DOON (P.G.) COLLEGE OF AGRICULTURE SCIENCE & TECHNOLOGY
CAMP ROAD SELAQUI, DEHRADUN-248011 (UTTARAKHAND)
(Under the Management of Maharani Laxmi Bai Memorial Educational Society)
AFFILIATED TO HEMVATI NANDAN BAHUGUNA GARHWAL UNIVERSITY
(--A CENTRAL UNIVERISTY--)
ISO 9001:2008 Certified

Energy Audit

Energy Audit Certificate

We hereby certify that we have conducted the Investment Grade Energy Audit of the buildings of Doon (PG) College of Agriculture Science & Technology, Camp Road, Selaqui, Dehradun with the best of our ability. We have calculated the total Energy consumption, Energy savings analysis, Solar Energy usage and gives suggestions for Optimum utilization of resources by College management. The Energy Savings potential in monitored areas are also mentioned in Energy Audit report.

We hereby certify that this study has been carried out by our BEE Certified Energy Auditors team and under the direct supervision of BEE Accredited Energy Auditor.

The Energy Audit report is available at Dean Academics of Doon (PG) College of Agriculture Science & Technology, Selaqui, Dehradun.

Certificate Issue Date: December'2022.

ASHISH VASHISHTH BEE Regn. No. EA-0140 ENERGY AUDITOR

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ENERGY AUDIT STUDY FOR

DOON GROUP
OF COLLEGES

Doon (PG) College of Agriculture Science & Technology Selaqui, Dehradun, Uttrakhand-248011

CONDUCTED BY:

Association of Energy Conservation & Environment Protection

32-B, Bhagirathi Puram, Engineers Enclave, G.M.S Road, Dehradun, Uttarakhand – 248001

Email: aecep29@gmail.com, Phone: 09456583967

Year- 2022

Contents

ABBREVIATIONS

A	Ampere
AC	Alternating Current
Avg.	Average
CFL	Compact Fluorescent Lamp
CFM	Cubic feet minute
DTL	Double Tube Light
DG	Diesel Generator
FAD	Free Air Delivery
FTL	Florescent Tube Light
GT	Generator Transformer
DTL	Double Tube Light
KL	Kilo Liter
KV	Kilo Volt
kVA	Kilo Volt Ampere
kW	Kilo Watts
kWh	Kilo Watt Hour
LED	Light Emitting Diode
L	Liters
M or m	Meter
Max.	Maximum
Min.	Minimum
MT	Metric Ton
MW	Mega Watt
No.	Number
OHT	Over Head Tank
PF	Power Factor
STL	Single Tube Light
TR	Ton of Refrigerant
V	Voltage

Acknowledgment

M/s. AECEP expresses sincere thanks to the Management of **"Doon (PG) College of Agriculture Science & Technology"** for their kind assistance and cooperation in carrying out the Energy Audit of their college. The site visits for the Energy Audit have been conducted during Sept.- Oct. 2022.
The Audit team of M/s. AECEP conveys their gratitude and thanks to the management of Doon (PG) College of Agriculture Science and Technology for their positive attitude toward Safety, Reliability, and Energy conservation program through Energy efficiency improvement and better utilization of available energy system infrastructures followed by their proactive role in conducting the energy audit study.

The Audit team would like to register their hearty thanks to Doon (PG) College of Agriculture Science and Technology, Dehradun officials for their guidance, coordination, active support, participation during the audit, and motivation of the audit team.

Official from Doon (PG) College of Agriculture Science and Technology, Dehradun

- Mr. Dariyav Singh - Chairman
- Dr. Sanjay Chaudhary - Director
- Dr. Manzoor Ahmad – Dean Academics

Energy Audit Team Members

- Mr. Ashish Vashishth – BEE Certified Energy Auditor, Project Head
- Mr. Ashu Sharma – BEE Accredited Energy Auditor
- Mr. Utkarsh Singh – Energy Auditor
- Mr. Dhirendra Gusain – Team Member

Association of Energy Conservation &
Environment Protection

Highlights of the Energy Audit

M/s. AECEP expresses sincere thanks to the Management of "Doon (PG) College of Agriculture Science & Technology" for their kind assistance and cooperation in carrying out the Energy Audit of their college. The site visits for the Energy Audit data have been taken on Sept 25, 2022.

The Broad Scope of work and Key Systems/Equipment covered during the Energy Audit was as follows:

- ***Review of Electricity Bills**, Contract Demand, and Power Factor: for the last year possibilities will be explored for further reduction of contract demand and improvement of P.F.*

- ***Electrical System Network:** This would include a detailed study of all the transformers of various rating/capacities their operational pattern, loading, no-load losses, power factor measurement on the main power distribution boards, and scope for improvement if any. the study would also cover possible improvements in energy metering systems for better control and monitoring*
- ***Study of Motors Pumps Loading** Study of motors above 10 KW in terms of measurement of Voltage (V), Current (I), Power (kW), and P.F. and thereby suggesting measures for energy saving like reduction in the size of motors or installation of an energy-saving device in the existing motors. Study of Pumps and their flow, thereby suggesting measures for energy saving like reduction in the size of Motors and Pumps of installation of the energy-saving device in the existing motors, optimization of pumps.*
- **Window / Split Air Conditioners:** Performance shall be evaluated as regards; their input power vis-à-vis TR capacity and performance will be compared to improve to the best in the category.
- ***Lighting System: -** Study of type and fitting of lighting. and suggest measures for improvements and energy conservation opportunities wherever feasible.*
- **DG Set:** Study the operations of DG set to evaluate their average cost of power Generation, Specific Energy Generation and subsequently identify areas wherein energy saving could be achieved after analyzing the operational practices, etc. of the DG Sets.

Key Points

- *Doon (PG) College of Agriculture Science and Technology, Dehradun, draws power from the Uttarakhand Power Corporation Limited, at 0.400 kV. The contracted load of the college is 89 kVA.*
- *During the site visit, measurements were made to record the load profile of the Institute building, which included the variations in the voltage, current, power factor, harmonics, etc. Analysis of the recordings indicated that the average voltage on the LT side was around 237 V. This may be an adequate voltage for motive loads like motors etc, but for the lighting systems normally, the voltage should be around 210 volts (phase to neutral). A reduction of around 8% in the lighting voltage can reduce the power consumption by around 20%.*
- *The building has not installed any capacitor bank panel on the LT side for PF improvement. However; if we look at the overall average monthly power factor is 0.98, which is* ***satisfactory****. The building is being billed on a KVAH basis; therefore, the effect of the power factor is inbuilt into the billing structure.*
- *The voltage harmonics levels were around 2.92 – 3.25 % and the levels of the current harmonics were 4.74 – 6.53%.* ***The Overall Voltage harmonics and the current harmonics are within limits.***
- *During the audit, performance of AC units was done on sample basics. From the calculation it is seen that the performance of some AC units is satisfactory and for some it is slightly higher. Hence, it is recommended to replace the old energy inefficient AC units with BEE 5 star rated energy efficient AC unit in phase manner.*
- *Around 536 No's of 36W Conventional Tube lights are installed in college campus. These lights must be replaced with energy efficient LED Lights. The resultant benefits in terms of energy savings work out to* ***Rs. 1.08 Lakhs*** *per annum with an estimated investment of* ***Rs. 1.88 Lakhs*** *and a simple payback period of* ***20-21 months.***
- *Around 683 No's of 75W ceiling Fans are installed in college campus. These fans must be replaced with energy efficient BLDC Fan. The resultant benefits in terms of energy savings work out to* ***Rs. 4.04 Lakhs*** *per annum with an estimated investment of* ***Rs. 19.12 Lakhs*** *and a simple payback period of* ***20-21 months.***
- *In college campus total 4 No's of Borewell pumps (2 HP X2 No's and 5 HP X 2 No's) are installed. 2 No's of Pumps (5 Hp x 1 No' and 2 Hp x 1 No') are installed in the main building side and the other 2 No's of Pumps (5 Hp x 1 No' and 2 Hp x 1 No') are installed in the Hostel Building side. The efficiency of 5 Hp pump main building is 51.28% which is satisfactory. The efficiency of 2 Hp pump main building is 38.29%, 2 hp mess*

pump hostel building is 33.01% and 5 Hp garden pump hostel building is 21.79% which is on the lower side. Hence, it is recommended to replace these pumps with energy efficient pumps. The resultant benefits in terms of energy savings work out to

- ***2 Hp Main Building Pump: Rs. 0.05 Lakhs** per annum with an estimated investment of **Rs. 0.12 Lakhs** and a simple payback period of **28-29 months***
- ***2 Hp Hostel Building Pump: Rs. 0.06 Lakhs** per annum with an estimated investment of **Rs. 0.12 Lakhs** and a simple payback period of **23-24 months***
- ***5 Hp Garden Hostel Building Pump: Rs. 0.22 Lakhs** per annum with an estimated investment of **Rs. 0.37 Lakhs** and a simple payback period of **20-21 months***

- *The college, has installed 1 No DG Set for in-house power generation. The operation of the DG set is limited to power cuts and testing only. Thus, no specific recommendations have been made*
- The college, has installed 1 No DG Set for in-house power generation. The operation of the DG set is limited to power cuts and testing only. Thus, no specific recommendations have been made. **Solar photovoltaic technologies** convert solar energy into useful energy forms by directly absorbing solar photons—particles of light that act as individual units of energy—and either converting part of the energy to electricity. *The resultant benefits in terms of energy savings work out to **Rs. 0.97 Lakhs** per annum with an estimated investment of **Rs. 5.0 Lakhs** and a simple payback period of **62-63 months.***

Cumulative Energy Saving Opportunities in kWh & Corresponding Monetary Benefits with Payback

ECO's	Energy Savings per Annum		Estimated Investments	Simple Payback Period
	KWh	Rs Lacs	(Rs Lacs)	(Months)
Medium Term Investment (12 to 24 Month)				
Replacement of pumps with Energy Efficient Pump: **5 Hp Hostel Building**	3,072	0.22	0.37	20-21
Replacement of Conventional Lights with Energy Efficient LED lights	15,436.8	1.08	1.88	20-21
Replacement of pumps with Energy Efficient Pump: **2 Hp Hostel Building**	891	0.06	0.12	23-24
Total	**19,400**	**1.36**	**2.37**	**20-21**
Long Term Investment (More than 24 Month)				
Replacement of pumps with Energy Efficient Pump: **2 Hp Main Building**	719	0.05	0.12	28-29
Replacement of Conventional Fans with BLDC Fans	57781.8	4.04	19.12	56-57
Installation of Solar Photo Voltaic Cell	13,800	0.97	5.00	62-63
Total	**72,301**	**5.06**	**24.24**	**57-58**
Garnd Total	**91,701**	**6.42**	**26.61**	**49-50**

CHAPTER 1 INTRODUCTION

1.1 The Project

With the advent of the energy crisis and exponential hikes in the costs of different forms of energy, Energy Audit is manifesting its due importance in every establishment. Energy Audit helps to understand more about the way energy is used in any establishment and helps in identifying areas where waste may occur and scope for improvement exists.

