Report on
Energy Audit
for
Shree Jain Vidya Prasarak Mandal, College of Education

by:

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Team Enertek

Anand Dande – CEA 29754

BEE Certified Energy Auditor

Preamble:

Shri Jain Vidya Prasarak Mandal College of Education, Chinchwad, Pune is a distinguished degree college affiliated to Pune University. It is situated very central to Chinchwad. The college is a calm spacious yet modern ambience. Sheltered in huge well architecture premises along with multiple institutes, the college has a unique atmosphere chiefly characterized by inter-disciplinary scholarly interactions and healthy competitive spirit, with enthusiasm to excel in various academic and extracurricular activities.

The mission of the college is ending with this and is:

1. To stimulate the academic environment for promotion of quality teaching and learning

2. To educate students for their career goals and success to enable them to take ownership and responsibility for their present and future learning by upgrading their academic and interpersonal skills.

3. To instill in students the moral, spiritual and social values to enable them to grow as useful citizens and developed individuals.

4. To nourish and nurture and develop all round personality of the students enabling them to get gainful employment or generate self-employment.

5. To generate safe conductive and friendly atmosphere at this college campus so that students and community members can optimize their academic career.

6. To fill the gap between academic, industrial, and business world by conducting seminars lectures demonstrations and visit to the academic industrial and business houses.

Executive Summary:

Electricity Bill:

Tariff Structure:

Sanctioned load for energy meters is 3 kW but maximum load is around 5 - 6 kW. Current tariff structures, **LTI** are recommended for below 20kW residential purpose. According to #322 of 2019 MERC amendment (Maharashtra Electricity Regulatory Commission); the recommended category for public services (such as schools, hospitals) is **LTVII–B tariff**.

MEP System:

Lighting System:

The average illumination level inside the classrooms was observed lower Lux levels. As per NBC college illumination recommended should be 300 Lux inside each classroom. To provide appropriate illumination to levels with high Uniformity and Diversity, we have proposed to replace these existing T5 and T8 lighting system with LED tube light for improving illumination levels upto 300 Lux improve efficacy of lighting to 100 Lumen/Watt.

Ceiling fans:

Existing ceiling fans in the classrooms are consuming 40W, 60 W and 85W power, which are conventional induction motor type fans. Considering the vintage of these fans, it would be prudent to replace these fans by new energy-efficient BLDC fans, which would consume around 28W to 30W power each.

Chapter 1

Audit Methodology:

ESIPL team carried out the entire energy and MEP audit study with a well-defined methodology and all the energy consuming areas were covered including billing analysis. The detailed methodology followed was as under:

1.1 Electrical Distribution System:

Scope of Work:

- Study the Load distribution pattern of major energy meters
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

- Find out the electrical normal & emergency loading.
- Type of tariff
- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

Performance audit:

Electric load recording with:

- Voltage, current, kVA, kW, kWh, P.F. and Hz
- Harmonic analysis for V_{THD} and I_{THD} levels
- Thermography of electrical panels for identifying 'hot-spots,' if any

1.2. Indoor Lighting:

Scope of Work:

- To study existing lighting scenario of facility and verify the building data
- To find out the performance of lighting fixtures
- To calculate (Watt/m^2) and compare lux with the bench mark/prevailing standard in the facility
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

All the lighting fixtures were inspected for following:

- No. of lights installed and no. of lights working

- Type of lights
- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

Performance audit:

Total connected lighting load from the Census was studied in detail as per following:

- Measurement of Lux level
- Measurement of room dimensions
- Power drawn by the lighting system

1.3. Pumps:

Scope of Work:

- To study existing pumping system of facility and verify the building data
- To carry out analysis
- To find out the performance of pumping system
- To compare the operating efficiency with the bench mark/prevailing standard in the facility
- To identify the causes of deviation in the performance and suggest recommendations for corrective actions
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

All pumps (Chilled water, Cooling water and domestic water) were audited for following:

- Total no. of pumps installed
- Total no. of pumps working
- Pressure gauge working
- Ammeter working
- General hygiene conditions
- Data on operating hours data was collected from the operating staff

Performance audit:

All working pumps from the Census were studied in detail as per following:

- Water flowrate, m^3/hr
- Head generated, mWC
- Power drawn by pump, kW

1.4. Power Quality Analysis:

Scope of Work:

- Check of incoming power quality using power analyser device (Data collected will indicate the status of deviations in power, harmonics, voltage sags, frequency
- Specific corrective actions will lead to decrease in losses and increased life of equipment)

Methodology:

- Inspection of power quality with Three phase power quality analyser at main incomer for understanding of various parameters.

1.5. HVAC System:

Scope of Work:

- To study existing split air conditioners of facility and verify the building data
- To find out the performance of air conditioners
- To compare the specific energy consumption with the bench mark/prevailing standard in the facility
- To identify the causes of deviation in the performance and suggest recommendations for corrective actions
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

- No. of ODUs and IDUs installed and no. of regularly operated machines
- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

1.6. Green Audit:

Scope of Work:

- To evaluate water layout and water consumption pattern in college premises
- To evaluate carbon footprints for energy consumption at college

- To identify opportunities for sewage treatment plant and waste management at college premises.

Methodology:

- To identify water usage consumption pattern in campus
- Identification of water sources and distribution analysis across points.
- Usage of renewable energy and consumption pattern for energy perspective
- Review of existing facilities available for waste disposal methodologies in campus.

Chapter 2

Billing Analysis:

Shree Jain Vidya Prasarak Mandal college of Education receives electricity supply from MSEDCL. One LT energy meters were installed for the college premises at electrical room.

The electrical load mainly comprises of the classroom lighting, office lighting, fans, Split AC units, domestic water pumping on an average, the building functions for about 10-11 hours a day for five and half days a week.

Sr. No.	Energy Meter Number	Tariff category	Phase	Contract Demand (kVA)	Connected Load (kW)	Operation status
1	170143728270	LT-I Res. 1 Phase	1		3	Operational

Detailed Bill Analysis:

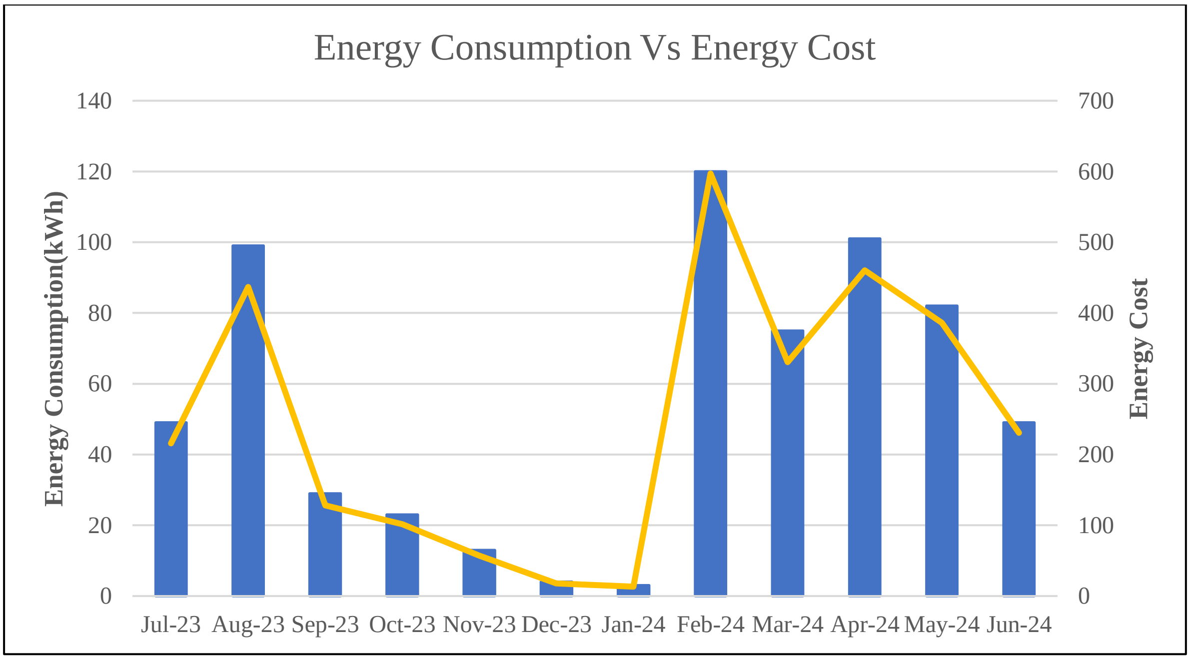
The following table shows the detailed bill analysis from the month of July 2024 to June 2024

Parameter/ Month	Jun-24	May-24	Apr-24	Mar-24	Feb-24	Jan-24	Dec-23	Nov-23	Oct-23	Sep-23	Aug-23	Jul-23
Sanctioned Load, kW	3	3	3	3	3	3	3	3	3	3	3	3
Energy Consumption, kWh	49	82	101	75	120	3	4	13	23	29	99	49
Fixed Charges, Rs.	138	138	129.96	126	126	126	126	126	126	126	252	126
Energy Charges, Rs.	231	386	461	331	597	13	18	57	101	128	437	216
Wheeling Charges, Rs.	57	96	118	88	140	4	5	15	27	34	116	57
Fuel Adjustment Charges, Rs.	20	33	25	19	33	1	1	2	3	0	0	0
Electricity Duty, Rs.	71	104	117	90	143	23	24	32	41	46	129	64
Tax On Sale, Rs.	0	0	0	0	0	0	0	0	0	0	0	0
Total Current Bill, Rs.	**₹ 2,699**	**₹ 2,167**	**₹ 1,399**	**₹ 642**	**₹ 1,047**	**₹ 166**	**₹ 179**	**₹ 236**	**₹ 303**	**₹ 334**	**₹ 465**	**₹ 465**
Specific Energy Consumption, Rs. /kWh	₹ 55	₹ 26	₹ 14	₹ 9	₹ 9	₹ 55	₹ 45	₹ 18	₹ 13	₹ 12	₹ 5	₹ 9

The annual energy consumption for energy meter has been summarized as under:

Energy Meter Consumer ID	Annual Energy Consumption 2023 – 2024, kWh
170143728270	647

Bar chart of Energy Consumption after June 2023



Energy consumption during 24-hour analysis was found around 60 kWh per day. Major contributors to energy consumption are Ceiling fans and T5 Tube lights, which contribute around 70 % of total load. Both needs to be replaced due to inefficiency of equipment's.

Detailed analysis of these major energy consuming energy meters revealed the following trends:

- Energy meters are in **LT II** category of tariff structure.
- For **LTII** Power meters, the power factor & TOD benefits are not accounted for billing but due to buildings nature of operation TOD night zone benefit is not being availed due to lower load in night zone.
- The energy charges (Rs. Bill value paid / kWh consumed) are around Rs. 11.8/kWh.

