Up-gradation of Conventional Buildings into Green Buildings [Case Study of Civil Engineering Department's Buildings in University of Central Punjab]

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Abstract

Buildings are one of the major sources of greenhouse gas emissions and they are contributing to climate change. Buildings not only consume natural resources in the form of construction materials during their construction phase but they also consume other resources in the form of water and energy during their operation and maintenance phase. If the building is not designed keeping in view its sustainability, it will not only be uneconomical but also socially and environmentally problematic. We have a massive built environment which is being constructed without considering its social and environmental consequences, even its long term economic aspects. While keeping in view triple bottom line, deconstruction of conventional buildings might not be an option. So their up-gradation in operations and maintenance phase might be an only practical and acceptable option in most of the cases. In this study two Civil Engineering Department's (CED's) Buildings in University of Central Punjab (UCP) are analyzed on the basis of LEED standards. At the end, recommendations are given to improve their performance and make them green and sustainable.

Keywords: Sustainable development, Green Buildings, LEED, Operation and maintenance

1. INTRODUCTION:

Civil engineering is arguably considered as the oldest engineering profession. As the ancient man searched and constructed shelter to protect himself, he must have got a very basic and simple unit. As the human civilization evolved, construction processes also evolved. Now, the modern units are supposed to provide basic needs of human being, which includes water supply system, sanitary system, gas, electricity etc. But, the problem is, conventional construction occurs at the cost of natural resources without considering their impact, future availability and fate. Built environment not only consumes resources during construction phase but they also consume resources during their operation and maintenance phase. Most of the natural resources used in conventional buildings are limited in nature. On the other hand, built environment contributes to more than two third of the total greenhouse gas emissions (EIA, 2008). These greenhouse gases are causing global warming and climate change. The rapid increase in population and living standards are resulting in high demand of built environment, which is further exacerbating the problem.

To cater the needs of ever increasing population, it is a high time to build green. Green building is a concept by which all the factors are taken into account to produce an economic, social and environment responsible structure. In it, negative effects of buildings are reduced as far as possible. Research shows that occupants of green buildings are 2% to 16% more productive (Vivian, L et al., 2005) because of enhanced indoor environmental quality due to the provision of natural lighting, ventilation, vegetation and their passive design. It also results in on average 24% less energy consumption as compared to typical buildings (Turner, 2008). The average marginal cost of green buildings is less than 2% (Gregory H. Kats, 2008) which are offset by savings over time.

In this work, two buildings of Civil Engineering Department, University of Central Punjab are studied. They are analyzed on the basis of LEED (Leadership in Energy and Environmental Design) which is the most widely used Green Building rating system in the world. On the basis of analysis, recommendations are given at the end to improve the efficiency of buildings. It will help in improving their energy efficiency, water efficiency and indoor environmental quality. They can improve health and productivity of its occupants while reducing their carbon footprint and expenses.

2. RESEARCH SIGNIFICANCE AND OBJECTIVES

It is recommended to think and design green from the start of project to get maximum out of it. But, unfortunately we have a massive conventionally built environment which is impacting the environment in its worst manner and which needs to be green. Demolishing them and reconstruction is not a feasible option; hence the unique solution is retrofitting to make them green.

The objectives are

- to make them suitable for the ecosystem
- to improve their energy and water efficiency
- to enhance indoor environmental quality for the better health and performance of its occupants by reducing waste and pollution generating through them and
- to make them economical.

3. METHODOLOGY AND DISCUSSION

There are many rating systems to gauge Green Buildings. We have used Leadership in Energy and Environmental Design (LEED) to conduct this study. It was first established in 1999 by US Green Building Council (USGBC) which was formed in 1992 to build green systems. LEED rating systems are used in this study to gauge two Civil Engineering Department's buildings present in University of Central Punjab, Lahore. Their aerial view captured from Google Earth is shown in fig. 1. The total covered area of buildings is 27,219sq.ft (or 2529 sq. m). It has 94 FTE (full time equivalent) occupants.

Figure 1: Aerial view of buildings

3.1 Sustainable Site

The purpose of sustainable site is to protect the ecosystem. The maintenance of the exterior should be easy. Minimum energy, water and manpower should be required for its management. Hazardous chemicals (in the form of paints) should not be used for aesthetic purposes as during rainfall they can be added into runoff. Provide pervious surface outside the building. Pervious surface allows infiltration of storm water into ground, which conserves water table and hydrology. Roof should be planted with native or adaptive vegetation to protect open habitat and to reduce heat island effect. The exterior of the buildings in our case is already in good condition and no paints are used on their exterior as shown in fig. 2. But, there must be a pest management plan to prevent pests entering into the building.

