

GREEN AUDIT & ENERGY AUDIT REPORT, 2019-20

ACKNOWLEDGEMENT

The green audit conducted by The Bhawanipur Education Society College is an internal audit that aims towards looking after a healthy environment. Though nascent, the initiative is taken up to foster the concept of environmental sustainability.

Sincere thanks to all for providing us necessary amenities and co-operation during the audit that helped in making the audit, a success.

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Audit Key Steps

Planning completed	March 2020
On site inspection completed	June 2020
Report presented to the IQAC by the audit team	July 2020
Report presented to the Management	August 2020
Report Accepted by the Management	August 2020

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EXECUTIVE SUMMARY

The Bhawanipur Education Society College planned for conducting a green audit of the college in March 2019, at the behest of the Internal Quality Assurance Cell (IQAC) of the college, which resolved to have a Green Campus Evaluation Plan. The report was finally submitted for approval to the principal and IQAC in June 2019, after completion of onsite inspection and assessment of

current practices, and scope for improvements.

The purpose of the audit was to make sure that the practices followed in the campus are healthy and environmentally sustainable. With this in mind, the specific objectives of the audit were to evaluate the degree to which the Departments are in compliance with the applicable regulations, policies and standards enjoined by regulatory authorities and to ensure that the development of the college aims at sustainable development and green campus.

The methodology used included physical inspection of the campus and review of the relevant documentation.

STATEMENT OF ASSURANCE

This kind of comprehensive audit has been conducted for the first time in the college. The audit procedure tried to meet the terms of International Standards of Internal Auditing.

The audit team is satisfied that sufficient and appropriate audit procedures were completed and evidence gathered to support the accuracy of the conclusions reached and contained in this report. The conclusions are based on an assessment of the situations as they existed at the time of the audit.

SUMMARY OF FINDINGS

The main findings of the audit show that, in general, all the departments and students are aware about the need for environmental protection at a general level.

However, on detailed review, it was observed that, as the college is implementing Green Campus Policy for the first time, many of the practices followed in the institution are still in nascent stage and needs further nurture. In addition, certain processes could benefit from further review in order to improve their efficiency, fairness and consistency.

OBJECTIVE AND SCOPE

Although there is no universal definition of Green Audit, we may define **it as systematic identification, quantification, recording, reporting and analysis of components of environmental diversity.** A Green Audit aims to analyze environmental practices within and outside (not in our purview) any organisation, which will have an impact on the ecological health and balance. It is initiated with the motive of inspecting activities within an institution which have the potential to affect the health and well being of its members and society at large, particularly the immediate neighbourhood. Subsequently it is conducted as a measure to ensure continuation of practices to ensure a healthy environment. In the case of educational institutions, a Green audit is assigned to the criteria 7 of NAAC, (National Assessment and Accreditation Council) which is a self governing organization of India which declares the institutions as Grade A, B or C according to the scores assigned during the accreditation.

The main objectives of Green Audit are as follows:

- To ensure development along with safeguarding the environment.

- To reduce energy consumption to foster environment.
- To assess whether the measures implemented by The Bhawanipur Education Society College have helped to reduce the Carbon Footprint.
- To assess whether investments made in increasing awareness among students regarding electricity, water management and environment in general have helped the Institution improve its carbon footprint.
- To assess whether non-academic activities of the Institution support the collection, recovery, reuse and recycling of solid wastes that harm the environment.
- To identify gaps and suggest recommendations to improve the Green Campus status of the institution.
- Impart environmental education through systematic environmental management approach and benchmarking for environmental protection
- To enable waste management through reduction of waste generation, solid- waste and water recycling
- More efficient resource management
- Recognize cost saving methods through waste minimizing and managing

The present Audit is conducted in view of assessing all necessary environmental components of The Bhawanipur Education Society College.

ABOUT THE COLLEGE

The Bhawanipur Education Society, founded in 1966, is a General Degree college affiliated to the University of Calcutta, which is administered as a linguistic minority institution by the Bhawanipur Gujarati Education Society. It runs programmes in B. Com, B.A, B.Sc., BBA, M.Com and M.A.(English). It is one of the renowned colleges of Kolkata, which is located in the heart of the city with a robust student strength of over 10,763. The college runs on three shifts which means that most of the infrastructural facilities are constantly in use. It has a number of laboratories in its premises.

