

Case study on ONGC Commercial Center BKC, Mumbai

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Abstract— Though term "Green Buildings" is becoming popular these days in various events of Social awareness campaigns of Save Environment but people are still bit skeptical to invest in the Green Buildings due to the fact that it costs more than regular buildings but however they fail to understand that extra cost invested would be returned in one eighth to one fifth of building life through energy savings and also it would give long term benefits in terms of maintenance also it would give an insurance to volatile fluctuations in prices of fossil fuels. This paper is intending to show exactly same with a help of case study about the Green Building and environmental friendly technologies used in the building. This case study is aimed at creating awareness by reflecting the reduction in energy usage, carbon emissions and a savings by using green technologies in the building.

Keywords —Green Buildings, carbon emissions energy. environment, cost, green technologies, savings

1. INTRODUCTION

Buildings have been an evolving with complexity with a lifetime of decades. Issues relating to the overall environmental impacts have strengthened the awareness of the role buildings play on our well-being. Continuous efforts have been made to improve all aspects of the environmental qualities of buildings (i.e. energy codes, automation & control schemes and thermal comfort etc.), however, a detailed approach in designing stages of the building are lacking, due to which the motive of the "green buildings" is not achieved to its potential.

However it is in the designing stages where the most of opportunities are available to make the changes which will benefit the building and help it sustaining.

In last decade many methods have been developed to determine the environmental impacts of the building and to help it in making it more environmental friendly. Many fields such as simulation of building physics, equipment performance, building materials etc. have now become a integrated part of the building designing. Also research is being done in order to improve indoor air quality, reduce energy consumption, recycled content in the structural components of the building to reduce the environmental damage of the building .

LEED (Leadership in Energy & Environmental Design) is a Green Building Rating System developed by USGBC in order to certify and promote standard for developing optimized power consumption in sustainable Buildings.

It evaluates the environmental performance from the whole building perspective over building's complete life cycle, which enhances the buildings retail value, importance and adds to its social value.

LEED Rating System also evaluates the building during its construction process various different

parameters such as to, Energy consumption, reduction in carbon emissions , onsite energy generation , ecofriendly material selection to achieve the four possible levels of certification. This four are classified into Platinum, Gold, Silver and LEED certified.

Each credit in the LEED rating system consists of a detailed description and documentation required for the projects assessment to achieve the certification by USGBC.

To compare the performance proposed designed case of the project it has been compared with the performance of the Building that agrees with ASHRAE 90.1-2004. The energy simulation and analysis performed on the building is the process of comparison of design case with respect to base case.

2 ENERGY SIMULATIONS

ONGC is located in Mumbai, which is being designed by Architect Hafeez Contractor which is contending for LEED (Leadership in Energy & Environmental Design) NC rating by USGBC. It requires energy simulation of buildings to demonstrate energy savings in order to get LEED rating.

It is a powerful tool to determine optimum size, engineering system, form and orientation which affects the energy consumption of overall building.

Energy performance of buildings can be improved in designing stages itself. Hence, it becomes necessary to run energy simulation in the designing stage of the project in order to get optimum energy saving results. The energy impact of HVAC system sizing, glazing selection, envelope optimizations lighting design can be minimized and so designed by using the results of energy simulation system.

For under design project estimating the annual cost of energy associated with operating a building is difficult as it depends on many factors related to construction details such as efficiency of lighting, local climate profile, operating schedules, orientations of walls and windows, HVAC systems and the equipment loading within the building.

10 potential points can be earned if the energy performance level is above the prerequisite standards. Calculations are done by comparing it with Base case. The table below highlights potential LEED credits that can be gained by maximizing the energy performance over the Base case.

With the architectural Building plans and specifications virtual model of the building base is developed for simulation. A base case model that is similar to ASHRAE/IESNA 90.1-2004 is then compared with the design case model and accordingly changes are made to add Energy efficiency measures to case model. The eligibility criteria for LEED is determined by percentage of operation cost saving of case model.

The simulation will help in determining the performances of the designed project and thus will help in finding out the overall effect building's energy consumption.

It is not possible to find out the actual annual energy costs required for operating a building, as it is still under construction. Many factors such as occupying density, building orientation, wall to window ratio, construction processes, HVAC systems, Lightings systems etc. will play a major role in determining the same.