It was with this objective that "**Association of Energy Conservation & Environment Protection",** 32-B, Bhagirathi Puram, Engineers Enclave, G.M.S Road, Dehradun, Uttarakhand, was entrusted with the job of conducting an Energy Audit of "Doon (PG) College of Agriculture Science and Technology, Dehradun".

1.2 Scope of Work

The Broad Scope of work was to:

1. **Electrical Distribution System**
    a) Review of present electrical distribution like cable loading, normal & emergency loads, electricity distribution in various areas/floors, etc.
    b) Study of Reactive Power Management and option for power factor improvement.
    c) Study of power quality issues like Harmonics, current unbalance, voltage unbalance, etc.
    d) Exploring the Energy Conservation Options (ENCON) in the electrical distribution system.
    e) Load survey regarding electrical energy consumption in the entire building.

2. **Lighting System**
    f) Review of a present lighting system, lighting inventories, etc.
    g) Estimation of lighting load at various locations like different floors, outside (campus) light, pump house, and other important locations.
    h) Detail Lux level survey at various locations and comparison with acceptable standards.
    i) Study of a present lighting control system and recommendations for improvement.
    j) Exploring the Energy Conservation Options (ENCON) in the lighting system.
3. **Air-Conditioning System**
    a) Review of AC
    b) Performance Assessment of Window/Split AC
    c) Analysis of AC Performance like an estimation of Energy Efficiency Ratio (EER i.e. KW/TR), Specific Energy Consumption (KW/TR) of AC, comparison of the operating data with the design data.

d) Exploring the Energy Conservation Options (ENCON) in AC system.

4. **Water pumping System**

a) Water pumping system efficiency improvement by retrofit or new installation.

b) Parameters Measured and Observed

c) Pump discharge flow

d) Suction head

e) Discharge head

f) Operating hours on year basis

g) Exploring the Energy Conservation Options (ENCON) in Water Pumping system.

5. Cost-Benefit Analysis of each ENCON option indicating a simple payback period, return on Investment.
6. Preparation & submission of Draft Energy Audit Report to "SL Education Institute, Pallupura Ghosi, Moradabad".
7. Preparation & submission of Detail Project Report after modification and changes made on the draft report in consultation with the "SL Education Institute, Pallupura Ghosi, Moradabad".
8. The recommendations have been backed up with techno-economic calculations including the estimated investments required for the implementation of the suggested measures and the payback period. Measurements have been made using appropriate instrumentation support for time-lapse and continuous recording of the operational parameters.

1.3 METHODOLOGY

The methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and Energy savings includes the following:

- Discussions with the concerned officials for identification of major areas of focus and other related systems.
- A team of engineers visited the Site and had discussions with the concerned officials/ supervisors to collect data/ information on the operations and Load Distribution within the Building. The data were analyzed to arrive at a **baseline 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.
- Computation and **in-depth analysis** of the collected data, including utilization of computerized analysis and other techniques as appropriate, were done to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.

1.4 INSTRUMENTATION SUPPORT

Instruments used for undertaking the audit include the following:

- Electric Load Manager with appropriate CTs & PTs for Power Measurements with recording facilities.
- Dual Type Digital Temperature (°C/°F) Measuring Device with appropriate probes;
- Ultra-Sonic Flow Meter
- Pressure Gauges
- Anemometers
- Lux Meter
- Hygrometer

CHAPTER 2 BASE LINE DATA

2.1 GENERAL DETAILS

Contact Details		
Brief description of Assignment	:	Detailed Energy Audit of Electrical Systems & Utility Equipments.
Name & Address of the Building	:	Doon (PG) College of Agriculture Science and Technology, Selaqui, Dehradun-248011
Operational Days	:	250 days per annum
Contact Officer	:	DCAST/Plu/09/22/73 ; Dt; 06/09/2022
Power		
Source	;	Uttarakhand Power Corporation Limited
Sanctioned Load	:	89 KVA
Annual Purchased Power Consumption	:	
Aug 2021-July-22	:	1,76,792 kWh 1,80,916 kVAh
Annual Purchased Power Bill	:	
Aug 2021-July-22	;	Rs. 12,36,760
Average Purchased Power Cost	:	
Aug 2021-July-22	;	Rs. 7.00 per kWh Rs. 6.84 per kVAh
Average Energy Cost		
Aug 2021-July-22		Rs. 5.85 per kVAh

CHAPTER 3 POWER CONSUMPTION

3.1 PURCHASED POWER

Doon (PG) College of Agriculture Science and Technology, Dehradun, draws power from the Uttarakhand Power Corporation Limited, at 0.400 kV. The contracted load of the college is 89 kVA.

3.2 REACTIVE POWER COMPENSATION

Based on the electricity bills, it was observed that the power factor varies from 0.96-to 0.98 i.e., the average power factor was 0.98 which appears to be satisfactory. The building is being billed on a kVAh basis; therefore, the effect of the power factor is inbuilt in the billing structure. The minimum, maximum, and average PF is as follows

Description	Power Factor
Min. PF	0.96
Max. PF	0.98
Average PF	0.98

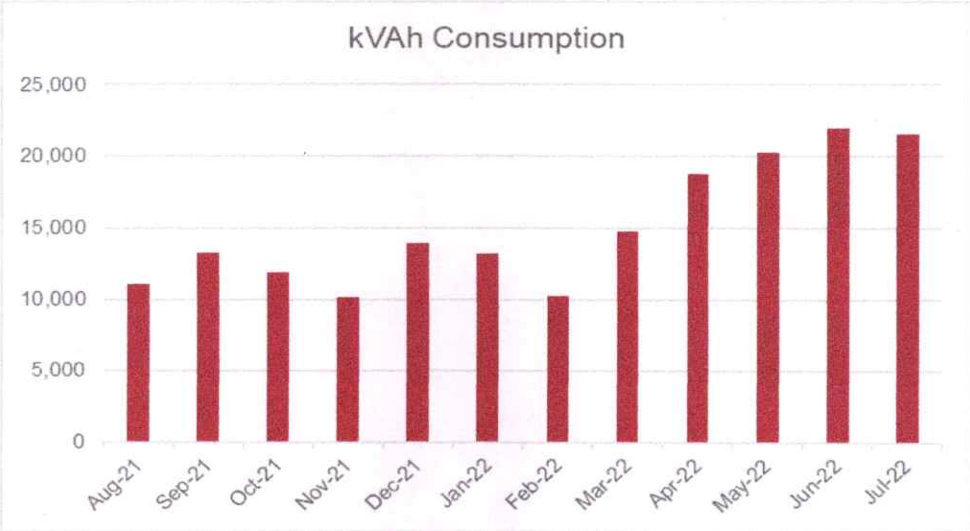
3.3 Purchased Power Consumption Pattern

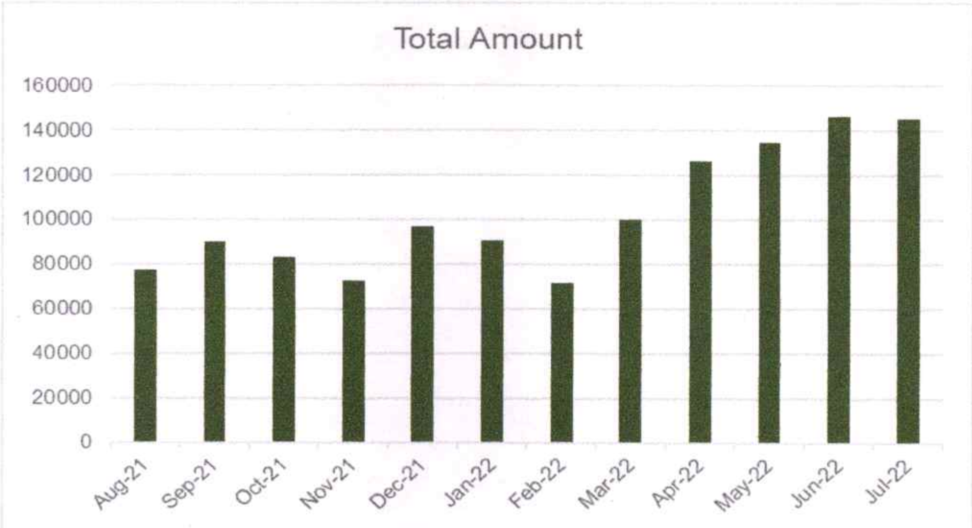
3.3.1 Aug-2021-July-2022

Month	Contracted Demand	Recorded Demand	Unit Consumption		PF	Energy Charges	Fixed Charges	FCA Charges	Electricity Duty	Green Energy Cess	Total
	KVA	KVA	kWh	kVAh		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Aug-21	89	50	10,804	11,072	0.98	64,218	8,010	775	3,241	1,080	77,324
Sep-21	89	49	12,860	13,232	0.97	76,746	8,010	926	3,858	1,286	90,279
Oct-21	89	47	11,492	11,820	0.97	68,556	8,010	2,246	3,448	1,149	83,409
Nov-21	89	39	9,728	10,112	0.96	58,650	8,010	1,921	2,918	973	72,472
Dec-21	89		13,668	13,956	0.98	80,945	8,010	2,652	4,100	1,367	97,074
Jan-22	89	45	13,016	13,200	0.99	76,560	8,010	1,320	3,905	1,302	90,413
Feb-22	89	41	9,960	10,212	0.98	59,230	8,010	1,021	2,988	996	71,606
Mar-22	89	56	14,432	14,756	0.98	85,585	8,010	1,476	4,330	1,443	100,336
Apr-22	89		18,484	18,792	0.98	110,873	8,455	0	5,545	1,848	126,721
May-22	89	68	19,824	20,276	0.98	119,628	8,455	0	5,947	1,982	135,119
Jun-22	89	76	21,444	21,952	0.98	129,517	8,455	0	6,433	2,144	146,549
Jul-22	89	72	21,080	21,536	0.98	127,062	8,455	1,508	6,324	2,108	145,457
Total			**176,792**	**180,916**	**0.98**	**1,057,568**	**97,900**	**13,844**	**53,038**	**17,679**	**1,236,760**

