ENERGY AUDIT REPORT | 2018-23

Prepared by Energy Audit Committee

TURKU HANSDA LAPSA HEMRAM MAHAVIDYALAY

Date of Audit: 15.12.2023

Endorsement of the External Energy Audit Team Members:

Sl. No.	Name with Designation	Signature and Seal
1.	Dr. Tapan Kr. Parichha, Principal, Suri Vidyasagar College Suri, Birbhum Email: surividyasagarcollege1942@gmail.com	T.K. Parichha Principal Suri Vidyasagar College Suri, Birbhum, PIN-731101
2.	Dr. Bibhas Dutta, Associate Professor, Department of Physics, Labpur Sambhunath College Email: bibhas.snc@gmail.com	Bibhas Dutta Dr. Bibhas Dutta Associate Professor, Dept. of Physics Sambhunath College, Labpur, Birbhum

Endorsement Of the Internal Energy Audit Team Members:

Sl. No.	Name with Designation	Signature and Seal
1.	Dr. Suman Mukherjee Teacher-In-Charge, THLH Mahavidyalay, Mallarpur Email: tlmprincipal@gmail.com Contact No.: 9126115159	Dr. Suman Mukherjee Teacher-in-Charge Turku Hansda Lapsa Hemram Mahavidyalay Mallarpur, Birbhum-731216
2.	Dr. Sk Nur Upsar, Co-Ordinator, IQAC THLH Mahavidyalay, Mallarpur Email: nur.tamanna11@gmail.com Contact No.: 9064862907	Dr. Sk Nur Upsar Coordinator Internal Quality Assurance Cell (IQAC) THLH Mahavidyalay Mallarpur, Birbhum,731216
3.	Prof. Amit Chandra Das, HOD, Department of Physics THLH Mahavidyalay, Mallarpur Email: amitcdas@gmail.com Contact No.: 9732097482	Head Department of Physics THLH Mahavidyalay Modian,Mallarpur,Ganpur,Birbhum-731216
4.	Dr. Hasan Askari, HOD, Department of Geography THLH Mahavidyalay, Mallarpur Email: mdhasanaskari90@gmail.com Contact No.: 7001924746	Head Department of Geography THLH Mahavidyalay Modian,Mallarpur,Ganpur,Birbhum-731216
5.	Dr. Washim Raja, HOD, Department of Chemistry THLH Mahavidyalay, Mallarpur Email: washim.raja89@gmail.com Contact No.: 9734284191	Head Department of Chemistry THLH Mahavidyalay Modian,Mallarpur,Ganpur,Birbhum-731216
6.	Prof. Chandan Mandal, Convener, Green Campus Committee THLH Mahavidyalay, Mallarpur Email: chandan.mdbazar@gmail.com Contact No.: 6296797800	Convener, Green Campus Committee, THLH Mahavidyalay Modian, Mallarpur, Birbhum - 731216
7.	Prof. Chandan Mondal, Coordinator, Incubation Centre THLH Mahavidyalay, Mallarpur Email: chandan.newton@gmail.com Ph: 8900664047	Co-ordinator, Incubation Centre, THLH Mahavidyalay Mallarpur, Birbhum - 731216

ACKNOWLEDGEMENT

We, Energy Audit Committee, express our sincere gratitude the management of Turku Hansda Lapsa Hemram Mahavidyalay for giving us an opportunity to conduct Energy Audit for the College located at Mallarpur, Birbhum.

We are grateful to IQAC coordinator & Professor, Department of Philosophy: Dr. Sk Nur Upsar for being a source of motivation to initiate the Energy Audit as Environmental and safety initiative.

We are indeed touched by the helpful attitude and co-operation of all faculties and technical staff, who rendered their valuable assistance and co-operation the course of study.

Energy Audit Committee/Team :

The study team constituted of the following senior teaching staff and from Energy Audit Committee:

- Dr. Suman Mukherjee, [Teacher-In-Charge], THLHM
- Dr. Nur Upsar, [Co-ordinator, IQAC] , THLHM
- Prof. Amit Chandra Das [HOD, Department of Physics], THLHM
- Dr. Washim Raja [HOD, Department of Chemistry], THLHM
- Dr. Hasan Askari [HOD, Department of Geography], THLHM
- Prof. Chandan Mandal [Convener, Green Campus Committee], THLHM
- Prof. Chandan Mondal [Coordinator, Incubation Centre], THLHM
- Dr. Tapan Kr. Parichha [Principal], Suri Vidyasagar College
- Dr. Bibhas Dutta [Associate Professor, Department of Physics], Labpur Sambhunath College

Signature of an External Member	Signature of an Internal Member	Signature of Principal/Teacher-In-Charge
Principal Suri Vidyasagar College Suri, Birbhum, PIN-731101	Dr. Sk Nur Upsar Coordinator Internal Quality Assurance Cell (IQAC) THLH Mahavidyalay Mallarpur, Birbhum,731216	Dr Suman Mukherjee Teacher-in-Charge Turku Hansda Lapsa Hemram Mahavidyalay Mallarpur, Birbhum-731216

0. EXECUTIVE SUMMARY

The executive summary of the energy audit report furnished in this section briefly gives the identified energy conservation measures in the College. After the Field measurements & analysis, we present herewith important observations made and various measures to reduce the Energy Consumption & mitigate the CO_2 emissions

0.1 AREAS FOR IMPROVEMENT

POWER FACTOR IMPROVEMENT:

- It was observing that the average power factor of College is 0.876 for 2018 to 2023 session. It should maintain Unity by the capacitor health check-up on regular basis.

DEMAND INCREASE 5.88 KVA TO 6.5 KVA.

It is analysed from last 05 Year electricity bills. Contract Demand of the College Campus is 5.88 KVA. Due to installation of new appliance, it is highly recommended to increase the demand from 5.88 KVA to 6.5 KVA.

LIGHTING SYSTEM:

- Replacement of "conventional T-12 (40 Watt)" Tube light by Energy Efficient LED lighting fixture T-5 (18Watt or 20 Watt) in all Buildings, have great potential for Energy saving. Expected Energy saving is the subject of load factor and total annual operating hours.
- Installation of "Timer control on Straight light and Focus light on Building" recommended for Energy saving in the campus.
- Installation of Motion sensor in Non-Working Area (Wash room, Electrical Room. etc.) recommended for Energy saving in the campus.
- Installation of "Solar Alone System" on Street lighting, campus Lighting and Building focus lighting are having good potential for energy saving.

0.2. Important Parameters: Electrical Energy:

Electricity is used for different purposes and at different sections in the college campus. The details of electricity distribution as mentioned below.

Sr. No.	Consumer No.	Electrical Meter No.	Location/Purpose	Payee
1.	522124342	SF503155	Lat 24.07254499 N Long 87.691115 E	Principal

The important parameters of electrical consumption as per Consumer no. in the campus are mentioned as below.

