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Green Building a Sustainable Approach to Save Energy

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ABSTRACT

One of the greatest recognized threat of the 21st century is the Climate change, caused by the release of greenhouse gases (mainly carbon dioxide) into the atmosphere. Portions of the energy consumption in India anguished China has also been on the raise due to sharp urbanization, population explosion, and immense growth of IT and related business. Buildings are the dominant and enhanced energy consumers in modern cities account up to 45% energy consumption. Their consumption can be splendidly cut back through improving efficiency, which is an effective means to lessen greenhouse gas emissions and slow down depletion of non- renewable energy resources. There is over 55% saving potential in the building sector and thus it is considered as a potential sector to meet the challenges of global energy and climate change. Along with introduction of energy efficiency measures, more effective means are needed to induce or compel greater efforts, especially to the signatories to the Kyoto Protocol. This review paper discusses the role of energy efficiency in green buildings in Indian scenario to reduce the energy consumption and environmental degradation through Green House Gas emission (GHG). The possibility and benefits of harmonizing governmental and private-sector schemes are also discussed.

***Keywords*--** Climate change, Green House Gas, Green Buildings, energy efficiency, Energy policies

I. INTRODUCTION

Climate change, caused by the release of greenhouse gases (mainly carbon dioxide) into the atmosphere, has been recognized as one of the greatest threats of the 21st century. Being the largest primary energy consumers, buildings make the world‘s biggest contribution to this growing menace.

India continues to develop; by 2030 it is likely to have GDP of 4 trillion USD and a population of 1.5 billion. Energy consumption in India and China is also on the raise due to sharp urbanization, population explosion, and intensive growth of IT and related business. Buildings account for more than 41% energy consumption in developed countries. Energy consumption in building is mainly for building services like, HVAC, lighting, water heating, pumping and fans amount to 40%. It is said that 18-20% of primary energy and 40% of total consumption takes place developed countries, like US and EU (Fig.1a) and. (Fig. 1b).

The total amount of energy used by commercial buildings has risen significantly since the 1980s, reflecting a 50% growth in the total amount of office space available and a 33% increase in energy consumption per square foot of space. The result is a 70% overall increase in the amount of energy used by commercial buildings since 1980, as highlighted in fig.1(a)

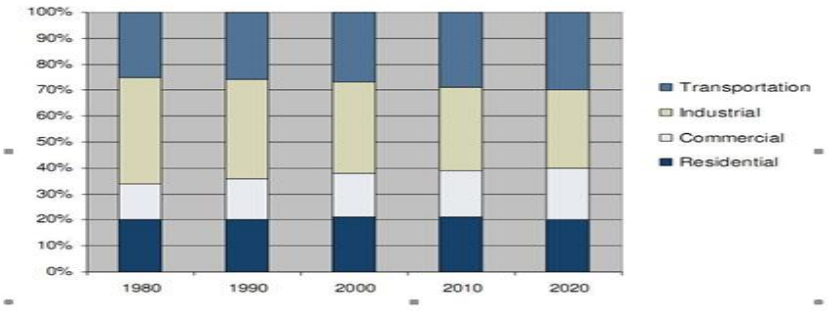

Fig. 1(a). Energy Consumption Forecast by Sector (U 1) (Source: EIA)

In developed countries the energy consumption growth rate is only marginally higher compared to the population growth rate. In developing countries like India population growth rate is expected is expected to grow at 10%. This trend is straining the Indian energy sector to a large extent challenging the to grow at 1.3% while the energy consumption rate energy planners for further fresh investments in power sector in addition to program for energy efficiency change.

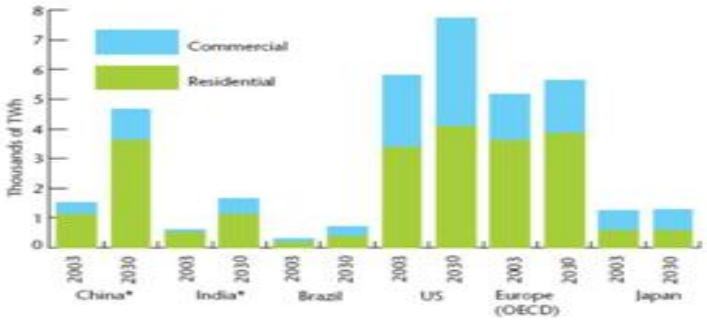

Fig. 1(b). Building energy projection by by regions in 2003 and 2030 (Source: IEA, 2008).

