2024

Energy Audit Report

Prepared For:

Ch. Devi Lal State Institute of Engineering & Technology Panni Wala Mota, Sirsa

Submitted By:

ECI CONSULTING ENGINEERS

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Abbreviation:

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
SEGR	Specific Energy Generation Ratio
SPC	Specific Power Consumption
KL	Kilo Liter
KV	Kilo Volt
Kva	Kilo Volt Ampere
Kw	Kilo Watt
KWh	Kilo Watt Hour
LED	Light Emitting Diode
Lit	Liters
M or m	Meter
Max.	Maximum
Min.	Minimum
MT	Metric Ton
MW	Mega Watt
No.	Number
PF	Power Factor
STL	Single Tube Light
TR	Ton of Refrigerant

1 ACKNOWLEDGEMENT

We are thankful to the management of Ch. Devi Lal State Institute of Engg. And Technology for awarding the “Energy Audit for the Institute to ECI Consulting Engineers Pvt. Ltd. This report captures the outcomes of Energy Audit.

The Audit team of ECI, conveys their gratitude and thanks to the management of Ch. Devi Lal Institute for their positive attitude in 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 thanks for their guidance, coordination, active support, participation during the audit and motivating the audit team.

Manjeet Singh
(AEA-0258)
Accredited Energy Auditor
Bureau of Energy Efficiency

1.1. MANAGEMENT TEAM

Director-principal	:	Dr. Y.P.S. Berwal
Associate Professor and Officer in charge Electricity	:	Sh. Puneet Chawla
Associate Professor and Head CSE Department	:	Dr. Sanjay Dahiya
Additional officer in charge electricity	:	Sh. Raman Kamboj

During the interaction with the top – management, we have noted that Management is highly committed for the objectives of Energy Saving. Most of the decisions have already been taken for the necessary implementation. In fact, certain options for Energy saving have already been implemented. These dedicated efforts deserve all the appreciation.

1.2. ENERGY AUDIT TEAM MEMBERS

Team Leader

Manjeet Singh, Accredited Energy Auditor (AEA-0258)

Team Members

Mr. Sachin Kumar

Mr. Karambir Singh

Mr. Satyender Kumar

2 EXECUTIVE SUMMARY

The study encompasses the examination of the existing energy use pattern of the plant. Energy audit is to identify techno-economic feasible measures to reduce the overall energy consumption of Ch. Devi Lal Institute of Engineering & Technology.

The report gives details of observation of the ECI team along with appropriate recommendations and supporting pay back calculations. The recommendations are based on the various operational parameters examined by the team and the information supplied to the team by the officials of Institute.

It is observed that campus has already implemented Energy Conservation measures and doing some best practices for saving the energy and Environment. Few of them are as follows:

1. Installation of LED lights
2. Installation of solar LED street lights

The methods adopted for the measurements and tabulation is in line with the best practices, as per guidelines from appropriate IEEE standards and in consonance with the Electricity rules. Details of energy saving measures recommended in the energy audit report given in table below:

Table 1: Energy Conservation Measures

Sr. No.	Energy Conservation Measures	Annual Electricity Saving in kW	Annual Monetary Saving in Lakh INR	Investment in INR	Simple Payback Period in Months
1	Power Factor Improvement by installation of Harmonic Filters	22233	197429	400000	24
2	Replacement of ACs (24 Nos.)	18009.36	760498.3	935760	14.8
3	Replacement of Pumps (8 Nos.)	239627	2127890	5600000	32
4	Replacement of HPSV lights	3285	34919	15000	5
5	Replacement of Ceiling Fans	167608	1781673	3280000	22

6	Replacement of FTL	9443	100382	43875	5
7	Replacement of street lights	13140	139678	300000	2
8	Solar Potential	230523	2450456	8000000	39

[1]Investment cost could be varied as per customer requirement.

3 INTRODUCTION

3.1. PROJECT DETAIL

With the advent of 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 ways 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 ECI was entrusted with the job of conducting Energy Audit of "Ch. Devi Lal State institute of Engineering & technology"

3.2. SCOPE OF WORK

The Scope of work for Energy Audit will include measurements / testing at site and submission of the report.

Scope of work includes:

- ➢ Review of present electricity, fuel oil & estimation of energy consumption in various end uses energy like lighting, Air-Conditioning, Water Pumping, etc. for defining of baseline, Static factors and independent variables etc.

- ➢ A detail study for energy conservation options of various energy sources like Electricity and Fuel oil in the building campuses and recommend actions for reducing the same.

1. Electrical Distribution System

   a) Review of present electrical distribution like Single Line Diagram (SLD), transformer loading, cable loading, normal & emergency loads, electricity distribution in various areas / floors etc. and assessment of maximum load of venues viz-a-viz capacity of substations feeding the venues.

   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 electrical distribution system.

2. Water Pumping System

   a) Review of water pumping, storage and distribution systems.

   b) Performance assessment of all major water pumps i.e. power consumption vs. flow delivered, estimation of pump efficiency etc.

   c) Exploring the Energy Conservation Options (ENCON) in Water Pumping System.

3. Energy Monitoring & Accounting System

   a) Detail review of present energy monitoring & accounting system in terms of metering, record keeping, data logging, periodic performance analysis etc.

   b) Recommend for effective energy monitoring & accounting system. The Deliverable s are a report consisting of following:

4. Details of the data collected regarding present electrical installations.

5. Performance of major energy consuming equipment.

6. Electrical safety recommendations & energy saving measures.

3.3. ENERGY AUDIT: METHODOLOGY AND APPROACH

Energy audit of was carried out by ECI with an objective of studying the present level of energy consumption pattern and identifying the energy saving possibilities in various sections of the plant. The task was accomplished by undertaking field visits to the plant. During the field visits number of on-site measurements were taken for different areas/systems and equipment in line with the objectives outlined for the study.

Detailed analysis was carried out based on data measured and information collected during field study and to identify specific options for energy savings in each of the selected areas. The following areas were covered as part of the energy audit study.

a) Pump House (STP & WTP)

b) Electrical System

c) Electric Motors

d) Air Conditioning System

e) Lighting System

3.4. INSTRUMENTATION SUPPORT

Energy Audit professionals used a range of portable thermal and electrical instruments during the field visit which include;

- Ultrasonic Flow meter (GE & ECI)
- Power Analyzer (ALM 36 & HIOKI)
- Hygrometer
- Thermography
- Clamp Meter

4 ABOUT CH. DEVI LAL STATE INSTITUTE OF ENGINEERING

The Ch. Devi Lal State Institute of Engineering and Technology (CDLSIET) in Panniwala Mota, Sirsa, was established in 2003. CDLSIET provides undergraduate engineering education in six different disciplines. The CDLSIET was founded in honour of the great farmer leader and former Deputy Prime Minister of India, Ch. Devi Lal. The institute is affiliated to Chaudhary Devi Lal University, Sirsa and is approved by the All-India Council of Technical Education (AICTE). Institute offers admission to its undergraduate engineering programmes through JEE Mains.

Figure 1: CDLSIET Campus

5 ENERGY SCENARIO

6.1. GENERAL DATA

Table 2: General Details

Contacts Details			
Brief description of Assignment	Energy Audit		
Name & Address of the Building	Ch. Devi Lal State Institute of Engineering & Technology		
Operational Days	365 days per annum		
Power			
Consumer No.	1739613000	3285613000	8685813000
Supply Voltage	11.00 kV	11.00kV	11.00kV
Source	DHBVN	DHBVN	DHBVN
Sanctioned Load (kW)	318.4	28.2	9.4
Maximum Demand (kVA)	139.2	39	13.53
Average Monthly Purchased Energy (kVAh)	28804.2	2031	346.56
Annual Purchased Energy (kVAh)	345650	24372.8	2772.53

6.2. ELECTRICITY BILL ANALYSIS

Electricity is the major source of energy of the Campus. There are three separate connections for STP, Water works and campus. The building is receiving electricity supply from DHBVN at 11 kV HT level and then it is reduced to 0.440 kV with the help of step-down transformers. This LT supply goes from sub-station feeders to different departmental DB's and from DB's, it goes to individual load.

6.3. ELECTRICITY BILL ANALYSIS OF CAMPUS

Electricity is the major source of energy of the Campus. The building is receiving electricity supply from DHBVN at 11 kV HT level and then it is reduced to 0.440 kV with the help of step-down transformers. This LT supply goes from sub-station feeders to different departmental DB's and from DB's, it goes to individual load.

