BUREAU OF ENERGY EFFICIENCY
Ministry of Power, Govt. of India

KHANINDRA TALUKDAR
B.E.E. Certified Energy Auditor
Regn No- EA-5846, Certificate No- 4039

National Productivity Council
an autonomous organization under,
Department for Promotion of Industry & Internal Trade
Ministry of Commerce and Industry, GOI

TO WHOM IT MAY CONCERN

This is to certify that Energy Audit of Kaliabor College was conducted for the period from April ,2021 to March,2022 by the undersigned as Certified Energy Auditor. The report was prepared on the basis of available records and found to be in order. Scanned copy of certificate as energy auditor is enclosed for reference.

Dated: 27th January, 2023.

K Talukdar.

(KhanindraTalukdar)
B.E.E. Certified Energy Auditor.
EA- 5846.

B.E.E. Certified Energy Auditor EA-5846 Date 27/1/2023

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National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr. / Ms. Khanindra Talukdar

son / daughter of Mr. D.D.Talukdar

has passed the National Certification Examination for Energy Auditors held in November - 2008, conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India.

He / She is qualified as Certified Energy Manager as well as Certified Energy Auditor.

He / She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for the Accredited Energy Auditor and issue of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the issuance of an official certificate by the Bureau of Energy Efficiency.

Place : Chennai, India

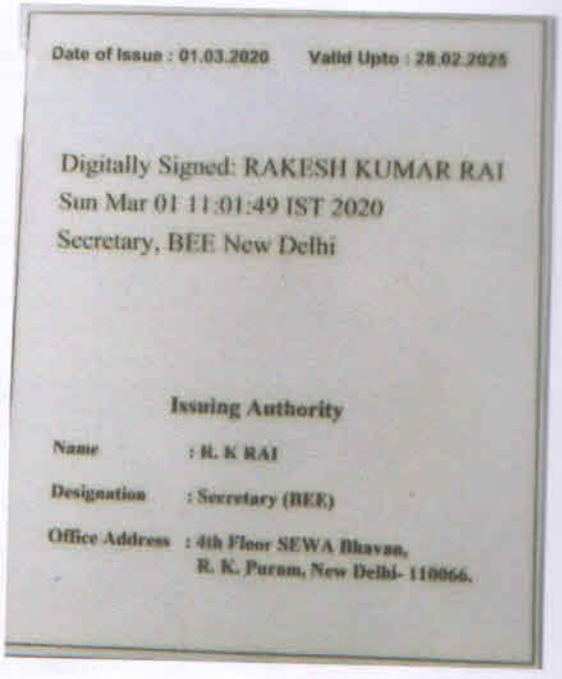
Date : 24th February, 2009

Controller of Examination

BUREAU OF ENERGY EFFICIENCY
NEW DELHI
CERTIFIED ENERGY MANAGER

Exam Reg. No.	: EA-5846
Certificate Reg. No.	: 5844
Name	: KHANINDRA TALUKDAR
Son/Daughter of	: D.D.TALUKDAR
Address	: E-6, RITURAJ ENCLAVE, GUWAHTI, GUWAHTI - 781003.

Signature of Certified Energy Manager :



Date of Issue : 01.03.2020 Valid Upto : 28.02.2025

Digitally Signed: RAKESH KUMAR RAI
Sun Mar 01 11:01:49 IST 2020
Secretary, BEE New Delhi

Issuing Authority

Name	: R. K RAI
Designation	: Secretary (BEE)
Office Address	: 4th Floor SEWA Bhavan, R. K. Puram, New Delhi- 110066.

Table of contents

1.Background

The only planet we belong to called "The Earth" is undergoing several unprecedented changes due to human activities over last several decades leading to climate change. Realizing the changing scenario United Nations organized a conference of leadersof member countries to discuss about the Sustainable Development in Rio de Janeiro in June2012. The conference was hosted by Brazil having the largest green cover of Amazon Forests. During the decade there were several other meetings in different countries at the behest of UN to discuss on remedial measures of Climate Change. The climate conference at Paris in 2015 adopted17 numbers of Sustainable Development Goals for the entire human population along with other living beings so as to make the world a sustainable one by 2030.

Sustainable Developments goals intend to deliver a just society with due to respect Earth and life in all its diversity by securing Earth's bounty and beauty for present and future generations. It also includes care for the community of life with understanding, compassion and love based on democratic societies that are just, participatory, sustainable and peaceful.

Goal seven of the SDGs aims to ensure affordable, reliable, sustainable and modern energy for all. Here energy means the clean energy like renewable energy generated by wind, hydro and solar power and other sources devoid of fossil fuels. Generation of power by burning fossil fuel is one of the major causes of global warming having triggered climate change. This is where we need to play our role to delay climate change by our actions at micro level. The institute of Kaliabor College haspioneered a lead role by installing a 40-kwp solar powered system to produce its own renewable energy sourcewhich is a step in right direction to supplement the adage "Think Global and Act Local".

2.Introduction to Energy Audit

Energy Audit is a better way to increase energy efficiency and reduce energy bills. An energy audit is an assessment of energy consumed within a time frame in a given location and to find out inefficiencies.

As per Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendation for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

In the provision of the Energy Conservation Act, 2001 the Bureau of Energy Efficiency has been set up under the ministry of power. The parliament of India passed the bill on conservation of energy bill in 2001 there by enlisting a set of rules to make efficient use of energy.

Conservation of energy has to become a part of our habit in our daily lives so as to save energy. Reducing use of fossil fuels will reduce carbon foot print and will help to build a sustainable future.

3.Scope of Works

3.1 Assessment of actual operating load and scope for optimizing load

- Review of existing electrical load in the campus
- Review of electrical load based on actual requirement

3.2 Study of individual units and means to conserve electrical power

- Study of existing use of power
- Review of unit wise electrical load based on requirement
- Recommendation for saving electricity

3.3 Energy conservation in Air-conditioning and water pumping system

- Observation in use of power and water
- Methods to save power and water

3.4 Diesel Generator (DG) set

- Existing standard of operation
- Performance of DG set in terms of specific fuel consumption
- Recommendation for optimum use of DG set

4 Energy Scenario of KaliaborCollege

Kaliabor Collegeis located at a picturesque location of NagaonDistrict atKuoritol by the side of the river Kolong. It is equipped with administrative block, Academic blocks,a central library, Science blocks with laboratories, various departments including English, Economics, Political science, Sociology, Assamese,smart class room, canteen,girls' hostelsso on along with auditorium. Entire campus of college is supplied with power by a 40Kwp off grid solar power, A DG set and grid power from APDCL.There is no distribution transformer to supply electricity as entire college is dependent on solar power and low-tensiongrid power. The college authorities justify that since most of the teaching hours are conducted in day hours solar power caters to the need of power supply. However, the load of air conditioners is met by electricity from grid supply. In the event of power failure DG set remains in standby mode and supplies power duringemergency.

