Green Building Retrofit for an Existing Commercial Building at Nehru Place, New Delhi

Apurv Ashish

Department of Architecture and Planning, IIT Roorkee, India

Abstract:

With the advent of economic growth and urbanization in developed and developing countries, the construction industry has seen a rapid growth; this boom in construction industry has brought about the menace of huge amount of energy consumption and greenhouse gas emission. Buildings are associated with high amount of consumption of energy and natural resources and negative environmental impact. In India, the commercial and residential sector consumes 30 % of the total electricity usage.

The energy efficiency in buildings is a new trend, most of the existing buildings were built much before the energy efficiency in buildings was a major concern, these existing buildings will be functional for next 30- 40 years to come, The energy crisis and rising fuel costs will grow in the near future and the energy requirements to run these existing buildings will be very high which would deem the building uneconomic to maintain and operate, the next step would be to dismantle the existing building and build a new one, It is not logical to replace every such existing building by constructing new energy efficient buildings in urban areas as it would disturb the everyday activities in neighbouring areas and cause environmental hazards, the best method is by retrofitting an existing property with new energy efficient features, Retrofitting an existing building will considerably improve life span of the building, improve the indoor air quality, reduce the annual heating and cooling energy requirements and carbon emissions significantly between 50- 70 % etc., failing to achieve proper retrofit of existing buildings will miss a golden opportunity which if not carried out would have negative impacts on the environment to endure decades.

This paper studies an existing building of Nehru Place, New Delhi, India and recommends retrofit options to evaluate the energy savings through retrofit. The results of this study can be utilized for green retrofits of the existing buildings in Nehru Place other such office buildings in Business Centres.

Keywords:

Green Building, Retrofit, Commercial Building at Nehru Place

Introduction: The buildings make up for more than 40% of all the total energy consumption in developed countries and rate of growth is constantly increasing in many developing and emerging economies. Our time sees depleting energy resources and rising fuel costs the present day energy crisis is constantly increasing and so is the energy demand due to rising living standards of the users of the existing buildings, to meet their comfort level inside the building, it is a common practice to install electric heaters and air conditioners etc. in the building, this accounts for higher energy needs for the buildings for their operation and inevitably a rise in burden on global energy demand.

Externally, an existing building and retrofitted building might look same or with minor alterations, but a retrofitted building has much more environmental benefits to provide such as enhanced productivity of the occupants, enhanced comfort inside the building, 30- 40% lower water consumption and 40- 50% lower energy consumption

Retrofitting of an existing building has many challenges and opportunities –

The selection of retrofit technologies and success of the retrofit project depends on uncertainties such as climate change, human behaviour change, services change, dealing with uncertainties and system interactions is a considerable technical challenge in any retrofit project, the other challenges are financial limitations and barriers, long payback periods and maintenance of retrofit equipment.

On the other hand , existing building retrofit has great opportunities such as improved energy efficiency, improved staff productivity, better thermal comfort etc. , retrofitting of existing buildings make them more liveable.

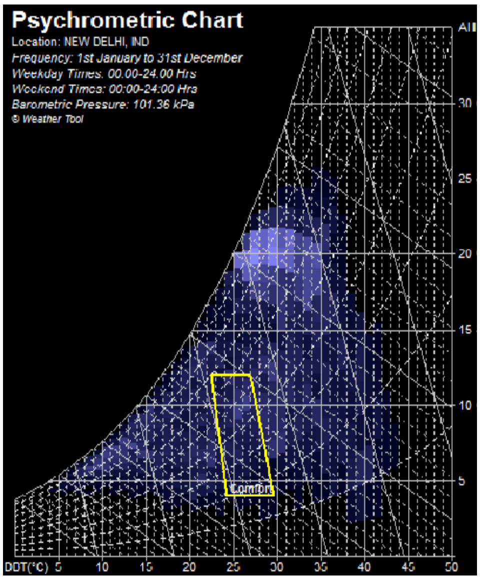
The main objective of this paper is to examine an existing building at Nehru Place as a case study for green retrofit modelling, Nehru Place is a very important business centre in South Delhi, The existing buildings of the commercial area are without proper maintenance, dilapidated floor and exterior etc.

As the site becomes older it's building also become less productive, use more operational energy and hence more emission of greenhouse gases, Lack of refurbishment of the site since its inception have also led to temperature change, decrease in rainfall, increase in rainwater runoff and decrease in ground water table levels at the micro level. So, the Business Centre of Nehru Place holds a very high potential for CO2 footprint reduction, energy savings and another energy efficient factors. Moreover, being the center of activities, the retrofit design will lead to a better place.

