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Application and implementation of green strategies, leed certification and rating system in university building

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To lead the development of green buildings, research on the status of green buildings, their benefits and barriers have attained significant. On the basis of literature reviews, a 'Green Building: Strategies and the certification' has been developed to verify the research framework of building in accordance with the applied strategies and awarded certification. By the means of the questionnaire survey, the data has been collected. In this project, various green strategies and sustainable practices have been adopted for two blocks within educational institution. Our existing buildings within campus can only manage to score 34 points out of a possible 110 in the current scenario which implies the campus has negligent green strategies and technologies. By the implementation of the proposed measures under the green strategies to the two blocks, the existing buildings within campus can achieve 58 points, which will make it eligible for a gold rated certification under Leadership in Environmental and Energy Design (LEED). Deep retrofits with aspects such as green power under which solar panels (25% of total electricity required is being produced by solar panels), biogas plant (to process 1.5-2 tons of organic waste produced per day), green roofs (extensive roofs to reduce heat island effect), sewage treatment plant (to treat up to 2.5MLD of waste water) which already is a credit, LED tube light replacement provision along with sensor technology to save nearly 8kwh per day.

Keywords: Green buildings, green strategies, energy conservation, LEED certification, rating system.

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1.**Introduction**

About one third of total energy in the world is consumed is by the built environment which is a collective term for all residential, commercial and industrial buildings which are basically man-made (Huang ziwei et al. 2018; Benjamin J. Birt et al. 2009). Both challenges and opportunities for the building sector is presented by the lifetime of buildings and related equipment. According to the IEA, the total energy consumption by the building industry is 39% of total energy consumed, 22% of the total water consumption, 38% of the carbon dioxide emissions and 68% of total electricity consumption (Pyonchan Ihm et al. 2009). The limiting factor of the infinite demand for energy and its production have to knock a balance for achieving the goal of sustainability (Meenakshi sharma et al. 2015). Thus, it is important to boost environmentally sound management of urban areas through more energy and resource efficient retrofits, eco-design and construction practices, taking green building development objectives into account (A.Darko et al. 2016).

Since most of buildings today were built with no or little knowledge of energy efficiency (Frontczak et al. 2011), the scope for incorporation of such futurist features into buildings is altruistic and barriers like higher investment, rules and regulations, etc. slows down the adoption of green buildings (Othman et al. 2005). Residential, public, and commercial buildings also offer unparalleled opportunities for energy savings because of their high energy consumption. According to the IEA, buildings account for some 42% of global energy savings potential by 2035, compared with the transport sector (21%) and the industrial sector (24%).

The EPA defines, "A green building is the practice of generating and using healthier and more resource-efficient models or deep retrofits of construction, renovation, operation, maintenance and demolition." A green building is "high performance building that is energy and water efficient, has good indoor air quality, uses environmentally sustainable materials and also uses the building site in a sustainable manner(UGBSC), property with a high-performance that considers and minimises its impact on the environment and human health(Jerry Yudelson et al. 2015), the practice that complements the classical building design concerns of economy, utility, durability, and comfort(USEPA), one which uses less water (G.Kats et al. 2018), optimises energy efficiency (Roper et al. 2006), conserves resources, produces less waste and eco-friendly (Myers et al. 2007) and provides healthier space for occupants (M. Frontczak et al. 2013) as compared to a conventional building(IGBC). Vegetation placed around buildings serves to reduce the surface temperature through direct shading of hard surfaces as well as cool the ambient air through consuming solar heat gain for transpiration and photosynthesis (Nyuk Hien Wong et al. 2003). It purposes to contribute to a better understanding of the concept of green building rating system and its role for achieving sustainable development (Hikmat H. Ali et al. 2009). Over the last decade, most policies and programs in the United States have focused on reducing energy consumption in buildings (Carol Menassa et al. 2012).