Sl. No.	Data on power supply	Values
1	Capacity of SolarGeneration in Kwp	40
1	Contract load demand from grid power in Kw	6
2	Assessed Connected Load in Kw	177.105
3	Units of Energy on Assessed connected load (April,2021-March,22) in kwh	31878.9
4	Annual consumption ofDiesel in Liters	300
5	Maximum dependance as power source	Off grid Solar power

LAYOUT OF KALIABOR COLLEGE, NAGAON

CAMPUS LAYOUT OF KALIABOR COLLEGE

Scale 1:710

LEGENDS

1. PRINCIPAL'S RESIDENCE.
2. ADMINISTRATIVE BLOCK.
3. SECURITY ROOM.
4. CAR PARKING.
5. CYCLE STAND-I.
6. CYCLE STAND-II.
7. ARTS BLOCK.
8. CENTRAL LIBRARY & COMPUTER SCIENCE DEPT. & DEPT. OF VOCATIONAL COURSES.
9. AUDITORIUM.
10. CANTEEN.
11. PM COMMERCE BUILDING.
12. DEPT. OF PHYSICS.
13. DEPT. OF BIOLOGICAL SCIENCE.
14. ORCHID HOUSE.
15. MICROBIOLOGY LAB.
16. DEPT. OF CHEMISTRY.
17. CLASS ROOM BUILDING-I.
18. CLASS ROOM BUILDING-II.
19. GIRLS HOSTEL.
20. WARDEN'S RESIDENCE-I.
21. GENTS TOILET.
22. GIRLS TOILET.
23. CLASS ROOM BUILDING-III.
24. INDOOR STADIUM.
25. VOLLEYBALL COURTS.
26. MULTIGYM.
27. BOYS HOSTEL.
28. RESIDENCE OF WARDEN-II.
29. STUDENTS UNION ROOM & BOYS COMMON ROOM.
30. RUSA ARTS BUILDING.
31. GIRLS COMMON ROOM.
32. DRINKING WATER SUPPLY.
33. ARYA BHATTA SCIENCE CENTER.
34. HERBAL MEDICINE GARDEN.

Methodology of Energy Audit:

The methodology for energy audit consists of preliminary audit, audit and post audit stages.

Step 1- Building a team for Energy conservation (ECC).

During the preliminary audit, an Energy Conservation Committee (ECC) is formed with the principal as the team leader. Energy Audit is a collective effort. It is essential that an energy conservation team is formed to carry forward the objectives of energy audit. A meeting is scheduled between the auditor and the team to start with. The agenda of meeting focuses on objectives, scope of works, rules and regulations, roles and responsibilities of team members and description of scheduled project activities. During meeting the team is enlightened about power system within the campus, energy system specifications, standard operating practices, importance of saving electricity and safety measures to be adopted during operation of various electrical equipment.

Step-2. Walk in Audit

After formation of ECC, members of the team with energy auditor goes aroundthe college campus to take a stock of various sources of electrical power and power consuming devices including illumination arrangement in class rooms and offices,lighting system, fan, air conditioners and various laboratory equipment in science blocks.

Step-3. Documents verification

In this phase various documents like energy bills, agreements with utility, log book of DG set are looked into to ascertain if the pattern of energy consumption for the year 20-21 for which energy audit is being conducted.

Step-4. Identification of energy consuming devices

After a study of the facilities, energy consuming devices are identified and where appropriate field measurements are collected to supplement findings.

Step-5. Bills by utility for analysis

This is one of the steps where bills served by utilities have to be verified to ascertain if cost incurred on electricity charges are reasonable. It also seeks to verify balance between energy actually required and energy consumed.

Step-6. Evaluation and feasibility of Energy Conservation Measures.

After walk in audit, scrutiny of relevant data, information based on available documents, measurements where required, feasibility of conservation measures is studied with pay back method. This may be segregated to short-, medium- and long-term period.

Step-7. Preparation of Audit finding report

The findings and recommendations of audit are documented in the audit report. This report includes description of existing power network within the campus and focuses on areas of major energy consuming locations. A discussion with Energy conservation Committee highlights the need for saving energy. This will lead to saving on cost of electricity consumption followed by recommendations on short, medium and long-term measures. These Energy saving measures try to rationalize the use of electricity and estimates payback period after implementation of the recommendations.

Step -8. Post audit period

The energy conservation measures (ECM) will bring benefits of energy and costs saving only after the recommendations are implemented. The onus is on the user and stake holders of the institution to implement the ECM. The energy auditor has to highlight the importance of implementing ECM so as to achieve broader goal of efficient use of energy as stated in the Energy Conservation Act 2001.

7. Energy conservation committee, Walk-in-audit, observation and evaluation

7.1 Energy Conservation Committee (ECC)

As a part of energy audit exercise energy auditor visited Kaliabor College, at Kuoritolon1st December,2022. The purpose was to have firsthand information onsources of power and network of electrical loads of KaliaborCollege, consumption pattern and prospect of saving energy. Conserving energy is always a collective work and collaborativeeffort. The management of KaliaborCollege was committed to exercise of the energy audit. At the suggestion of forming an energy conservation committee by energy auditor, college authority wasproactiveto form the ECC and to ensure full participation of all stake holders including teachers, staff and students. The energy conservation committee was formed with principal of KaliaborCollege as the team leader and thefollowingteam members as follows.

1. Dr.UttamBaurah, Principal, Kaliabor College- Team Leader
2. Dr.H.K. Chaliha, former Principal - Member
3. Mr.ParagDahalAssistant Professor-Member.
4. Dr. Jayanta Kr. Das,Assistant professor - Member.
5. Dr.RinjuBharali, Assistant professor -Member.
6. Mr.KhanindraTalukdar, Auditor - Member.
7. Mr.PutulBasumatari, Electrician -Member

7.2 Walk in audit and observation:

Walk in audit forms a part of preliminary audit. In this exercise energy auditor along with Energy Conservation Team (ECC) makes an inspection of the college campus to have an objective assessment and to observe use of electrical energy at different blocks and departments of college. The purpose of walk-in - audit is to have an insight into electrical network and power consuming devices and explore any possibility of saving power. The devices included appliances like Tube lamps, Fans, plug points (both 6 and 16 amps), computers, projectors, audio visual systems, water pumps, air conditioners, class rooms of Zoology, Botany, Physics, Mathematics, Chemistry and related laboratories of science departments. The team visited class rooms of History, Economics, Political Science, Education, English, Assamese, Sociology etc. The team also looked into otherinfrastructures likeauditorium, Central library, girl's hostel, canteen,common rooms, toilets etc. This was a learning experience for members and energy auditor to observe and evaluate the need for electricity at locations in an objective manner. Diesel generator was also observed during walk-in audit. It helped the team to judge whether there can be saving of power by its optimum use.