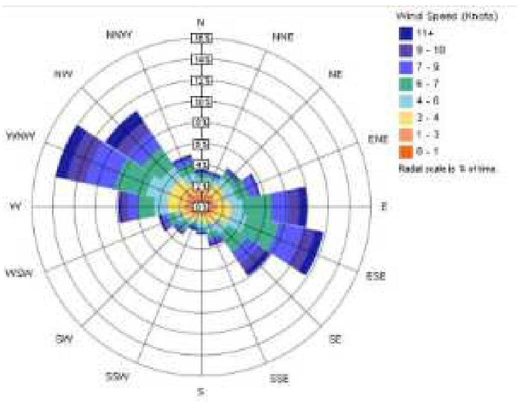
Site Details -

Geographical Location- The site is located 28.6*N Latitude and 77.2*E Longitude. The site is located in south zone F2 in Delhi at the intersection of Outer Ring Road and Lala Lajpat Rai Path. Its site area is 38.20 hectare. It has an average altitude of 216 m; the site is almost flat but slopes a bit towards North direction.

Climate- The site has a composite type climate which is known to have tremendously hot and arid summers and very cold winters. The temperature in range from 15'C in January (minimum 2'C) to 35'C in June (maximum 48'C). The mean annual temperature is 24.8'C. Highest Rainfall occurs in the month of Jul. (200 mm approx).

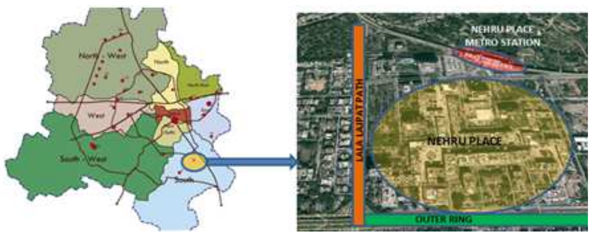


WIND- North-westerly winds usually prevail; however, while from the midst of June to end of July south-easterly winds prevail.



About Nehru place, New Delhi – It is located in South Zone F2 at the intersection of the outer ring road and LalaLajpatRai Path, It's site area is 38.20 hectares, It was proposed by DDA during Master Plan (1961- 81), The center was planned for a population of 3,00,000, the first priority was given to the shopping cum commercial complex (Including Paras cinemas) and second to the hotels and municipal functions, The master plan recommended 82 acres of land for the business centre. The distribution is as follows -

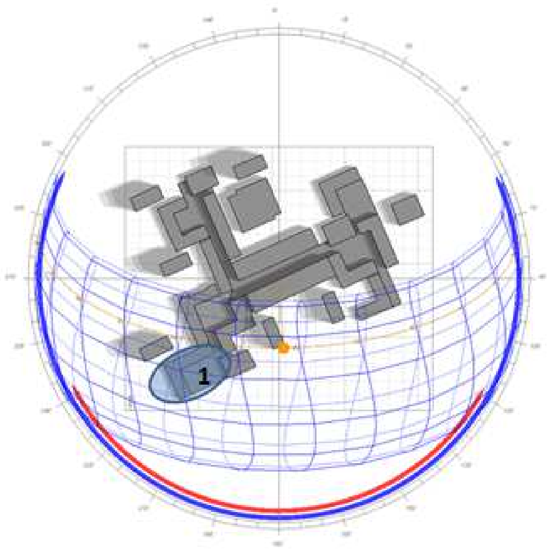
1) 10 acres for the govt. offices.
2) 15 Acres for work cum industrial centre.
3) Remaining 57 acres of land to be developed for various other commercial uses and service industries.



Nehru Place is accessible by all forms of public transport, as it lies next to the outer ring road, an arc that encompasses major parts of South Delhi and the bus service is very frequent, Has its own Delhi metro station on violet line, It has its own bus terminus known as Nehru place Bus Terminal, Private taxis are also available, as well as paid parking for cars and motorcycles. The famous Bahai Lotus Temple is also located close by. Now Nehru Place is accessible by Delhi Metro. The nearest metro station includes Nehru Place and Kalkaji Mandi.

The famous Bahai Lotus Temple is also located close by. Now Nehru Place is accessible by Delhi Metro. The nearest metro station includes Nehru Place and Kalkaji Mandir.

