Energy Audit Report

JUNE-2024

Ram Lal Anand College

New Delhi

Conducted By : EM Project Services

A-615, Shastri Nagar-new Delhi-110052

Certified Energy Auditor-EA-9011

We as an energy audit team of EM Project Services wish to express gratitude to the following members of Ram Lal Anand College, University of Delhi for awarding this work of Detailed Energy Audit in the month of June-2024:

1. Prof. Dr. .Rakesh K. Gupta, Principal
2. Dr. Rajesh Sachdev

We also express gratitude to other members of Ram Lal Anand College maintenance and other operations team members for showing keen interest and co-operation, which was extended during the course of our study. We also convey thanks to maintenance staff who were directly or indirectly involved for facilitating collection of data and recording field measurements.

We hope that the recommendations given in the Report, if implemented will result in reduction in Energy consumption and annual Energy cost of College.

Audit Team

M/s EM Project Services Audit team for this assignment consisted of Energy Auditors, Engineers and Experts namely

1. Sh. Satvinder Singh, Accredited Energy Auditor (AEA-0294),
2. Sh.Niraj Gupta, Energy Audit data Engineer
3. Ranjeet Singh, Instrumentation & Data collection Executive
4. Mr. Vaibhav Sharma, Electrical Engineer

Place: Delhi Date: 19-06-2024

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List of Abbreviations and Acronyms

AC	Air Conditioning
AHU	Air Handling Unit
APFC	Automatic Power Factor Control
BTU	British Thermal Unit
CFL	Compact Fluorescent Lamp
CFM	Cubic Feet per Minute
COP	Coefficient of Performance
CO_2	Carbon Dioxide
CT	Cooling Tower
CW	Cooling Water
DBT	Dry Bulb Temperature
DG	Diesel Generator
EE	Energy Efficient
EER	Energy Efficiency Ratio
ENCON	Energy Conservation Measures
EPI	Energy Performance Index
FD	Force Draft
FRP	Fibre Reinforced Plastic
FTL	Fluorescent Tube Light
HP	Horse Power
HPSV	High Pressure Sodium Vapour
HT	High Tension
HVAC	Heating, Ventilation and Air conditioning
ID	Induced Draft
IEEE	Institute of Electrical and Electronics Engineers
INR	Indian Rupees
IRR	Internal Rate of Return
kVA	Kilovolt Ampere
kVAh	Kilovolt Ampere Hour
kVAR	Kilovolt Ampere Reactive
kWh	Kilowatt Hour
LED	Light Emitting Diode
LT	Low Tension
MH	Metal Halide
Mkcal	Million Kilo Calories
PF	Power Factor
SVL	Sodium Vapour Lamps
THD	Total Harmonic Distortion
TR	Ton of refrigeration
TRh	Ton of refrigeration in one hour
TOD	Time of Day
VFD	Variable Frequency Drive
WBT	Wet Bulb Temperature

1.1. *Objective of the energy audit study*

The objective of the energy audit is to review the present energy consumption scenario, monitoring and analysis of the use of energy and explore the energy conservation options including submission of a detailed energy audit report containing recommendations for improving energy efficiency with cost benefit analysis.

The detailed energy audit identifies all possible energy conservation measures including detailed project (energy efficiency) engineering. It will provide a dynamic model of energy use characteristics of both the existing facility and all energy conservation measures identified. Extensive attention is given to understanding not only the operating characteristics of all energy consuming systems but also situations which cause load profile variations on both annual and daily basis

1.2. *About the energy audit location*

Ram Lal Anand College was founded in the year 1964 by Late Shri Ram Lal Anand, a senior advocate in the Supreme Court of India, in response to the growing social demand in the sixties for providing educational opportunities at the university level. The college was initially managed by the Ram Lal Anand College Trust. It was later taken over by the University of Delhi. Since 1973, it has been run by the University of Delhi as a University Maintained Institution.

The college is located in the picturesque surroundings against the backdrop of the Aravali ranges in the neighborhood of the South Campus of the University of Delhi and several other educational institutions. It has a vast campus, spread over ten acres of land with green lawns and elegant buildings of much sprawling architectural merit. The college has excellent infrastructure, with state of the art Laboratories, Seminar room ,Amphitheatre, Library, Playground and Cafeteria. The campus is Wi-Fi enabled. Being a multi-disciplinary, co-educational institution it has approximately 2500 students pursuing different courses in Arts, Commerce and Science streams. Ram Lal Anand College is administered by a statutory Governing Body as per the University Ordinances and legislated by the Executive Council of the University of Delhi.

Observations and Recommendations

Electricity

- Correct power factor to at least 0.999 under rated load conditions and maintain during all times.
- Set transformer taps to optimum settings.
- Disconnect primary supply to all equipments.
- Practice switching off all the equipment from mains at the time it is not required for long periods and end of day.
- Export power to grid if you have any surplus in your captive generation-Solar PV. Monitor during Week Ends and Holidays.

- Shut off unnecessary computers, printers, and copiers and primary supply to UPS at night.
- Monitor Solar PV generation.
- Check Load Balancing periodically, at least quarterly for savings and safety consideration.

Pumps

- Replace old pumps with new Energy Efficient pumps

Air-conditioning

1. Use fans along with AC so that higher temperature tolerance can be attained. Raising of set temperature will reduce the energy consumption through Air-Conditioners.