Table 3: Electricity Bill Analysis of FY 2023

Billing Month	Contract Demand, kW	Grid Power kwh	Grid Power kVAh	Recorded Max. Demand, kVA	Excess Demand from Recorded Demand, kVA	P.F.
Jan-23	318.4	58334	59850	115.76	210.9	0.975
Feb-23	318.4	20096	23030	81.36	283.5	0.873
Mar-23	318.4	12052	19086	42.24	462.0	0.631
Apr-23	318.4	21946	24922	57.76	303.8	0.881
May-23	318.4	28826	30040	78.40	253.4	0.960
Jun-23	318.4	36576	37808	102.88	226.2	0.967
Jul-23	318.4	26996	28306	91.04	242.8	0.954
Aug-23	318.4	13744	15382	53.44	302.9	0.894
Sep-23	318.4	25616	26870	74.80	259.2	0.953
Oct-23	318.4	27084	29863	86.88	264.2	0.907
Nov-23	318.4	15840	20120	59.28	345.2	0.787
Dec-23	318.4	28099	30371	82.72	261.4	0.925
T/Avg	318.4	26267.51	28804.17	77.21	284.6	0.892

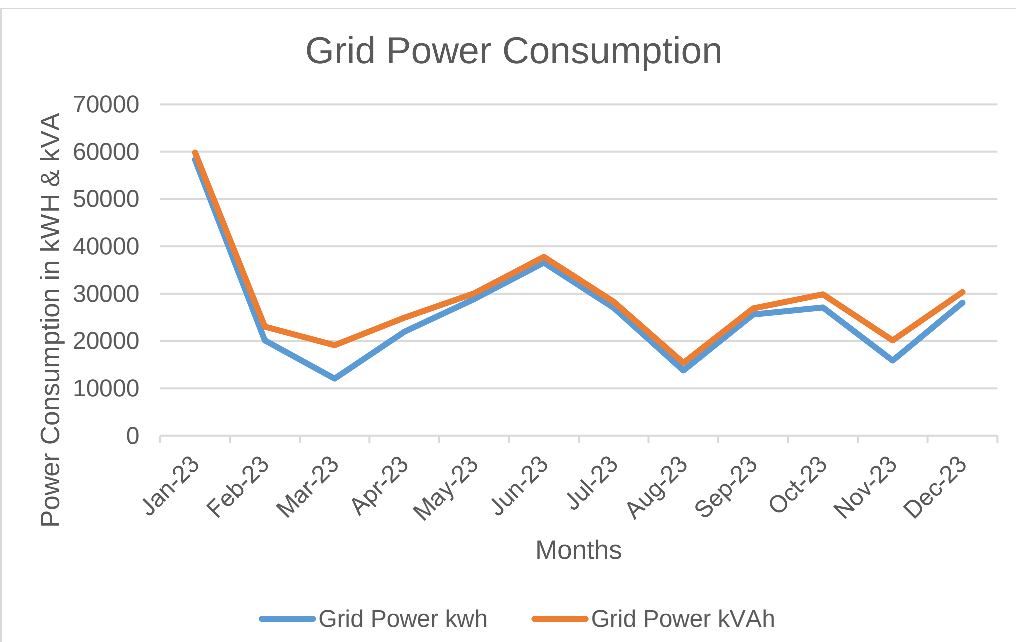

Figure 2: Energy Consumption trend in 2023

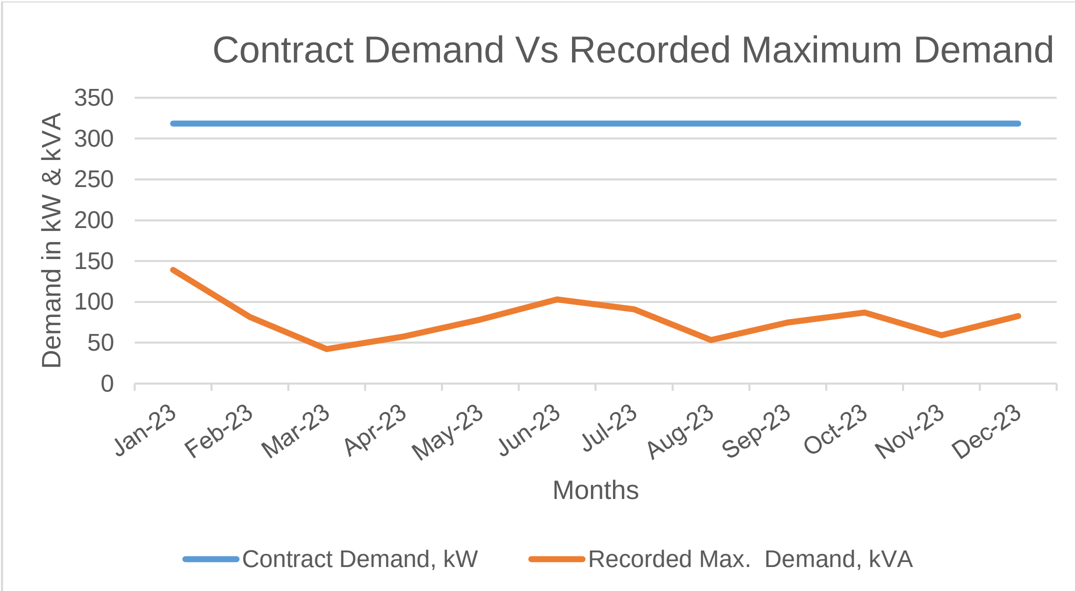

Figure 3: Maximum Demand trend in 2023

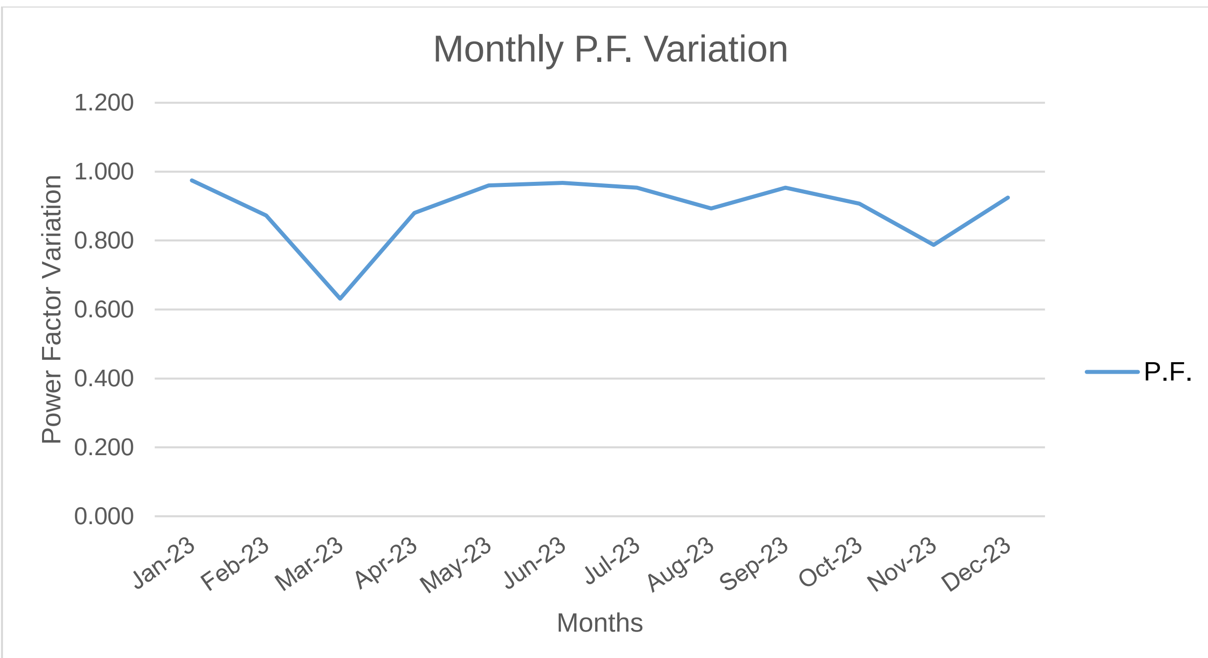

Figure 4: Monthly Power Factor Variation in 2023

Observations:

- The average monthly Maximum Demand is significantly below the contract demand, indicates there is potential to optimize and reduce the contract demand to better align with actual consumption, thereby reducing cost.

- Average Power Factor is .892 which means the electrical system is not working as efficiently as it should be.

Recommendation: The maximum demand currently stands at 115.76, which is significantly below the contracted demand of 318.4kW. There is an opportunity to reduce our contract demand to better align with actual usage. By adjusting the contract demand to 150 kW, we can realize savings amounting to 27426 rupees per month. This adjustment ensure that we are not overpaying for unused energy capacity operations.