Some observations during walk in audit

- It was gratifying to learn that major portion of power for the college was suppliedby off grid 40kwp solarsystem with battery for storage.
- It was also observed that the solar panels were shaded by trees and were filled with dust layers rendering the solar system inefficient to generate optimum power.
- Roof top Solar panels needed to be cleaned regularly to ensure optimum performance.

- There were a number of plug points (6 and 16 amps) in science laboratories which were rarely used.
- 40-watt Tube lamps, CFL, Metal halides and Halogen lamps used for illumination consumed a lot of power which can be replaced by LED lamps to save power.
- The DG set was used occasionally and there was a need to maintain a log book to record fuel consumption and other parameters.
- Water taps in toilets needed to be leak proof to prevent wastage of water.
- Air filters of air conditioners needed to be cleaned as a part of annual maintenance exercise to save power.
- All class rooms should have a MCB (miniature circuit breaker) to put off electrical appliances after the classes are over.

- There could be some hoarding in prominent places in the campus to highlight about need to save power.
- The illumination level of the class rooms and toilets need to be optimized.

7.3 Data Collection

Walk in audit is followed by data collection relating to generation of power by solarsystem, bills served by the utility (Assam Power Distribution Company Limited), log book of DG Setto know consumption of diesel oil to generate power.

ANALYSIS AND EVALUATION

Relevant data have been tabulated in various tables for scrutiny and analysis.

- Load study of Kaliabor College at Kuoritol, Nagaon is tabulated on page-10.

- Table 2shows quantities of electrical devices in use and power consumption on the basis of use for 6 hours per day for 30 days per month. Page-11.
- Table 3 shows various components of electrical devices consuming power in terms of percentages. (Page-12)
- Pie chart adjoining Table-3 shows power consumption in percentages.(Page-12)
- Analysis of energy saving, payback period and investment (1,2,3,4,5). (Page-13,14,15)
- Table-4 illustrates energy saving, payback period and investment. (Page-15)
- the sources of power the institute uses including solar, grid and DG generated power. (Page-16)
- Table-5 shows month wise consumption of grid power being consumed. (Page-17)
- Graphic-1 shows the monthly pattern of grid power for 2021-22. (Page-17)

- Table-6 informs about number of students, teachers and staff in the institution. It also indicates power consumed by each person and reflects each individual as stake holder and to be conscious about need to save power. (Page-18)

Load Study of Kollabor College, Kuoritol, Nagaon

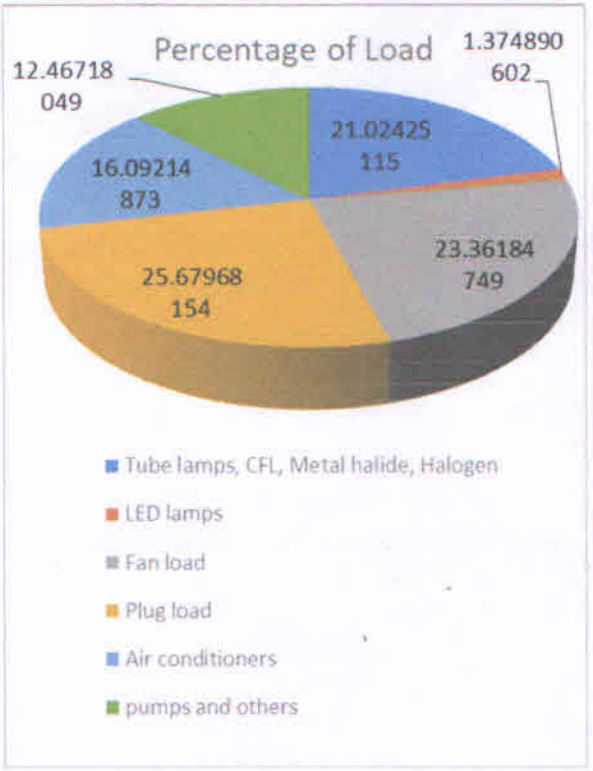
Sl no	Academic Area & Depts	Tube (40w)	CFL	LED (40w)	LED (20w)	LED (7w)	M. Halide	6 A plug	16A plug	Celing Fan	Exhaust Fan	Com puter	Print er	AC	Photo stat	Pump	Other s
1	Girls Common Room	2						2		2							
2	Distance Learning cel	5						16	2	3		1	1		1		
3	Cash Counter	2						6	1	2					1		
4	Office	7						14		5							
5	Old Principal Office	6						10	2	3				1	1		
6	Accounts Branch I	3						5		2							
7	Accounts Branch II	4						8	4	2							
8	Vice Principal Office	4						7		2							
9	IQAC	3						3		2							
10	Hall No-10		24					8		12							
11	Education Dept	2						10		4							
12	Education Lab	4						10		3							
13	Room no-1	4						2		4							
14	Room no-2	4						2		4							
15	Political Science Dept	2						4		2							
16	Assamese Dept	2						4		2							
17	Room No -5	2						4		2							
18	Room No -6	2						4		2							
19	English Dept	2						4		2							
20	Teachers Common Ro	4						2		4							
21	Economics Dept	3						6		2							
22	Room No-20	6						2		7							
23	Room No-21	4						2		4							
24	Room No-22	5						2		6							
25	All Verandah	10															
26	Auditorium	30	60					8	4	28						1	
27	Principal Quarter	10	10					5	3	4	1			1		1	
28	Girls Hostel Ground Fl	38						17	3	17						1	
29	Girls Hostel First Floo	32	22					16	2	16							
30	Hostel Warden	8	4					3	2	3							
31	Girls rec. Room	4						2		2							
32	Store	1															
33	NCC	2						2		1							
34	Room No-27	2						1		1							
35	Room No-28,29	4						2		3							
36	Room No-30	2								1							
37	Room No-31	2								1							
38	Hall No-32	12						3		11							
39	Chemistry Lab-1	2				3		2	1		1(200w)						
40	Chemistry Lab-2	4									1(200w)						
42	Demo room																
43	Balance room					7		3	2								
44	Common room	2				1		2	4	1	2						
45	Corridor					2											
46	Physical Lab	3						1	2	2	2						
47	Class room	1						5		1	3 (wall fan)						
48	Bio- Science Dept consists ofBiology, Zoology and Bio-technonlogy . Connected Load is shown in total for all class rooms, labs, seminar room etc															1	
49	Physics Department consists of Class room,labs,teachers room,canteen etc	38	42					50	16	39			6				
50	Library	40							18	21	3						
51	Indoor stadium	8	21	8	6	9		32	5	14	5		1				
52	Computer Lab-1	10	10				12	4	2	4	2						
53	Computer Lab-2	2				9		17	23								
54	Administrative Bldg							1	20								5 kva u
55	Kolong Conference	6															3kva ur
56	Principal's office			4	2					4		2	2	2			
57	Store,Kitchen, toilet	1				9		2	12	1		2	2	2			
58	IQAC with Lobby	4				7		1									
59	Mahabahu auditorium	2						8		3							
60	Waiting shed at GF				58	8		7	8	15							
61	Kitchen Corridor	4			2	4		1									
62	General Branch-1	2															
63	General Branch-2	4						4		2	1	1	1		2		
64	Accounts Branch	8							4	4							
65	Waiting shed and store	2						2	6	4		2	2				
66	Lobby at Ground Floor	4				9		1	2								
67						17											
68	RCC G+3 Bldg :GF	386	193	12	68	85	12	339	148	286	16	8	8	13	5		
69	First Floor	30	10					20	1	24	2						
70	Second Floor	30	10					20	2	25	2						
71	Third Floor	30	10					20	2	25	2			4			
72	Academic Building:G+3	120	60					20	2	25	2						
73		626	293	12	68	85	12	90	20	60	8			2			
								509	175	445	32	8	8	19	5		