2. Install outdoor units and Window type AC's in a ventilated area without obstruction to rejected heat.

3. Due to longer hot season, practice two wet services of Air Conditioners.

4. Check Air filters of AC's monthly basis and should be cleaned for increasing effectiveness and energy savings.

Lighting

- Maintain records for the specification of purchased fixtures that is luminous efficacy, THD-Current and Power Factor etc.
- LEDs installed more than 5 years old should be considered to be replaced with new LED's with high luminous efficacy.
- Reduce excessive illumination levels to standard levels using switching with re-adjustments and switching off
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Consider day lighting, skylights, etc.
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED if installed

DG Set

1. Insulate Exhaust silencer

2. Raise it to the height requirement of CPCB.

Buildings

1. In Air Conditioned areas, Window glasses be replaced with Spectrally selective glasses for reduction of Air-Conditioning load.

2. Add vestibules or revolving doors to primary exterior personnel doors.

3. Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.

4. Use intermediate doors in stairways and vertical passages to minimize building stack effect

5. In Auditorium free cooling through fresh air be explored. Air conditioning should be started 15 minutes before arrival of attendees and before that only Air conditioning can be run on non-Cooling mode with air supply only.

6. On exposed roofs not provided with solar PV, cool roof as per requirement of ECBC be provided. (Broken glazed high SRI tiles)

7. Use dock seals at shipping and receiving doors.

Water & Wastewater

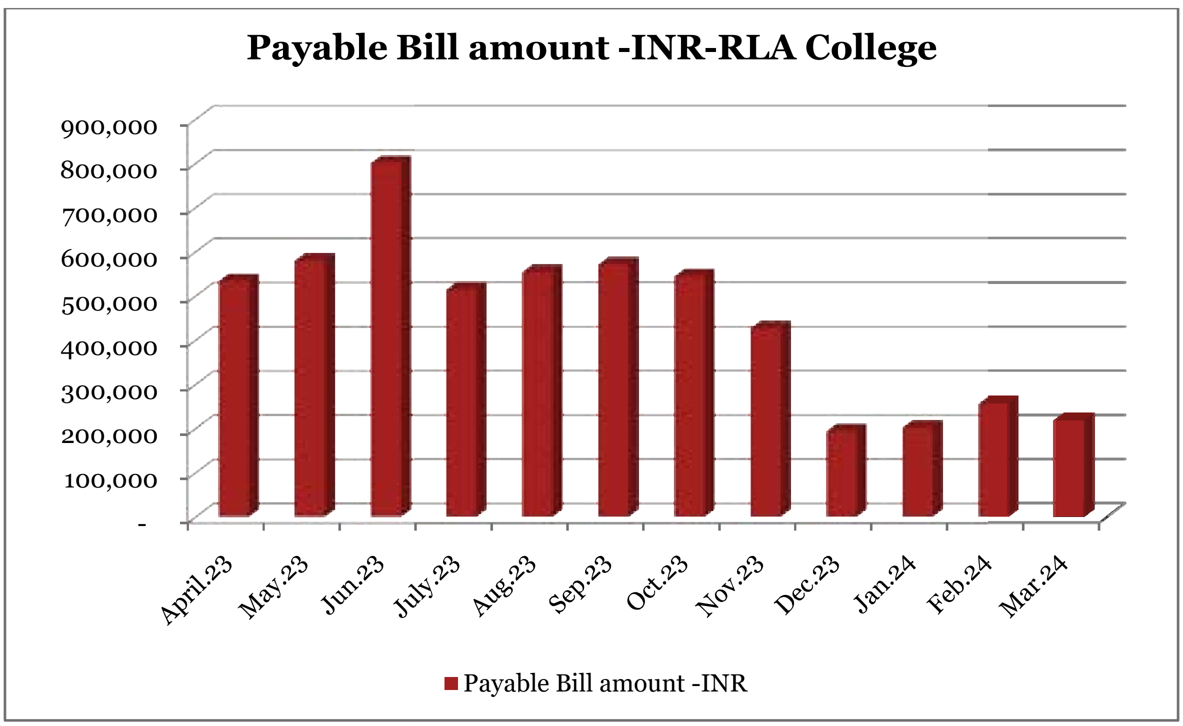
- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.

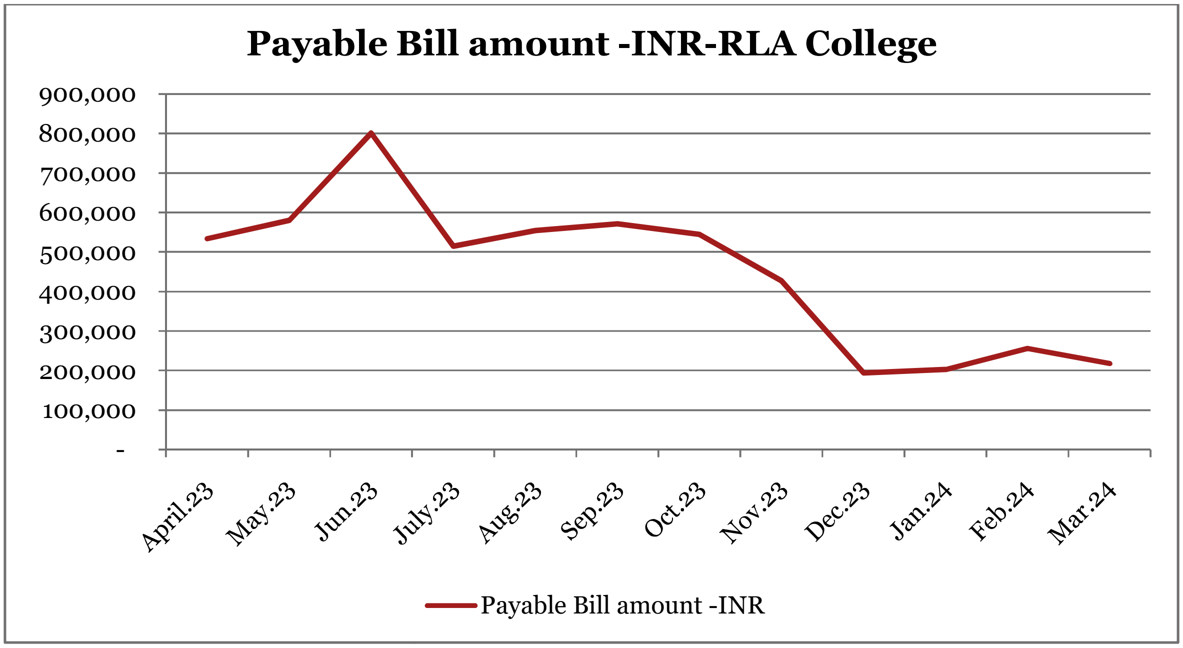
- Verify the water meter readings.
- **Miscellaneous**
- Meter any unmetered utilities.
- Know what is normal efficient use.
- Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off