The simulation is done by developing a "virtual model" of the Building designed on the basis of architectural plans and specifications. Also a base line model has been developed that is similar to ASHRAE/IESNA 90.1-2004 The Model is then designed by necessary making changes to the Base case Model by adding the energy efficiency measures that could reduce the power consumption of the. With reduction in consumption of the annual we would be able to determine the percentage of operation cost savings of the designed model which in turn will help in determining the eligibility criterion for LEED credit points. This will be expressed in rupees per unit, which then will be compared to the rates of purchased electricity.

Table -1: LEED points rating system

Energy Cost Savings	LEED Points	Energy Cost Savings	LEED Points
10.5%	1	28.0%	6
14%	2	31.5%	7
17.5%	3	35.0%	8
21.0%	4	38.5%	9
24.5%	5	42.0%	10

3 PROJECT DESCRIPTION

The ONGC Mumbai consists of G + 8 floors and two basements. The proposed building has a conditioned area of approximately 3, 38,600 sq.ft. The building is being designed by "Architect Hafeez Contractor". The services of building are being designed by AECOM MEP. The overall window wall ratio is approximately 48%.

For each floor a zoning plan was developed & data was feed into the simulation model. Properties such, occupancy rate, outside air requirement equipment power density as lighting power density and many others. Physical properties such as of floor-to-floor height, material conductivity & fenestration area etc. were included.

Many of energy conservation methods such as lighting controls & systems, double glazed windows, insulation for roofs, chillers type, sizing will be added to the Base case to optimize the performance of the proposed building.

4 BASE CASE MODEL

The ASHRAE 90.1-2004 Minimally Compliant Base case model is used to benchmark the proposed design, as well as determine the LEED points.

This model is based upon the proposed design, but the performance parameters listed above are defined to reflect the minimum efficiency levels that ASHRAE 90.1-2004 defines for various building components. These parameters are listed below.

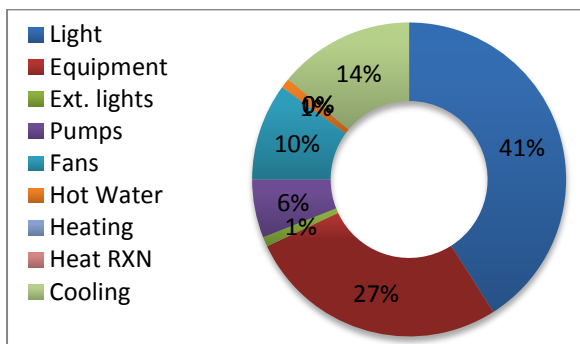


Chart -1: Energy Consumption for Baseline (1,000 Kwh)

DCV, CO2 sensors installed

Heat Recovery Wheel installed

No Economizer

Central Plant

2 nos. Water cooled Centrifugal chillers with COP of 6.3 and 2 nos. Vapor Absorption Machine with COP of 1.0 at ARI conditions

VSD's on Secondary pumps and Cooling towers

High efficiency pumps

Utility Rates -

Electricity	:	Rs
⊙ charge	7.5/Kwh	
	:	Rs
⊙ Gas	20/SCM	

Domestic Hot Water

Requirement – 5000 liters/day

Source – Solar Panels

5 PROPOSED DESIGN

Proposed case assumptions are based on project drawings.

Building Envelope

Exterior wall construction: Spandrel glass with U-value = 0.520 Btu/ hr.ft²° F and 50mm glass wool insulation. Overall U-Value = 0.09 Btu/ hr.ft²° F

Roof Construction: 9" thick RCC with 3" Extruded Polystyrene insulation entirely above deck, (R-15). Roof assembly U-Value = 0.054 Btu/ hr.ft²° F

Window to wall ratio: 48%

Fenestration properties for glazing facade(vision area): Refer Appendix-IV

Shading Devices: Automatic Roller blinds installed at Central Atrium

Lighting Equipment

An average lighting power density of 0.63 W/sqft (Building area method) in office & 0.3W/sqft in parking