As buildings are key to Asia‘s future, building heating and cooling are the most energy-intensive activities, followed by electricity use for lighting and appliances (Harvey, 2009). India being in a temperate climate, demand for cooling is more intensive than heating. Greenhouse gas emissions from buildings energy use significantly exceed those from transportation. It was predicted by International Panel on Climate Change (IPCC) that CO_2 emissions from buildings (including through the use of electricity) could increase from 8.6 billion tones in 2004 to 15.6 in 2030 under a high growth scenario. Energy consumption at lower costs (passive methods) in buildings will offer greater potential to meet CO_2 reduction targets than any other sectors. Energy used for heating and cooling can be reduced through ventilation, heat sinks, the use of solar panel and improved insulation. Electricity consumption can also be reduced through use of CFL & LED lighting or increased use of natural lighting and the use of energy-efficient appliances. Improved efficiency in the building sector and de-carbonizing the power sector could offer significant potential emissions reduction.

II. MANDATORY GOING GREEN

Green Buildings save the resources in the entire lifecycle of the structure and it starts from Green design. Green design has environmental, economic and social elements that benefit all stakeholders, including owners and the occupants. Even though these broad benefits are oft discussed in the context of Green Buildings, it is interesting to go a step forward and compile the specific salutary spin offs that may come with Green Buildings.With rapid improvements in construction techniques and ethos, it is possible that many of the contemporary office buildings being built across metropolitan cities in India may have already included some of the Green features listed in the table as part of the buildings being delivered for occupation

III. INDIAN URBAN POPULATION AND ENERGY CONSUMPTION PATTERN IN BUILDINGS

The global urban population is expected to grow from 47% of the total in 2000 to 70% in 2050. Figure 2 shows the rising urban population trend in developing countries like China, India and Brazil. The urban populations of China and India are continuing to grow rapidly to 2050, reaching more than one billion in China and India. By 2050, it is predicted that about 73% of the Chinese population will be urban, increasing from 40% in 2005. In India drastic urbanization is mainly due to both socio–political motivation.

In line with expanding development and population, India‘s building sector is expected to grow five-fold from 2005 to 2050 as two-thirds of the commercial and high-rise residential structures that will exist in 2030 are yet to be built (70%). While India's total energy requirement is projected to grow at 6.5 percent per year between 2010-11 and 2016-17 to support the country‘s projected growth rate, India is in route to becoming the world‘s second largest emitter of greenhouse gases

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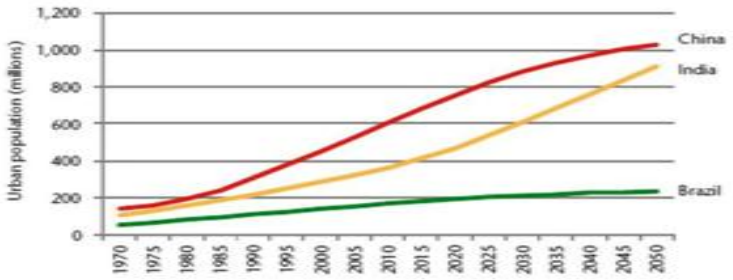
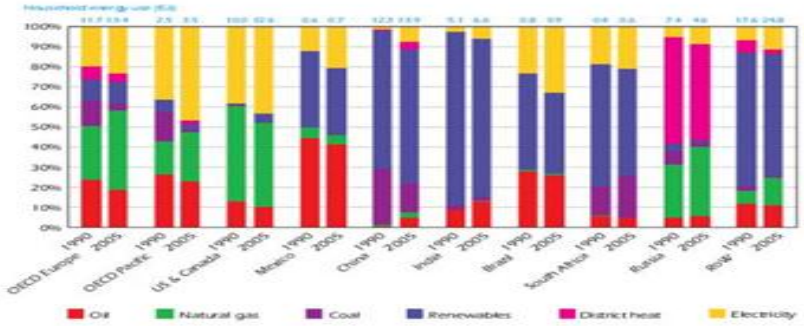


Figure 2. The rising urban population in developing countries (China, India, Brazil) (WBCSD, 2009)

Energy consumption varies widely by size, building type, culture and wealth. Average home size is 200m^2 in the US and only 40 m^2 in India.