Figure 2: Front view of building

Fuel consumption during transportation produces greenhouse gases. Alternative transportation e.g. university's transportation, public transportation and carpooling should be encouraged by giving incentives. 26 buses are dedicated to University and public transportation is also available as shown in fig. 3 and fig. 4 respectively. University should start awareness campaign to promote them.

Figure3: University's transportation

Figure 4: Public Transportation

3.1 Water Efficiency

Plumbing fittings must be efficient and should be designed according to the codes. Any leakage must be repaired on time. The consumption of water must not be greater than the baseline. Proper metering should be done in the building to track the consumption and to predict the leakages in case of abnormal readings. Baseline in our case is 626 gallons per day (or 2.37 m^3 per day). Water metering system is not provided in the buildings so their consumption cannot be metered. Sensor water taps are recommended to save water. Provision of grey water usage should also be given to reduce the consumption of potable water.

3.2 Energy and Atmosphere

Install energy meters throughout the building to track consumption. Conduct ASHRAE

Level- I walk through analysis for the building's assessment, to plan and maintain energy efficient strategies. ASHRAE (American Society of Heating, Refrigeration and Air conditioning Engineers) is devoted to the advancement of indoor environment control technology in the HVAC industry (ASHRAE, 1973). ASHRAE level 1 walk through analysis involves interviews of facility staff, review of utility bills, review of other operating data and walkthrough the facility to identify areas of energy inefficiency. Ensure that building is fulfilling minimum energy performance requirements. ENERGY STAR Portfolio Manager can be used for this purpose. If the building is not fulfilling minimum energy performance requirements, conduct ASHRAE Level II energy audit and optimize energy efficiency performance (Cottrell, 2011). ASHRAE Level II energy audit includes detailed calculations of energy inefficiencies and financial losses.

Prohibit CFC-based refrigerants because they deplete ozone layer. Develop plan for operations and up gradations. Also train the staff accordingly for operations and minor repairs to maintain and optimization of energy performance. Identify opportunities through which energy performance can be further enhanced. Renewable energy should be used to decrease the negative impacts of non- renewable energy usage.

In our case study area, energy meters are not installed in the buildings. Energy meters are the backbone of energy performance calculations and they are mandatory for green buildings. The roof of buildings is already installed with solar panels as shown in fig. 5 but again energy meters are not installed with them so we do not have any data about their electricity generation and consumption through renewable means.

Figure 5: Solar panels installed on roof.

3.3 Materials and Resources

Make a sustainable purchasing and solid waste management policy to reduce environmental impacts of materials. Purchasing of post-consumer, post-industrial and rapidly renewable materials should be preferred. The material and products used in the building should be harvested and processed within 500 miles (or 804.7 km) of the project. Conduct audit of waste to establish baseline to increase recycling and waste diversion. Divert waste from incineration and landfill and maximize their reuse and recycling.

3.4 Indoor Environmental Quality

The building should comply with ASHRAE 62.1-2007 standards for ventilation. Smoking should be prohibited inside the building and provide smoking area 25ft away from the entrance of building and outdoor air intakes. Install MERV13 or better air filters on all air intakes and they must be maintained and replaced on regular basis to reduce particulates in air. Make green cleaning policy for the purchase of cleaning products and equipment. Guidelines should be made for the handling and storage of cleaning chemicals and staff should be trained accordingly. Feedback from the occupants should be taken for the continuous improvement in policy. Install permanent monitoring CO_2 sensors. ASHRAE STANDARD 55-2004 should be observed for the acoustic, thermal and other comforts of occupants. Occupants must have an access to lightings control for their comfort and productivity. Daylight and outside views should be introduced to regularly occupied areas, to make connection of occupants with outdoor environment.

4. CONCLUSIONS:

On the basis of analysis it is concluded that with some minor and major changes energy efficiency, water efficiency and indoor environmental quality of the buildings under consideration can be improved and their carbon foot print can be reduced significantly.

In the section below some improvements are recommended to improve the performance of buildings.

5. RECOMMENDATIONS:

Following are the recommendations based on the analysis made in this study for the social, environmental and economic improvements of buildings under consideration, in their Operations and Maintenance phase.

- Provide impervious surface outside the building to promote infiltration of storm water into the ground to conserve water table and hydrology
- Provide native or adaptive vegetation over the roof to protect open habitat and to reduce heat island effect
- Encourage occupants to use university's, public and shared transport by giving incentives to reduce emissions due to commute
- Install water and energy meters to track losses, performances and efficiencies of the systems
- Give provision of grey water usage in toilets to reduce the consumption of potable water
- Make a sustainable purchasing and solid waste management policy to reduce environmental impacts of materials
- Install MERV13 or better air filters on all air intakes

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