The specific objective was to determine whether there were any significant differences in the users' perceptions of a range of factors concerned with the operation, environmental conditions, control and degree of satisfaction with the green building and conventional building (George Baird et al. 2012). All types of buildings are going the Green way in today's world such as Offices, Residential, Banks, Institutions, Hospitals, Hotels, Townships, Schools etc., With the increase in demand and necessity to go green for efficiency and sustainability, the rating system for the green buildings is important and made necessary (A.P.C.Chan et al. 2017). The Leadership in Energy & Environmental Design (LEED) is one such rating system introduced for certifying Green Buildings which is developed by the USGBC (Cryer et al. 2006), the organization promoting sustainability through Green Buildings. LEED is a framework for appraising building conduct against set criteria and standard points of references. The standards for the LEED Green Building Rating System were developed for new and existing constructions in year 2000 and are currently available.

2. Levels of Leed Certification for Existing Buildings

Table 1. Levels of leed certification for existing building

Certification	Recognition	Existing Campus
Certified	Best practices	36-44
Silver	Outstanding performance	45-53
Gold	National excellence	54-66
Platinum	Global leadership	67-90

3. Benchmarks for Leed for Existing Buildings in Campus

Table 2. Table for water efficiency

Water Efficiency	Possible Points	Awarded Points
Water use reduction-20% reduction	2	2
Innovative wastewater technologies	2 to 4	2
Water efficient landscaping	4	4

Table 3. Energy and atmosphere

Energy And Atmosphere	Possible Points	Awarded Points For Existing Buildings
Fundamental commissioning of building energy systems Optimize energy performance	1 to 19	1
Onsite renewable energy	1 to 7	1
Enhanced commissioning	2	0
Enhanced refrigerator management	2	0
Measurement and verification	3	0
Green power	2	0

Table 4. Table for materials and resources

Materials And Resources	Possible Points	Awarded Points For Existing Buildings
Building reuse- maintain existing walls, floors and roof	1 to 3	2
Maintain 50% interior non-structural elements	1	1
Construction waste management	1 to 2	0
Materials reuse	1 to 2	0
Recycled content	1 to 2	0
Regional materials	1 to 2	0
Rapidly renewable materials	1	0
Certified wood	1	0

Table 5. Table for indoor environmental

Indoor Environmental Quality	Possible Points	Awarded Points For Existing Buildings
Outdoor air delivery monitoring	1	0
Increased ventilation	1	1
Construction IAQ management plan		
-during construction	1	0
-before occupancy	1	1
Indoor chemical and pollutant source control	1	0
Controllability of systems		
-lighting	1	0
-thermal comfort	1	0
Thermal comfort		
-design	1	0
-verification	1	0
Low emitting materials		
-adhesives and sealants	1	0
-paints and coatings	1	0
-flooring system	1	1
-composite wood and agri-fibre products	1	0
Daylight and views		
-daylight	1	0
-views	1	0

Table 6. Table for innovation and design process

Innovation and Design Process	Possible Points	Awarded Points for Existing Buildings
Innovation in design		
-specific title	1	0
-specific title	1	0
-specific title	1	0
-specific title	1	0
-specific title	1	0
LEED accredited professional	1	0

Table 7. Table for regional priority credits

Regional Priority Credits	Possible Points	Awarded Points for Existing Buildings
Regional priority		
-specific credit	1	1
-specific credit	1	1
-specific credit	1	1
-specific credit	1	1

Table 8. Table for regional priority credits

Sustainable Sites	Possible Points	Awarded Points For Existing Buildings
Construction activity pollution prevention Site selection	1	1
Development density and community connectivity	5	2
Brownfield development	1	0
Stormwater design -quality control	2	0
Alternative transportation -public transportation access	6	4
-bicycle storage and changing rooms	1	0
-low emitting and fuel efficient vehicles	3	3
-parking capacity	2	2
Site development -protect or restore habitat	1	1
-maximize open space	1	1
Heat island effect -non-roof	1	0
-roof	1	0
Light pollution reduction	1	0
TOTAL POSSIBLE POINTS	115	POINTS 34

4. Data collection

Food waste generated: 1.5 to 2.0 Tonnes/working day which is 45 to 60 Tonnes/month.
Water usage: 20 Litres/capita/working day.
As estimated, for 1000 members from the civil and bio-tech blocks: 1000*20= 20,000 l/day which is 6,00,000 l/month.

