PANCHAKOT MAHAVIDYALAYA

SARBARI, NETURIA, PURULIA

Affiliated to Sidho Kanho Birsha University, Purulia

https://panchakotmv.ac.in

ENERGY AUDIT REPORT

Session: 2020-2021

INDEX

PREFACE

Over the period of several months, a team was in charge of gathering data for the energy audit of the Panchakot Mahavidyalaya campus.

The purpose of this audit was to find out how convenient it would be to advance the campus's energy competency. The key goals were to reduce energy use while preserving or enhancing human comfort, safety, and health. This audit went beyond just counting the amount of energy used to determine which appliances were the most energy-efficient. Additionally, several typical appliance-related daily habits have been offered, which may aid in lowering usage.

A group of members completed the energy audit survey. All of the data was gathered from every office, department, lab, classroom and moreover from common areas such as canteen, central library, gymnasium, internet café, computer center, server room, seminar room, conference hall and hostels. The work was completed by considering the quantity of lights, fans, air conditioners, and other electrical as well as electronic equipments in every room. The participation of various components in the total electricity consumption was calculated.

Based on an actual survey and in-depth analysis conducted during the audit, the report takes into account the energy consumption trends of the college premises. The study compiles a list of potential steps to preserve and effectively use the resources, sources, and their potential for energy savings was also evaluated.

We anticipate that faculty, staff, and students will optimize adherence to the guidelines in the most efficient manner.

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INTRODUCTION

A committee made up of experts and faculties from several reputable institutes carried out this audit. Based on Central and State regulatory and statutory requirements, the Committee created an audit questionnaire. The fundamental information was acquired, compiled and examined by the committee. Overall, the audit finds that Panchakot Mahavidyalaya campus is a healthy place to be. The committee has recommended both short- and long-term measures to improve environmental conditions regarding energy efficiency to higher authorities. All College stakeholders have agreed to provide the recommended changes due consideration and to take advantage of available opportunities. Below is a list of the members of the Committee:

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06	Dr. Wahidur Rahman	Department of Chemistry, Panchakot Mahavidyalaya
07	Dr. Jayanta Das	Dept. of Physics, Panchakot Mahavidyalaya

ENERGY AUDIT & ITS TYPES

What is Energy Audit? In order to find, measure, and report on opportunities for improved energy performance, an energy audit is a systematic examination of energy use and consumption within a specified energy audit scope.

Energy audit analysis generally involves:

- Analysis of energy consumable systems and the utility bills
- Survey about the condition of the system
- Understanding the need of the consumer
- Evaluating the possible energy conservation measures
- Estimating the energy saving potential

Energy Conservation: This indicator covers natural gas, cars, high-energy-consuming devices in science labs, lighting, and appliances including air conditioners, energy sources, energy monitoring, and energy consumption. Energy use needs no justification because it is an obvious component of campus sustainability and should be included in the assessment. Use of least papers in daily basis substituted by the electronic messages and notices are the another aspects of the energy conservation strategies are exercised here.

Type of Energy Audit: There are mainly three categories of energy audit.

(1) Walk-Through Audit: A walk-through assessment of the campus is part of this audit, which identifies areas that require more investigation as well as maintenance, operational or defective equipment issues. The outcomes of a stroll involve locating possible energy-saving possibilities, evaluating how well energy-saving measures are being implemented qualitatively, and estimating the amount of energy that could be saved by audit.

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(3) Investment Grade Audit: This audit provides a thorough breakdown of energy consumption, together with a qualitative review of the implementation, a breakdown of the investments, operations and maintenance expenses, and an examination of the investment model.

NECESSITY OF ENERGY AUDIT AT EDUCATIONAL INSTITUTE

The current educational system is focused on providing the students with a high-quality education through the use of a variety of electric and electronic tools, such as computers, internet access, audio-visual classrooms, video conference capabilities, LCD projectors, wi-fi, etc. In this sense, it is important to maximize the uses of various electric and electronic teaching tools, and students should receive training on how to do so. To maintain the facilities' good condition, regular auditing activities are necessary for the school system to use the aforementioned equipment continuously. Frequent auditing activities support the best possible use of the equipment, diagnosis of the electrical leakage, and equipment maintenance. Regular auditing helps to minimize power consumption and prevent needless waste.

Since educational institutions employ large numbers of people and have more opportunities for energy conservation, which is defined as reducing energy consumption without sacrificing quantity or quality, they are typically chosen for energy audits.

Although energy cannot be seen, we can see its effects, such as heat, light, and power, therefore we know it exists. This indication covers lighting, appliances, cars, energy sources, energy monitoring, and energy consumption. Energy use is an obvious component of campus sustainability, therefore there's no need to justify its inclusion in the evaluation. An energy-efficient light emitting diode (LED) requires less than 10 W, whereas an outdated incandescent bulb needs between 60 and 100 W. Energy auditing focuses on conservation and ways to lower energy use that contribute to environmental deterioration. For this reason, every environmentally conscious organization needs to review how it uses energy.

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Gymnasium	1
Computer center	1
Seminar Room	1
Conference Hall	1
Boys Hostel	1
Girls Hostel	1

METHODOLOGY OF ENERGY AUDIT

The energy audit was done in accordance with the following steps:

1. **Data Collection:** In preliminary data collection phase, exhaustive data collection was performed using different tools such as observation, survey communicating with responsible persons and measurements.

Following steps were taken for data collection: (1) Site Visit (2) Data about the general information was collected by observation and interview. (3) The power consumption of appliances was recorded by taking an average value in some cases.

2. **Actual Measurement and Analysis:** Analyzing historical data entails examining the current energy consumption trend, which is done by examining at the specifics of the last 12 months' electricity bills. This data is then compared to same corresponding to the last few years to comprehend the energy conservation efficiency of the college.

In order to estimate sector-wise load consumption, this stage entails measuring the real site and conducting field trials using a variety of portable measurement tools.

3. **Energy Conservation Opportunities Identification, Evaluation and Recommendation:** The potential for energy conservation found during the energy audit are evaluated in this step. It indicates the practical guidelines and suggestions to the college for the potential energy savings in future.

ENERGY CONSUMPTION PROFILE (2020-2021)

Following are the major components of electricity consumption in the institution:

Sr. No	Name of the component	Total Number (frequency)	Wattage (of a single component/unit)
1	Tube Light	240	50
2	CFL Bulb	7	30
3	LED Bulb	247	10
4	Ceiling Fan	214	75
5	Mounted Wall Fan	23	60
6	Stand Fan	1	60
7	Exhaust Fan	8	50
8	Projector	2	250
9	Smart Board	3	220
10	Split AC	29	1500
11	Speaker	13	100
12	Aqua Guard	5	50
13	Computer	85	200
14	Xerox Machine	4	800
15	Printer	7	250
16	Electric Kettle	2	1500
17	Refrigerator	6	400
18	Water Pump	4	500
19	Wi-fi Router	1	20
20	Television	4	70
21	Cooler	1	400

Table 1: Numbers of various electric components and their Wattage

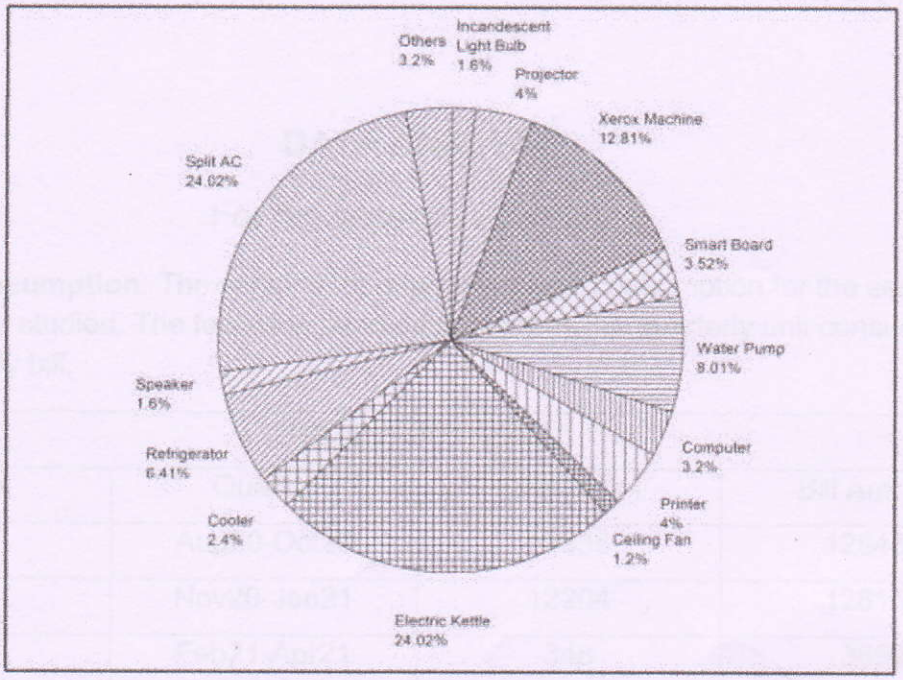

Figure 1: Pie-chart Plot of the Relative Wattage of Various Electrical Components

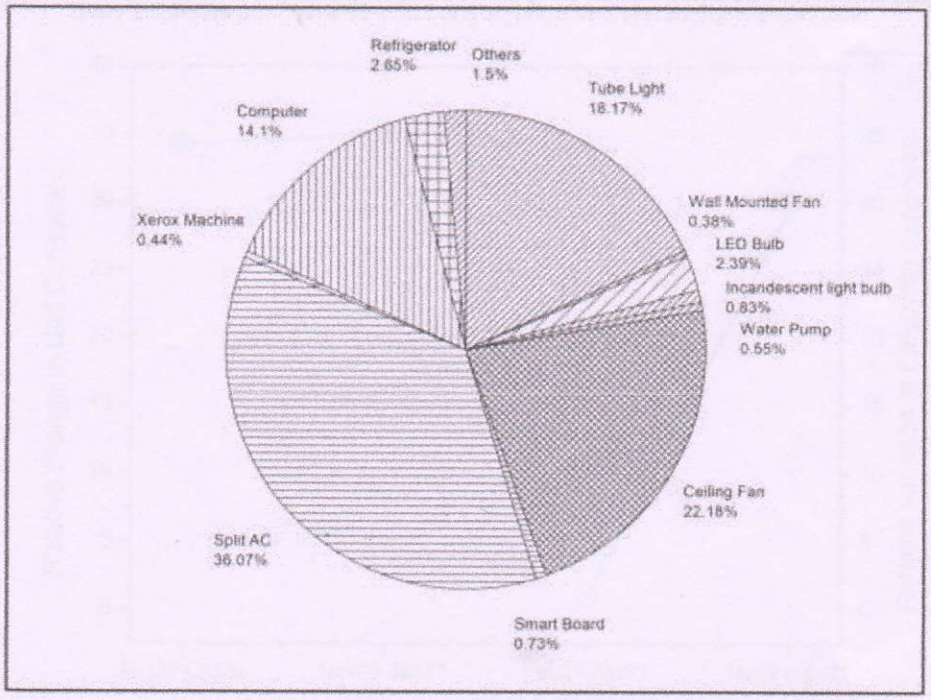

Figure 2: Plot of Relative Power Consumption by Various Electrical Components

DATA ANALYSIS

For the session: 2020-2021

Energy Consumption: The variation of quarterly power consumption for the session 2022-2023 is studied. The following table demonstrates the quarterly unit consumption and electricity bill.