Other Cost Saving measures:

As per MERC guidelines, a prompt payment discount of one percent of the monthly bill (excluding Taxes and Duties) shall be provided to consumers for payment of electricity bills within 7 days from the date of their issue.

In case the electricity bill is not paid within the due date mentioned on the bill, delayed payment charges on the billed amount, including the taxes, cess, duties, etc..., shall be levied on simple interest basis at the rate of 1.25% on the billed amount for the first month of delay.

A discount of 0.25% of the monthly bill (excluding taxes and duties), subject to a cap of Rs. 500/-, shall be provided to LT category consumers for payment of electricity bills through various modes of digital payment such as credit cards, debit cards, UPI, BHIM, internet banking, mobile banking, mobile wallets, etc....

College management can avail this benefit and make necessary provisions for making digital payments to MSEDCL.

Chapter 3

MEP Systems

3.1. Lighting System:

Shree Jain Vidya Prasarak Mandal College of Education has single building, which includes 105 number of lighting fixtures and out of that 33% of lighting fixtures are T8 Type. This lighting is inefficient in terms of lumens/watt and that can be better replaced with LED lighting fixtures.

The total lighting load for all building is 2.62 kW and with overall BUA of 20,282.72 ft2 the actual LPD is 0.129 W/ft2.Avergae diversity for illumination is 0.29 and uniformity is 0.47. Both Diversity and Uniformity need to be improved by fixing additional lighting fixtures.

Existing Lighting scheme:

Floor	Sr. No.	Location	Room Area, m^2	Wattage					Total Wattage, W
				9	12	18	20	36	
Ground Floor	1	Library	58.67				1	1	56
	2	B.Ed.- Computer Lab	56.91				2		40
	3	B.Ed.- Science Lab	57.13		2		1	1	80
	4	B.Ed.- Classroom 2	57.31				3	4	204
	5	B.Ed.- Classroom 1	60.10				3		60
	6	Ladies Washroom	57.03				4		80
	7	Ground Floor Passage in Front of Science Lab	56.79				3	1	96
	8	Visit Room- 1	57.06					2	72
	9	Visit Room- 2	32.13				1	1	56
	10	Administrative Office	32.13				1	1	56
	11	B.Ed. Ladies Staff Room	57.85				2		40
	12	B.Ed. Gents Staff Room	93.52				17		340
	13	Passage in Front of Principal Room	74.03				7		140
	14	Principal Room	33.56					2	72
	15	Exam Dept.	51.81				1		20
	16	Stairs Ground Floor	37.48				2		40
First Floor	17	B.Ed.- Classroom 3	7.00	0	0	0	0	0	0
	18	B.Ed.- Classroom 4	8.40					1	36
	19	Room Infront of Gents Toilet First Floor	35.18				1		20
	20	Economics Education	57.34					2	72
	21	Boys Toilet	57.14					1	36
	22	B.Ed.- Mathematics Method Room	57.59					1	36
	23	B.Ed.- Marathi Method Room	57.27					2	72
	24	Passage in Front of Exam Dept.	58.68				2	1	76
	25	Stairs between Ground Floor and 1st Floor	56.69				1	1	56
Second Floor	26	Hindi Method Room	57.01				1	1	56
	27	B.Ed.- Geography Method Room	56.84				2		40

Floor	Sr. No.	Location	Room Area, m^2	Wattage					Total Wattage, W
				9	12	18	20	36	
	28	Passage in Front of Geography Method Room	57.18				2		40
	29	B.Ed.- English Method Room	122.11					4	144
	30	B.Ed.- NAAC Room	22.62					4	144
	31	B.Ed.- Seminar Hall	32.37					2	72
	32	Passage in Front of Seminar Hall	94.00				7		140
	33	Stairs Near Terrace	41.32				1		20
	34	Stairs Near 2nd Floor	51.81				1		20
	35	Stairs Between 1st and 2nd Floor	37.48				2		40
	36	Stair's 1st Floor	8.12					1	36
	37	Stairs between Ground Floor and 1st Floor	35.18				1		20

Energy Saving Calculations:

Sr. No.	Location	Average Lux	Existing Lumen	Required Lumens	Proposed Total Wattage	Existing Wattage	Saving Wattage
1	Library	367.2	25808	21083	220	140	-80.00
2	B.Ed.- Computer Lab	423.0	10273	7286	100	40	-60.00
3	B.Ed.- Science Lab	111.0	2263	6114	80	40	-40.00
4	B.Ed.- Classroom 2	148.5	4291	8666	120	60	-60.00
5	B.Ed.- Classroom 1	106.0	3072	8698	120	80	-40.00
6	Ladies Washroom	180.6	1570	2608	40	20	-20.00
7	Ground Floor Passage in Front of Science Lab	517.8	9753	5650	80	40	-40.00
8	Visit Room- 1	630.0	7931	3777	60	40	-20.00
9	Visit Room- 2	680.1	9412	4152	60	40	-20.00
10	Administrative Office	366.3	3705	3034	40	40	0.00
11	B.Ed. Ladies Staff Room	218.4	2480	3407	60	40	-20.00
12	B.Ed. Gents Staff Room	238.6	2574	3236	60	40	-20
13	Passage in Front of Principal Room	769.8	21511	8383	120	40	-80.00
14	Principal Room	146.4	1978	4053	60	20	-40.00
15	Exam Dept.	195.1	1337	2056	40	20	-20.00
16	Stairs Ground Floor	65.5	1313	6011	80	20	-60.00
17	B.Ed.- Classroom 3	228.2	10537	13853	180	80	-100.00
18	B.Ed.- Classroom 4	328.9	14917	13605	180	80	-100.00
19	Room Infront of Gents Toilet First Floor	297.3	6747	6807	100	40	-60.00
20	Economics Education	193.9	3445	5331	80	40	-40.00
21	Boys Toilet	150.3	1281	2556	40	20	-20.00
22	B.Ed.- Mathematics Method Room	229.0	5145	6741	100	40	-60.00
23	B.Ed.- Marathi Method Room	398.2	8929	6727	100	40	-60.00
24	Passage in Front of Exam Dept.	211.7	5673	8039	120	40	-80.00
25	Stairs between Ground Floor and 1st Floor	284.8	5707	6011	80	20	-60.00
26	Hindi Method Room	650.2	14801	6829	100	40	-60.00
27	B.Ed.- Geography Method Room	309.8	7044	6821	100	40	-60.00
28	Passage in Front of Geography Method Room	216.5	1342	1861	40	20	-20.00

Sr. No.	Location	Average Lux	Existing Lumen	Required Lumens	Proposed Total Wattage	Existing Wattage	Saving Wattage
29	B.Ed.- English Method Room	328.0	7523	6881	100	20	-80.00
30	B.Ed.- NAAC Room	133.1	1207	2722	40	20	-20.00
31	B.Ed.- Seminar Hall	266.6	24581	27658	360	140	-220.00
32	Passage in Front of Seminar Hall	613.7	21537	10528	140	40	-100.00
33	Stairs Near Terrace	49.7	777	4693	60	20	-40.00
34	Stairs Near 2nd Floor	97.5	1954	6011	80	20	-60.00
35	Stairs Between 1st and 2nd Floor	302.2	6055	6011	80	20	-60.00
36	Stair's 1st Floor	128.5	2574	6011	80	20	-60.00
37	Stairs between Ground Floor and 1st Floor	284.8	5707	6011	80	20	-60.00
				Total	3580	1540	-2040

Recommendation:

Majority of fluorescent lighting fixtures are of T5 and T8 type, their lumen output values are lower, when compared with energy efficient LED tubes. An exercise was carried of calculating existing lumen levels in the classroom and how many fixtures would be needed to get required illumination levels, when 20W LED tube-lights would be used.

Total, 182 (considering existing LED fixtures) nos. of LED tube-lights would be needed to meet desired illumination levels as NBC-2016. Quantity of fixtures would increase, and the overall lighting load would be increased by 2.04 kW.

Calculations for Additional Quantity:

Parameters	Value
Existing Connected load, kW	1.54
Proposed connected load, kW	3.58
Additional Power, kW	2.04
No of 20 W Tube for replacement	77
20 W Tube Price Rs. /Unit	200
Initial Investment in Lakh	0.16

Calculation Replacement of Existing Quantity (Lights-36W)

Parameters	Value
Existing quantity of Lights(36W), nos.	35

Parameters	Value
Existing power for Lights, W	36
Total Power consumed by Lights, kW	1.26
Proposed quantity of Lights(36W), nos.	77
Recommended power for Lights, W	1.54
Total proposed power by all Lights, kW	3.58

Illumination Study:

The illumination includes the area wise lux levels measurements to verify the adequacy of the lighting levels. The standards referred for the illumination study is national building code 2016 Volume-2. The following table shows the area wise lux levels.

Location	Average	Maximum	Minimum	Diversity	Uniformity	Comment
Library	367.2	1300	70	0.19	0.05	Adequate
B.Ed.- Computer Lab	423.0	762	254	0.33	0.60	Adequate
B.Ed.- Science Lab	111.0	210	57	0.27	0.51	Inadequate
B.Ed.- Classroom 2	148.5	285	54	0.19	0.36	Inadequate
B.Ed.- Classroom 1	106.0	165	52	0.32	0.49	Inadequate
Ladies Washroom	180.6	245	120	0.49	0.66	Inadequate
Ground Floor Passage in Front of Science Lab	517.8	745	256	0.34	0.49	Adequate
Visit Room- 1	630.0	1400	334	0.24	0.53	Adequate
Visit Room- 2	680.1	2000	292	0.15	0.43	Adequate
Administrative Office	366.3	480	268	0.56	0.73	Adequate
B.Ed. Ladies Staff Room	218.4	322	125	0.39	0.57	Inadequate
B.Ed. Gents Staff Room	238.6	345	125	0.36	0.52	Inadequate
Passage in Front of Principal Room	769.8	946	600	0.63	0.78	Adequate
Principal Room	146.4	210	79	0.38	0.54	Inadequate
Exam Dept.	195.1	360	100	0.28	0.51	Inadequate
Stairs Ground Floor	65.5	119	21	0.18	0.32	Inadequate
B.Ed.- Classroom 3	228.2	378	135	0.36	0.59	Inadequate
B.Ed.- Classroom 4	328.9	575	165	0.29	0.50	Adequate
Room Infront of Gents Toilet First Floor	297.3	456	189	0.41	0.64	Inadequate
Economics Education	193.9	273	55	0.20	0.28	Inadequate
Boys Toilet	150.3	215	80	0.37	0.53	Inadequate
B.Ed.- Mathematics Method Room	229.0	477	76	0.16	0.33	Inadequate
B.Ed.- Marathi Method Room	398.2	854	114	0.13	0.29	Adequate
Passage in Front of Exam Dept.	211.7	833	45	0.05	0.21	Inadequate
Stairs between Ground Floor and 1st Floor	284.8	450	123	0.27	0.43	Inadequate
Hindi Method Room	650.2	2275	226	0.10	0.35	Adequate

Location	Average	Maximum	Minimum	Diversity	Uniformity	Comment
B.Ed.- Geography Method Room	309.8	545	35	0.06	0.11	Adequate
Passage in Front of Geography Method Room	216.5	300	111	0.37	0.51	Inadequate
B.Ed.- English Method Room	328.0	585	190	0.32	0.58	Adequate
B.Ed.- NAAC Room	133.1	223	80	0.36	0.60	Inadequate
B.Ed.- Seminar Hall	266.6	550	120	0.22	0.45	Inadequate
Passage in Front of Seminar Hall	613.7	1222	80	0.07	0.13	Adequate
Stairs Near Terrace	49.7	120	10	0.08	0.20	Inadequate
Stairs Near 2nd Floor	97.5	120	80	0.67	0.82	Inadequate
Stairs Between 1st and 2nd Floor	302.2	450	150	0.33	0.50	Adequate

The table shows that 23 areas have inadequate lighting levels and 14 Areas has adequate lighting levels. To mitigate the standard lighting levels facility needs to install additional lighting levels.