Sr. No	Consumer No.	Parameter	Max	Min	Average
1.	522124342	Units consumed, kWh	5149	138	2827.2
		Electricity Bill amount	37443	12485	24870.7

0.3. Important Parameters: CO_2 Emissions (Average, MT/Month)

Sl. No.	Consumer No.	Particulars	Value MT
1.	522124342	CO_2- Emissions- Electricity Usage	**9.5**
Total			**9.5**

On the basis of average electricity usage CO_2 emission is 0.79 MT/Month. On the basis of average electricity consumption CO_2 emission is 9.5 MT/annum. In addition to this LPG is being consumed for canteen for food preparation. Nearly LPG consumption annually is 12 commercial cylinders i.e. 174 kg/annum. On the basis of average LPG usage CO_2 emission is 0.522 MT/annum.

0.4. Benchmark: In terms of Electrical Energy & CO_2 emissions:

We now present two important benchmarks in respect of Electrical Energy consumption & CO_2 emissions as under.

Sl. No.	Particulars	Value	Unit
1.	Electrical Energy consumed	0.0234	kWh/sq ft
2.	CO_2- Emissions	0.786	Kg/sq ft

0.5. Recommendations:

We present herewith various proposals to reduce the Electrical Energy demand and reduce the CO_2 emissions

Sr. No.	Recommendation	Annual saving potential in kWh /Kg of LPG	Annual Saving Potential in MT of CO_2	Annual monetary gain, Rs.
1.	Installation of Heat pump integrated with solar water heater	----	----	----
2.	Increase more Solar street lights	----	-----	----
3.	Fine tune of APFC	-	-	-
4.	Solar powered light for hoarding	-	-	-
5.	Solar charging stations	-	-	-

Notes & assumptions:

1. 1 Unit of Electrical Energy releases 0.8 Kg of CO_2 into atmosphere
2. 1 Kg of LPG releases 3 Kg of CO_2 into atmosphere
3. Daily working hours: 10
4. Annual working Days: 280
5. Average Rate of Electrical Energy- Rs 06 per kWh

Chapter-I
INTRODUCTION

1.1 About College:

Our college under the Green Canopy of Shal & Mahuya Forest, named after the two great tribal leaders of Birbhum, Turku Hansda & Lapsa Hembram. THLH Mahavidyalay was established on 1st August, 2006 with a view to catering higher education to the aspiring students of a wide area surrounding Mallarpur, Birbhum. THLH Mahavidyalay of Birbhum District in West Bengal is situated in a plot of 5 acre land on the Raniganj-Suri-Moregram NH 60.

1.2 General Details of Turku Hansda Lapsa Hemram Mahavidyalay, Mallarpur:

Sr. No.	Head	Particulars
1.	Name of Institution	Turku Hansda Lapsa Hemram Mahavidyalay
2.	Address	Modian, Mallarpur, Birbhum, WB 731101
3.	Year of Establishment	2006
4.	Salient Features	Affiliated by College of Burdwan
5.	Courses offered	Graduate Level courses in Mathematics, Physics, Chemistry, Bengali, Philosophy, Political Science, History, Geography, English and Physical Education
6.	Total built up area	12078.8 sq. m

1.3 VISION

Education for all with Value Systems of Empathy, Enrichment, Equity, Excellence, Empowerment, Entrepreneurship & Enlightenment to Serve the Society

1.4 MISSION

The institution is dedicated towards the goal of preserving healthy relationship among all its stakeholders to practice the following:

- Spreading education to the grass-root levels of society particularly for students who are primarily first-generation learners.
- Providing support to the socially, economically and morally backward set of students to encourage inclusion without discrimination.
- Increase awareness about various subjects among the young learners through extensional activities and outreach programs to prepare them for their future.
- Enable the marginalised tribal students to empower themselves through quality education and participative learning.
- Facilitate interdisciplinary learning by accommodating the scope of activities like sports, extra- curricular projects, field works etc.
- A minimum Nature invasive policy is preached and practised in the educational approach of the institution

1.5 About Energy Audit

Energy audit helps to understand more about the ways energy is used in any plant and helps in identifying areas where waste may occur and scope for improvement exists. The overall energy efficiency from generation to final consumer becomes 50%. Hence one unit saved in the end user is equivalent to two units generated in the power plant. (1 Unit / 0.5 Efficiency = 2 Units)

Energy audit is the most efficient way to identify the strength and weakness of energy management practices and to find a way to solve problem. Energy audit is one kind of professional approach towards a responsible way in utilizing economic, financial, and social and natural resources. Energy audits can "add value" to the management approaches being taken by the institute and is a way of identifying, evaluating the system.

The ENERGY AUDIT TEAM carried out the energy audit at the site to find loopholes in the energy consumption pattern for THLH Mahavidyalay. A technical report has been prepared as per the need and the requirement of the project.

1.6 Objectives of Energy Auditing

- To study present level of Energy Consumption
- To Study the present CO2 emissions
- To assess the various equipment/facilities from Energy efficiency aspect
- To measure various Electrical parameters
- To study Scope for usage of Renewable Energy
- To study various measures to reduce the Energy Consumption

1.7 Audit Methodology:

Methodology adopted for achieving the desired objectives viz.: Assessment of the current operational status and energy savings include the following:

- Team of Audit Committee Members visited the site and had discussions with the concerned supervisors to collected data and load distribution for the overall premises. The data was analysed to arrive at a base line energy consumption pattern.
- Measurements and monitoring with the help of appropriate instruments including continuous and / or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.
- Trend analysis of costs and consumptions.
- Capacity and efficiency test of major utility equipment's, wherever applicable.
- Estimation of various losses

1.8 Energy Audit Instruments:

1. Portable Power Analyzer
2. Lux meter
3. Anemometer
4. Digital Temperature Indicator
5. CO_2 Meter

Unit: II
Power Supply System

2.1 Transformers:

The power supply for the THLH Mahavidyalay is from grid, with the help of 25 KV feeders under Different Tariff Category. Sanctioned load of the college is 6 kVA. College has 01 Nos transformer.

2.2 DG Sets:

The college has 01 Nos DG sets to supply Emergency power during the grid Power Failure. The Capacity of the DG sets is given below.