Table-2.

Energy Consumption of loads for 6hours/day for 30 days a month								
Sl no	Load	watt/ unit	Quantity	Total watts	Kilowatts	Assessed kilowatt	Kwh= Kw*6*30	Remark
1	Tube light	40	626	25040	25.04	25.04	4507.2	1. Monthly Energy consumption is assessed assuming that average use of each load is 6 hrs. per day for 30 days.
2	CFL	15	293	4395	4.395	4.395	791.1	
3	LED	40	12	480	0.48	0.48	86.4	
4	LED	20	68	1360	1.36	1.36	244.8	
5	LED	7	85	595	0.595	0.595	107.1	
6	Metal halide	150	12	1800	1.8	1.8	324	
7	6A plug	100	509	50900	50.9	10.18	1832.4	2.Total number of 6A & 16Aplugs are 509 and 175 respectively. (Rows 7 & 8). Assessed Kw is arrived at by assuming that 1/5th of plugs will be used for 6 hrs. for 30 days.
8	16Aplug	1000	175	175000	175	35	6300	
9	Ceiling fan	75	445	33375	33.375	33.375	6007.5	
10	Exhaust	250	32	8000	8	8	1440	
11	Computer	35	8	280	0.28	0.28	50.4	
12	Printer	360	8	2880	2.88	2.88	518.4	
13	AC	1500	19	28500	28.5	28.5	5130	
14	Photostat	1600	5	8000	8	8	1440	
15	pump	760	4	3040	3.04	3.04	547.2	3.It is presumed that laboratory equipment will be powered by plugs as per requirement.
16	UPS	1000	8	8000	8	8	1440	
17	Halogen	500	12	6000	6	6	1080	
18	Aqua guard	60	3	180	0.18	0.18	32.4	
19	**Total Load**			**357825**	**357.825**	**177.105**	**31878.9**	

Table-3Component of Electrical Loads in Kw and as percentage basisin Pie chart

Sl no	Item	% Load	Kw
1	Tube lamps, CFL, Metal halide, Halogen	21.024	37.235
2	LED lamps	1.3749	2.435
3	Fan load	23.362	41.375
4	Plug load	25.68	45.48
5	Air conditioners	16.092	28.5
6	pumps and others	12.467	22.08
7	Total Electrical Load	100	177.105



- Out of the total load conventionalLamps comprises 21.02% as compared to 1.37% LED Lamps.
- Fan, Plug and Air conditionerscomprise 23.36%,25.68% and 16.1% of electrical loads respectively.
- Pump and others comprise 12.47% of load.
- There is scope of saving power by replacing conventional lamps.
- A considerable amount of power can be saved by replacing conventional fans.

Cost Analysis and Payback period after replacements with efficient devices

1. **Cost analysis and payback period of replacing 40w tube with LEDs**

- Total number of 40-watt tube lamp : 626
- Average power of tube lamps :40watts
- Average power of LED : 9 w
- Power saved per LED : (40-9) = 31 watts
- Total power saved : 626*31= 19406 watt = 19.406kw
- Average use of TUBE lamps per year :270 days * 6hrs/day= 1620 hrs
- Total energy saved per year : 19.406* 1620= 31437.72 kwh= 31738 (say)
- Saving in Rupees per year : 31738*7.08= Rs.129491
- Total cost of replacing tube lights : = (626*90) = Rs. 56340
- Payback time of Capital cost :56340/129491= .435 years= 5.22 months

2. **Cost Analysis and Payback period of replacing CFLs with LEDs.**

- Total number of Compact Fluorescent Lamps (CFL): 293
- Average power of CFL : 23watts
- Average power of LED : 9w
- Power saved per LED = (23-9) = 14w
- Total Power saved = (293*14) = 4102 watts=4.102 Kw
- Average use of CFL per year = (270*6) =1620 Hrs
- Total energy saved per year = (4.102*1620) = 6645.24 Kwh
- Saving per year@Rs7.08/unit =(6645.24*7.08) =47048.29=47048
- Average cost of replacing each CFL (9w) = Rs.90.00
- Total cost of replacing all CFLs = (293*90) = Rs.26370.00
- Payback time of capital cost = 26370/47048.29= .56 years.

=6.72 months.

3. **Cost Analysis and Payback period of replacing Metal Halides with LEDs.**

- Total number of Halide Lamps: 12
- Average power of Halide Lamps: 150 watts
- Average power of LED : 80w
- Power saved per LED = (150-80) = 70w
- Total Power saved = (70*12) = 840 watts=.84 Kw
- Average use of Metal Halide per year assuming 100 days@6 hrs. per day = (100*6) =600 Hrs
- Total energy saved per year = (.84*600) = 504Kwh
- Saving in Rupees per year@7.08/unit = (504*7.08) = Rs.3568.32
- Average cost of replacing each LED (80w) = Rs 2400
- Total cost of replacing all metal halide = (12*2400) = Rs.28800
- Payback time of capital cost = 28800/3568.32= 8.07 years

4. **Cost Analysis and Payback period of replacing Halogen Lamps(500w) with LEDs.**

- Total number of Halogen Lamps :12
- Average power of Halide Lamps :500 watts
- Average power of LED : 80w
- Power saved per LED = (500-80) = 420w
- Total Power saved = (420*12) = 5040 watts=5.04 Kw
- Average use of Metal Halogen per year assuming 200 days@11 hrs. per day = (200*11) =2200 Hrs
- Total energy saved per year = (5.04*1200) = 6048Kwh
- Per unit cost of energy charge = Rs.7.08
- Saving in Rupees per year@7.08/unit = (6048*7.08) = Rs.42819.84=42820
- Average cost of replacing each LED (80w) = Rs 2400
- Total cost of replacing all metal halide = (12*2400) = Rs.28800
- Payback time of capital cost = 28800/42820 = .672 years =8.064 months