3.2. Ceiling Fans:

College of Education has 37 number of ceiling fans for air circulation at various classrooms, staff rooms and passages across building. These existing ceiling fans are with conventional inductive motor and consume 75W power each. The total connected fan load for the building is 2.775 kW.

As per NBC-2016, 5 to 7 Air changes per hour have been recommended for classrooms. Typically, most of the classrooms has 2 - 3 nos. ceiling fans

Exiting Scenario:

Sr. No	Location	75 W Fan	Total Wattage (W)
1	Library	4	300
2	B.Ed.- Computer Lab	2	150
3	B.Ed.- Science Lab	2	150
4	B.Ed.- Classroom 2	1	75
5	B.Ed.- Classroom 1	2	150
6	Ladies Washroom	0	0
7	Ground Floor Passage in Front of Science Lab	1	75
8	Visit Room- 1	1	75
9	Visit Room- 2	1	75
10	Administrative Office	1	75
11	B.Ed. Ladies Staff Room	1	75
12	B.Ed. Gents Staff Room	1	75
13	Passage in Front of Principal Room	1	75
14	Principal Room	1	75
15	Exam Dept.	1	75
16	Stairs Ground Floor	0	0
17	B.Ed.- Classroom 3	2	150
18	B.Ed.- Classroom 4	2	150
19	Room Infront of Gents Toilet First Floor	1	75
20	Economics Education	1	75
21	Boys Toilet	0	0
22	B.Ed.- Mathematics Method Room	1	75
23	B.Ed.- Marathi Method Room	1	75
24	Passage in Front of Exam Dept.	0	0
25	Stairs between Ground Floor and 1st Floor	0	0
26	Hindi Method Room	1	75
27	B.Ed.- Geography Method Room	1	75
28	Passage in Front of Geography Method Room	0	0
29	B.Ed.- English Method Room	0	0
30	B.Ed.- NAAC Room	1	75
31	B.Ed.- Seminar Hall	0	0
32	Passage in Front of Seminar Hall	6	450
33	Stairs Near Terrace	0	0
34	Stairs Near 2nd Floor	0	0
35	Stairs Between 1st and 2nd Floor	0	0
36	Stair's 1st Floor	0	0
37	Stairs between Ground Floor and 1st Floor	0	0
	Total	**37**	**2775**

According to **NBC-2016, clause 5.7.4**, the number of recommended ceiling fans are calculated according to room dimensions. There are changes in some of classroom and addition of fans are required of further mechanical ventilation.

Location	**Length, M**	**Width, M**	**Number of Fans Recommended**	**Sweep**	**Total Airflow**
Library	7.89	7.43	4	1200	51600
B.Ed.- Computer Lab	7.881	7.221	4	1200	51600
B.Ed.- Science Lab	7.889	7.242	4	1200	51600
B.Ed.- Classroom 2	7.9	7.254	4	1200	51600
B.Ed.- Classroom 1	6.829	8.8	4	1200	51600
Ladies Washroom	7.908	7.212	4	1200	51600
Ground Floor Passage in Front of Science Lab	7.898	7.191	4	1200	51600
Visit Room- 1	7.892	7.33	4	1200	51600
Visit Room- 2	6.006	5.35	2	1400	31200
Administrative Office	6.006	5.378	2	1400	31200
B.Ed. Ladies Staff Room	7.926	7.299	4	1200	51600
B.Ed. Gents Staff Room	7.952	11.761	4	1500	62400
Passage in Front of Principal Room	10.883	6.802	4	1400	62400
Principal Room	7.946	4.246	4	1200	51600
Exam Dept.	17.54	2.954	3	1500	46800
Stairs Ground Floor	34.5	2.863	4	1500	51600
B.Ed.- Classroom 3	2.8	2.6	4	1400	62400
B.Ed.- Classroom 4	2.6	2.7	4	1200	62400
Room Infront of Gents Toilet First Floor	32.312	2.863	3	1500	38700
Economics Education	7.911	7.248	4	1200	51600
Boys Toilet	7.889	7.243	4	1200	51600
B.Ed.- Mathematics Method Room	7.886	7.303	4	1200	51600
B.Ed.- Marathi Method Room	7.89	7.258	4	1200	51600
Passage in Front of Exam Dept.	6.795	8.636	4	1200	51600
Stairs between Ground Floor and 1st Floor	7.857	7.215	4	1200	51600
Hindi Method Room	7.892	7.224	4	1200	51600
B.Ed.- Geography Method Room	7.871	7.221	4	1200	51600
Passage in Front of Geography Method Room	7.932	7.209	4	1200	51600
B.Ed.- English Method Room	15.176	8.046	6	1500	93600
B.Ed.- NAAC Room	3.9	5.8	1	1400	15600
B.Ed.- Seminar Hall	6.069	5.333	2	1400	31200
Passage in Front of Seminar Hall	7.84	11.99	0	1500	0
Stairs Near Terrace	5.371	7.693	2	1400	31200
Stairs Near 2nd Floor	17.54	2.954			0
Stairs Between 1st and 2nd Floor	34.5	2.863			0
Stair’s 1st Floor	2.8	2.6			0
Stairs between Ground Floor and 1st Floor	32.312	2.863			0

Additional Fan Quantity to be installed at these rooms:

Sr. No	Location	Additional Quantity Required
1	Library	0
2	B.Ed.- Computer Lab	2
3	B.Ed.- Science Lab	2
4	B.Ed.- Classroom 2	3
5	B.Ed.- Classroom 1	2
6	Ladies Washroom	4
7	Ground Floor Passage in Front of Science Lab	3
8	Visit Room- 1	3
9	Visit Room- 2	1
10	Administrative Office	1
11	B.Ed. Ladies Staff Room	3
12	B.Ed. Gents Staff Room	3
13	Passage in Front of Principal Room	3
14	Principal Room	3
15	Exam Dept.	2
16	Stairs Ground Floor	4
17	B.Ed.- Classroom 3	2
18	B.Ed.- Classroom 4	2
19	Room Infront of Gents Toilet First Floor	2
20	Economics Education	3
21	Boys Toilet	4
22	B.Ed.- Mathematics Method Room	3
23	B.Ed.- Marathi Method Room	3
24	Passage in Front of Exam Dept.	4
25	Stairs between Ground Floor and 1st Floor	4
26	Hindi Method Room	3
27	B.Ed.- Geography Method Room	3
28	Passage in Front of Geography Method Room	4
29	B.Ed.- English Method Room	6
30	B.Ed.- NAAC Room	0
31	B.Ed.- Seminar Hall	2
32	Passage in Front of Seminar Hall	0
33	Stairs Near Terrace	0
34	Stairs Near 2nd Floor	0
35	Stairs Between 1st and 2nd Floor	0
36	Stair's 1st Floor	0
37	Stairs between Ground Floor and 1st Floor	0

Recommendation:

Existing ceiling fans can be replaced with energy-efficient brushless DC (BLDC) fans, which consume lower power and have higher air volume sweep. The other benefits of BLDC fans are lower noise generation, which is an advantage for college environment.

The proposed power consumption, after installation of BLDC fans, would reduce form 7.35 kW to 2.744 kW; resulting in savings of 4.606 kW of power per hour of usage.

Energy Saving calculations:

Parameters	Value
Proposed quantity of ceiling fans, nos.	80
Total Power consumed by existing fans, kW	2.775
Recommended power for BLDC fans, kW	28
Total proposed power by all BLDC fans, kW	2.24
Expected Power Savings, kW	1.7
Expected energy Savings per annum, kWh	2782
Annual cost savings, Rs. Lakh	0.24
Investment required, Rs. /Fan	2800
Total Investment, Rs. Lakh	1.03
Simple payback period, years	4

3.3. Air Conditioning System:

There are no Room air conditioners have been installed college. While installing air conditioning system with new split air conditioning system, latest BEE Star labelled air conditioning system should be selected for installation. As per BEE's notification dated 10th November 2021, the minimum Energy efficiency ratio (EER) has been published in the gazette for manufacturing companies and consumer. Star labelling

- **Time period:** From 1st January, 2021 to 31st December, 2023

Reference (BEE STAR Labelling)

Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star Level	**Minimum EER**	**Max EER**
1	3.3	3.49
2	3.5	3.79
3	3.8	4.39
4	4.4	4.99
5	5.0	

Comparison of EER and payback period-

For various operating hours we have evaluated Air conditioning selection option on operating hours. Various star rated system of same capacity has higher initial investment and different operating costs. For initial selection of AC system, we have evaluated following data

AC system for 8 Hours/day usage:

AC TR Load	Star rating	Annual energy Consumption (kWh)	Operating Cost (Rs.)	Initial Investment (Rs.)	Operating Cost Difference (Rs.)	Initial Cost Difference (Rs.)	Payback Period (Rs.)	proposition
1.0	3	1108	10,475	31,990	766	3,000	3.9	4 Star v/s 3 Star
	4	1027	9,708	34,990	883	4,000	4.5	5 Star v/s 4 Star
	5	934	8,826	38,990	1,649	7,000	4.2	5 Star v/s 3 Star
1.5	3	1663	15,712	31,499	1,150	2,321	2.0	4 Star v/s 3 Star
	4	1541	14,562	33,820	1,324	6,170	4.7	5 Star v/s 4 Star
	5	1401	13,238	39,990	2,473	8,491	3.4	5 Star v/s 3 Star
2.0	3	2217	20,949	49,499	2,857	4,491	1.6	4 Star v/s 3 Star
	4	1915	18,092	53,990	2,171	3,000	1.4	5 Star v/s 4 Star
	5	1685	15,921	56,990	5,028	7,491	1.5	5 Star v/s 3 Star

Considering 8 hours operation period, the management should select BEE 5-Star rated split air conditioning system. As the operating cost of 5-Star system is much lower than any other Star rated air conditioning system, the incremental cost of system can be easily compensated with higher usage.