The case study –



The existing building is a four storeyed L shape structure, has a total floor area of 11,904 ft^2 of which most of the space constitute the office area and rest corridors and staircase. It has a roof area of approximately 29780 ft^2 and aligned in south east-North West direction. Doors mainly facing the south east direction. Services like staircase and toilets are on the North West direction, thus buffering the internal spaces from west side. The building is not in a very poor form and shows signs of wear and tear over the years of its operation.

Key design features of the existing building as per the five key areas viz. Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources and Indoor Environment Quality, are discussed below-

1. Most of the surroundings around the building are hard paved with paver block and no vegetation on the frontal side i.e., south east, Hard surfaces outside the building increase rainwater runoff and also cause heat island effect. Because of this impervious paved site area rain water runoff is carried away in underground drains which results in low ground water levels. The rear side i.e., north west side is not paved and has foliage here and there, the overall sight of the building does not give a very pleasant look in sustainable site context.

2. Water usage in the building is primarily for toilets and drinking, there are no water efficient fixtures or equipment in the building. The water usage is 50,700 l / yr.

3. The average energy usage of the building is about 216,987 kWh/ year which is mainly due to lighting systems and other equipment like computer, printers etc.

4. The external wall is brick wall with plaster painted white with lime, the building shows lack of maintenance as the walls show wear and cracks.

Enhancing indoor air quality contributes to the health and the well-being of the occupants but there is no such HVAC system to improve it, the building runs on split and window AC's during summer when heat is high while in winters every room uses 1- 2 heaters to keep the room warm, this increases the building energy needs. The indoor air quality inside the building is very low and needs a major improvement.

From the above study it is but evident that the existing building has no such green design features for energy efficiency and indoor environment, There must be a step taken to improve some of the existing operational equipment, fixtures and practices, Energy efficient retrofit can be done for the building using simulation software and recommendations through analysis done.

Discussion and Analysis -

The input data required for performing energy simulation by Autodesk Ecotect software are building climate data, building drawing such plans, sections and elevations, envelope design elements such as walls, windows, roofs etc., materials and construction elements etc. To perform energy simulation, The building is 3D modelled in Revit Architecture, the rooms of the building is assigned and a .gbxml file is created which is simulated in Ecotect, or the building is directly modelled in Ecotect Analysis, The building is then divided into various zones, These zones are more specifically a single enclosed homogeneous volume of air, as per their usage and occupancy they are simulated to find the results for Thermal Analysis, Resource consumption analysis, Acoustical Analysis, Insulation level Analysis and Lighting analysis etc., after a preliminary simulation for the base model has been carried out, the next step is choosing feasible solutions for improvement of the building, Identify an individual or group of such retrofit design intervention, project to decide their combined potential in the building using simulation tools.

After the simulation with new design intervention has been performed on the base model, the results can be compared to the initial simulated result and one can clearly see whether there is an improvement in building's thermal comfort, operational energy, Indoor temperature etc.

If we retrofit the building with a mixed mode HVAC system. The simulated results obtained from Ecotect Analysis model for energy consumption by the commercial building shows that the total energy consumption for cooling the building/ year would approximately be 819411.84 KWh/year for the building Heat gain through the windows can be considerably be reduced by refurbishing the present single clear glazed aluminium window with Double glazed low-E aluminium frame window and adding 3 feet sunshade on the windows, Though the windows are recessed in the wall, that is not enough to stop harmful sunrays in the time of the year when sun is low.

but, if we perform a combined retrofit with Mixed Mode HVAC system, Double glazed low-E aluminium frame window and 3 feet shading on windows the cooling load comes down to 7,12,908.48 KWh/year hence a saving of 1,06,503.36 KWh/year i.e., a saving of 13% yearly. With these three design intervention we can get savings on energy consumption for cooling of the building, more such combined interventions can be carried out and final savings in energy consumption can be found out.

Providing lighting controls for the building using light sensors, dimmers and occupancy sensors would reduce the overall energy consumption of the building, The roof has an area of 2872.69 ft^2 and solar power generation potential of 654,619 Kwh/year, By use of power generation through solar photovoltaic cells, the building can produce and use its own energy, It's dependency for electricity on power grids would be reduced tremendously.