Session 2020-2021			
Sr. No.	Quarter	Unit (kWh)	Bill Amount
1	Aug20-Oct20	11958	125439
2	Nov20-Jan21	12204	128150
3	Feb21-Apr21	348	3659
4	May21-Jul21	10390	108063
5	**Total**	**34900**	**365311**

Table 2: Shows quarter-wise unit consumption and electricity expenditure

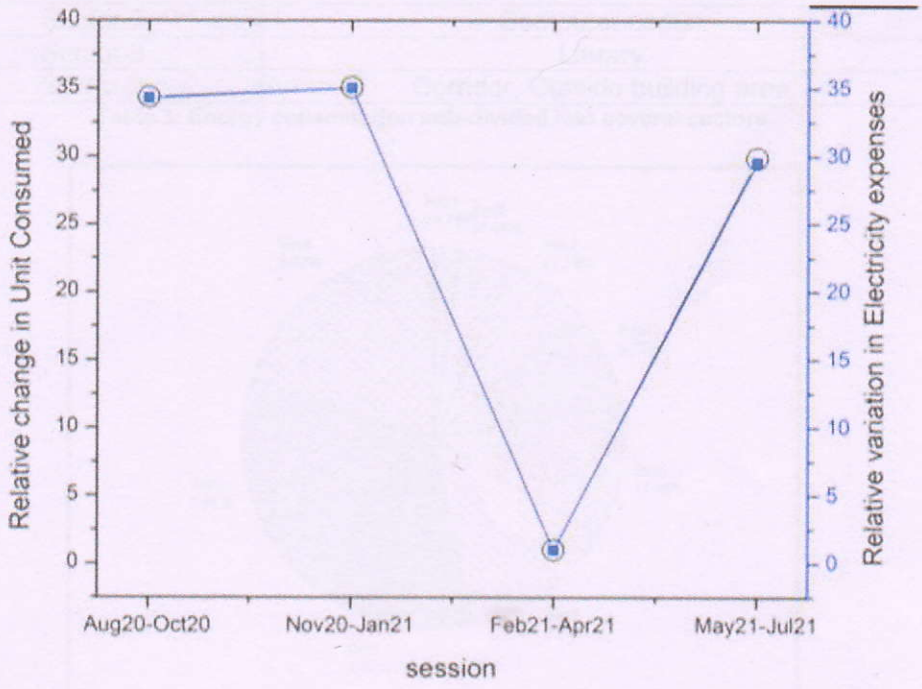

Figure 3: Relative variation of electricity consumption and expenses are shown for the session 2020-21

In table 1, the quarter-wise consumption of electricity units and the corresponding electricity bills are shown where an overall increment of the consumption could be observed. The relative change in power consumption is plotted in figure3.

Estimation of Sector-Wise Energy Distribution: The data for the distribution of loads at various offices, departments, library, canteen, staff rooms etc. were collected by the survey team.

The whole college premise is divided into several suitable sectors and the power consumption in these sectors is roughly estimated. The allotments of different sectors are described below:

Name of Sectors	Rooms
Sector-1	Principal chamber, Office room, Meeting room, Server Room, Teaching Staff Room
Sector-2	Departments of Physics, Chemistry, Computer Science, Botany, Geography, Zoology
Sector-3	All classrooms
Sector-4	Canteen, Internet café, Gymnasium
Sector-5	Conference hall, Seminar room
Sector-6	Hostels, Students Common room
Sector-7	Computer center
Sector-8	Library
Sector-9	Corridor, Outside building area

Table 3: Energy consumption sub-divided into several sectors

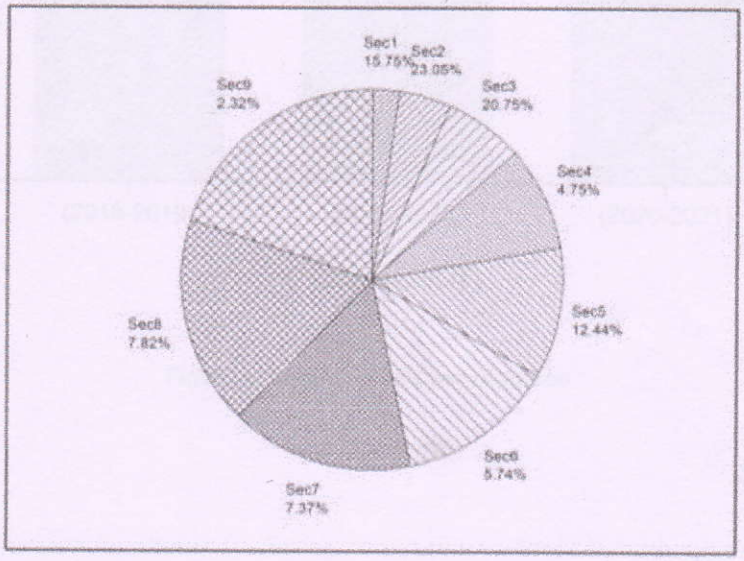

Figure 4: Sector-wise estimated power consumption 2020-2021

YEAR-WISE ELECTRICITY CONSUMPTION

Here the year-wise electricity unit consumption and corresponding financial expenditures are enlisted for the last five years:

Session	Unit consumption (Q)	Electricity Bill
2018-2019	41518	422679
2019-2020	35283	400320
2020-2021	34900	365311

Table 4: Year-wise unit consumption and electricity bill

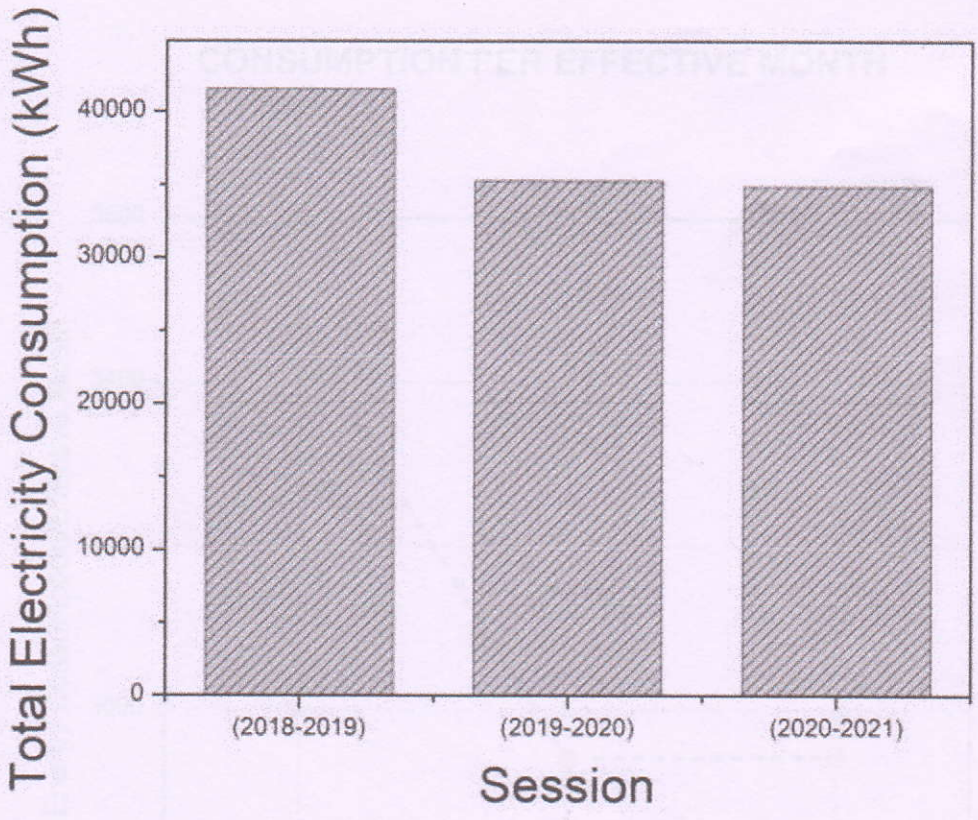

Figure 5: Year-wise unit consumption

MEMBER COUNT SESSION-WISE

The following table provides session-wise data for the number of Full Time Teaching (FTT) staffs, State Aided College Teachers (SACT), Non-Teaching Staffs (NTS), and Number of students in the college:

Stakeholder Category	2018-19	2019-20	2020-21
FTT	17	20	23
SACT	0	29	29
NTS	18	18	18
STUDENTS	1248	1634	1641
TOTAL	1283	1701	1711

CONSUMPTION PER EFFECTIVE MONTH

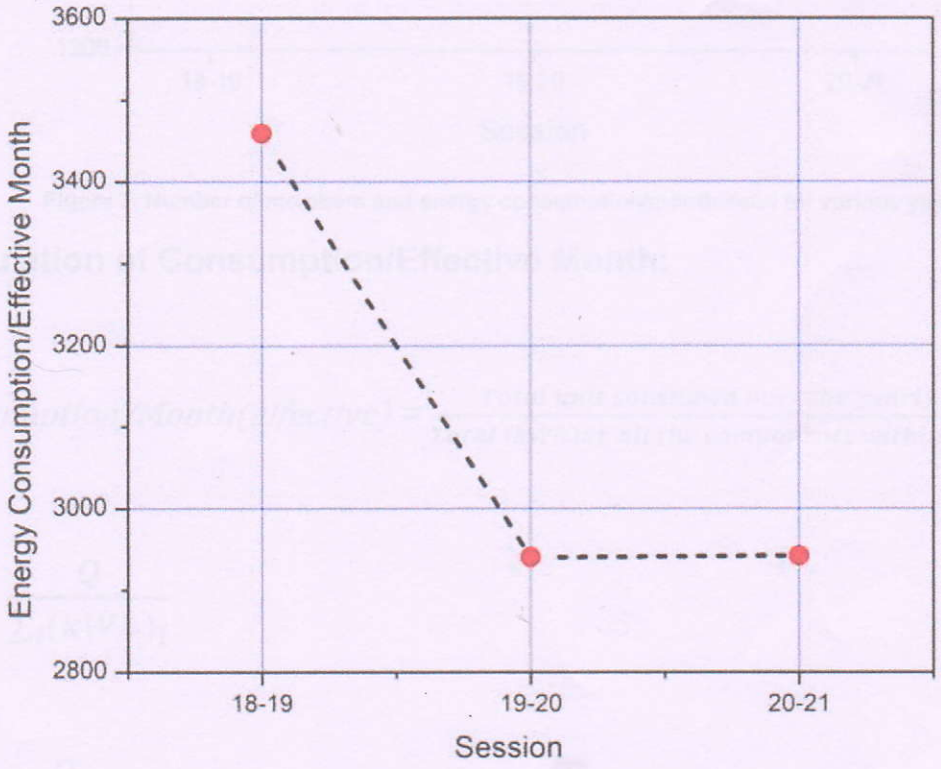

Figure 6: energy consumption per effective month for last few years.