5.1.1 Electricity Bill Analysis of Water Works

Table 4: Bill Analysis of Water Works

Billing Month	Contract Demand, kW	Grid Power kwh	Grid Power kVAh	Recorded Max. Demand, kVA	Excess Demand from Contract Demand, kVA	P.F.
Jan-23	28.2	1114.5	1348.5	33.0	1.12	0.826
Feb-23	28.2	1252.5	1513.5	33.0	1.08	0.828
Mar-23	28.2	1177.5	1437.0	33.0	1.41	0.819
Apr-23	28.2	1927.5	2296.5	39.0	-5.40	0.839
May-23	28.2	1945.5	2344.5	36.0	-2.02	0.830
Jun-23	28.2	2166.0	2532.0	37.5	-4.53	0.855
Jul-23	28.2	2160.0	2251.5	36.0	-6.61	0.959
Aug-23	28.2	1449.0	1545	33.0	-2.93	0.938
Sep-23	28.2	1894.5	2227.5	37.5	-4.34	0.851
Oct-23	28.2	2160.0	2565.0	37.5	-4.01	0.842
Nov-23	28.2	1713.0	2127.0	39.0	-3.98	0.805
Dec-23	28.2	1821.0	2184.7	37.2	-3.37	0.834
T/Avg	28.2	1731.7	2031.4	35.97	-2.80	0.852

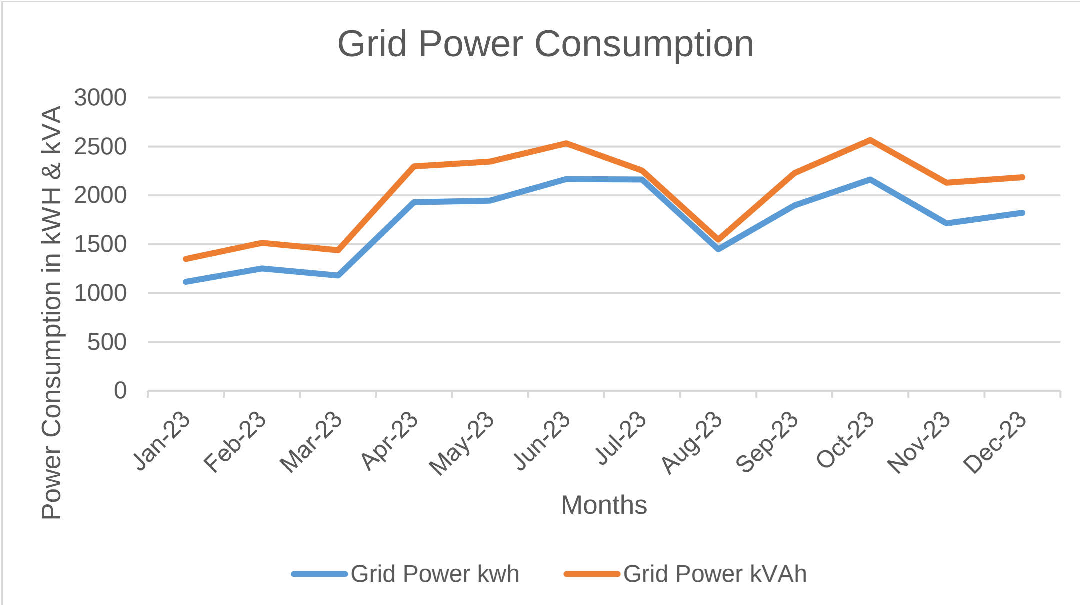

Figure 5: Grid Power Consumption for Water Works in 2023

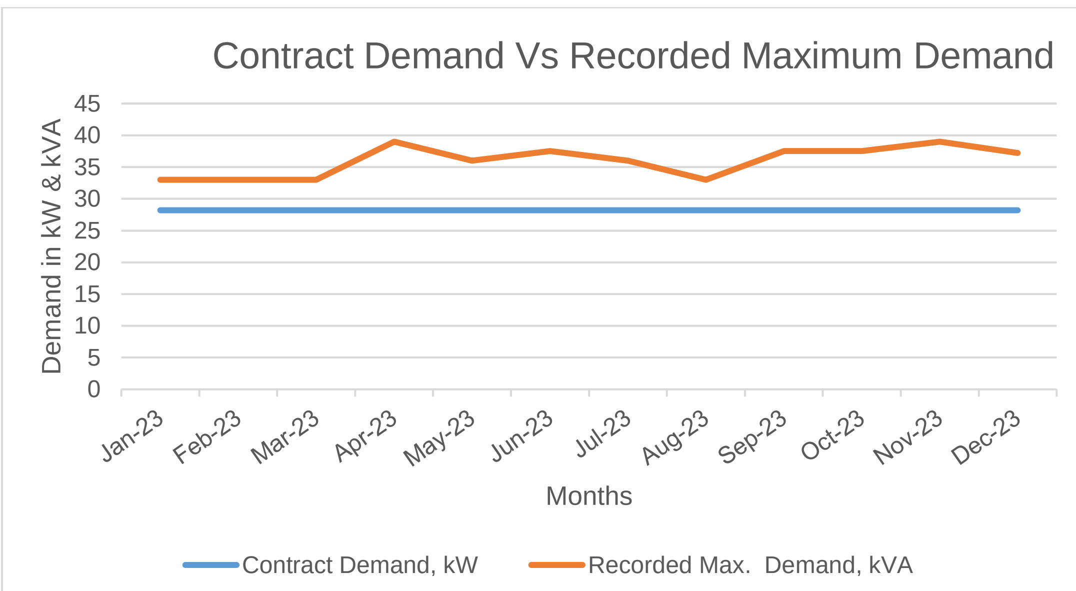

Figure 6: Recorded Maximum Demand in 2023

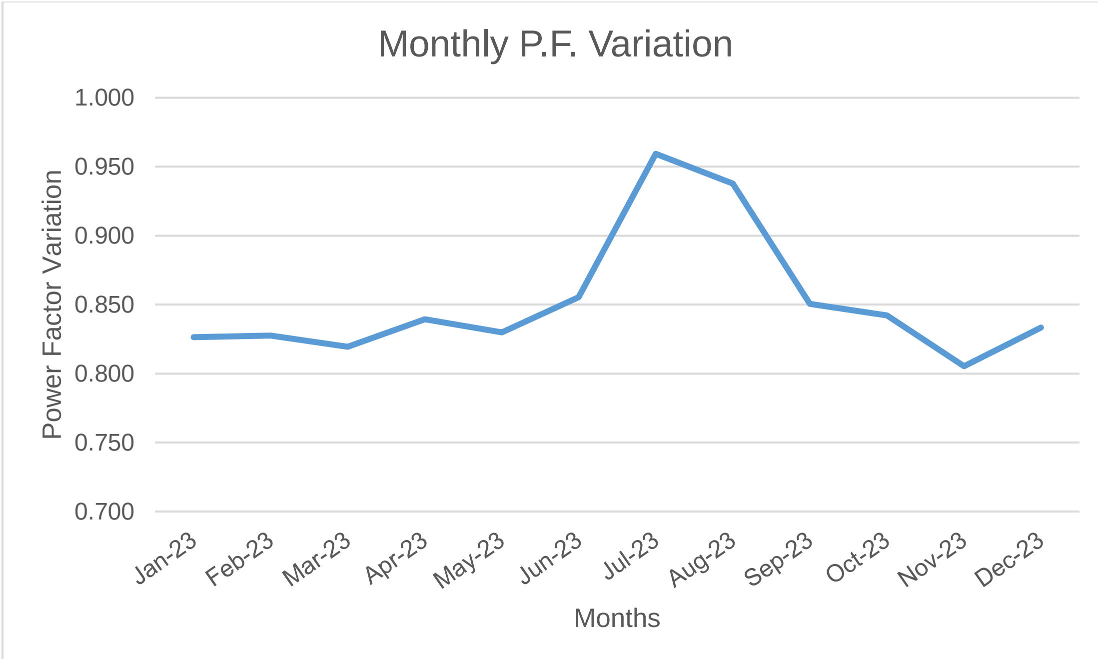

Figure 7: Power Factor Variation in 2023

Observations:

- The contract demand is 28.2 lower than the average recorded demand. This suggest that the actual power usage often exceeds the contracted amount, potentially to additional costs and penalties.
- Average Power Factor is .85 which means the electrical system is not working as efficiently as it should be.

Recommendation:

- Adjust the contract demand to match actual power usage.
- Improve electrical system efficiency to reduce power waste.
- Improve power factor by optimizing or upgrading electrical equipments.

5.1.2 Electricity Bill Analysis of STP

Table 5: Bill Analysis of STP

Billing Month	Contract Demand, kW	Grid Power kwh	Grid Power kVAh	Recorded Max. Demand, Kw	Excess Max Demand from Billable Demand, kVA	P.F.
Jan-23	9.4	303.48	NA	NA	NA	NA
Feb-23	9.4	325.16	NA	NA	NA	NA
Mar-23	9.4	336.00	NA	NA	NA	NA
Apr-23	9.4	281.81	NA	NA	NA	NA
May-23	9.4	480.00	572.00	NA	NA	0.839
Jun-23	9.4	108.71	124.66	8.63	0.77	0.872
Jul-23	9.4	38.29	43.34	6.1	3.30	0.883
Aug-23	9.4	25.62	28.93	8.09	1.31	0.886
Sep-23	9.4	47.55	56.62	8.72	0.68	0.840
Oct-23	9.4	90.76	113.58	8.82	0.58	0.799
Nov-23	9.4	74.07	84.14	NA	NA	0.880
Dec-23	9.4	1110.45	1749.26	13.53	-4.13	0.635
T/Avg	9.4	268.49	346.56	8.98	0.42	0.829

Note:

- In the November 2023 electricity bill, it was observed that the recorded grid power in kVAH was less than the corresponding kWh. The calculation of kVAH was based on the average power factor.
- kVAH and maximum demand not available in bills.