5. **Cost Analysis and Payback period of replacing Ceiling fans (75w) with BLDC fans (35w)**

- Total number of Ceiling Fans : 445
- Average power of ceiling fans : 75watts
- Average power of BLDC fan : 35 w
- Power saved per BLDC fan = (75-35) = 40w
- Total Power saved = (445*40) = 17800 watts=1780 Kw
- Average use of BLDC per year assuming 200 days@6 hrs. per day = (200*6) =1200 Hrs
- Total energy saved per year = (1780*1200) = 2136000Kwh
- Per unit cost of energy charge = Rs.7.08
- Saving in Rupees per year@7.08/unit = (2136000*7.08) =Rs.151228.80
- Average cost of replacing each Fan (35w) = Rs 3800
- Total cost of replacing 445 Fans = (445*3800) = Rs.1691000
- Payback time of capital cost = 1691000/151228.80 = 11.18 years =11.18 years

Table-4.Power saving, Investment & Payback period chart

SLno	Item to be replaced	Replaced by	Power saved (Kwh)	Capital invested (Rs)	Payback period (month)
1	40-watt tube	20-watt LED	31738	Rs. 56340	5.22 months
2	Compact Fluorescent Lamps (CFL) 23-w	9-watt LED	6645.24	Rs.26370.00	6.72 months
3	Metal Halides 150 -w	80 w LED	504	Rs.28800	8.07 years
4	Halogen Lamps500-w	80 w LED	6048	Rs.28800	8.064 months
5	Ceiling fans 75-w	35 w BLDC	2136000	Rs.1691000	11.18years
			2180935.24	Rs.18,31,310	
	Total money saved @ Rs.7.08 per unit= 2180935.24 *7.08=Rs.15,441,021.5				

The larger aim of saving energy by replacing existing devices with efficient equipment is to ensure lesser carbon footprint which in turn will help to delay warming at micro level.

Further in order to save our resources towards sustainability such a step will be offset by lesser load on the system and result in longer and efficient service by the system.

Sources of Power for Kaliabor College:

After the walk-in audit of the college campus, it was learnt that the institution had following source to meet power demand.

1. A 40kwp solar panel was installed with battery storage to supply power in off grid mode.
2. There was a contract agreement for 6 kw of grid power supplied by Assam Power Distribution Company Limited.
3. A diesel generator was available in standby mode in the event of non-availability of above two sources.
4. The power generated by the solar panel reportedly had 80% efficiency. No meter was available to record the unit generated by solar panel. As such solar generation had to be calculated by conventional methods and on the basis of some assumption.

Generation of Solar Power:

During our walk-inaudit, it was noted that the panels of 40Kwp off grid solar system was without energy meter for which energy generated could not be measured. Further the panels were coated with layers of dust and a number of panels were shaded by trees. Under such circumstances we can assume the efficiency of solar system to be at 70%. Further as most of the panels were shaded, we assume total sun shine to be available at 4 hours per day. Therefore, power generated by the off grid solar system = 40*0.7*4=112 kwh per day. Power generated per month= 112*30= 3360 kwh per month.

Power from DG set: As reported 300 liters of diesel is used annually for DG set for emergency power. As the DG set is working on Carnot cycle the efficiency of engine may be taken as 35%.

A general rule of thumb is that a diesel generator will use **0.4 L of diesel per kWh** produced.It is reported that the DG uses 300 liters of diesel annually. In the absence of any log book for logging operation of the DG set it will be inappropriate tocomment on the generation of DG set.

To ensure that energy audit is in order there has to be appropriate measuring devices. Without correct measurements itwill be inappropriate to go thru arbitrary measures as such measures will not serve the purpose of energy audit.

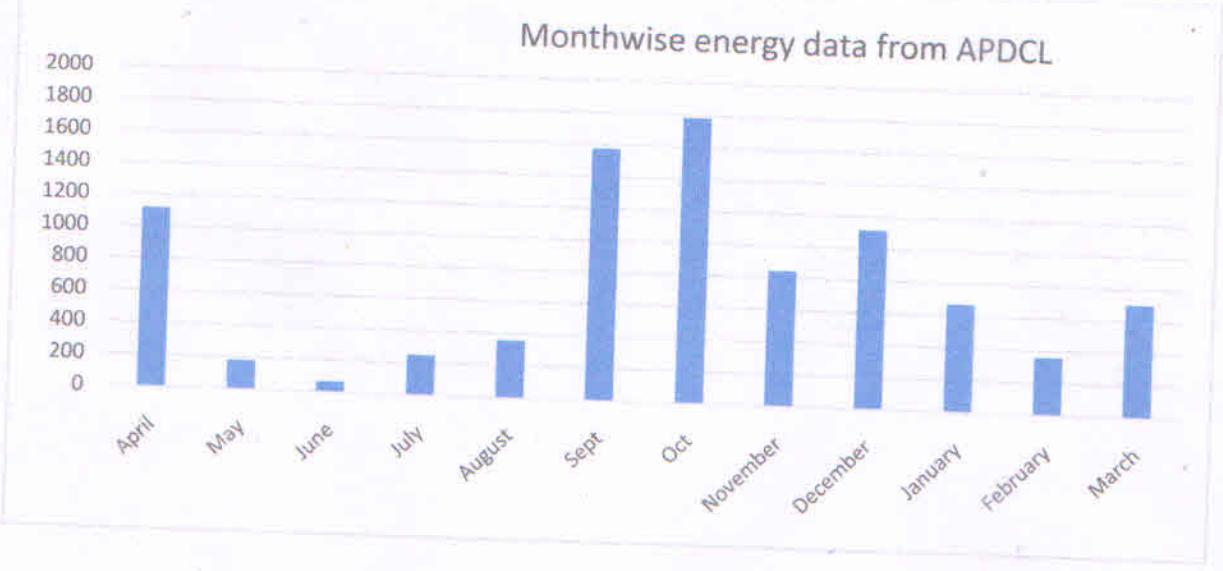
Power from APDCL is recorded month wise: Total power demanded by the college as per the bills served=9029 units for 2021-22. Average monthly grid power= 9029/12=752 units. The graphics-1 shows the pattern of grid power consumed by Kaliabor College.

Table-5. Grid Power consumption record for 2021-22 at Koliabor College, Assam

Year	Month	Unit consumed in Kwh
2021	April	1117
	May	183
	June	68
	July	249
	August	358
	Sept	1575
	Oct	1783
	Nov	843
	Dec	1117
2022	January	673
	February	360
	March	703
	Total	9029

Source: APDCL, Kaliabor Electrical Sub-Divn.