Sr. No	DG Location	Capacity of DG	Quantity
1.	Main College	25 KVA	01

Figure: - DG sets photographs in college

Observation :

- DG set is used only in case of power failure.
- There is requirement of energy and fuel meters to monitor total unit generation with respect to fuel consumption

Chapter-III
Energy Bill analysis

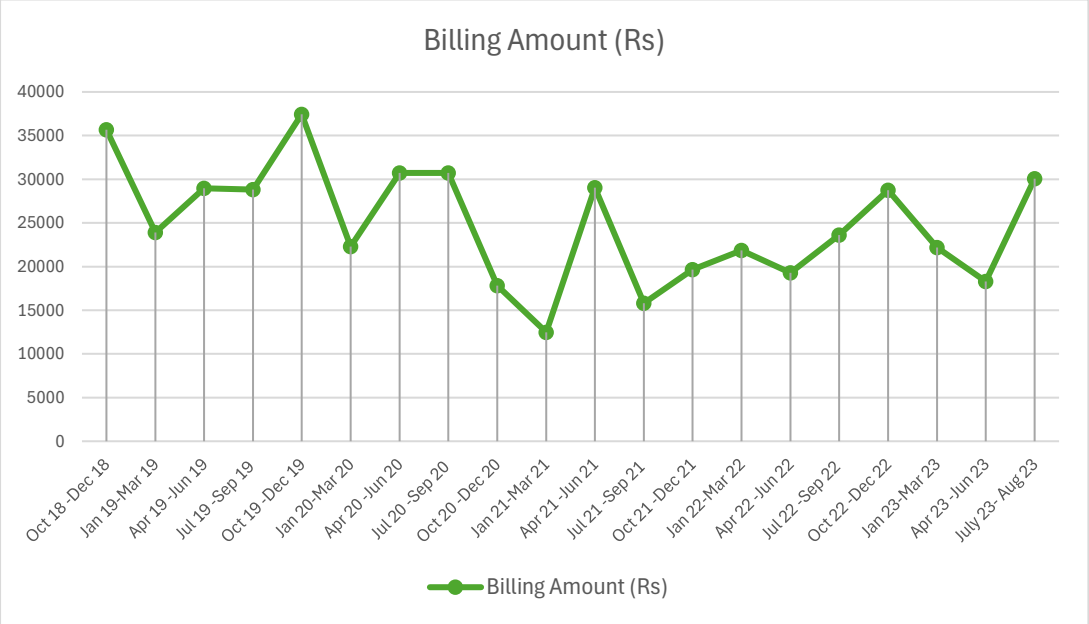
3. HISTORICAL DATA ANALYSIS: ELECTRICAL ENERGY

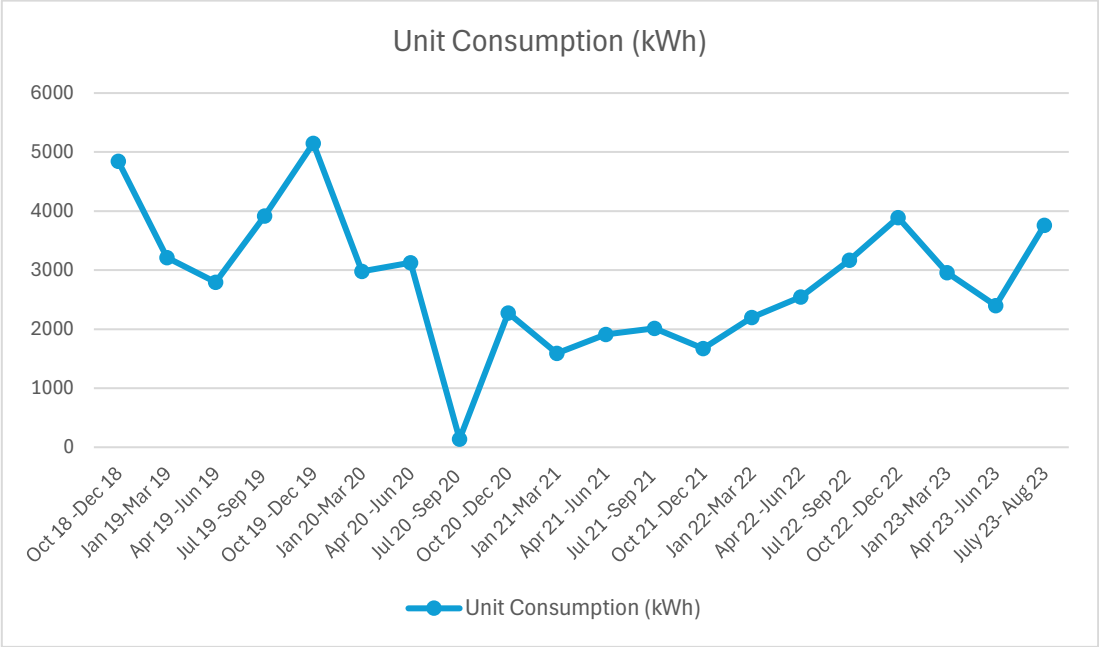
In this chapter, we present the analysis of last year Electricity Bills

3.1 Consumer No. 522124342

This consumer is the major contributors for billing. Monthly consumption for last few months and bill amount is as follows.

Sr. No	Bill Period	Unit Consumption (KWh)	Power Factor	Billing Amount (Rs)	Overall, per unit Charges (Rs/ KWh)
1.	Oct 18 -Dec 18	4845	0.88	35319	7.36
2.	Jan 19-Mar 19	3213	0.83	23914	7.44
3.	Apr 19 -Jun 19	2793	0.94	28978	10.38
4.	Jul 19 -Sep 19	3917	0.86	28833	7.36
5.	Oct 19 -Dec 19	5149	0.89	37443	7.27
6.	Jan 20-Mar 20	2979	0.90	22279	7.48
7.	Apr 20 -Jun 20	3128	0.90	30741	9.83
8.	Jul 20 -Sep 20	138	---	---	---
9.	Oct 20 -Dec 20	2275	0.89	17823	7.83
10.	Jan 21-Mar 21	1589	0.83	12440	7.86
11.	Apr 21 -Jun 21	1912	0.87	29028	15.18
12.	Jul 21 -Sep 21	2013	0.89	15810	7.85
13.	Oct 21 -Dec 21	1671	0.85	19638	11.75
14.	Jan 22-Mar 22	2199	0.86	21867	9.94
15.	Apr 22 -Jun 22	2545	0.83	19293	7.58
16.	Jul 22 -Sep 22	3168	0.89	23600	7.45
17.	Oct 22 -Dec 22	3891	0.91	28741	7.39
18.	Jan 23-Mar 23	2957	0.88	22175	7.50
19.	Apr 23 -Jun 23	2402	0.87	18281	7.61
20.	Jul 23- Aug 23	3760	0.86	30067	8.00