Note: Dec-21 and April-22 bill was not provided by the college management. For kVAh consumption and kWh Consumption, we have taken the, units mentioned in the next month bill for that month.


kWh Consumption
25,000
20,000
15,000
10,000
5,000
0
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22


kVAh Consumption
25,000
20,000
15,000
10,000
5,000
0
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22


Total Amount
160000
140000
120000
100000
80000
60000
40000
20000
0
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22

CHAPTER 4 BUILDING LOAD PROFILE

4.1 LOADING ON MAIN INCOMER

The total loading was recorded on LT Side and the averaged-out readings are given herein:

4.1.1 Load Profile

Parameter	Unit	Min	Max	Average
L1 RMS Voltage	V	34.90	254.40	238.53
L2 RMS Voltage	V	33.80	244.00	229.95
L3 RMS Voltage	V	35.60	261.00	241.16
L1 RMS Current	Amp	7.01	70.73	42.27
L2 RMS Current	Amp	7.01	104.89	78.40
L3 RMS Current	Amp	4.47	59.21	40.80
L1 PF	-	0.963	0.998	0.987
L2 PF	-	0.980	0.999	0.996
L3 PF	-	0.929	0.975	0.953
L1 Active Power	KW	0.24	17.96	9.95
L2 Active Power	KW	0.23	25.57	17.96
L3 Active Power	KW	0.15	15.07	9.38
Total Active Power	**KW**	**0.62**	**58.59**	**37.29**
L1 Apparent Power	KVA	0.24	17.99	10.08
L2 Apparent Power	KVA	0.24	25.59	18.03
L3 Apparent Power	KVA	0.16	15.45	9.84
Total Apparent Power	**KVA**	**0.64**	**59.04**	**37.95**
L1 THD Voltage	%	1.40	38.90	3.25
L2 THD Voltage	%	1.50	38.80	2.92
L3 THD Voltage	%	1.50	38.90	3.09
L1 THD Current	%	2.80	11.30	6.53
L2 THD Current	%	3.60	6.30	4.74
L3 THD Current	%	4.00	8.40	5.98

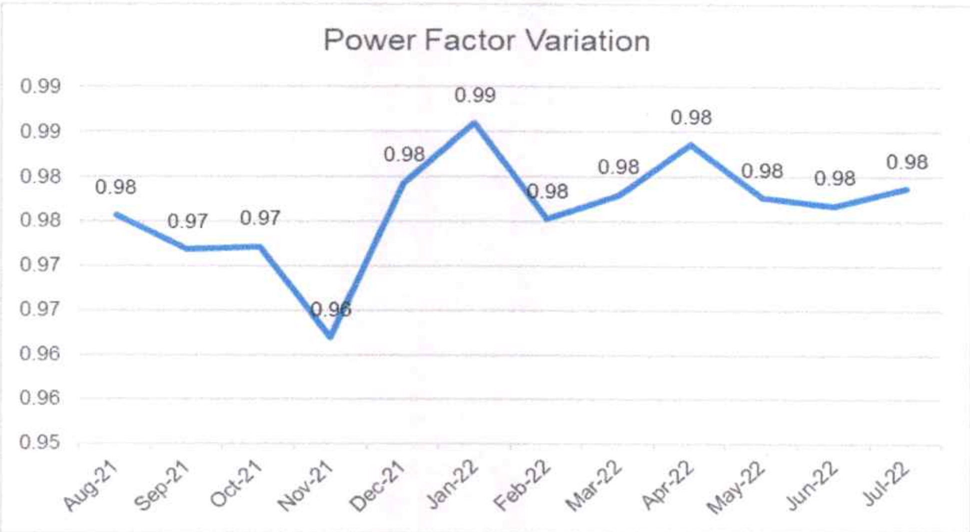
CHAPTER 5 REACTIVE POWER COMPENSATION

5.1 Capacitor Bank Installed

College has not installed an Automatic power factor controller (APFC) for Power factor improvement. However, if we look at the monthly power factor, it varies from 0.96-to 0.98, and the avg. PF is 0.98, which is satisfactory.

5.2 Actual Power Factor from Bill

Month	Power Factor
Aug-21	0.98
Sep-21	0.97
Oct-21	0.97
Nov-21	0.96
Dec-21	0.98
Jan-22	0.99
Feb-22	0.98
Mar-22	0.98
Apr-22	0.98
May-22	0.98
Jun-22	0.98
Jul-22	0.98
Average	**0.98**



5.3 REMARK

The building has not installed any capacitor bank panel on the LT side for PF improvement. However; if we look at the overall average monthly power factor is 0.98, which is satisfactory. The building is being billed on a kVAh basis; therefore, the effect of the power factor is inbuilt into the billing structure. The power factor is 0.98, so no specific recommendation has been made on the improvement of PF.

CHAPTER 6 POWER QUALITY

6.1 POWER QUALITY & HARMONICS

Equipment based on frequency conversion techniques generates harmonics. With the increased use of such equipment, **harmonics-related problems** have been enhanced.

The harmonic currents generated by different types of loads travel back to the source. While traveling back to the source, they generate harmonic voltages, following simple Ohm's Law. Harmonic voltages, which appear on the system bus, are harmful to other equipment connected on the same bus. In general, sensitive electronic equipment connected to this bus will be affected.

The Harmonics Level on the LT Side was measured, details of which are as under: -

The Harmonic Voltage and Current Limitations set forth by IEEE 519 1992 are:

- Maximum Individual Frequency Voltage Harmonic: 3%
- Total Harmonic Distortion of the Voltage: 5%

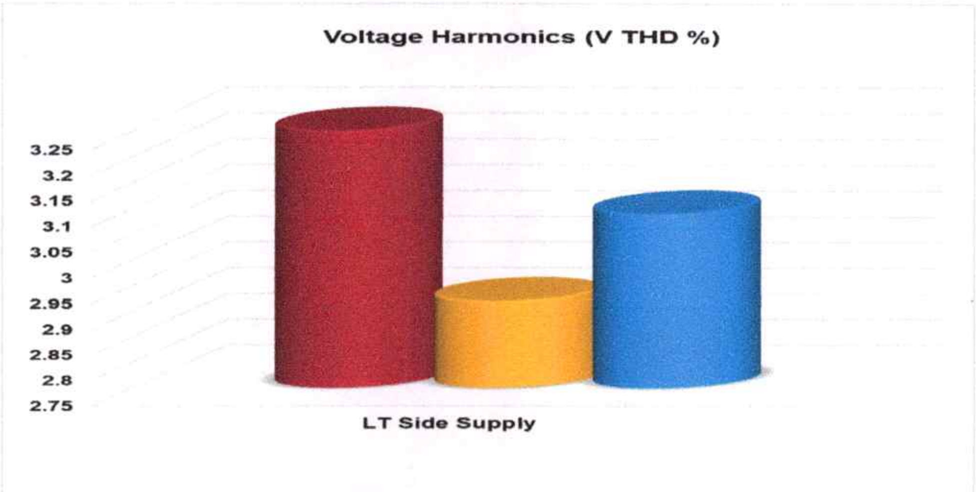
harmonic current limitations

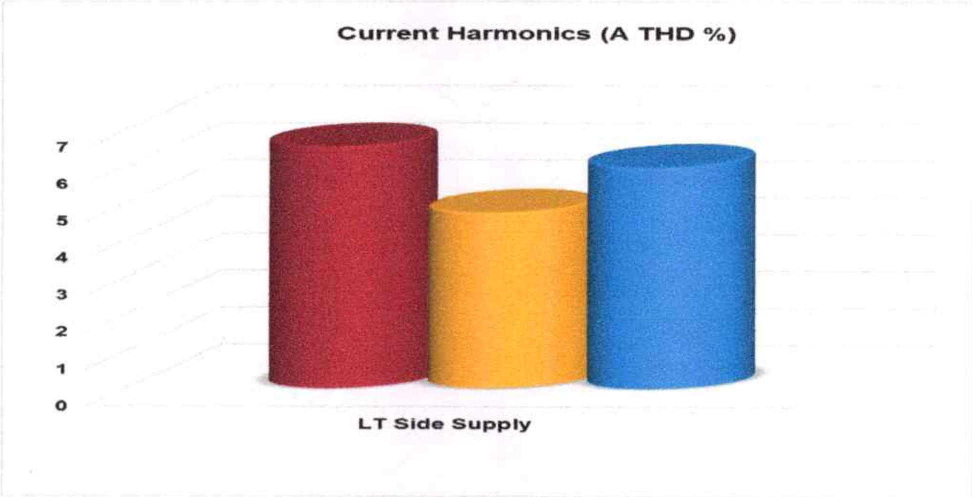
Maximum Harmonic Current Distortion in Percent of IL
120 Volt through 69 KV
Individual Harmonic Order (Odd Harmonics)

ISC/IL	h<11	11<h<17	17<h<23	23<h<35	35<h	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits
TDD refers to Total Demand Distortion based on the average demand current at the fundamental frequency and measured at the PCC (Point of Common Coupling).
*All power generation equipment is limited to these values of current distortion regardless of ISC/ IL value.
ISC = Maximum short-circuit current at PCC.
IL = Maximum demand load current (fundamental) at the PCC.
h = Harmonic number.

Particulars	LT Side Supply
Voltage Harmonics (V THD)	
"R" Phase	3.25
"Y" Phase	2.92
"B" Phase	3.09
Current Harmonics (A THD)	
"R" Phase	6.53
"Y" Phase	4.74
"B" Phase	5.98





As detailed above, the voltage harmonics levels were around 2.92 – 3.25 % and the levels of the current harmonics were 4.74 – 6.53%. **The Overall Voltage harmonics and the current harmonics are within limits.**

If the Harmonics level is on the higher side then appropriate harmonic filters may have to be installed in the system.

Different technologies are available to mitigate the harmonics of the system. These include:

Detuned or broadband harmonic filters: these filter banks are tuned to a frequency just below the predominant harmonic frequency. If the predominant harmonic frequency is say, 5th, it is normal practice to tune the filters to 189 Hz, or 3.78^{th} harmonic, in 50 Hz systems.