CONSUMPTION PER HEAD PER EFFECTIVE MONTH

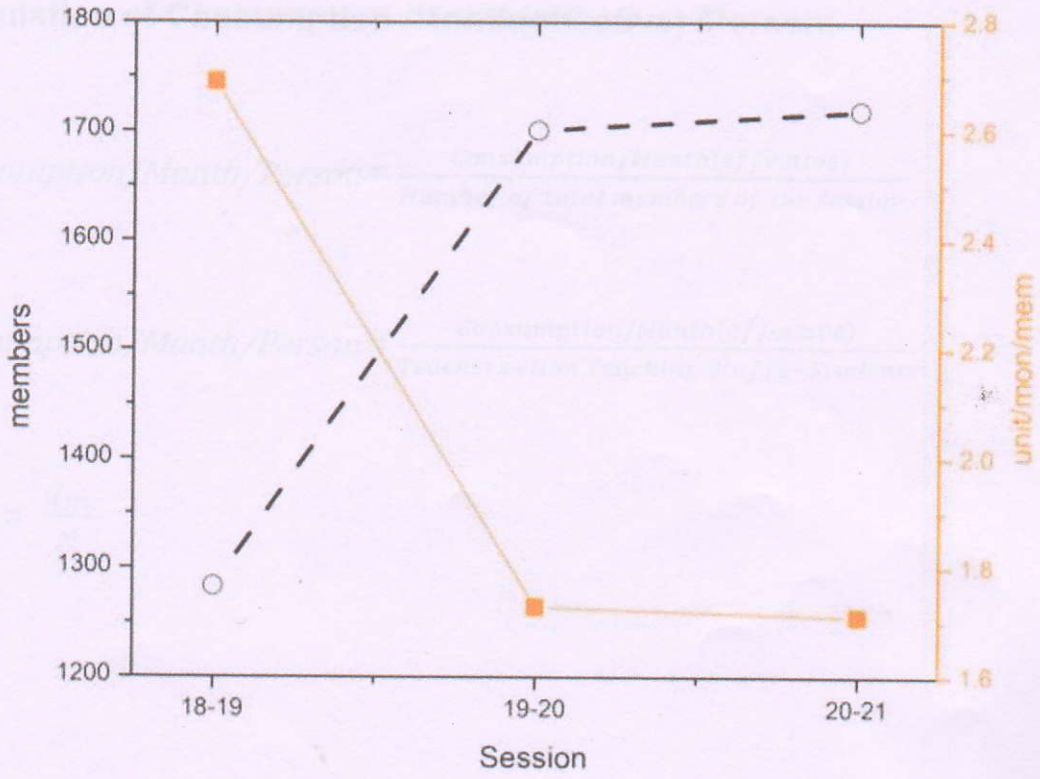

Figure 7: Number of members and energy consumption/month/head for various years

Calculation of Consumption/Effective Month:

$$Consumption/Month(effective) = \frac{Total\ unit\ consumed\ over\ the\ yearly\ session}{Total\ (kWh) of\ all\ the\ components\ within\ the\ college}$$

$$q_m = \frac{Q}{\sum_i (kWh)_i}$$

$$q_m = \frac{Q}{\frac{\sum_i (Wh)_i}{1000}}$$

Calculation of Consumption /Month(effective) /Person:

$$Consumption/Month/Person = \frac{Consumption/Month(effective)}{Number\ of\ total\ members\ of\ the\ session}$$

$$Consumption/Month/Person = \frac{Consumption/Month(effective)}{Teachers+Non\ Teaching\ Staffs+Students}$$

$$q_{mp} = \frac{q_m}{N}$$

LOAD DISTRIBUTION SURVEY (2020-2021)

PANCHAKOT MAHAVIDYALAYA

Load Type	Principal Room	Office Room	Server Room	Teacher Room1	Teacher Room2	Teacher Room3	Meeting Room	Canteen	Internet Cafe	Gym
Tube Light		7	4	3	3		1		3	6
Incandescent Bulb										1
CFL				1						
LED Bulb	19			13			14	6		
Ceiling Fan		5	2	2	2	5	2	1		5
Wall Mounted Fan	1	1				1	1			
Stand Fan	1									
Exhaust Fan	1	1				3		1		
Projector										
Smart Board										
Split AC	1	1	1	1	1	1	1	1		
Speaker				1						1
Water Purifier		1						1		
Computer	1	3	3			3	2		7	
Xerox Machine	1	2	1							
Printer	1	1								
Electric Kettle	1									
Refrigerator	1							2		
Water Pump										
Television	1					1				
Cooler										

Table 5: Load distribution survey matrix

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LOAD DISTRIBUTION SURVEY (2020-2021)

PANCHAKOT MAHAVIDYALAYA

Load Type	Physics	Math	Comp.Sc.	Zoo	Bot	Chem	Geog	All Classroom	Conf. Hall	Seminar Room	Comp. Center	Library
Tube Light	5	3	9	10	2	5	12	86	14	6	1	24
Incandescent Bulb								12				4
CFL					1		5					
LED Bulb				1		10	2		34	13	20	9
Ceiling Fan	5	1	8	9	4	1	15	114				7
Wall Mounted Fan	1				1				9	8		
Stand Fan												
Exhaust Fan					1							
Projector									1	1		
Smart Board		1	1	1								
Split AC	1	1	2	2	1	1	1		6	2	3	2
Speaker									12			
Water Purifier												1
Computer	1	1	15	1		1	10		1	1	30	5
Xerox Machine												1
Printer				1		1	1					1
Electric Kettle							1					
Refrigerator				1	1	1						
Water Pump												
Television										1		
Cooler												1

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LOAD DISTRIBUTION SURVEY (2020-2021)

PANCHAKOT MAHAVIDYALAYA

Load Type	College Corridor	Outside Building	Girls' Common Room	Girls' Hostel	Boys' Hostel	Total
Tube Light	25		2	18	22	271
Incandescent Bulb	1			3	4	25
CFL						7
LED Bulb	40		2			183
Ceiling Fan			3	7	16	214
Wall Mounted Fan						23
Stand Fan						1
Exhaust Fan	1					8
Projector						2
Smart Board						3
Split AC						30
Speaker						13
Water Purifier					1	5
Computer						85
Xerox Machine						4
Printer						7
Electric Kettle						2
Refrigerator						6
Water Pump	2	1			1	4
Television	1					4
Cooler						1

INFERENCES FROM DATA ANALYSIS

- Electrical unit consumption in this session is almost equal (slightly less) to the previous session 2019-2020.(See table 4 & figure 5)
- However, as could be seen in fig. 7 graph, there is a gradual decrement of the energy consumption of electricity per effective month per member of the college.

ENERGY-SAVING RECOMMENDATIONS

- The college should conduct more save-energy awareness programs for students & staff.
- Incandescent light bulbs should be replaced with CFL/LED
- Auto-power-switch off systems may be introduced wherever possible and practicable.
- The college has installed solar panels this year. Setting up of more energy efficient solar panels is recommended.
- Efficiency of Diesel Generator needs to be improved.
- Shut off unnecessary computers, printers, and copiers while not in use
- Turn off all the classroom lights and fan while not in use.
- Reduce the usage of Air Conditioner as much as possible.
- Use the water pumps in a more efficient way.
- Increase the number of LED in the campus, mostly in classrooms.

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Following steps were taken for data collection: (1) Site Visit (2) Data about the general information was collected by observation and interview. (3) The power consumption of appliances was recorded by taking an average value in some cases.

2. **Actual Measurement and Analysis:** Analyzing historical data entails examining the current energy consumption trend, which is done by examining at the specifics of the last 12 months' electricity bills. This data is then compared to same corresponding to the last few years to comprehend the energy conservation efficiency of the college.

In order to estimate sector-wise load consumption, this stage entails measuring the real site and conducting field trials using a variety of portable measurement tools.

3. **Energy Conservation Opportunities Identification, Evaluation and Recommendation:** The potential for energy conservation found during the energy audit are evaluated in this step. It indicates the practical guidelines and suggestions to the college for the potential energy savings in future.

ENERGY CONSUMPTION PROFILE (2021-2022)

Following are the major components of electricity consumption in the institution:

Sr. No	Name of the component	Total Number (frequency)	Wattage (of a single component/unit)
1	Tube Light	271	50
2	CFL Bulb	7	30
3	LED Bulb	193	10
4	Ceiling Fan	214	75
5	Mounted Wall Fan	23	60
6	Stand Fan	1	60
7	Exhaust Fan	8	50
8	Projector	2	250
9	Smart Board	3	220
10	Split AC	29	1500
11	Speaker	13	100
12	Aqua Guard	5	50
13	Computer	85	200
14	Xerox Machine	4	800
15	Printer	7	250
16	Electric Kettle	2	1500
17	Refrigerator	6	400
18	Water Pump	4	500
19	Wi-fi Router	1	20
20	Television	4	70
21	Cooler	1	400