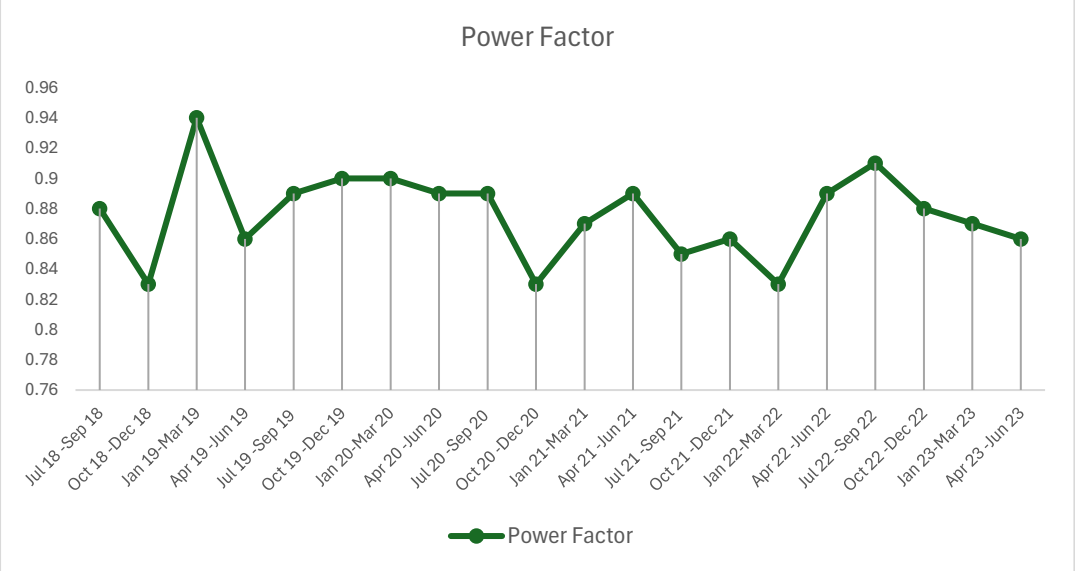


3.2 Observation:

It was found that total energy consumption in the last 5 years 56544 units. The average annual energy charges is Rs 8.8 /KWh.

3.3: - Average Power Factor of the college

Sr. No	Bill Period	Power Factor
1.	Oct 18 -Dec 18	0.88
2.	Jan 19-Mar 19	0.83
3.	Apr 19 -Jun 19	0.94
4.	Jul 19 -Sep 19	0.86
5.	Oct 19 -Dec 19	0.89
6.	Jan 20-Mar 20	0.90
7.	Apr 20 -Jun 20	0.90
8.	Jul 20 -Sep 20	0.89
9.	Oct 20 -Dec 20	0.89
10.	Jan 21-Mar 21	0.83
11.	Apr 21 -Jun 21	0.87
12.	Jul 21 -Sep 21	0.89
13.	Oct 21 -Dec 21	0.85
14.	Jan 22-Mar 22	0.86
15.	Apr 22 -Jun 22	0.83
16.	Jul 22 -Sep 22	0.89
17.	Oct 22 -Dec 22	0.91
18.	Jan 23-Mar 23	0.88
19.	Apr 23 -Jun 23	0.87
20.	July 23- Aug 23	0.86



3.4: Observation:

The average power factor was 0.876 for the session 2018-23. It is the recommended to maintain power factor unity.

3.5: Summary:

Sr. No	Consumer No.	Average Annual Electricity Consumption, kWh	Average Annual Bill, Rs
1.	522124342	11308.8	99482.8

3.6 Key Inference drawn:

From the above analysis, we present following important parameters:

Sr. No	Consumer No.	Parameter	Max	Min	Average
1.	522124342	Units consumed, kWh	5149	138	2827.2
		Electricity Bill amount	37443	12485	24870.7

3.7 Benchmarking:

Now we compute the Electrical Energy Consumed per square feet of the College Building as under

Sl. No	Parameter	Value	Unit
1.	Avg. Units consumed,	2827.2	kWh
2.	College area	12078.8	Sq ft
3.	Unit consumed/sq ft	0.0234	kWh/sq ft

Chapter-IV
Connected Load System

4 HVAC system

4.2 Air Conditioning Load

In the college, there are package unit of 4 x 1.5TR split units Air-conditioners to maintain comfort temperature in the Smart-Room/ office etc. Package units are installed mainly for the Auditorium.

Due to the minimal use of AC, the Energy efficiency assessment could not be done for the ACs. However, it was observed that some split ACs fitted in the office carries 5 star, which is good from energy efficiency point of view. It is recommended that whenever new split/ window ACs are being installed, it should be 5 star rated. Filters of package units were also checked during study which was found very clean. College has installed Package Split AC for cooling system in college. Details are given in below.

Sr. No	Types of Equipment's	Quantity	Total Capacity	Unit
1.	1.5 T Split AC	04	6	Tr

Energy Consumption in star rated split office is given above for information.

Sl.	Type of AC	Rated TR	Star	KW
1.	Split	1.5	*	1.91 - 2.1
2.	Split	1.5	**	1.75 - 1.9
3.	Split	1.5	***	1.65 - 1.74
4.	Split	1.5	****	1.55 - 1.64
5.	Split	1.5	*****	1.45 - 1.54

Star rated window ACs are also available in the market. It also consumes similar power as there in split office. Proper cleaning of ACs are very important for its output performance. At least, once in two months cleaning of ACs filter is recommended during the season.

4.3 Electrical Motors in College:

College has installed various type of motor for different application. Details are given in the table.

Sr. No	Type	Capacity (HP)	Capacity (KW)	Quantity (Nos)	Total kW
1.	Bore well Pump	2	1.50	4	6
2.	Garden water Pump	1.5	1.12	1	1.12
	Total KW in Motors			5	7.12