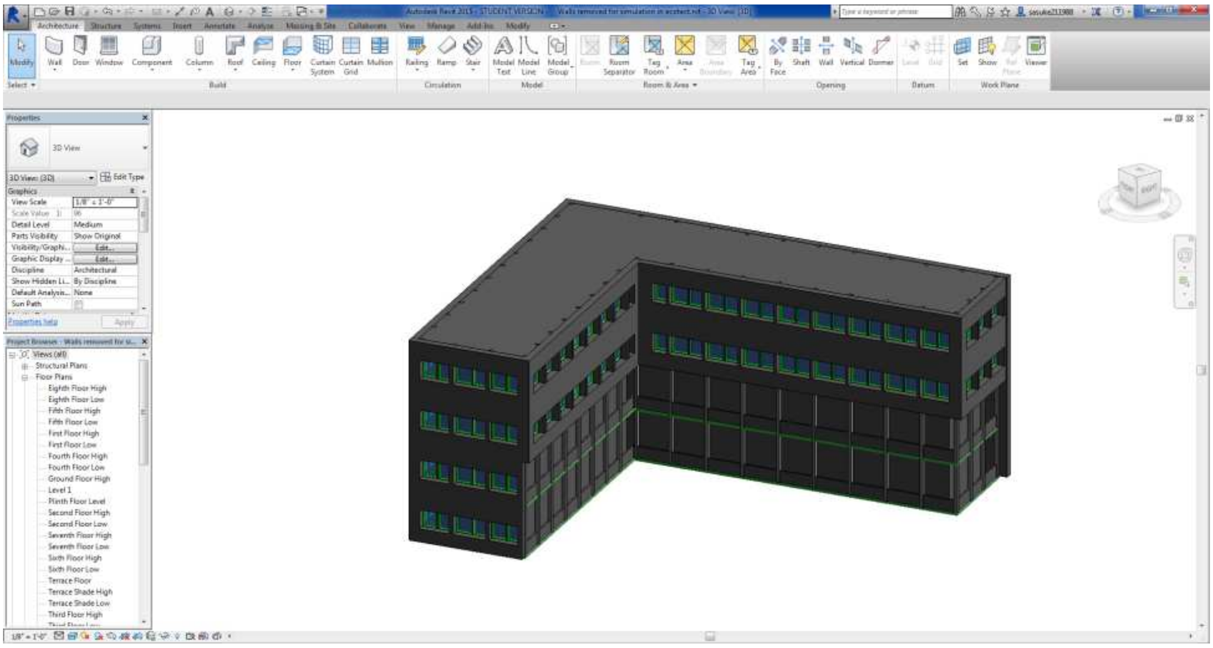


Fig – Snapshot of the existing building modelled in Revit Architecture.