The college intends to adopt the ‘Green Campus’ system for environmental sustainability. The goal is to reduce CO₂ emission, energy and water usage, while creating an environmentally literate campus where students can learn the idea of protection of environment and stay healthy. The ‘Green Campus’ is a very new concept adopted by this college. The college administration is still working on the multiple facets of ‘Green Campus’ including efficient Resource Management, Waste Management, Reducing Paper Use, and use of

Alternative Energy.

	ATTRIBUTES	VARIABLES
COLLEGE AREA	CAMPUS AREA	2 Bigha 11 Khatta 11Chitak 17Sq.ft.
	BUILT UP AREA	1,54,682 Sq.ft.
POPULATION	STUDENTS	11283

AUDIT GOALS OF THE COLLEGE

The college, with the advice of the Internal Quality Assessment Cell (IQAC) has set up an environmental quality assessment body aimed at performing the green audit of the institution.

METHODOLOGY

The Green Audit taken up by the Green Audit team of The Bhawanipur Education Society College had been divided into three stages:

The Pre Audit Stage:

In the pre-audit stage, meetings provided opportunities to discuss the feasibility of such an audit. It also provided the team with basic data required to start the process, prior to the onsite inspection by the team. The audit procedure and audit plan was handed over at this meeting and discussed in advance of the audit itself. The Audit team was also approved at this meeting. The audit protocol and audit plan were handed over at this meeting and discussed in advance of the audit itself.

The Management of the college showed commitment towards the green audit and its outcome, during the pre-audit meeting. They were ready to encourage all green activities were willing to formulate policies based on green auditing report

The Audit Stage:

The Audit Stage encompasses of the team selection and the field works performed. Looking after the unique structure, location and ambiance of the college, the Green Audit Team focused on Material Issues pertaining to college which have the highest influence on the Green Attributes of the College. The Audit stage also focused on the Methodology adopted. Checklist approach is adopted for transparent evaluation of the topics and increase readability for independent reader.

The Post Audit Stage:

The post-audit stage ensures formulation of Draft findings and sent to management response. Since the audit is done internally, it was important to ensure management approval for the draft. After getting draft approval, the audit team went for final report formulation

AUDIT FRAMEWORK AND DETAILED FINDINGS

The following audit framework is used for conducting Green Audit in 2017-18. The framework also lists the findings and observations for every criterion

Control Objective	Control(S)	Audit Observation
WATER MANAGEMENT	Repair sources of water leakage, such as dripping taps.	Regular checking and maintenance of pipelines are done to control water wastage.
	Minimize wastage of water and use of electricity during water filtration process, if used, such as water purifier.	Yes, the college has water purifiers of reputed brands installed in all departments.
	Use an efficient and hygienic water storage mechanism to minimize the loss of water during storage	Bulk water supply is provided by KMC, and it is stored in Underground reservoir as well as overhead tank.
	Encourage to decrease excess water usage.	Sanitaryware has been installed which uses modern technology for minimizing wastage of water. Posters in the campus alert everyone to the importance of saving water and turning off taps.
	Install water recycling mechanism.	No such mechanism is adopted.
ENERGY MANAGEMENT	Appreciate that it is preferable to purchase electricity from companies that invest in new sources of renewable and carbon-neutral electricity	The college does not have any choice other than CESC for electric supply.

	<p>Look into the possibility of on-site micro-generation of renewable electricity.</p>	<p>Recommended for setup of introduction of SOLAR PANNELS UNIT</p>
	<p>Encourage staff, students and conference guests to save energy through visible reminders, incentives and information to increase awareness. This particularly concerns turning off electrical appliances when not in use</p>	<p>College Administration has taken several steps/ measures for this section</p>
	<p>Monitor and understand the importance of energy consumption.</p>	
	<p>Ensures that all electronic and electrical equipments, such as computers, are switched off when not in use and is generally configured in power saving mode when such option is available</p>	<p>Super vision has done by supporting staff in regular fashion.</p>
<p><u>USE OF NON-TOXIC ORGANIC/GREEN PRODUCTS</u></p>	<p>Minimize the use of fertilizers and pesticides in college grounds, opting for the use of vermin compost produced on site wherever possible</p>	<p>Moderate amounts of organic-fertilizers are used in the college.</p>