AC system for 5 Hours/day usage:

AC TR Load	Star rating	Annual energy Consumption (kWh)	Operating Cost (Rs.)	Initial Investment (Rs.)	Operating Cost Difference (Rs.)	Initial Cost Difference (Rs.)	Payback Period (Rs.)	proposition
1	3	693	6,547	31,990	479	3,000	6.3	4 Star v/s 3 Star
	4	642	6,068	34,990	552	4,000	7.3	5 Star v/s 4 Star
	5	584	5,516	38,990	1,031	7,000	6.8	5 Star v/s 3 Star
1.5	3	1039	9,820	31,499	719	2,321	3.2	4 Star v/s 3 Star
	4	963	9,101	33,820	827	6,170	7.5	5 Star v/s 4 Star
	5	876	8,274	39,990	1,546	8,491	5.5	5 Star v/s 3 Star
2	3	1386	13,093	49,499	1,785	4,491	2.5	4 Star v/s 3 Star
	4	1197	11,308	53,990	1,357	3,000	2.2	5 Star v/s 4 Star
	5	1053	9,951	56,990	3,142	7,491	2.4	5 Star v/s 3 Star

Considering 5 hours operation period; the management should select BEE 4-Star rated split air conditioning system.

Considering lower operation hours and impact of power consumption, system selection of BEE 4-Star rated system would be more appropriate.

AC system for 3 Hours/day usage:

AC TR Load	Star rating	Annual energy Consumption (kWh)	Operating Cost (Rs.)	Initial Investment (Rs.)	Operating Cost Difference (Rs.)	Initial Cost Difference (Rs.)	Payback Period (Rs.)	proposition
1	3	416	3,928	31,990	287	3,000	10.4	4 Star v/s 3 Star
	4	385	3,641	34,990	331	4,000	12.1	5 Star v/s 4 Star
	5	350	3,310	38,990	618	7,000	11.3	5 Star v/s 3 Star
1.5	3	623	5,892	31,499	431	2,321	5.4	4 Star v/s 3 Star
	4	578	5,461	33,820	496	6,170	12.4	5 Star v/s 4 Star
	5	525	4,964	39,990	928	8,491	9.2	5 Star v/s 3 Star
2	3	831	7,856	49,499	1,071	4,491	4.2	4 Star v/s 3 Star
	4	718	6,785	53,990	814	3,000	3.7	5 Star v/s 4 Star
	5	632	5,971	56,990	1,885	7,491	4.0	5 Star v/s 3 Star

Considering 3 hours operation per day, the management should invest into BEE 3-Star split air conditioning system. Considering fewer operating hours per day, and power consumption of system; it would be prudent for management to select BEE 4-Star system over a BEE 3-Star rated system.

Chapter 4

Power Quality Analysis:

In the Power Quality study, the Site team carried out the power quality survey for the load. 3 Phase energy analyser was connected at the main incoming feeder for the period of 24 Hours.

The energy parameters logged were as under:

- Voltage Profile
- Current Trends
- Power trends and consumption
- Power Factor
- Frequency
- Harmonics
- Unbalance, if any

To measure the electrical parameters for the meters, a 3-phase power analyser with the following details has been connected to the main incoming for 24 hours.

Details of 3 Phase Power Analyser:	
Make	**Fluke**
Model number	**434 II**
Serial Number	**39783011**
CT Details	**iFlex CTs 6000A**

4.1. Test Method:

- As per requirement, the instruments stated above were connected at the main incoming of the panel
- Logging of electrical parameters was done for 24 hours' duration
- Measuring interval period, set on the device, was 1 min (60 reading in 1 hour) with minimum maximum and average for each reading.
- Following parameters have been measured and recorded by the instrument:
    - Voltage(V): Phase Voltage, Line Voltage, Peak Voltage, N-G voltage
    - Current(A): Line Current, Peak Current
    - Power (kW, kVA, kVAR): Active, Reactive, Apparent
    - Energy (kWh, kVAh, kVARh): Active, Reactive, Apparent

- Harmonics (V_{THD} and I_{THD})
- Voltage & current unbalance
- Power Factor
- Frequency (Hz)

- The readings taken, were compared with the reference standards available for tolerances. For detailed information, Electricity Supply Act or Electricity Act were also referred.

Reference Codes and Standards:

Parameters	Reference Limits	Referenced Standards
Power Frequency	Mean Value of fundamental measured over 10s +/- 2% for 99.5%	EN 50160
Voltage magnitude Variation	+/- 10% for 95% of week, mean 10mins RMS values	EN 50160
Harmonics Voltage	V_{THD} < 5%individual V-h <3%	IEEE 519
Harmonics Currents	I_{THD} %: as defined by ratio of 1 (short circuit)/ 1(Full load)	IEEE 519
Supply voltage unbalance	positive, Negative and zero sequence, 2% between line to line	EN 61000-2-12
Load Unbalance	Positive, Negative and zero sequence, leakage currents <500ma	EN 50161

Harmonic Standards:

Parameters	Benchmark
Total Harmonic Distortion in Voltage and Current (THD)	Less than 5% for 69kv and below (As per IEEE)
Individual harmonic distortion in Voltage and current	Less than 3% for 69kv and below (As per IEEE)
Neutral Current	Less than 10% of load current
Ground Leakage	Ideally Zero
Voltage Variation in transformer's secondary	Less than 3 percentage (As per Electrical Standard)

Voltage Distortion Limits		
Bus Voltage at PCC	**Individual Voltage Distortion (%)**	**Total Voltage Distortion THD (%)**

Below 69 kV	3.0	5.0
69 kV to 161 kV	1.5	2.5
161 kV and above	1.0	1.5
Note: High voltage systems can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user		

Maximum % Harmonic Current Distortion of an individual Harmonic Order (Odd)						
Individual Harmonic order (Odd Harmonics)						
ISC / IL	< 11	11 < 17	17 – 20	23 < 35	35 <	TDD
< 20	4.0	2.0	1.5	0.6	0.3	6.0
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

4.2. Summary of Observations:

1. **Voltage:**

   The voltage values were recorded for 24 hours at an interval of 5 Sec the voltage variations can be represented as follows:

Parameters	**UoM**	**V_{rms} ph-n RN**	**V_{rms} ph-n YN**	**V_{rms} ph-n BN**	**V_{rms} ph-n NG**	**V_{rms} ph-ph RY**	**V_{rms} ph-ph YB**	**V_{rms} ph-ph RB**
Maximum	V	256.36	251.02	256.74	5.16	442.35	439.93	440.94
Minimum	V	238.95	237.82	242.19	1.64	417.70	415.88	415.23
Average	V	247.44	243.93	248.82	2.97	428.62	426.65	426.59

Observations and Remarks:

- Voltage was found to be normal across all phases. The mean voltage values were 246.73V and 427.29V.
- Voltage observed was within permissible limits.

Standards Referred:
EN50160: Voltage Fluctuation is within 10% and is within permissible limits.

2. Current:

Current values were recorded across all phases including neutral Current. The current fluctuations observed were as under:

Parameter	UoM	Current R	Current Y	Current B	Current N
Maximum	A	20.30	18.80	10.40	3.90
Minimum	A	7.80	10.30	1.50	2.30
Average	A	10.54	13.58	3.15	2.63

Observations and Comments:

- Current is driven by the load. This parameter has no limit and is based upon the requirement of the load.
- Neutral Current was in the permissible limit.

Recommendations:
Load & Phase balancing should be done

3. Frequency:

Frequency of the network is being monitored in this logging session. The summary can be shared as follows

Parameter	UoM	Frequency
Maximum	Hz	50.07
Minimum	Hz	49.70
Average	Hz	49.95

Observations and Remarks:

Frequency variations were within acceptable tolerance of ± 2%

Standards Referred:
EN 50160: Mean Value of fundamental measured over 10s ± 2% for 99.5%

4. Power:

Active, reactive, and apparent power has been recorded and summarised as below:

Power	Parameters	UoM	R Phase	Y Phase	B Phase	Total
Active Power	Maximum	kW	4.87	4.35	2.25	9.39
	Minimum	kW	1.85	2.37	0.33	4.59
	Average	kW	2.53	3.14	0.71	6.39
Apparent Power	Maximum	kVA	4.91	4.59	2.44	10.32
	Minimum	kVA	1.92	2.52	0.37	5.58
	Average	kVA	2.61	3.31	0.78	7.55
Reactive Power	Maximum	kVAR	0.21	-0.1	0.95	0.39
	Minimum	kVAR	-0.49	-0.44	0.08	-0.6
	Average	kVAR	-0.29	-0.24	0.23	-0.30

5. Power Factor:

Parameter	R Phase	Y Phase	B Phase	Total
Maximum	0.99	0.97	0.97	0.94
Minimum	0.95	0.94	0.77	0.78
Average	0.97	0.95	0.90	0.85

Observations and Remarks:

- As seen in the table above, the average power factor is 0.85.

6. Energy:

As seen in the power section, the energy that has been consumed over 24 hours can be stated as follows

Parameter	UoM	Energy Consumed			
Phase		R Phase	Y Phase	B Phase	Total
Active Energy	kWh	57.27	71.07	16.12	144.47

Apparent Energy	kVAh	59	74.89	17.73	170.79
Reactive Energy	KVArh	-6.65	-5.35	5.12	-6.73

Observations and Remarks:

- The energy consumed by the load is in line with consumption pattern.

7. Harmonics:

The summary of harmonics recorded is as under:

Parameters	UoM	Voltage R Phase	Voltage Y Phase	Voltage B Phase	Current R Phase	Current Y Phase	Current B Phase
Max	%	2.63	3.19	2.55	22.94	33.17	42.05
Min	%	1.90	2.11	1.65	7.69	18.00	7.71
Avg.	%	2.31	2.68	2.09	16.19	28.18	18.77

Observations and Remarks:

Voltage Harmonics:

- Total Voltage Harmonics were within acceptable limits of 5%, and individual Harmonic distortion was within 3 % limits.