6.4. ELECTRICITY PROFILE

The load profile of the electrical parameters was recorded by using a portable 3-phase power analyzer. During the recording, the power analyzer recorded all the electrical parameters for further detailed analysis. The analysis of the different parameters recorded 24 hours reading at the LT incoming main supply is given below:

Table 6: Incomer Electrical Parameters

Location: Incomer Dated &Time recording: 11.03.2024 6:55 PM to 12.03.2024 3:30 PM									
Parameters	**Voltage (kV)**			**Current (Amp)**			**Power**		**Power Factor**
	U12	**U23**	**U31**	**A1**	**A2**	**A3**	**watt**	**VA**	**-**
Maximum	458.8	459.3	455.2	98.6	64.6	68.8	14903.0	15452.0	1.0
Minimum	396.1	397.0	393.5	27.2	7.9	15.4	50544.0	50603.0	.96
Average	433.5	434.4	431.0	48.2	24.3	29.3	25078.3	25285.4	.99

(A) Graphical Voltage Profile (Volt)

All electrical equipment has a designed range of operating voltage. Therefore, it is important to operate all electrical equipment, within the specified voltage range. The voltage variations in all the three phases (R, Y and B) were recorded at the main Supply. The graphs below depict the variations in the voltage:

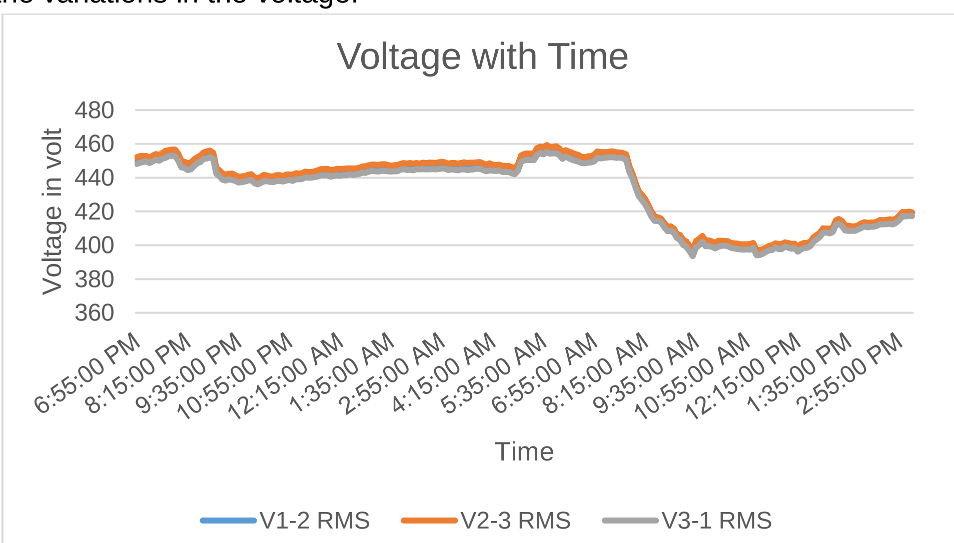

Figure 8: Voltage Profile Main I/C

(B) Graphical Current Profile (I)

Current profile is the variation in the electrical current versus time. The current variations in all the three phases (R, Y and B) were recorded at the main panel of the transformer. The graphs below present the variations in the current:

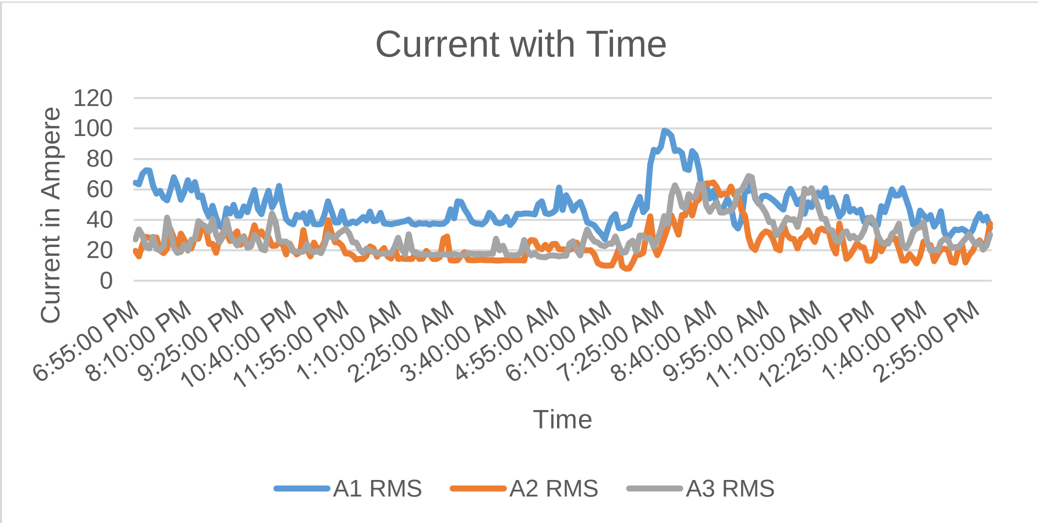

Figure 9: Current Profile of Main I/C

C) Graphical Power Factor Profile

Under the current tariff system, the billed units are in kVAh and the demand charges for apparent power (kVA) depend on the power factor. If the facility has a low power factor, then the demand drawn from the grid will increase and consequently the facility will incurmore demand charges. The variation in the power factor was recorded to explore opportunities for improvement. The graph below presents the variations in the power factorof the power supply to the building:

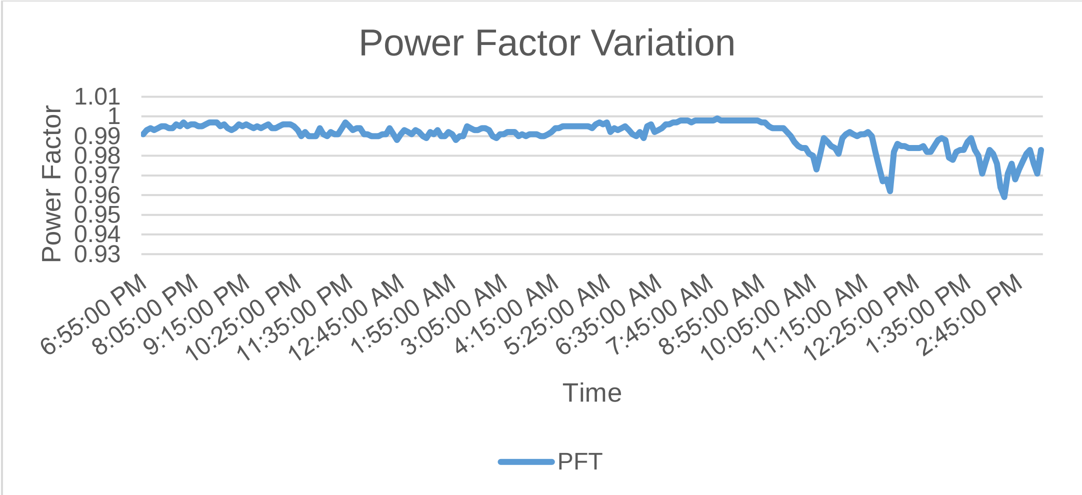

Figure 10: Power Factor Profile of I/C

D)Graphical Load Profile (Watt & VA)

During the energy audit studies, the total operating load at the transformer was recorded tofind out the variation in the load at different times of the day. The following graph depictsthe variation in the load and apparent power of the premises:

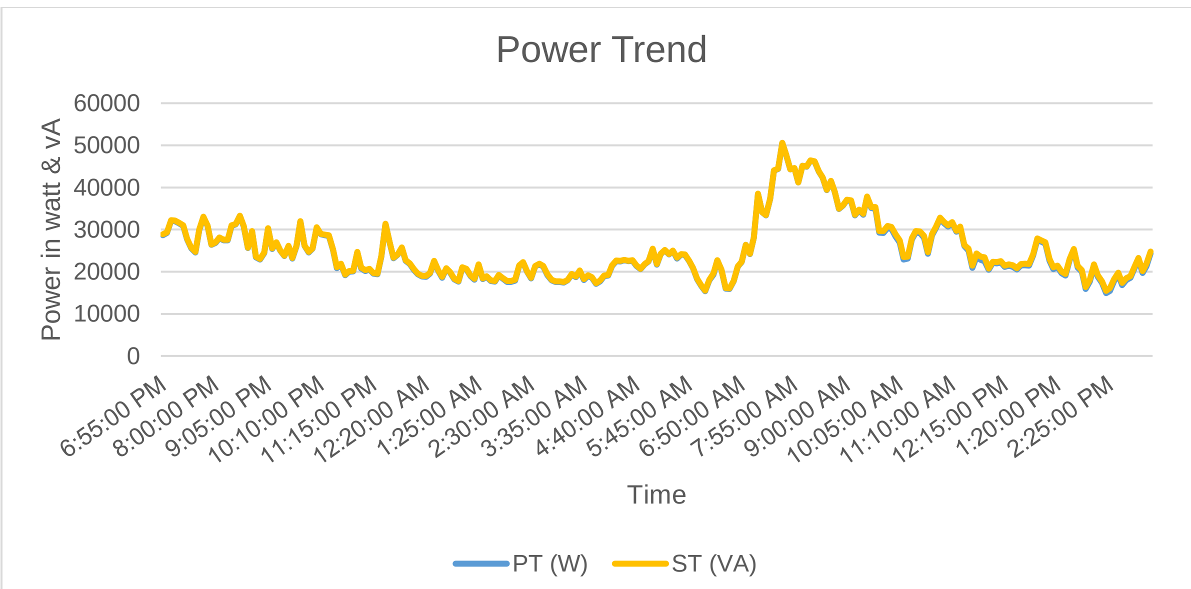

Figure 11: Power Variation Trend

6 Performance Evaluation of Utility

6.1 Electricity Consumption & Generation

Major Source of Electricity of the terminal is DHBVN and DG for emergency purpose. Electricity consumption details of the institute are given as below:

Table 7: Electricity Consumption

Months Year	Campus (CN-1739613000)	Water Works (CN-3285613000)	STP (CN-8685813000)	Total Electricity
	kWH	kWH	kWH	kWH
Jan-23	58334	9824	303.5	68461.48
Feb-23	20096	9854	325.2	30275.16
Mar-23	12052	9802	336.0	22190.08
Apr-23	21946	9705	281.8	31932.81
May-23	28826	9726	480.0	39032.08
Jun-23	36576	9798	108.7	46482.71
Jul-23	26996	9810	38.3	36844.21
Aug-23	13744	9542	25.6	23311.62
Sep-23	25616	9120	47.5	34783.55
Oct-23	27084	9241	90.8	36415.84
Nov-23	15840	8285	74.1	24199.07
Dec-23	28100	7491	1110.5	36701.37
Total	**315210**	**20781**	**3221.9**	**430629.98**

Section wise Energy Consumption:

The electricity supply for college is provided by UHBVN. The electricity supply is divided into 3 Nos electricity connections with separate energy meters in college campus. The Major electrical consumption source in the campus as below:

Table 8: Section Wise Energy Consumption

Month	CN1	Boys Hostel	Girl's Hostel	Others/Academic	WTP	STP
Jan-23	58334	13229	766	44339	1114.5	303.5

Month	CN1	Boys Hostel	Girl's Hostel	Others/Academic	WTP	STP
Feb-23	20096.00	13229	766	6101	1252.5	325.2
Mar-23	12052.08	7813	551	3688	1177.5	336.0
Apr-23	21946.00	7813	551	13582	1927.5	281.8
May-23	28826.08	7813	551	20462	1945.5	480.0
Jun-23	36576.00	20572	1450	14554	2166.0	108.7
Jul-23	26995.92	8000	744	18252	2160.0	38.3
Aug-23	13744.00	1234	184	12326	1449.0	25.6
Sep-23	25616.00	11050	926	13640	1894.5	47.5
Oct-23	27084.08	9562	728	16794	2160.0	90.8
Nov-23	15840.00	10920	902	4018	1713.0	74.1
Dec-23	28099.92	11842	1720	14538	1821.0	1110.4
Total	315210.10	123078	9838	182294	20781.0	3221.9

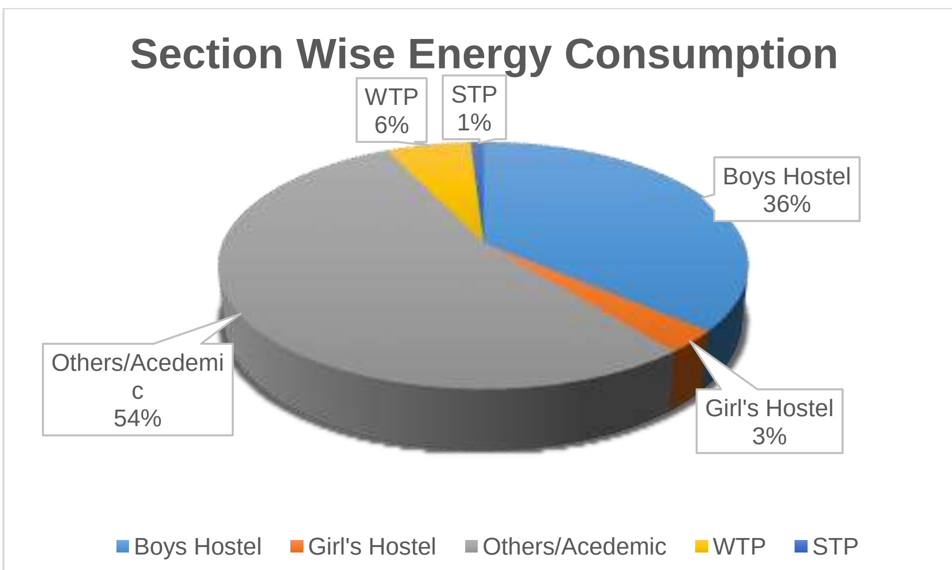

Figure 12: Section Wise Energy Consumption

6.2 TRANSFORMER

There is one main transformer having capacity of 800kVA for the whole campus except STP and water works. During energy audit, performance evaluation of main transformer has been carried out. Transformer feeding the supply to different sections of plant.

6.2.1 Transformer Loss Calculations

Table 9: Transformer Loss Calculations

S. No.	Rated Specifications	Units	Main Transformer
1	Capacity	KVA	800
2	Voltage	Volt	433
3	Current	Amp	1000
4	Make	-	Kirloskar
5	Type of Cooling	-	ONAN
6	Frequency	Hz	50
7	Impedance	%	4.66
8	Year	-	2008
Performance Analysis of Transformer			
1	Measured Voltage	Volt	433
2	Measured Current	Amp	33.9
3	Measured Load	kVA	25.42
4	Tested/Standard No Load Loss	kW	1.5
5	Tested/Standard Load Loss	kW	11.3
6	Running No Load Loss	kW	1.50
7	Running Load Loss	kW	0.01
8	Total Losses of Transformer	kW	1.51
9	Operating Power Factor	-	0.99
10	Total Loss	kVA	1.50
11	Transformer Efficiency, %	%	94.05

Observations:

Transformer is operating at very less loading (3.2%) which is very less as compared to optimum load capacity. This results in less efficiency of transformer.

6.3 HARMONICS STUDY

Harmonics are the periodic steady-state distortions of the sine wave due to equipment generating a frequency other than the standard 50 cycles per second as now a day’s equipment became more sophisticated and with the proliferations of non-linear loads, harmonics have become a pronounced problem on many power systems. Now a-days in many areas non-linear load are approaching significantly.

The Effects of the Harmonics Current are:

- Additional copper losses
- Increased core losses
- Increased electromagnetic interference with communication circuits.

The Effects of the Harmonics Voltage are:

- Increased dielectric stress on insulation
- Electro static interference with communication circuits
- Resonance between reactance and capacitance

Causes: There are many sources of harmonics in Power system but all harmonics sources share a common characteristic. This is a non-linear voltage current operating relationship and any device that alters the sinusoidal wave form of voltage or current is harmonics producer.

The following are the source of harmonics: Electronic ballasts; non—linear loads; variable frequency drives, diodes, transistors, thyristors, rectifier output, frequency conversion, Transformers; circuit breakers; phone systems; capacitor banks; motors, Computers (power supplies) PC, laptop, mainframe, Servers, Monitors, Video display, Copiers, scanners, FAX machines, printers, plotters, lighting controls, UPS systems, battery charges & data centres etc. etc.

Effects: Overheating of electrical equipment; random breakers tripping, High Neutral current due to 3rd Harmonics, interference with communication, non-proper recording of metering, increase in cooper loss, heating of equipment's such as transformer & generators, breakers & fuse operation occur. Harmonics contents can place serious Burden on power distribution system. If harmonics distortion may suppose 35%, the distribution of harmonics then will be 5th order 27% 7th order 5%, 11th order – 2 % and 13th order 1%.