Table 1: Numbers of various electric components and their Wattage

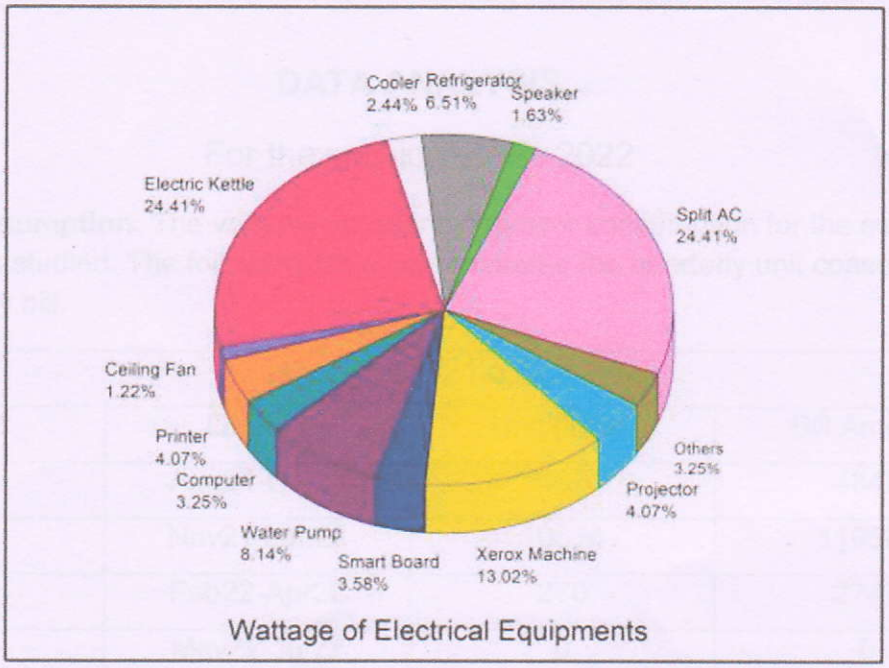

Figure 1: Pie-chart Plot of the Relative Wattage of Various Electrical Components

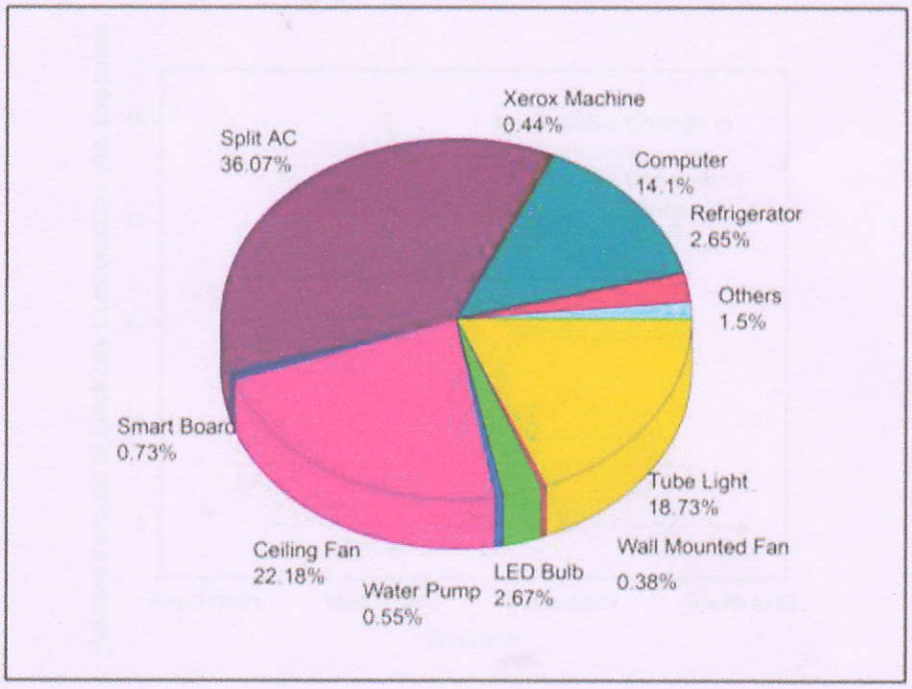

Figure 2: Plot of Relative Power Consumption by Various Electrical Components

DATA ANALYSIS

For the session: 2021-2022

Energy Consumption: The variation of quarterly power consumption for the session 2021-2022 is studied. The following table demonstrates the quarterly unit consumption and electricity bill.

Session 2021-2022			
Sr. No.	Quarter	Unit (kWh)	Bill Amount
1	Aug21-Oct21	465	4842
2	Nov21-Jan22	10634	110582
3	Feb22-Apr22	270	2747
4	May22-Jul22	0	0
	Total	**11369**	**118171**

Table 2: Shows quarter-wise unit consumption and electricity expenditure

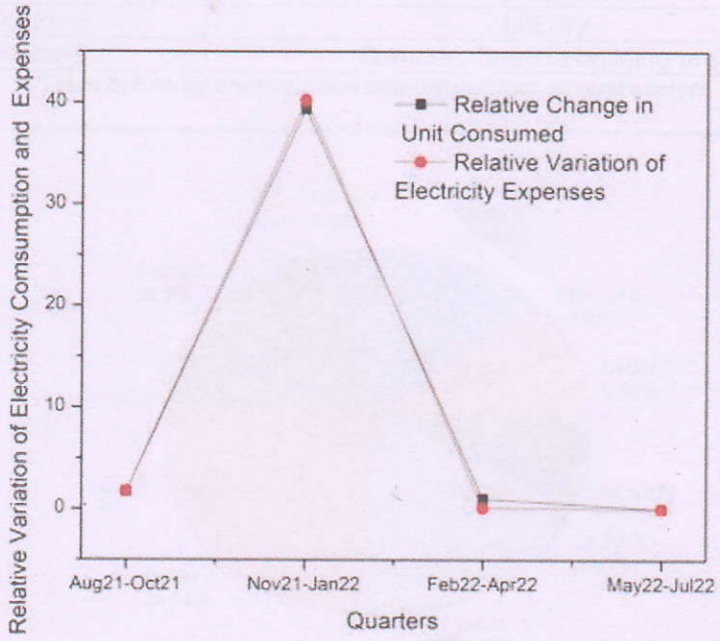

Figure 3: Relative variation of electricity consumption and expenses are shown for the session 2021-22

In table 1, the quarter-wise consumption of electricity units and the corresponding electricity bills are shown where an overall increment of the consumption could be observed. The relative change in power consumption is plotted in figure3.

Estimation of Sector-Wise Energy Distribution: The data for the distribution of loads at various offices, departments, library, canteen, staff rooms etc. were collected by the survey team.

The whole college premise is divided into several suitable sectors and the power consumption in these sectors is roughly estimated. The allotments of different sectors are described below:

Name of Sectors	Rooms
Sector-1	Principal chamber, Office room, Meeting room, Server Room, Teaching Staff Room
Sector-2	Departments of Physics, Chemistry, Computer Science, Botany, Geography, Zoology
Sector-3	All classrooms
Sector-4	Canteen, Internet café, Gymnasium
Sector-5	Conference hall, Seminar room
Sector-6	Hostels, Students Common room
Sector-7	Computer center
Sector-8	Library
Sector-9	Corridor, Outside building area

Table 3: Energy consumption sub-divided into several sectors

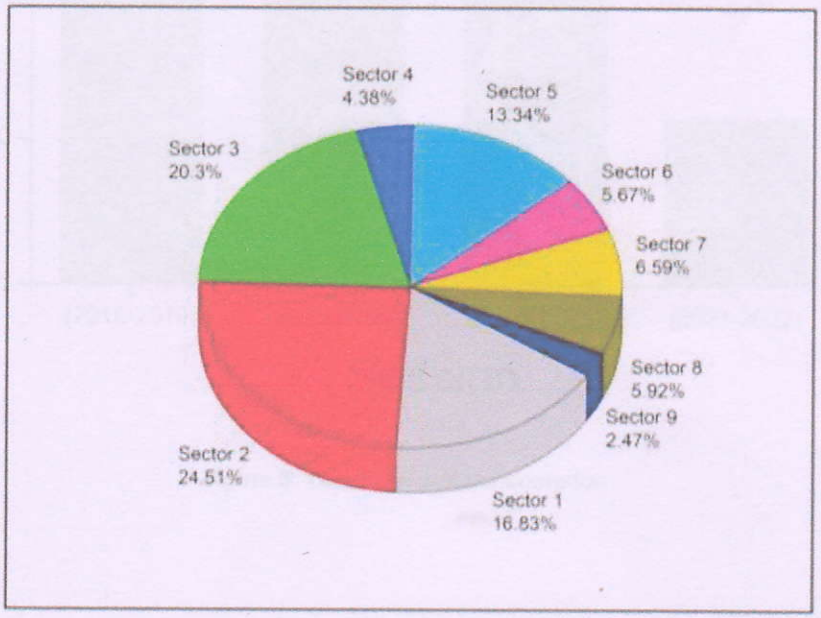

Figure 4: Sector-wise estimated power consumption 2021-2022

YEAR-WISE ELECTRICITY CONSUMPTION

Here the year-wise electricity unit consumption and corresponding financial expenditures are enlisted for the last four years:

Session	Unit consumption (Q)	Electricity Bill
2018-2019	41518	422679
2019-2020	35283	400320
2020-2021	34900	365311
2021-2022	11369	118171