	<p>Ensure that all cleaning products used by college staff have a minimal detrimental impact on the environment, i.e. are biodegradable and non-toxic</p>	<p>Cleaning products used in the college are all green products. For pest control management, chemicals used are recommended by WHO and CIB , with LD 50 level.</p>
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WASTE MANAGEMENT	<p>Make full use of all recycling facilities from students canteen and private suppliers, including glass, cans, white coloured and brown paper, batteries, print cartridges, cardboard and furniture.</p>	<p>No, the college does not have any such recycling device to carry on the procedure. Waste is segregated at the origin and handed over to KMC for disposal.</p>
		<p>No, the college does not have any such devices.</p>
	<p>Recycle or safely dispose of dry wastes, computers and electrical appliances.</p>	<p>All dry wastes (paper, metal, glass, other dry waste, e-waste, etc.) are separated in different bins in the college and resell to the local vendor</p>
	<p>Provide sufficient, accessible and well-publicized collection points for recyclable waste, with responsibility for recycling clearly allocated</p>	<p>The college has set up separate bins to ensure proper segregation and collection of the various wastes. The responsibility of recyclable waste is however still not taken up the college.</p>
	<p>Make specific arrangements for events, such as community events, seminars and conferences in order to both arise consciousness among students and others and also to minimize the waste produced and maximize what is recycled/reused</p>	<p>The college organized several seminar and community program by the departments to ensure both consciousness and awareness among students and community members.</p>
	<p>Dispose all waste, whether solid or otherwise, in a scientific manner and ensure that it is not released directly to the environment</p>	<p>Yes, the college disposes all wastes, whether solid or otherwise, in a scientific manner and ensure that it is not released directly to the environment.</p>
	<p>To recycle and reuse of kitchen wastes (from canteen)</p>	<p>System to be introduced.</p>

<u>OPTIMISING RECYCLING OF WEAST AND MINIMIZING THE GENERATION OF NON-RECYCLABLE WASTE</u>	Proposals have been made for the following installations in the Chemistry Laboratory: 1. Water Chiller Plant for water condenser to save water 2. Using rotary evaporator with an attached condenser to dry materials which will allow reusing solvent.	Not Achieved.
<u>REDUCING ENERGY CONSUMPTION FROM CONVENTIONAL ENERGY SOURCES</u>	100% use of LED lights	Achieved
	Replacement of old Air conditioners with energy efficient ACs.	No of ACs replaced 62 Total percentage of energy efficient Acs.75%
	Having more classrooms with adequate natural light to reduce consumption of electricity.	For operating ACs, the windows have to remain closed, thus barring natural light.
<u>MINIMISING THE USE OF CHEMICAL POLLUTANTS</u>	In the Chemistry Lab : 1. Chemicals used in the lab for reaction are not discharged into the environment, rather stored in sealed containers. 2. Instead of using harmful gases like H ₂ S, Cl ₂ , etc, equivalent less harmful chemicals are used. 3. Micro amount of starting material is provided to the students for laboratory experiments.	Achieved
<u>ENFORCEMENT OF ENVIRONMENTAL POLICY</u>	Ensure that all students, teachers and staff in general and the Environmental Development Committee and the Canteen Squad are appraised of the environmental objectives and policies of the institutions.	Achieved
	Ensure that an Audit is conducted regularly and the recommendations implemented on the ground.	Achieved

CARBON FOOTPRINT REDUCTION	Ensure use of eco friendly transport option	College does not provide transport to either staff or students.
	Promote environmental awareness as a part of course work in various curricular areas, independent research projects, and community service	UGC projects on sustainable development/ natural resources. Compulsory ENVS paper of 100 marks in the University Syllabus for all the students of all streams to develop Environmental Awareness (70 MCQ + 30 Project).
	Reduce the rate at which the College contributes to the depletion and degradation of natural resources	The college uses energy efficient lights and air conditioners as well as modern sanitation to minimize consumption of resources.
	Create awareness of environmental sustainability and takes actions to ensure environmental sustainability.	Seminars and awareness programmers are conducted periodically on nature and natural resources.
	Review architecture of existing buildings and reviews ways, in consultation with experts, to reduce usage of energy for such buildings, offering greatest efficiency for energy and water usage.	New constructions are in compliance with green standard.