Solutions: Harmonics filters employ the use of power electronic technology, which monitors the nonlinear load and dynamically corrects a wide range of harmonics, such as the 3rd to 51st harmonics orders. By the injection of a compensating current into the load, the waveform is restored which dramatically reduce distortion to less than 5% THD, meeting IEEE 519 standards. Further to meet other power quality demand surge protection, metering, relay protection, control, SCADA and communication can be one of the solutions. Solution can range from simply tightening connections in a switchboard to help overheating of conductors, to use of a 200% rated neutral in a panel board:

The percentage of total current and voltage harmonic distortion in all the three phases (R, Y and B) were recorded at the main incoming panel. The graphs below depict the percentage of total harmonic distortion in the electrical distribution system:

Voltage Harmonics Observed

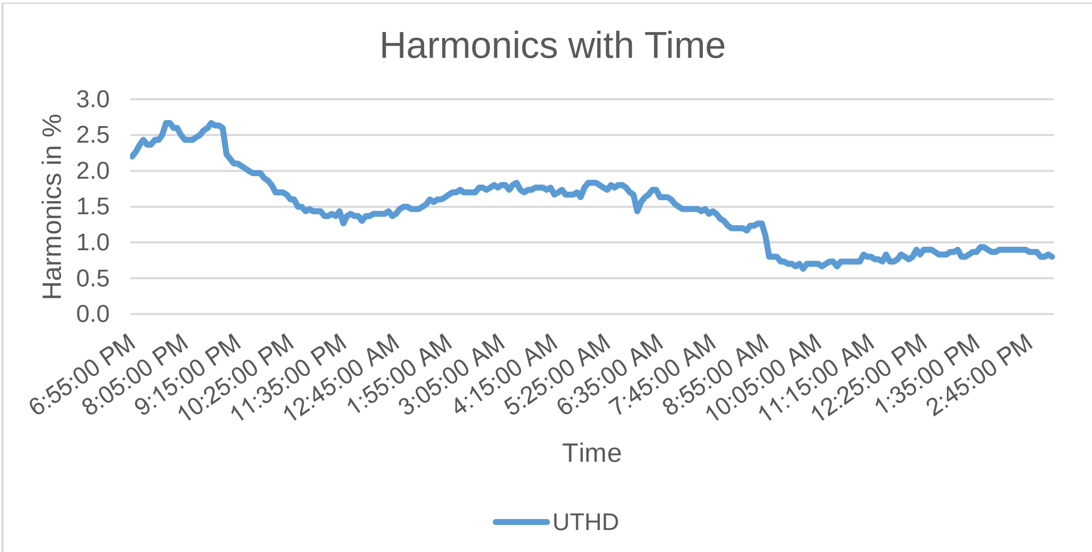

Figure 13: Voltage Total Harmonics Distortion (%) at LT Panel

The Voltage Harmonics at the incomer of the Transformer measured at the main incomer of the LT Panel found to be satisfactory within the permissible limits as per the IEEE.

Current Harmonics Observed

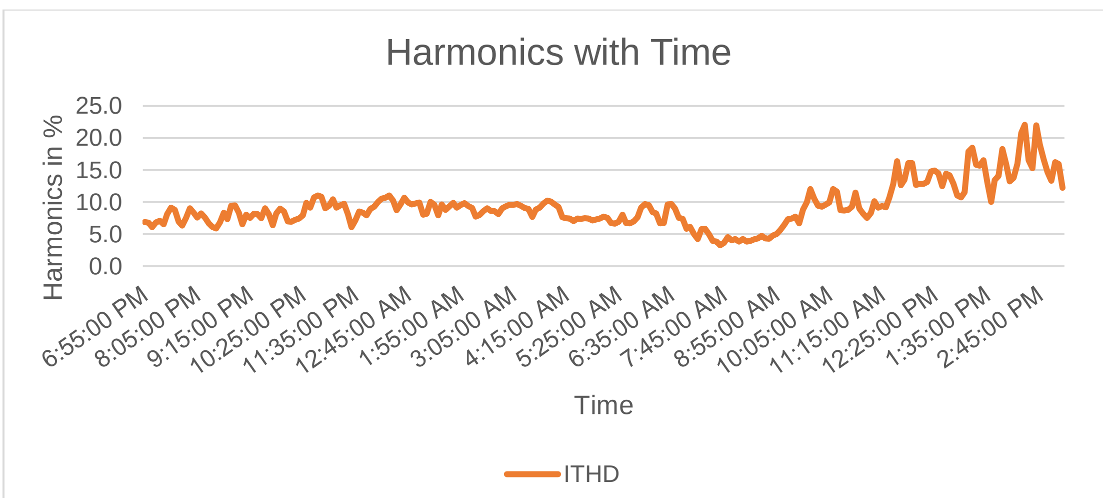

Figure 14: Current Total Harmonics Distortion (%) at LT Panel

The Current Harmonics Percentage measured at the incomer of the Transformer at the LT Panel found to be more than the permissible limits of the IEEE.

Table 10: Voltage Total Harmonics Distortion %

Description	Voltage Harmonics (V THD) %(Measured)	IEEE Standards for Current Harmonics
Average	1.4	3% variation
Max	2.7	
Min	0.6	

Table 11: Current Total Harmonics Distortion %

Description	Current Harmonics (A THD) %(Measured)	IEEE Standards for Current Harmonics
Average	9.3	8% variation
Max	22.1	
Min	3.3	

Observations:

- The percentage of Max. Voltage THD are within recommended limits as per IEEE Standards i.e. 3% variation for voltage.
- The percentage of Max. Current THD are exceeding the recommended limits as per IEEE Standards i.e. 8% variation for current.

Recommendation:

Harmonic Filters may be installed to suppress the harmonics which will also result in improvement of Power factor.

6.4 PUMPS

There are two water treatment plant in the campus WTP and STP. The details of pump as given below:

Table 12: WTP and STP Pumps Detail

Parameters Design Parameters	Unit	WTP		STP		
Pump		**RWP-1**	**Supply-2**	**FFP-1**	**FFP-2**	**RAW STP-1**
Fluid to be Handeled		Water	Water	Water	Water	Water
Rated flow	m^3/hr	111	84	21.6	21.6	NA
Rated head	M	12	45	22	22	NA
Motor rating	kW	5.5	22.5	2.2	2.2	7.5
Speed	RPM	1,450	1,450	1,450	1,450	1,450
Parameters Measured						
Total suction head	M	-3.7	-0.6	2	2	-2.6
Total discharge head	M	5	28	20	20	3.2
Average flow delivered	m^3/hr	6.4	13.5	6.7	7.3	11
Density of Fluid	kg/m^3	1000	1000	1000	1000	1000
Motor input power	kW	5.093	18.13	1.58	1.76	10.5
Performance Evaluation						
Total head developed	M	8.7	28.6	18	18	5.8
Head utilization	%	72.50	63.56	81.82	81.82	NA
Flow utilization	%	5.77	16.07	31.02	33.80	NA
Hydraulic power developed by pump	kW	0.15	1.05	0.33	0.36	0.17
Motor input power	kW	5.093	18.13	1.58	1.76	10.5
Calculated overall (Pump set) efficiency	**%**	3%	6%	21%	20%	2%
Rated motor efficiency	%	85.00%	85.00%	85.00%	85.00%	85.00%
Calculated Pump efficiency	%	3.50%	6.82%	24.45%	23.91%	1.95%
Specific energy consumption	kW/m^3	0.80	1.34	0.24	0.24	0.95

Observation:

- RWP-2 & Supply pump at WTP and Raw Water Pump-2 are not due to maintenance problem.
- It has been observed that most of the pumps are very old and performance of the pumps has been deteriorated considerably.

Recommendation:

- It is recommended to replace these pumps with new energy Efficient pumps.

6.5 DG SET

There is one DG Sets for emergency electricity supply. DG diesel consumption is given as under:

Table 13: DG Performance

Months Year	Running time	Product Handled	Specific Consumption
	Minutes	Litre	Litre/Minute
Jan-23	243	24	0.0987
Feb-23	150	15	0.1
Mar-23	Nill	Nill	-
Apr-23	Nill	Nill	-
May-23	Nill	Nill	-
Jun-23	Nill	Nill	-
Jul-23	Nill	Nill	-
Aug-23	Nill	Nill	-
Sep-23	185	19	0.103
Oct-23	125	12	0.096
Nov-23	60	6	0.1
Dec-23	Nill	Nill	Nill

Observations:

DG Sets is used for the operation of fans, lights in academic block, girls' hostel and boys' hostel in case of grid power failure. DG set is used very rarely.

6.6 AIR CONDITIONING SYSTEM

There are Split & Window type ACs are installed for air conditioning system and there is not centralized HVAC System.

Table 14: Performance of ACs

Sr. No.	Location/Name of Room	Type of AC (Window/Split)	Tonnage	Wattage	Quantity	Star Rating	Current Annual Energy Consumption @ 1600hrs	Annual Electricity Consumption For proposed ACs	Energy Saving	Monetory Saving	Cost of AC
1	Girl's hostel	Window	1.5	2010	2	2	3216	750.39	2465.61	21697	38990
2	Computer lab-1	Split	1.5	2550	4	Non Star	4080	750.39	3329.61	29300	38990
3	Computer lab-2	Split	1.5	2550	4	Non Star	4080	750.39	3329.61	29300	38990
4	Server room	Split	1.5	2550	1	Non Star	4080	750.39	3329.61	29300	38990
5	Director office	Split	1.5	1960	1	2	3136	750.39	2385.61	20993	38990
				2105	2	3	3368	750.39	2617.61	23035	38990
6	Library	Split	1.5	2550	4	Non Star	4080	750.39	3329.61	29300	38990
7	Room No-118	Split	1.5	2105	2	3	3368	750.39	2617.61	23035	38990
8	Room No-310	Split	1.5	2105	2	3	3368	750.39	2617.61	23035	38990
9	TPO	Split	1.5	2105	2	3	3368	750.39	2617.61	23035	38990

Note: Operating Hours of ACs are considered as 1600 as per BEE guidelines for calculation of annual energy consumption for star rating of ACs.