Intelligent buildings make several contributions to reducing GHG emissions (table 1.). More than 40% CO2 emissions in developed countries come from eating, cooling and powering buildings. For existing buildings, good insulation, efficient boiler, window glazing and recovering heat from ventilation systems are efficient ways to reduce emissions



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IV. BUILDING ENERGY BY SOURCES

Real Estate Value	Sustainable Asset Management	Environmental Effects	Ultimate Effects
Improved indoor air quality (IAQ), productivity, and occupant satisfaction Advanced capabilities to deal with "churn" (occupant turnover / evolving mission) Reduced future capital expenditures Higher resale value or lease rates	Optimized asset management and better space utilization Reduced cost for moves, adds and changes (MAC) Reduced capital costs including cabling, administration, training, and project management	Reduced greenhouse gas and carbon dioxide emissions Reduced energy and water usage Reduced construction and demolition waste Leveraged renewable energy technologies	Healthier and more comfortable building environment Improved long-term economic performance Sustainability- easier to maintain and built to last More competitive; "best of breed" procurement More efficient use of O&M

The objective of sustainable development is to reduce the baseline energy consumption by supporting adoption and implementation of efficiency measures in buildings is well supported in India by the use of energy

efficient passive and active techniques. Compact planning is emphasized to enable daylight and naturally ventilated indoor areas. Landscaped courtyards are adopted as they act as a climate buffer and reduce glare. Efficient use of land, water, natural lighting and air make all the difference in achieving sustainability. Typically, the building envelope is designed differently in all six climatic zones keeping in view of the climatic advantage one can derive. As an example, the exposure of the south wall to sunlight is maximized by incorporation of a solarium in cold climates, whereas insulated reinforced cement concrete (RCC) diaphragm walls are used in hot climates to limit its direct radiation.

The integration of windows with light shelves and double-glazed windows with proper sealing further ensures the building efficiency and reduces cooling loads. Buildings oriented longitudinally along the east-west axis with openings along the north-south axis. For increased cross-ventilation and reducing summer gains. Passive and active systems are to be configured in accordance to the climatic zone to achieve the ambient temperature in the space. Passive systems such as radioactive cooling through roof ponds, earth air tunnel systems; direct and indirect evaporative cooling and solar water heating are prevalent in most parts of the country. Active systems such as a hybrid chilled water system, chilled beams, thermal energy storage, vapour absorption systems, and under floor air-distribution systems have also been widely accepted in developed countries.

V. BACKGROUND OF ENERGY EFFICIENCY IN INDIA

There is an urgent need to improve the energy efficiency of the Indian economy. About 70% of the infrastructure in 2030, such as buildings, will be added in next two decades—between 2012 and 2032. The projections for energy demand in 2032 imply a fourfold increase in requirements. Such a dramatic increase of energy supply will be difficult to manage because of resource constraints.. In 2001, the Government of India (GoI) passed the Energy Conservation Act (ECAct, 2001) and the following year established the Bureau of Energy Efficiency (BEE) under its provisions. One of the first initiatives of BEE was to prepare an Energy Conservation Action Plan, which was released in August 2002. In June 2008, India released the first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate change mitigation and adaptation. The plan identified eight core national missions ‘including a National Mission for Enhanced Energy Efficiency (NMEEE).

