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Energy Savings of Green Building using Solar Photovoltaic Systems Case of a Commercial

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Abstract: The executive summary of the energy audit report furnished in this section briefly gives the identified energy conservation measures and other recommendation during the project that can be implemented in a phased manner to conserve energy, increase productivity. Also Green Audit is the most efficient way to identify the strength and weakness of environmentally sustainable practices and to find a way to solve problem. The executive summary of the Green Audit report furnished in this section briefly gives the identified green intiative taken by university and further recommendation for green campus, solid waste management and their impact on carbon foot print in the campus. This paper outlines the solutions for the energy efficient futuristic buildings. The implementation of lastest technology in construction will lead to better building with green rating. Buildings are the greatest consumers of water, energy and materials. The idea of green buildings promotes use of renewable energy, recyclable & recycled products. Green building has to save water 36-40%, save energy 30-40% and save material 25-40% compared to conventional building. Green building is which one high thermal insulations, terrace gardening, ventilation and energy efficient appliances.

Index Terms **– Energy audit, Green audit, Carbon foot print analysis, Solar Energy, increase in efficiency, energy efficient appliances**

The executive summary of the energy audit report furnished in this section briefly gives the identified energy conservation measures and other recommendation during the project that can be implemented in a phased manner to conserve energy, increase productivity inside the university campus.

I. RENEWABLE ENERGY INITIATIVE TAKEN BY UNIVERSITY

- 53 KWp SOLAR PHOTOVOLTAIC ROOFTOP INSTALLATION
  - ❖ University has 53 KWp solar photovoltaic roof top grid connected system installed on administration building in may-2020. Total Power generation from June-2021 to May-2022 is 78,426 units. It is about 19.86 % of total Energy consumption of the university.

Solar Unit Generation (June 2021-May 2022)	Grid Unit Consumption (June 2021-May 2022)	Total Unit Consumption (Solar+ Grid)	RE Share (%) Year 2021-22
78,426	3,16,351	3,94,777	19.86%

- LIGHTING SYSTEM
  - ❖ Replacement of "conventional T-12 (40 Watt) and T-8 (36 Watt)" tube light by energy efficient LED lighting fixture was taken up phased manner. In all 140 lighting fixtures have replaced with LED 20-watt 6000 k white buttons.
  - ❖ University has updated following conventional lighting fixtures by energy efficient LED lighting and purchase energy efficient lighting product for new construction under energy policy of the university.
  - ❖ University has replacement of 752 No of "conventional T-12 (40 Watt) and T-8 (36 Watt)" tube light by energy efficient LED lighting (20Watt) fixture.
  - ❖ 194 no. of 18 Watt CFL replaced by 7 & 9 watt LED bulb.

II. AREA OF IMPROVEMENT

- TIMER CONTROLLED STREET LIGHTS
  - ❖ Installation of "Timer control on high mast and street lighting" in university campus is recommended.

- CEILING FAN AND EXHAUST FAN:
  - ❖ Replacement of "conventional ceiling fan (60 Watt) by energy efficient star rated fan or BLDC based energy efficient fan (28Watt) in "admin building, class rooms, laboratories and faculties cabin" have great potential for energy saving.
  - ❖ Replacement of "conventional exhaust fan (70 Watt) by energy efficient star rated fan or BLDC based energy efficient Fan (20 Watt) in old building class rooms, laboratories and faculties cabin have great potential for energy saving.

- IOT BASED ENERGY MONITORING SYSTEM AT MAIN FEEDER
  - ❖ Installation of "Cloud based (IoT based) energy monitoring system" including harmonic measurement (total voltage and current harmonic distortion %) in power house will be good initiate for energy monitoring as well as student demo project for management. Expected energy saving potential about 5 to 6%.
  - ❖ Installation of energy meters between transformer and main PCC panel with IOT system will monitor line losses of the system. It will give real time measurement of power factor and line losses from the cable.

- SYNCHRONIZATION OF DG SET WITH SOLAR SYSTEM
  - ❖ Installation of "Cloud based fuel and unit generation monitoring system" in DG set will help to monitor specific unit generation by DG set during failure of the grid power.
  - ❖ It was observed that during the power failure of the grid, solar unit generations also stop. Synchronization of the solar system with DG set increases the utilization capacity of the solar system.

