ISSN: 2456-1363
International Journal of Scientific Research & Growth
A Multidisciplinary Peer Reviewed and Refereed International Journal
Volume-3 Issue-5 December- 2018
www.ijsrg.com
editor@ijsrg.com

Green Retrofitting Of Existing Building- A Case Study

[1]Dr. Rajeev Kansal, [2]Dr. M. K. Trivedi, [3]Neeraj Varma
[1,2]Professor, Department of civil Engineering, Madhav Institute of Technology & Science, Gwalior, M.P., India
[3]M.Tech. Scholar, Madhav Institute of Technology & Science, Gwalior, M.P., India
E-mail- dr.rkansal@mitsgwalior.in

Abstract
The Building construction sector is becoming one of the highest contributors to the country's carbon emissions. It alone accounts for 22 per cent of India's total carbon emissions. It is expected that this impact to increase further with the efforts to combat housing shortage affecting more than 60 million households in the country, adding to the huge resource and energy footprints of the sector.
Since an opportunity to reduce primary energy use lies within the existing building stock, retrofitting of old buildings is one such solution to answer queries about energy efficiency. To improve energy efficiency, it is a proven high-volume, low-cost strategy that can help in tackling one of the major causes of climate change.
Transformation of existing Building refers to using a process that is environmentally responsible and resource efficient in operational lifecycle to building. Benefits of the retrofit technologies in existing buildings is provided by case study.
Keywords: *- operational lifecycle, energy efficiency, green retrofitting, Green Building, Saving.*

1- INTRODUCTION

A "Green retrofitting" of existing building is defined as "a modification in building with design and construction processes which significantly reduce or eliminate negative impact of buildings on the environment and occupants." The term essentially refers to a building which is energy efficient and environment friendly in terms of minimal disturbance to environment during service. It, therefore, encompasses the planning, construction processes and service performance aspects of the building. Green buildings result from integrated design and construction processes which reduce the negative impact of building on the environment and the occupants. Green Buildings are considered to be important component of any model for sustainable urban development.

Benefits of Green Building

- Reduces environmental impact through energy efficiency and waste recycling.
- Helps in saving natural resources.
- Lower operational cost resulting from efficient resource use through reduction in energy and water requirements.
- Improves health through better indoor air quality.

Disadvantages of Green Building

- Initial cost of green retrofitting is high.
- Requires advanced technology.
- Requirement of skilled labours.

Renewable Energy Sources

- Wind energy
- Solar hot water heating (also called solar thermal)
- solar electricity
- Ground or air source heat pumps
- Biomass and Bio fuels

2- DETAILS OF CASE STUDY

2.1 INTRODUCTION

The Communication Building is a four stories plus basement, located in City Centre, District Gwalior. The building's construction was completed in 1998. It's situated on a land of 2500 m^2 (26900 ft^2) of Free hold office and communication centre housing telephone exchange equipment's. It is observed that it attracts around 500 to 600 visitors per day and has an office population of around 130 to 150 persons. The green retrofit project began in 2014 with the goals to transform the building into a more energy efficient and eco-friendly structure. In terms of economic feasibility, the expected income stream enhancements included:

- Decreasing capital improvement program costs;
- Decreasing utilities budget due to achieving higher efficiencies in energy and water usage;
- Decreasing building operations budget due to lower maintenance and repair costs;
- Increasing rent and occupancy due to providing higher quality spaces of greater services and amenities; and
- Additional income from new facilities, amenities, and tenant service offerings.

2.2 BUILDING DESCRIPTION

- Name of Building – COMMUNICATION BUILDING AT CITY CENTRE GWALIOR
- Place and Address of Building – NEAR INCOME TAX OFFICE AT CITY CENTRE GWALIOR
- City- GWALIOR
- No of Storeys- Basement, G+3 storied
- Type of Construction- RCC Framed Structure
- Cost of Construction- Approximately Rs 5 crore (Year 1998) including Civil and Electrical

2.3 ANALYSIS OF CASE STUDY

2.3.1 ENERGY DEMAND

Following measures are proposed for implementing the green retrofitting of building under consideration of case study.

- Reduction of energy demand
- Provision of renewable energy source to reduce dependency on conventional electricity source for solar energy generation photo voltic cells panels installed on roof.
- Replacement of conventional electricity fixture and appliances with energy efficient electrical fixture and appliances.