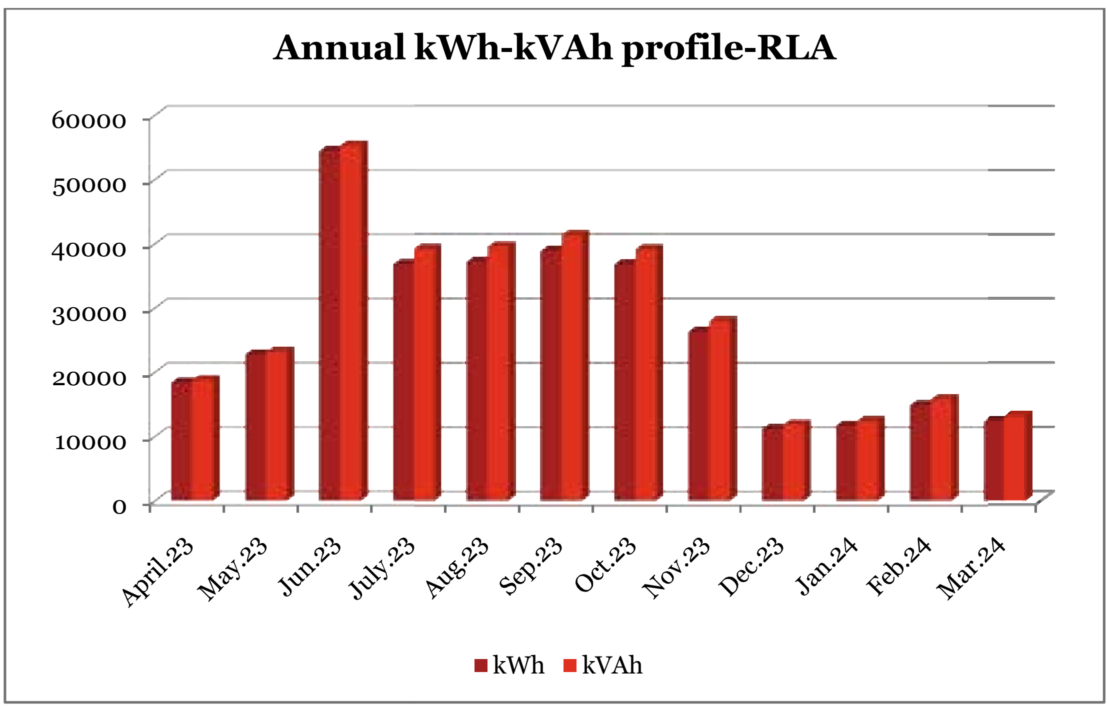
Present electricity consumption scenario

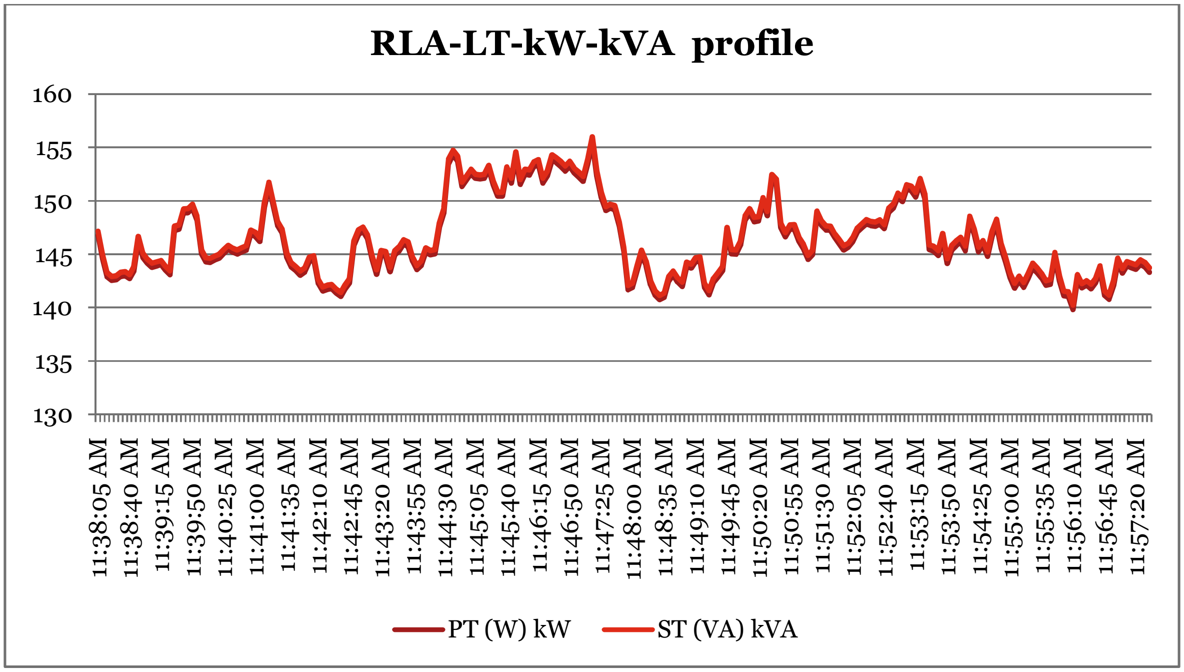
As per data available and collected at site billing for Electricity consumption is given here under The consumption data from April-2023 to March-2024 hereunder:

Ram Lal Anand College Energy use profile




Payable Bill amount -INR-RLA College
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
-
April.23
May.23
Jun.23
July.23
Aug.23
Sep.23
Oct.23
Nov.23
Dec.23
Jan.24
Feb.24
Mar.24
Payable Bill amount -INR


Annual kWh-kVAh profile-RLA
60000
50000
40000
30000
20000
10000
0
April.23
May.23
Jun.23
July.23
Aug.23
Sep.23
Oct.23
Nov.23
Dec.23
Jan.24
Feb.24
Mar.24
kWh
kVAh



From the above graph it is observed that Electricity instantaneous Load recorded is 160 kW.

The major energy consuming equipment in the College are Air conditioning and Lighting.

The following are the energy consumption aspects in Ram lal Anand College

1. Air Conditioning system-Window/Split and Cassette type Air Conditioners.

2. Fans and Ventilation system-Ceiling Fans and Exhaust Fans

2. Internal Lighting

3. External lighting

4. Water pumping system

5. Elevator

6. Office Equipment-Computers, Scanners,

Renewable Energy

In the college premises the renewable energy plant –Solar PV has been installed for generation of Electricity through solar PV and thus reducing the CO_2 foot print of the college. At present, there is no system in place for recording the generated energy by Solar PV system installed on day-to-day basis. Energy generation loss if not monitored can cause heavy losses and will defeat the purpose of its existence. The strict monitoring through App is recommended and it is required to be maintained on day-to-day basis.

Check any deviations from the design deviation from the target generation reported and corrective action should be initiated immediately.

A summary of the proposed energy conservation measures is provided below:

Table 1: summary of the proposed energy conservation measures

S. No.	Proposed energy conservation measures	Qty. to be replaced	Total annual energy savings (kWh)	Total annual monetary savings (INR)	Anticipated investment (INR)	Simple payback period (months)
Encon -Electrical						
1	Existing-Ceiling fans -70 Watts to be replaced with Super energy efficient fans-28 Watts	20	1890	15120	38850	30.83
		Nos.				
2	Existing-Ceiling fans -60 Watts to be replaced with Super energy efficient fans-28 Watts	145	10440	83520	281663	40.47
3	Replacement of Old Split AC with 5 star Inverter type Air conditioners	15	16875	135000	337500	30.00
		TR				
4	Reduction of Distribution Losses with Over-all balancing and reduction of Neutral current to 25 % of present value	1	3799	30393	25000	9.87
		Nos				
5	Replacement of 3 HP Submersible pump-20 years old		4350	34800	36750	12.67
	Total		**37,354**	**298,833**	**719,763**	**28.90**

2.1. *Methodology adopted for the audit*

A detailed energy audit was conducted at Ram Lal Anand College from 14th June-2024 to 17th June-2024. The energy audit team comprised of energy experts. During the field visit, a range of portable energy audit instruments were used to take various measurements at different sections of the Club. In addition, design and operational data were collected from logbooks and equipment manuals. Discussions were held with various concerned personnel at the College to understand its operations and energy requirements completely. The energy audit focused on the study of all major energy consuming equipment and the evaluation of operational efficiency/performance of such equipment from the energy conservation point of view.

The methodology adopted for the audit involved:

- ✓ Resource planning, establish/organize the Energy audit team
- ✓ Organize instruments & time frame
- ✓ Historic data analysis, baseline data collection
- ✓ Annual energy bill and energy consumption pattern
- ✓ Measurement: Motor survey, insulation, and lighting survey with portable instruments for collection of more and accurate data, confirm and compare operating data with design data.
- ✓ Trials/Experiments:
    - Power monitoring (MDI, PF, kWh etc.)
    - Load variation trends
- ✓ Equipment Performance Documentation, report presentation to the top management

2.2. *List of Instruments Used*

Apart from onsite instruments, portable instrument used in the study include:

- ✓ Portable Power Analyzer
- ✓ I.R. Thermometer (Non contact type)
- ✓ Digital Thermo-Meter
- ✓ Anemometer
- ✓ Portable Flow Meter
- ✓ Thermometers

2.3. *Details of energy consuming equipment*

The details of the major energy consuming equipment in the Club are provided below.

S.No.	Location	No. of Lighting LED Fixtures
1	Room No.1	4
2	Room No.1A	3
3	Room No.2 (lap Top)	6
4	Room No.3	6
5	Room No.4	4
6	Room No.5	4
7	Room No.6	3
8	Room No.7	7
9	Room No.8	4
10	Room No.9	4
11	Room No.10	4
12	Room No.11	4
13	Room No.12	8
14	Room No.13	4
15	Room No.14	6
16	Room No. 15 (General Computer room)	12
17	Room No. 16	12
18	Room No. 17	4
19	Room No.18 (FM Media)	24
20	Room No.20 (NCC)	1
21	Room No. 21 (Geology Department)	2
22	Room No.22 (Physics lab)	1
23	Room No. 23	2
24	Room No. 25 -Geology Department	3
25	Room No. 26-Geology Department	3
26	Room No. 27-Geology Department	6
27	Room No. 28	2
28	Room No. 29	2
29	Room NO.30	4
30	Room No. 31- (Micro-Biology Department)	2
31	Room No. 32- (Micro-Biology Department)	2
32	Room No. 33- (Micro-Biology Department)	2
33	Room No. 34- (Micro-Biology Department)	2