Current Harmonics:

- Current Harmonics were higher than upper tolerance limits of 8%
- The individual harmonic distortions were higher limit 8%
- Harmonics of order 5^{th} and 7^{th} were observed to be above 8% as per prescribed limits.

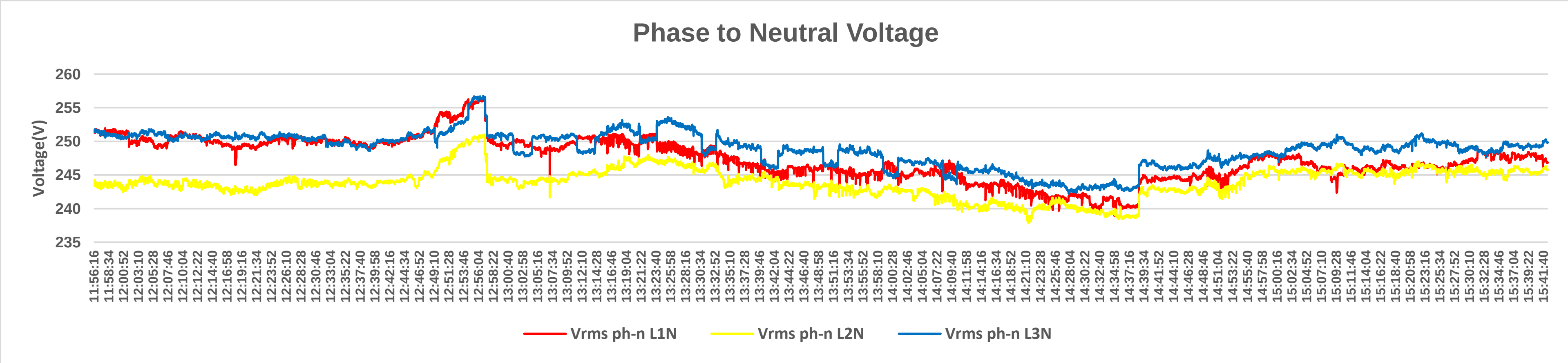
Recommendation:

- To reduce the effects of harmonics on the system by phase balancing at load side.
- Further reduction in harmonics will be done by implementation of earthing for LT load.