Table 4: Year-wise unit consumption and electricity bill

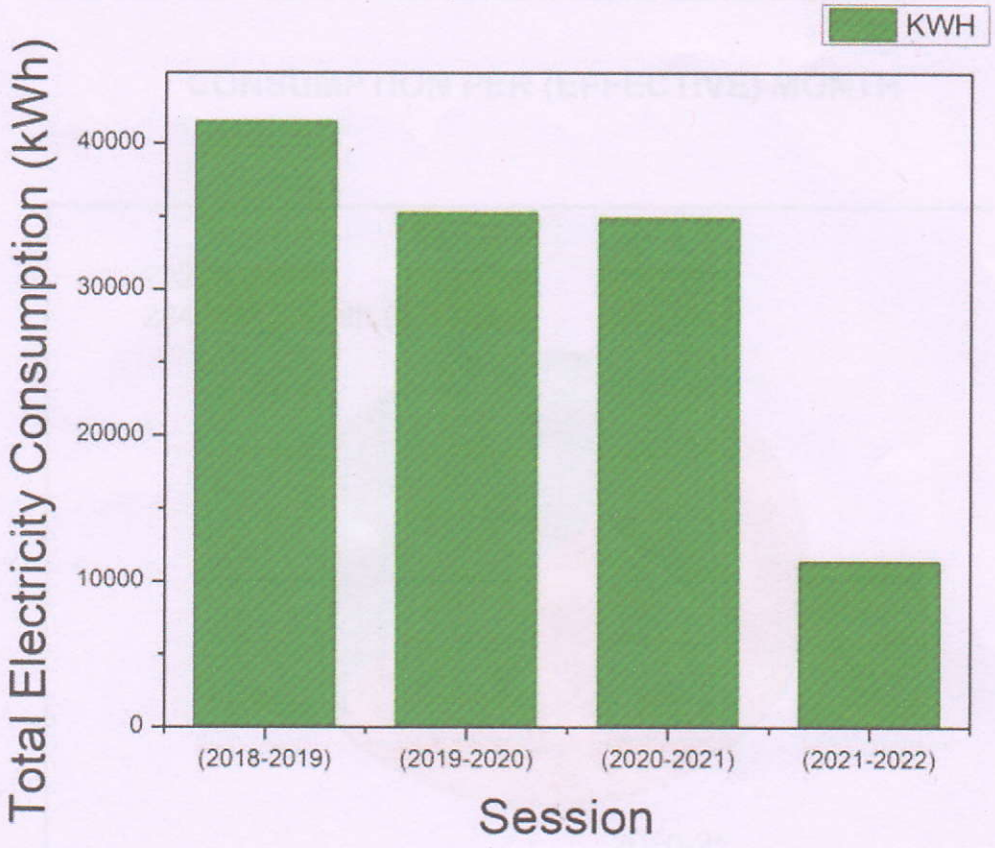

Figure 5: Year-wise unit consumption

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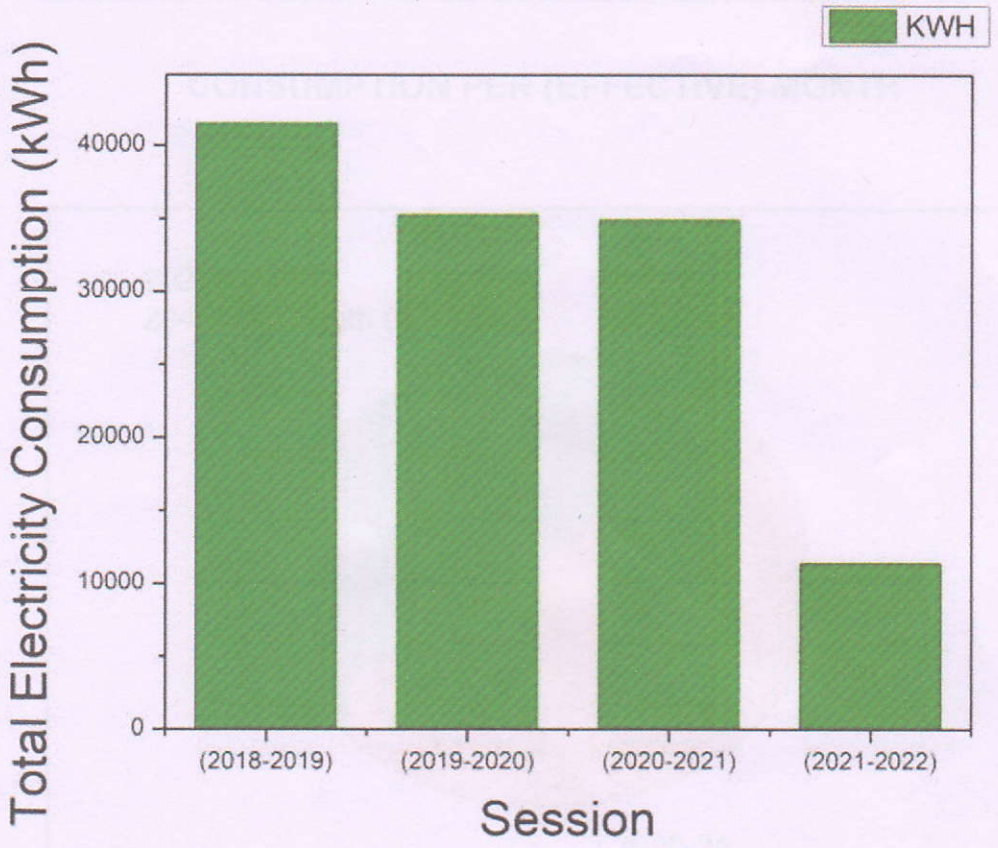

Figure 5: Year-wise unit consumption

MEMBER COUNT SESSION-WISE

The following table provides session-wise data for the number of Full Time Teaching (FTT) staffs, State Aided College Teachers (SACT), Non-Teaching Staffs (NTS), and Number of students in the college:

Stakeholder Category	Session			
	2018-19	2019-20	2020-21	2021-22
FTT	17	20	23	20
SACT	0	29	29	29
NTS	18	18	18	20
STUDENTS	1248	1634	1641	2083
TOTAL	1283	1701	1711	2152

CONSUMPTION PER (EFFECTIVE) MONTH

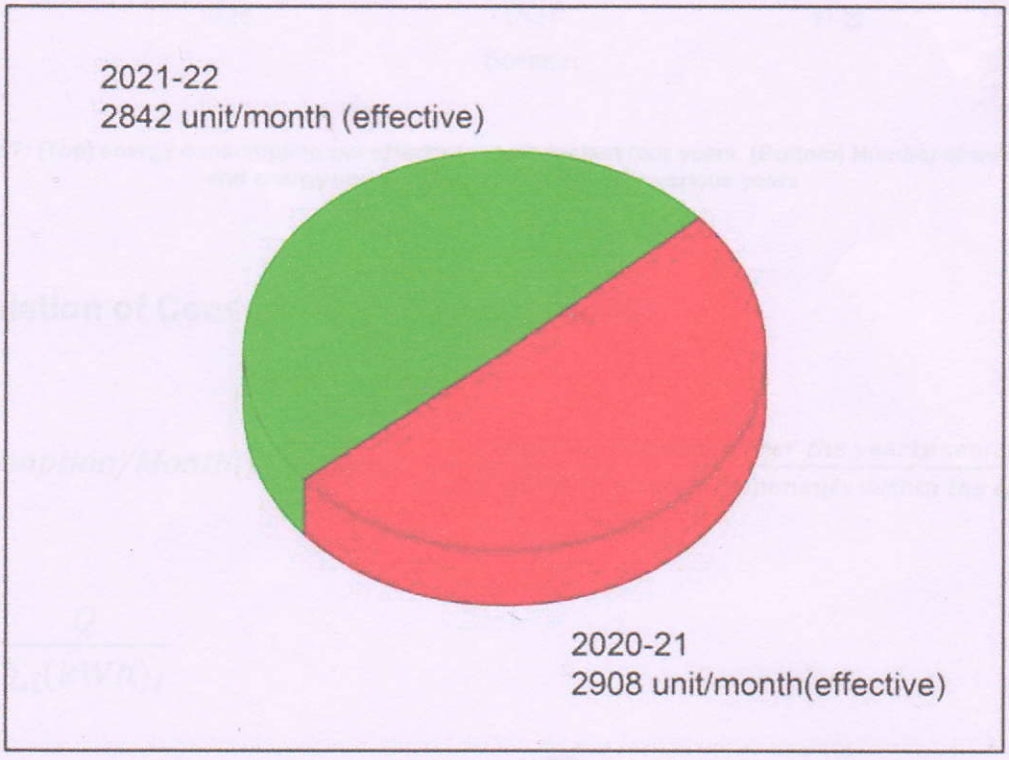

Figure 6: Pie-chart demonstrating the energy consumption per (effective) month for the sessions 2021-22 & 2020-21

CONSUMPTION PER HEAD PER EFFECTIVE MONTH

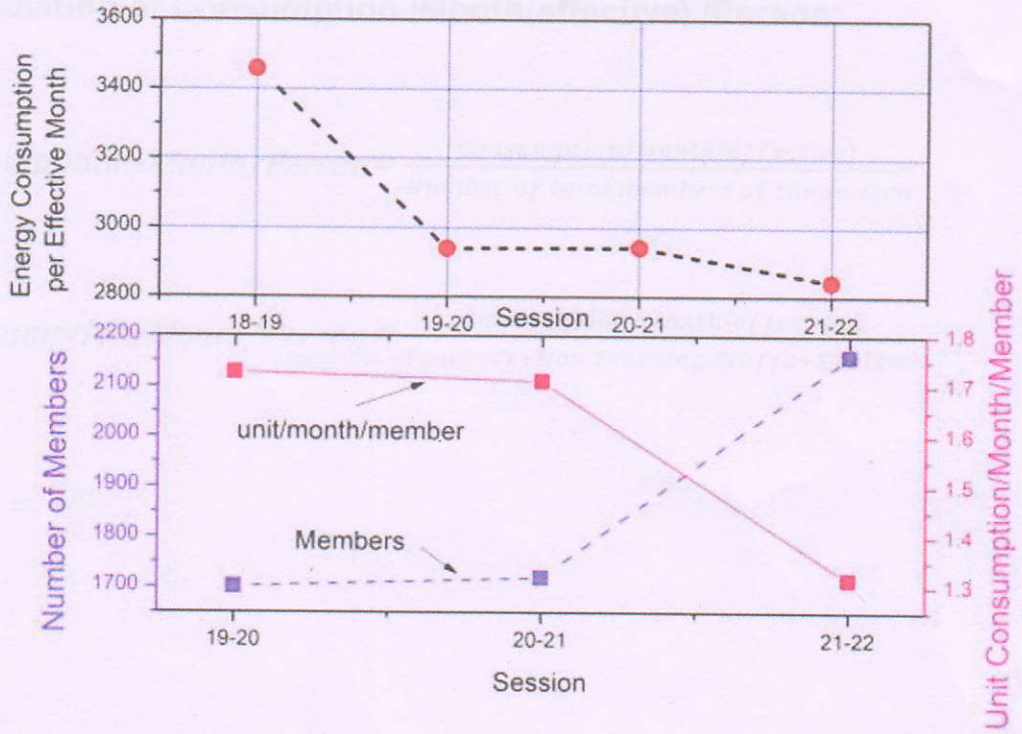

Figure 7: (Top) energy consumption per effective month for last four years. (Bottom) Number of members and energy consumption/month/head for various years

Calculation of Consumption/Effective Month:

$$Consumption/Month(effective) = \frac{Total\ unit\ consumed\ over\ the\ yearly\ session}{Total\ (kWh) of\ all\ the\ components\ within\ the\ college}$$

$$q_m = \frac{Q}{\sum_i (kWh)_i}$$

$$q_m = \frac{Q}{\frac{\sum_i (Wh)_i}{1000}}$$

Calculation of Consumption /Month(effective) /Person:

$$Consumption/Month/Person = \frac{Consumption/Month(effective)}{Number\ of\ total\ members\ of\ the\ session}$$

$$Consumption/Month/Person = \frac{Consumption/Month(effective)}{Teachers+Non\ Teaching\ Staffs+Students}$$

$$q_{mp} = \frac{q_m}{N}$$

LOAD DISTRIBUTION SURVEY (2021-2022)