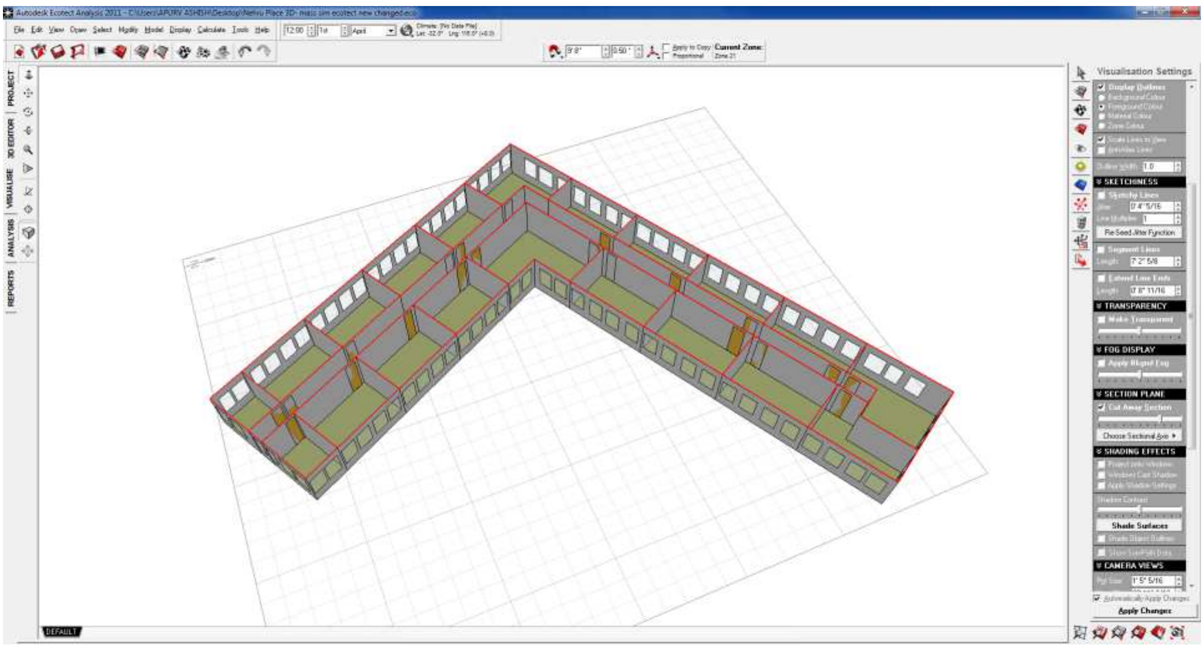


Fig –Snapshot of a floor the existing building modelled in Ecotect Analysis

The roof area of 2872.69 ft^2 can be converted to green roof which would help save rainwater through rainwater harvesting; the plants will cool the building through evapo-transpiration hence save 25% of the total energy consumption.

The single glazed aluminium windows (considered to be 90% transparent) can be refurbished into double glazed Low- e aluminium windows which would considerably decrease the heat gain inside the building, this will further reduce total energy consumption.

Finding Thermal Comfort by using a mixed mode HVAC system, double glazed, low- aluminium frame window instead of single glazed aluminium frame window and 3 feet shading on windows solid core pine timber door and plaster foil heat retention ceramic roof , we see that the thermal comfort inside the building gets highly improved,

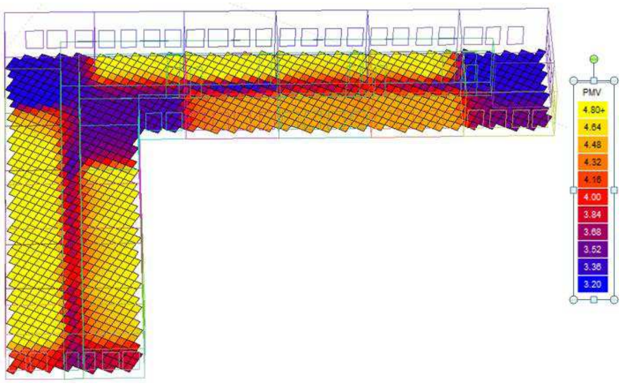


Fig.: Predicted Mean Vote value range: 3.20- 4.80 PMV, people work in uncomfortable condition while using the space.

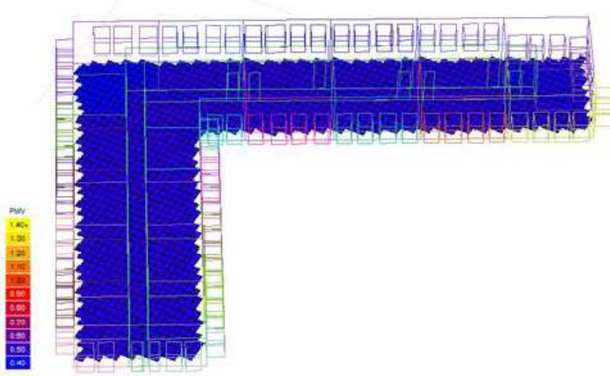


Fig. : : Predicted Mean Vote value range 0.40- 1.40 PMV for final retrofitted case by using Mixed Mode HVAC system, Double glazed low-E aluminium frame window and 3 feet shading on windows, solid core pine timber door and Plaster foil heat retention ceramic roof. It shows that people work in a comfortable condition.

PMV value is the indicator of temperature sensitivity of human body i.e., Range +3= Hot, +2= Warm, +1= slightly warm, 0= Neutral, -1= slightly cool, -2= Cool, -3= Cold

Though the windows are recessed into the walls, it is not enough to shade the windows properly. High amount of harmful sun's rays enter through the windows, this increases the heat gain and glare is produced in the room in the areas near to the window, A 3 feet sun shading device can be used to avoid glare and entry of heat inside the rooms.

