Africa are projected to be three of the fastest growing and most populous regions. In case of China, as the pace of economic growth is increasing, the greater is the energy consumption. In Africa Industrial sector has been a major contributor where as India has the fastest growing economy but unable to reach the projected energy demand.

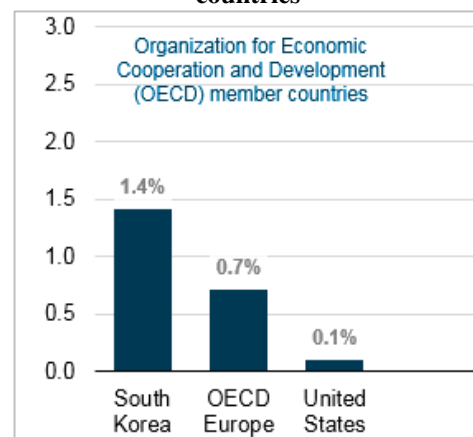
As of 2015, china has 132 quadrillion Btu energy use which is much higher in the past 35 years, Africa is the 8th largest regional energy consumer with 23 quadrillion Btu and India is the 4th largest energy consumer with a possibility of becoming 3rd soon.

II. INDIA: A MAJOR CONTRIBUTOR TO GLOBAL ENERGY DEMAND

India has one of the fastest growing economies, but it is not projected to reach the level of energy consumption seen in other major economies. Energy consumption for residential and commercial buildings in India is expected to increase by an average of 2.7% per year between 2015 and 2040, more than twice the global average increase (see Figure 2).

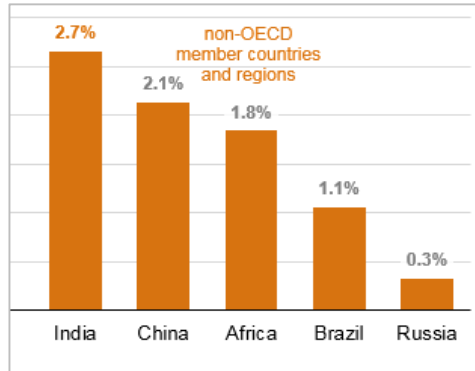
Being 2nd largest population, 3rd largest economy measured in purchasing power parity (PPP) and 4th largest energy consumer, average energy change in building energy consumption has risen to 2.7% with compare to various OECD and non OECD member countries and regions like south Korea, US, Europe, Brazil and Russia (see Figure 1).

Figure 1. Average annual change in buildings energy consumption, 2015-2040 percent per year in OECD countries



Source: U.S. Energy Information Administration

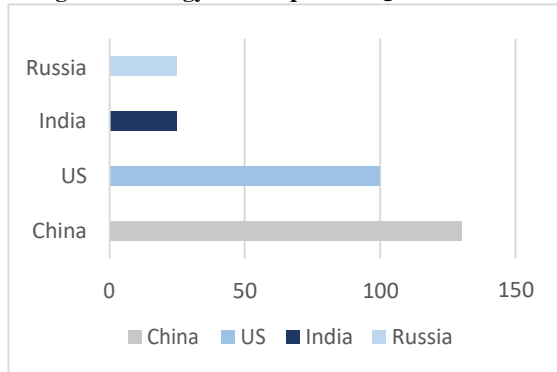
Figure 2. Average annual change in buildings energy consumption, 2015-2040 percent per year in non OECD countries



Source: U.S. Energy Information Administration

Buildings energy consumption in India is expected to increase faster than in other regions. It also projects that among all regions of the world, the fastest growth in buildings energy consumption through 2040 will occur in India (International Energy Outlook, 2017).

Figure 3. Energy consumption in Quadrillion Btu



Source: U.S. Energy Information Administration

Energy demand in India will be rising further in coming decades with increasing population and fast pace of growing economy. Simultaneously urbanization is taking place at much higher rate in the country leading to migration and increasing demand in housing sector. With the growth of residential sector, there has been a major consumption and emission. Building energy consumption doesn't only comprise of residential sector in the country but most of the growth in this demand is the result of increased electricity and natural gas use because of better attainability to various energy sources like increased use of energy equipment and appliances.