Graphic -1.



The chart-1 above depicts the month wise pattern of energy consumption from APDCL.

Consumption of energy per person per month

Category	Numbers
Students, Teachers and Staff	2500

Total Energy consumption for period -April21-March22= 31879Kwh
Energy consumed per person during the period= 31879/2500= 12.751 units (Kwh) per person per month.

It is an indication of power consumed by each person during the period considered. It is desiredthat the quantity of power consumed by each person should be reduced to save on electricity.

Diesel Generator Set:

There is one Diesel Generator set of 45Kva capacity to take care of standby power in the event of failure of power supply by APDCL. The technical specifications of the DG set are as follows:

Make	Green Power Limited
Rated HP	58
Machine Type	Four stroke IC engine
Voltage	415
Rated KW	42
Current in Amps	73
Frequency	50hz
Phase	Three phases
Cooling medium	Water cooling
RPM	1500

Performance assessment of the Diesel Generator set:

In order to assess performance of DG set it is essential to know Specific Fuel Consumption. Specific Fuel Consumption expressed in litres per hour or gram per Kwh is an indication of quantity of diesel required to generate one unit of electricity. The parameter is of direct relevance to end users as it relates to operating cost of generating electricity from DG sets. However, for that to happen we need to have a monthly fuel consumption and monthly energy generation data of 12 months.

As informed by maintenance person present DG set has been in operation for last 10 years. As such engine consumes more oil than the present generation DG set. The management could think of a replacing the present set with an efficient DG set sto have better fuel efficiency. It appears that the DG set was used as and when power supply to the college was disrupted. It was reported that the DG set was maintained by college authorities regularly.It was also learnt that no log book was maintained to record daily consumption of diesel oil. Further energy generation data was not available. Both log book and energy meter would be installed to have accurate data on diesel consumption.

The standard value of fuel consumption/hr of 52 KVA DG set are as follows:

	Load %	Fuel Consumption	Unit
Fuel Consumption	At 100 % load	10	Litres per hour
	At 75 % load	8	DO
	At 50 % load	7	DO

Follow up measures after walk-in-audit:

- As informed by authorities a log book is being maintained starting from Jan'23 to record month wise consumption of fuel.
- An agreement to be signed with the supplier of the DG Set is in process to look after maintenance aspect of DG Set. This is a right move in the sense that DG set will be ready to supply essential power in standby mode every time the grid power /solar power goes out.

9. Water pumping system:

There were four numbers of water pumps to cater to need of students, staff and teachers. As water is essential for our day-to-day activities the pumps, lines, valves, taps and joints need to be maintained without any leak so as to prevent wastage of water. So far drinking water is concerned it needs to be tested periodically to ensure compliance standards of drinking water in an approved laboratory.

10. Air conditioning System:

Air conditioners are energy consuming devices and need maintenance on regular basis. As the college is located in a location away from the business hub these Air Conditionersneed to operate during summer season. To that extent it is appropriate to maintain air conditioners so that excess energy is not consumed.

- The filters of the air conditioners need to be cleaned on a regular basis.
- Clogged filters increase consumption of excess energy due to overloading of compressor.

11. Recommendations:

Short term measures

i. Adigital energy meter should be installed at Solar power generation system to monitor generation of power on daily basis. Power generated can be monitored with the help of a browserwith internet connection.

ii. Layers of dirt in the form of dust must be removed regularly on weekly basis to ensure optimum generation of power.

iii. Partial shedding of solar panels due to trees should be done away with by trimming the branches of trees to ensure optimum generation of power.

iv. All 40w tube lamps, CFL, halide and halogen lamps should be replaced by energy efficient LED lamps in phased manner depending on use value of the lamps.

v. Unused plugs (6 and 16amps) should be plugged and isolated from circuit.

Midterm measures

vi. Conventional ceiling fans (75kw) may be replaced by energy efficient 35w BLDC (Brush Less Direct Current) fansin phased manner depending on use value of fans.

vii. Filters of Air conditioners should be cleaned to reduce load on ACs.

12. Implementation of Audit recommendations:

i. It is confirmed by the management that 40watt tube lamps, halogen and metal halide lamps are being replaced in phases by energy efficient LED lamps.

ii. Measures have been initiated to clean the solar panels on regularbasis to ensure optimum generation of power.

iii. Unused plugs (6& 16 amps) are being isolatedfrom the system as per the priority.

13. Standard operating practices:

13.1 Illumination:

Lux level is a measurement of illumination. For class rooms lux level is standardized at 300 lux. Natural light is the best and most important light to incorporate in the classrooms. Natural sun light provides physical and physiological benefits to both students and teachers. However, LED lights are best man-made lights for illumination of class rooms. Higher illumination if needed should be evaluated for the specific needs of class rooms.

13.2 Air- Conditioning system:

As mentioned, air conditioners should have regular cleaning of air filter. Depending on efficiency rating by BEE it is always betterto opt for air conditioners with higher star rating (4-to-5-star rating) which are energy efficient.

13.3 Earthing system, preventive maintenance and safety:

The term Earthing means connection of the neutral points of the supply system or non-current carrying parts of electrical apparatus, such as metallic frame work, metallic covering of cables, stay wire etc. to the general mass of earth in such a manner that at all times immediate discharge of electricity takes place without danger. Safehandling of electricity is one of the most important aspects of dealing with electricity. It needs to be underlined that all electrical devices including laboratory power points need to be earthed to avoid any short circuit which may lead to electrical accidents.

Every electrical system should be earthed to ensure safety of the equipment and safety of person handling equipment. There should be scheduled inspection of electrical networks to take up preventive maintenance and ensure safety. It is better to go for a technological upgradeof protection system by installation of Earth Leakage Circuit Breaker (ELCB) in the circuit to prevent any accident due to earth leakage. Solar panels need to be solidly earthed to prevent any accident.

13.4 Awareness on Energy conservation:

The need to save energy has to be understood by all stake holders as source of generating electricity by fossil fuel has become incompatible with global warming. Awareness on need for energy conservation has to percolate to every level of society by means of hoarding in prominent places, organizing discussion and popular talks, quiz and so on.

13.5 Formats for monitoring energy consumption:

It is expected that after implementation of short-term recommendations in energy audit there will be reduce energy usage of Koliabor College. To keep a track of consumption of energy following formats may be used.