2.3.2 WATER SAVING

For reduction in water consumption following measures are recommended

i) Upgrade Urinals to waterless urinals
ii) Low water use faucets installed.
iii) Installation of sensors for water saving in WC.
iv) Roof Water Harvesting.

2.3.3 ENVIRONMENT AND HYGIENE

The Indoor environmental quality which includes maintaining indoor thermal and usual comfort and air quality for developing hygienic living condition is an essential requirement of green building. For maintaining these high quality standards following measures were adopted.

- Low VOC indoor paints applied instead of conventional high VOC paints.
- Roof of the building provided with reflective tiles so that difference between ambient temperature and roof temperature may be increased i.e. temperature of roof will be more cooler/hotter than ambient temperature.
- Outer wall of building painted with light colour reflective paint.
- Windows conventional glass of windows replaced by high performance glasses keeping in mind consideration of reducing

indoor lamination electricity load by providing natural light infiltration in rooms apart from heat reflection.

2.4 DATA ANALYSIS

2.4.1 PROVISION OF RENEWABLE ENERGY

The energy demand can be offset by use of renewable energy resources. One such method is by harvesting solar radiations. The payback calculation of 50 KW Solar Power Plant installed for reducing the conventional energy demand.

Capital Cost of 50 KW Solar Plant – Rs 46, 24,811/-

Subsidy from State Government – Rs 7, 50,000/-

Subsidy from Central Government - Rs 9, 37,500/-

Net Capital cost of Plant – Rs 29, 37,311/-

Pay Back Period calculated is 4-1/2 years

Total Saving in 25 years - Rs 1, 36, 95,000/-

The Solar unit Generation Plant was installed at the Roof of the building. The units generated at the end of every fortnight were observed and noted namely for the period April-2018 to August 2018 and is given in Table-1.

Table 1 -Fortnight Report on Details of Solar units generation

Name of Building	Communication Building at City Centre Gwalior	
District Gwalior	Gwalior	
Capacity of Solar Plant in kWp as per Actual at Site	50	
Date of Commissioning	02/10/2017	
Period	Total No. of Unit Generated	Total savings in Rs.
Total Up to 01/04/2018	30566	290377
15/04/2018	2796	26562
30/04/2018	4197	39871.5
15/05/2018	3131	29744.5
31/05/2018	3680	34960
15/06/2018	3785	35957.5
30/06/2018	2713	25773.5
15/07/2018	2697	25621.5
31/07/2018	2047	19446.5
15/8/2018	2423	23018.5
31/8/2018	2175	20662.5
Total Up to 31/08/2018	60210	571995

2.4.2 REDUCTION IN ENERGY DEMAND

Replacement of conventional electricity fixture and appliances with energy efficient electrical fixture and appliances. Following changes were implemented and comparative saving of energy in KWH and in Rs tabulated as below.

TABLE 2 – Energy Saving by using Energy Efficient Fixtures

S. No	CONVENTIONAL FIXTURES		ENERGY EFICIENT FIXTURES	
	Equipment / Devices	Total Energy Consumption per day (WH)	Equipment /Devices	Total Energy Consumption per day (WH)
1	CFL	17648	LED	10728

2	Single Rod Tube Light	42080	LED Single Rod Tube Light	17532
3	Double Rod Tube Light	94880	LED Double Rod Tube Light	42696
4	Wall Fan	31800	Wall Fan	19080
5	Ceiling Fan	58000	Ceiling Fan	34800
6	Air conditioner	648600	Air conditioner	496800
7	Computer	168500	Computer	121320
8	Printer	14480	Printer	10340
9	Package AC	1386000	Package AC	1050000
10	Cooler	48600	Cooler	21600
11	Compound Light	24912	Compound Light	6480
12	Motor	36000	Motor	24000
	TOTAL	2571500	TOTAL	1855376
Energy Consumption with conventional fixtures KWH/ Per day (Total)		2571.50	Energy Consumption with Energy Efficient fixtures (Total)	1855.38
Energy Consumption of Conventional fixtures in KWH per month 2571.45x24 (working days)=		61716.00	Energy Consumptions of Energy Efficient fixtures in KWH per month 1855.38x24 (working days) =	44529.00
Rate of electricity per unit		Rs 9.50	Rate of electricity per unit	Rs 9.50
Total Electricity Bill Amount with convential fixtures		Rs 586,302.00	Total Electricity Bill Amount with energy efficient fixtures	Rs 423,026.00
SAVING IN ELECTRICITY BILL OF GREEN BUILDING AS COMPARED TO CONVENTIONAL BUILDING				Rs 163,276.00

2.4.3 ESTIMATION OF WATER USE IN BUILDING

2.4.3.1 ESTIMATION OF WATER DEMAND IN CONVENTIONAL BUILDING

The building is situated in Gwalior zone where the average rainfall corresponds to about 75cm to 90 cm roughly during Monsoon season i.e. from July to Sept for about 90 days. The Roof of the building provides excellent opportunity for water harvesting. The potential of water available for water harvesting is calculated below.