Occupancy Sensors installed in non-regularly occupied areas

Daylight control (Photo sensors) installed in occupied perimeter spaces

Air Side HVAC System

AHU system with reheat, VAV Boxes

VSD's on AHU's

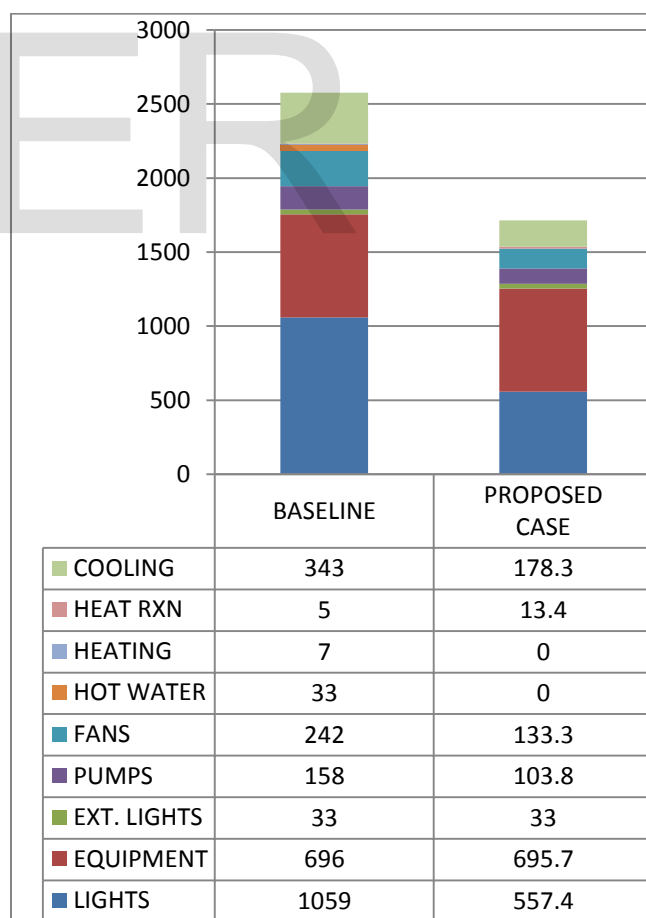


Chart -2: Energy Consumption Comparison Design case vs Base Case (1,000 kWh)

6 CONCLUSIONS

Proposed Design shows great reductions in energy consumption as compared with the ASHRAE 90.1-2004 stipulated Base case model. Improved lighting power density as well as daylight sensors in the office spaces, along with reduction in cooling loads due to high glazing specifications and an optimized lighting design have contributed to energy reductions.

The energy costs for the design case model are compared with the energy costs for the ASHRAE 90.1-2004 minimally-compliant model in order to calculate the LEEDNC v2.0 points for Energy and Atmosphere Credit 1. The end-uses considered for the calculations are the, Exhaust and ventilation Fans, Hot water geyser, Lighting and Heating & Cooling Pumps & Auxiliary Equipment. The annual energy costs were calculated using the applicable utility data discussed earlier.

By considering all the design parameters it can concluded that results of the energy simulations have come out to be positive and the project will be able to meet all the requirements of LEED NC-Environment and Atmosphere (EA) Prerequisite 2.Hence it can help in achieving 28.42% savings in energy consumption cost over its ASHRAE base case model.

Additionally, on-site photovoltaic array of capacity 160 kWp would generate 224000 kWh of annual electricity reducing the design case energy costs by Rs.16,80,000 which increases the energy cost savings to 37.13% over the base case.

This project should be able to achieve eight points under the criteria of USGBC LEED NC EA1 based on these results obtained.