Format-1

Monthly energy consumption from APDCL for year 2022-23						
Month of Year	Units billed (Kwh)	Recorded demand (Kva)	Electricity duty (Rs)	Cost ofbilled units (Rs)	Bill for recorded demand (Rs)	Total bill (Rs)

Format-II

Log Book for Diesel Generator Set			
Month of Year	**Diesel in litres**	**Energy inKwh**	**Running time From --To**

Format-III

Log Book for off grid Solar system			
Month of Year	**Solar power generated (Kwh)**	**Battery health**	**Remarks**

The above stated formats need to be filled up regularly so that all stake holders of the college can keep a track of the energy systems. The responsibility of monitoring the system may be done by deploying students class room wise so that students are aware of the need to save power. This practice will also be carried to respective homes and society will be enriched by power saving practices.

14. Acknowledgement:

We express our thanks and gratitude to the management of Kaliabor College for giving us the opportunity to conduct energy audit of the institution.

We are also grateful to Dr. Uttam Baruah, principal and former principal Dr. H.K. Chaliha, Kaliabor College,Kuoritol, Nagaon Assam for his valuable comments/feedback and for support with which we could prepare this audit report.

We express our sincere thanks to Sri. Parag Dahal and Dr. BasisthaKalita and all other persons for their support and guidance during the exercise of energy audit.

K talukdar.

(Khanindra Talukdar.)

B.E.E Certified Energy Auditor

(EA-5846)

Dated- 27th January, 2023.

B.E.E. Certified Energy Auditor EA-5846 Date 27/1/2023

GREEN AND ENVIRONMENT AUDIT REPORT

KALIABOR COLLEGE

PERIOD-2020-21

কলিয়াবৰ শাখা বিজ্ঞান সমিতি
KALIABOR BRANCH SCIENCE SOCIETY

(অসম বিজ্ঞান সমিতিৰ অন্তর্ভুক্ত/Affiliated to Assam Science Society)

কলিয়াবৰ ঃ নগাঁও ঃ অসম ◆ Kaliabor : Nagaon : Assam

স্থাপিত ঃ ১৯৭৮ চন / Estd. 1978

প্রসঙ্গ / Ref ঃ

দিনাংক / Date ঃ

This is to certify that the Green and Environment Audit of Kaliabor College for the year 2020-2021 was conducted under the supervision and support of Assam Science Society, Kaliabor Branch.

Bhupen Sarma

সভাপতি / সম্পাদক
কলিয়াবৰ শাখা বিজ্ঞান সমিতি

1. Introduction

1.1 Introduction to environmental audit

Environmental audit or **Green audit** is a general term that reflects various kinds of evaluations intended to identify environmental compliance and management system, implementation gaps, along with related corrective actions. It aims to analyze environmental practices within and outside of the concerned sites, which will have an impact on the ecofriendly ambience. Green audit is a useful tool to determine how and where the most energy or water resources are being used; and can then considerations be given on how to implement changes and make savings. It can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve waste minimization plan.

It can create health consciousness and promote environmental awareness, values and ethics.
It imparts a better understanding of Green impact on campus to staff and students.

1.2 Need for environmental audit

If self enquiry is a natural and necessary outgrowth of a quality education, it could also be stated that institutional self enquiry is a natural and necessary outgrowth of a quality educational institution. Thus, it is imperative that evaluates its own contributions toward a sustainable future. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more prevalent.

The rapid urbanization and economic development at local, regional and global level has led to several environmental and ecological crises. On this background, it becomes imperative to adopt the system of the "**Green Campus**" for the Institutes which will lead to sustainable development and at the same time reduces a sizable amount of atmospheric carbon dioxide from the environment. The National Assessment and Accreditation Council, New Delhi (NAAC) has made it mandatory that all Higher Educational Institutions should submit an annual Green Audit Report. Moreover, it is part of Corporate Social Responsibility of the Higher Educational Institutions to ensure that they contribute towards the reduction of global warming through Carbon Footprint reduction measures.

1.3 General and Specific Objectives of Green Auditing

Concerns about environmental degradation and realization of values of environment are logical consequences of scholarly research, teaching and learning process. In its pursuit for improving environmental quality and to maintain a pristine environment for the future generations, the students of Kaliabor College have made a self-inquiry on environmental quality of the campus with the following objectives to achieve:

The general objectives are:

To prepare a baseline report on biodiversity and other resources, measures to mitigate resource wastage and improve resource quality and sustainable practices.

The specific objectives are:

- To prepare a checklist of floral diversity in and around the college campus.
- To suggest measures to improve biodiversity within the college campus.

- To monitor the energy consumption pattern of the college.
- To assess the quantity of water usage within the college campus.
- To suggest sustainable energy usage and water conservation practices.
- To find out various sources of organic and solid waste generation and mitigation possibilities.
- To inculcate values of sustainable development practices through green audit mechanism.
- Awareness generation among students concerning real issues of environment and its sustainability
- Promotion of environmental awareness through participatory auditing process; and
- To create a report that document baseline data of good practices and provide strategies and action plans towards improving environmental quality for future.

2. Environment policy of the college

2.1 Site inspection

Site inspection was done by Faculty and students. The process of green audit was an enriching environmental awareness programme for the students who participated in the green auditing. The experience of green auditing was a first time experience for most of the students. They shared their expectations about a green campus and gave suggestions for the audit recommendations.

2.2 Review of documents and records

Documents such as electricity bills and water charge remittance bills, laboratory equipment registers, purchase register, and stock registers were examined and data was collected. College calendars, previous phase NAAC self-assessment reports were also verified as part of data collection.

2.3 Review of policies

Discussions were made with the college governing council members and with the Principal regarding policies on environmental management. The college is very keen in bringing green practices in order to make an environment friendly centre for learning and research. The management is eager to understand the measures practiced in disposal of hazardous waste and better waste disposal or recycling methods possible. The management is keen in installation of renewable energy sources and hence brings down the excessive cost and wastage of financial resources.

3 Methodology

Environmental audit is based on the Survey by Questionnaire. The survey was done in the whole campus by dividing it into various sections. On the basis of data requirement, set of questionnaires about electricity consumption, water consumption, waste generation, solid waste collection and transport were prepared.

3.1 Survey by questionnaire

Questionnaire survey was conducted in the College Campus. The different questionnaire formats were restructured also with different combinations and modifications. The final sets of questionnaires were prepared based on solid waste, energy, fuel, water, hazardous wastes and e wastes. The framed questionnaires were distributed among students, and staff of the College to fetch the information pertaining to the Environmental audit.

The questionnaires contained the general information of the concerned section, including name of the section, total number of students and employees, number of buildings along with the area under build up. The maintaining of records for handling of solid and hazardous wastes holds much importance in green audit. It is quite possible that the loss of water and energy resources can occur due to improper maintenances and therefore their assessment holds importance as far as green audit is concerned.

3.2 Data evaluation

The information gathered during the surveys was compiled for the further analysis.

