Conversion of existing building into green building

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Abstract:- 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. Before turning to upgrading building into sustainable green building this study understands the marketing dynamics of greening existing building. It often taking advantages of renewable resources , e.g. using sunlight through photovoltaic equipment, and using plants and trees through vertical wall gardening, garden in balcony of the house, led lighting, and vermin compost plant, grass pavers and also aluminum paints outside or inside of the building. Many other techniques are used, such as using low-impact building materials or using packed gravel or permeable concrete instead of conventional concrete or asphalt below the grass pavers to enhance replenishment of ground water. The construction and installation charges have also been computed. The study concentrates on the advantageous outcomes once the building converted to green building. .

Keywords - Green building, LEED rating system, vertical gardening, aluminum paint, vermin composite plant, LED lighting, grass pavers, solar power generation.

INTRODUCTION

"Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building."

The recent trend toward sustainable buildings is obvious in new construction as architects and contractors focus on using green techniques in the building process – as well as making sure the building follows eco-friendly standards in its usage. Renovations and additions follow this same concept. There are steps to be taken to make existing buildings follow the same opportunities of green living that are expected from new buildings.

Green buildings are designed in such a way to reduce overall impact on environment and human health by:

i. Reducing trash, pollution and degradation of environment.

ii. Efficiently using energy, water and other resources.

iii. Protecting occupant health and improving productivity.

The green building concept is gradually gaining momentum in India. A green building typically applies practices like harvesting energy and water and using environmentally friendly materials in its design, construction, operation and maintenance and sustains the environment. Development of green buildings has many monetary benefits such as low energy, waste disposal, water cost, and low environmental and emission costs (Kats, 2003).

The advantages and benefits of the green buildings are spread out over the life span of the building and should be looked at in the long run and not on the initial cost.

OBJECTIVES

As per the study conducted on the a residential building 4 story building with ground floor parking which is located in Jaipur, Rajasthan many of the parameters were found existing in the building. But it was found that certain aspects were not fulfilled like: rain water harvesting and efficient solid waste maintenance. Therefore, solar power plant and gardening plants considers the major role in the existing building to making it green building.

Hence the following objectives are drawn:

- To determine the monthly energy consumption in building.
- To suggest a suitable method for installation of vermin compost plant for solid waste.
- To determine the additional energy consumption by heating and cooling sources.

- To suggest a method of gardening and aluminum paint.
- To install a efficient concrete pavers.

LEED FOR EXISTING BUILDINGS

Leadership in Energy and Environmental Design, or LEED, is a building certification process developed by the U.S. Green Building Council (USGBC), a non-profit organization (NOT a government agency) headquartered in Washington, D.C.

The USGBC developed the LEED certification process to enhance environmental awareness among architects and building contractors, and to encourage the design and construction of energy-efficient, water-conserving buildings that use sustainable or green resources and materials.

The LEED certification process uses a point system to determine the environmental merits of a building; there are different rating systems for homes, commercial buildings, interior renovations, schools, neighborhood developments, and other construction projects.

For most projects, there are four levels of LEED certification, depending on how many points the project has earned: certified, silver, gold or platinum. According to the USGBC, there are nine key areas measured by LEED:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere
4. Materials and Resources
5. Indoor Environmental Quality
6. Location and Linkages
7. Awareness and Education
8. Innovation in Design
9. Regional Priority

Points for LEED EB

There are four levels of certification in the LEED-EB O&M rating system. The levels are differentiated by a range of points that can be achieved by fulfilling a combination of credits in the 5 LEED categories. Below are the different levels and point categories:

Table: 1 LEED Points distribution and Rating distribution.

Points distribution based on category			Rating distribution based on points scored	
Category			Category Certification	points
	Sustainable sites	26		
	Water efficiency	10	Platinum	80- 110
	Energy and atmosphere	35	Gold	60-79
	Materials and resources	14	Silver	50 - 59
	Indoor environmental quality	15	Certified	40 -49
	Innovation in design	6		
	Regional priority	4		
	Total	100		

METHODOLOGY

The following methodology has been adopted in the present study;

1. **Vertical gardening**

A vertical garden is a garden that grows upward (vertically) using a trellis or other support system, rather than on the ground (horizontally). Living walls or green walls are self sufficient vertical gardens that are attached to the exterior or interior of a building. They differ from green façades in that the plants root in a structural support which is fastened to the wall itself.

Improve the beauty of your garden and increase curb appeal by adding character, variety, structure and color. Create eye candy by planting at eye level with vertical garden structures like hanging baskets and window boxes. Installing a green wall acts as a natural air conditioner, balancing humidity levels in the process to keep us comfortable. **Improve both indoor and outdoor air quality** by removing harmful VOCs (volatile organic compounds) and absorbing pollutants.