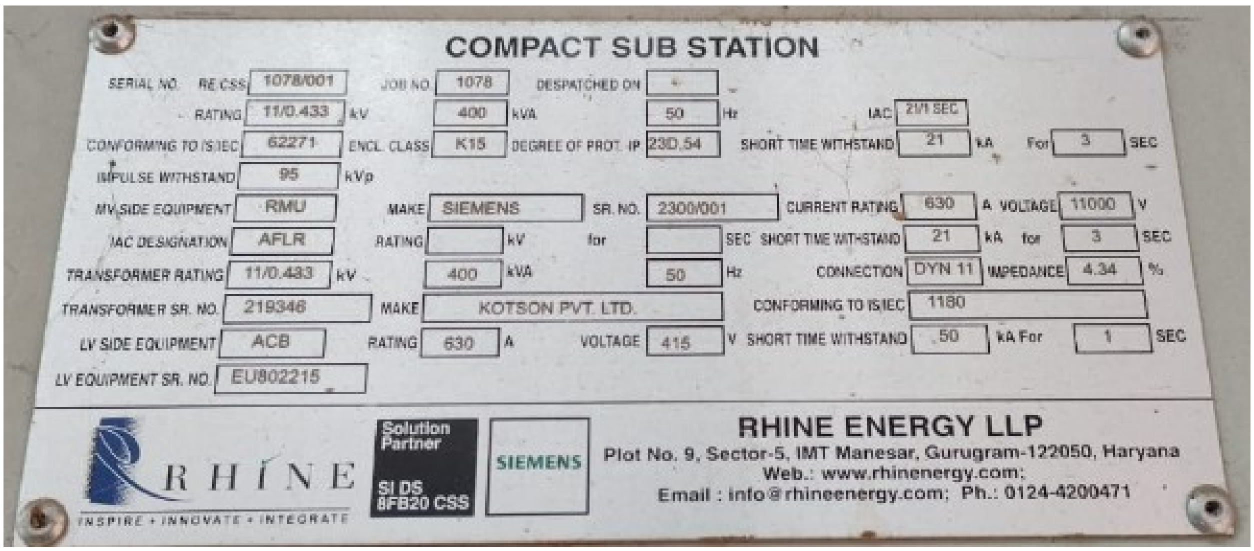
34	Room No. 35- (Micro-Biology Department)	2
35	Room No. 36- (Micro-Biology Department)	2
36	Room No. 37- (Micro-Biology Department)	3
37	Room No. 38- (Micro-Biology Department)	8
38	Room No. 39- (Micro-Biology Department)	6
39	Room No. 40- (Micro-Biology Department)	8
40	Room No. 41- (Micro-Biology Department)	6
41	Room No.44	2
42	Room No.45	2
43	Porta cabin 1	4
44	Porta cabin 2	6
45	Porta cabin 3	4
46	Porta cabin 4	6
47	Porta cabin 5	10
48	Porta cabin 6	8
49	Porta cabin 7	8
50	Porta cabin 8	8
51	Porta cabin 9	9
52	Porta cabin 10	9
53	Porta cabin -11	9
54	Porta cabin -12	11
55	Porta cabin -13	4
56	Library	88
57	Research Lab-1-GF	3
58	BIMC Lab	7
59	Office and Admn.	28
60	Sports Room	8
61	ampi Theatre-GF	28
62	Seminar Room	20
63	AO Room	4
64	Principal PA room	4
65	Principal Room	12
66	Conference Room	8
67	IQAC/Ecell	6
68	Staff Room	8
69	Reading Room	2
70	Examination/COM	3

71	Pantry Room	1
72	Girls Common Room	2
73	Canteen	47
74	Room No. 19 (NCC)	4
75	Room No.43	10
76	Main gate Security Room	2
77	Amphitheatre -I floor	32
78	medical room	4
79	Room No. 42 commerce Lab	8
80	Research lab-2 -FF	5
81	Room No. 46 -Statistics Department	9
82	Staff Room-2	4
83	Micro Lab lobby	6
84	Wash Room	20
	Total	**675**

Inventory of Water Coolers		
S. No	**Location**	**Qty-Numbers**
1	Ground Floor	2
2	Canteen	1
3	First Floor near Micro Lab	1
4	Third Floor Porta Cabin	1
5	Staff Room	1
6	Pantry	1
	Total	**7**

Table 4: Details of Transformers for College –Compact Sub-Station

S.No	Description	Capacity	Unit
1	Capacity	400	kVA
2	Voltage Ratio	11kV/.433	kV



Annual Electrical Energy Use Pattern

S.No.	Month	Payable Bill amount -INR
1	April.23	534,060.00
2	May.23	580,750.00
3	Jun.23	801,260.00
4	July.23	514,500.00
5	Aug.23	554,660.00
6	Sep.23	571,510.00
7	Oct.23	544,870.00
8	Nov.23	427,020.00
9	Dec.23	194,220.00
10	Jan.24	202,410.00
11	Feb.24	256,130.00
12	Mar.24	218,120.00
	Total	**5,399,510.00**

3.1.1. Cable loading, normal and emergency loads

The electric current corresponds to total power (kVA) that depends on the power factor, flows from utility-supply point to various load points of the unit through power cables (mostly made of aluminum). During the above power transport, considerable power wasted to oppose the resistance of the cable. The cable resistance increases with length but decreases with cross-section i.e. increase in size. Therefore, the cable capacity has to be selected accordingly to keep the losses within 0.75% and it is only active load, which causes the change in PF from no load to full load. By installing capacitors, we can change the PF of supply system and hence the I^2R of the old cable between supply source and motor.