3.3 Analysis and reporting

The completed questionnaires were tabulated as per their modules in excel spreadsheets.
This tabulated data was used for further analysis. Average and percentage values were determined to avoid complications. With the help of student volunteers, the major part of the data was compiled, which the committee analysed. The data regarding the plantation , Data on energy and water and data on solid waste generation were carried out by the Department of Botany.

4 Data Analysis

4.1 Land use Audit

Kaliabor college is using land for diverse purposes so that facilities are provided to all concerned for the smooth functioning and working. The College covers an area of 37 bighas (12.23 acres) After digital image processing of the area, the information about the area occupied by the various land uses from the map is gathered.

4.2 Energy audit

Energy audit is the key to systematic approach for decision making in the sphere of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies the energy usage according to its functions. The energy is utilized in the Campus for lighting, running of laboratory instruments, appliances, water heating, ground water pumping, cooking and transportation.

Table 1: The data regarding the energy consumption in the College campus is as following:

Building	Peak time load daytime	Peak time load daytime	Supply from renewable source	Supply from Non-renewable source	Intelligent Daylight use power saved

				(grid)	
Old Academic Building	5KW	0.5KW	5KW		
Auditorium	6Kw	6Kw	6Kw		
Girls Hostel	1Kw	3Kw	1Kw		
Deptt. Of Chemistry	2.5Kw	0.5Kw	2.5Kw		
Deptt. Of Biology	5.5KW	0.2KW	5.5KW		
Deppt of Physics	5 Kw	0.1 Kw	5 Kw	Standby	
RUSA Buiding	1.5 Kw	0.5 Kw	1.5 Kw		
Library	3Kw	0.1Kw	3.Kw		
Indoor stadium	4Kw	4Kw	2Kw		1KW
Administrative Building	4 Kw	1.2 Kw	4 Kw		1Kw
Canteen	2K W	0.5K W	2K W		1KW
Boys Hostel	1K W	3K W	0.5K W	2Kw	
Campus	0	0.5KW	0.4KW	0.1Kw	
Total	**40.5Kw**	**18.1KW**	**25KW**	**2.1KW**	**3KW**

Most of the energy requirements of the college are met by hydropower generated electricity supplied by the State Government. Some amount of energy requirement is met out of the power generated by the Solar Power Plant in the College.

College staff members use personal vehicles and their approximate number goes to 65. Most of the students use public transport, indicating lesser carbon foot print of the student community.

4.3 Water audit

Water audit is conducted periodically to determine water supplied in the distribution system as well as water lost and/or used within a distribution system. It aims to establish the water consumption pattern in individual sections, so as to realise the consumption levels with respect to exploring various pollution prevention and waste water minimization opportunities. Water audit also helps to establish the existing water distribution system as well as waste water collection and recycling, if any. The water is supplied in the college by the ground water supply.

The storage capacity of water in the College is shown in Table 2 .

Table 2 :Total water storage capacity in the college

S. No.	Storage Resources	Number	Storage Capacity (in litres)
1	Water Tanks	3	15000L
2	Underground water tanks	2	

There is a system donated by NRL under its CSR initiative which provides pure and safe drinking water for students.
Construction of water tanks has led to the collection of rain water and thus conserving the rainwater for watering plants.

4.4 Solid waste audit

The solid waste management is in order with the installation of incinerator, dust bins and their daily cleaning. The College has its own collection facility that collects the solid wastes daily from Residential complex, Hostels and Departments. This helps in maintaining the cleanliness by providing an efficient, safe and regulated management of solid wastes in the Campus.
The data showed that the total generation of solid waste in the Campus is 8 kg per day. Out of which non biodegradable is 3 kg per day while the biodegradable is 5 kg per day. It is noteworthy that College has adopted an environmentally sound practice of converting biodegradable waste into compost which is a useful resource. The compost produced is used in the nurseries and the gardens of the college.

The study showed that biodegradable waste constitutes a significant component of solid waste in the College. The non biodegradable component of solid waste is recyclable especially plastics. Work is going on under "Atmaram Research and Incubation Centre" for converting waste plastic into usable products.

4.5 Plantation audit

College maintains its own small gardens and extensive plantation drives the campus turned into a lush green spot with fair magnitude of biodiversity and have attracted a lot of faunal diversity including birds, reptiles and small mammals.
More than 50% area of the campus is green having different species broad leaved trees, shrubs, and perennial herbs.

College has established Orchid House and Herbal Garden with the financial support from different funding agencies of Govt. of India. The topography and altitudinal gradient of campus helps it support diverse vegetation of the tropical and temperate types. Orchid Garden is the conservatory of 32 species. Campus have many Angiosperms belonging to families Poaceae, Asteraceae, Fabaceae, Solanaceae, Lamiaceae, Malvaceae, Menispermaceae, Zingiberaceae, Liliaceae, etc. 3 species of Gymnosperms including *Juniparus prostata*, *Thuja orientalis*, *Cycas revoluta* are also grown. However, Shrubs includes *Citrus sp*, *Duranta sp*, *Cassia tora*, *Lawsonia inermis*, *Datura stramonium*, *Rouvolfia tetraphylla*, *Ricinus communis* etc. Climbers namely *Tinospora cordifolia*, *Asparagus racemosus*, *Piper longum*, *Piper nigrum* are also grown in the Garden of the Campus.

Table3 : Number of species of different types of vegetation

S. No	Growth form	Number of Species
1.	Trees	20
2.	Shrubs	13
3.	Climbers	4
4.	Herbs	26

5. Recommendations

The committee has made short term and long term suggestions to take environment protection to higher levels and it is hoped that this will receive due attention of College authorities.

1. Environmental auditing may be conducted by the College every year.
2. Rainwater harvesting facilities may be established at both administrative and academic campuses, foreseeing future needs of water.
3. Specific waste management plans should be adopted to manage solid waste in the campus, with the assistance of State Swachhta Mission and use of plastic carry bags, thermocol cups, plates and flex boards should be banned inside the College campus.
4. Propose a system for collection and disposal of waste sorted out as organic and others on a daily basis, managed by the campus administration. The wastes generated can be used for promoting organic farming activities within the campus. There should be a system for the management of hazardous wastes.
5. Frame a holistic campus development plan to foresee the future developmental needs in tune with green charter adopted by the College.
6. All the blocks in the Campus should develop a garden in front of the building.
7. Green habitat concept should be adopted for all the building construction activities of the College campus in future, which may help a long way in reducing energy usage, increasing aesthetic appeal of the buildings and class rooms, besides reducing carbon foot print. Further, more green spaces should be established all around the campus around larger trees and shades for the benefit of the students.
8. Fire safety instruments should be installed in all the buildings.
9. Setting up of 10 more street lights in different places of the campus.
10. Installation of one more Solar power unit of 20 KW to meet the demand.

Co-ordinator
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