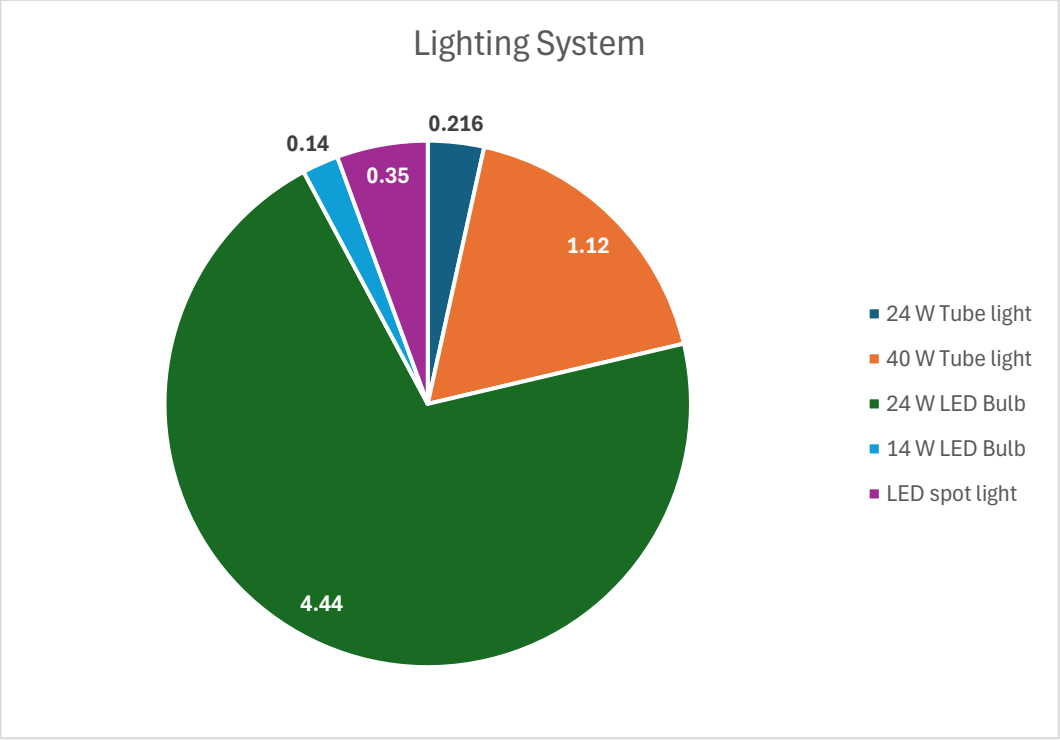
Chapter-V
Connected Load System

5.1 Lighting system of college:

The total lighting (luminary) load of the college is about 8 kW which includes Fluorescent tubes 24w/ 40w, LED lights 14w/ 24w etc. LED lights is good from energy efficiency point of view. LED tube lights are also available in the market, which is also good from energy efficiency point of view. Whenever 36/40w tube gets fuse (not in warranty period) then it could be replaced by 18w/ 9w LED tube. There are 6 nos of street lights which are working on solar power with battery. These lights are switched ON in the night with the help of timer. During study, tube lights were ON in the class room and it was observed that lux level was good (240 – 320) in the class room near to window. But Lux level was down (120 – 200) near the entrance door and its wall side. It is advisable to increase some tube lights in the class room for better lux value. College has installed different types of lighting system.
Details are given in the table

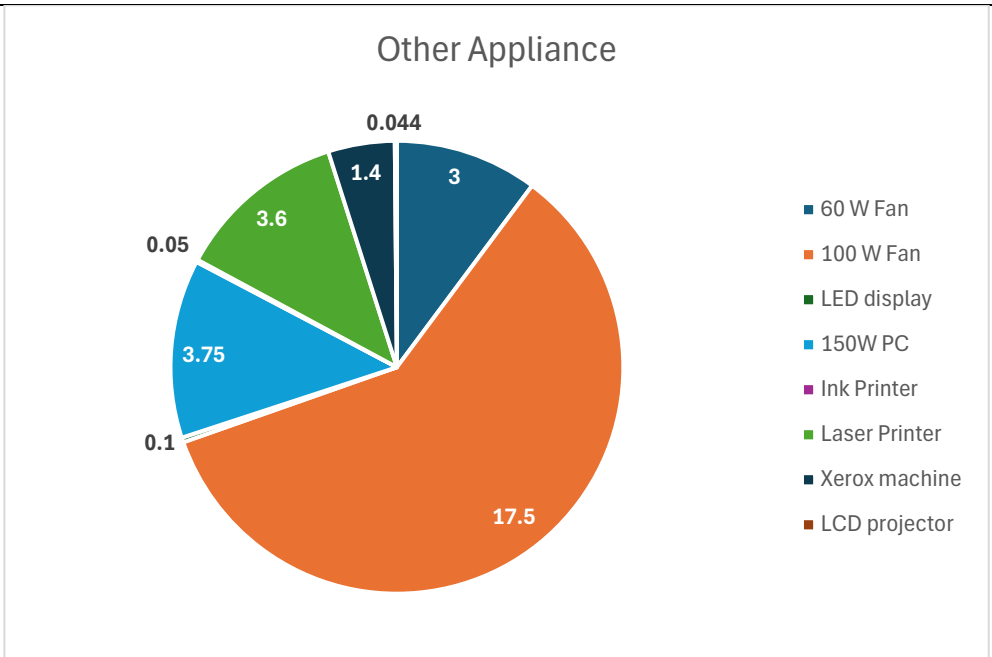
Sr. No	Type	Load (Watt)	Quantity (Nos)	Total Power kW
1.	24 W Tube light	24	09	0.216
2.	40 W Tube light	40	28	1.12
3.	24 W LED Bulb	24	185	4.44
4.	14 W LED Bulb	14	10	0.14
7.	LED spot light	50	07	0.35
	Total Lighting load in kW			6.266

We present the same in a PIE Chart as under



Other type appliances of the college are given below:

Sr. No	Type	Load (Watt)	Quantity (Nos)	Total Power kW
1.	60 W Fan	60	50	3
2.	100 W Fan	100	175	17.5
3.	LED display	100	01	0.1
4.	150W PC	150	25	3.75
5.	Ink Printer	50	01	0.05
6.	Laser Printer	450	08	3.6
7.	Xerox machine	700	02	1.4
8.	LCD projector	22	02	0.044
	Total Lighting load in kW			29.444



Chapter-VI
CARBON FOOTPRINTING

A Carbon Foot print is defined as the Total Greenhouse Gas emissions, emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various forms of Energy used by the College for performing its day to day activities. The college uses electrical energy for operating various electrical gadgets.

The Carbon footprint per year is calculated (www.carbonfootprint.com) based on electricity usage per year in which CO_2 emission from electricity and the sum of transportation per year in terms of number of the shuttle buses service operated by the Organization and number of cars, motorcycles and trucks entering in the Organization campus. These factors are multiplied with total number of trips in each day and approximate travel distance of vehicles covered in each day with a coefficient (0.01) to calculate the emission of CO_2 in metric tons per year.

Humans contribute an increase of carbon dioxide emissions by burning fossil fuels, deforestation, and cement production. Methane (CH4) is largely released by coal, oil, and natural gas industries. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. The largest source of greenhouse gas emissions from human activities is from burning fossil fuels for electricity, heat, and transportation.