	<p>Display environmental awareness posters and conduct awareness seminars.</p>	<p>Yes, the college places several posters and placards in the campus to ensure that environmental awareness is conducted. Also, seminars are organized on environmental theme in the college.</p>
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RECOMMENDATIONS

Criteria	Recommendation
<p>Maximise the use of renewable energy to initiate healthy and sustainable practices.</p>	<p>Install solar cell/panels as sources of continuous renewable energy to run both hardware and software labs to minimise thermal power consumption. Install environment friendly generators.</p>
<p>To channelize water resource</p>	<p>Space should be found for Reservoirs for collecting rainwater flowing from the roof tops.</p>

Maximize the proportion of waste that is recycled & minimize the quantity of non-recyclable refuse

Chemistry laboratory:

- Repeated distillation of used solvent may be done to reduce the solvent waste, thereby minimising pollution.
- Solid chemical waste like organic dye and inorganic complexes should be kept in closed containers and handed over to be the Calcutta Municipal Corporation following norms of the Pollution Control Board.
- Chemical waste not recyclable should be kept in controlled waste-bins.
- All organic solvents should be collected in controlled waste-bin through a process of incineration.

Concentrated acids and alkalis to be wash down drains with excess water.

Software & Hardware Labs:

- E-waste, other than batteries, which are not returned to the vendors, should be disposed off at collection centres authorised by the Pollution Control Board.

Canteen:

- Use of non bio-degradable plates for serving lunch should be stopped.
- Composting of organic waste may be started.

Campus in general:

- Rainwater harvesting should be seriously considered.
- Move towards a plastic free campus, and take measures to recycle existing plastic that is discarded.

Reduce energy consumption, especially of energy derived from fossil fuels	At least common areas should be served by electricity from solar panel. Conduct switch off drills periodically.
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Flora and Carbon Footprint Reduction

Carbon Footprint is historically defined as the total set of greenhouse gas emissions caused by an individual, event, organization or product, expressed as Carbon dioxide equivalent.

Floristic status of the institution

The Bhawanipur Education Society College is located in about 2.6 bigha of land (1.04 acre or 45302.4 square feet) in the heart of the city of Kolkata.

After deducting the built up area of ground floor (25,551 sqft) and the playground(3200sq ft) the projected area available for various types of flora is 16551.4 square feet (0.45 acre) of land.

However with the normal spacing of 6x10 feet, the total number of trees shall be taken up as 600/acre. This is a theoretical assumption.

The college has the following number of plants

Sl .No	Particulars of Flora	Number/area
1	Full-grown trees	50
2	Semi-grown trees	35
3	Bushes	40
4	Lawn	4980 sq.ft.

Carbon absorption by flora in the Institution

Carbon absorption capacity of one full grown tree = 6.8 kg CO₂

1. Therefore the carbon absorption capacity of 50 full grown trees in the campus of the college is

$50 \times 6.8 \text{ kg CO}_2 = 340 \text{ Kg}$ or **0.34 tonnes of CO₂**

2. The carbon absorption capacity of 35 semi-grown trees is 50% of that of full grown trees. Hence the carbon absorption is $35 \times 3.4 \text{ kg CO}_2 = 119 \text{ kg}$ of CO₂ or **0.119 tonnes of CO₂**.

3. There are 40 bushes of various species being raised in the gardens of the college. In the absence of a detail scientific study and botanical survey, the per plant carbon absorption was assumed to be 200 g. Based on this the total carbon absorption of 32 plants was calculated to be $40 \times 200 \text{ g} = 8 \text{ kg}$ or **0.008 tonnes of CO₂**.