4.1 Credit in the campus

Recycling the waste water through SEWAGE TREATMENT PLANT and reusing for different purposes.
Electricity bill of the two blocks in campus:

Table 9. Table for block 1

Month	Units In Kwhr	Cost In Rs
July	30800	200200
August	38700	251550
September	44720	290680

Table 10. Table for block 2

Month	Units In Kwhr	Cost In Rs
July	13880	90220
August	17960	116740
September	20282	131820

5. Methods and Areas to be Worked Upon for Leed Certification

For 1kwh of electricity, about 0.4717 kg of coal is to be burnt, which is equivalent to 2.5 rupees per unit at the current coal price. Coal (bituminous) produces about 0.9389 kg of CO_2 into the atmosphere which damages the environment and the atmosphere. Therefore, areas that should be worked upon for a green and energy efficient existing building in campus are green power, Material reuse, Recycled content, Certified wood, Lighting, Thermal comfort – Design and verification, Low emitting materials, Paints and coatings, Day light and views, Brownfield development, Alternate transportation – Bicycle storage and changing rooms, Heat Island effect – Non roof and roof, Light pollution reduction.

Green strategies to be implemented in campus are as follows,

5.1. Solar power

A subset of renewable energy that represents those renewable energy resources and technologies that provide the most environmental benefit. EPA defines it as electricity produced from solar, wind, geo-thermal, biogas, edible biomass, low impact small hydroelectric sources. In the campus, green power can be achieved by providing solar panels, producing biogas and edible biomass from food wastage, providing green roofs. Provide 5kw solar installation that produces 22 units of electricity on an average per day.

Figure 1. 5kw off grid solar panel

5.2. Biogas

A fixed dome biogas plant should be made where the main process is an anaerobic decomposition. The biogas generated can be directly used as a substitute for cooking gas or to generate electricity also. 1kg of organic bio waste or food waste will produce about $0.45m^3$ of biogas on an average.

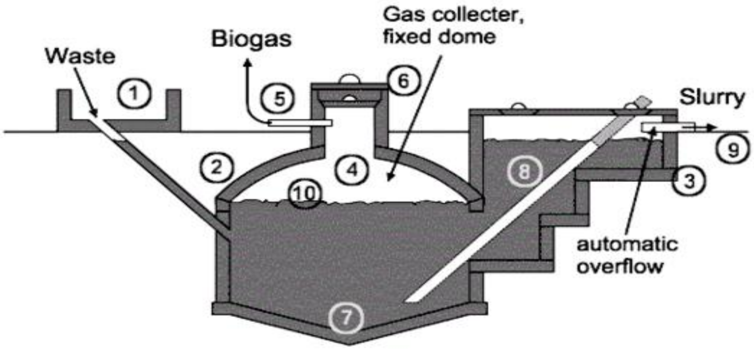

Figure 2. Fixed dome biogas plant

From the diagram: 1. Waste Inlet chamber; 2. Spent slurry (manure); 3. Biogas collector, fixed dome; 4. Outlet for biogas; 5. Gas valve; 6. Underground digester tank; 7. Outlet chamber; 8. Slurry; 9. Food waste, dung and water mixture.