6.1 Bill Period wise Consumption of Electrical Energy

Sr. No	Bill Period	Unit Consumption (KWh)
1.	Oct 18 -Dec 18	4845
2.	Jan 19-Mar 19	3213
3.	Apr 19 -Jun 19	2793
4.	Jul 19 -Sep 19	3917
5.	Oct 19 -Dec 19	5149
6.	Jan 20-Mar 20	2979
7.	Apr 20 -Jun 20	3128
8.	Jul 20 -Sep 20	138
9.	Oct 20 -Dec 20	2275
10.	Jan 21-Mar 21	1589
11.	Apr 21 -Jun 21	1912
12.	Jul 21 -Sep 21	2013
13.	Oct 21 -Dec 21	1671
14.	Jan 22-Mar 22	2199
15.	Apr 22 -Jun 22	2545
16.	Jul 22 -Sep 22	3168
17.	Oct 22 -Dec 22	3891
18.	Jan 23-Mar 23	2957
19.	Apr 23 -Jun 23	2402
20.	July 23- Aug 23	3760

6.2 Basis for computation of CO_2 Emissions:

The basis of Calculation for CO_2 emissions due to Electrical Energy are as under

- 1 Unit (kWh) of Electrical Energy releases 0.8 Kg of CO_2 into atmosphere

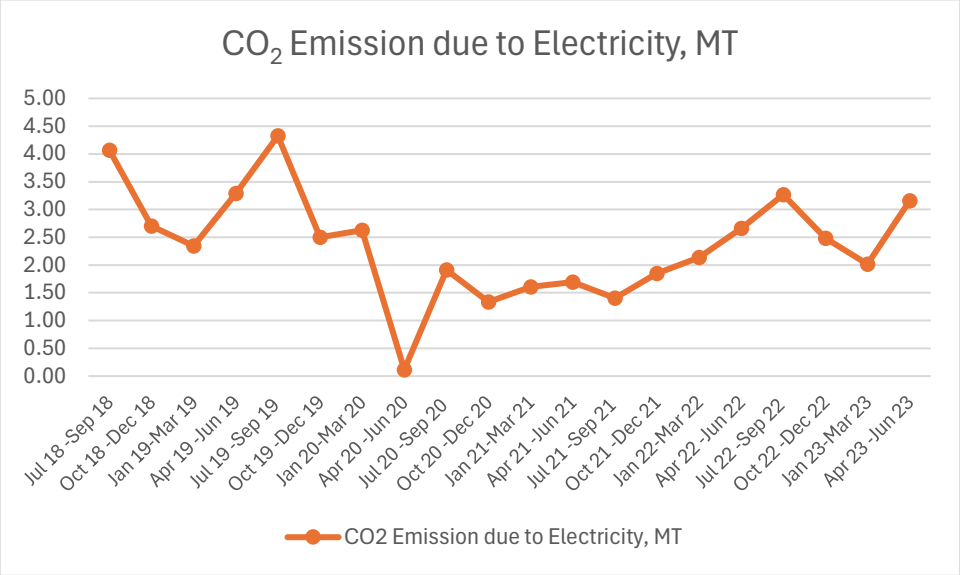
Based on the above Data we compute the CO_2 emissions which are being released into the atmosphere by the College due to its Day-to-Day operations.

Reference of Set values of CO_2 level:

- 350-1000 ppm: Typical level found in occupied spaces with good air exchange along with pure air.
- 1000-2000 ppm: Moderate level associated with complaints of drowsiness and poor air quality.
- 2000-5000 ppm: Critical level associated with headaches, sleepiness, and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may present.

6.3 Bill Period wise CO_2 Emissions:

Sr. No	Bill Period	Unit Consumption (KWh)	CO_2 Emission due to Electricity, MT
1.	Oct 18 -Dec 18	4845	4.07
2.	Jan 19-Mar 19	3213	2.70
3.	Apr 19 -Jun 19	2793	2.35
4.	Jul 19 -Sep 19	3917	3.29
5.	Oct 19 -Dec 19	5149	4.33
6.	Jan 20-Mar 20	2979	2.50
7.	Apr 20 -Jun 20	3128	2.63
8.	Jul 20 -Sep 20	138	0.12
9.	Oct 20 -Dec 20	2275	1.91
10.	Jan 21-Mar 21	1589	1.33
11.	Apr 21 -Jun 21	1912	1.61
12.	Jul 21 -Sep 21	2013	1.69
13.	Oct 21 -Dec 21	1671	1.40
14.	Jan 22-Mar 22	2199	1.85
15.	Apr 22 -Jun 22	2545	2.14
16.	Jul 22 -Sep 22	3168	2.66
17.	Oct 22 -Dec 22	3891	3.27
18.	Jan 23-Mar 23	2957	2.48
19.	Apr 23 -Jun 23	2402	2.02
20.	July 23- Aug 23	3760	3.16
Average per annum		11308.8	9.50



6.4 Calculation of Carbon Footprint at THLH Mahavidyalay with respect to electricity usage

The Carbon footprint calculation can be conducted based on the stage of calculation as stated in www.carbonfootprint.com, which is the sum of electricity usage per year.
The CO_2 emission from electricity
= (electricity usage per year in kWh/1000) x 0.84 metric tons

Notes:
Electricity usage per year = 11308.8 kWh
0.84 is the coefficient to convert kWh to metric tons.

6.5 Benchmarking: Now we compute the CO_2 emissions per sq ft basis as under:

Sl. No.	Parameter	Value	Unit
1.	Average annual CO_2 emissions	9.50	MT/annum
2.	College area	12078.8	Sq ft
3.	CO_2 emissions/sq ft	0.786	Kg of CO_2/sq ft

6.6 Ways to reduce Carbon Footprint

Understanding the carbon footprint can help limit the impact of your consumption on the environment. Small changes can make a big difference in the long run, for example when it comes to transportation, food, clothing, waste, etc. Here are some tips:

Food

- Consume local and seasonal products.
- Limit meat consumption, especially beef.
- Select fish from sustainable fishing.
- Bring reusable shopping bags and avoid products with excessive plastic packaging
- Make sure to buy only what you need, to avoid waste

Clothing

- Take good care of your clothes

- Try swapping, borrowing, renting or buying second-hand
- Buy responsibly-made clothes, e.g. made from recycled material or with an ecolabel

Transport

- Cycle or use public transport
- Be smart about when and how you drive

Energy and waste

- Turn down the heating by 1°, it will already make a difference
- Take short showers
- Turn off the water while you brush your teeth or clean the dishes
- Unplug your electronic equipment and don't leave your phone on charge when the battery is already full
- Select energy efficient products with an "A" label (EU Energy label)
- Limit and recycle your waste.

Best Practices followed in the Organization.