4. Total area of the lawn is 4980 sq.ft. The carbon absorption capacity 10 sq.ft. area of lawn is 1g carbon dioxide. Hence 4980 sq.ft. of lawn absorbs 498 g or 0.498 kg of carbon dioxide per day. At this rate total carbon absorption per year ($0.498 \text{ kg} \times 365$) = 181.77 kg or **0.182 tonnes per year**

5. The grand total of carbon absorption by the flora in the campus of The Bhawanipur Education Society College is $(0.34 + 0.119 + 0.008 + 0.182) =$ **0.649 tonnes**.

Calculation of oxygen emission by flora

The number of liters in 1 kilogram depends on the density of the substance being measured. Litre is a unit of volume, and kilogram a unit of mass. Litres and kilograms are approximately equivalent when the substance measured has a density of close to 1 kilogram per litre.

On average, one full-grown tree produces nearly 260 pounds or 117.6 kg of oxygen each year. Two mature trees can provide enough oxygen for a family of four.

1. Total oxygen emitted by 50 full-grown trees per year ($117.6 \text{ kg} \times 50$) = 5880 kg = or **5.88 tonnes**
2. Total oxygen emitted by 35 semi-grown trees (58.8×35) = 2058 kg or **2.058 tonnes** (oxygen emission is 50% of that of the full-grown).
3. Total oxygen emitted by 40 bushes is calculated based on the following oxygen-inhaling requirement per person per day. A normal human being requires 550 litres of oxygen per day 400 bushes produce enough oxygen per day to enable a person to breathe adequate quantity of oxygen of 550 litres. Total quantum of oxygen produced by 400 plants per day is 550 litres of oxygen.

Taking 400 plants as one unit, the number of units of bushes in the campus $(40/400) = 0.1$

Total quantity of oxygen produced by 0.1 units is $(0.1 \times 550 \text{ litres}) = 55 \text{ litres}$ of oxygen per day.

The annual production of oxygen at this rate $(55 \times 365) = 20075 \text{ liters}$ or kg of oxygen, which is approximately **20.07 tonnes** of oxygen.

Lawn is an incredible oxygen –making machine. A 4980 sq.ft. area will supply enough oxygen to support one person for a day . Quantitatively speaking , this area of grass produces 550 litres of oxygen per day.

The total area of lawn in the campus is 4980 sq.ft. In units, the value $(4980/25) = 199.2$ units, which produce $(199.2 \times 550 \text{ liters of oxygen}) = 109560 \text{ liters}$ of oxygen per day. Total quantity of oxygen produced by the 4980 sq.ft. of lawn per year $(109560 \text{ liters/ day} \times 365) = 39989400 \text{ liters}$ or approximately **39989.4 tonnes**.

Carbon Footprint Reduction Table

Carbon dioxide absorption

Sl. No.	Flora	Quantity of CO ₂ (tonnes)
1	50 Full-grown trees	0.34
2	35 Semi-grown trees	0.119
3	40 Bushes	0.008
4	4980 Sq.ft. of lawn	0.182
Total		0.649

Oxygen emission by flora

Sl. No.	Flora	Quantity of O ₂ (tonnes)
1	50 Full-grown trees	5.88
2	35 Semi-grown trees	2.058
3	40 Bushes	20.07
4	4980 Sq.ft. of lawn	39989.4
Total		40,017.408

I. Energy-saving measures and Carbon Footprint Reduction

CESC bills of the college show that total consumption of electricity for the period 2019-2020 was 366244 kwh. This includes air-conditioners which consume about 20% of electricity.

0.538 kg or approximately ½ kg of coal produce 1 unit of electricity i.e 1 KW hour (1000 watts).
The total quantity of coal required to produce 366244 kwh of electricity (366244 *0.538 kg coal) = 197039.272 kg or **197.039272 tonnes**.

CO₂ emission by coal

One kilogram of coal emits 2.86 kg of CO₂ thereby increasing the carbon footprint which in turn contributes to global warming.

Therefore, 380.360082 tonnes of coal consumed indirectly by the Institution through consumption of 706989 units of electricity led to the emission of (197039.272 kg of coal *2.86 kg of CO₂) 563532.31792 kg or **563.532 tonnes of CO₂** into atmosphere.

The management of The Bhawanipur Education Society College is conscious of this damage to the environment and has been implementing various programs/ activities to reduce energy consumption on the one hand and increase green energy sources on the other.