Observations:

- Most of the ACs are older than 8-10 years having 3-Star, 2-Star & even Non-Star ratings and these are consuming more energy than specified due to age of these ACs.

Recommendations:

- Old ACs are required to be replaced with new energy efficient BEE 5 Star as per Energy Conservation Measures section.

6.7 LIGHTNING SYSTEM

CDLSIET has replaced most of the lighting fixtures with energy efficient LED lights, which is good initiative. However, there is further scope of improvement for energy saving.

Table 15: Lighting Inventory

Sr. No.	Location/Name of Room	Type of Light	Wattage	Quantity	Total Watt	Annual Operating Hours
1	Boys hostel	Led bulb	18	402	7236	2120
			10	32	320	
			100	10	1000	
		Tube lights	20	161	3220	2120
			40	10	400	
		Halogen	250	2	500	4380
2	Girl's hostel	Led bulb	18	77	1386	2120
			9	83	747	
			100	10	1000	
3	Academic block	Tube lights	40	351	14040	1920
			18	212	3816	
			9	20	180	
4	Workshop	Led bulb	18	93	1674	1920

Observation:

- The installed lights are energy efficient LED except 5 HPSV (250W) & 351 FTL(40W).
- In Library, There is huge scope of using day light but windows are covered with almirahs.

Recommendation:

- Install motion sensors in unmanned areas, office cabins.

6.8 OTHER EQUIPMENTS

6.8.1 Ceiling/Exhaust Fans

Ceiling fans and exhaust fans play pivotal roles in enhancing indoor comfort and maintaining air quality in various settings. At present, 80-watt ceiling fans and 150-watt exhaust fans are in used in which most of the fans are rewinded so consume more electricity.

Table 16: Fan Inventory

<table>
<tr><th>Sr. No.</th><th>Location/Name of Room</th><th>Type of Fan</th><th>Wattage</th><th>Quantity</th><th>Annual Operating Hours</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Girl's hostel</td><td>Ceiling fan</td><td>80</td><td>278</td><td rowspan="2">2700</td></tr>
<tr><td>Exhaust fan</td><td>150</td><td>4</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Boys hostel</td><td rowspan="2">Ceiling fan</td><td>80</td><td>482</td><td rowspan="3">2700</td></tr>
<tr><td>60</td><td>30</td></tr>
<tr><td>Exhaust fan</td><td>150</td><td>3</td></tr>
<tr><td>3</td><td>Academic block</td><td>Ceiling fan</td><td>80</td><td>486</td><td>1440</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Workshop</td><td>Ceiling fan</td><td>80</td><td>57</td><td rowspan="2">1440</td></tr>
<tr><td>Exhaust fan</td><td>150</td><td>9</td></tr>
<tr><td>5</td><td>Substation</td><td>Ceiling fan</td><td>80</td><td>9</td><td>4320</td></tr>
</table>

Observation:

- Most of the fans are old and rewinded.

Recommendation:

- Replace all Ceiling fans with BLDC fans (30watt).

6.8.2 Geyser's Inventory

Table 17: Geyser Inventory

Sr. No.	Location/Name of Room	Capacity (Liters)	Wattage	Quantity	Star Rating	Make	Annual Operating Hours
1	Girl's hostel	25	2000	10	4	Zolta	1600
2	Boys hostel	50	2000	5	5	Multistar	1600
			2000	8	3	Racold	
			2000	5	4	Havells	

Observation:

➢ All the geysers are new and BEE star rated.

Recommendation:

➢ No recommendation.

6.8.3 Miscellaneous Item

The other energy consuming electrical items are given as below:

Table 18: Miscellaneous items

Sr. No.	Location/Name of Room	Name of Equipment	Quantity
1	Girl's hostel	Fridge	1
		Water cooler	2
2	Academic block	Podium	2
		Projector	1
		Water cooler	3
3	Boys hostel	Mixy	1
		Grinder	1
		Flying insect killer	10
		D-Freeze	2
		Water cooler	4
		Cooler	44
		Baking oven	1
		Hotcase	1
		Heater/Kettle/Iron	150-200
4	Main Gate	Halogen lights	3

7 ENERGY CONSERVATION OPPORTUNITIES

7.1 IMPROVEMENT IN POWER FACTOR

Existing Scenario: The average power factor observed during the audit period was found to be in the range of 0.858, which is low considering mostly non-resistive nature of the load.

Expected Scenario: It is recommended to do servicing of capacitors to increase the power factor.

The tentative energy and monetary saving are tabulated below:

Table 19: ECM calculation for improvement in power factor

Parameter	Unit	CN-1739613000	CN-3285613000	CN-8685813000
Annual energy consumption	kWh	315210.1	20781	3221.9
Existing average power factor		0.892	0.852	0.830
Existing kVAh	kVAh	353374.5	24390.8	3881.8
Proposed average power factor		0.99	0.99	0.99
Proposed kVAh	kVAh	318394.0	20990.9	3254.4
Saving in kVAh	kVAh	34980.5	3399.9	627.4
Unit Rate	INR	10.6	11.0	30.4
Proposed monetary saving	INR	371842.8	37331.3	19090.6
Investment	INR	200000.0	40000.0	25000.0
Simple payback	months	6.5	12.9	15.7

7.2 REPLACEMENT OF OLD ACS

Existing Scenario: There are Split & Window type ACs are installed for air conditioning system. Most of the ACs are older than 8-10 years having 3-Star & Non-Star ratings but these are consuming more energy than specified due to age of these ACs.

Expected Scenario: Old ACs are required to replace as per Energy Conservation Measures section.

Table 20: ECM calculation for ACs

Parameter	Unit	Value
Measured Annual Energy Consumption @ 1600 hrs	kWh	89552
Annual Electricity Consumption For 5 Star Rated AC for period 2022-24	kWh	18009.7
Monetary Saving	INR	760498.3
Investment	INR	935760
Payback Period	Months	14.8

7.3 REPLACEMENT OF OLD INEFFICIENT PUMPS

Existing Scenario: The performance of all pumps has considerably deteriorated

Expected Scenario: Replacing old inefficient pumps with newer more efficient model can lead to improved energy and cost savings, enhanced performance, reduced maintenance, environmental benefits and compliance with regulations.

Table 21: ECM calculation for Pumps

Parameter	Unit	Value
Annual energy consumption	kWh	58645
Energy Saving	kWh	51441
Unit Rate	INR	10.63
Proposed monetary saving	INR	546818
Investment	INR	730000
Simple payback	**months**	**16**

7.4 REPLACEMENT OF HPSV LIGHTS

Existing Scenario: In current lighting setup, we are using 250watt HPSV lights. These lights consume a significant amount of energy, leading to higher electricity bills. HPSV lights contribute to carbon emissions and are not the most sustainable lighting option available.

Expected Scenario: Transitioning to 100watt LED lights from 250-watt halogen lights would represent a cost-effective, energy efficient and environmentally friendly lighting solution, providing long-term benefits.

Table 22: ECM calculation of HPSV lights

Parameter	Unit	Value
Annual energy consumption	kWh	5475
Energy Saving	kWh	3285
Unit Rate	INR	10.63
Proposed monetary saving	INR	34919.6
No of 100 Watt LED	Nos.	5
Cost of LED	INR	3000
Investment	INR	15000
Simple payback	**months**	**5**

7.5 REPLACEMENT OF CEILING FANS

Existing Scenario: Right now, there are 80-watt ceiling fans that use a decent amount of electricity. They do their job in keeping the room cool, but they might not be the most energy efficient option out there. Over time these fans might start making more noise, need repair or not work as well as they used to.

Expected Scenario: If we switch to 30-watt BLDC fans we can expect to save a lot on electricity bills because they use less power. These fans are designed to last longer, make less noise and need fewer repairs. Overall switching to these fans would be a smart move for saving energy, reducing cost and enjoying better performance.

Table 23: ECM calculation of Ceiling fans

Parameter	Unit	Value
Annual energy consumption	kWh	268172.8
Energy Saving	kWh	167608
Unit Rate	INR	10.63
Proposed monetary saving	INR	1781673
No of VLDC Fans	Nos.	1312
Cost of Fan	INR	2500
Investment	INR	3280000
Simple payback	**months**	**22**

7.6 Replacement of FTL

Existing Scenario: currently, using 40-watt FTL (Fluorescent Tube Lights) for lighting which consume a relatively high amount of electricity. While these bulbs provide adequate lighting, they are not the most energy efficient. Over time, the brightness of these bulbs may decrease and they may require frequent replacements due to their shorter lifespan compared to newer lighting technologies.