Fixed population = 150 Nos

Floating population = 600 Nos

Residential = 15 Nos

Consumption of water (lpcd) of office population = 45 lits/day

Consumption of water (lpcd) ofresidential population = 155 lits/day

Peak water demand

Maximum daily demand (office 1.5 x 750 x 45 = 50,625 litres/day

population)

Maximum daily demand (residential population) 1.5 x 15 x 155 = 3,488 litres/day

Total water demand = 54,113 litres/day

2.4.4 ROOF TOP HARVESTING

The rain water which otherwise would have been gone as waste through rain water pipes was proposed to be collected from the rain water pipes outlet. Quantity of water so collected is calculated below.

Area of Roof =1418 Sqm

Average rainfall during monsoon season = 75 cm

Average monsoon season= 90 days

Runoff coefficient =0.85

Total Water harvested

Rain water harvesting= Rainfall x Area of catchment (Roof) x Run off coefficient

=0.75x1418x0.85

= 904 cum Say 900 cum

= 9,00,000 litres

Total water harvested= 9,00,000 litres in 90 days

Average water harvested = 9,00,000/90= 10,000 lit per day

An underground water tank with capacity of 20,000 litres was constructed so as to provide buffer storage for water collected from Roof which otherwise goes into the drain as waste water.

Cost of construction of underground tank of 20,000 lit capacity assuming rate for construction of underground sump as Rs 20 per litre Cost of construction of underground tank of 20,000 lit capacity 20,000x20=Rs 4,00,000/-

Waste water 9,00,000 litre used for ground water recharge by using trench harvesting system.

2.5 RESULT AND CONCLUSION

2.5.1 SAVING IN ENERGY

Saving in electricity by virtue of different alternatives may be classified in following heads tabulated in Table No.3

Table No. 3 – Energy utilization/production by different parameters

Sr. No	*Parameters*	*Green Building Wh/day*	*Conventional Building Wh/day*
1	Luminaries	70956	154608
2	Consumption using HVAC	1622280	2173000
3	Saving by Computer & printers	131660	182980
4	Compound light	6480	24912
5	Water motor	24000	36000
6	Total energy saved in watts per month (taking 24 working days)	17187 KWH	
7	Saving in Rs.per month	Rs. 163276.00	

	@ Rs 9,50 per unit	

2.5.2 RENEWABLE ENERGY SOURCE

Solar Energy plant of 50KW installed. Detail of plant summarized as below

Capital Cost of 50 KW Solar Plant – Rs 46,24,811/-
Subsidy from State Government – Rs 7,50,000/-
Subsidy from Central Government - Rs 9,37,500/-
Net Capital cost of Plant – Rs 29,37,311/-
Pay Back Period calculated is 4-1/2 years
Total Saving in 25 years - Rs 1,36,95,000/-

2.5.3 CAPITAL COST OF GREEN MEASURES & PAYBACK

Measures adopted for green retrofitting leads to green premium, the capital cost and payback period tabulated below

Table No.4- Capital cost of different green measures and pay back

S. No.	Element	Cost
1	LED	29925
2	LED Single Rod Tube Light	66030
3	LED Double Rod Tube Light	139500
4	Wall Fan	59200
5	Ceiling Fan	149400
6	Air conditioner	1396800
9	Package AC	3500000
10	Cooler	96000
11	Compound Light	27300
12	Motor	18000
13	Paint	489900
14	Reflective Tiles	1361280
15	Rain water Harvesting	400000
16	Water Efficient Fixtures	200000
17	High efficiency glass	240000
18	Solar Panel	2937311
	TOTAL	11,110,646.00

Resale value of old Air Conditioner and Package AC		
1	Old Air Conditioner 36x5000=	-180000
2	Package AC 40000x14=	-560000
	Total	-740000
	Total (A)-(B)=	10,370,646.00