Active Harmonic Filters: *these units are designed in such a manner that, they will inject harmonic* frequencies into the system, which will be in anti-phase of the load harmonic frequencies. This will effectively free the source being loaded due to harmonics.

6.2 Observations & Suggestions:

It is clear from the above data that the Overall Voltage harmonics and the Current harmonics are within the limits.

6.3 Major Causes of Harmonics

Devices that draw non-sinusoidal currents when a sinusoidal voltage is applied create harmonics. Frequently these are devices that convert AC to DC. Some of these devices are listed below:

Electronic Switching Power Converters

- Computers, Uninterruptible power supplies (UPS), Solid-state rectifiers
- Electronic process control equipment, PLCs, etc
- Electronic lighting ballasts, including light dimmer

- Reduced voltage motor controllers

Arcing Devices

- Discharge lighting, e.g. Fluorescent, Sodium, and Mercury vapor
- Arc furnaces, Welding equipment, Electrical traction system, Ferromagnetic Devices
- Transformers operating near saturation level
- Magnetic ballasts (Saturated Iron core)
- Induction heating equipment, Chokes, Motors

Appliances

- TV sets, air conditioners, washing machines, microwave ovens
- Fax machines, photocopiers, printers

These devices use power electronics like SCRs, diodes, and thyristors, which are a growing

Percentage of the load in industrial power systems.

Many problems can arise from harmonic currents in a power system. Some problems are easy to detect; others exist and persist because harmonics are not suspected. Higher RMS current and voltage in the system are caused by harmonic currents, which can result in any of the problems listed below:

Blinking of Incandescent Lights	Transformer Saturation
Capacitor Failure	Harmonic Resonance
Circuit Breakers Tripping	Inductive Heating and Overload
Conductor Failure	Inductive Heating
Electronic Equipment Shutting down	Voltage Distortion
Flickering of Fluorescent Lights	Transformer Saturation
Fuses Blowing for No Apparent Reason	Inductive Heating and Overload
Motor Failures (overheating)	Voltage Drop
Neutral Conductor and Terminal Failures	Additive Triplen Currents
Electromagnetic Load Failures	Inductive Heating
Overheating of Metal Enclosures	Inductive Heating
Power Interference on Voice Communication	Harmonic Noise
Transformer Failures	Inductive Heating

CHAPTER 7 STUDY OF AIR-CONDITIONED SYSTEM

7.1 Systems Installed

Split Air Conditioning units of various capacities are installed at different locations within the building.

Identification	Star Rating	Tonnage	No. of Units	Total Tonnage
Auditorium				
Auditorium Hall	-	2	6	12
Computer Lab				
Room-38	5	1.5	2	3
Guest House				
Room	-	1.5	1	1.5
Central Library				
Hall	5	1.5	8	12
Dean Office				
Office	-	1.5	3	4.5
Director Office				
Office	-	1.5	1	1.5
Principal Office	-	1.5	1	1.5
Examination Cell	-	1.5	1	1.5
LAB				
Room-17	-	1.5	1	1.5
Botany	-	1.5	1	1.5
Zoology	-	1.5	1	1.5
Food Technology	-	1.5	1	1.5
New Building				
Conference Room	-	1.5	2	3
Total			**29**	**46.5**

7.1.1 Indicative TR Load Profile for Air Conditioning

o Small Office Cabins	:	0.1 TR m^2
o Medium Size Office with 10-30 people occupancy with Central A/c	:	0.06 TR/m^2
o Large Multistoried office complex with Central A/c	:	0.04 TR/m^2

7.1.2 Criteria considered for Performance Evaluation of Split & Window A/Cs

Type of AC	Capacity (TR)	Specific Power Consumption (SPC) range of Star Labelled A/Cs (KW/TR)		Permissible Limit is 5% higher than the SPC of Star Labelled A/Cs (KW/TR)
Window	1.5	1.24	1.43	1.5
Window	2	1.27	1.33	1.39
Split	1.5	1.1	1.32	1.38
Split	2	1.06	1.31	1.37

7.2 PERFORMANCE OF AC UNITS:

Particulars	Capacity (TR)	Power Drawn (KW)	TR Delivered	Coff. Of Performance (COP)	Energy Efficiency Ratio (EER)	SEC (KW/TR)	Remark
Computer Lab							
Room-38	1.50	1.34	1.21	3.18	10.83	1.11	Satisfactory
Central Library							
Hall	1.50	1.36	1.19	3.08	10.49	1.14	Satisfactory
LAB							
Room-17	1.50	1.54	1.12	2.56	8.72	1.38	Slightly Higher
Food Technology	1.50	1.52	1.11	2.57	8.76	1.37	Slightly Higher

Remark: During the audit, performance of AC units was done on sample basics. From the above calculation it is seen that the performance of some AC units is satisfactory and for some it is slightly higher. Hence, it is recommended to replace the old energy inefficient AC units with BEE 5 star rated energy efficient AC unit in phase manned.

CHAPTER 8 LIGHTING SYSTEMS

8.1 LIGHTING

8.1.1 Systems Installed

Conventional and LED lights are installed at various locations in the college premises. Details are as follows

Identification	Conventional Tube light (36 W)	LED (5W)	LED Bulb (9W)	LED (9 W)	LED (12 W)	LED (15 W)	STL LED (20W)	LED PL (36 W)	LED (40W)	LED Light (100W)
Store Block										
Thiess Room	6						6			
Store Room	9									
Store Gallery			1				2			2
Store Block Room-61	8									
Store Block Room-62	8									
New Mess										
New Mess					40					
Kitchen							7			1
Auditorium										
Auditorium Hall		16						26	2	
Wash Room	4									
Carpenter Room	2									
Main Gate	8		2				5			1
Med Room							5			
Forestry Building										
Room-52	4									

Identification	Conventional Tube light (36 W)	LED (5W)	LED Bulb (9W)	LED (9 W)	LED (12 W)	LED (15 W)	STL LED (20W)	LED PL (36 W)	LED (40W)	LED Light (100W)
Room-53	4									
Room-54	3									
Room-55	3									
Room-56	4									
Office	3									
Corridor	1						2			
Room-57	4									
Room-58	4									
Room-59	4									
Room-60	8									
Old Building										
Fishery Staff Room	6									
Fishery Lab	3						4			
Agriculture Lab	4									
Room -33	3									
Library	4						7			
Room-28	4									
Room-32	4									
Corridor 1st Floor	12						2			
Room-31	4									
Room-30	4									

Identification	Conventional Tube light (36 W)	LED (5W)	LED Bulb (9W)	LED (9 W)	LED (12 W)	LED (15 W)	STL LED (20W)	LED PL (36 W)	LED (40W)	LED Light (100W)
Computer Lab										
Room-38	9									
Room-39	6						1			
Room-37	3									
Room-36	3									
Room-35	4									
Corridor 2nd Floor	4						4			
Management Office 2nd Floor			2				2			
Management Office 3rd Floor	4									
Room-46	3									
Room-47	3									
Room-45	5									
Room-48	4									
Room-44	6									
Room-43	2									
Room-50	2						2			
Room-49	4									
Corridor 3rd Floor			2				4			
Guest House										
Room	1		7			4				3
Central Library										

Identification	Conventional Tube light (36 W)	LED (5W)	LED Bulb (9W)	LED (9 W)	LED (12 W)	LED (15 W)	STL LED (20W)	LED PL (36 W)	LED (40W)	LED Light (100W)
Hall					78					
Dean Office										
Office		6	1		16	28				
Mandir										
Hall							6			
Director Office										
Director Office						15				
Account Office	1						6			
Principal Office						8	1			
Corridor					3					1
Examination Cell	1					7	1			
College Office	1					4	1			
LAB										
Horticulture	3									
Biochemistry	7						2			
Soil Science	7						1			
Plant Protection	1						5			
Environment Science	2						1			
Room-17							1			
Microbiology	4									
Corridor			1				1			

Identification	Conventional Tube light (36 W)	LED (5W)	LED Bulb (9W)	LED (9 W)	LED (12 W)	LED (15 W)	STL LED (20W)	LED PL (36 W)	LED (40W)	LED Light (100W)
Room-21	1						1			
Botany			12							
Plant Tissue Culture	2			10						
Agronomy				16						
Forestry Lab				16						
Agriculture Engg.				18						
Zoology				12						
Sforce Exam				9						
Extension Lab				15						
Food Technology				20						
Corridor				18						
New Building										
Room-101	9						3			
Room-102	5									
Room-103	8									
Room-104	4									
Room-105	7									
Room-106	6									
Corridor Ground Floor	17									
Room-107	8									
Room-108	8									

Identification	Conventional Tube light (36 W)	LED (5W)	LED Bulb (9W)	LED (9 W)	LED (12 W)	LED (15 W)	STL LED (20W)	LED PL (36 W)	LED (40W)	LED Light (100W)
Room-109	4									
Room-110	5									
Room-111	5									
Room-112	6									
Room-113	9									
Room-114	4									
Room-115	10									
Room-116	9									
Room-117	6									
Room-118	8									
Room-119	4									
Room-120	4									
Corridor 1st Floor	14									
Room-121	3									
Room-122	4									
Room-123	6									
Front			8				1			
Room-124	8									
Room-125	4									
Room-126	7									
Room-127	6									

Identification	Conventional Tube light (36 W)	LED (5W)	LED Bulb (9W)	LED (9 W)	LED (12 W)	LED (15 W)	STL LED (20W)	LED PL (36 W)	LED (40W)	LED Light (100W)
Room-128	8									
Room-129	4									
Room-130	4									
Guard Room							2			
Corridor 2nd Floor	16									
Conference Room		18								
Seminar Room		16						2		3
Ajay Boys Hostel										
Washroom	4									
Corridor Ground Floor	6									
Room-Ground Floor	6						31			
Corridor 1st Floor	4									
Room-1st Floor	28						17			
Corridor 2nd Floor	7									
Room-2nd Floor	23						22			
Total Count	**536**	**56**	**36**	**134**	**137**	**66**	**156**	**28**	**2**	**11**
Total Wattage	**19296**	**280**	**324**	**1206**	**1644**	**990**	**3120**	**1008**	**80**	**1100**

8.2 Other Loads

Identification	Ceiling Fan (75 W)	Wall Fan (60W)	Exhaust Fan (60W)	Exhaust Fan (410W)	Computer (100W)	Printer (100W)	Fridge (200W)	TV (100W)
Store Block								
Thiess Room	6				3			
Store Room	8	2			1			
Store Gallery	4							
Store Block Room-61	8							
Store Block Room-62	8							
New Mess								
New Mess	45		4					
Kitchen	5			2				
Auditorium								
Auditorium Hall		10						
Carpenter Room	2							
Main Gate	1							
Med Room	3							
Forestry Building								
Room-52	4							
Room-53	4							
Room-54	4							
Room-55	4							
Room-56	4							