Flowing Current In Feeders

The cable loss is proportional to I^2R (square of current flow and resistance of cable). Normally the current rating given by manufacturer is to withstand thermal stress. From the energy conservation point of view, the above needs to be devalued based on length.

Reducing Loss

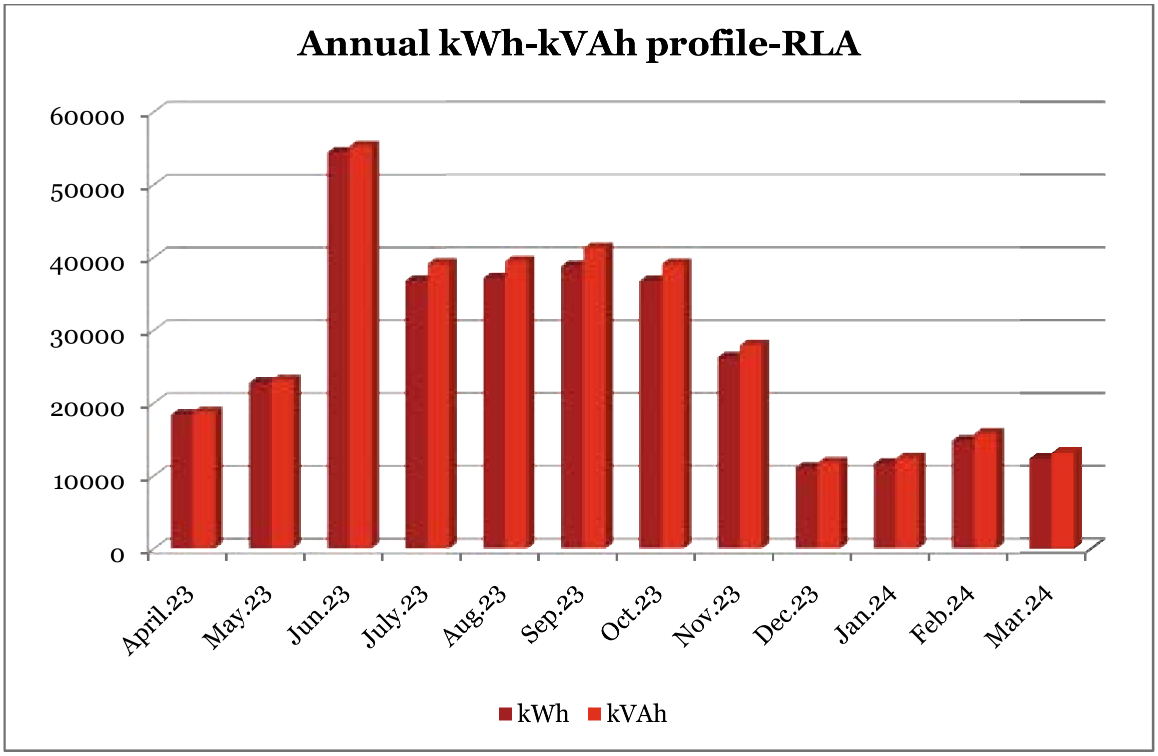
There are two methods to reduce I^2R cable loss in feeders. They are: (i) reducing the current in cables by adding capacitors near to load or bifurcating the overloaded feeders (ii) reducing the resistance of cable by increasing its size or running additional run of cable of equal size.

Capacitor Shifting/ Addition

It is possible to reduce current; thereby I^2R losses in cable by providing additional capacitors near to feeder end/ motor end.

3.2. Sources and utilization of electricity

S.No.	Month	kWh	kVAh
1	April.23	18393	18789
2	May.23	22795	23166
3	Jun.23	54438	55326
4	July.23	36826	39176.6
5	Aug.23	37161	39532.98
6	Sep.23	38840	41319.15
7	Oct.23	36781	39128.72
8	Nov.23	26291	27969.15
9	Dec.23	11171	11884.04
10	Jan.24	11712	12459.57
11	Feb.24	14880	15829.79
12	Mar.24	12330	13117.02
	Total	321618	337698

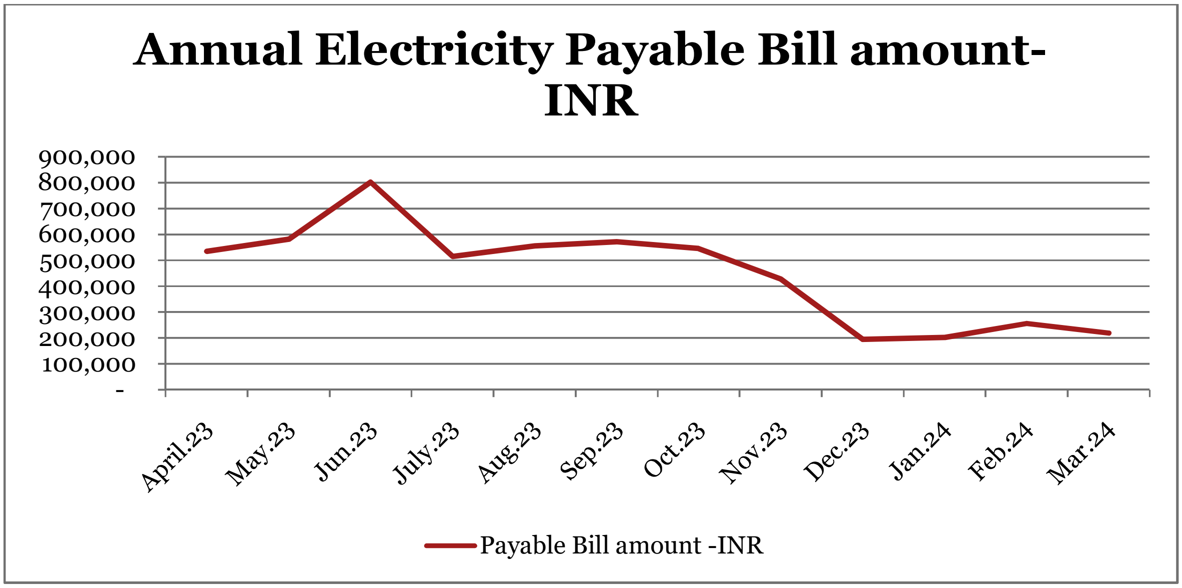


3.3. *Total energy/electricity utilization and cost scenario of the facility*

3.3.1. Energy cost scenario of the facility

The energy audit team also collected information on the monthly electricity bills paid by the Club presents the total annual electricity cost and average unit cost of monthly electricity for the last year. (As data collected from office)