Figure : vertical wall plantation.

2. **Vermin composting**

Vermin compost is the end product of a process called vermin composting, which uses earthworms to increase the speed of the composting process and ensure higher-quality compost. Vermin compost is essentially what ends up being applied to plants in the garden. To increase production capacity solid waste comes from house and kitchen as like food waste, raw paper waste, cow dung, coconut waste, and egg waste with mainly increase production rate in vermin compost or de composting, is used. Ultimately, vermin composting results in rich, black, earthy-smelling compost that will help garden to healthy growth. In addition to vermin compost there is vermin cast, which is slightly different. Vermin cast, also known as worm castings, is the excrement from the worms, minus the rest of the compost.

Vermin compost plant is installed on the back side of the building which is into the plot area. Plant area is included about 1m wide and 1 m length and 0.8 m depth size 2 beds.

Plant is considered to be top covered and shaded beds. Two beds are used for 30 days cycling time.

Figure : small vermin compost bin.

3. Grass pavers

Grass pavers are the paving tiles which have large number of rhombus shaped openings so that water can percolate through ground and thereby help in raising the ground water table. By using this product, it allows surface water to seep into the aggregate and slow down the run off that would have been on a concrete or asphalt surface. Grass pavers are primarily used in areas where soil erosion or water drainage is of paramount concern. For example, grass driveway pavers help stabilize the soil in an area where lots of vehicular traffic may unsettle and damage it. Water can also drain easily in between these paving stones, putting less pressure on water draining systems that would otherwise have to accept all of this rainwater running down grade. This can help with containing and controlling water pollution, as runoff from asphalt driveways can be very polluting due to all the chemical it carries. Grass pavers, however, allow water to drain free and clear, and thus represent an environmentally friendly driveway and paving solution.

Figure : concrete grass pavers with lawn view.

Grass pavers are mainly sized in a small area which in both side of building around 26 sq m area of the building. Grass pavers are durable so it may be used for driveway near the parking lot. They are less costly from plain concrete or brick pavers but a little maintenance cost is more for maintaining grass into it.

4. Aluminum paint

Aluminum paint is a coating material that consists of a resin base filled with solid flecks of aluminum. The resin helps the paint to flow, and gives it strength and durability, while the aluminum flakes give the paint a shiny, metallic finish. This type of paint generally has a silvery finish, and many manufacturers only produce one shade of aluminum-based paint. Others add pigments to produce different paint shades. No matter what color of paint is used, the finish tends to darken over time due to the effects of oxidation.

Aluminum based paint has the capacity to reflect the sunrays falling on it which ultimately reduces the heat intake in the building and thereby creates a better atmosphere to live in. For the major period of the day the south facing wall is directly exposed to the sunlight and it absorbs heat during the whole day and then the wall keeps emitting the heat. So by the provision of aluminum based paint on the outer wall and roof this effect can be reduced.

5. LED Lighting

LED lights are up to 80% more efficient than traditional lighting such as fluorescent and incandescent lights. 95% of the energy in LEDs is converted into light and only 5% is wasted as heat. This is compared to fluorescent lights which convert 95% of energy to heat and only 5% into light. LED lights also draw much less power than traditional lighting; a typical 84 watt fluorescent can be replaced by a 36 watt LED to give the same level of light. Less energy use reduces the demand from power plants and decreases greenhouse gas emissions.

6. Solar power plant

Photovoltaic (PV) solar power plant is used for larger development of solar power generation. In a solar roof top system, the solar panels are installed on the roof of any residential, commercial, institution and industrial building. The solar roof top system may come up with storage facility using battery or grid connected.
Solar PV cells converts sunlight to generate electricity through a photovoltaic process. There are two types of solar PV systems: off-grid and grid connected.

An off-grid system is not connected to the electricity grid and therefore requires battery storage. An off-grid solar system must be designed appropriately so that it will generate enough power throughout the year and have enough battery capacity to meet the home's requirements, even in the depths of winter when there is less sunlight. The high cost of batteries and inverters means off-grid systems are much more expensive than on-grid systems and so are usually only needed in more remote areas that are far from any electricity grid.

On-grid or grid-tie solar systems are by far the most common and widely used by homes and businesses. These systems are connected to the public electricity grid and do not require battery storage. Any solar power that you generate fr om an on-grid system (which is not used directly in your home) is exported onto the electricity grid and you usually get paid a feed-in-tariff (FiT) for the energy you export.

Figure : 15 kw power plant in Jaipur city.