PANCHAKOT MAHAVIDYALAYA

Load Type	Principal Room	Office Room	Server Room	Teacher Room1	Teacher Room2	Teacher Room3	Meeting Room	Canteen	Internet Cafe	Gym
Tube Light		7	4	3	3		1		3	6
CFL				1						
LED Bulb	19			13			14	6		
Ceiling Fan		5	2	2	2	5	2	1		5
Wall Mounted Fan	1	1				1	1			
Stand Fan	1									
Exhaust Fan	1	1				3		1		
Projector										
Smart Board										
Split AC	1	1	1	1	1	1	1	1		
Speaker				1						1
Water Purifier		1						1		
Computer	1	3	3			3	2		7	
Xerox Machine	1	2	1							
Printer	1	1								
Electric Kettle	1									
Refrigerator	1							2		
Water Pump										
Television	1					1				
Cooler										

Table 5: Load distribution survey matrix

Continued to next page

LOAD DISTRIBUTION SURVEY (2021-2022)

PANCHAKOT MAHAVIDYALAYA

Load Type	Physics	Math	CompSc.	Zoo	Bot	Chem	Geog	All Classroom	Conf. Hall	Seminar Room	Comp.Center	Library
Tube Light	5	3	9	10	2	5	12	86	14	6	1	24
CFL					1		5					
LED Bulb				1		10	2		34	13	20	9
Ceiling Fan	5	1	8	9	4	1	15	114				7
Wall Mounted Fan	1				1				9	8		
Stand Fan												
Exhaust Fan					1							
Projector									1	1		
Smart Board		1	1	1								
Split AC	1	1	2	2	1	1	1		6	2	3	2
Speaker									12			
Water Purifier												1
Computer	1	1	15	1		1	10		1	1	30	5
Xerox Machine												1
Printer				1		1	1					1
Electric Kettle							1					
Refrigerator				1	1	1						
Water Pump												
Television										1		
Cooler												1

LOAD DISTRIBUTION SURVEY (2021-2022)

PANCHAKOT MAHAVIDYALAYA

Load Type	College Corridor	Outside Building	Girls' Common Room	Girls' Hostel	Boys' Hostel	Total
Tube Light	25		2	18	22	271
CFL						7
LED Bulb	50		2			193
Ceiling Fan			3	7	16	214
Wall Mounted Fan						23
Stand Fan						1
Exhaust Fan	1					8
Projector						2
Smart Board						3
Split AC						30
Speaker						13
Water Purifier					1	5
Computer						85
Xerox Machine						4
Printer						7
Electric Kettle						2
Refrigerator						6
Water Pump	2	1			1	4
Television	1					4
Cooler						1

INFERENCES FROM DATA ANALYSIS

- The time series plot of total unit consumption per academic year in fig. 5 shows an overall gradual decrement over the years except for the session 2021-2022, where a sudden dip could be observed. This is due to reduced electricity consumption during the COVID lockdown period.
- However, as could be seen in fig. 7 graph, there is a gradual decrement of the energy consumption calculated per effective month and also the consumption of electricity per member of the college also decreases over the last few years.

ENERGY-SAVING RECOMMENDATIONS

- The college should conduct more save-energy awareness programs for students & staff.
- More energy efficient fans should be installed
- Auto-power-switch off systems may be introduced wherever possible and practicable.
- Installation of solar panels at suitable places within the campus is recommended.
- Efficiency of Diesel Generator needs to be improved.
- Shut off unnecessary computers, printers, and copiers while not in use
- Turn off all the classroom lights and fan while not in use.
- Reduce the usage of Air Conditioner as much as possible.
- Use the water pumps in a more efficient way.
- Increase the number of LED in the campus, mostly in classrooms.

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Vice Principal
Asansol Girls' College
Asansol

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Dr. Gautam Jana
Assistant Professor
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Dr. Meenakshi Chakraborty Sen
Associate Professor
Department of Physics, Asansol Girls' College, Asansol

Dr. Saptarshi Chakraborty
Principal
Panchakot Mahavidyalaya
Purulia

Principal
PANCHAKOT MAHAVIDYALAYA
Sarbari*Neturia*Purulia

Dr. Wahidur Rahman
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PANCHAKOT MAHAVIDYALAYA

SARBARI, NETURIA, PURULIA

Affiliated to Sidho Kanho Birsha University, Purulia

https://panchakotmv.ac.in

ENERGY AUDIT REPORT

Session: 2022-2023

INDEX

PREFACE

Over the period of several months, a team was in charge of gathering data for the energy audit of the Panchakot Mahavidyalaya campus.

The purpose of this audit was to find out how convenient it would be to advance the campus's energy competency. The key goals were to reduce energy use while preserving or enhancing human comfort, safety, and health. This audit went beyond just counting the amount of energy used to determine which appliances were the most energy-efficient. Additionally, several typical appliance-related daily habits have been offered, which may aid in lowering usage.

A group of members completed the energy audit survey. All of the data was gathered from every office, department, lab, classroom and moreover from common areas such as canteen, central library, gymnasium, internet café, computer center, server room, seminar room, conference hall and hostels. The work was completed by considering the quantity of lights, fans, air conditioners, and other electrical as well as electronic equipments in every room. The participation of various components in the total electricity consumption was calculated.

Based on an actual survey and in-depth analysis conducted during the audit, the report takes into account the energy consumption trends of the college premises. The study compiles a list of potential steps to preserve and effectively use the resources, sources, and their potential for energy savings was also evaluated.

We anticipate that faculty, staff, and students will optimize adherence to the guidelines in the most efficient manner.

ACKNOWLEDGEMENT

We express our sincere thanks to Dr. Saptarshi Chakraborty, Principal, Panchakot Mahavidyalaya for motivating, and giving us the opportunity for energy audit. We would like to express our sincere thanks to Dr. Wahidur Rahman, Department of Chemistry, and Dr. Jayanta Das, Dept. of Physics of Panchakot Mahavidyalaya for their valuable suggestions. Last but not the least, we thank all the faculty members, staffs who have partially extended their cooperation during the course of the energy audit.

INTRODUCTION

A committee made up of experts and faculties from several reputable institutes carried out this audit. Based on Central and State regulatory and statutory requirements, the Committee created an audit questionnaire. The fundamental information was acquired, compiled and examined by the committee. Overall, the audit finds that Panchakot Mahavidyalaya campus is a healthy place to be. The committee has recommended both short- and long-term measures to improve environmental conditions regarding energy efficiency to higher authorities. All College stakeholders have agreed to provide the recommended changes due consideration and to take advantage of available opportunities. Below is a list of the members of the Committee:

Serial No.	Name	Designation
01	Dr. Sandip Kumar Ghatak,	Vice Principal, Asansol Girls' College, Asansol
02	Dr. Biru Rajak	Coordinator, IQAC, Asansol Girls' College, Asansol
03	Dr. Gautam Jana	Assistant Professor, Department of Chemistry, Asansol Girls' College, Asansol
04	Dr. Meenakshi Chakraborty Sen	Associate Professor, Department of Physics, Asansol Girls' College, Asansol
05	Dr. Saptarshi Chakraborty	Principal, Panchakot Mahavidyalaya
06	Dr. Wahidur Rahman	Department of Chemistry, Panchakot Mahavidyalaya
07	Dr. Jayanta Das	Dept. of Physics, Panchakot Mahavidyalaya

ENERGY AUDIT & ITS TYPES

What is Energy Audit? In order to find, measure, and report on opportunities for improved energy performance, an energy audit is a systematic examination of energy use and consumption within a specified energy audit scope.

Energy audit analysis generally involves:

- Analysis of energy consumable systems and the utility bills
- Survey about the condition of the system
- Understanding the need of the consumer
- Evaluating the possible energy conservation measures
- Estimating the energy saving potential

Energy Conservation: This indicator covers natural gas, cars, high-energy-consuming devices in science labs, lighting, and appliances including air conditioners, energy sources, energy monitoring, and energy consumption. Energy use needs no justification because it is an obvious component of campus sustainability and should be included in the assessment. Use of least papers in daily basis substituted by the electronic messages and notices are the another aspects of the energy conservation strategies are exercised here.

Type of Energy Audit: There are mainly three categories of energy audit.

(1) Walk-Through Audit: A walk-through assessment of the campus is part of this audit, which identifies areas that require more investigation as well as maintenance, operational or defective equipment issues. The outcomes of a stroll involve locating possible energy-saving possibilities, evaluating how well energy-saving measures are being implemented qualitatively, and estimating the amount of energy that could be saved by audit.

(2) General Audit: The preliminary audit is expanded upon by the general audit, also known as the mini-audit or whole site energy audit. For a duration of 12 to 36 months, utility bills are gathered, enabling the auditor to assess the facility's energy consumption patterns and demand rate frameworks. Given the facility's operational characteristics, this kind of audit will be able to find any energy-conservation methods that are suitable for it.

(3) Investment Grade Audit: This audit provides a thorough breakdown of energy consumption, together with a qualitative review of the implementation, a breakdown of the investments, operations and maintenance expenses, and an examination of the investment model.

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NECESSITY OF ENERGY AUDIT AT EDUCATIONAL INSTITUTE

The current educational system is focused on providing the students with a high-quality education through the use of a variety of electric and electronic tools, such as computers, internet access, audio-visual classrooms, video conference capabilities, LCD projectors, wi-fi, etc. In this sense, it is important to maximize the uses of various electric and electronic teaching tools, and students should receive training on how to do so. To maintain the facilities' good condition, regular auditing activities are necessary for the school system to use the aforementioned equipment continuously. Frequent auditing activities support the best possible use of the equipment, diagnosis of the electrical leakage, and equipment maintenance. Regular auditing helps to minimize power consumption and prevent needless waste.

Since educational institutions employ large numbers of people and have more opportunities for energy conservation, which is defined as reducing energy consumption without sacrificing quantity or quality, they are typically chosen for energy audits.

Although energy cannot be seen, we can see its effects, such as heat, light, and power, therefore we know it exists. This indication covers lighting, appliances, cars, energy sources, energy monitoring, and energy consumption. Energy use is an obvious component of campus sustainability, therefore there's no need to justify its inclusion in the evaluation. An energy-efficient light emitting diode (LED) requires less than 10 W, whereas an outdated incandescent bulb needs between 60 and 100 W. Energy auditing focuses on conservation and ways to lower energy use that contribute to environmental deterioration. For this reason, every environmentally conscious organization needs to review how it uses energy.

ABOUT THE COLLEGE

Panchakot Mahavidyalaya
Sarbari, Neturia, Purulia

Mission: This college's mission encompasses not just the pursuit of academic excellence but also the inspiration, guidance, and empowerment of our students to become critical thinkers, lifelong learners, and contributing members of a dynamic global community. The college responsibly creates an environment for the students' multifaceted development that is both intellectually stimulating and supportive of their growth. This enables them to reach their full potential and become inspired learners, creative problem solvers, and innovative thinkers who are ready to succeed in the twenty-first century. This is only feasible in a comprehensive, student-centered setting where their gifts, skills, and capacities are recognized, developed, and supported. The college is a destiny to the students to reflect, communicate, and demonstrate their abilities.