5.3. Green roof

A roof that contains a soil (growing media) and vegetation layer as its outermost surface which is also called

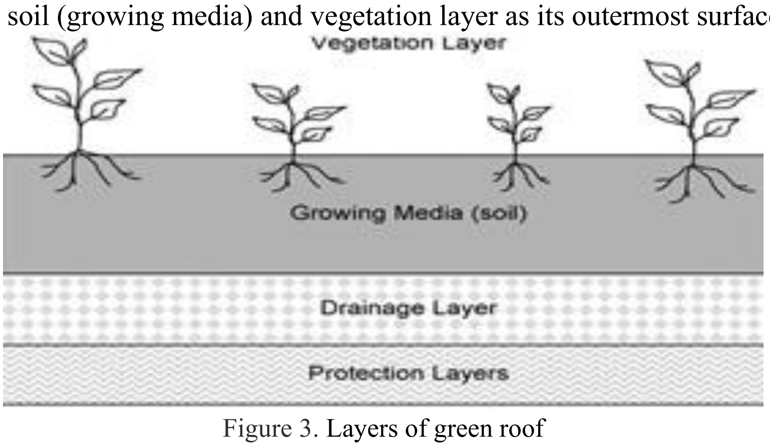

Figure 3. Layers of green roof

eco roof. A drainage layer, a root barrier, and a waterproof membrane are included. The growing media depth is usually between 10 and 30 cm. Green roofs are basically of two types. First one is intensive green roofs which has deeper soils (greater than 20cm) and the next is extensive green roofs that has thinner implementations (less than 20cm). The ppotential benefits of green roofs include, Aesthetic appeal, Habitat conservation, Storm water run-off reduction, Energy conservation.

5.4. Reused material and recycled content

They are sustainable as they minimize landfill waste, decrease the need for raw materials, reduce environmental impacts and energy use and lower air and water pollution (from incineration and landfills). Some of the reused materials and recycled content are: Steel from reinforcing, wire, containers; Concrete – can be broken down and recycled as base course in driveways and footpath; Paper and cardboard; Topsoil; Paint – number of manufacturers/retainers take back left overs; Untreated timber – hardwood flooring, laminated beams, untreated framing; Electrical fittings – light fittings, switches, thermostats; Terrazzo – terrazzo surfaces are made from recycled glass and cast concrete etc.

5.5. Paints and coatings

Green seal certification presence is important. Numerous paint and coating labels and certifications exist, but green seal is one of the best known and used for green buildings. The LEED credit for low emitting paints and coatings uses GS and SCAQMD standards including performance criteria as well as restrictions on chemical content. Three GS standards apply to different categories of coatings: GS-11 paints and coatings; GS-43 recycled content latex paints; GS-47 stains and finishes. GS sealed paints produce lower VOC emissions and less ozone pollution, low risk of health effects or chemical sensitivities and improves indoor air quality.

5.6. Certified wood

This wood come from responsibly managed forests and is defined by a particular standard with third-party certification audits performed by accredited certification bodies. Wood products from responsible sources are good choice for most green building projects.

5.7. Lighting

The design can reduce light pollution and improve interior environments. For interior lighting, direct line of sight to exterior transparent or translucent openings, fixtures to be selected that minimize illumination in the direction of openings. For exterior lighting, the design should include only such illumination as needed for safety and security with lighting power densities lower than permitted under ASHRAE/IESNA standards.

5.8. Thermal comfort

The condition of mind that expresses satisfaction with the thermal environment present. Factors influencing can be environmental such as Air velocity, Air temperature, Radiant temperature, Relative humidity or personal such as Clothing, Metabolic heat, Well-being and sickness. Thermal comfort can be achieved through good design, construction and maintenance like using a HVAC system that regulates MRT, minimise leakage, Design and building for some occupant control, Maintain the thermal environment and make changes as necessary, planning and executing green roof top measures.

5.9. Low emitting materials

The low-emitting materials are necessary to improve indoor air quality. Few areas to be checked upon for VOC content are interior paints and coatings applied on site, Interior adhesives and sealants applied on site (including flooring adhesives, Flooring, Composite wood, Ceilings, walls, thermal, and acoustic insulation.

5.10. Day light and views

A green building consists of important components as the natural lighting provided by the sun and the views of outdoors. The benefits of daylighting are connecting occupants with the outdoors, stabilizing circadian rhythms, reducing the amount of electrical lighting needed which decreases energy use.