On grid solar power plant consists solar panels, solar grid tied inverter, solar net meter, cables and mc4 connectors for balancing the power plant installation. The batteries may be used in on grid system also for backup use in night time or for when no light because of weather.

CALCULATIONS AND RESULT

1. Vertical gardening

Cost Analysis of vertical gardening on walls and balcony area of the building.
Area required for plantation = 650 sq m

Table 1. cost analysis of vertical garden.

ITEMS	QUANTITY	PRICE
Pots required	No. 288	Rs. 25,056.00
Drip required for irrigation or watering	Length 144 m	Rs. 12,528.00
Sheet and fabrics	Pieces 400 per 12 pots	Rs. 1,036.36
Plants and seeds		Rs. 57,600.00
Manure and fertilizers		Rs. 20,000.00
Installation		Rs. 40,800
Total cost		**Rs. 157,020.67**

Cost comparison with heating and cooling system in building

Cost of air conditioning in single home = Rs. 25,000.00

Total cost of air conditioning in building for 12 houses = **Rs. 3,00,000.00**

Cost reduction

Total Cost saving in building = 300,000 – 157,020.67 **= Rs. 142,979.33**

2. Vermin composting

Table 2. total cost analysis of the vermin compost plant.

COST ANALYSIS OF VERMICOMPOSTING PLANT	
Total cost of excavation	Rs. 800.00
Total cost of construction	Rs. 20,000.00
Total	Rs. 20,800.00
Add miscellaneous and contingencies @ 5%	Rs. 1,040.00
Total	Rs.21,840
Cost of Earthworms	Rs.4,800
TOTAL	**Rs. 26,640.00**

Cost comparison by using manure with fertilizers from market

Cost of manure per kg = Rs. 200

Quantity of manure = 100 kg per year

Total cost of manure = **Rs. 20,000**

Cost reduction

Total cost = 26,640 – 20,000 = **Rs. 6,640.00**

3. Grass paver

The cost analysis of grass pavers is tabulated below:

Dimensions of grass pavers = 0.5mX1.0m

Dimension of area to be paved = 1 m X 16 m and 1 m X 10 m

Total no of pavers required = 52

Cost of each paver = Rs. 55

Total cost of pavers = 55 X 52 = Rs. 2,860

Placing charges = Rs. 420

Total cost **= Rs. 3,280**

Cost comparison by using plain concrete brick pavers

Total no. of pavers for the same area = 100

Cost of each concrete solid pavers = Rs. 50

Total cost of pavers used = 100 X 50 = Rs. 5,000.00

Total cost with placing price = 5,000 + 420 = **Rs. 5,420.00**

Let us suppose cost saved on grass pavers use

Total cost saved = 5,420 – 3,280 = Rs. 2,140.00

Therefore the concrete pavers are already there, so only extra installation charges are used.

Now, total cost on plain pavers = 420 + 1,000 = Rs.1,420.

Total cost of paver operation = Rs. 3,280 + 1,420 = Rs. 4,700.

4. Aluminum paint

Table 4 cost of aluminum based paint

ANALYSIS OF ALUMINIUM BASED PAINT	
Category	Quantity
Total area to be painted	800 sq m
Total quantity of paint required	40 liters
Total cost of paint	Rs. 120 per liters
Total cost of labor for painting	Rs. 4,300
TOTAL	**Rs. 9,100.00**

Cost comparison by using acrylic Asian paint on building

Quantity of paint = 60 lit

Cost of paint = Rs. 70 per lit

Total paint cost = (60 X 70) + 4,300 = **Rs. 8,500.00**

Cost saving

Total cost saving = 9,100 – 8,500 = **Rs. 600**

5. LED Lighting

Table 5. analysis of total cost

COST COMPARISON BETWEEN CFL AND LED LIGHTS		
Items	Quantity	Price
CFL bulb power	No. 110 / 40 w	Rs. 250 each
Total price of CFL lights	4,400 w	**Rs. 27,500**
LED bulb power	No. 110 / 9 w	Rs. 90 each
Total LED bulb price	990 w power	**Rs. 9,900.00**

The total energy consumed is 4,400 w – 990 w = 3,410 w.

Total extra cost paid is 33,000 – 900 = Rs. 24,000.

The Saving of energy is **3,410 w**, and saving of total cost is **Rs. 17,600**.

6. Solar power plant

Analysis of energy and cost saved after completion of the changes suggested:

General domestic consumption of electricity on the basis of average monthly consumption.