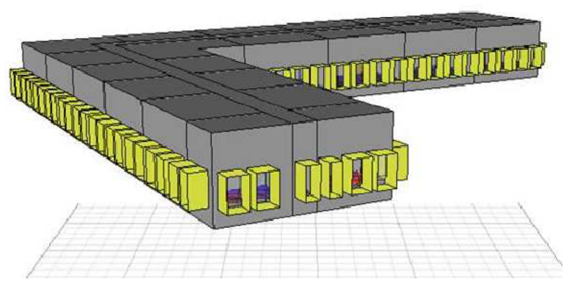


Fig. : Use of 3 feet sunshades on the window

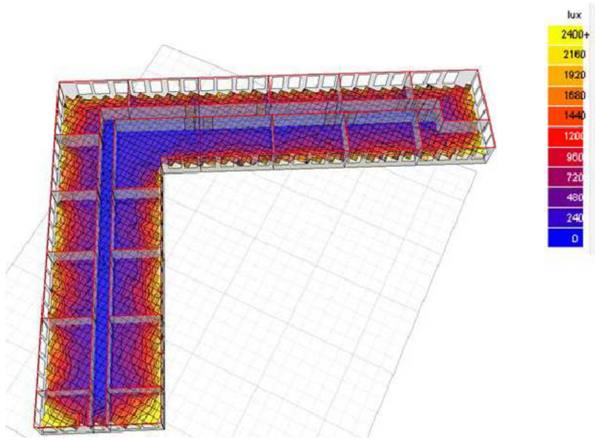


Fig. : Simulation for lighting levels for base case showed glare for areas in the room near the window.

When sunshades were introduced on the windows it showed optimum lighting level inside the room.

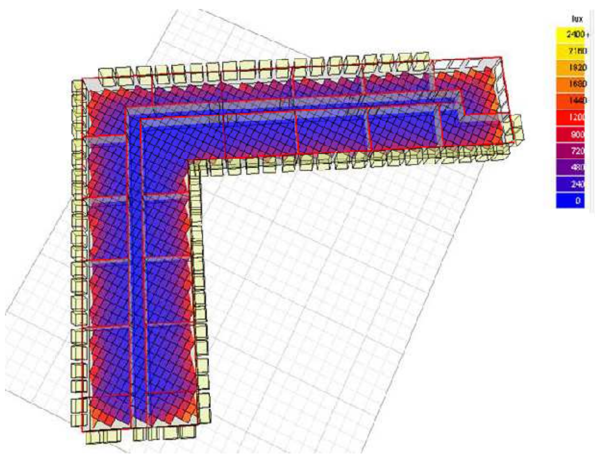


Fig. : Improved lighting level inside the rooms.

By incorporating the above retrofit design interventions in the building, the building will consume less energy and will perform well in terms of lighting, Thermal comfort etc. Below are some more design interventions to make the building more energy efficient -

Water Efficiency -

Water efficiency in the building can be achieved by using water efficient fixtures, rain water harvesting, and grey water reuse etc. Use of low water flushes, waterless urinals, auto control valves, pressure reducing devices and dual flush toilets etc. this can reduce the water use by 40- 50%. Reduce landscape water requirement - reducing 50-70% water consumption by appropriate planting (xeriscaping) and efficient irrigation systems. Rainwater collected from the roofs makes an important contribution to the availability of drinking water. It can supplement the subsoil water level and increase urban greenery. After treatment, rainwater would be used in flushing toilets, watering garden, terraces and washing cars etc. Managing waste water from building through biofiltratlon and landscape design- zero energy utilization. Waste water that will be treated can be used for flushing toilets, watering garden, terrace and washing cars, Green roofs can be provided which makes the building less susceptible to thermal gains and reduce rainwater runoff, The green roof also creates contiguous vegetation for Bio-Diversity, Micro Climate Moderation, Carbon Sinking, Economic Use, Noise and Dust Reduction. Green Roof will reduce temperatures mostly by evapo-transpiration.

Energy and Environment –

Mechanical conditioning and heating can be minimized by passive solar design techniques. Use of variable refrigerant flow (VRF) systems for air-conditioning with high coefficient of performance will help in saving energy. Use of five star BEE labeled fans and appliances will save life-cycle costs. Employ 100% zero-ozone depleting potential insulation (ODP). Hydrochloro- fluorocarbon (HCFC) and chlorofluorocarbon (CEC) free HVAC and refrigeration systems and fire extinguishing systems.