5.11. Brownfield development

A 'brownfield' land is an area of land or premises that has been previously used, but has subsequently become vacant, derelict or contaminated. Benefits of brownfield remediation and redevelopment are such as removal or treatment of harmful substances; increase in area property values; existing infrastructure maintain. ed for location and community linkage, less land usage than comparable greenfield developments, economic benefits from reinvestment in blighted properties.

5.12. Alternative transportation – Bicycle storage

Whose main intention is to reduce pollution from auto use and to reduce land development from auto use. Provision of bike rack (based on 0.05 FTE measured at peak periods) with 200 yards and provision of changing room and shower (based on 0.005 FTE within 200 yards).

6. Results And Discussion - Cost Analysis

A conventional tube light consumes around 36watt when switched on for an hour. This means that its capacity is 36w. Hence when operated for about 8hours its power requirement is around 0.288 unit. Here 1unit= 1kwh (36*8/1000). Similarly, a ceiling fan consumes around 100w of power when operated for one hour. When operated for 8hours, then power consumption=0.8units.

6.1. Solar energy

Solar systems are of various capacities like: 1kw, 1.5kw, 2kw, 2.5kw, 3kw, 4kw, 5kw etc. On an average 1.5kw capacity system produces 5.8kwh electricity. Most ideal solution is when the rays of the sun hits the panel at 90 degrees. An average orientation is approximately 77 degrees. 5kw capacity solar panel needs around 500sqft of space generating close to 350-850kwh of AC per month (assuming sun striking the panel for around 5 hours). The cost of a 5kw capacity panel ranges from 4lakh-6lakh which on average produces around 22 units of electricity per day. Thus, the payback period is around 3-4 years.

Table 11. Table for block area

Sr. No.	Block Name	Total Area (M2)	Area Usable (Reducing 300m2)	Number Of Panels
1	BLOCK 1	1010	720	16
2	BLOCK 2	1730	1430	31
			2150	47

Here, considering one panel requires 500sqft space (which is 45.46m^2),
Total space provided= 2150m$^{2;}$
Total number of panels provided=47
Cost of 1 panel= 500000
Total investment= 23500000 (2.35 crore)

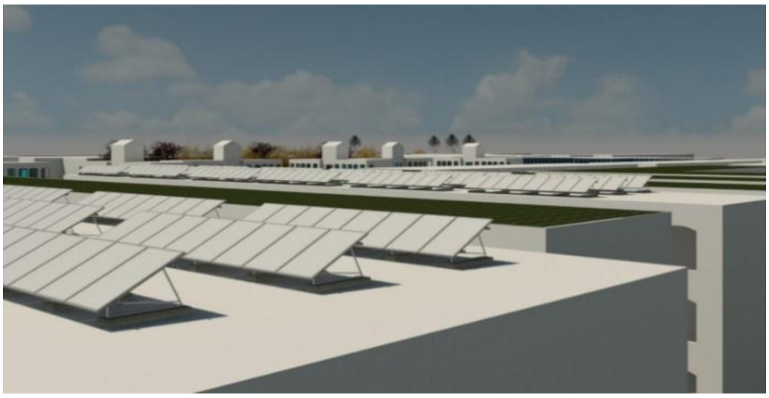

Figure 4. Solar panel on the roof of civil block

6.2. Green roofs

As a very rough indication, it costs around 7000 rupees per meter squared for extensive green roof and around 10500 per meter squared for the intensive variety. Green roof installation companies will be able to give clearer figure based on site's specifications as these figures will vary. Total area = 2740m^2;

Table 12. Table for green roof cost

TYPE OF GREEN ROOF	COST PER m2	TOTAL INVESTMENT
Extensive Roof	7000	17290000(1.72 CRORE)
Intensive Roof	1O5OO	25935000(2.59 CRORE)

It keeps the cooling costs low and reduces the energy consumption.