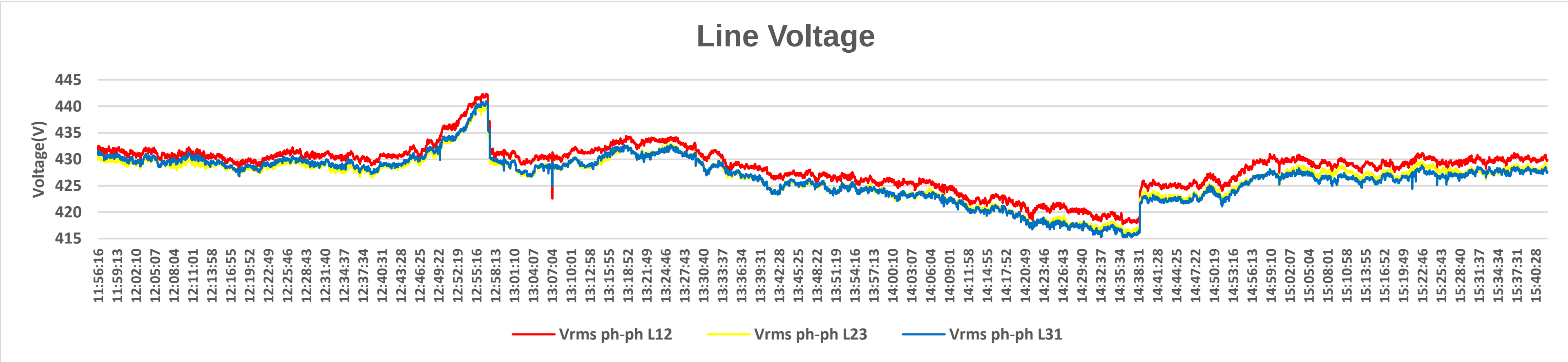
Standard Referred: IEEE 519

Graphs

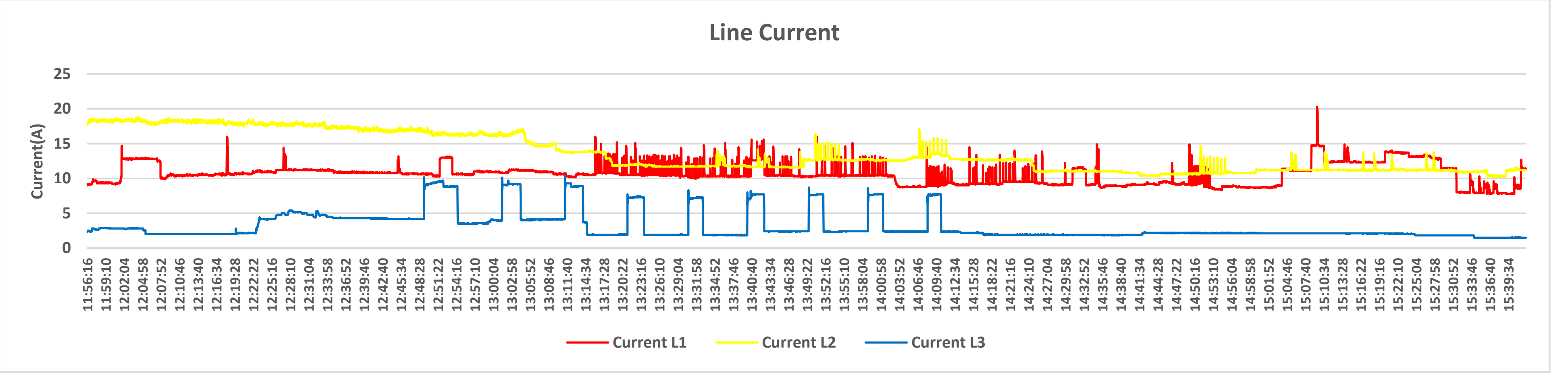
I) Phase Voltage-



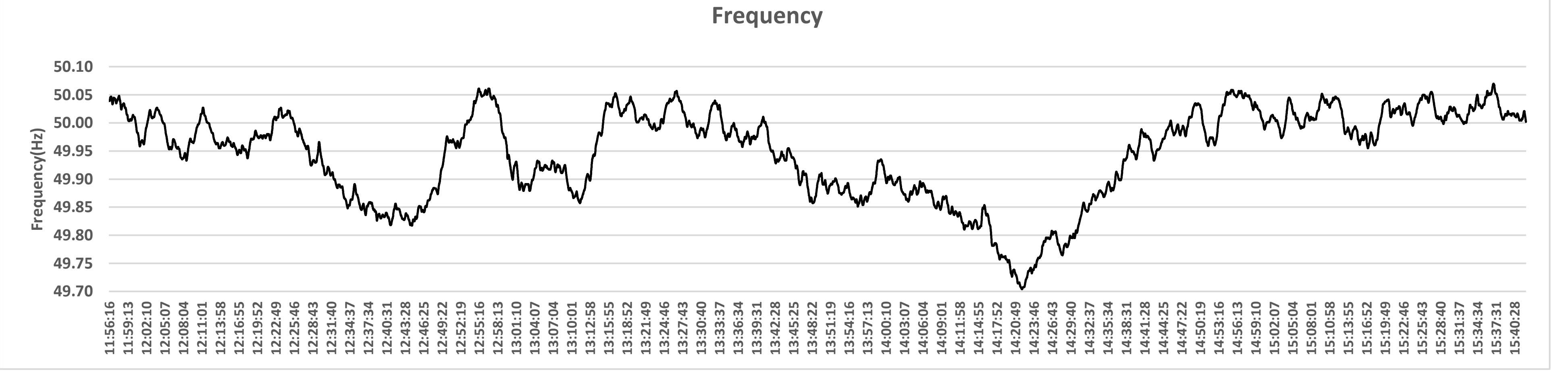
II) Line Voltage-



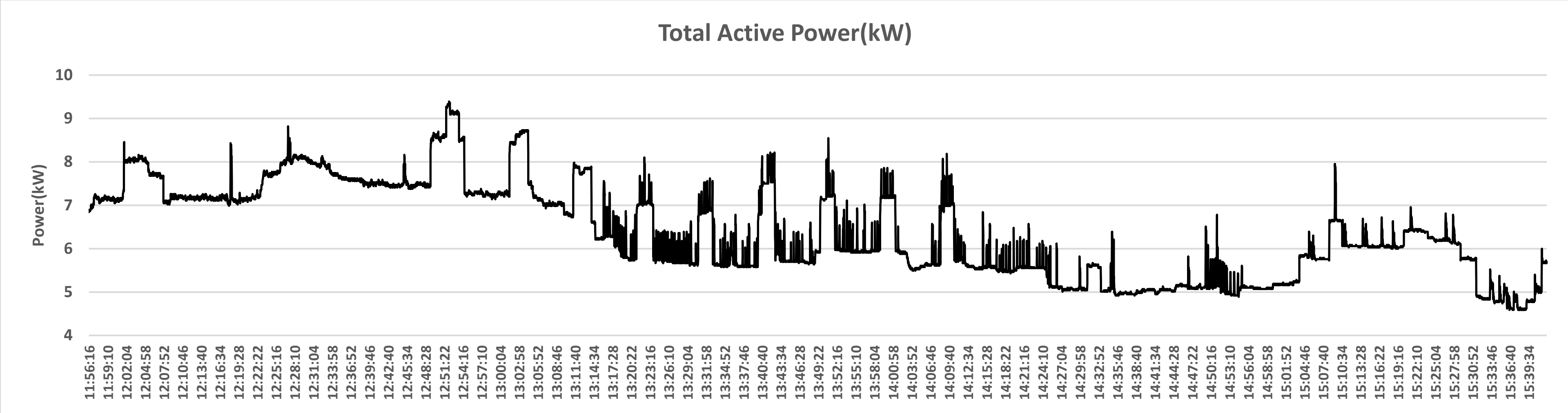
III) Line Current-



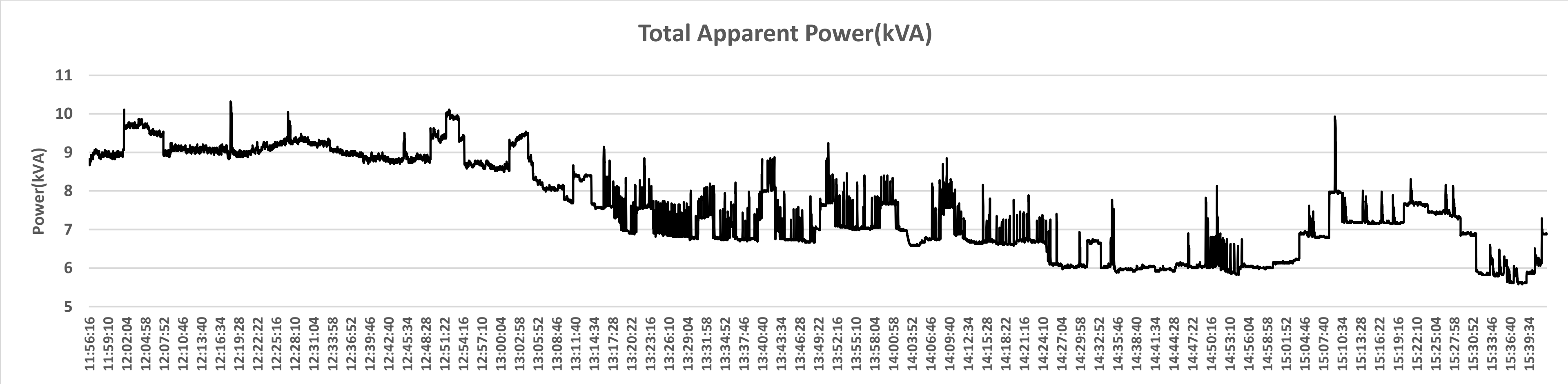
IV) Frequency-



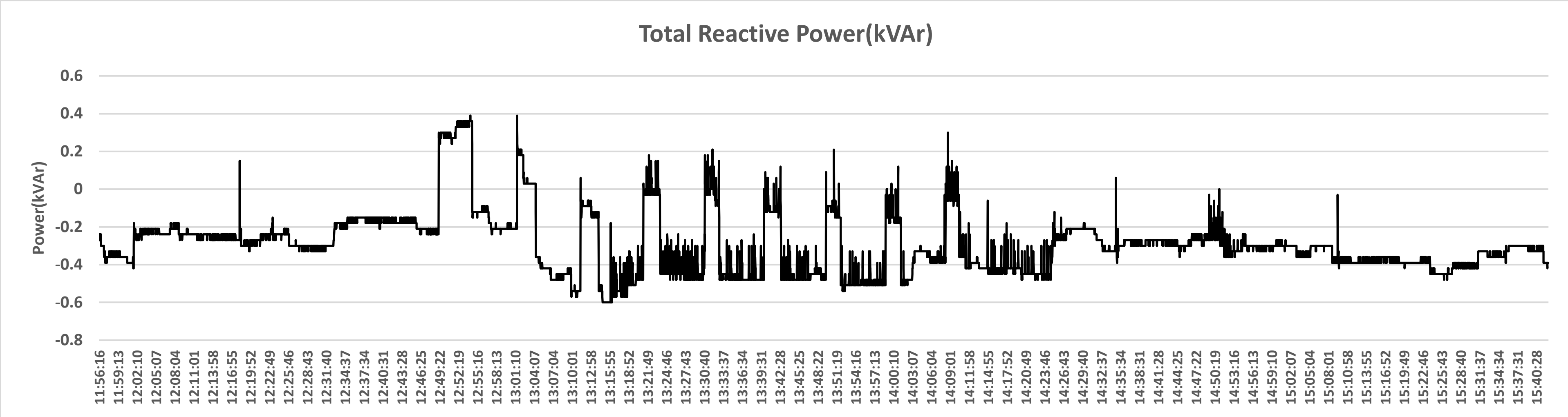
V) Active Power(kW)-



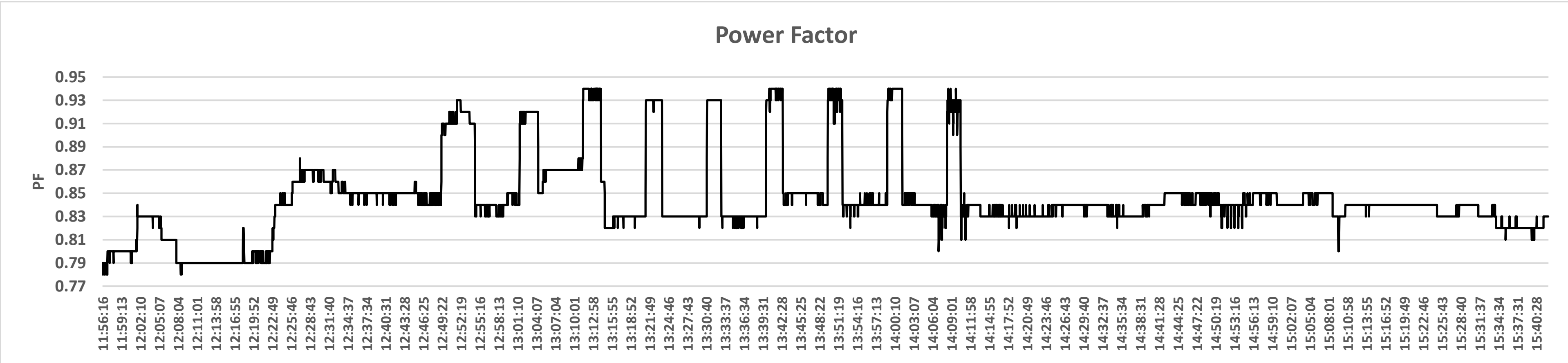
VI) Apparent Power(kVA)-



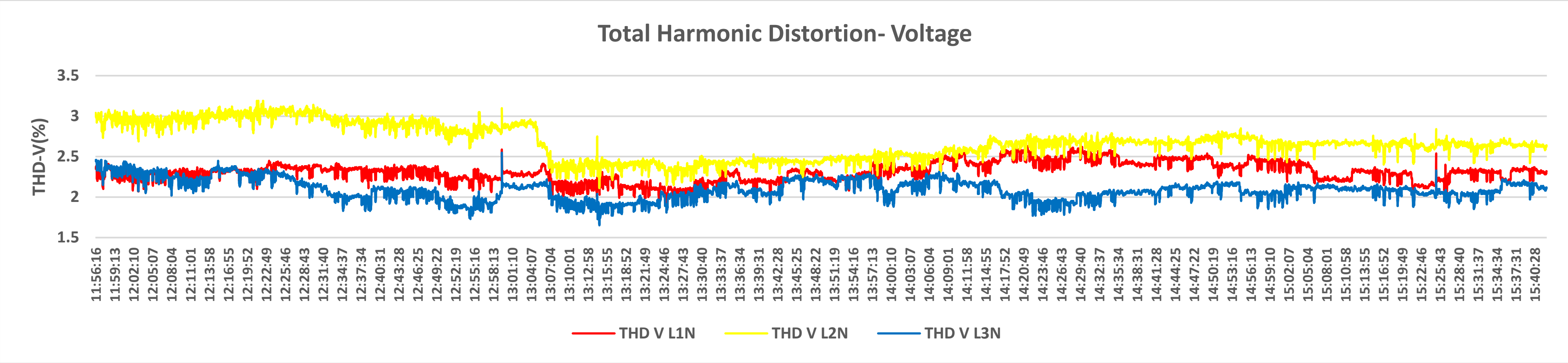
VII) Reactive Power(kVAR)-



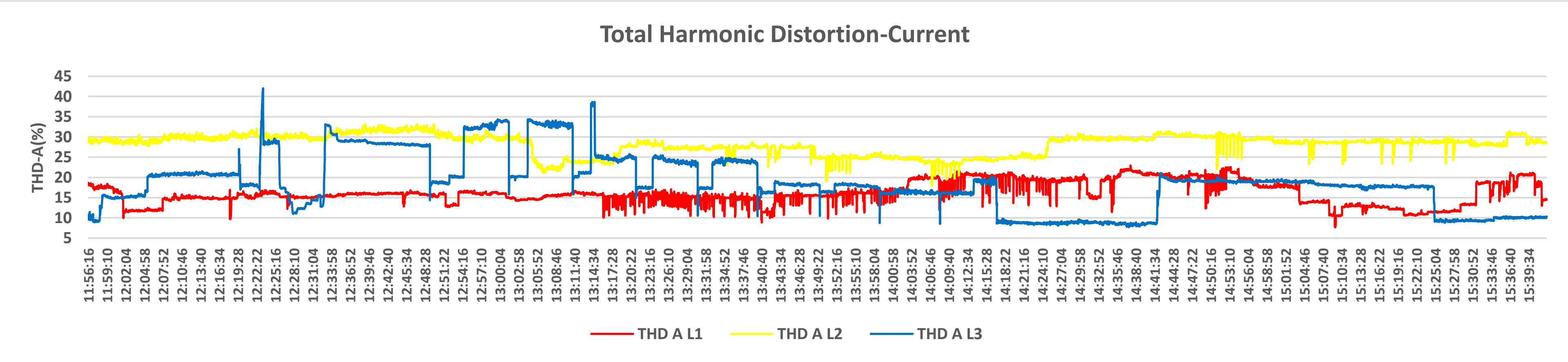
VIII) Power Factor-



IX) Total Harmonic Distortion Voltage-



X) Total Harmonic Distortion Current-



Chapter 5

Water Audit:

AUDIT FINDINGS & OBSERVATIONS

The building is primarily dedicated to Conducting classes of students. All floor includes an office, meeting rooms, and Classrooms.

Drinking and Domestic use water is delivered from a well situated in the campus itself into the underground domestic tank of 20,000 litter capacity. Currently, there are no re-use, reclaim, or harvested rainwater sources being used as an alternative water supply. At this time, no records could be provided to accurately determine the volume of water supply withdrawals from the deep well and spring. As such, we are unable to determine the average daily water use based on historical water use. Storage Tank is located at behind the Maim building. As to the wastewater coming from the locators, there is no existing treatment of such. Kitchen and bathroom water are sourced from the Storage Tanks.

Water is pumped to terrace with the help of 1 HP pump. Single tank of 15000 litter's capacity is located on rooftop which provides water to entire building for domestic, drinking & washroom purpose with 1-inch pipeline.

