Energy Audit of Jalpaiguri Government Engineering College Campus

Final Report

4th Year B. Tech Students of

Department Of Electrical Engineering

Jalpaiguri Government Engineering College

Danguajhar, Jalpaiguri – 735102

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This report has been prepared by

With the support and cooperation of the Final year students of the Department of Electrical Engineering.

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PREFACE:

An energy audit is a study of a plant or facility to determine how and where energy is used and to identify methods for energy savings. It includes process or system that will reduce the amount of energy input into the system without negatively affecting the output. There is now a universal recognition of the fact that new technologies and much greater use of some that already exist provide the most hopeful prospects for the future. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options.

This energy audit of the Jalpaiguri Government Engineering College Campus was carried out by the final year students (B. Tech) of the Department of Electrical Engineering. This report is just one step, a mere mile marker towards our destination of achieving energy efficiency and we would like to emphasise that an energy audit is a continuous process. We have compiled a list of possible actions to conserve and efficiently utilize our scarce resources and identified their savings potential. The next step would be to prioritize their implementation.

We look forward with optimism that the institute authorities, staff and students shall ensure the maximum execution of the recommendations and the success of this work.

INTRODUCTION:

This Energy Audit Report aims at making the campus of Jalpaiguri Government Engineering College more energy efficient. The entire campus includes the main college building, the canteens, hostels, workshops, auditorium, and the Quarters. The main college building consists of appliances that contribute to a chunk of energy consumption that can be minimized with the adaptation of efficient methodologies. Also, the hostels contribute to huge consumption of electrical energy that can be minimized with the efficient use of modern energy-saving electrical appliances that include low-watt consuming LEDs and energy-efficient fans.

Jalpaiguri Government Engineering College's energy bill keeps up at around INR 400000(per month). This amount is huge and thus naturally is large enough and thus naturally attracts attention when we understand that quite a lot of energy is being wasted, which in turn would mean that a huge number of financial resources are being wasted.

Making the college main building and hostel area energy efficient as they constitute a majority of the energy consumption on the college campus will not only help the institute reduce its expenses but also will help us fulfil our moral responsibility of not wasting this precious resource, which is scarcely available to rest of the people of the country.

This would act as a prototype project, the lessons learnt here can be put to practice in the future as we progress and move to other parts of the campus.

We are confident that the schemes that are being suggested in this report, when put to work are bound to be beneficial to the college as they would serve as the stepping stone toward making an energy-efficient campus.

Overview of College Campus:

The entire college campus can be divided into two broad sections.

- *The College Main Building.*
- *Rest of the College Campus.*

The College Main Building:

The College Main Building contributes to the major consumption of energy and is the main area of concern where the analysis and later measures need to be applied. The College Main Building consists of six engineering departments and three basic science departments along with Humanities.

The six engineering departments include:

- *Department of Electrical Engineering.*
- *Department of Mechanical Engineering.*
- *Department of Computer Science and Engineering.*
- *Department of Civil Engineering.*
- *Department of Electronics and Communication Engineering.*
- *Department of Information Technology.*

The other departments include:

- *Department of Mathematics.*
- *Department of Physics.*
- *Department of Chemistry.*
- *Department of Humanities.*

Rest of the College Campus:

The Rest of the College Campus consists of:

- *Hostels.*
- *Workshops.*
- *Quarters.*
- *Canteens.*
- *Auditorium.*
- *Street lighting.*

Scheme of Calculation:

The entire process of preparing the report involves the following steps:

- *Data Collection.*
- *Data Preparation.*
- *Data Visualization.*
- *Report Preparation.*

Before moving onto the various steps of preparing the report let us look at the two most used terms in the report on the basis of which the entire data has been collected and prepared and on the basis of which the calculations are made.

There are three terms:

- *Static Load*
- *Dynamic Load*
- *Consumption Factor.*

Let us see the above terms one by one:

Static Load: It is the actual quantity of load that has been placed, without considering the actual duration for which the appliances run. It is the total kw value which is actually the sum of ratings of the appliances. (Total wattage/1000 = equivalent kw).

Dynamic Load: It is the actual amount of loaf that consumes power, irrespective of the total load connected in the building or a certain area. The Dynamic load is always less than the Static load.

Consumption Factor: It gives the relation between the static load and the dynamic load.

Consumption Factor = Dynamic Load/Static Load

Consumption Factor is always less than 1. Calculations reveal the value of consumption factor is about 0.82-0.85.

The report focuses on the calculation of static load and preparing data for calculation and visualization and later finding the Consumption Factor and use it to find out the dynamic load.

For calculating the kwh value, a time duration has been considered for the College main building. It is assumed to be working from 11:00 AM to 18:00 PM. For street lights a greater duration is considered. It is taken from 18:00 PM to 6:00 AM.

Before describing the various steps involved in making of the report, all the steps are primarily applied on the College Main Building as it contributes to the main area of consumption and the others include the Hostels, Auditorium and Workshops. Rest are lumped based on the Monthly Consumption obtained from College Authorities.

The various process involved in making the report are:

1) *Data Collection*: This is the first step which involves collecting the number and ratings of different appliances in the campus area. The loads have been divided mainly into 4 parts; they are:
    - *Fans*
    - *Lights (Both tube lights and incandescent bulbs) • Air Conditioners.*
    - *Computers.*
    - *Printers.*

The static load is being collected and are later tabulated. The process of data collection has been done first on the 'The College Main Building' and then on the 'Rest of the College Campus'. The aim of collecting the Static load is that it gives us the actual value of maximum value of the load, which in a hypothetical case may be drawn when all the appliances are running for the defined time period. The data has been collected per department per room wise for the College Main Building, Corridors for College Main building and per room for hostels, workshops and auditorium.

2) *Data Preparation:* This step involves the cleaning of the collected data and then tabulating them in order to make them ready for further analysis and data visualization. The data has been tabulated for each department as per fan, light (main loads), AC, Computers and Printers. The ratings have been taken in watt of each load and their quantity has also been tabulated in order to obtain the total kw.
3) *Data Visualization:* This step involves one of the most important steps in the report where the tabulated data is being made to convert into graphical plots. This

step involves the transformation of the raw cleaned data into a visual output which enables us to get the actual picture of the static load in a more easy, engaging manner which turns out be lucrative.

4) *Report Preparation:* Finally, the entire collected data and the plots obtained from those data is put to shape in in order to obtain a fruitful output. Calculations are made on the data and the graphs are placed in proper place and order to fulfil the aim of the report and give a pretty clear picture of the energy consumption in the campus and from the final vivid view of the analysis done, measures are suggested to reduce the consumption and make the campus an energy efficient campus.

Determination of Static Load & Visualization:

In this section, we determine the static load of each department including the other portions of the campus that contribute to large quantity of power consumption. The consumption is mainly based on the loads that include: fans, lights, ACs, computers and printers. First, the light and the fan loads are being shown as they contribute the maximum consumption of power in the campus followed by ACs, computers and printers. As mentioned before, our main area of concern is the College Main Building as it consumes the maximum quantity of power.

The readings and the plots have been in a chronological manner. It starts with the departments. The readings for the departments have been shown room-wise. Then it follows the common area which includes other rooms other than the departmental classrooms, teacher's room, labs and corridor related to respective departments.

Then comes the hostel area, which again consumes a large power. Finally, the total load of each department, common area, hostel area, gym, auditorium and the street lighting are shown.

The ACs, computers and printers are only in the College Main Building, so they are shown as last. The scheme of representing the AC, Computer and Printers is done on Department basis and on the rooms based under common area.

We start with fan and light loads and in an order mentioned above followed by AC, Computers and Printers.

The fan and light loads are shown in the same graph. For visualization purpose bar graph is used with Y-axis representing *Power Consumption in Watts* and X-axis an abstract object.

Determination of Fan and Light Loads:

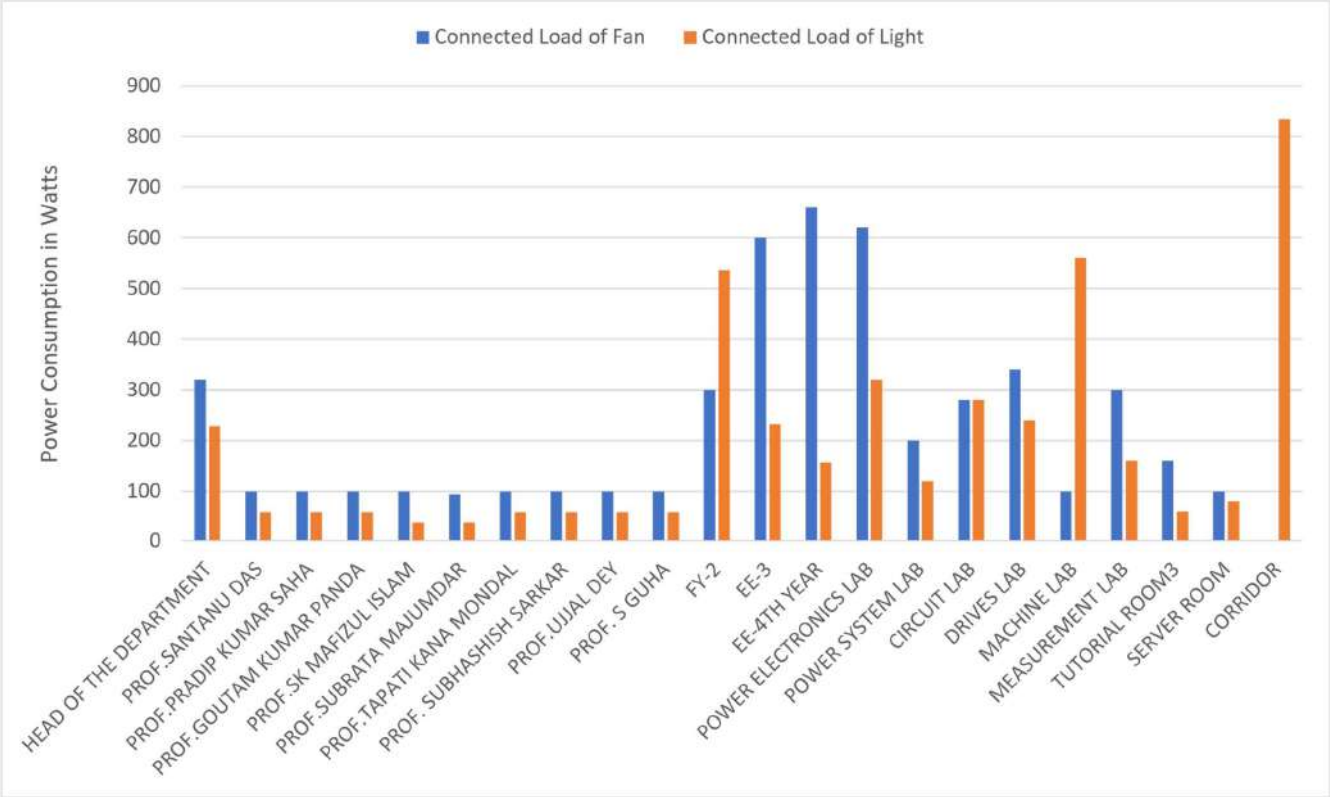
1. Department of Electrical Engineering.

Tabular Data Representation:

ROOM	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT (W)
HEAD OF THE DEPARTMENT	320	228
PROF.SANTANU DAS	100	58
PROF.PRADIP KUMAR SAHA	100	58
PROF.GOUTAM KUMAR PANDA	100	58
PROF.SK MAFIZUL ISLAM	100	38
PROF.SUBRATA MAJUMDAR	93	38
PROF.TAPATI KANA MONDAL	100	58
PROF. SUBHASHISH SARKAR	100	58
PROF.UJJAL DEY	100	58
PROF. S GUHA	100	58
FY-2	300	536
EE-3	600	232
EE-4TH YEAR	660	156
POWER ELECTRONICS LAB	620	320
POWER SYSTEM LAB	200	120

CIRCUIT LAB	280	280
DRIVES LAB	340	240
MACHINE LAB	100	560
MEASUREMENT LAB	300	160
TUTORIAL ROOM3	160	60
SERVER ROOM	100	80
CORRIDOR	---	834
TOTAL	4873	4288

Data Visualization using Bar Plots

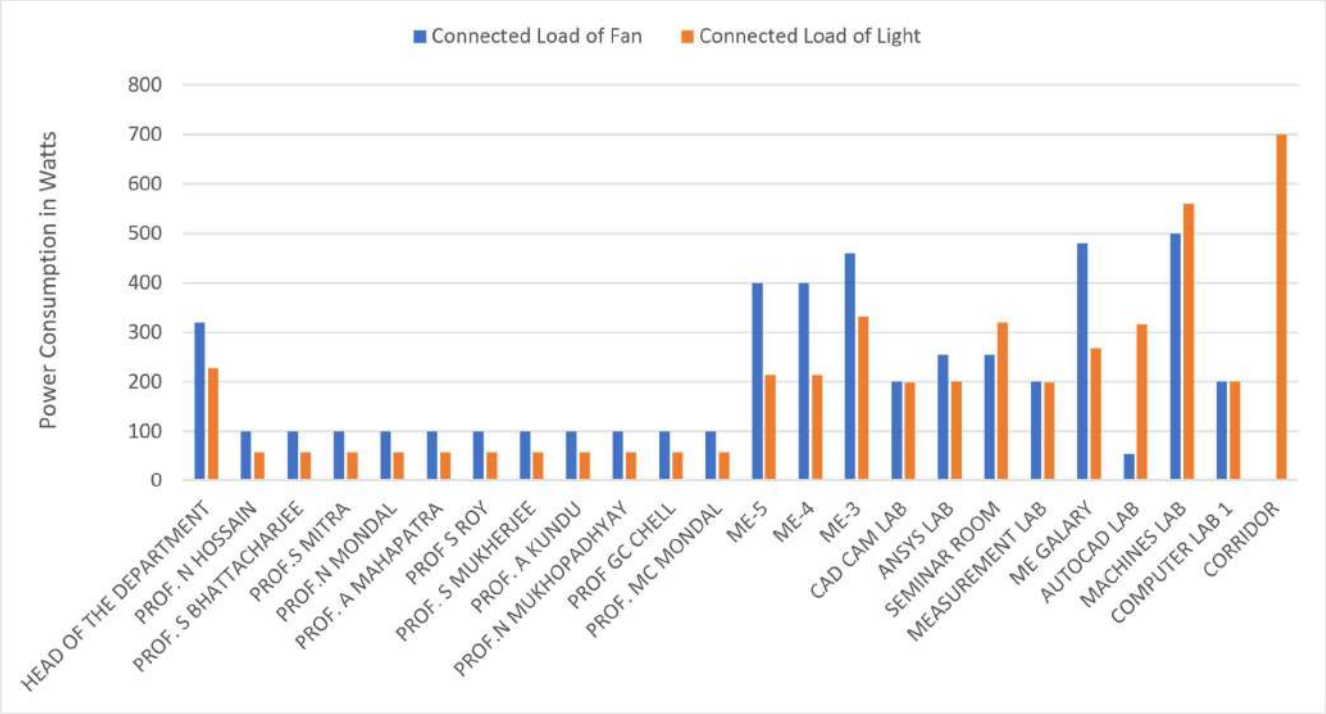


2. Department of Mechanical Engineering.

Tabular Data Representation:

ROOM	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT (W)
HEAD OF THE DEPARTMENT	320	228
PROF. N HOSSAIN	100	58
PROF. S BHATTACHARJEE	100	58
PROF.S MITRA	100	58
PROF.N MONDAL	100	58
PROF. A MAHAPATRA	100	58
PROF S ROY	100	58
PROF. S MUKHERJEE	100	58
PROF. A KUNDU	100	58
PROF.N MUKHOPADHYAY	100	58
PROF GC CHELL	100	58
PROF. MC MONDAL	100	58
ME-5	400	214
ME-4	400	214
ME-3	460	332
CAD CAM LAB	200	198
ANSYS LAB	255	200
SEMINAR ROOM	255	320
MEASUREMENT LAB	200	198
ME GALARY	480	268
AUTOCAD LAB	55	316
MACHINES LAB	500	560
COMPUTER LAB 1	200	200
CORRIDOR	--	700
TOTAL	4505	4586

Data Visualization using Bar Plots



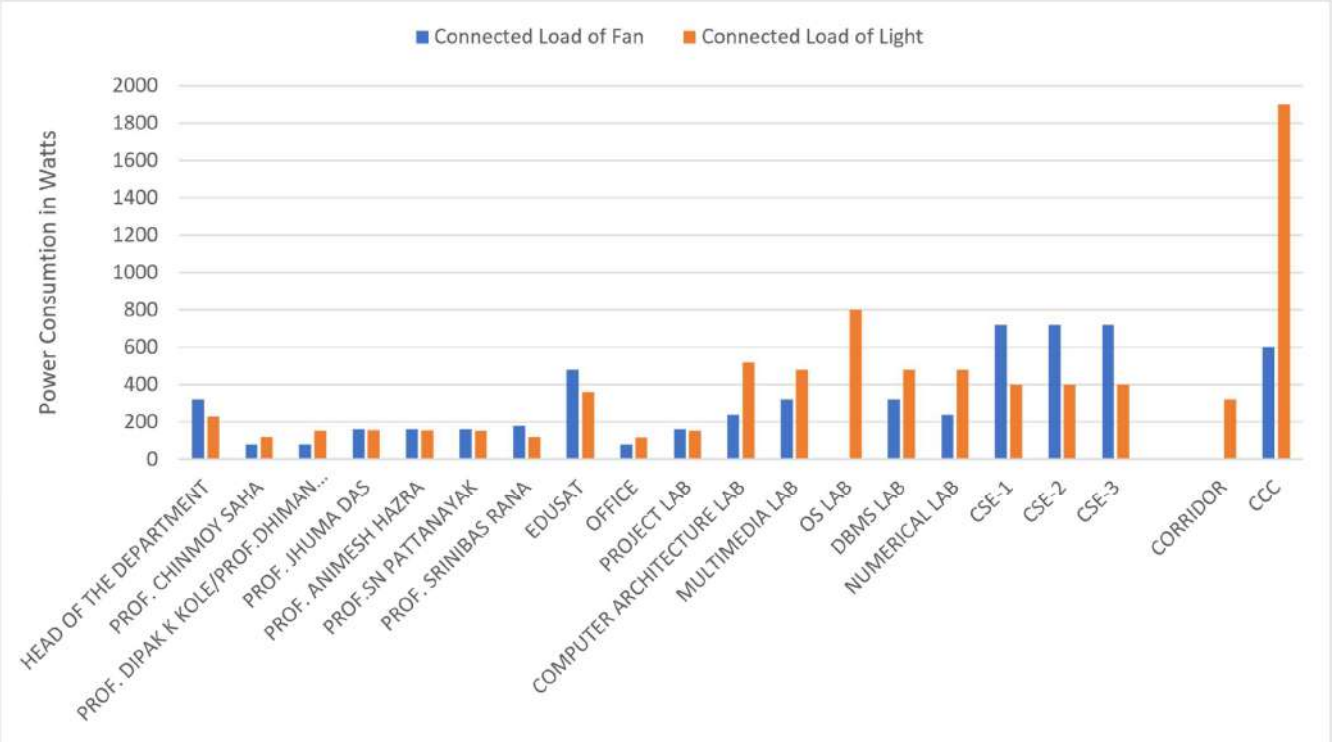
3. Department of Computer Science and Engineering