They are

- Replacing high energy-consuming lighting system with energy-efficient lighting system.
- Installing a 540-kW pilot solar PV power system through placing 10 solar panels.

Analysis of CO₂ reduction through the above measures

1. Installing energy-efficient lighting system

Institution has reduced CO₂ emissions indirectly by replacing high energy-consuming Tube lights with energy efficient LED Tube lights system. To understand the carbon emission reduction, it is appropriate to compare the units of electricity consumed between Tube lights and LED Tube lights.

The following table illustrates this

Sl. No.	Contents	Value
1.	Total no. of Tube lights used earlier	828
2.	Average energy consumption by an Tube lights	40W
3.	Energy consumed by 828 Tube lights for 5 hr/day	331.20 KW hr or 331.20 units
4.	Energy consumption of 828 Tube lights for 300 days/ year	99360 kW hr or 99360 units

828 Tube lights are replaced with 828 LED Tube lights

Sl. No.	Contents	Value
1.	Energy consumed by 828 LED tube lights for 5 hr/ day	165.6 kW hr or 165.6 units
2.	Energy consumption of 828 LED Tube lights for 300 days/year	49680 kW hr or 49680 units
3.	Energy saved by LED Tube lights for 5 hr/day	165.6 kW hr
4.	Energy saved by LED Tube lights for 300 days/year	49680 kW hr or 49680 units

Carbon Footprint Reduction Analysis

First, it is appropriate to analyse the carbon emission due to consumption of 10,800 units of electricity by 2000 Tube lights per year. The standard tool of analysis employed in this Green Audit is coal equivalent of electricity.

0.538 kg of coal is required to produced 1 unit of electricity

Total units of electricity consumed by 2000 Tube lights =10,800 units

Coal equivalent of 10,800 units (10800*0.538 kg coal)= 5810.4 kg or **5.8104 tonnes**.

1 kg coal emits 2.86 kg of CO₂ into the atmosphere.

At this rate, 5810.4 kg coal emits $(5810.4 \times 2.86) = 16617.744$ kg or **16.617744 tonnes of CO₂**.

The following are the CO₂ reduction measures adopted in the Institution.

1. LED Tube lights

2000 Tube lights which consume 180 units of electricity were replaced with 2000 LED Tube lights. At this rate the coal equivalent $(180 \times 0.538 \text{ kg}) = 96.84 \text{ kg}$ or 0.09684 tonnes.

Carbon emission reduction achieved through use of LED Tube lights $(16.617744 - 0.09684) = \mathbf{16.520904 \text{ tonnes}}$
The positive impact of energy efficiency in this section on Carbon Footprint is **16.520904 tonnes of CO₂**.

Environment consciousness

Environment has become a popular subject in the last three decades. Some of the problems faced by humankind directly or indirectly are due to ozone depletion, greenhouse effect, acid rain, global warming, air-water pollution and fossil fuel combustion. Chemicals and allied processes are the most important among these. Noticing the bad effects of chemicals and traditional energy sources on environment and human life, the Institution has been trying to find solutions for a better life. For this, creating awareness about environment issues and the conservation of the ecosystem have become increasingly important in the life skill education in the college.

The rationale behind the environmental education is based on three factors:

- a) If people are aware of the need for and the ways of protecting the environment they will act to preserve it,
- b) The student community should assume responsibility for educating others about the need for environment protection and
- c) Environmental education can be effective as a part of college curriculum. Hence the Institution prioritizes it.

Suggestions and Recommendations

1. Available area of lawn shall be raised through the involvement of EcoClub and students from NSS or NCC to enhance oxygen emission more.
2. Compostable solid waste shall be collected and deposited in solid waste collection tanks. These wastes shall be profitably converted into compost and applied to gardens and trees to reduce the application of chemical-based fertilizers and pesticides.
3. Solar panels shall be installed immediately on the top of the buildings to enhance solar power productivity, aluminium foil-based reflectors shall be installed on the eastern and western sides of the solar panel.
4. Students from the Computer Science Department shall be trained as e-waste managers to manage e-waste. These e-managers shall be in constant touch with schools, orphanages and parish houses through social media and inform them of the outdated computer systems that shall be used by them. They also shall dispose of the less efficient, damaged and non-functioning e-wastes to the vendors.
5. All the water taps shall be fitted with high-efficiency aerator taps to reduce wastage of water. All toilets shall be fitted with dual flush water closets, which will reduce water consumption by 40%.