- Transformer, Generators and UPS are protected properly with fencing and kept awareness boards on 'Dangers' and 'Warnings'.
- Most of places, sign board of 'Switch ON' and 'Switch OFF' are kept towards saving energy measures to the stakeholders.
- Electrical wires, switch boxes and stabilizers are properly covered without any damage which will cause any problems to the staff and student members.
- Application has made for Installation roof top solar power plant.
- LED lights and Solar street lights are used.
- HVLS Fans are fitted in the auditorium.
- Water level controllers are used.
- Power factor is maintained near to unity with APFC.
- 5 stars based ACs.
- Replaced old generation computers and TVs with LED monitors.
- Use of few star rated equipment

S.No.	Requirements and checklists of the audit	Conformity		
		Yes	No	NA
1.	Have internal Energy audit procedures been developed and implemented in the Organization?	✓		
2.	Have programmes for the achievement of energy efficiency and conservation objectives been established and implemented as on today in the campus?	✓		
3.	Has a Management Representative, Electrical Engineer, Staff incharge been assigned for energy savings on power consumptions?	✓		
4.	Have programmes for the achievement of prescribed financial outlay for current bills for each building in the campus towards power consumptions?	✓		

5.	Has the organization ensured that personnel performing environmental specific tasks have the required knowledge on energy audit (e.g. education, training programme, seminar, workshop, camp, etc.)?	✓		
6.	Are objectives and targets documented towards energy audit periodically and any Register is made?			✓
7.	Any analysis of energy flows for energy conservation in terms of the amount of energy input into the system without negatively affecting the output in buildings	✓		
8.	Implications of alternative energy efficiency measures sufficient to satisfy the financial criteria of sophisticated investors	✓		
9.	Identification of the most efficient and cost-effective Energy Conservation Opportunities (ECOs) or Measures (ECMs) taken by the Management	✓		
10.	Are the following energy efficiency and conservation aspects considered in sufficient detail?			
	a. Fluorescent (tube) lights, Incandescent lamp and sodium vapour lights are replaced with CFL / LED	✓		
	b. Number of Uninterruptible power supply (UPS) and Power generators for power back-up to alternative current supply facility in each building		✓	
	c. Number of solar panels, solar lights, solar water heaters, electric water heater installed	✓		
	d. Automatic sprinkler system used for irrigation purpose		✓	
	e. Ultra-violet lights and any other harmful lights used with safety precautions			✓
	f. Attempt in reducing the energy expense and carbon footprint	✓		
	g. Disposal facility for hazardous arise from electrical gadgets, equipment and installation	✓		
	h. Renewable energy utilization (solar panel, wind mill)			✓
	i. Natural / Mechanical air ventilation at Indoor / Outdoor auditorium, stadium, seminar halls, etc.			✓
	j. Sign boards indicating Switch OFF / ON, Danger at Electrical equipment and Power transformers in the campus	✓		
11.	Signing of MoU with Govt. and NGOs to ensure about the energy conservation and efficiency in the campus	✓		
12.	Conduction of awareness programmes and outreach programmes on the energy conservation and efficiency	✓		

13.	The details of public transport, battery operated / electric vehicles, biofuel use, exhaust fans, boiling water system, chillers and geysers on energy savings mode			✓
14.	Projects and Dissertation works on the energy conservation and efficiency carried out by students and staff members		✓	
15.	Steps taken to take care of daylighting, AC machines heat emission and ecofriendly Refrigerators, etc.	✓		
16.	Use of water metering, IoT based energy efficiency practices, remote waterlines, automation of electrical fittings and gadgets to save energy		✓	
17.	Are all monitoring electrical equipment appropriately maintained and calibrated?			✓
18.	Are any energy conservation technologies and retrofit for energy conservation equipment being implemented?			✓
19.	Skylight roof ratio, fenestration plan and Daylight illuminance in building construction towards energy efficiency*	✓		
20.	Any Automatic Lighting Shutoff with occupancy Sensors and Timers, Exterior / Interior lighting control facility*		✓	
21.	Have any rooms and guest suites a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles*	✓		
22.	Total electricity usage divided by total campus' population (kWh per person)	✓		
23.	The ratio of renewable energy production divided by total energy usage per year	✓		
24.	Total carbon footprint divided by total campus' population (metric tons per person)	✓		
25.	Elements of green building implementation as reflected in all construction and renovation policies	✓		
26.	Greenhouse gas emission reduction awareness programme to the stakeholders	✓		

General Energy Conservation Tips

Electricity :

Schedule your operations to maintain a high load factor

Minimize maximum demand by tripping loads through a demand controller

Use standby electric generation equipment for on-peak high load periods.

Correct power factor to at least 0.99 under rated load conditions.

Set transformer taps to optimum settings.

Shut off unnecessary computers, printers, and copiers at night.

Motors :

- Properly size to the load for optimum efficiency.
- (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)

- Check alignment.
- Provide proper ventilation
- (For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- (An Imbalanced voltage can reduce 3 - 5% in motor input power)
- Demand efficiency restoration after motor rewinding.

Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed.

Pumps:

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller offices.
- Stop running both pumps -- add an auto-start for an on-line spare or add a
- booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

HVAC (Heating / Ventilation / Air Conditioning):

- Tune up the HVAC control system.
- Consider installing a building automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.
- Balance the system to minimize flows and reduce blower/fan/pump power requirements.
- Eliminate or reduce reheat whenever possible.
- Use appropriate HVAC thermostat setback.

- Use building thermal lag to minimize HVAC equipment operating time.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.
- Reduce HVAC system operating hours (e.g. -- night, weekend).
- Optimize ventilation.
- Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).
- Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
- Use evaporative cooling in dry climates.
- Clean HVAC office coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.
- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air-conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in high-bay areas.
- Relocate air diffusers to optimum heights in areas with high ceilings.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.
- Use professionally-designed industrial ventilation hoods for dust and vapor control.
- Use local infrared heat for personnel rather than heating the entire area.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
- Purchase only high-efficiency models for HVAC offices.
- Put HVAC window offices on timer control.
- Don't oversize cooling offices. (Oversized offices will "short cycle" which results in poor humidity control.)
- Install multi-fueling capability and run with the cheapest fuel available at the time.
- Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
- Minimize HVAC fan speeds.
- Consider desiccant drying of outside air to reduce cooling requirements in humid climates.
- Seal leaky HVAC ductwork.
- Seal all leaks around coils.

- Repair loose or damaged flexible connections (including those under air handling offices).
- Eliminate simultaneous heating and cooling during seasonal transition periods.
- Zone HVAC air and water systems to minimize energy use.
- Inspect, clean, lubricate, and adjust damper blades and linkages.
- Establish an HVAC efficiency-maintenance program. Start with an energy audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

Lighting:

- Reduce excessive illumination levels to standard levels using switching; de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapour lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high-pressure sodium, metal halide, fluorescent, mercury vapour, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider day lighting, sky lights, etc.
- Consider painting the walls a lighter colour and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED.

DG sets:

- Optimize loading
- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW Buildings
- Seal exterior cracks / openings / gaps with caulk, gasketing, weather stripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.

- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

Water & Wastewater:

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Eliminate once-through cooling with water.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blow down to minimize it.
- Provide proper tools for wash down -- especially self-closing nozzles.
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.
- Use the lowest possible hot water temperature.
- Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.
- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Use freeze protection valves rather than manual bleeding of lines.
- Consider leased and mobile water treatment systems, especially for deionized water.
- Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
- Install pre-treatment to reduce TOC and BOD surcharges.
- Verify the water meter readings. (You'd be amazed how long a meter reading can be estimated after the meter breaks or the meter pit fills with water!)
- Verify the sewer flows if the sewer bills are based on them

Miscellaneous :

- Meter any unmetered utilities to know what normal efficient use is. Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Consider buying utilities from neighbours, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high-pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

Recommendations for improving the energy efficiency and energy conservation in the Organization

The energy audit included suggestions for energy cost reduction, preventive maintenance and quality control activities, all of which are critical for utility operation in the audit sites.