Month	kVAh	Payable Bill amount -INR
April.23	18789	534,060
May.23	23166	580,750
Jun.23	55326	801,260
July.23	39177	514,500
Aug.23	39533	554,660
Sep.23	41319	571,510
Oct.23	39129	544,870
Nov.23	27969	427,020
Dec.23	11884	194,220
Jan.24	12460	202,410
Feb.24	15830	256,130
Mar.24	13117	218,120
Total	**337698**	**5,399,510**


Annual Electricity Payable Bill amount-INR
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
-
April.23
May.23
Jun.23
July.23
Aug.23
Sep.23
Oct.23
Nov.23
Dec.23
Jan.24
Feb.24
Mar.24
Payable Bill amount -INR

The Ram Lal Anand Collegeis getting electrical power supply from BSES Delhi distribution limited at 11 kV..

Table 17: Electricity Tariff Analysis-Club

Parameter	Details
Consumer Name	Ram Lal Anand College
Account No./CA	100015054
Supply Voltage (kV)	11
Metering (kV)	11
Sanctioned Load(KVA)	254 kW
Contract Demand(kVA)	200

A detailed twelve months electricity bills analysis of the location is provided below:

4.1. *Load profile*

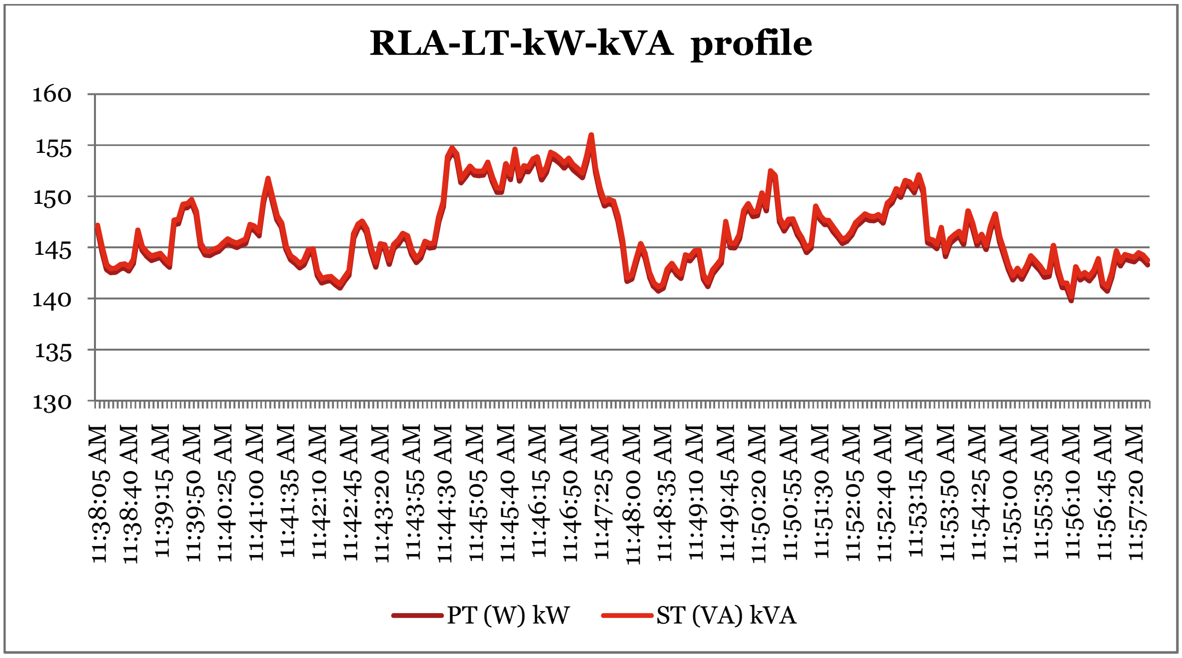
The load profile of the electrical parameters were recorded by using a portable 3-phase power analyzer. During the recording, the power analyzer recorded all the electrical parameters for further detailed analysis. The College has one transformers (11Kv/0.433Kv) of capacity 400 kVA meet the electricity demand.