Saving in electricity per month	Rs.163276.00
Saving in electricity per Year (C)x12=	Rs. 1959312.00
Pay Back period for green retrofitting in years (C)/E=	5.29 years

3- CONCLUSION

In India some world class Green Building are constructed in past years, but a large volume of existing building need to be Green Retrofitted. The fast paced growth in economic and human activity across the India has put environmental resources under tremendous pressure thereby becoming a cause for irreversible damages to the environment at large and putting the quality of life of future generations to unknown risks. The increasing apprehension towards the environment is pushing the policy makers to seek sustainable solutions, leading to the origin of the theory of green buildings.

An Green retrofitting of Building requires dozens of decisions by home designers and contractors. These decisions affect the initial cost of retrofitting and the cost benefit ratio. In the present work, 'Green Retrofitting' concept is studied in detail. A case study of existing communication building situated in Gwalior has been carried out and standard green alternatives are for the same has been determined. After green retrofitting following are the major conclusions derived:

1. Green Retrofitting is very much essential and the awareness among all stakeholders is required to be created.
2. 30% of water demand has been reduced from Low flow plumbing fixtures saving 16,200 lit. Water per day.
3. Annually 9,00,000 litre rain water harvested from roof top harvesting. For rain water storage a underground tank of capacity 20,000 lit. constructed.
4. Annually 8590 kwh i.e., Rs 19,60,000 has been saved annually from Energy efficient fixtures and appliances.
5. Renewable Solar Panels generates 72,000 unit energy annually. And reduces dependency on conventional energy source to reduce carbon footprint.
6. Total Investment for "Green Retrofitting" of Communication building isRs 11,110,646. The overall Pay-back period of retrofitting measures in 5.3 years which is very cost effective.

Apart from quantitative benefits other non-quantitative and qualitative benefits also be enumerated in conclusion they are

Economical benefits:

Studies show that installing green building technologies can be cost-efficient in the long run. It can create jobs and expand the local tax base to create economically competitive communities.

Social benefits:

Improving indoor environmental quality creates a healthier environment for the occupants of a building, which may help

increase their productivity. Stronger neighborhoods that create a greater sense of community.

Increase Productivity:

Increased workforce productivity in commercial buildings ultimately holds the greatest potential savings.—far greater than energy or water savings. If we can only increase 10% efficiency of work force it leads to 15% saving for employers in employee cost.

4- REFERENCES

i. ADaRSH (Association for Development and Research of Sustainable Habitats). 2013a. "About GRIHA." http://www.grihaindia.org/index.php?option=com_content&view=article&id=73.

ii. ADaRSH (Association for Development and Research of Sustainable Habitats). 2013b. "GRIHA for LargeDevelopment." http://www.grihaindia.org/index.php?option=com_content&view=article&id=93.

iii. ADaRSH (Association for Development and Research of Sustainable Habitats). 2013c."GRIHARating."http://www.grihaindia.org/index.php?option=com_content&view=article&id=87

iv. Babbie, E. (2003),The Practice of Social Research.Wadsworth Publishing.

v. Berdahl, P. and S. Bretz. 1997."Preliminary Survey of the Solar Reflectance of Cool Roofing Materials,"Energy and Buildings - Special Issue onUrban Heat Islands and Cool Communities

vi. Bhandare, R.N. et al., 2013. Economical Aspects of Green Building. Paripex- Indian Journal of Research, 2(3), pp.88–90.

vii. Census of India 2011, Series-H: Tables on Houses, Household Amenities and Assets

viii. Cool Roof Rating Council. Accessibleat: http://www.coolroofs.org/

ix. Cowan, Stuart. (1995), Ecological Design. Washington, DC:Island Press.

x. Cruywagen, J.H., 2013. The cost of "going green" – A case study, In: Proceedings of 6th Annual SACQSP Research Conference on "Green Vision 20/20", Cape Town, South Africa, 20 – 21 June 2013, 79-91.

xi. Devarshi Tathagat, Dr.Ramesh D. Dod,2015, Role of Green Buildings in Sustainable Construction- Need, Challenges and Scope in the Indian Scenario, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 2 Ver. II (Mar - Apr. 2015), PP 01-09 www.iosrjournals.orgDOI: 10.9790/1684-12220109.