Name of the Institute	Panchakot Mahavidyalaya
Address	Sarbari, PO: Neturia, Dist: Purulia, PIN: 723121
Year of establishment	2000
Total Campus Area	6.902 Acres
Total Built up Area	2.001 Acres
Total Open Space Area	1.147 Acres
Total Green Area	3.754 Acres
Number of Departments	16
Total Number of Classrooms	25
Principal Office	1
Meeting Room	1
Server Room	1
Staff Office Room	1
Library	1
Cyber café	1
Gymnasium	1
Computer center	1
Seminar Room	1
Conference Hall	1
Boys Hostel	1
Girls Hostel	1

METHODOLOGY OF ENERGY AUDIT

The energy audit was done in accordance with the following steps:

1. **Data Collection:** In preliminary data collection phase, exhaustive data collection was performed using different tools such as observation, survey communicating with responsible persons and measurements.

Following steps were taken for data collection: (1) Site Visit (2) Data about the general information was collected by observation and interview. (3) The power consumption of appliances was recorded by taking an average value in some cases.

2. **Actual Measurement and Analysis:** Analyzing historical data entails examining the current energy consumption trend, which is done by examining at the specifics of the last 12 months' electricity bills. This data is then compared to same corresponding to the last few years to comprehend the energy conservation efficiency of the college.

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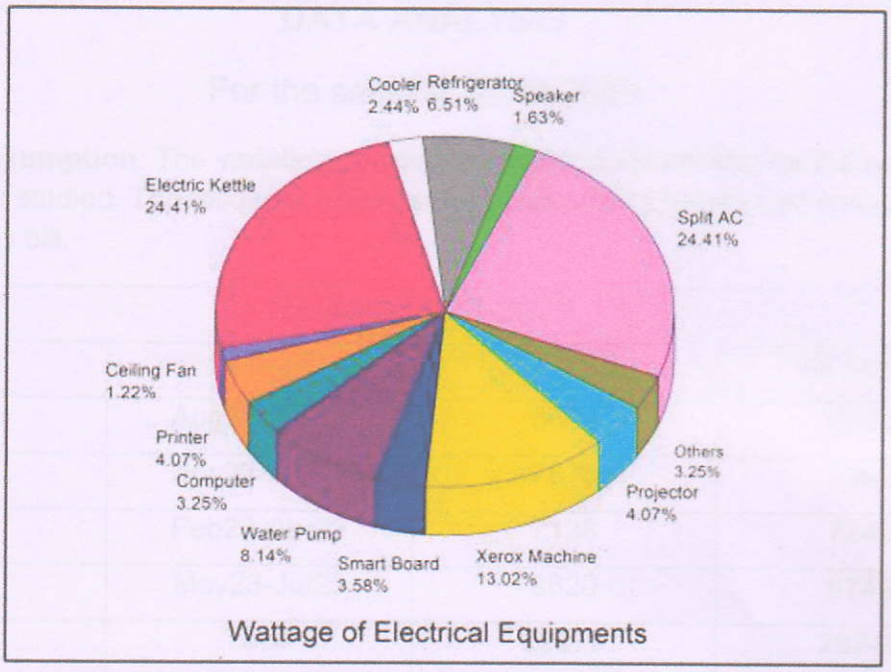

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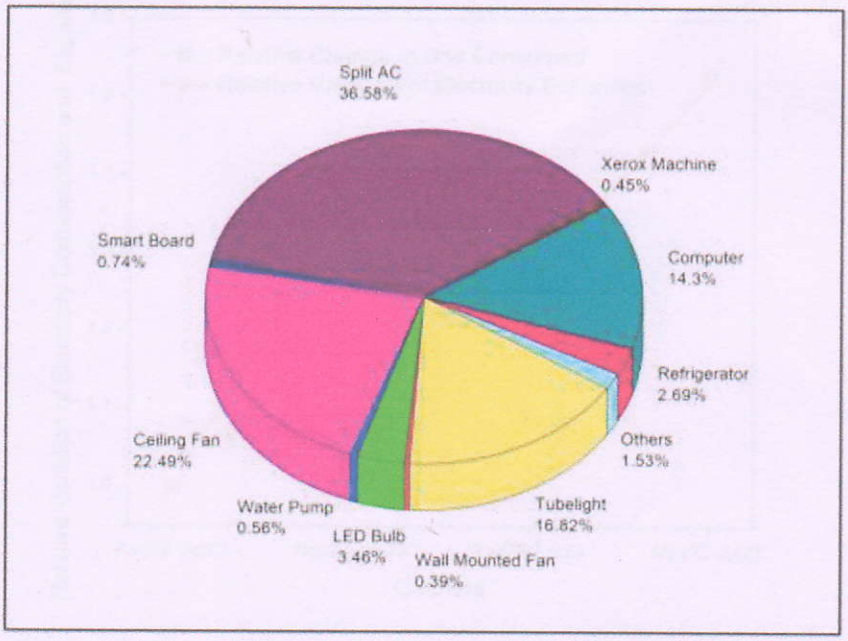

Figure 2: Plot of Relative Power Consumption by Various Electrical Components

DATA ANALYSIS

For the session: 2022-2023

Energy Consumption: The variation of quarterly power consumption for the session 2022-2023 is studied. The following table demonstrates the quarterly unit consumption and electricity bill.

Session 2022-2023			
Sr. No.	Quarter	Unit (kWh)	Bill Amount
1	Aug22-Oct22	5638	57557
2	Nov22-Jan23	7874	79923
3	Feb23-Apr23	7138	72435
4	May23-Jul23	8620	87493
5	**Total**	**29270**	**297408**

Table 2: Shows quarter-wise unit consumption and electricity expenditure

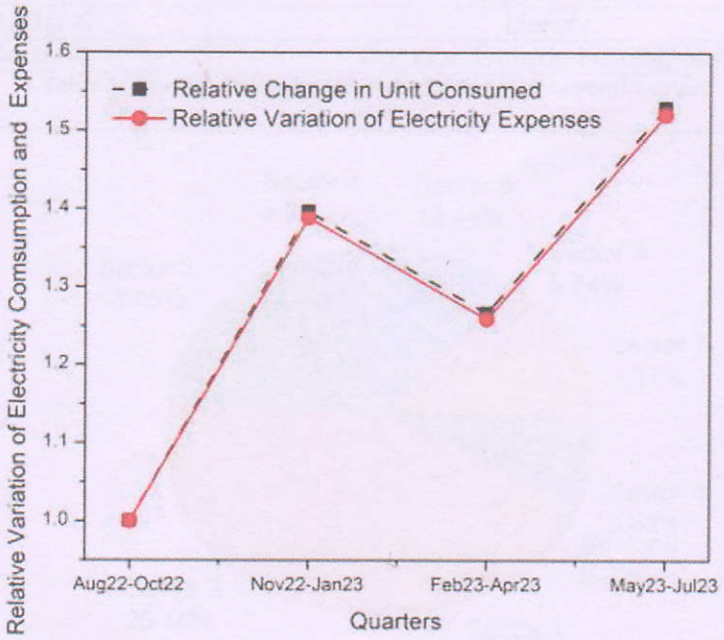

Figure 3: Relative variation of electricity consumption and expenses are shown for the session 2022-23

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Estimation of Sector-Wise Energy Distribution: The data for the distribution of loads at various offices, departments, library, canteen, staff rooms etc. were collected by the survey team.

The whole college premise is divided into several suitable sectors and the power consumption in these sectors is roughly estimated. The allotments of different sectors are described below:

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Sector-2	Departments of Physics, Chemistry, Computer Science, Botany, Geography, Zoology
Sector-3	All classrooms
Sector-4	Canteen, Internet café, Gymnasium
Sector-5	Conference hall, Seminar room
Sector-6	Hostels, Students Common room
Sector-7	Computer center
Sector-8	Library
Sector-9	Corridor, Outside building area

Table 3: Energy consumption sub-divided into several sectors

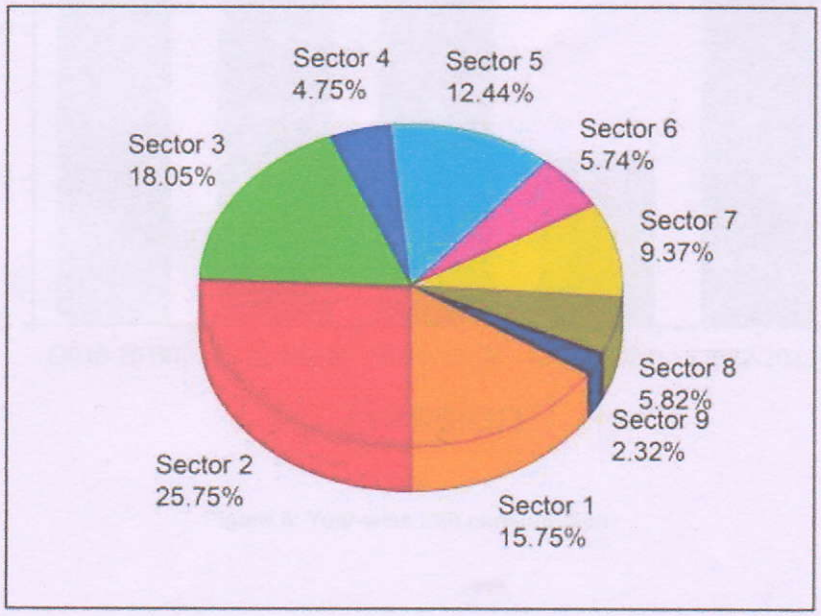

Figure 4: Sector-wise estimated power consumption 2022-2023

YEAR-WISE ELECTRICITY CONSUMPTION

Here the year-wise electricity unit consumption and corresponding financial expenditures are enlisted for the last five years:

Session	Unit consumption (Q)	Electricity Bill
2018-2019	41518	422679
2019-2020	35283	400320
2020-2021	34900	365311
2021-2022	11369	118171
2022-2023	29270	297408