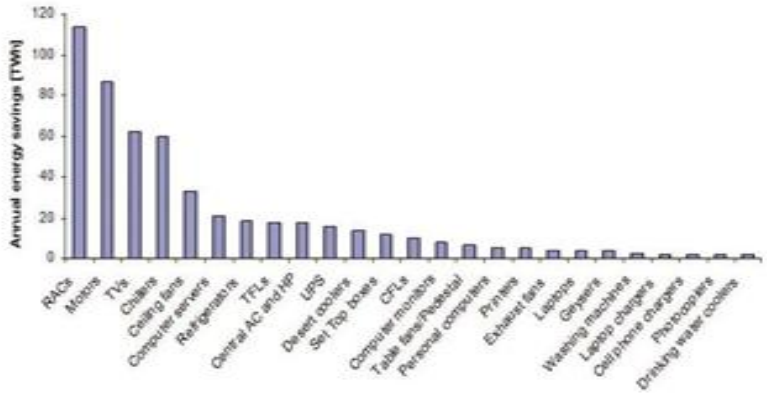
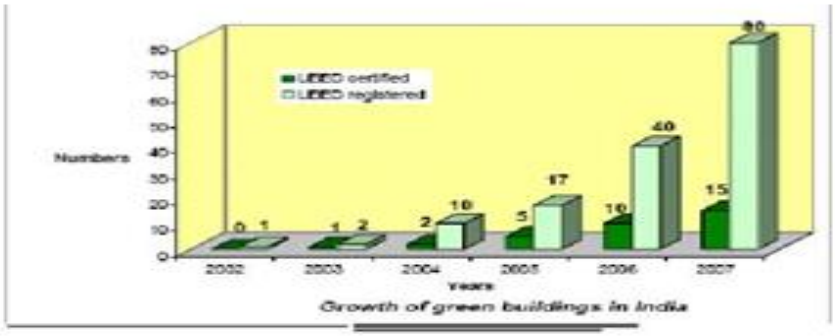


Fig.5 Annual saving potential of top 25 products

VI. ENERGY EFFICIENCY IN INDIAN BUILDINGS

Majority of energy consumption in buildings occurs for HVAC, lighting pumping, etc, Higher the energy consumption greater the opportunities for energy efficiency Energy conservation and efficiency are the buzz words these days but developed countries have left the developing world far behind. Awareness and dissemination of information are the keywords that lead to late start of the whole process. There is an urgent need to improve the energy efficiency of the Indian economy. About 70% of the infrastructure in 2030, such as buildings, will be added in next two decades between 2012 and 2032.



For existing buildings, good insulation, efficient boiler, window glazing and recovering heat from ventilation systems are efficient ways to reduce emissions. The benefits of energy efficiency in building are compelling, cost effective and can help consumers to save money in the long term. It helps to meet energy targets and resource energy shortage. There are many ways and means to achieve Energy efficiency in buildings can be achieved by adopting strategies like using low energy materials, insulation for walls, roofs, roof garden, glass carpet for roof, glass technology. Figure 6 shows the growth story of sustainable or green buildings in India.

VII. ENERGY EFFICIENT BUILT - GREEN BUILDING CONCEPT

Innovations in technology and production processes have resulted in significant changes in building industry. The future of buildings depends not only on innovation by homebuilders, but also on promotion by planners. Growth of green buildings in India Planners are interested in promoting innovative practices that conserve the environment, improve quality and reduce costs.

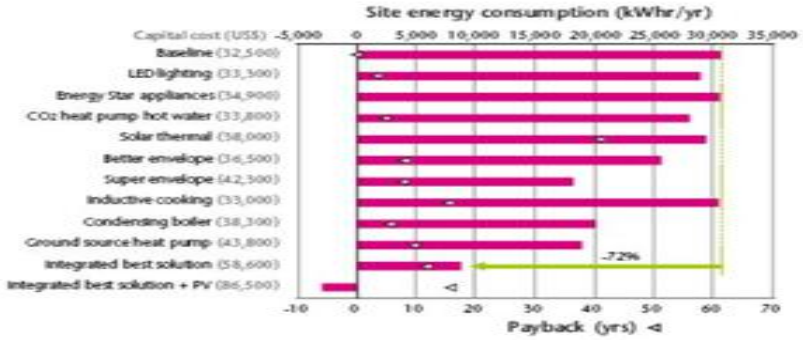


Figure 8. Integrated building design as best solution to reduce energy consumption (Source: WBSCD, 2009)

Green Building (GB) is synonymous with 'high performance buildings', 'sustainable design and construction' as well as other terms that refer to a holistic approach to design and construction. Green Building design strives to balance environmental responsibility, resource efficiency, occupant comfort, and wellbeing and community sensitivity. The Green Building design includes all players in an integrated development process, from the design team (building owners, architects, engineers and consultants), the construction team (material manufacturers, contractors and waste haulers), and maintenance staff and building occupants. The green building process results in a high quality product that maximizes the owner's returns on investment by sustained savings of energy by 40 -50 %, Water savings: 20-30 % and a good reduction in initial investment.