Identification	Ceiling Fan (75 W)	Wall Fan (60W)	Exhaust Fan (60W)	Exhaust Fan (410W)	Computer (100W)	Printer (100W)	Fridge (200W)	TV (100W)
Office	2							
Room-57	4							
Room-58	4							
Room-59	4							
Room-60	7							
Old Building								
Fishery Staff Room	3							
Fishery Lab	4							
Agriculture Lab	4							
Room -33	4							
Library	8							
Room-28	4							
Room-32	4							
Corridor 1st Floor	2							
Room-31	4							
Room-30	4							
Computer Lab								
Room-38	8				51			
Room-39	8							
Room-37	4							
Room-36	4							

Identification	Ceiling Fan (75 W)	Wall Fan (60W)	Exhaust Fan (60W)	Exhaust Fan (410W)	Computer (100W)	Printer (100W)	Fridge (200W)	TV (100W)
Room-35	4							
Management Office 2nd Floor	2							
Management Office 3rd Floor	3							
Room-46	4							
Room-47	4							
Room-45	8							
Room-48	4							
Room-44	8							
Room-43	4							
Room-50	4							
Room-49	4							
Guest House								
Room	1							
Central Library								
Hall	40				12	1		
Dean Office								
Office	8	2			2	2	1	1
Mandir								
Director Office								
Director Office	1		1					1
Account Office	5		1				1	

Identification	Ceiling Fan (75 W)	Wall Fan (60W)	Exhaust Fan (60W)	Exhaust Fan (410W)	Computer (100W)	Printer (100W)	Fridge (200W)	TV (100W)
Principal Office	1							
Corridor	1							
Examination Cell	4		1		2	3		
College Office	2	1			3	2		
LAB								
Horticulture	4						1	
Biochemistry	3		1					
Soil Science	4			1				
Plant Protection	2		1					
Environment Science	1							
Room-17	1				1			
Microbiology	2	2		1				
Room-21	1							
Botany	5						1	
Plant Tissue Culture	3						1	
Agronomy	6		1					
Forestry Lab	9		1					
Agriculture Engg.	8							
Zoology	4							
Sforce Exam	4							
Extension Lab	5				1			

Identification	Ceiling Fan (75 W)	Wall Fan (60W)	Exhaust Fan (60W)	Exhaust Fan (410W)	Computer (100W)	Printer (100W)	Fridge (200W)	TV (100W)
Food Technology	6							
Corridor	6							
New Building								
Room-101	3							
Room-102	4							
Room-103	8							
Room-104	4							
Room-105	8							1
Room-106	6							
Room-107	8							1
Room-108	8							
Room-109	4							1
Room-110	4							
Room-111	4							
Room-112	4	6						
Room-113	8							
Room-114	4							1
Room-115	8							1
Room-116	8							1
Room-117	8							1
Room-118	8							

Identification	Ceiling Fan (75 W)	Wall Fan (60W)	Exhaust Fan (60W)	Exhaust Fan (410W)	Computer (100W)	Printer (100W)	Fridge (200W)	TV (100W)
Room-119	4	1						
Room-120	4				1	1		
Room-121	4							
Room-122	4							
Room-123	8							
Front	1							
Room-124	8							
Room-125	4							
Room-126	8							
Room-127	8							1
Room-128	8							
Room-129	4							
Room-130	4							
Guard Room	1	1						
Conference Room					1			
Ajay Boys Hostel								
Room-Ground Floor	35							1
Room-1st Floor	43							
Room-2nd Floor	44							
Total Count	**683**	**25**	**11**	**4**	**78**	**9**	**5**	**11**
Total Wattage	**51225**	**1500**	**660**	**1640**	**7800**	**900**	**1000**	**1100**

8.3 Recommendations

8.3.1 Optimization of the Main Incomer Voltage on Main Panel

The average voltage on the LT side was around 237 V. This may be an adequate voltage for motive loads like motors etc, but for the lighting systems normally, the voltage should be around 210 volts (phase to neutral). A reduction of around 8% in the lighting voltage can reduce power consumption by around 12%.

8.3.2 Replacement of Inefficient Conventional Lamps with Energy Efficient LED Lights

Around 536 No's of 36W Conventional Tube lights are installed in college campus. These lights must be replaced with energy efficient LED Lights. The resultant savings are as follows:

Particulars	Present Situation	Post Implementation
Conventional Tube Lights may be replaced with Energy Efficient (EE) LED Lights		
Power drawn per Conventional STL (Watts)	36	20
No of lights to be replaced	536	
Net Reduction in the Power Drawn	**8,576 Watts**	
➲ Total reduction in the power Drawn	= 8,576 Watts	
➲ Working Hours per annum	= 1,800 hrs. (300 days X 6 hrs.)	
➲ Energy Savings per annum	= 15,436.8 kWh	
➲ Electric Power Rate	= Rs 7.00 per kWh	
➲ Monitory Benefit	= **Rs 1,08,057.6**	
➲ Estimated Investments @ Rs 350 per LED	= Rs 1,87,600	
➲ Simple Payback Period	= **20-21 months**	

8.3.3 Replacement of Inefficient Fans with Energy Efficient BLDC Fans

Around 683 No's of 75W ceiling Fans are installed in college campus. These fans must be replaced with energy efficient BLDC fan. The resultant savings are as follows:

Particulars	Present Situation	Post Implementation
Conventional Fans may be replaced with Energy Efficient (EE) BLDC Fans		
Power drawn per Conventional Fan (Watts)	75	28
No of fans to be replaced	683	
Net Reduction in the Power Drawn	**32,101 Watts**	
➲ Total reduction in the power Drawn	= 32,101 Watts	
➲ Working Hours per annum	= 1,800 hrs. (300 days X 6 hrs.)	
➲ Energy Savings per annum	= 57,781.8 kWh	

Particulars	Present Situation	Post Implementation
➲ Electric Power Rate	= Rs 7.00 per kWh	
➲ Monitory Benefit	= **Rs 4,04,472.6**	
➲ Estimated Investments @ Rs 2800 per BLDC	= Rs 19,12,400	
➲ Simple Payback Period	= **56-57 months**	

8.3.4 Lighting Control

Although there is no simpler way to reduce the amount of energy consumed by the lighting system than to manually turn it OFF whenever not needed, this is not done as often as it could be. In response, automatic lighting control strategies can be adopted:

- Scheduling Control: Use a time scheduling device to control lighting systems according to predetermined schedules

A central processor with relays is usually capable of controlling several output channels, each of which may be assigned to one or more lighting circuits. Overrides can be provided to accommodate individuals who use the space during scheduled off-hours.

- Daylighting: Control lights in response to the presence of daylight illumination in the space
- Lumen Maintenance: gradually adjust the electric light levels over time to correspond with the depreciation of light output from aging lamps.
- Occupancy Sensing: Control light in response to the presence or absence of people in the space.

CHAPTER 9 STUDY OF WATER PUMPS

9.1 RATED SPECIFICATIONS OF WATER SUPPLY PUMPS

In college campus total 4 No's of Borewell pumps (2 HP X2 No's and 5 HP X 2 No's) are installed. 2 No's of Pumps (5 Hp x 1 No' and 2 Hp x 1 No') are installed in the main building side and the other 2 No's of Pumps (5 Hp x 1 No' and 2 Hp x 1 No') are installed in the Hostel Building side. The Running of 2 Hp main building pump is 4 Hrs./day, 5 hp main building pump is 1 Hr./day, 2 hp (Mess) hostel building pump is 4 hrs/day and 5 hp garden pump hostel building is 4 hrs/day.

9.2 PUMP PERFORMANCE

During the audit, Flow of the pump was measured using the portable ultrasonic flow meter, discharge pressure was using the pressure gauge, suction pressure was calculated as per the water level depth. The performance of the pumps are as follows:

Particulars	Unit	2 Hp Pump (Main Building)	5 Hp Pump (Main Building)	2 Hp Mess Pump Hostel Building	5 Hp Garden Pump Hostel Building
Flow	(m3/hr.)	3.87	14.4	3.45	2.2
Suction Pressure	(Kg/cm2)	-2.7	-2.7	-2.7	-2.7
Discharge Pressure	(Kg/cm2)	1.8	1.4	1.8	9.2
Head	(meter)	45	41	45	119
Density of Fluid	(Kg/m3)	1000	1000	1000	1000
Acceleration due to gravity	(m/s2)	9.81	9.81	9.81	9.81
Hydraulic Power	(KW)	0.47	1.61	0.42	0.71
Actual Power Consumption	(KW)	1.46	3.69	1.51	3.85
Motor Efficiency	%	85%	85%	85%	85%
System Efficiency	%	**32.54**	**43.59**	**28.06**	**18.52**
Pump Efficiency	%	**38.29**	**51.28**	**33.01**	**21.79**

Remark: The efficiency of 2 Hp pump main building is 38.29%, 2 hp mess pump hostel building is 33.01% and 5 Hp garden pump hostel building is 21.79% which is on the lower side.

The efficiency of 5 Hp pump main building is 51.28% which is satisfactory.