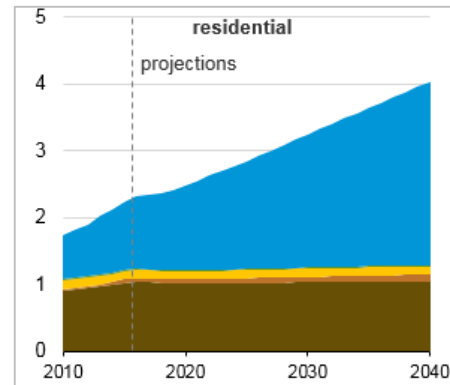
As per world resource institute, Total energy demand in India by 2047 would increase to 18,125 Twh in which industrial sector will be a major contributor having a demand of 9,920 Twh. Second major contributor would be transportation sector with a demand of 4,414 Twh. Commercial and residential sectors will majorly comprise of lighting and heating with domestic lighting and appliances demand of 622 Twh and commercial lighting and appliances demand of 181 Twh. The commercial and residential sectors would also comprise of heating and cooking demand of 580 Twh and 925 Twh respectively.

It also projects, India's energy consumption by fuel by 2015-2040 in residential as well as commercial sectors, in

which residential becomes the leading contributor with 4 Btu with almost twice a demand as commercial (see Figure 4 & 5).

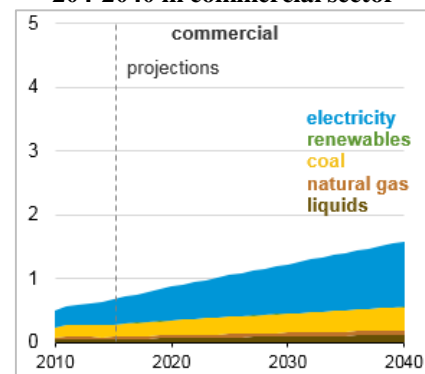
As energy consumption in residential sectors is considered to increase about 8-10% by 2050, it is crucial for the country to develop energy efficiency strategies to control the increasing energy demand. This may include some focused policies and market interventions.

Figure 4. India's building energy consumption by fuel, 204-2040 in residential sector



Source: U.S. Energy Information Administration, International Energy Outlook 2017

Figure 5. India's building energy consumption by fuel, 204-2040 in commercial sector



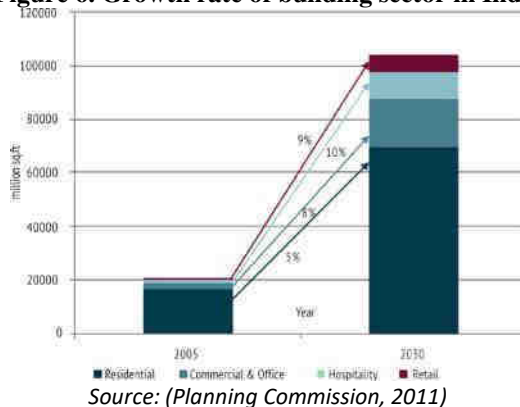
Source: U.S. Energy Information Administration, International Energy Outlook 2017

III. EMPHASIS ON RESIDENTIAL SECTOR

With increased growth rate of urbanization and construction India will have 20 billion sq.m of new building floor area added more by 2030. Along with emerging housing policies like PMAY which focuses on housing for all by 2022 would lead to a boost in construction industries leading to 85-90 % of the new constructions for residential purposes. As a result of predicted pace of economic development in the country the overall energy use in urban areas is expected to be doubled by 2050 compared to 2005 levels as per NITI Ayog. Due to the growth rate of residential building sector in the country, 22% of overall energy used by this sector in urban areas. India is currently experiencing one of the fastest growth rates in new buildings globally, mainly in the residential sector. Energy demand from residential buildings is expected to rise sharply in the coming decades, due to the combined growth of Population, Urbanization, GDP and Consumer purchasing power (India Energy Security Scenarios 2047 , n.d.).

The Bureau of Energy Efficiency, a Government agency, predicts that India's constructed floor area will increase by around five times from 2005 to 2030. (Developing an Energy Conservation Building Code implementation strategy in India). This will lead to a dramatic increase in the demand for improved domestic comfort.

Figure 6. Growth rate of building sector in India



As per various studies total residential floor area of India will much larger than its total commercial floor area in 2030. CEU data suggests that, by 2050, 85% of floor space will be in residential use, while 15% will be used for commercial purposes.