Consumption up to first 50 Units per Month = 385 Paise per Unit

Consumption above 50 Units and up to 150 Units per Month = 610 paise per unit

The analysis of energy saved per hour is given below:

Total number of tube lights = 110

Power of each tube light = 40 watt

Watt Total power all tube lights = 110 X 40 = 4,400 Watt

Total number of fans = 54

Power of each fans = 60 watt

Watt Total power all fans = 54 X 60 = 3,240 Watt

Total number of fridge/freeze = 10

Power of each fridge = 300 Watt

Watt Total power all fridges = 3,000 Watt

Other miscellaneous consumptions = 10,000 Watt (tentative)

Total energy consumption per hour = 20,640 Watt = 20.64 Kilo Watt

Calculate energy consumption cost per day = 20.64 kw X 6 hrs per day = 123.84 kwh per day

Calculate energy consumption cost per month = 123.84 kwh X 30 days = 3,715.2 kwh per month

Cost of 1 Kilo Watt electricity = Rs. 6 (approx.)

Where 1 unit = 1 kwh

Total energy consumption per month = 6 X 3,715.2 = Rs. 22,291.20

Cost reduction:

Approximate cost reduction after implementation of changes = 1500 units per month

Total Energy reduction = (1500 kw X 6 hrs) – 3,715.2 kwh

= (9,000 – 3,715.2) kwh

= 5,284.8 kwh per month

Whereas 1 kwh = Rs. 4

Total Cost of energy produced by solar power = Rs. 4 X 9,000 kwh = Rs. 36,000.00

Total extra energy saved = 36,000 – 22,291.20= **Rs. 13,708.80**

COST ANALYSIS OF SOLAR POWER PLANT

Total solar system price = Rs. 527,490.00

The total energy consumption is calculated around 4,507.20 kwh for 6 hr in a day. The solar system with 15 kw capacity may generate 1500 units per month, or 9,000 kwh per 6 hr in a day. Therefore, total consumed energy per month is full filed by solar power plant and more energy is generated around **5,284.8 kwh** per month. It gives more profit of **Rs. 13,708.80** (40 – 50 % energy saving) by net metering of both out and in energy calculation.

CONCLUSIONS

The following conclusions are obtained from the present study:

1. For solid waste disposal vermin composite plants of dimension 1.0 X 1.0 sq m and 2 number beds are suitable for 30 days cycle with 0.80 m depth in required area of 2.0 sqm.
2. The total construction of vermin composite plants is found to be Rs. 26,640.00.
3. Total cost saved in plant is found to be Rs. 6,640.00.
4. The area of vertical gardening is found to be 630 sq ft for wall and 25 ft for balcony.
5. The total cost of vertical gardening is found to be Rs. 142,979.330.
6. Total cost saved in vertical gardening Rs.300,000.00.
7. The area required for aluminum paint on wall and roof is about 800 sq m.
8. The total cost required for aluminum based paint is found out to be Rs. 9,100.
9. Total cost saved in painting is Rs. 600.00.
10. The total requirement of LED bulb in building is about 220 bulbs. The cost of LED light cost is found to be Rs. 33,000.
11. Total energy saved by lighting system = 3,410 w
12. The total cost saved of LED bulb is found to be Rs.17,600.
13. The area of grass paver installation is about 26 sq m.
14. The total cost of grass pavers is found to be Rs. 4,700.
15. Total cost saved in concrete plain pavement Rs. 2,560.00.
16. Total cost of solar power installation on roof top of the building is found to be Rs.
17. Total energy consumed by building is found to be 3,715.2 kwh of about Rs. 22,291.20.
18. The energy produced by 15 kw solar power plant is found to be 9,000 kwh of about Rs. 36,000.00
19. The tentative electrical energy saved per annum after the suggested changes are found by solar system to be 5,284.8 Kilo Watt hr of about Rs. 31,708.8 which is about 40 – 50 % of the total monthly energy production.

Paybacks of total cost

20. Total cost of solar plant is found to be Rs. 527,490.00.
21. Total cost of retrofitting of the building is found to be Rs 714,850.67.
22. Total cost saving is Rs. 214,888.13 in a month.

23. Total Cost saved is about Rs. 13,708.8 per month in a year from solar power system. If life of solar power is about 20 to 25 year, therefore, the price of solar panel will be returned in about 4 to 5 years. And total cost is returned in around 6 to 8 years.

24. LEED rating system

    LEED certification points to categories building in rating system.

Category	Points
Site selection	1
Water efficiency	0
Energy efficiency	9
Materials	1
Indoor air quality	4
Innovation and regional	0
Total points	15

The building under consideration has obtained in all 49 credits.

Hence it is eligible to fall under the 'CERTIFIED' category according to LEED standard (40 -49).
Hence, total points obtained after retrofitting will be 49 + 15 = 64.
Which will undergoes in "GOLD" category.

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