As the building is quite old, offices still use incandescent light bulbs or fluorescent tube lights, these luminaries use high amount of energy so it's time to switch to the use of efficient luminaries (after carrying out lighting power density analysis) for high intensity light output, occupancy sensor lighting, dimmers, Light-emitting diode (led) lighting for longer operating life around 50.000 hours and better energy efficiency, will save energy up to 90 percent., Sensor automation for controlling lights in outdoors and indoors to save on energy. Solar water heater should be planned to heat water. New Delhi has ample sunlight and wind for providing renewable energy, Solar panels, hydrogen fuel cells and a wind mill will be used for electricity generation. Outdoor lighting load will be reduced through optimum design and use of solar panels for electricity generation.

Materials and Resources –

Use renewable, locally available products such as bamboo, ply boards, rubber, eucalyptus, lute, stalk boards, cotton as materials for retrofits. Materials with high recycled content and low maintenance, Eco-friendly glues and adhesives. Low volatile organic compound (VOC) paints for good health and environment, regionally and locally available building finishing materials: Bamboo. Particle Boards, Rubber wood, gypsum, rough stone finishes, Ceramic tiles, Kota stones, Local stone, terrazzo and broken china flooring available from other existing construction sites. Composite wood products such as hardboards block boards. Recycled materials for doors, window Frames and shutters.

Indoor Environment Quality-

Ensure healthy indoor air quality, water quality and noise levels to reduce global warming potential. Good acoustics will be provided by various construction techniques and protection against exterior noise. Emergency exit doors and escape routes will be provided in all the buildings specially hostels. Firefighting security will be maintained in the campus by using sprinklers, fire alarms and fire hydrants.

Conclusion –

With high energy prices, dipping reserves of conventional forms of energy and increasing greenhouse gases, energy efficient retrofit of an existing building is the need of the hour. The construction sector devours about 30 % of the total energy use and this share will rise in the coming years. Green retrofit measures with paybacks in 5 years or less can reduce energy use and carbon emission by 40 %.

A green retrofit of an existing commercial asset, for example, can be as simple as installing new heating, ventilating, and air conditioning components, mounting solar panels on a roof, or placing a bike rack outside the building etc., retrofit involves multiple complex renovations on building's interior as well. Better Indoor air quality leads to enhanced user environment and productivity, through energy efficient retrofit increased work productivity ultimately holds the greatest profit potential for an enterprise, far greater than energy or water savings. Though investors and lenders are unlikely to become involved in new sustainable development deals during the current downturn, green retrofitting of existing income-producing buildings is one area they may endorse during this period if they are made acquainted about the enhanced user productivity which leads to profit from the enhanced productivity.

Retrofits do not yield the same profit margin as do construction projects begun from the ground up, but they are a safer play in the current economic climate. Green renovations are generally less risky because they involve fewer material expenses since the structural components are already in place and the only price to be paid is for equipment/inventories, this is very profitable for an enterprise as they can continue using the same building for work at the time of retrofitting.

Similarly, Nehru Place with nearly 1300 offices and nearly 12,500 people engaged indifferent business, generates around Rs 1000 crore/year to government revenue. As the retrofit processes commence in phases, the people involved in business there will not have to vacate the place but they can continue to work in the buildings hence not generate losses, after the energy efficient retrofitting of the building is over they will reap the benefits of not only an upgraded building but also a place where they can Live and breathe through improvement in indoor air quality, not only will it give a new horizon to their business but at the same time improve the significance of the place.

References

1. Castleton, H. F., Stovin, V., Beck, S. B. M., & Davison, J. B. (2010). Green roofs; building energy savings and the potential for retrofit. *Energy and Buildings*, *42*(10), 1582-1591.
2. Tobias, L., & Vavaroutsos, G. (2012). *Retrofitting Buildings to be Green and Energy-Efficient: Optimizing Building Performance, Tenant Satisfaction, and Financial Return*. Urban Land Institute.
3. Dong, B., Kennedy, C., & Pressnail, K. (2005). Comparing life cycle implications of building retrofit and replacement options. *Canadian Journal of Civil Engineering*, *32*(6), 1051-1063.
4. Woolley, T., Kimmins, S., Harrison, R., & Harrison, P. (2002). *Green Building Handbook: Volume 1: A Guide to Building Products and Their Impact on the Environment*. Routledge.
5. Singh, B. B., & Jain, V. K. (1995). A comparative study of noise levels in some residential, industrial and commercial areas of Delhi. *Environmental monitoring and assessment*, *35*(1), 1-11.
6. Favero, P. (2003). Phantasms in a" Starry" Place: Space and Identification in a Central New Delhi Market. *Cultural Anthropology*, *18*(4), 551-584.