Table 1: Building population was based on information provided by staff as follows:

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Ground Floor	10 Employees & Security	Mon. – Fri.	10 hrs./day
First Floor	70 Students/7 Staff	Mon. – Fri.	10 hrs./day
Second Floor	70 Students/7 Staff	Mon. – Fri.	10 hrs./day

Chapter 6

Carbon Foot printing:

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

6.1. Basis for computation of CO2 Emissions:

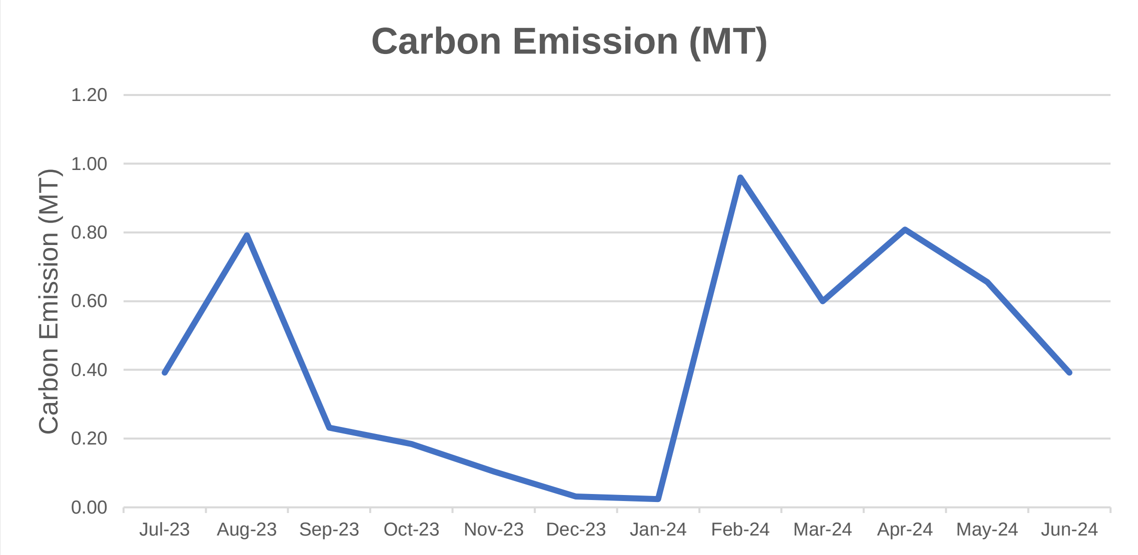
The basis of Calculation for CO2 emissions due to Electrical Energy are as under 1 Unit (kWh) of Electrical Energy releases 0.8 Kg of CO2 into atmosphere Based on the above Data we compute the CO2 emissions which are being released in to the atmosphere by the College due to its Day-to-Day operations.

6.2. Month wise Consumption of Electrical Energy:

We herewith furnish the details of electrical Energy consumption consumer number wise as under –

Month wise CO2 Emissions: 170143728687

Month	Energy Consumption (kWh)	Carbon Emission (MT)
Jun-24	49	0.39
May-24	82	0.66
Apr-24	101	0.81
Mar-24	75	0.60
Feb-24	120	0.96
Jan-24	3	0.02
Dec-23	4	0.03
Nov-23	13	0.10
Oct-23	23	0.18
Sep-23	29	0.23
Aug-23	99	0.79
Jul-23	49	0.39
Total	647	5.176
Minimum	3	0.024
Maximum	120	0.96
Average	53.9	0.4
Jun-24	49	0.39



6.3. Benchmarking:

Now we compute the CO_2 emissions per Sq. ft basis as under:

Sr. No	Parameter	Value	Unit
1	CO_2 emissions	5.176	MT/annum
2	Total Built up area	20,282	Sq ft
3	**CO_2 Emission Benchmark**	**0.255**	**Kg of CO_2/Sq. ft**

Chapter 7

Rain Water Harvesting:

The system of rain water harvesting is an integral part of any educational institution. This system helps to conserve the rain water and to use during the time of its desirable. This system helps the students to understand the basic concepts of rainwater harvesting system and their effective use in the real life.

It is seen that there is a natural slope at the Institute campus, such natural slope can be used to take the water through some specific path and absorb under the ground. There is one empty bore well in the Institute campus, such empty bore well can be charged with the use of rainwater harvesting system. In addition to this some ring wells can be prepared and rainwater, gray waste water from all the building can be taken through some specific path in these ring wells and used to charge under the ground to maintain the ground level water.

7.1. Advantages of rain water harvesting –

(a) Promotes adequacy of underground water

(b) Mitigates the effect of drought

(c) Reduces soil erosion as surface run-off is reduced

(d) Decreases load on storm water disposal system

(e) Reduces flood hazards

(f) Improves ground water quality / decreases salinity (by dilution)

(g) Prevents ingress of sea water in subsurface aquifersin coastal areas

(h) Improves ground water table, thus saving energy (to lift water)

(i) The cost of recharging subsurface aquifer is lower than surface reservoirs

(j) The subsurface aquifer also serves as storage and distribution system

(k) No land is wasted for storage purpose and no population displacement is involved

(l) Storing water underground is environment friendly

7.2. Rain water harvesting potential –

The total amount of water that is received in the form of rainfall over an area is called the rain water endowment of that area. Out of this, the amount that can be effectively harvested is called rain water harvesting potential.

All the water which is falling over an area cannot be effectively harvested, due to various losses on account of evaporation, spillage etc. Because of these factors the quantity of rain water which can effectively be harvested is always less than the rain water endowment. The collection efficiency is mainly dependent on factors like runoff coefficient and first flush wastage etc. Runoff is the term applied to the water that flows away from catchments after falling on its surface in the form of rain.

Runoff depends upon the area and type of catchment over which it falls as well as surface features. Runoff can be generated from both paved and unpaved catchment areas. Paved surfaces have a greater capacity of retaining water on the surface and runoff from unpaved surface is less in comparison to paved surface. In all calculations for runoff estimation, runoff coefficient is used to account for losses due to spillage, leakage, infiltrations catchment surface wetting and evaporation, which will ultimately result into reduced runoff. Runoff coefficient for any catchment is the ratio of the volume of water that run off a surface to the total volume of rainfall on the surface.

The runoff coefficient for various surfaces is given in following table –

Sr. No.	Type of catchment	Coefficient
1.	Roof Catchment	
	Tiles	0.8 – 0.9
	Corrugated metal sheets	0.7 – 0.
2.	Ground Surface Coverings	
	Concrete	0.6 – 0.8
	Brick Surface	0.5 – 0.6
3.	Untreated ground catchments	

	Soil on slope less than10 %	0.0 – 0.3
	Rocky natural catchments	0.2 – 0.5

Based on the above factors, the water harvesting potential of site could be estimated using the following equation:

Rain Water harvesting potential = Amount of Rainfall x area of catchment x Runoff coefficient

7.3. Rain water harvesting methods –

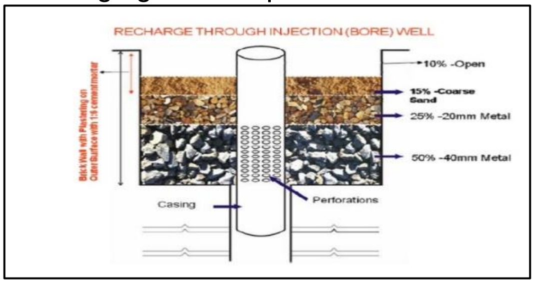
(a) Storing rain water for direct use

(b) Recharging ground water aquifers, from roof top run off

(c) Recharging ground water aquifers with runoff from ground area

According to the site of Institute the method of recharging ground water aquifers from roof top run off may be suitable. Recharging ground water aquifers from roof top run off. Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows into the recharge well, as shown in following Figure. The recharge well should preferably be shallower than the water table. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth.

The schematic diagram of recharging water aquifers from solar roof top run off is as follows -



7.4. Existing Situation –

Institute has not Installed rain water harvesting setup at building. Enertek Recommends to install rain water harvesting setup.

Chapter 8

Waste Disposal & Vermi composting:

8.1. Vermiculture Composting Culture –

Vermicomposting is basically a managed process of worms digesting organic matter to transform the material into a beneficial soil amendment. The institute has been started Vermi culture composting culture in house on 30 Sq. meter land. The main purpose of this is to reduce disposable waste in the Institute campus and after complete process of Vermi composting it is used as manure for plantation and greenery in the campus. It is also used for the demonstration and awareness in farmers to implement organic farming and its importance.

The main benefits of the process are to reduce the waste in the environment and utilized for some useful purpose and it is cost savings process.

The earthworms being voracious eaters consume the biodegradable matter and give out a part of the matter as excreta or Vermi-castings. The Vermi-casting containing nutrients is a rich manure for the plants. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Fruits, flowers and vegetables and other plant products grown using vermicompost are reported to have better keeping quality. A growing number of individuals and institutions are taking interest in the production.

Process:

The process of composting crop residues / Agri wastes using earthworms comprise spreading the agricultural wastes and cow dung in gradually built-up shallow layers. The pits are kept shallow to avoid heat built-up that could kill earthworms. To enable earthworms to transform the material relatively faster a temperature of around 300C is maintained. The final product generated by this process is called vermicompost which essentially consist of the casts made by earthworms eating the raw organic materials. The process consists of constructing brick lined beds generally of 0.9 to 1.5 m width and 0.25 to 0.3 m height are constructed inside a shed open from all sides. For commercial production, the beds can be prepared with 15 m length, 1.5 m width and 0.6 m height spread equally below and above the ground. While the length of the beds can be made as per convenience, the width and height cannot be increased as an increased width affects the ease of operation and an increased height on conversion rate due to heat built up. Cow dung and farm waste can be placed in layers to make a heap of about 0.6 to 0.9 m height. Earthworms are introduced in between the layers @ 350 worms per m3 of bed volume that weighs nearly 1 Kg. The beds are maintained at about 40-50% moisture content and a temperature of 20–300 C by sprinkling water over the beds. When the commercial scale production is aimed at, in addition to the cost of production, considerable amount must be invested initially on capital items. The capital cost may work out to about Rs. 5000 to 6000 for every tonne of vermicompost production capacity. The high unit capital cost is since large units require considerable expenditure on preparation of Vermi beds, shed to provide shelter to these beds and machinery. However, these expenditures are incurred only once. Under the operational cost, transportation of raw materials as also the finished product are the key activities. When the source organic wastes and dung are away from the production facility and the finished product requires transportation to far off places before being marketed, the operational cost would increase. However, in most of the cases, the activity is viable and bankable. Following are the items required to be considered while setting up a unit for production of Vermi-compost.

Components of a Commercial Unit –

Commercial units must be developed based on availability of cow dung locally. If some big dairy is functioning then such unit will be an associated activity. Commercial units must not be designed based on imported cow dung.

1. Sheds

For a Vermi-composting unit, whether small or big, this is an essential item and is required for securing the Vermi beds. They could be of attached roof supported by bamboo rafters or steel trusses. Locally available roofing materials or HDPE sheet may also be used in roofing to keep the capital investment at reasonably lower level. If the size is so chosen as to prevent wetting of beds due to rain on a windy day, they could be open sheds. While designing the sheds adequate room/pathways must be left around the beds for easy movement of the laborers attending to the filling and harvesting the beds.

2. Vermi-beds

Normally the beds have 0.3 to 0.6 m height depending on the provision for drainage of excess water. Care should be taken to make the bed with uniform height over the entire width to avoid low production owing to low bed volumes.