Tabular Data Representation

ROOM	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT (W)
HEAD OF THE DEPARTMENT	320	228
PROF. CHINMOY SAHA	80	118
PROF. DIPAK K KOLE/PROF.DHIMAN MONDAL	80	152
PROF. JHUMA DAS	160	156
PROF. ANIMESH HAZRA	160	154
PROF.SN PATTANAYAK	160	152
PROF. SRINIBAS RANA	180	118
EDUSAT	480	360
OFFICE	80	116
PROJECT LAB	160	152
COMPUTER ARCHITECTURE LAB	240	520
MULTIMEDIA LAB	320	480
OS LAB	--	800
DBMS LAB	320	480
NUMERICAL LAB	240	480
CSE-1	720	400
CSE-2	720	400
CSE-3	720	400
CORRIDOR	--	320
CCC	600	1900

TOTAL	5740	7886

Data Visualization using Bar Plots

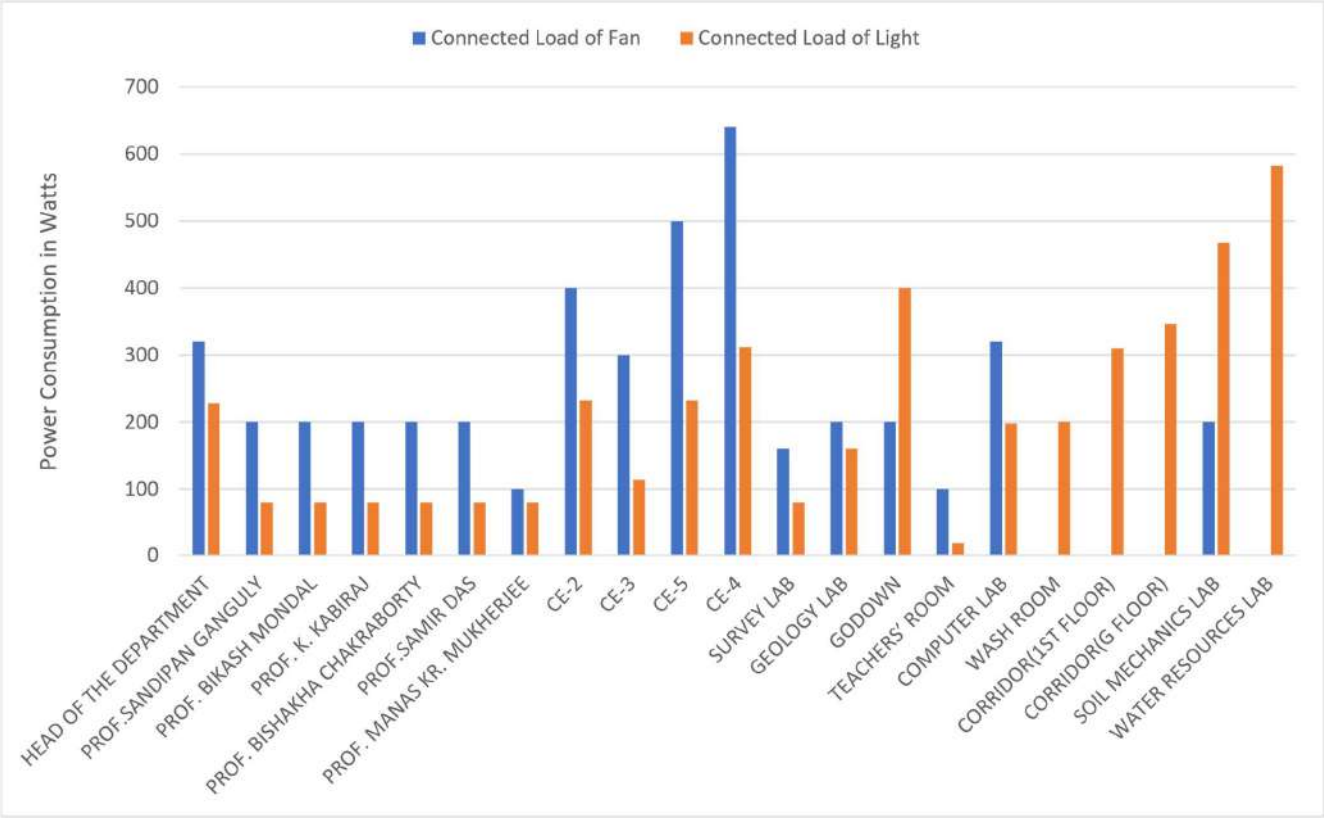


4. Department of Civil Engineering

Tabular Data Representation

ROOM	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT (W)
HEAD OF THE DEPARTMENT	320	228
PROF.SANDIPAN GANGULY	200	80
PROF. BIKASH MONDAL	200	80
PROF. K. KABIRAJ	200	80
PROF. BISHAKHA CHAKRABORTY	200	80
PROF.SAMIR DAS	200	80
PROF. MANAS KR. MUKHERJEE	100	80
CE-2	400	232
CE-3	300	114
CE-5	500	232
CE-4	640	312
SURVEY LAB	160	80
GEOLOGY LAB	200	160
GODOWN	200	400
TEACHERS' ROOM	100	20
COMPUTER LAB	320	198
WASH ROOM	--	200
CORRIDOR (1ST FLOOR)		310
CORRIDOR (G FLOOR)		346
SOIL MECHANICS LAB	200	468
WATER RESOURCES LAB	--	582
TOTAL	4400	4362