Expected Scenario: By replacing the 40-watt FTL bulbs with 18-watt Led bulbs, we can expect several improvements. Firstly, there will be a significant reduction in electricity consumption leading to lower electricity bill and overall energy saving. Secondly Led bulbs have a much longer lifespan compared to FTL bulbs reducing the frequency of replacement and maintenance costs over time.

Table 24: ECM of FTL

Parameter	Unit	Value
Annual energy consumption	kWh	19315.8
Energy Saving	kWh	9443.28
Unit Rate	INR	10.63
Proposed monetary saving	INR	100382
No of LED	Nos.	351
Cost of LED	INR	125
Investment	INR	43875
Simple payback	**months**	**5**

7.7 Replacement of Street Lights with Smart Solar LED Light

Existing Scenario: In present regular street lights are in used that run on electricity from the grid. These lights use a lot of power, which makes our electricity bills go up. They also need frequent repairs and bulb changes because they can get damaged easily from weather or vandalism.

Expected Scenario: If we switch to smart solar LED street lights, things would get better. These lights use solar power, so they’re cheaper to run and better for environment. They also last longer and need fewer repairs. The best part is they come with sensors and controls that let us adjust the brightness and timing based on what’s happening in real time. Overall, these smart solar LED lights would be a smarter, more efficient and cost-effective choice for us.

Table 25: ECM of Street lights

Parameter	Unit	Value
Annual energy consumption	kWh	13140
Energy Saving	kWh	13140
Unit Rate	INR	10.63
Proposed monetary saving	INR	139678
No of LED	Nos.	60
Cost of One Set of Light	INR	5000
Investment	INR	300000
Simple payback	**months**	**25**

8 SOLAR ENERGY GENERATION POTENTIAL

Installation of solar panel on college campus offers numerous advantages both environmentally and economically. Firstly, campus usually has ample space available, making it feasible to set up large solar panel arrays without much hassle. Secondly Harnessing the college's energy cost in the long run by generating the electricity from sun, the college can offset a portion of its traditional energy consumption, leading to substantial savings on utility bills. The college should seriously consider investing in solar energy for its campus to capitalize on its solar potential. The solar potential as given below:

Table 26: Solar Energy Potential

Sr No	Name of building	Approx. Roof top area for solar panel (Sq. m)	Capacity of solar plant(kW)	Generation(kWH/year)
1	Academic Building	3550	400	580603
2	Workshop	1300	180	261305
3	Boys Hostel	4700	300	434681
4	Girls Hostel	3800	180	28688

PROPOSED CAPACITY:

As per the electricity bills, maximum recorded demand is 115kW for main institute and this contract demand includes girls' hostel, boys' hostel and academic block. So, we proposed setting up a 150kW solar plant to meet energy needs. With current usage at 115kW, this plant will provide sufficient power and even offers extra capacity. We can install the plant on one roof or separate for separate locations. This initiative aims save costs, reduce environmental footprint and enhance energy independence.

Table 27: ECM of Solar

Parameter	Unit	Value
Annual energy consumption	kWh	315210
Energy Saving	kWh	230523
Unit Rate	INR	10.63
Proposed monetary saving	INR	2450456
Investment	INR	8000000
Simple payback	**Months**	**39**

Note: This investment is without subsidy.

We have also put proposals for solar plants with capacity of 40kW for WTP and 15kW for STP respectively. The campus possesses ample space suitable for the installation of these plants. However, the feasibility of theses installations hinges on government policies, which we need to verify from DHVNL/HAREDA before proceeding further.

9 BEST PRACTICES FOR ENERGY CONSERVATION

9.1 ANALYSIS OF THE POWER SYSTEMS

An analysis of an electrical power system may uncover energy waste, fire hazards, and equipment failure. Facility /energy managers increasingly find that reliability-centred maintenance can save money, energy, and downtime.

System Problem	Common Causes	Possible Effects	Solutions
Voltage imbalances among the three phases	Improper transformer tap settings, single-phase loads not balanced among phases, poor connections, bad conductors, transformer grounds or faults.	Motor vibration, premature motor failure A 5% imbalance causes a 40% increase in motor losses.	Balance loads among phases.
Voltage deviations from rated voltages (too low or high)	Improper transformer settings, Incorrect selection of motors.	Over-voltages in motors reduce efficiency, power factor and equipment life Increased temperature	Correct transformer settings, motor ratings and motor input voltages
Poor connections in distribution or at connected loads.	Loose bus bar connections, loose cable connections, corroded connections, poor crimps, loose or worn contactors	Produces heat, causes failure at connection site, leads to voltage drops and voltage imbalances	Use Infra Red camera to locate hot-spots and correct.
Undersized conductors.	Facilities expanding beyond original designs, poor power factors	Voltage drop and energy waste.	Reduce the load by conservation load scheduling.
Insulation leakage	Degradation over time due to extreme temperatures, abrasion, moisture, chemicals	May leak to ground or to another phase. Variable energy waste.	Replace conductors, insulators
Low Power Factor	Inductive loads such as motors, transformers, and lighting ballasts Non-linear loads, such as most electronic loads.	Reduces current-carrying capacity of wiring, voltage regulation effectiveness, and equipment life.	Add capacitors to counteract reactive loads.
Harmonics (non-sinusoidal voltage and/or current wave forms)	Office-electronics, UPSs, variable frequency drives, high intensity discharge lighting, and electronic and core-coil ballasts.	Over-heating of neutral conductors, motors, transformers, switch gear. Voltage drop, low power factors, reduced capacity.	Take care with equipment selection and isolate sensitive electronics from noisy circuits.

9.2 ENERGY EFFICIENCY IN DG SETS

- Ensure steady load conditions on the DG set, and provide cold, dust free air at intake (use of air washers for large sets, in case of dry, hot weather, can be considered).

- Improve air filtration.

- Ensure fuel oil storage, handling and preparation as per manufacturers' guidelines/oil company data.

- Consider fuel oil additives in case they benefit fuel oil properties for DG set usage.

- Calibrate fuel injection pumps frequently.

- Ensure compliance with maintenance checklist.

- Ensure steady load conditions, avoiding fluctuations, imbalance in phases, harmonic loads.

- In case of a base load operation, consider waste heat recovery system adoption for steam generation or refrigeration chiller unit incorporation. Even the Jacket Cooling Water is amenable for heat recovery, vapour absorption system adoption.

- Consider parallel operation among the DG sets for improved loading and fuel economy thereof.

- Carryout regular field trials to monitor DG set performance, and maintenance planning as per requirements

9.3 ENERGY EFFICIENCY IN LIGHTING SYSTEM

- Grouping of lighting system, to provide greater flexibility in lighting control. Providing individual / group controls for lighting for energy efficiency such as:

  - On / off type voltage regulation type (for illuminance control)

  - Group control switches / units

  - Occupancy sensors

  - Photocell controls

  - Timer operated controls

- Pager operated controls
- Computerized lighting control programs

- Installation of microprocessor-based controllers
- Optimum usage of daylighting
- Installation of "exclusive" transformer for lighting. Installation of servo stabilizer for lighting feeder. Install input voltage regulators / controllers for energy efficiency as well as longer life expectancy for lamps where higher voltages, fluctuations are expected.
- Installation of high frequency (HF) electronic ballasts in place of conventional ballasts. Replace conventional magnetic ballasts by more energy efficient ballasts, with due consideration to life and power factor apart from watt loss.

Table 28: Characteristic of Different type of Lamps

Lamp type	Luminous efficiency / (lm/W)	Color rendering index	Color temperature /K	Life / h	Adjust the light
Fluorescent lamp	70~90	80	4000	20000	√
High-pressure mercury lamp	35~65	40~60	4500	15000	×
HPS	120~140	25	＜2500	20000	√
Metal halide lamp	80~120	60~80	4000	20000	√
Electromagnetic induction lamp	85	＞80	2700~6500	15000	×
LED lamp	110~130	＞70	2700~6500	50000	√

10 ENERGY AUDIT CERTIFICATE

Organization	:	Ch. Devi Lal State Institute of Engg. & Technology
Address	:	22KM Stone, NH-9, Sirsa Dabwali Load, Vill. Panniwala Mota, Sirsa-175101
Type of Audit	:	Energy Audit
Date of Site Audit	:	12.03.2024 & 13.03.2024
Next Audit Due on	:	12.03.2027

ECI Consulting Engineers has conducted Energy Audit of the campus mentioned above, taking into account the relevant norms and best practices for educational institutions & buildings as per BEE guidelines. For details on the audit findings, please refer to the detailed Energy Audit Report.

Manjeet Singh
(AEA-0258)
Accredited Energy Auditor
Bureau of Energy Efficiency