The bed width should not be more that 1.5 m to allow easy access to the center of the bed.

3. **Fencing and Roads/Paths**

The site area needs development for construction of structures and development of roads and pathways for easy movement of hand-drawn trolleys/wheel barrows for conveying the raw material and the finished products to and from the Vermi sheds. The entire area must be fenced to prevent trespass by animals and other unwanted elements. These could be estimated based on the length of the periphery of the farm and the length and type of roads/paths required. The costs on fencing and formation of roads should be kept low as these investments are essential for a production unit, yet would not lead to increase in production.

4**. Water Supply System**

As the beds must be kept moist always with about 50% moisture content, there is a need to plan for a water source, lifting mechanism and a system of conveying and applying the water to the Vermi-beds. Drippers with round the clock flow arrangement would be quite handy for continuous supply and saving on water. Such a water supply system requires considerable initial investment. However, it reduces the operational cost on hand watering and proves economical in the long run. The cost of these items would depend on the capacity of the unit and the type of water supply chosen.

5. Transportation

For any Vermi-composting unit transport arrangement is a must. When the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require a three-tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become infructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products between the storage point and the Vermi-compost sheds could also be included in the project cost.

Recommendations –

Enertek recommends to install Waste Composting and Vermi-composting project of appropriate size.

Chapter 9

Sewage Treatment Plant:

It includes physical, biological, and sometimes chemical processes to remove pollutants. Its aim is to produce an environmentally safe sewage water, called effluent, and a solid waste, called sludge or biosolids, suitable for disposal or reuse. Reuse is often for agricultural purposes, but more recently, sludge is being used as a fuel source.

Water from the mains, used by manufacturing, farming, houses (toilets, baths, showers, kitchens, sinks), hospitals, commercial and industrial sites, is reduced in quality because of the introduction of contaminating constituents. Organic wastes, suspended solids, bacteria, nitrates, and phosphates are pollutants that must be removed. The features of wastewater treatment systems are determined by:

The nature of the municipal and industrial wastes that are conveyed to them by the sewers. The amount of treatment required to keep the quality of the receiving streams and rivers. Discharges from treatment plants are usually diluted in rivers, lakes, or estuaries. They also may, after sterilization, be used for certain types of irrigation (such as golf courses), transported to lagoons where they are evaporated, or discharged through underground outfalls into the sea. However, sewage water outflows from treatment works must meet effluent standards set by the Environment Agency to avoid polluting the waters that receive them. In this process, aerobic bacteria digest the pollutants. To establish an aerobic bacterial colony, you must provide air for the bacteria to breathe. In a sewage treatment plant, air is continuously supplied to the Biozone either by direct Surface Aeration using Impellers propelled by pumps which whisk the surface of the liquid with air, or by Submerged Diffused Aeration using blowers for air supply through bubble diffusers at the bottom of the tank. (The most modern aerobic sewage systems use natural air currents and do not require electricity, though these are only used for small scale sewage systems now. Once again, the public leads the way!) Aerobic conditions lead to an aerobic bacterial colony being established. These achieve almost complete oxidation and digestion of organic matter and organic pollutants to Carbon Dioxide, Water and Nitrogen, thus eliminating the odor and pollution problem above. The effluent produced by this process is non-polluting and can be discharged to a watercourse

Conventional sewage water treatment involves either two or three stages, called primary, secondary, and tertiary treatment. Before these treatments, preliminary removal of rags, cloths, sanitary items, etc. is also carried out at municipal sewage works.

9.1 Primary Treatment

This is usually anaerobic. First, the solids are separated from the sewage. They settle out at the base of a primary settlement tank. The sludge is continuously being reduced in volume by the anaerobic process, resulting in a vastly reduced total mass when compared to the original volume entering the system.

The primary settlement tank has the sludge removed when it is about 30% of the tank volume.

9.2. Secondary Treatment

This is Aerobic. The liquid from the Primary treatment contains dissolved and particulate biological matter. This is progressively converted into clean water by using indigenous, water-borne aerobic micro-organisms and bacteria which digest the pollutants. In most cases, this effluent is clean enough for discharge directly to rivers.

9.3. Tertiary Treatment

In some cases, the effluent resulting from secondary treatment is not clean enough for discharge. This may be because the stream it is being discharged into is very sensitive, has rare plants and animals or is already polluted by someone's septic tank. The Environment Agency may then require a very high standard of treatment with a view to the new discharge being CLEANER than the water in the stream and to, in effect, 'Clean it up a bit'. It is usually either Phosphorous or Ammoniacal Nitrogen or both that the E.A. want reduced. Tertiary treatment involves this process. If Phosphorous is the culprit, then a continuous dosing system to remove it is the tertiary treatment. If Ammoniacal Nitrogen is the problem, then the sewage treatment plant process must involve a nitrifying and then de-nitrification stage to convert the ammoniacal nitrogen to Nitrogen gas that harmlessly enters the atmosphere.

Current Situation -
There is no existing Sewage Treatment Plant system installed at the campus.

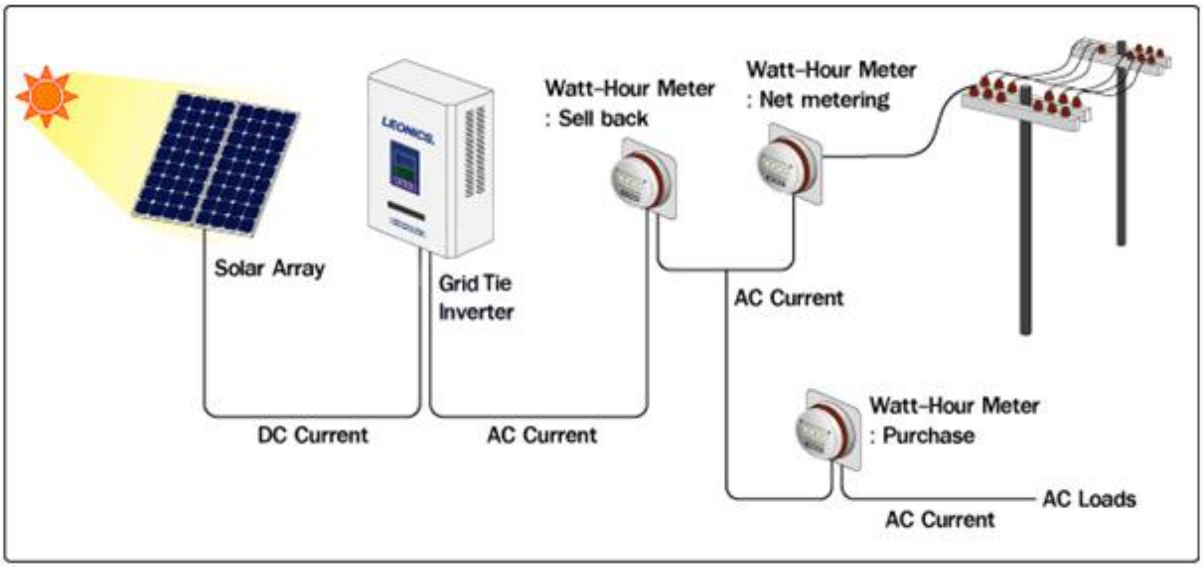
Recommendation -
Enertek recommends to install Sewage Treatment Plant of appropriate size.

Chapter 10

Solar PV:

The college Should opt for rooftop solar photovoltaics plant. This is a clean and green source of energy that can be directly utilized as a substitute to the Grid Power. In this section we shall be seeing the benefits and proposal for Solar PV system – On Grid Type

In this system, there is no battery backup required, the energy generated is directly utilized by the load and the excess units are fed back into the grid with a net meter. At the end of the month the difference of the two will be your actual billed units. This system is more cost effective than a Battery type/ Islanding type/ Solar PV off grid system.



Benefits of solar: -

- Electricity produced by solar cells is clean and silent. Because they do not use fuel other than sunshine, PV systems do not release any harmful air or water pollution into the environment, deplete natural resources, or endanger animal or human health.
- Photovoltaic systems are quiet and visually unobtrusive.
- Small-scale solar plants can take advantage of unused space on rooftops of existing buildings.
- Solar energy is a locally available renewable resource. It does not need to be imported from other regions of the country or across the world. This reduces environmental impacts associated with transportation and reduces our dependence on imported oil. And, unlike fuels that are mined and harvested, when we use solar energy to produce electricity we do not deplete or alter the resource.

Total solar PV capacity that can be connected on roof is 3 kW depending on actual space available on the roof of science building which is facing south direction.

Considering 3 kW System-

- Units generated per day = 14 kWh
- Annual Generation Possible = 4,928 kWh
- Area required = 30 sqm
- Saving = 49,275 INR per year
- Investment = 1,95,000 INR plus taxes
- Depreciation applicable
- Possible Payback – 4 yrs.

Note: - Figures mentioned here are based on thumb rule, Quotation will be given that will cover the necessary details on request.
According to peak, Shine hours and global irradiance available at location = 4.5 kWh/kWp Generation Considered
Solar Payback & estimated generation

Year	Energy kWh/Anum	Energy (kWh) rate	Cost saving (Rs.)
1	4,928	₹ 10.00	₹ 49,275
2	4,878	₹ 10.20	₹ 49,758
3	4,829	₹ 10.40	₹ 50,246
4	4,781	₹ 10.61	₹ 50,738
5	4,733	₹ 10.82	₹ 51,235
6	4,686	₹ 11.04	₹ 51,737
7	4,639	₹ 11.26	₹ 52,244
8	4,593	₹ 11.49	₹ 52,756
9	4,547	₹ 11.72	₹ 53,273
10	4,501	₹ 11.95	₹ 53,795
11	4,456	₹ 12.19	₹ 54,323
12	4,412	₹ 12.43	₹ 54,855
13	4,368	₹ 12.68	₹ 55,393
14	4,324	₹ 12.94	₹ 55,935
15	4,281	₹ 13.19	₹ 56,484
16	4,238	₹ 13.46	₹ 57,037
17	4,196	₹ 13.73	₹ 57,596
18	4,154	₹ 14.00	₹ 58,160
19	4,112	₹ 14.28	₹ 58,730
20	4,071	₹ 14.57	₹ 59,306
21	4,030	₹ 14.86	₹ 59,887
22	3,990	₹ 15.16	₹ 60,474
23	3,950	₹ 15.46	₹ 61,067
24	3,911	₹ 15.77	₹ 61,665
25	3,871	₹ 16.08	₹ 62,270
Total	1,09,479		₹ 13,88,240

- *Note Considering 1% Degradation of Solar Panels and System per annum*

  2% increase considered in electricity cost per annum