Data Visualization using Bar Plots

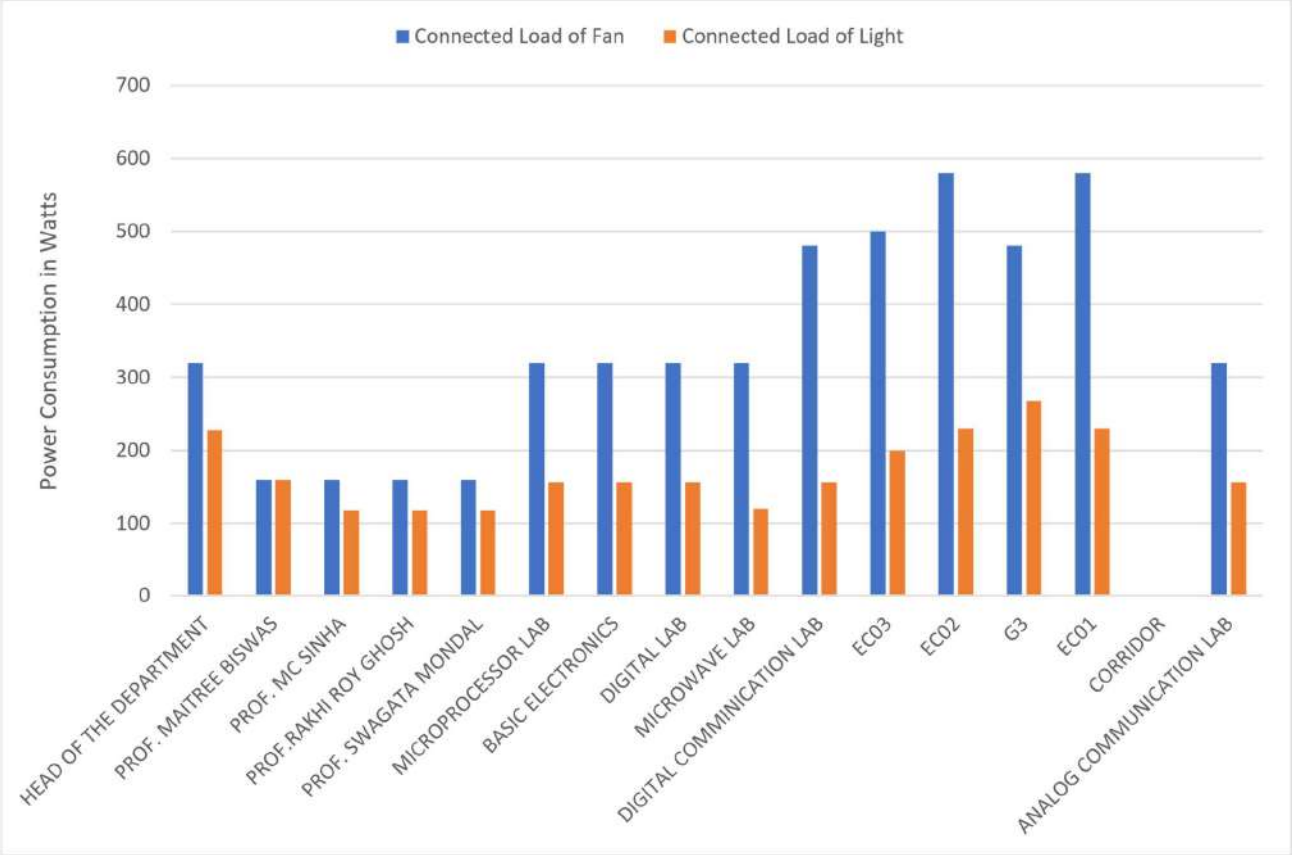


5. Department of Electronics and Communication Engineering

Tabular Representation of Data

ROOM	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT (W)
HEAD OF THE DEPARTMENT	320	228
PROF. MAITREE BISWAS	160	160
PROF. MC SINHA	160	118
PROF.RAKHI ROY GHOSH	160	118
PROF. SWAGATA MONDAL	160	118
MICROPROCESSOR LAB	320	156
BASIC ELECTRONICS	320	156
DIGITAL LAB	320	156
MICROWAVE LAB	320	120
DIGITAL COMMINICATION LAB	480	156
EC03	500	200
EC02	580	230
G3	480	268
EC01	580	230
CORRIDOR	--	--
ANALOG COMMUNICATION LAB	320	156
TOTAL	5180	2570

Data Visualization using Bar Plots

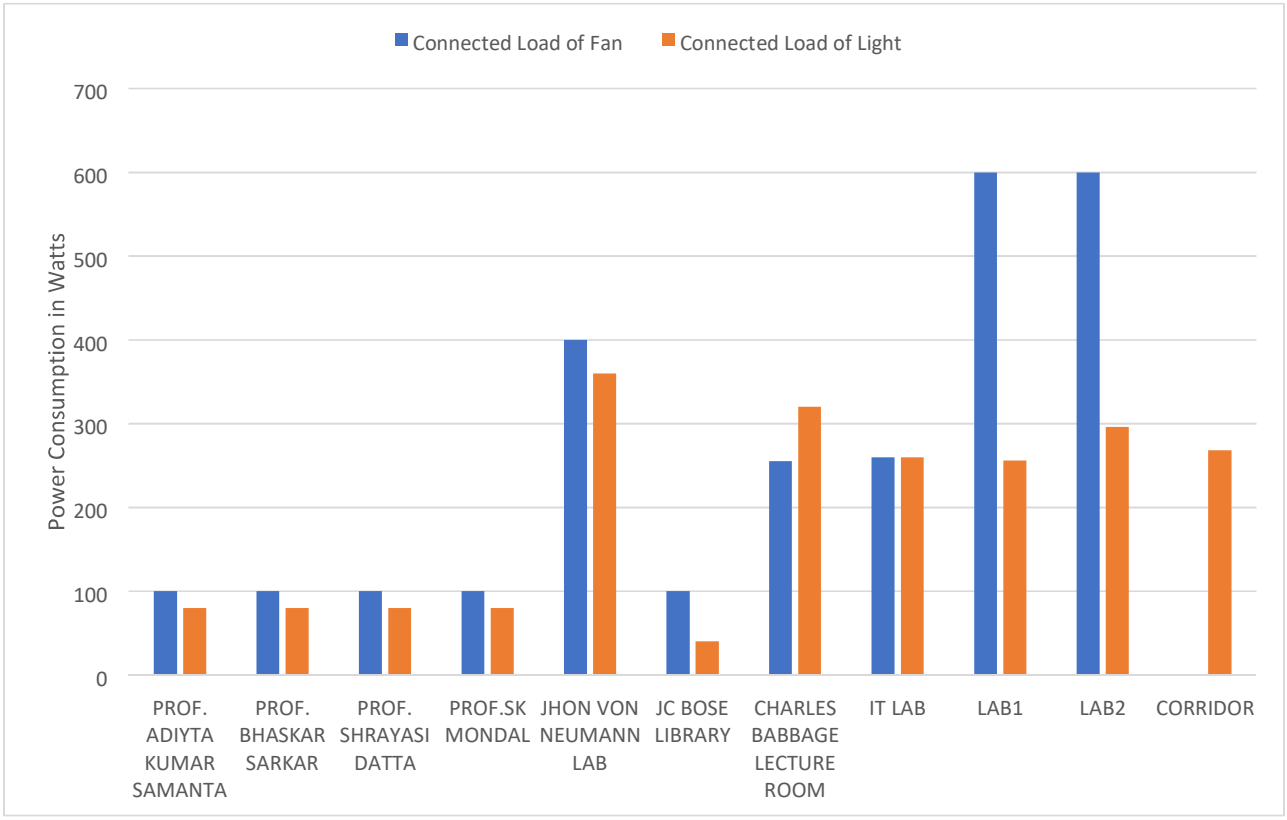


6. Department of Information Technology.

Tabular Representation of Data

ROOM	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT (W)
PROF. ADIYTA KUMAR SAMANTA	100	80
PROF. BHASKAR SARKAR	100	80
PROF. SHRAYASI DATTA	100	80
PROF.SK MONDAL	100	80
JHON VON NEUMANN LAB	400	360
JC BOSE LIBRARY	100	40
CHARLES BABBAGE LECTURE ROOM	255	320
IT LAB	260	260
LAB1	600	256
LAB2	600	296
CORRIDOR	---	268
TOTAL	2615	2120

Data Visualization with Bar Plots

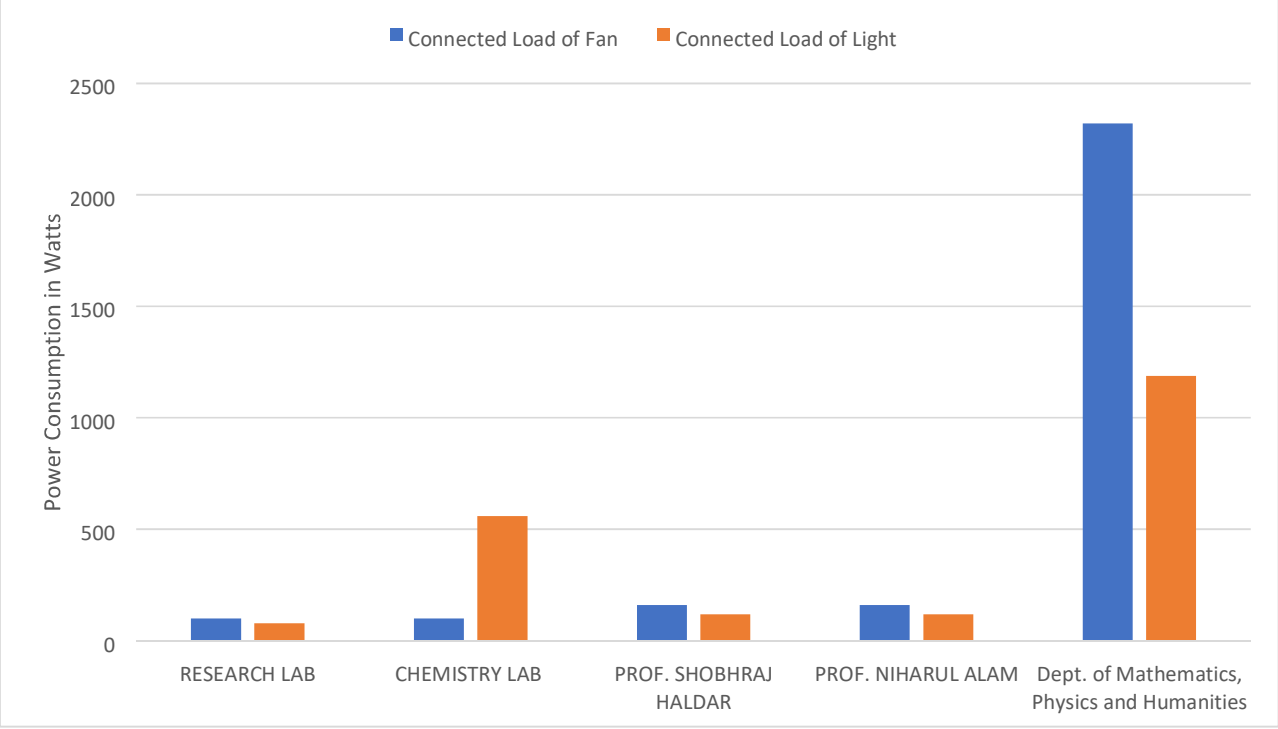


7. Department of Mathematics, Physics, Chemistry and Humanities.

Tabular Representation of Data

ROOM	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT (W)
RESEARCH LAB	100	78
CHEMISTRY LAB PROF. SHOBHRAJ HALDAR	100	560
PROF. NIHARUL ALAM	160	118
Dept. of Mathematics, Physics and Humanities	160	118
	2320	1188