9.3 RECOMMENDATION;

The efficiency of 2 Hp pump main building is 38.29%, 2 hp mess pump hostel building is 33.01% and 5 Hp garden pump hostel building is 21.79% which is on the lower side, hence, it is recommended to replace these pumps with energy efficient pumps. The resultant savings are as follows;

Description	Unit	2 Hp Pump (Main Building	2 Hp Mess Pump Hostel Building	5 Hp Garden Pump Hostel Building
Measured Pump Efficiency	%	38.29	33.01	21.79
Average Power consumption	Kw	1.46	1.51	3.85
Operating days per annum	days	300	300	300
Operating hours per day	Hr.	4	4	4
Energy consumption per Year	KWH per Annum	1,750	1,809	4,622
Proposed System				
Pump Efficiency	%	65	65	65
Power consumption	Kw	0.86	0.77	1.29
Operating days per annum	days	300	300	300
Operating hours per day	Hr.	4	4	4
Energy consumption	kWH per Annum	1,031	919	1,549
Net reduction in power	Kwh	719	891	3,072
Electricity Cost	Rs/kwh	7.00	7.00	7.00
Annual Cost Saving	**Rs.**	**5,034.49**	**6,233.52**	**21,507.16**
Investment for Pump	**Rs.**	**12,000.00**	**12,000.00**	**37,000.00**
Simple Payback Period	**Month**	**28-29**	**23-24**	**20-21**

CHAPTER 10 STUDY OF DG SET

10.1 D.G. Rated Specifications

The college, has installed 1 No DG Set for in-house power generation. The rated specification of DG is as follows

DG Set Installed:

Identification	Units	DG-1
Alternator		
Make		Kirloskar
KVA Rating	KVA	62.5
Engine		
Make		Jacson
Year of Manufacturing	Yeas	2007

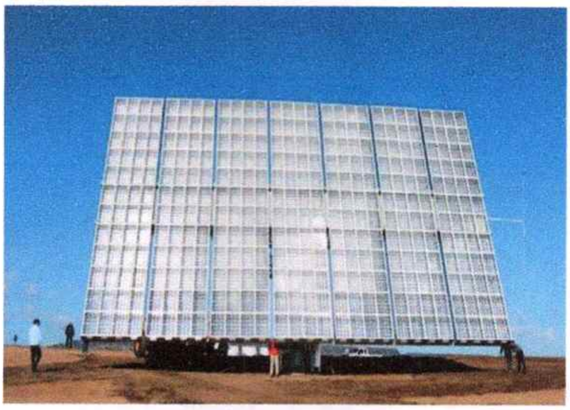
10.2 Remarks

The operation of the DG set is limited to power cuts and testing only. Thus, no specific *recommendations have been made.*

CHAPTER 11 OTHER POSSIBLE AREAS FOR ENERGY SAVINGS

11.1 Installation of Solar Photovoltaic Cell (SPV)

Solar Photo Voltaic Cell system is not installed in the college campus. It is recommended to install a 10 KWp Solar Photovoltaic Cell (Grid Connected) for Power Generation for lighting load in the building, which would supply light to the lighting feeder. **Solar photovoltaic technologies** convert solar energy into useful energy forms by directly absorbing solar photons—particles of light that act as individual units of energy—and either converting part of the energy to electricity.



The resultant monitory benefit has been worked out as follows:

Parameters	Unit	Value
Solar photovoltaic capacity	KWp	10
Unit generation per day	kWh/kWp	4.6
Number of operating days in a year	Number	300
Annual unit generation	kWh/year	13,800
Electricity charges	INR/kWh	7
Annual monetary saving	**INR/Year**	**96,600**
Price of 30 KWp Solar Plant	**INR**	**5,00,000**
Simple payback period	**Months**	**62-63**

11.2 Day Light Harvesting

Although there is no simpler way to reduce the amount of energy consumed by the lighting system than to manually turn it OFF whenever not needed, this is not done as often as it could be. In response, automatic lighting control strategies can be adopted:

- Scheduling Control: Use a time scheduling device to control lighting systems according to predetermined schedules

A central processor with relays is usually capable of controlling several output channels, each of which may be assigned to one or more lighting circuits. Overrides can be provided to accommodate individuals who use the space during scheduled off-hours.

- Daylighting: Control lights in response to the presence of daylight illumination in the space
- Lumen Maintenance: gradually adjust the electric light levels over time to correspond with the depreciation of light output from aging lamps.
- Occupancy Sensing: Control light in response to the presence or absence of people in the space

These are automatic scheduling devices that detect motion and turn ON / OFF the lights accordingly. Most of these devices can be calibrated for sensitivity and for the length of time delay between the last detected occupancy and extinguishing of light. Occupancy sensors typically consist of a motion detector, a control unit, and a relay.

Occupancy-linked control can be achieved using infrared, acoustic, ultrasonic, or microwave sensors, which detect either movement or noise in room spaces. These sensors switch lighting on when occupancy is detected, and off again after a set time period when no occupancy movement is detected. They are designed to override manual switches and to prevent a situation where lighting is left on in unoccupied spaces. With this type of system, it is important to incorporate a built-in time delay, since occupants often remain still or quiet for short periods and do not appreciate being plunged into darkness if not constantly moving around.

Daylight Harvesting is the term used in sustainable architecture and the building controls for a control system that reduces the use of artificial lighting with electric lamps in building interiors when natural daylight is available, in order to reduce energy consumption. The concept of daylight harvesting is simple. Digital photo sensors detect daylight levels and automatically adjust the output level of electric lighting to create a balance. The goal is energy savings.

Until now there have been barriers to widespread acceptance of daylight harvesting. This is due in part to complications associated with commissioning. With the availability of integrated micro panel lighting controls, with 2 or 4 switching outputs daylight harvesting is feasible. The features normally include unique set points, delays, and adjustment curves for every relay.

Institute management installed motion sensors in lighting in toilets, Rooms. AECEP acknowledges and appreciates the commitment of the management toward the conservation of Energy.

11.3 Timed Based Control or Daylight Linked Control

Timed-turnoff switches are the least expensive type of automatic lighting control. In some cases, their low cost and ease of installation make it desirable to use them where more efficient controls would be too expensive. Newer types of timed-turnoff switches are completely electronic and silent. The best choice is an electronic unit that allows the engineering staff to set a fixed time interval behind the cover plate. This system is recommended for street Lighting applications in the building. Photoelectric cells can be used either simply to switch lighting on and off, or for dimming. They may be mounted either externally or internally. It is however important to incorporate time delays into the control system to avoid repeated rapid switching caused, for example, by fast-moving clouds. By using an internally mounted photoelectric dimming control system, it is possible to ensure that the sum of daylight and electric lighting always reaches the design level by sensing the total light in the controlled area and adjusting the output of the electric lighting accordingly. If daylight alone is able to meet the design requirements, then the electric lighting can be turned off. The energy-saving potential of dimming control is greater than a simple photoelectric switching system.

11.4 Localized Switching

Localized switching should be used in applications, which contain large spaces. Local switches give individual occupants control over their visual environment and also facilitate energy savings. By using localized switching, it is possible to turn off artificial lighting in specific areas, while still operating it in other areas where it is required, a situation which is impossible if the lighting for an entire space is controlled from a single switch.

CHAPTER 12 GENERAL TIPS FOR ENERGY CONSERVATION IN DIFFERENT UTILITY SYSTEMS

12.1 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 underrated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

12.2 Motors

- Properly size to the load for optimum efficiency.
- (High-efficiency motors offer 4 - 5% higher efficiency than standard motors)
- Check alignment.
- Provide proper ventilation
- (For every 10°C increase in motor operating temperature over the recommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- Demand efficiency restoration after motor rewinding.

12.3 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.

12.4 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 units.
- Stop running both pumps -- add an auto-start for an online 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.

12.5 Lighting

- Reduce excessive illumination levels to standard levels using switching, delamping, etc. (Know the electrical effects before doing delamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapor lighting, etc. The efficiency (lumens/watt) of various technologies ranges from best to worst approximately as follows: low-pressure sodium, high-pressure sodium, metal halide, fluorescent, mercury vapor, and incandescent.
- Select ballasts and lamps carefully with high power factors 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 daylighting, skylights, etc.
- Consider painting the walls a lighter color 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.

12.6 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

12.7 BUILDINGS

- Seal exterior cracks/openings/gaps with caulk, gaskets, weatherstripping, 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 the light is required, consider replacing exterior windows with insulated glass blocks.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to your 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 the 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.

12.8 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 blowdown to minimize it.
- Provide proper tools for washing down -- especially self-closing nozzles.
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair of 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 pretreatment 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

12.9 Miscellaneous

- Meter any unmetered utilities. 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 utility contracts to reflect current loads and variations.
- Consider buying utilities from neighbors, 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 the 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 the winter heat tracing that is on in summer.

CHAPTER 13 ENERGY MANAGEMENT STRATEGY

Energy Management should be seen as a continuous process. Strategies should be reviewed annually and revised as necessary. The key activities suggested have been outlined below:

13.1 Identify a strategic Corporate Approach

The starting point in energy management is to identify a strategic corporate approach to energy management. Clear accountability for energy usage needs to be established, appropriate financial and staffing resources must be allocated and reporting procedures initiated. An energy management program requires commitment from the whole organization in order to be successful. A record of Energy consumption must be kept and monitored on regular basis, to optimize Energy consumption. For this, various meters may have to be installed.

13.2 Designate an Energy Manager

An Energy Manager must be identified and time-bound responsibility must be given to him in getting implemented the findings of the Energy Audit points, which the Building / Establishment has planned to implement.

13.3 Set up an Energy Monitoring and Reporting System

Successful energy management requires the establishment of a system to collect/ analyze and report the energy costs and consumption patterns. This will enable an overview of energy use and its related costs, as well as facilitate the identification of savings that might `otherwise not be detected. The system needs to record both historical and ongoing energy use, as well as cost information from billing data and is capable of producing summary reports on a regular basis. This information will provide the means by which trends can be analyzed and reviewed for corrective measures.

13.4 Implement a Staff Awareness and Training Program

A key ingredient to the success of an energy management program is maintaining a high level of awareness among staff. This can be achieved in a number of ways, including formal training, newsletters, posters, and publications. It is important to communicate program plans and case studies that demonstrate savings and to report results at least at 12-month intervals. Staff may need training from specialists on energy-saving practices and equipment.