III. CARBON FOOT PRINT ANALYSIS MEASURE AFTER GREEN AUDIT IN UNIVERSITY

Green Audit is the most efficient way to identify the strength and weakness of environmentally sustainable practices and to find a way to solve problem. The executive summary of the Green Audit report furnished in this section briefly gives the identified green intiative taken by university and further recommendation for green campus, solid waste management and their impact on carbon foot print in the campus.

GREEN INITIATIVE TAKEN BY THE UNIVERSITY

- CAMPAIGN OF PLANTATION AND GREEN CAMPUS:
  - ❖ University has around **7545** no of plant & trees in the campus. Its good initiative taken by management for green campus under the campaign of plantation. **It's APPRECIABLE.**
  - ❖ We have found that after Biomass Calculation and CO_2 Sequestration of the Trees that is **349.83 Tons /Year.** CO_2 Reduction in this year. **It's APPRECIABLE.**

- 53 KWp SOLAR PHOTOVOLTAIC ROOFTOP INSTALLATION:
  - ❖ University has 53 KWp solar photovoltaic roof top grid connected system installed onadministration building in may-2020. Total Power generation from June-2021 to May-2022 is 78,426 units. It is about 19.86 % of total Energy consumption of the university.

- CO_2 FOOT PRINT ANALYSIS:

Total Carbon Footprint generated By the campus = Carbon footprint by electricity + Carbon footprint by Vehicles + Carbon footprint by DG Sets. - Carbon Neutralize by tree - Carbon Neutralize by solar

Total Carbon Foot Print by campus:

287.87 + 5.163 + 2.58 -349.83 -75.39 = -129.60 tons/year It's Appreciable for Green Campus.

RECOMMENDATION FOR IMPROVEMENT

- Recommendation for Herbal & medicinal plants:
  - ❖ List of recommended of herbal & medicinal plant in annexure list. University management can be purchase above recommended plants in future plantation.
- **List of Tree/Plant with Quantity show on University campus board**
  - ❖ List of Tree/plant in University campus. It should be show Tree/plant name with quantity on university board.

QR CODE SYSTEM ON TREE:

- While the world seems to be going digital, people lack the time to read books and process the information they contain. Hence, University can be provided QR codes on the trees for its information and to exploit the rapidly growing platform for a unique purpose.

IV. ENERGY CONSERVATION MEASURES & CASE STUDIES

Case Study No.-1

	Conventional T-12 (40 Watt) and T-8 (36 Watt)" Tube Light By Energy Efficient LED Lighting (20Watt).		
University Building			
1	Total (36W) Tube Lights	No.	752
2	Rated Power	Watt	36
3	Operating Hrs	Hrs/day	12
4	Operating Annual Days	Days/Year	250
5	Unit Consumed Annually	kWh/Year	81216
Calculated Saving after tube replacement			
1	Replacement with 20 W LED tube Light	Watt/unit	20
2	Unit Consumed Annually	kWh/Year	45120
3	Energy Saving (Old- New Annual Consumption)	kWh	36096
4	Total Annual Energy Cost Saving @ Rs. 10.70 per unit	INR	386227
Estimated Investment cost calculation			
1	Capital Cost (180 per tubelight)	INR	135360
2	TOTAL INVESTMENT	INR	135360
3	Net Annual Saving	INR	386227
4	Simple payback (Investment/annual savings)	Month	4.21

Case Study No.-2

194 no. of 18 Watt CFL replaced by 9 watt LED bulb

	Replacing (18 W) CFL with Energy efficient (9 W) LED Bulb		
University Building			
1	Total (18W) Tube	No.	194
2	Rated Power	Watt	18
3	Operating Hrs	Hrs/day	12
4	Operating Annual Days	Days/Year	250
5	Unit Consumed Annually	kWh/Year	10476
Calculated Saving after LED Bulb replacement			
1	Replacement with 9 W LED Bulb	Watt/unit	9
2	Unit Consumed Annually	kWh/Year	5238
3	Energy Saving (Old- New Annual Consumption)	kWh	5238
4	Total Annual Energy Cost Saving @ Rs. 10.70 per unit	INR	56046
Estimated Investment cost calculation			
1	Capital Cost (100 per tube light)	INR	19400
2	TOTAL INVESTMENT	INR	19400
3	Net Annual Saving	INR	56046
4	Simple payback (Investment/annual savings)	Month	4.15