Data Visualization using Bar Plots

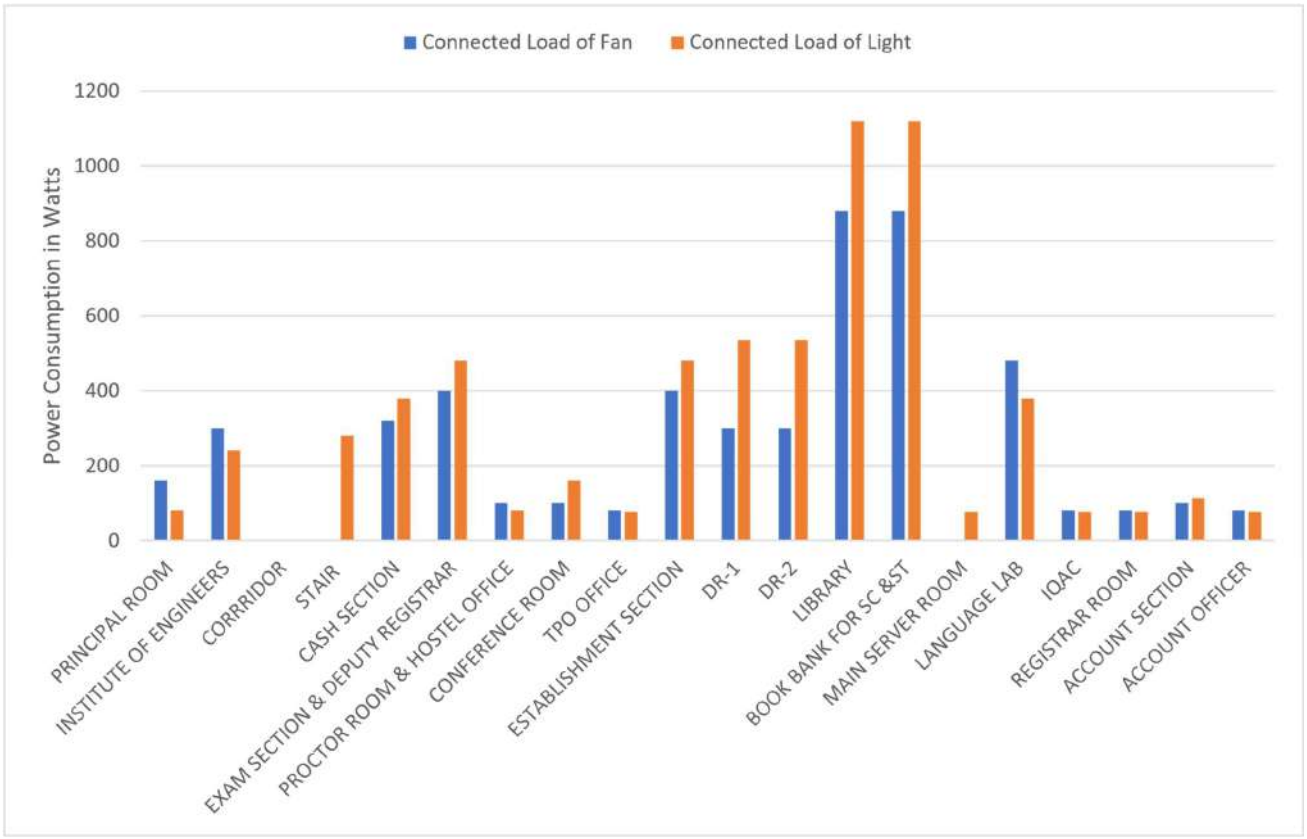


8. Common Area

Tabular Data Representation

AREA	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT(W)
PRINCIPAL ROOM	160	80
INSTITUTE OF ENGINEERS	300	240
CORRRIDOR	---	
STAIR	---	280
CASH SECTION	320	380
EXAM SECTION & DEPUTY REGISTRAR	400	480
PROCTOR ROOM & HOSTEL OFFICE	100	80
CONFERENCE ROOM	100	160
TPO OFFICE	80	76
ESTABLISHMENT SECTION	400	480
DR-1	300	536
DR-2	300	536
LIBRARY	880	1120
BOOK BANK FOR SC &ST	880	1120
MAIN SERVER ROOM	--	76
LANGUAGE LAB	480	380
IQAC	80	76
REGISTRAR ROOM	80	76
ACCOUNT SECTION	100	114
ACCOUNT OFFICER	80	76
TOTAL	5040	6366

Data Visualization using Bar Plots



9. Hostels

Tabular Representation of Data

HOSTEL	CONNCTED LOAD OF FAN(W)	CONNCTED LOAD OF LIGHT(W)
BH-1	13350	6440
BH-2	11000	4800
BH-3	8470	6600
BH-4	10980	7120
LH	3850	6600
TOTAL	47650	31560

BH-1: Boys' Hostel 1

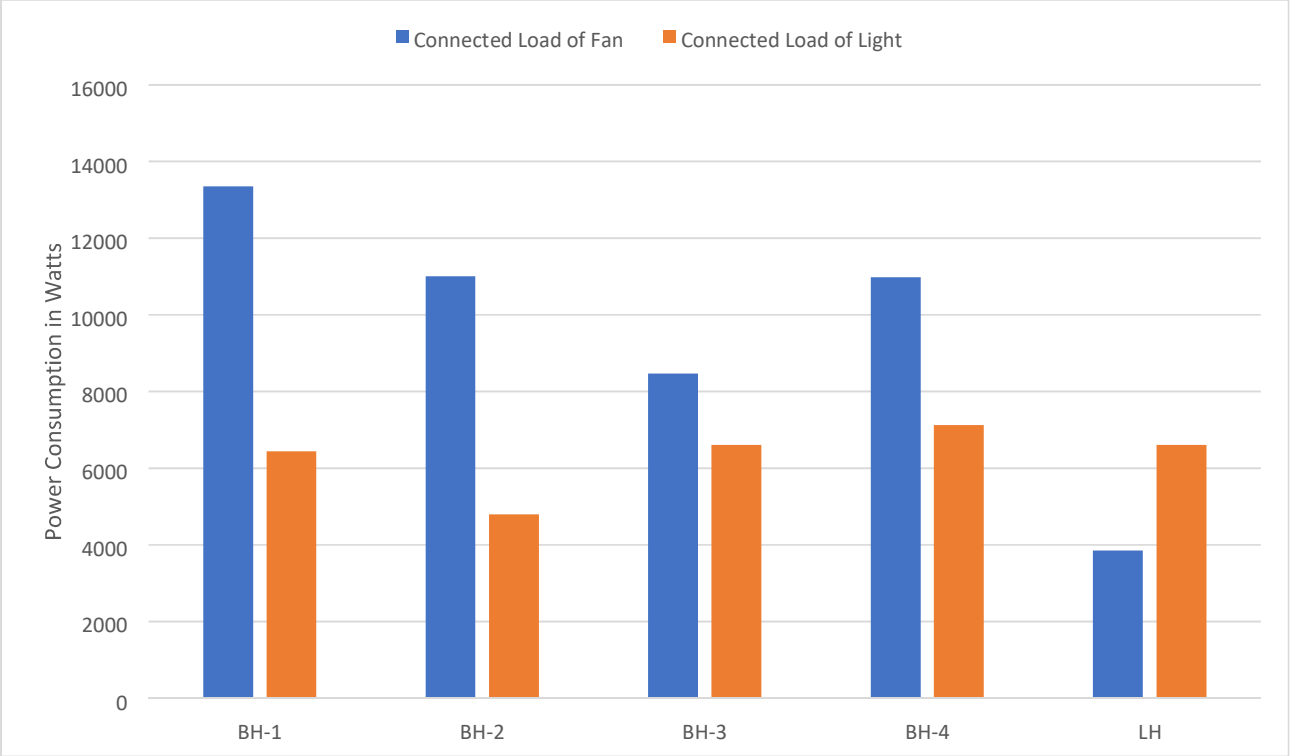
BH-2: Boys' Hostel 2

BH-3: Boys' Hostel 3

BH-4: Boys' Hostel 4 LH:

Ladies Hostel

Data Visualization using Bar Plots



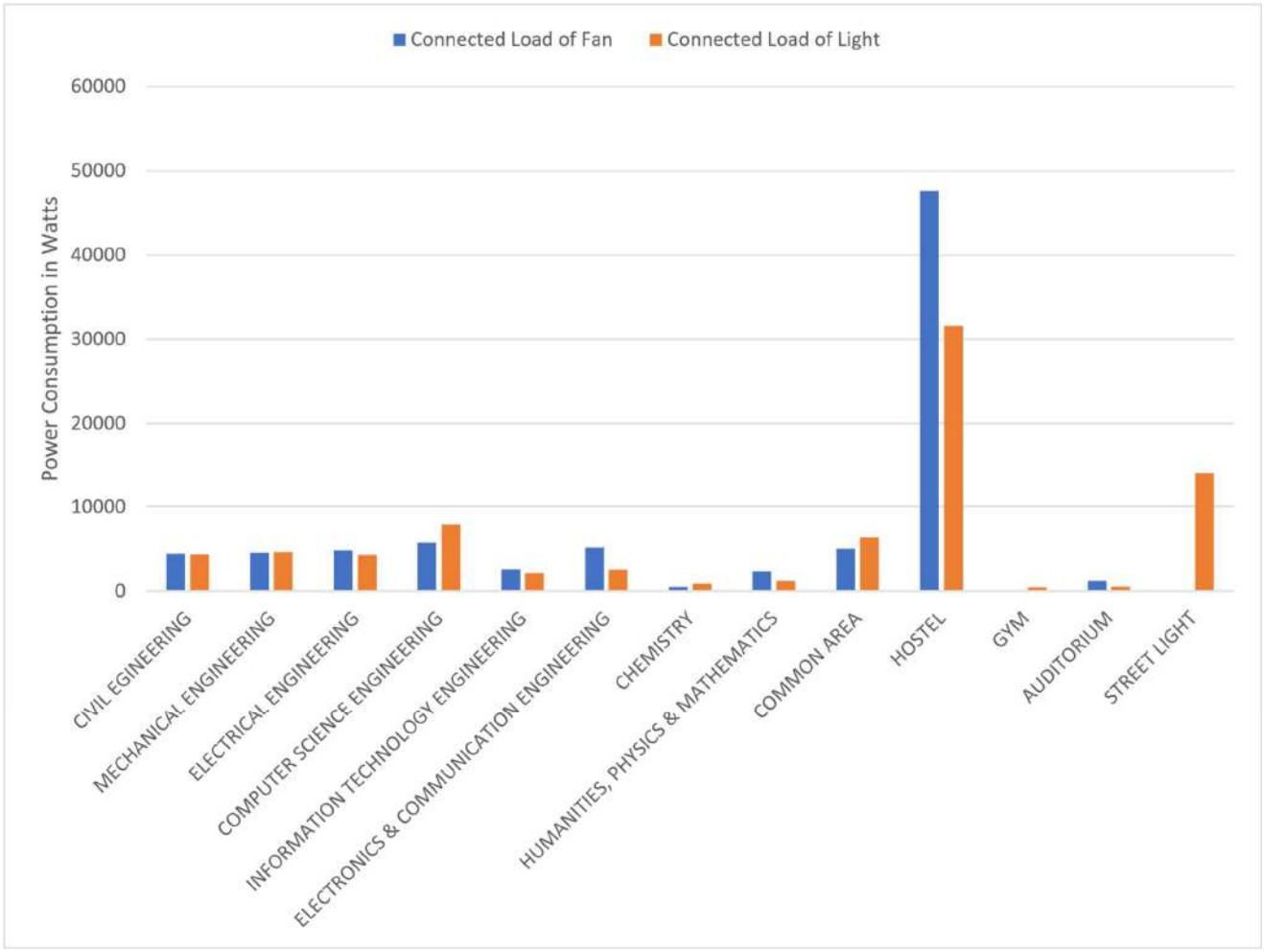
In the above tables and graphs all the departments of the College have been shown. Also, the Common Area places are shown which include Principal's Room, Accounts' Section, Cash Section, Institute of Engineers, Examination Section, Library, etc. The Common Area is chosen separately under a entire differently block to distinguish the administrative part of the college campus and their related connected load. The departments have been shown room-wise to give a pretty clear picture of the connected load. The other part that contributes to a large power consumption are the Hostels. The four Boys' Hostel and one Ladies Hostel are shown hostel wise with their total fan and light loading. As the majority of the load is being contributed by the fan and light load, so the above graphs show the static load of fan and light load. In the following section the total consumption of fan and light load will be shown. The later part will show the connected loads of ACs, computers and printers.

10. Total Fan and Light Load in the Campus.

Tabular Representation

DEPARTMENT OR PLACE	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT(W)
CIVIL EGINEERING	4400	4362
MECHANICAL ENGINEERING	4505	4586
ELECTRICAL ENGINEERING	4873	4288
COMPUTER SCIENCE ENGINEERING	5740	7886
INFORMATION TECHNOLOGY ENGINEERING	2615	2120
ELECTRONICS & COMMUNICATION ENGINEERING	5180	2570
CHEMISTRY	520	874
HUMANITIES, PHYSICS & MATHEMATICS	2320	1180
COMMON AREA	5040	6366
HOSTEL	47650	31560
GYM	--	480
AUDITORIUM	1200	560
STREET LIGHT	---	14110
TOTAL	84043	80942

Data Visualization using Bar Plots

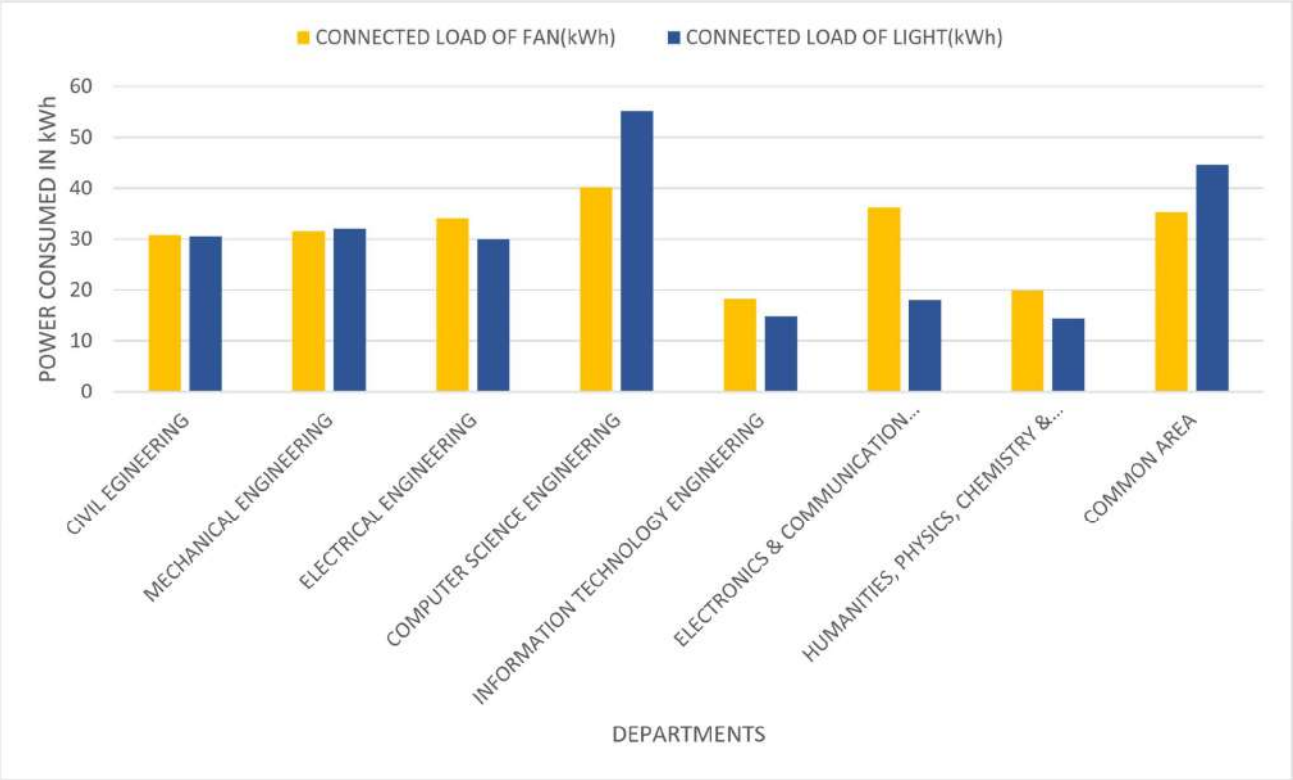


Total Fan and Light Load along with kWh.

DEPARTMENT OR PLACE	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT(W)	CONNECTED LOAD OF FAN (kWh)	CONNECTED LOAD OF LIGHT (kWh)
CIVIL EGINEERING	4400	4362	30.8	30.534
MECHANICAL ENGINEERING	4505	4586	31.535	32.102
ELECTRICAL ENGINEERING	4873	4288	34.111	30.016
COMPUTER SCIENCE ENGINEERING	5740	7886	40.18	55.202
INFORMATION TECHNOLOGY ENGINEERING	2615	2120	18.305	14.84
ELECTRONICS & COMMUNICATION ENGINEERING	5180	2570	36.26	17.99
HUMANITIES, PHYSICS, CHEMISTRY & MATHEMATICS	2840	2054	19.88	14.378
COMMON AREA	5040	6366	35.28	44.562

Loads are considered on for 7 hours

Data Visualization using Bar Plots for kWh:



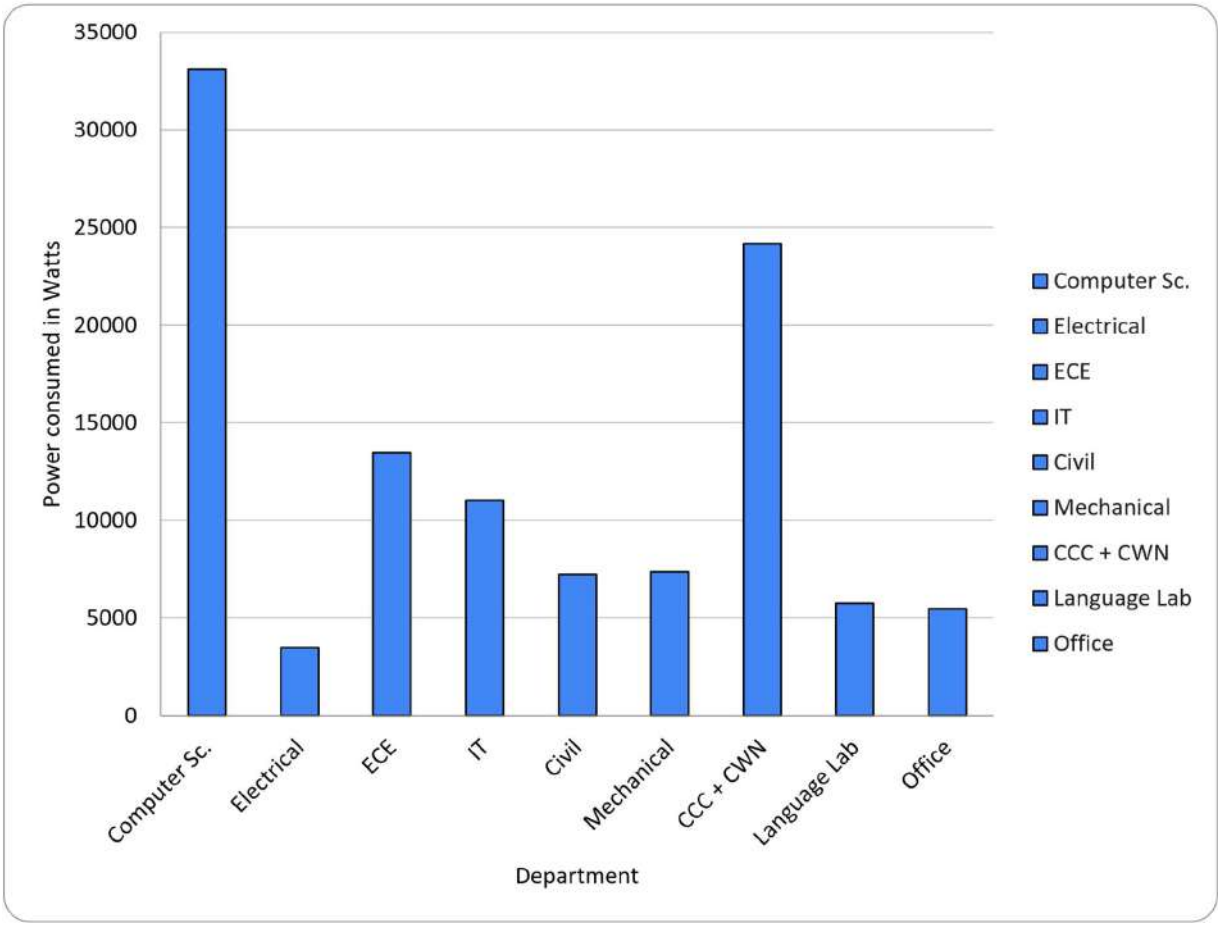
Determination of Air Conditioner, Computers & Printers Load:

AC Loads:

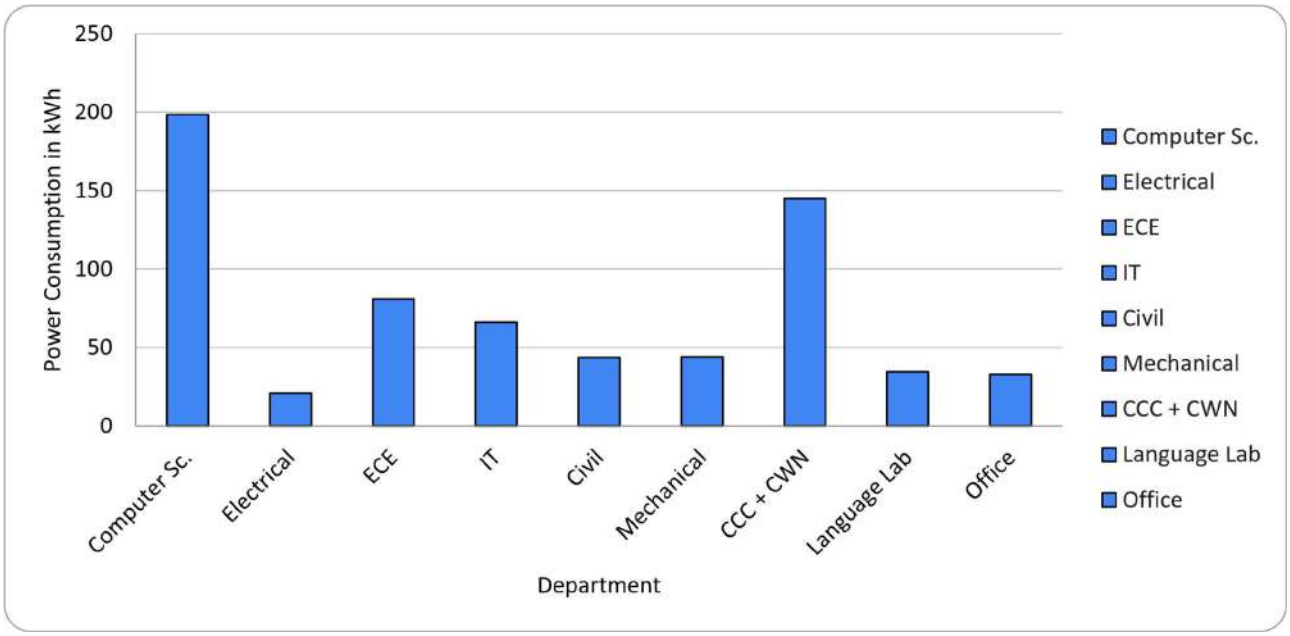
The AC loads have been shown department wise and also for specific rooms where there are ACs. The graphs of the connected load i.e., the static load in shown as well as the static energy consumption is also shown considering the time duration of the office hours as mentioned before. The need for showing the energy consumption is that it gives a clear idea

for how long should the ACs be operated to save energy and also gives an idea of measures that needs to be applied to minimize the consumption.

Bar Plot for Power Consumed in Watts.



Bar Plot for Energy Consumed in kWh.



AC Count:

Dept. of Computer Science Engineering: 19

Dept. of Electrical Engineering: 2

Dept. of Electronics and Communication Engineering: 8

Dept. of Information Technology: 8

Dept. of Civil Engineering: 5

Dept. of Mechanical Engineering: 5

CCC+CWN: 14

Language Lab: 4

Office: 3

Total: 68

Total AC Load in tons: 104.5

Computers and Printers.

Department	Computer (LCD monitor)	Printers	Power Consumed by Computers (Watt/hour)	Power Consumed by Computers in a Day (Watt)	Power Consumed by Printers in a day
CSE					
Electrical	19	10	2850	17100	4000
ECE	10	2	1500	9000	800
IT	62		9300	55800	0
Mechanical	23		3450	20700	0
Civil	21	6	3150	18900	2400
CCC + CWN	53	2	7950	47700	800
Library	3	2	450	2700	800
Chemistry	2	1	300	1800	400
Others (The Institute of Engineers)	1	1	150	900	400
Total	194	24	29100	174600	9600

Other Machines include:

XEROX Machine: 1

Inverter: 3

Projector: 1

Cooler: 1

Determination of Dynamic Load

The above tables and plots show the static load for the campus area. But in order to get the actual picture of the load under work and the energy consumption we need to get the estimation of the dynamic load and its related energy consumption. The data has been collected for a short duration of time but in detail. So, the static load is accurate in its value. But in order to determine the dynamic load some methods have been applied and estimations have been made using mathematical and statistical methods. The result of these calculations was the forming of a factor known as the Consumption Factor that gave the relation between the dynamic load and the static load.

Scheme of determining the Dynamic Load:

In order to determine the dynamic load, we have devised a method of dividing the entire academic year into three parts:

- Summer
- Monsoon
- Winter

The entire year consists of two semesters that run among the above three parts. The odd semester runs between the Monsoons and the Winters whereas the even semester runs between Winters and the Summer. The summer and monsoon face the maximum demand due to prolonged working of fans and ACs. The light loads are almost same for both the semester periods. As a result of which we can see that the load consumption is distributed and is seen to have more value during the odd semester.

The college campus has a defined contract load value that can be obtained from the electricity bills on a per month basis. As the thought of considering the static load as the dynamic load is a hypothetical case so it results in value much higher than that of the contract load. The pf for the campus is considered to be between 0.88-0.92. The contract load for the campus is 3.2 kVA. The static load surpasses the contract load by a huge amount. So, a factor has to be devised in order to determine the dynamic load form the static load. This factor is known as the consumption factor.

In order to determine a dynamic load, we have taken a part of the campus for our experiment purpose. This part is the part of the campus where the value of the actual load can be estimated by some means. The method for calculating the actual load is discussed later.

From this value we get the estimated value of the dynamic load of a part of the campus, then take the exact static load of that part of the campus and divide the dynamic load obtained by the static load calculated. This gives a number known as the consumption factor. A single result can't be used to validate the truthfulness of the value. So, we have done repeated experiments, calculated dynamic load of a smaller part of area and divided it by the static load of that part to obtain a series of values of consumption factor. Then, we applied statistical methods to obtain a range of values of this consumption factor. The range obtained is found to be 0.82-8.85. The rest of the campus portion, which was not taken under calculation for obtaining the consumption factor is then utilized on them by using their static load value to obtain the dynamic load values. Thus, we obtain the entire dynamic load with the help of the consumption factor.