IV. RESIDENTIAL BUILDING ENERGY CONSUMPTION IN INDIA

A survey has been conducted by CEPT University on energy consumption of 800 households in four climate zones of India, to map the current penetration rate of appliances and electricity consumption patterns. Key information, including residential unit areas, monthly energy consumption, connected loads and numbers of appliances, together with their power ratings and operational patterns, has been gathered in the survey. The information collected has been analysed to understand current energy consumption patterns for different sizes of residential units with varying occupancy rates, appliances and climate zones.

Projection scenarios indicate that electricity consumption is predicted to rise by more than eight times under the business-as usual scenario. Using focused policy and market efforts, moderate, aggressive and very aggressive strategies can limit the consumption increases to five times, four times and three times the current energy usage, respectively. Under the business - as usual scenario, the annual electricity use per household is predicted to increase from 650 kWh in 2012 to 2750 kWh by 2050. Using a very aggressive policy strategy, the increase in household electricity consumption could be cut to 1170 kWh per household in 2050 (Residential Buildings in India: energy use projections & savings potentials, 2014).

Energy consumption projection in residential sector as per GBPN proposed policy scenario, states that The residential sector's overall energy use is projected to grow by 800% by 2050 as compared to 2012 levels, that is 8 times. The building sector will emit 7 times more CO₂ by 2050 compared to 2005 levels.

It can be concluded from the above study that India is experiencing higher penetration and increased usage of energy-consuming appliances in residential buildings.

V. OPPORTUNITIES AND CHALLENGES IN REDUCING RESIDENTIAL BUILDING ENERGY DEMAND

5.1 Challenges

There are numerous challenges as well as barriers in energy efficiency measures and reduction of consumption, along with increasing population, urbanization at a greater pace as well as increasing demand. There need to be an awareness and knowledge about potential and benefits of energy consumption which can lead to better addressal of energy consumption challenges, energy supply constraints and inappropriate energy pricing in different sectors including market failures and financial challenges also contributes to the same. Whereas in India there are no proper legislations and inefficiencies in various policy focus in this sector.

5.2 Opportunities

Possible opportunities for energy efficiency and reducing energy demand includes promoting energy conservation, interventions by development and city authorities, involving private sector and multi- partnership approaches including various stakeholders. Listed below are some more initiatives which can be taken to achieve energy efficiency and demand reduction. Development of adequate data base, research development and regulatory legislative support shall inform better scope in energy reduction areas.

VI. REDUCING RESIDENTIAL BUILDING ENERGY DEMAND

Measure in reducing residential building energy demand could be challenging in such scenarios where increasing population and urbanization with growing energy demand comes along with energy supply constraints and inappropriate energy pricing and improper legislation backing. However improving efficiency in urban infrastructure, baseline study of residential, commercial energy consumption in various climatic zones of India would result in keeping a better track on energy requirement of the country.

There is a need of building a strong focus on residential energy use, thermal comfort, various energy conservation and efficiency measures at community level and moreover bringing it to a minor scale of household level via developing new residential energy building codes through manifesting and analyzing several international policies for energy conservation.

Addressing climate change, reducing greenhouse gases emission through various approaches at city level intervention by involving different infrastructure, transportation, environmental and urban planning professions together working at dwelling units or neighborhood level could be a significant approach.

Government initiatives involving utility suppliers like state electricity companies and interventions through different housing schemes and central government policy makers such as MOHUA, MOUD and Ministry of environment is a required measure that shall be taken for policy and legislative backing in the country. Multi stakeholder approaches involving finance institutes for energy conservation at residential unit level taking an example of NHB's refinance scheme could be an effective measure. The National Housing

Bank has set up a refinance scheme, Equipment in Homes, for the installation of solar water heating and solar lighting, to promote the use of energy-saving solar equipment in the domestic context [4].

CONCLUSION

Reduction of building energy demand and improving energy efficiency in India, comes with various opportunities as well as challenges. India is associated with numerous hurdles of urbanization, population growth and a high growth rate of energy consumption. Addressing any of the challenge independently or without any aid will always result in loss of resources, manpower as well as energy.

On the other hand this issue comes along with number of opportunities, which should be taken into account by multi-partnership approach. Various stake holders as well as beneficiaries shall take the initiative to deal with this challenge of energy consumption. Some basic approaches like selection of appropriate electrical appliances, building automation system and use of renewable energy resources would help in reduction of energy consumption.

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