Energy Audit:

Definition of Energy Audit

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

Why the Need for Energy Audit

- The three top operating expenses are energy (both electrical and thermal), labour and materials.
- Energy would emerge as a top ranker for cost reduction
- primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs
- Energy Audit provides a " bench-mark" (Reference point) for managing energy in the organization

Detailed Energy Audit

- Detailed Energy Audit evaluates all systems and equipment which consume energy and the audit comprises a detailed study on energy savings and costs.
- Detailed Energy Audit is carried out in 3 phases
- The Pre-audit Phase
- The Audit Phase
- The Post-Audit Phase

Energy audit methodology

The methodology adopted for this audit was -----

- Formation of audit groups for specific areas and end use
- Visual inspection and data collection
- Observations on the general condition of the facility and equipment and quantification .
- Identification / verification of energy consumption and other parameters by measurements
- Detailed calculations, analyses and assumptions
- Validation
- Potential energy saving opportunities
- Implementation

Grouping and strategy

The following groups were formed with specific target areas and end uses assigned Team

- 1: Lighting , Fans etc. in Hostel 1 to Hostel Team
- 2: Lighting, Fans etc. in Hostel 6 to Hostel 9 & GH1 Team
- 3: Data logging Team

4: Past Data Collection from IWD (internal Works Department)

The groups were allowed the use of various measuring instruments like Lux meters to assist in the auditing activity.

Quantification by end use

The loads were segregated based on the end use as lighting and fans, Computer/printers, water pumping. Quantification, types and necessary measurements were carried out. The details are given below:

- LIGHTINGS _____ K.W
- FANS _____ K.W
- AIR-CONDITIONER _____ K.W
- COMPUTER _____ K.W

College Rooms

The Institute has about 7571 Fluorescent tube lights. Hostels are having 4393 fans in different Hostels. The total lighting load from the above is 302 kW and the connected fan load is 352 kW.

Computers and monitors account for 30%-40% of the energy used by office equipment. Their energy consumption is second only to office lighting. It is estimated that a power managed computer consumes less than half the energy of a computer without power management. The total number of computers in different hostels in the campus is 3950. In which No. of desktops is around 1500 and No. of laptops is 2450.

Benchmarking

Energy benchmarking involves the development of quantitative and qualitative indicators through the collection and analysis of energy-related data and energy management practices. Benchmarking in simplistic terms is the process of comparing the performance of a given process with that of the best possible process and to try to improve the standard of the process to improve quality of the system, product, services etc. It allows organizations to develop plans on how to adopt such best practices, usually with the aim of increasing some Aspect of performance. Benchmarking may be a one-off event, but is often treated as a continuous process in which organizations continually seek to challenge their practices. Benchmarking is a method which should be used on a continual basis as best practices are always evolving. Benchmarking of energy consumption is a powerful tool for performance assessment and logical evolution of avenues for improvement. Historical data, well documented, helps to bring out energy consumption and cost trends month-wise / daily. Trend analysis of energy consumption, cost, relevant production features, specific energy consumption, help to understand effects of capacity utilization on energy use efficiency and costs on a broader scale. The basis for benchmarking the energy consumption at IIT-K Hostels is energy consumed per student. The benchmarking parameters are as following: Hostel energy performance kWh consumed per sq.m o

Recommendations

There are a number of ways in which the present situation may be improved. Following is a list of

recommendations that we make that will help make IIT Kanpur an energy efficient system. 1. Installation of solar water heaters. We calculate the parameters that will be associated with this recommendation. Analysis for the Solar water heating systems for hostels of IIT Kanpur Sample calculation for Hall of Residence II Residents 462 Assuming an average requirement of 20 L of hot water per day Thus daily amount of hot water used= 462x20 = 9240 L

2. Replacement of rheostatic regulators with electronic However studies done at IIT Bombay have shown that the electronic regulator is more energy efficient but experience suggests that resistive regulators are more durable. Though it is still mentioned here as a possible option.