Figure 5. Proposed Green Roof (extensive)

6.3. Lighting

LED tube light replacement

Table 13. Table for power consumption

SR NO.	DETAILS	CURRENT	PROPOSED
1	Power consumption	36W	16W
2	Cost	450Rs	600Rs
3	Total number of tube lights required	50	50
4	Power consumption of all tube lights	14.4KWh per day	6.4KWh per day
5	Total investment	22500	30000

Total saving in power by proposed models= 8KWh per day
Cost saved per year= 12000 @ 5 per kWh for 300 days usage
The return on investment is 2.5 years
The tube lights have a life of 12-15 years

6.4. Sensor controlled lights

At present, there is a system in place for block 18 to cut power off during the break time which is centrally operated system which automatically cuts power off to the building during the 15-minute (tea) break and 45-minute (lunch) break. Cost of implementation of this system for one single block is around 65000 rupees. Hence cost of implementation for 2 blocks is 130,000 rupees. This system is more expensive to implement than the proposed system using sensor-controlled lighting.

Figure 6. Proposed sensor and LED tube lights in classroom

This system is provided only for class rooms where each classroom on an average require 2 sensors. This is mainly due to the reason that classrooms have active and frequent movement of students.
Total number of classrooms in both the blocks=40 (taking 50 in average including laboratories and staff rooms)
Cost of individual sensor= 2000 (including installation, labour, wiring)
Total investment= 50*2*2000 = 2,00,000 rupees

6.5. Alternative transportation – bicycle storage
Providing a bicycle path on the existing road network for a width of 1.5m where existing width of all roads currently is 20 feet. The cost of an average bicycle about 6000 per cycle.
Number of cycles being provided = 300
Total investment on cycle = 6000*300 = 1800000 (18 lakh)
Also, provision for markers is approximately 2 lakhs, therefore, the total investment in bicycle network is 20 lakh rupees.

Figure 7. Proposed bicycle network within campus

The costs for **GS paints and coatings** would vary with the quality of paint and area to be painted. Similarly, **the certified wood** can be provided according to the demand. **Reusing and recycling** depends on the amount of leftover content **Trees to be panted** more along the roadside for 0.5m in the campus.

6.6. Certification for existing blocks
After the application of the possible green strategies for sustainable buildings within the campus, we can conclude that the areas of improvement could be awarded by LEED as follows

Table 14. Table for areas of improvement

AREAS OF IMPROVEMENT	POSSIBLE POINTS	AWARDED POINTS FOR EXISTING BUILDINGS
Green power	2	2
Material reuse and recycle content	2 to 4	4
Certified wood	1	1
Controllability of systems		
Lighting	1	1
Thermal comfort		
-design	1	1
-verification	1	1
Low emitting materials		
-adhesives and sealants	1	1
-paints and coatings	1	1
-flooring system	1	1
-composite wood and agrifiber products	1	1
Daylight and views	4	2
Brownfield development	1	1
Stormwater design quality control	2	2
Alternative transportation - bicycle storage and changing rooms	1	1

Heat island effect -non roof - roof	1 1	1 1
Light pollution reduction	1	1
	Total possible points 110	Achieved points 34+24=58

Now, the total achieved points for existing buildings (block 1 and block 2) in institution will be 58. Hence, it will be awarded with "GOLD CERTIFICATION" under LEED holding the recognition of national excellence.

7. Conclusion

The importance of the presented research is in forwarding the research effort on the operational performance of the green building concept in campus. The promotion of green building operation is the next step of the evaluation process in building sector and is also an equitable means to control the operational stage. After reviewing the existing conventional building and its rating, this paper presents a case study in Sathyabama institute of science and technology where the green strategies are applied on existed building. This paper presented the evaluation of the key criteria for implementing green strategies which included Energy saving; Water saving; Material saving & Utilization for the operational phase. Thereafter, existing buildings are certified by LEED and the cost of implementation and building performance are analysed along with the calculation of pay back period of investment. An analysis of the GEB studies have illuminated that green performance of the existing buildings has improved significantly using the most acceptable green strategies or technologies.

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