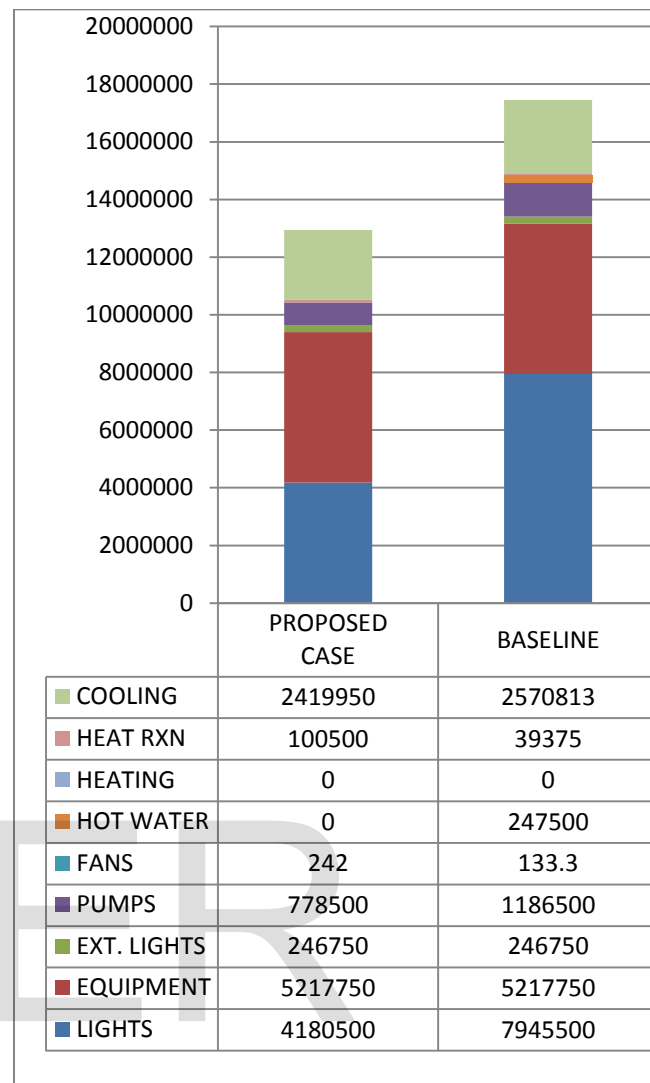


Chart 4: Energy –Cost Comparison for Regulated Energy
Designed vs Base case (RUPEES)

APPENDIX I: DETAILED COMPARISON BETWEEN BASE CASE BUILDING & PROPOSED DESIGN:

Sr. no.	Model Input Parameter	Base Case	Proposed Design
1	Exterior Wall Construction	Wall U value- 0.124 Btu/hr sqft°F	Spandrel glass with U-value = 0.520 Btu/ hr.ft²° F and 50mm glass wool insulation U-value = 0.090

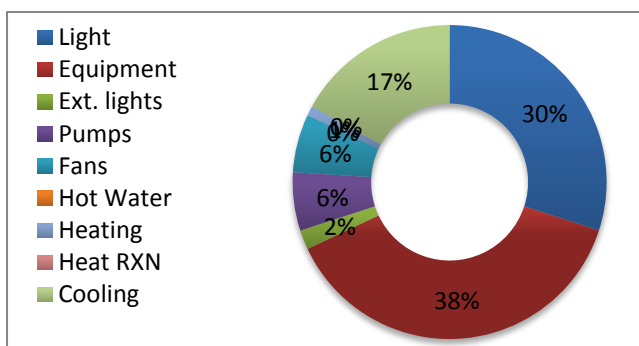


Chart -3: Energy-Cost for Energy consumption in Proposed design case (RUPEES)

2	Roof Construction	Insulation entirely above deck, U value-0.063 Btu/hr sqft°F	9" thick RCC with 3" Extruded Polystyrene insulation entirely above deck, (R-15) U-value = 0.054
3	Glazing	U Value: 1.22 Btu/hrsqt°F SC (All):0.29	As per Appendix- IV
4	Shading Device	None	Roller blinds installed at Central Atrium
5	Window Wall Ratio	40%	48%
6	Lighting Power Density	An average LPD of 1.0 W/sqft(Building Area Method) in Office & 0.3W/sqft in parking	An average LPD of 0.63 W/sqft(Building Area Method) in Office & 0.2W/sqft in parking
7	Occupancy sensors	None	Installed in non-regularly occupied areas
8	Daylight Sensors	None	Installed in occupied per space
9	Chiller Parameter	Water cooled Centrifugal Chillers, COP 6.1	2 nos. Water cooled Centrifugal Chillers, COP 6.3 and 2 no. Vapour Absorption Machine, COP-1.0

East & West (Vision panel)	1.76	0.26	0.23	31%
East & West (Spandrel panel)	5.8	0.52	0.45	33%
North & South (Vision panel)	1.76	0.26	0.23	31%
North & South (Spandrel panel)	5.8	0.52	0.45	33%
Side Atrium (Vision panel)	1.70	0.44	0.38	58%
Side Atrium (Spandrel panel)	1.70	0.44	0.38	58%

**APPENDIX II
FENESTRATION PROPERTIES FOR
GLAZING FACADE (VISION AREA):**

Energy Cost Savings	U-value (W/sq m K)	SC	SHGC	VLT
Central Atrium	2.78	0.91	0.79	79%

7. FUTURE SCOPE

Though this case study broadly glorifies the benefits of the Green Building and its pivotal role in reducing the carbon emissions in the environmental atmosphere, this case study still has a great depth to be discovered in terms of detailed analysis of green technologies used in the building. Also there happens to be a lot of scope in finding the cost and return on investment period. There are few researchers who are working on to conclude that the investment made on the green technologies of the building may yield more returns than fixed deposits in banks during the life cycle of the building.

Millions of square feet of spaces are being generated every year which relies heavily on the power generated by the thermal power plants. This dependency on conventional energies needs to be reduced drastically in order to preserve earth's environment. Hence green building agencies need to promote new and green technologies. Other than that, there seems to be a lot of voids in the will of government of India to promote green technologies.

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