Annexure-1

Recommended Lux Levels for different locations

➢ **Entrance**	
Entrance halls, lobbies, waiting rooms	= 200
Enquiry Desks	= 500
Gate Houses	= 200
➢ **Circulation Areas**	
Lifts	= 100
Corridors, passageways, stairs	= 100
Escalators, revelators	= 150
➢ **Medicine & First Aid Centers**	
Consulting Rooms, Treatment Rooms	= 500
Rest Rooms	= 150
Medical Stores	= 150
➢ **Staff Rooms**	
Offices	= 300
Changing, locker and cleaners room, Cloak rooms, lavatories	= 100
Rest Rooms	= 150
➢ **Staff Restaurants**	
Canteens, Cafeterias, dining rooms, mess rooms	= 200
Survey, vegetable preparation, washing up area	= 300
Food preparation & cooking	= 500
Food stores, cellars	= 150
➢ **Communication**	
Switch board rooms	= 300
Telephone, apparatus rooms	= 150
Telex room, post rooms	= 500
Reprographic room	= 300

Annexure-2

Energy Efficient Equipment Suppliers

Product/ Equipment	Contact Details
AC Drives	Rockers Control System, SCO 819, 2nd Floor, NAC, Manimajra, Chandigarh 16010 Ph: 0172 – 2730900, 5071627
AC Drives	Allen Bradley India Ltd C-11, Industrial Area, Site-IV, Sahibabad, Ghaziabad 201 010
AC Drives	Asea Brown Boveri Ltd Guru Nanak Foundation Building, 15-16, Qutab Institutional Area, Saheed Jeet Singh Sansanwal Marg, New Delhi - 110 067
AC Drives	Crompton Greaves Ltd. Machine 3 Division, A-6/2, MIDC Area, Ahmednagar 414 111.
Automation, Panel Meters	Conzerv System 44P Electronic City Phase –II, East Hosur Road, Bangalore – 560100 Ph: 080-51189700 www.conzerv.com
Automation, Panel Meters	Selec controls Pvt Ltd E – 121, Ansa Industrial Estate, Saki Vihar Road, Mumbai 400072 Ph: 022-28471882, 28476443 www.selecindia.com
Automation, sensors, twilight switches	Electro Art Plot No K-11, MIDC Area, Ambad, Nashik –422010, ı: 0253-5603954, 2380918 www.electronicswitchesindia.com
Burners	WESMAN ENGINEERING (P) LTD. 503-504 Eros Apartments, 56 Nehru Place, New Delhi 110019 Tel: +91 (11) 26431723 Fax: +91 (11) 26434577
Burners, Furnace Recuperators, Hot air generators, Heating & Pumping unit, Laddle preheating	ENCON, 12/3, Mathura Road, Faridabad-121003 Phone: 0129 -25275454 Fax: 0129 –25279070 www.encon.co.in
Capacitors	Asian Electronics Ltd. Plot 68, MIDC, Satpur, Nasik 422 007
Capacitors	Shreem Capacitors Pvt. Ltd. 7/39, Vikram Vihar, Lajpat Nagar-IV, New Delhi - 110 024
Capacitors and APFC Panels	Matrix Controls & Engineers Pvt Ltd, Rajeev Batra 9811624440, Rajeev@matrixcapacior.com E- 725 DSIDC, Industrial Complex, Narela, GT Road, Delhi – 110040 Ph: 01127786945 / 46 / 47 www.matrixcapacitor.com
Capacitors and APFC Panels	Standard Capacitors, B-70/43, DSIDC Complex, Lawrence road Industrial Area, Delhi –110035, Ph: 011 –27181490, 27151027 www.standardcapacitors.com
Capacitors and APFC Panels	Saif Electronics 174, Hira Building, 1st Floor, Carnac Road, ɔsite Police Commissioner office , Mumbai – 400002 Ph : 022 – 2064626 , 22086613 www.saifel.com
Compressed Air Piping	Legris India Pvt Ltd. Legris House, 99 Pace city –1, sector 37, Gurgaon- 122001 Ph : 9958297093 , 9811054826 www.transair.legris.com
Eco-ventilators	Nu Plast pipes & profiles SCF – 124, sector 17 Market, Faridabad – 121002 Ph : 0129 – 6546217 , 4070023
Electrical measurement Instruments	Riken Instrumentation Ltd 369, Industrial Area, Phase –II, Panchkula, Haryana Ph : 0172 – 2591651, 2592028 , www.rikeninstrumenatation.com
Energy Management & Control Systems	Manaco Energy Solutions (P) Ltd. A-6, Shanti Apts.,21 & 22, 1st Cross St, TTK Road, Alwarpet, Chennai-18 , 044-42316164, www.mesco.co.in

Product/ Equipment	Contact Details
Energy Saving Products	Gautam Enterprises 205, Vinay Indl. Est., Chicholi Bunder Link Road, Malad (West), Mumbai - 64, India Tel: (91-22) 2875 04 22, Fax: (91-22) 2873 6985 www.gautament.com
Energy Saving products	Techmark Engineers & Consultants. K-1/28 Ground Floor, Chittaranjan Park New Delhi-110019 Telephone: 91-011-26238349 Fax : 91-011-51603925
Flue Gas Analyzers / Oxygen Analyzer	Engineers Pvt. Ltd., 90A (2nd Floor), Amritpuri B, Main Road, East of Kailash, Opp. Iskcon Temple, New Delhi – 110 065 Telephone No 26226328, 26213009; Fax: 26285202 www.nevco.co.in
Flue Gas Analyzers / Oxygen Analyzer	ACE Instruments & Controls1, Biradari, Above Kashi Dairy, M.G. Road,Ghatkopar (W), Bombay – 400 086 Tel.: 5125153, 5122762
Flue Gas Analyzers / Oxygen Analyzer	Testo India Pvt Ltd, Pune 020 – 25665085, www.testo.com
FRP Blades and cooling tower accessories	Eneertech Engineers SCO 144 – 145, Sector 34A, Chandigarh Ph : 0172 – 5018077, 9876022225
VAC related instruments Thermocouples, pipe fittings, pressure gauges	Waaree , 36 Damji shamji Industrial Complex Off Mahakali caves road, Andheri East Mumbai 400093 022 –66963030 26874778 www.waaree.com
Temperature Meters (600 °C to 1800 °C)	Toshniwal Industries Pvt. Ltd. Industrial Area, Mahukupura, AJMER - 305 002,
Temperature Meters (upto 1500 °C)	KUSAM MECO, G-17 , Bharat Industrial Area ,T.J. Road, Sewree Mumbai 400015,Ph : 022 – 24156638, 24124540 www.kusam-meco.co.in
Insulations	Lloyd Insulation (India) Ltd. P.B. No. 4321, Kalkaji Industrial Area Punj Sons Premises, New Delhi – 110 019 Ph: 26430746-7 Fax: 26478601/26467259
Insulations	Himal Supply (India) Ltd 168 , Rajagarden, New Delhi – 110015 Ph : 011-25438602 , 25448602 www.himalsupply.com
LED lighting	Synergy Solar (P) ltd SCO 133, sector 28D, Chandigarh Ph 0172-6451133 www.synergysolars.com
Lighting Systems	Philips India Ltd Regional office-North, 9th floor Ashoka Estate, 24, Barakhamba Road New Delhi – 110 001 Telephone No.: 3353280, 3317442, Fax No.: 3314332
Lighting Systems	Crompton Greaves Ltd. Lighting Business Group, 405, Concorde, RC Dutt Road, Baroda – 390 007
Lighting Systems	SRAM India Ltd. Signature Towers,11th Floor, Tower B, South City-I, Gurgaon 122001, HaryanaTel: 0124- 6526175, 6526178, 6526185 Fax: 0124- 6526184
Lighting Systems	Asian Electronics, Surya Place, First Floor, K-185/1, Sarai Julena,New Friends Colony, New Delhi – 110 025
Lighting Systems	Philips India Limited , Technopolis Knowledge Park,Nelco Complex, Mahakali Caves Road, Chakala,Andheri (East), Mumbai 400 093.Tel : 022 56912000
Lighting Systems	Roshni Ltd.Padma Tower-I, Rajendra Palace, New Delhi 110 006.
Lighting Systems	ipro LimitedSco 196-197, Sector 34-A, Chandigarh - 160 022
Lighting Systems	RAM India Ltd. Signature Towers, 11th Floor, Tower B, South City-

Product/ Equipment	Contact Details
	I, Gurgaon 122001, Haryana Tel: 0124- 6526175, 6526178, 6526185 Fax: 0124- 6526184
Lighting Voltage Control Systems	Electric & Machinery Corporation C-57, Focal Point, Ludhiana – 141010 Ph : 2670250 , 2676890 , www.jindalelectric.com
Lighting Voltage Control Systems	Electronics (India) Pvt. Ltd. Plot No.82, KIADB Industrial Area, Bommasandra – Jigani Link Road, Jigani Hobli, Anekal Taluk, Bangalore District – 562 106 Telefax: +91 - 8110 – 414547 / 414548, 414549 / 414550 E-mail ID: eleindia@energysaversindia.com Website: www.energysaversindia.com
Soft starters	Electronics (India) LtdE-6, GIDC Electronics Zone, Ghandinagar – 382028 , Gujarat Ph : 079 –23289101-3, www.amtechelectronics.com
Thermocouples and Heaters	Beeco Electronics 450 –A, Industrial Area, Phase-II, Chandigarh 160002, Ph : 0172 – 5083350, 5073750 , www.beecoelectronics.com
Thermocouples and temperature gauges & sensors	icrosystem , 1005, Hemkunt House, 6, Rajendra Place New Delhi, Ph : 011-25786350, 09312600075 ,www.radix.co.in

Note: -The suppliers mentioned above are not the only ones or the best in the market. The management may contact other suppliers for competitive rates/ specifications.