Table 4: Year-wise unit consumption and electricity bill

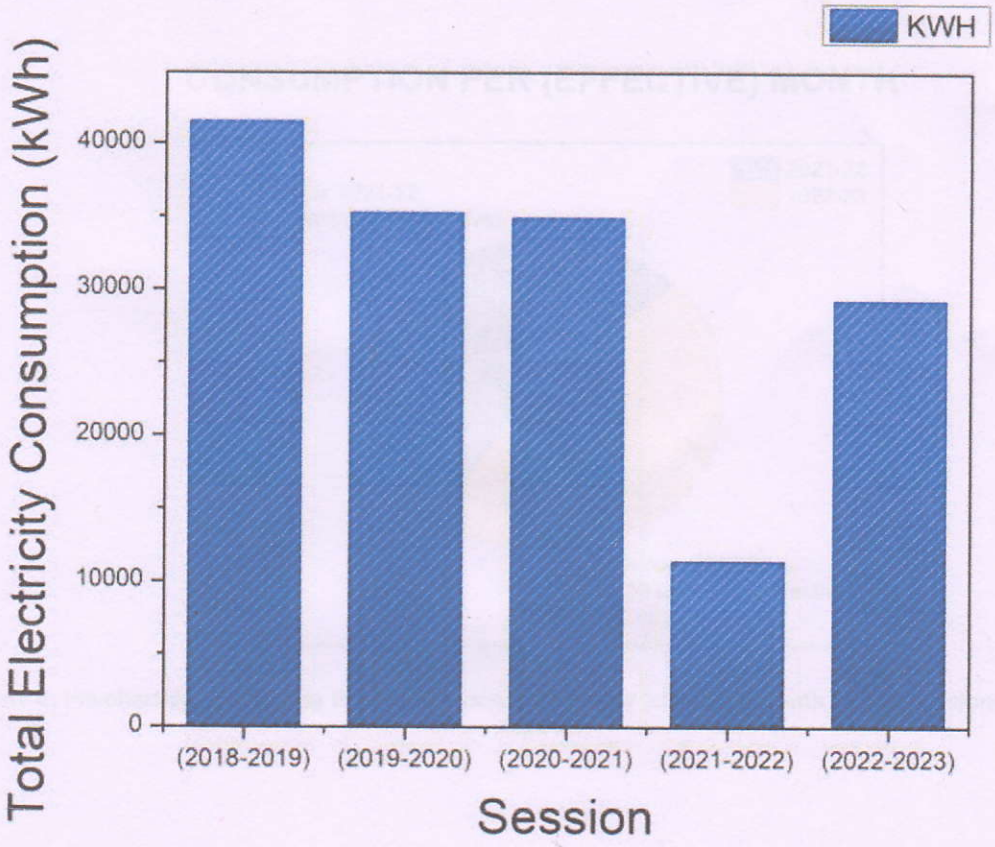

Figure 5: Year-wise unit consumption

MEMBER COUNT SESSION-WISE

The following table provides session-wise data for the number of Full Time Teaching (FTT) staffs, State Aided College Teachers (SACT), Non-Teaching Staffs (NTS), and Number of students in the college:

Stakeholder Category	Session				
	2018-19	2019-20	2020-21	2021-22	2022-23
FTT	17	20	23	20	20
SACT	0	29	29	29	29
NTS	18	18	18	20	18
STUDENTS	1248	1634	1641	2083	1953
TOTAL	1283	1701	1711	2152	2020

CONSUMPTION PER (EFFECTIVE) MONTH

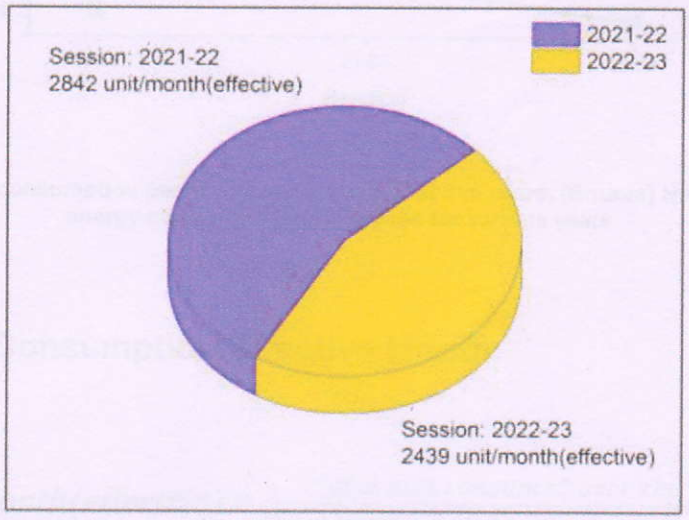

Figure 6: Pie-chart demonstrating the energy consumption per (effective) month for the sessions 2021-22 & 2022-23

CONSUMPTION PER HEAD PER EFFECTIVE MONTH

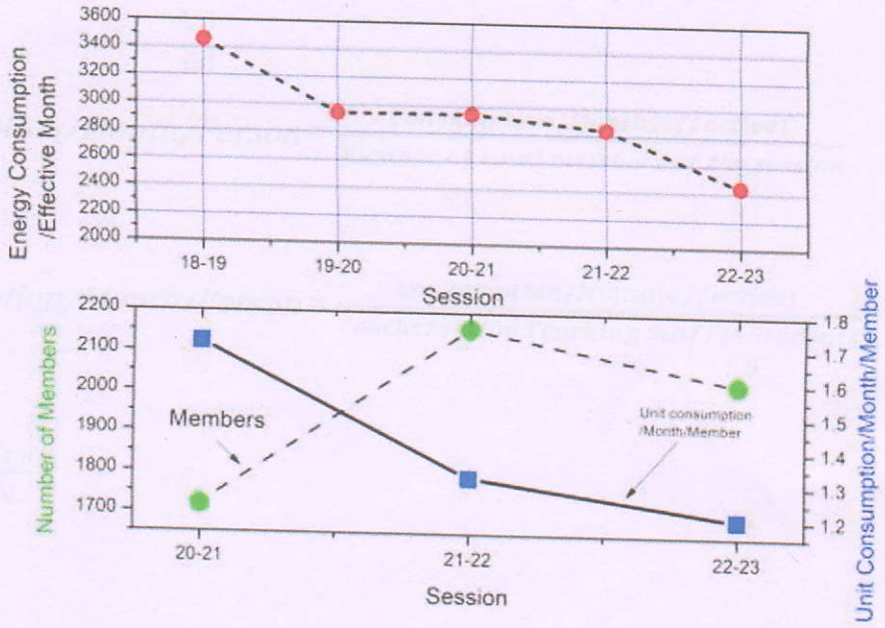

Figure 7: (Top) energy consumption per effective month for last five years. (Bottom) Number of members and energy consumption/month/head for various years

Calculation of Consumption/Effective Month:

$$Consumption/Month(effective) = \frac{Total\ unit\ consumed\ over\ the\ yearly\ session}{Total\ (kWh) of\ all\ the\ components\ within\ the\ college}$$

$$q_m = \frac{Q}{\sum_i (kWh)_i}$$

$$q_m = \frac{Q}{\frac{\sum_i (Wh)_i}{1000}}$$

Calculation of Consumption /Month(effective) /Person:

$$Consumption/Month/Person = \frac{Consumption/Month(effective)}{Number\ of\ total\ members\ of\ the\ session}$$

$$Consumption/Month/Person = \frac{Consumption/Month(effective)}{Teachers+Non\ Teaching\ Staffs+Students}$$

$$q_{mp} = \frac{q_m}{N}$$

LOAD DISTRIBUTION SURVEY (2022-2023)

PANCHAKOT MAHAVIDYALAYA

Load Type	Principal Room	Office Room	Server Room	Teacher Room1	Teacher Room2	Teacher Room3	Meeting Room	Canteen	Internet Cafe	Gym
Tube Light		7	4	3	3		1		3	6
CFL				1						
LED Bulb	19			13			14	6		
Ceiling Fan		5	2	2	2	5	2	1		5
Wall Mounted Fan	1	1				1	1			
Stand Fan	1									
Exhaust Fan	1	1				3		1		
Projector										
Smart Board										
Split AC	1	1	1	1	1	1	1	1		
Speaker				1						1
Water Purifier		1						1		
Computer	1	3	3			3	2		7	
Xerox Machine	1	2	1							
Printer	1	1								
Electric Kettle	1									
Refrigerator	1							2		
Water Pump										
Television	1					1				
Cooler										

Table 5: Load distribution survey matrix

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LOAD DISTRIBUTION SURVEY (2022-2023)

PANCHAKOT MAHAVIDYALAYA

Load Type	Physics	Math	Comp. Sc.	Zoo	Bot	Chem	Geo	All Classroom	Conf. Hall	Seminar Room	Comp. Center	Library
Tube Light	5	3	9	10	2	5	12	86				18
CFL					1		5					
LED Bulb				1		10	2		64	13	35	18
Ceiling Fan	5	1	8	9	4	1	15	114				7
Wall Mounted Fan	1				1				9	8		
Stand Fan												
Exhaust Fan					1							
Projector									1	1		
Smart Board		1	1	1								
Split AC	1	1	2	2	1	1	1		6	2	3	2
Speaker									12			
Water Purifier												1
Computer	1	1	15	1		1	10		1	1	30	5
Xerox Machine												1
Printer				1		1	1					1
Electric Kettle							1					
Refrigerator				1	1	1						
Water Pump												
Television										1		
Cooler												1

Continued to next page

LOAD DISTRIBUTION SURVEY (2022-2023)

PANCHAKOT MAHAVIDYALAYA

Load Type	College Corridor	Outside Building	Girls' Common Room	Girls' Hostel	Boys' Hostel	Total
Tube Light	21		2	18	22	240
CFL						7
LED Bulb	50		2			247
Ceiling Fan			3	7	16	214
Wall Mounted Fan						23
Stand Fan						1
Exhaust Fan	1					8
Projector						2
Smart Board						3
Split AC						30
Speaker						13
Water Purifier					1	5
Computer						85
Xerox Machine						4
Printer						7
Electric Kettle						2
Refrigerator						6
Water Pump	2	1			1	4
Television	1					4
Cooler						1

INFERENCES FROM DATA ANALYSIS

- The time series plot of total unit consumption per academic year in fig. 5 shows an overall gradual decrement over the years except for the session 2021-2022, where a sudden dip could be observed. This is due to reduced electricity consumption during the COVID lockdown period.
- However, as could be seen in fig. 7 graph, there is a gradual decrement of the energy consumption calculated per effective month and also the consumption of electricity per member of the college also decreases over the last few years.

ENERGY-SAVING RECOMMENDATIONS

- The college should conduct more save-energy awareness programs for students and staff.
- More energy efficient fans should be installed
- Auto-power-switch off systems may be introduced wherever possible and practicable.
- The college has installed solar panels this year. Setting up of more energy efficient solar panels is recommended.
- Efficiency of Diesel Generator needs to be improved.
- Shut off unnecessary computers, printers, and copiers while not in use
- Turn off all the classroom lights and fan while not in use.
- Reduce the usage of Air Conditioner as much as possible.
- Use the water pumps in a more efficient way.
- Increase the number of LED in the campus, mostly in classrooms.

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