Case Study No.-3

	Replacing (60W) Ceiling Fan with Energy efficient BLDC Fan (28 W)		
University Building			
1	Ceiling Fan(60 W)	No.	982
2	Rated Power	Watt	60
3	Operating Hrs	Hrs/day	12
4	Operating Annual Days	Days/Year	300
5	Unit Consumed Annually	kWh/Year	212112

Calculated Saving after replacement			
1	Replacement with 28 W BLDC Fan	Watt/unit	28
2	Unit Consumed Annually	kWh/Year	98986
3	Energy Saving (Old- New Annual Consumption)	kWh	113126
4	Total Annual Energy Cost Saving @ Rs. 10.70 per unit	INR	1210452
Estimited Investment cost calculation			
1	Capital Cost (Rs.1800/- per Fan)	INR	1767600
2	TOTAL INVESTMENT	INR	1767600
3	Net Annual Saving	INR	1210452
4	Simple payback (Investment/annual savings)	Month	17.52

Case Study No.-4

Efficiency & Quality improvement of Solar Photovoltaic Roof Top Grid Connected Systems (53 KWp)

Recommendation:

- one of the more efficient solar panel models
- panels with High Concentrated Photovoltaic (CPV) Cells
- Avoid installing solar panels in shaded areas
- Get an expert to install your solar panels
- Clean your solar panels
- Monitor your solar panel output using energy management software.

Conclusion:

- If commercial solar panels aren't installed, maintained and monitored correctly, you likely won't achieve maximum efficiency when it comes to electricity output.
- These six tips should help you improve solar panel efficiency and maintain optimal performance levels, saving you money and reducing your businesses impact on the planet.

Case Study No.-5

Air Conditioning System

Recommendation:

- It is recommended to replaced Sprit AC by BEE star rated AC
- It is recommended "Fall Ceiling "in air conditioning area. It will be reduced air conditioning load of AC and unit consumption**.**
- According to studies, for every one degree we raise the temperature of AC to, up to 6% electricity can be saved, So far, the default temperature for AC's in India was 20 or 21 Degrees. Thus by increasing it to 24 degree you bare savings 18 to 20 % electricity- It is simple Maths.
- Reduced the infiltration from door and window in air conditioning area
- Keep doors and windows closed in air-conditionedspace, particularly doors leading to stairwells and external areas.
- Avoid Usage of Air-conditioners in the eveninghours & favorable climate conditions.
- Use pedestal fan instead of air-conditioners duringnon laboratory hours.
- Installation of energy saver for each AC.
- Insulate wall & ceiling.
- Routine maintenance for air filters& cooling pinsto make proper operation at regular interval.
- Use air curtains in front of door to avoid false airentry.

Case Study No.-6

Lighting

- Switch off lights when absent from your work area for more than 30 minutes including in bathrooms, meeting rooms, lecture theatres and corridors.
- Maximize the use of natural light and turn on lights only when there is inadequate lighting.
- Promote LED lamps instead of incandescent bulbs.
- Promote electronic chokes for florescent lamps instead of EMT chokes.

Case Study No.-7

Computer and Monitors

- Online UPS – Battery Status Indication. It can be switched-off during non-use period. To minimize no-load power consumption.
- Advice on PC energy saving features likeadvanced LED monitor.
- Switch-off the Offline UPS. When the power failure is less. Improves life of SMF Batteries. Over charging will leads to bulging of batteriesand leads to battery failure.

Adjust your power management settings to putyour screen to sleep if it is not in use for more than five minutes

V. CONCLUSION

Green building reduces energy consumptions in numerous ways. Decrease embodies energy of the building through efficient design, use of recycled and local materials and recycling construction waste. Green building design reduces energy consumption over its lifetime. Strategically placing windows and skylight can eliminate the need for electrical lighting during the day. High quality insulation reduces temperature regulation costs in both summer and winter. Green building consumes less water as compared to conventional building.

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