VIII. BRIGHT GREEN BUILDING

Another concept in the area of energy efficient and environment friendly building is the emergence of Bright Green Building (BGB). Bright green building is one that is both intelligent and green. It is a building that uses both technology and process to create a facility that is safe, healthy and comfortable, and enables productivity and wellbeing for its occupants. It provides timely, integrated system information for its owners so that they may make intelligent decisions regarding its operation and

maintenance, and has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved intelligent operation, maintenance and optimization. A bright green building is designed, constructed, and operated with minimum impact on the environment, with emphasis on conserving resources, using energy efficiently and creating healthy occupied environments. Sustainability is measured in three interdependent dimensions: environmental stewardship, economic prosperity and social responsibility. Bright green buildings exhibit key attributes of environmental sustainability to benefit present and future generations.

In bright green buildings, fully networked systems transcend the simple integration of independent systems to achieve interaction across all systems, allowing them to work collectively, optimizing a building's performance, and constantly creating an environment that is conducive to the occupants. Bright green buildings provide a dynamic environment that responds to occupants changing needs and lifestyles. As technology advances, and as information and communication expectations become more sophisticated, networking solutions both converge and automate divergent technologies to improve responsiveness, efficiency, and performance. To achieve this, bright green buildings converge data, voice, and video with security, HVAC, lighting, and other electronic controls on a single network platform that facilitates user management, space utilization, energy conservation, comfort, and systems improvement. Fig.9 outlines the commonalities between intelligent and green buildings that form the basis of a bright green building and highlights the impact of that convergence.

Visibility of these demonstration projects to the public has helped to raise awareness of the energy saving and thermal comfort benefits of cool roofs.

Convergence of Intelligent and Green Buildings (source Frost & Sullivan)

IX. GREEN BUILDING RATING SYSTEMS

Motivated by a desire to appear environmentally conscious, many commercial facilities have adopted ―Green technologies‖ in order to earn ―Green and Sustainable‖ certifications. The Green Buildings Ratings and Certification process has gained tremendous momentum over the last few years. Particularly, growth in the number of projects certified by rating systems such as Energy Star and LEED has nearly doubled in size during this period.

In India, the Indian Green Building Council (IGBC) provides LEED ratings to structures and aims to make the country one of the leaders in green buildings by the year 2015.The Green rating for Integrated Habitat Assessment (GRIHA) is the National Rating System of India. It has been conceived by The Energy and Resources Institute (TERI) and developed jointly with the Ministry of New and Renewable Energy, India. It is a design evaluation system for green building and is intended for all kinds of buildings across every climatic zone in India. According to a 2008 news report in the Indian Express, Mumbai had registered 30 green building projects, at the time the highest among Indian cities. Thanks to the gradual spread of awareness about eco-friendly constructions, there has been a considerable rise in the number of registered green buildings in India. According to 2008 IGBC data, there are 315 green buildings in India, of which 250 are commercial properties.

X. CONCLUSION

Green building brings together a vast array of practices, techniques, and skills to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees

through green roofs, rain gardens, and reduction of rainwater run-off. Many other techniques are used, such as using wood as a building material, or using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water. While the practices, or technologies, employed in green building are constantly evolving and may differ from region to region, fundamental principles persist from which the method is derived: Siting and Structure Design Efficiency, Energy Efficiency, Water Efficiency, Materials Efficiency, Indoor Environmental Quality Enhancement, Operations and Maintenance Optimization, and Waste and Toxics Reduction. The essence of green building is an optimization of one or more of these principles. Also, with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect. On the aesthetic side of green architecture or sustainable design is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. There are several key steps in designing sustainable buildings: specify 'green' building materials from local sources, reduce loads, optimize systems, and generate on-site renewable energy.

With the convergence of urbanization, globalization and a rapidly changing and expanding economy, India is experiencing a rapid spurt in building construction across a range of city activities and socio-economic spectrum, increasing consumption of building materials such as glass, cement, metals and ceramics. Maximum consumption of these energy materials is a reason for environmental degradation. LEED rating provided opportunities to introduce new products and materials. Now there is an imminent need for service providers, who would be required in large numbers, not in hundreds but thousands, as the movement is heading to reach greater heights. The green building movement is here to stay for the benefit of individuals, society and the country at large.

The application of codes like ASHARE / ECBC as a benchmark can help in designing high performance buildings. There exist tremendous opportunities to introduce new materials, equipment and technologies which can help enhance energy efficiency of buildings.

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