So, it implies that the actual load is almost 82-85 percent of the connected load which is well under the contract demand.

Methodology adopted in determining Dynamic Load:

For calculating the dynamic load, a method has been adopted wherein the Academic Routine of the college is used to determine the actual dynamic load of the various departments by considering the actual class duration of various departments from the routines and the actual duration for which the rooms in the departments are on load. This is the set of data we have used for the experiment and further calculation purpose. This is used to determine the consumption factor, which can later be applied to other set of data to obtain the actual dynamic load.

This method is used to calculate per day actual load of various departments which further helps in calculating the actual loading of a week of all departments and moving one step ahead gives the load connected of a month, which is the value we need. Also knowing the actual hours for which the loads are active we can calculate the actual energy consumption too.

Since a single year has two semesters, and each semester has around 4-5 months, we calculate the consumption factor of a month by using a month as the training data set and rest of the months as the testing data set. In this way we get two set of values, one for the odd semester and other for the even semester. At first glance it seems that the even semester is a winter semester as it consists of more winter months than odd semester. But the winter months of January and February cut down on the AC and fan loads but March, April and finally in May sees a steady rise in fan load followed by the AC load. So, the area of confusion that even semester has low loading is almost neutralized as the odd semester also have November and December winter months which shows steady dip in fan and AC loads, with month of October having almost no academic activities. Thus, we get a bunch of values of consumption factor under two sets on which further statistical methods are applied to get a range of values of consumption factor. This yields a range of 0.82-0.85.

Thus, the dynamic load is almost 82 to 85 percent of the static loading in the campus.

Measures for improving Energy Efficiency.

Saving of energy starts with the normal human sense of using the resources efficiently and operating them only when required and switching them off and cut down the unnecessary power consumption. But still certain measures need to be applied to cut down the total power consumption under normal loading condition. Here are some suggested adoptions that will minimize the power consumption to great level. The initial costing may seem to be a factor but in the long run the total power consumption and hence the energy consumed will be minimized and the monthly as well as the annual electricity bill will be reduced by great extent.

The measures include two ways of application:

- Replacing the fan and light load.
- Replacing of AC load by newer energy efficient ones and proper distribution of ACs.

Method 1: (Reduction in Fan and light loads)

- Replacing all 100 W fans by 40W fans.
- Replacing all 40W and 38W lights by 20W Crompton tubes.
- LEDs can also be used which further gives lesser energy consumption and lighter.

Also, replacement of lights by the above measures can lead to lesser number of tube lights and higher luminous intensity thus increasing the overall efficiency of the workplace.

Also, the fans suggested to replace will consume much lesser energy and is of light weight too.

Method 2: (Reducing Consumption in ACs and distributing them)

- The old Blue Star ACs and other ACs are to be replaced by new Voltas ACs.
- The 1 ton and 1.5-ton ACs are to be replaced by new Voltas ACs of rating 3 to 4 stars.
- The 2-ton ACs are to be replaced by new Voltas ACs of rating 5 stars.
- In bigger rooms like the labs in computer labs, in place of using two 1-ton ACs 1 2ton AC can be used.

- For classrooms, where ACs are required, instead of using 4 1-ton ACs 2 1.5 ton ACs can be used.

- The ACs nowadays are with inverter technology and are much energy efficient so using them will reduce the loading and the rest of the loading can be used to place 1ton ACs in different teacher's room, in order to increase the comfort and also the unnecessary fan loads. In this case 1-ton ACs are sufficient. For small rooms ACmight be avoided and only fans are enough for proper cooling along with saving energy.

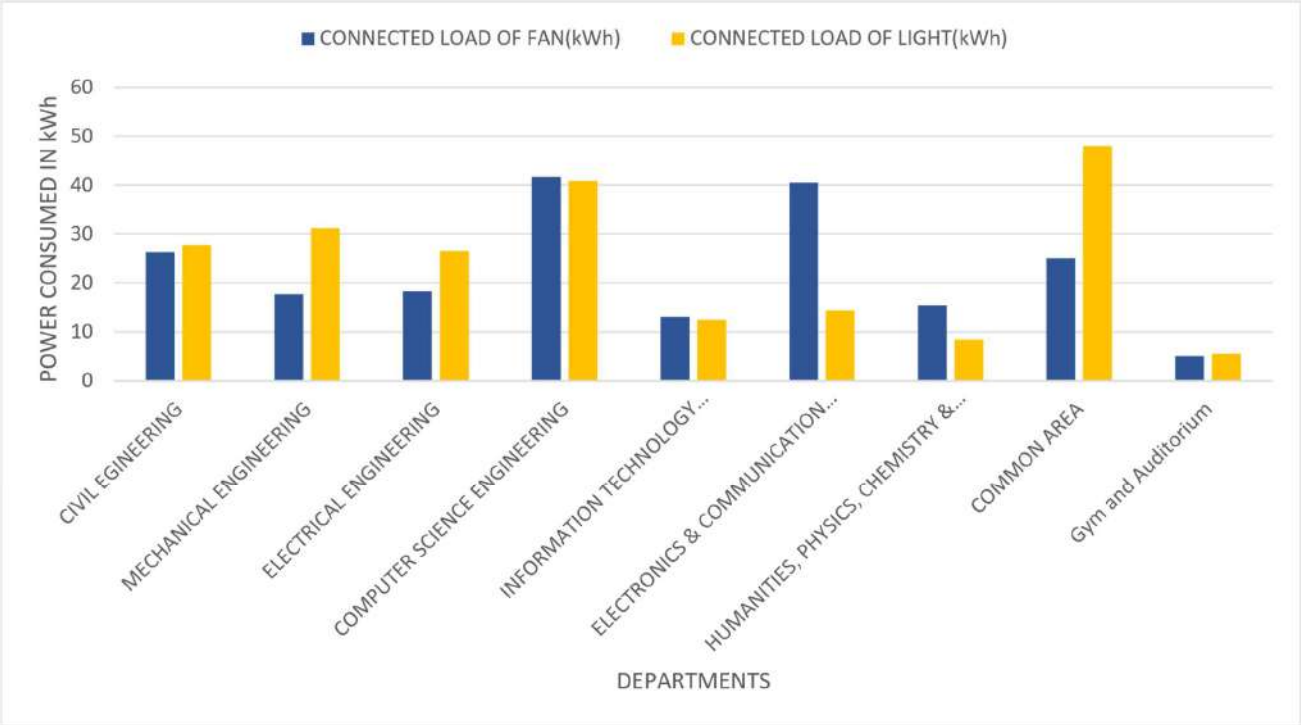
The total saving of the fan and the light load on the static load is shown below. It is to be noted that all the replacement are done on the static load and the dynamic loading can be found by multiplying it with the consumption factor calculated before.

Tabular Data Representation

DEPARTMENT OR PLACE	CONNECTED LOAD OF FAN(W)	CONNECTED LOAD OF LIGHT(W)	CONNECTED LOAD OF FAN (kWh)	CONNECTED LOAD OF LIGHT (kWh)
CIVIL EGINEERING	3760	3960	26.32	27.72
MECHANICAL ENGINEERING	2520	4460	17.64	31.22
ELECTRICAL ENGINEERING	2620	3800	18.34	26.6
COMPUTER SCIENCE ENGINEERING	5960	5840	41.72	40.88
INFORMATION TECHNOLOGY ENGINEERING	1860	1780	13.02	12.46
ELECTRONICS & COMMUNICATION ENGINEERING	5780	2060	40.46	14.42
HUMANITIES, PHYSICS, CHEMISTRY & MATHEMATICS	2200	1200	15.4	8.4
COMMON AREA	3580	6860	25.06	48.02
Gym and Auditorium	720	800	5.04	5.6
TOTAL			203	215.32

The loads are considered on for 7 hours.

Data Visualization with Bar Plots



By applying the above measures, the estimated reduction in the static load is found to be 2530 percent. Assuming almost linear relationship while applying consumption factor on the above data, the actual demand load is to be minimized by 25-29 percent.

Thus, the energy consumption is also reduced to great extent, making the campus as energy efficient one.

Conclusion

The report is aimed at making the campus of Jalpaiguri Government Engineering College Energy efficient. The report begins with the various terminologies used followed by detailed static load representation and later using it with the help of mathematical and statistical tools to find the value of consumption factor and finally the dynamic load or the actual load value.

In the later section various measures has been suggested to reduce the power consumption and also make the distribution of load more efficient so that proper appliances can be used in all places and make the fan load and AC load efficient. Also, the lighting loads have been suggested that will reduce the consumption to great extent and also enhance the luminous intensity, so that lower number lighting can be utilised to get more luminous intensity and save power at the same time making the visibility of the workplace proper. The reduction in power consumption and load value is well enough as obtained from calculated results.

Abiding by normal energy saving norms and at the same time following the measures mentioned in the report will prove to be highly beneficial in the long run and would contribute towards achieving the milestone of making the campus an energy efficient one.