- Procurement of equipment with energy efficiency (4-5 star rated equipment) during replacement may be considered.
- Sub meters in all the buildings for energy monitoring is recommended so that energy load required and energy consumption in each building may be noted.
- Optimal water usage and temperature settings may be used which are coming under automatic process towards energy savings.
- Continuous monitoring and analysis of energy consumption by dedicated team may be planned within the campus.
- Promoting ECON awareness and practice among the stakeholders may be conducted periodical through Association, Clubs, Forums and Chapters.
- Turn off electrical equipment when not in use
- Maintain appliances and replace old appliances in all laboratories.
- Use computers and electronic equipment in power saving mode.
- Installation of Biogas plant for hostel kitchen as well canteen.
- Automatic switches with occupancy sensors in common areas
- Monthly use of electricity in the College is very high which may be reduce to a greater extent by means of undertaking a periodical energy audit.
- There are fans of older generation and non-energy efficient which can be phase out by replacing with new energy efficient fans.
- Regular monitoring of equipment in all laboratories and immediate rectification of any problems.

- Value added / Non-formal / Certificate / Diploma course on 'Energy and Environment Management Audits' may be conducted for the benefit of students and research scholars to become a certified Lead Auditor.

Recommendations on Carbon Footprint in the Organization

- Establish a more efficient cooking system to save gas in hostel kitchen and canteen.
- More use of generators, inverters and UPS every day should be discouraged.
- Switch off the lights, fan, air conditioners, equipment and instruments when they are not in use.
- Large number of ventilation and exhaust systems may be placed in auditorium, seminar and conference halls to reduce the carbon dioxide level among the participating students, scholars and staff members.

Steps undertaken to amend the suggestions given in the previous Energy Audit Report

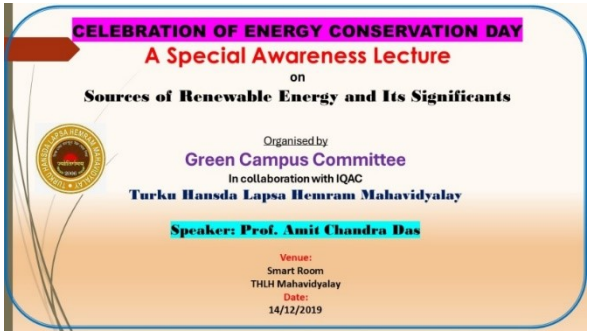
As per the previous internal Energy Audit report, the following steps were undertaken to amend the suggestions and recommendations.

Sl. No.	Suggestions made during the previous Energy Audit Report	Steps taken to amend the suggestions of the previous Energy Audit Report
1.	Suggested to install Roof top solar power plants and Solar water heaters	Applied for Installation Roof top solar power plants almost all buildings and Solar water heaters at Hostels
2.	Recommended to fit HVLS Fans and Exhaust fans in the auditorium and Indoor stadium for proper ventilation	HVLS Fans and Exhaust fans are fitted in the auditorium and Indoor stadium for proper ventilation to the stakeholders for maintaining a proper ecosystem and energy conservation strategies
3.	Suggested to protect all Transformer, Generators and UPS with fencing and keep the awareness boards and safety signs on 'Dangers' and 'Warnings, etc.	Transformer, Generators and UPS are protected properly with fencing and kept awareness boards and safety signs on 'Dangers' and 'Warnings for safety purpose and to draw the attention about safety intervention.
4.	Advised to cover Electrical wires, switch boxes, inverters, and stabilizers not to cause any problem to the staff and student members	Electrical wires, switch boxes, inverters, and stabilizers are properly covered without any damage not to cause any problem to the staff and student members in the campus.
5.	Advised to replace old generation computers and TVs with LED monitors and old incandescent (tungsten) bulbs with LED lights and install automatic street solar lights.	Replaced old generation computers and TVs with LED monitors, most of the places, old incandescent (tungsten) bulb uses with LED lights and installed automatic street solar lights in the campus which indicated the positive indication on energy savings.
6.	Instructed to replace Overhead Projectors with LCD projectors to reduce the power consumption.	Replaced Overhead Projectors with LCD projectors for the effective power consumption and management.

Energy related Seminars and Programme

Sl. No	Name of the Programme	Date	Speaker	Purpose/Outcome
1.	World Energy Conservation Day	14/12/2018	Prof. Chandan Mandal, Department of Bengali	
2.	"Source of Renewable Energy and Its Significant"	14/12/2019	Prof. Amit Chandra Das, Department of Physics	
3.	"Unplug for the Planet"	14/12/2022	Prof. Dipankar Sinha & Prof. Sujay Das, Department of Geography	

"Source of Renewable Energy and Its Significant"
14/12/2019



Programme Banner | Lecture by Amit Chandra Das

7. Conclusions

Considering the fact that the organization is a well-established, long time run establishment with good reputation, there is significant scope for conserving energy and make the campus as self-sustained in it. The energy conservation initiatives taken up by the institution are substantial. Energy efficient lighting schemes, awareness created among stakeholders and necessary power backups are being practiced by the institution. There are some best Practices followed on Energy Audit in the Organization like Transformers, Generators and UPS are protected properly with fencing and kept awareness boards on 'Dangers' and 'Warnings'. It is observed that the most of places, sign board of 'Switch ON' and 'Switch OFF' are kept towards saving energy measures to the stakeholders. Electrical wires, switch boxes and stabilizers are properly covered without any damage which will cause any problems to the staff and student members. Adaptation of sprinkler irrigation in the campus to minimize the energy potential are well appreciated. Few recommendations, in addition, can further improve the energy savings of the Organization. This may lead to the prosperous future in context of Energy Efficiency Campus and thus sustainable environment and community development to the stakeholders in coming years to come.

Dr. Tapan Kr. Parichha,
Principal,
Suri Vidyasagar College
Suri, Birbhum

Principal
Suri Vidyasagar College
Suri, Birbhum, PIN-731101

Dr. Suman Mukherjee
Teacher-In-Charge,
THLH Mahavidyalay,
Mallarpur

Dr Suman Mukherjee
Teacher-in-Charge
Turku Hansda Lapsa Hemram Mahavidyalay
Mallarpur, Birbhum-731216

Dr. Bibhas Dutta,
Associate Professor, Department of Physics,
Labpur Sambhunath College

Dr. Bibhas Dutta
Associate Professor, Dept. of Physics
Sambhunath College, Labpur, Birbhum

TURKU HANSDA LAPSA HEMRAM MAHAVIDYALAY
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