xii. Energy And Buildings,2014, Centre forScience and Environment, New Delhi 110062, INDIA

xiii. Government of India, Council of Scientific & Industrial Research. (2001). Annual Report 2000-2001. New Delhi: Government of India.

xiv. Government of India, Renewable Energy Development Agency Limited. (2001). Annual Report 2000-2001. New Delhi: Government of India.

xv. Government of India, Strategic Plan of Ministry of Urban Developmentfor 2011-2016,"http://www.performance.

gov.in/sites/default/files/document/strategy/UD.pdf.

xvi. Green Rating for Integrated Habitat Assessment (GRIHA) a National Rating System for Green Buildings by Ministry of New and Renewable Energy, Government of India.

xvii. Hyderabad Metropolitan Development Authority, (undated). "GRIHAScheme for Promoting Implementation of Energy Efficient Solar/Green Building Programme." http://www.hmda.gov.in/EBGH/incentives.html.

xviii. IGBC (Indian Green Building Council). 2013e. "Vision." http://www.igbc.in/site/igbc/index.jsp#.

xix. IGBC, 2014a. IGBC Green New Buildings. Indian Green Building Council, pp.1–4. Available at:https://igbc.in/igbc/redirectHtml.htm?redVal=showGreenNewBuilding snosign[Accessed November 2, 2014].

xx. IGBC, 2014b. IGBC: Present Situation. Indian Green Building Council, pp.1–3. Available at: https://igbc.in/igbc/ [Accessed November 7, 2014].

xxi. IIHS (Indian Institute for Human Settlements). 2012. "Urban India 2011: Evidence."http://citiesalliance.org/sites/citiesalliance.org/files/IUC%20Booklet%20on%20Indian%20cities.pdf.

xxii. IIMB-WP N0. 485 , Facilitating Green Building Adoption - An Optimization Based Decision Support Tool , Debjyoti Roychowdhury. Rajluxmi V Murthy .Jose P D ,March 2015

xxiii. Jigneshkumr R. Chaudhari1, Prof.Keyur D. Tandel Prof.VijayK. Patel,Energy saving of Green Building Using Solar Photovoltaic Systems, International Journal of Innovative Research in Science, Engineering and Technology,ISSN: 2319-8753, Vol. 2, Issue 5, May 2013

xxiv. Kats, G., & Capital, E., 2003. The cost and financial benefits of green buildings: A report to California's sustainable building task force, developed for the Sustainable Building Task Force, California, USA.

xxv. Ministry of non-conventional energy sources. (2008). Book "Energy efficient buildings in India" Green Buildings Anthology, Government of India

xxvi. Milne, N., 2012. The Rands and Sense of Green Building: Re-visited. Building the Business case for Green Commercial buildings in South Africa. Green Building Council, Cape Town, South Africa.

xxvii. Nangare Priyanka, Warudkar Abhijit, Cost Analysis of Green Building,International Journal of Scientific Engineering and Research (IJSER), ISSN (Online): 2347-3878, Volume 3 Issue 6, June 2015

xxviii. Sandeep Ashar (Times of India), 2013. "Green building code: No tax cuts,FSI sops for eco-friendly buildings in Maharashtra." http://articles.timesofindia.indiatimes.com/2013-07-01/mumbai/40306587_1_green-buildings-new-codefsi.

xxix. Sodha M.S., Sawhney R.L., Singh S.P., Kaur J., Deshmukh M.K. and Sharma A.K., Designpatterns for solar passive cooling and demonstration of

novel concepts, Final Report, R & DProject no. 15/40/87-ST, Ministry of Non-conventional Energy Sources, Government of India,New Delhi, 1991.

xxx. SwarnkarDinesh K., Transformation Of Existing Building Stock -Green Technology Application In Construction, International Journal of Scientific Research & Growth, ISSN: 2456-1363, Volume-2 Issue-2 June- 2017

xxxi. SwarnkarDinesh K., Green Retrofitting Of Existing Buildings Using Cool Roof Technology, International Journal of Scientific Research & Growth, ISSN: 2456-1363, Volume-2 Issue-2 June- 2017.

xxxii. The Indian Building Code Community, (undated). "Energy ConservationBuilding Code Helping Home and Business Owners." http://www.ibecc.in/learning-ecbc?q=introduction_ecbc.

xxxiii. The Cool Colors project. Accessible at:http://coolcolors.lbl.gov/