Detailed Energy Audit

The detailed audit goes beyond quantitative estimates of costs and savings. It includes engineering recommendations and well-defined project, giving due priorities. Approximately 95% of all energy is accounted for during the detailed audit. The detailed energy audit is conducted after the preliminary energy audit. Sophisticated instrumentation including flow meter, flue gas analyzer, scanners and other advanced instruments are used to compute energy efficiency.

1. Analysis of energy use

Identifying where energy is used is useful because it identifies which areas the audit should focus on and raises awareness of energy use and cost.

Analysis of energy use in the review of management structures and procedures for controlling energy use. This is a good source data for allocating energy use. The plant manager can also list all equipment used and the corresponding operating hours. With this information, one can create spreadsheet information and generate charts useful for analysis.

Electrically Connected load Study

2019-2020			
Types of Load	No.	Watt/unit	Total Kilo watt hr/ month
LED Tube	781	20	4686
LED Street Light	47	20	282
Stage Light	94	80	2256
Led lamp/ Panel Light	1820	16	8736
Exhaust fan	70	100	2100
Ceiling fan	600	100	18000
Wall Fan	76	100	2280

CFL Lamp	37	18	199.8
PC(LED)	293	450	39555
Laptop	40	80	960
Scanner Printer	23	350	2415
Printer	30	350	3150
Fridge	5	300	450
Water Cooler	19	300	1710
Television	22	100	660
LCD TV			0
Mixer	6	100	180
Xerox	5	100	150
AC- 3 STAR	296	1000	88800
AC-5 STAR	4	900	1080
Projector	70	60	1260
Stand fan	23	100	690
Water Pump	7	375	787.5
Genetator DG	2	160	96
Genetator DG	1	135	40.5

Recommendations for Energy conservation

S. No Recommended Energy Consumptions Measures

1	Turning off the lights and computer when not in use
3	Replacing all FTL's by LED lights of equal similarities
4	Replacing all Laser Printers by Ink-jet Printers
5	Use of motion sensors in corridors and toilets
6	Replacing conventional choke of all FTL's by Electronic choke.
7	Use of fans in Air Conditioned rooms
8	Installation of Inverters in Air Conditioners
9	Installation of energy saver in 1.5 ton Air Conditioners
10	Replacing rheostatic speed regulators of all fans in college rooms with electronics speed regulators

Calculation done by the Energy Audit team on Saving of Energy Bill

Replacement of 40 W tube light by Led Tube light 20 Watt

Wattage of existing lamp of Previous year = 40 watt

Duration of use of lamp in one year excluding Sundays

Total energy consumption by 40 W tube lights = $275 \times 40 \times 300 = 3300$ KWhr

(No. of Tube lights 275, Days per year 300)

This year we have replaced all 40 watt tube light by LED tube light 20 watt

Wattage of LED tube light=20 watt

Difference in wattage of lamp and T5 = $40 - 20 = 20$ watt

Total energy consumption by Led tube lights = $275 \times 20 \times 300 = 1650$ KWh

Difference in energy consumption = $3300 - 1650 = 1650$ KWh

Saving in energy bill

Cost/unit @ Rs 7.50 (1unit=1kwh) : Rs. 1650x7.50= 12375 Rs per annum

And finally, ...

This audit observation done by the Energy Audit team will be successful when the Head of the Institution and other's staff members understand that energy audit produces the highest profits of the Institution at a minimum cost.

Certification by the Internal Audit Team

Sl No.	Name of the Internal Audit Members	Signature with Date
1	Ms. Paramita Chakravarty	
2	Mr. Tathagata Sen	
3	Dr. Samir Kanti Datta	
4	Dr. Purba Roy Chowdhury	
5	Dr. Samir Kumar Siddhanta	
6	Mr. Debarup Roy	
6	Mr. Sanjib Halder	
7	Mr. Prasanta Chowdhury	

Certification by the External Audit Team

Sl No.	Name of the External Audit Members	Signature with Date
Expert 1	Prof. B.B. Paira	
Expert 2	Prof. Samir Banerjee	
Expert 3	Dr. Anup Sikdar	

DECLARATION

I agree with all the recommendation and observation mentioned in this report.

Original signature by the principal with Seal