Annexure-3

Date	Time	Voltage (Volt)			Current (Amp)			Power Factor			Load (KW)			Total Load	V THD %			A THD %		
		R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase	(KW)	R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase
9/24/2022	11:35:00 AM	243.2	241.2	238.2	39.83	103.21	53.72	0.995	0.999	0.964	9.64	24.87	12.34	46.84	1.4	1.5	1.5	5.6	4	5
9/24/2022	11:40:00 AM	241.9	239.9	237.2	41.93	101.51	53.48	0.99	0.998	0.968	10.04	24.30	12.28	46.62	1.6	1.7	1.6	5.3	4	4.9
9/24/2022	11:45:00 AM	242	239.8	236.7	35.74	100.38	52.02	0.988	0.998	0.965	8.55	24.02	11.88	44.45	1.6	1.6	1.6	6.4	4	4.9
9/24/2022	11:50:00 AM	241.2	239.5	236.4	33.51	86.29	49.53	0.985	0.997	0.966	7.96	20.60	11.31	39.88	1.6	1.7	1.6	7	4.3	5
9/24/2022	11:55:00 AM	242.7	239.8	237.3	33.04	77.77	51.1	0.982	0.994	0.968	7.87	18.54	11.74	38.15	1.6	1.7	1.5	7.8	5.1	5
9/24/2022	12:00:00 PM	242.4	240.1	237.1	35.17	66.37	51.5	0.983	0.995	0.967	8.38	15.86	11.81	36.04	1.7	1.8	1.6	8.3	5.8	4.8
9/24/2022	12:05:00 PM	242.3	240.5	237.7	40.19	64.41	53.97	0.977	0.995	0.966	9.51	15.41	12.39	37.32	1.5	1.6	1.5	8.9	5.8	4.6
9/24/2022	12:10:00 PM	242.3	240.2	238.2	46.56	65.85	58.61	0.986	0.996	0.966	11.12	15.75	13.49	40.36	1.6	1.7	1.5	4.8	6.1	4.4
9/24/2022	12:15:00 PM	241.8	234.3	245.4	46.66	66.16	55.47	0.989	0.997	0.968	11.16	15.45	13.18	39.79	2.5	2.1	2.3	8	6.3	4.6
9/24/2022	12:20:00 PM	241.4	232.7	247.2	52.65	68.52	54.77	0.973	0.997	0.97	12.37	15.90	13.13	41.40	2.8	2.2	2.6	8.2	6.3	4.7
9/24/2022	12:25:00 PM	241.6	233.2	247.9	54.61	67.75	54.09	0.963	0.997	0.97	12.71	15.75	13.01	41.46	2.6	2.2	2.5	6.1	6.3	4.8
9/24/2022	12:30:00 PM	242.6	233.6	248.6	52.56	65.29	52.17	0.991	0.997	0.967	12.64	15.21	12.54	40.38	2.6	2.2	2.6	5.2	6.3	5.1
9/24/2022	12:35:00 PM	242.8	233.7	248.8	50.94	64.77	49.44	0.992	0.997	0.967	12.27	15.09	11.89	39.26	2.6	2.2	2.6	5.7	6.3	5.4
9/24/2022	12:40:00 PM	243.3	234.2	249.3	49.96	64.06	49.47	0.993	0.997	0.967	12.07	14.96	11.93	38.95	2.5	2.2	2.6	4.5	6.1	5.4
9/24/2022	12:45:00 PM	242.6	233.6	248.6	60.87	71.87	59.21	0.969	0.986	0.935	14.31	16.55	13.76	44.63	2.3	2.1	2.5	3.4	5.1	4.5
9/24/2022	12:50:00 PM	243.9	234.8	250.3	69.22	72.66	59.18	0.977	0.985	0.932	16.49	16.80	13.81	47.10	2.3	2.1	2.5	2.8	4.9	4.6
9/24/2022	12:55:00 PM	246.6	237	253	70.73	76.57	59.17	0.976	0.983	0.929	17.02	17.84	13.91	48.77	2.3	2.1	2.4	2.8	4.6	4.5
9/24/2022	1:00:00 PM	249.4	239.3	255.9	67.68	71.94	50.19	0.987	0.989	0.936	16.66	17.03	12.02	45.71	2.3	2.1	2.4	3.2	4.9	5.6
9/24/2022	1:05:00 PM	250.5	240.3	256.9	60.64	63.8	41.15	0.993	0.996	0.954	15.08	15.27	10.09	40.44	2.4	2.1	2.4	5.4	5.1	7.3
9/24/2022	1:10:00 PM	34.9	33.8	35.6	7.01	7.01	4.47	0.989	0.996	0.954	0.24	0.24	0.15	0.63	38.9	38.8	38.9	9.3	4.6	7.4
9/24/2022	1:15:00 PM	98.7	95.4	100.3	15.52	17.07	9.29	0.978	0.98	0.959	1.50	1.60	0.89	3.99	13.3	13	13.3	4.9	4.8	5.7
9/24/2022	1:20:00 PM	254.4	244	261	43.22	57.64	30.14	0.996	0.998	0.975	10.95	14.04	7.67	32.66	2.5	2.2	2.3	6.6	5	4.7
9/24/2022	1:25:00 PM	250.9	240.6	256.9	42.86	58.5	31.48	0.993	0.997	0.974	10.68	14.03	7.88	32.59	2.4	2.1	2.3	7.7	5.1	4
9/24/2022	1:30:00 PM	247.2	237.1	253	50.19	63.48	37.64	0.99	0.996	0.964	12.28	14.99	9.18	36.45	2.6	2	2.2	8.2	4.7	5.6
9/24/2022	1:35:00 PM	245.9	235.8	251.3	52.6	70.21	45.48	0.989	0.996	0.955	12.79	16.49	10.91	40.20	2.5	2	2.1	7	4.5	7.1
9/24/2022	1:40:00 PM	245.7	235.3	250.5	51.13	77.76	45.13	0.989	0.997	0.951	12.42	18.24	10.75	41.42	2.4	2	2.1	6.2	4.3	5.6
9/24/2022	1:45:00 PM	245.7	235.1	250.4	52.61	82.87	43.53	0.989	0.998	0.949	12.78	19.44	10.34	42.57	2.5	2	2.1	6.9	4.2	5.7
9/24/2022	1:50:00 PM	247.1	236.2	251.3	41.31	88.75	41.27	0.986	0.998	0.945	10.06	20.92	9.80	40.79	2.4	2	2.1	6.2	3.9	5.8
9/24/2022	1:55:00 PM	247.7	236.3	251.1	37.37	98.17	39.67	0.981	0.999	0.944	9.08	23.17	9.40	41.66	2.3	1.9	2.2	6.7	3.6	5.9
9/24/2022	2:00:00 PM	246.6	235.5	249.8	37.5	101.92	39.89	0.983	0.999	0.946	9.09	23.98	9.43	42.49	2.4	1.9	2.1	6.6	3.7	6.1
9/24/2022	2:05:00 PM	245.8	235.2	249.2	40.98	93.72	39.32	0.985	0.998	0.945	9.92	22.00	9.26	41.18	2.4	2	2.1	6.1	4	6.4
9/24/2022	2:10:00 PM	246.3	235.6	249.4	36.35	86.22	38.28	0.983	0.998	0.943	8.80	20.27	9.00	38.08	2.4	2	2.2	7	4.5	6.6
9/24/2022	2:15:00 PM	246.6	235.7	249.6	37.93	88.56	37.77	0.987	0.998	0.943	9.23	20.83	8.89	38.95	2.4	2	2.2	6.8	4.6	6.7
9/24/2022	2:20:00 PM	247	235.9	249.7	37.18	97.92	36.84	0.991	0.998	0.942	9.10	23.05	8.67	40.82	2.4	1.9	2.1	7	4.1	6.8
9/24/2022	2:25:00 PM	246.4	235.3	249.3	39.21	99.05	36.09	0.989	0.999	0.939	9.56	23.28	8.45	41.29	2.4	1.9	2.1	6.4	4.1	7
9/24/2022	2:30:00 PM	246.9	236	249.9	39.19	98.94	35	0.988	0.999	0.938	9.56	23.33	8.20	41.09	2.4	1.9	2.1	5.6	4	6.8
9/24/2022	2:35:00 PM	248	237.3	251	35.78	93.45	34.6	0.987	0.999	0.938	8.76	22.15	8.15	39.06	2.3	1.9	2.1	5.2	4.2	6.4
9/24/2022	2:40:00 PM	248	237	250.9	41.01	98.2	34.45	0.98	0.998	0.937	9.97	23.23	8.10	41.29	2.5	1.9	2.1	9.2	4	6.4
9/24/2022	2:45:00 PM	247.9	236.7	250.4	40.11	103.99	34.58	0.98	0.999	0.938	9.74	24.59	8.12	42.46	2.4	1.9	2.1	8.1	3.7	6.2
9/24/2022	2:50:00 PM	247.3	235.7	250.3	47.02	104.89	34.51	0.99	0.998	0.939	11.51	24.67	8.11	44.30	2.3	1.9	2.1	5.2	3.6	6.1
9/24/2022	2:55:00 PM	247.3	236.4	250.6	49.3	92.02	31.72	0.99	0.998	0.942	12.07	21.71	7.49	41.27	2.5	1.9	2.1	7.6	4	6.9

Date	Time	Voltage (Volt)			Current (Amp)			Power Factor			Load (KW)			Total Load	V THD %			A THD %		
		R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase	(KW)	R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase
9/24/2022	3:00:00 PM	247.9	237.3	251.3	39.31	80.76	26.26	0.996	0.999	0.95	9.71	19.15	6.27	35.12	2.3	1.9	2.1	5.9	4.6	8.4
9/24/2022	3:05:00 PM	247.9	237.4	251	31.84	80.41	27.02	0.994	0.998	0.953	7.85	19.05	6.46	33.36	2.3	1.9	2.1	6.9	4.6	8
9/24/2022	3:10:00 PM	247.3	236.8	250.1	31.32	78.84	28.52	0.993	0.998	0.952	7.69	18.63	6.79	33.11	2.4	1.9	2.1	8.9	4.8	7.7
9/24/2022	3:15:00 PM	246.9	236.6	249.8	31.33	78.18	28.85	0.988	0.999	0.954	7.64	18.48	6.88	33.00	2.5	1.9	2.1	11.3	5	7.8
9/24/2022	3:20:00 PM	247.1	236.8	250	29.18	80.04	29.43	0.992	0.998	0.956	7.15	18.92	7.03	33.10	2.4	1.9	2.1	9.2	4.8	7.7
9/24/2022	3:25:00 PM	247.5	237.1	250.2	26.51	79.6	29.45	0.997	0.998	0.952	6.54	18.84	7.01	32.39	2.3	1.9	2.1	6.7	4.8	7.6
9/24/2022	3:30:00 PM	248.4	237.9	251.2	31.72	81.41	29.8	0.998	0.998	0.944	7.86	19.33	7.07	34.26	2.3	1.9	2.1	5.7	4.7	7.1
9/24/2022	3:35:00 PM	248.2	237.9	251.2	32.33	82.62	30.58	0.994	0.998	0.951	7.98	19.62	7.31	34.90	2.3	1.9	2.1	5.6	4.7	7.5
	MINIMUM	**34.90**	**33.80**	**35.60**	**7.01**	**7.01**	**4.47**	**0.96**	**0.98**	**0.93**	**0.24**	**0.23**	**0.15**	**0.62**	**1.40**	**1.50**	**1.50**	**2.80**	**3.60**	**4.00**
	MAXIMUM	**254.40**	**244.00**	**261.00**	**70.73**	**104.89**	**59.21**	**1.00**	**1.00**	**0.98**	**17.96**	**25.57**	**15.07**	**58.59**	**38.90**	**38.80**	**38.90**	**11.30**	**6.30**	**8.40**
	AVERAGE	**238.53**	**229.95**	**241.16**	**42.27**	**78.40**	**40.80**	**0.99**	**1.00**	**0.95**	**9.95**	**17.96**	**9.38**	**37.29**	**3.25**	**2.92**	**3.09**	**6.53**	**4.74**	**5.98**