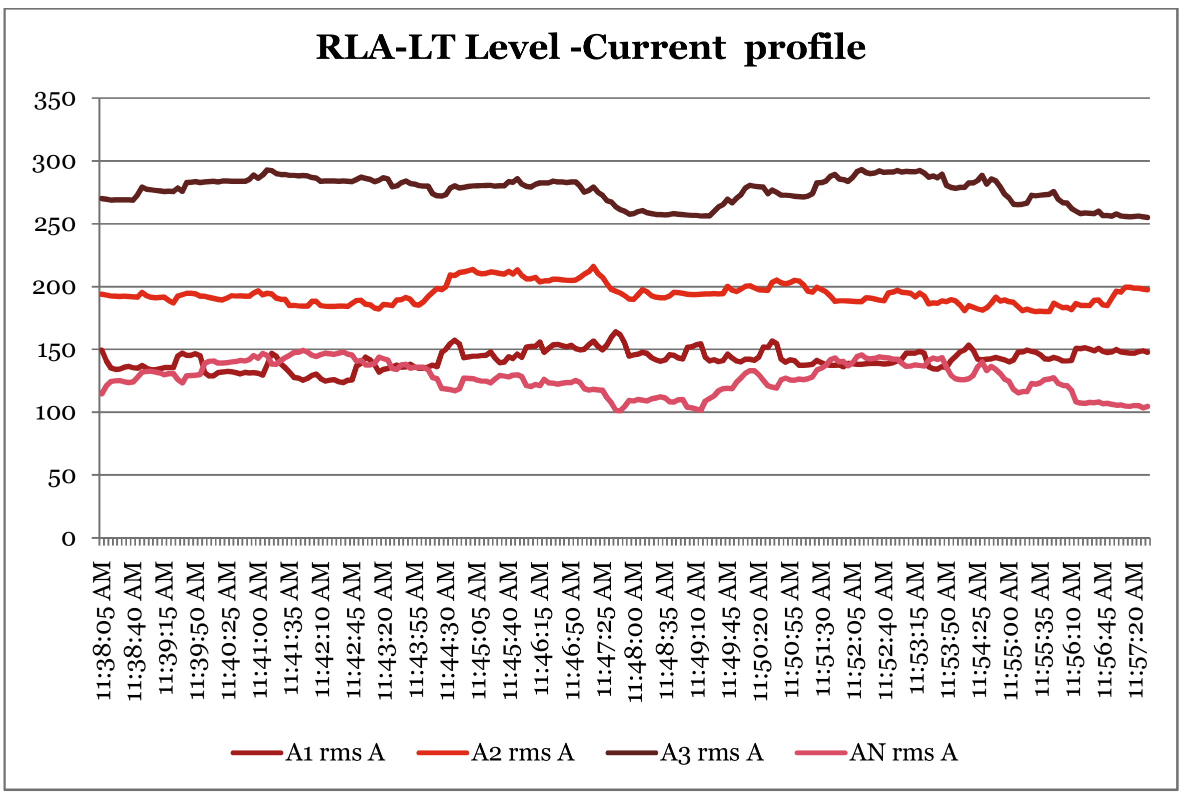
Real power (kW) and apparent power profile (kVA)

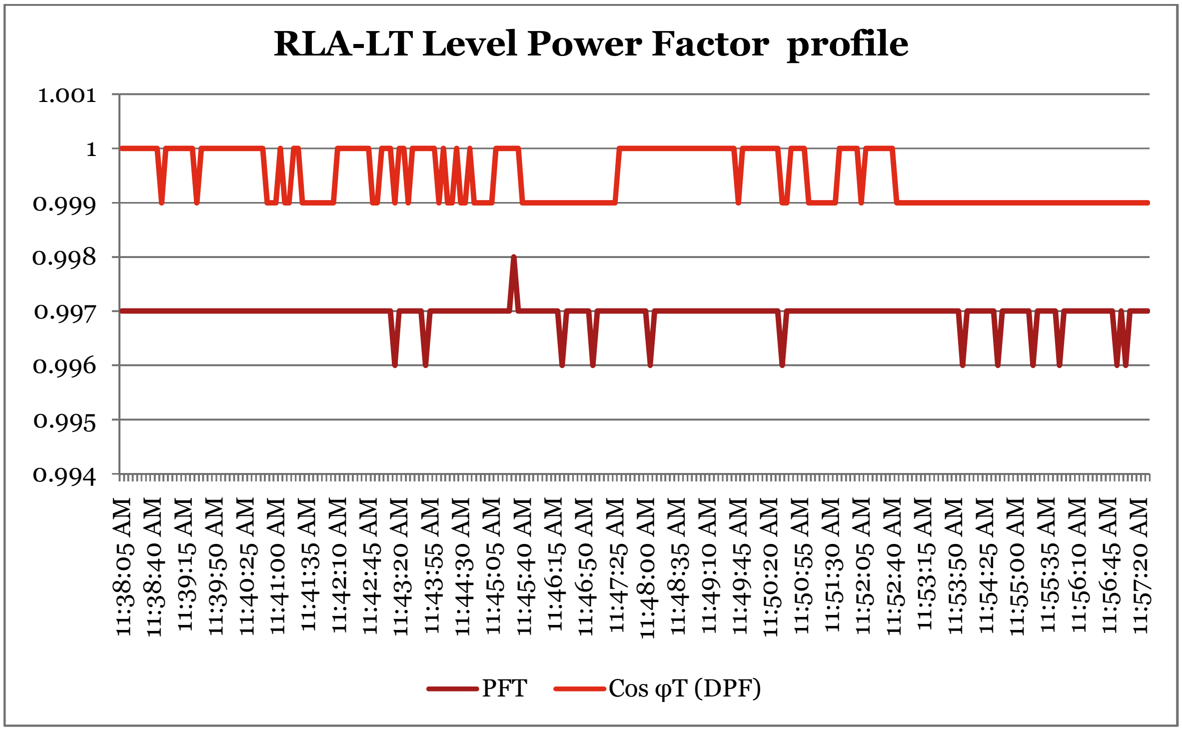
Load (real power) profile and apparent power profile is the variation in the electrical load versus time. In any electrical system, the vector sum of the active power (kW) and reactive power (kVAR) make up the total (or apparent) power (kVA) used. This is the power generated by a generation station for the user to perform a given amount of work. The total power is measured in kVA (Kilo Volts-Amperes) and the load or active power is measured in kW (kilowatts) and they become equal as and when the power factor approaches unity. Total electricity charges (units and demand) are based on the load or active power (kW) and apparent power (kVA).

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

Power Analyzer Data

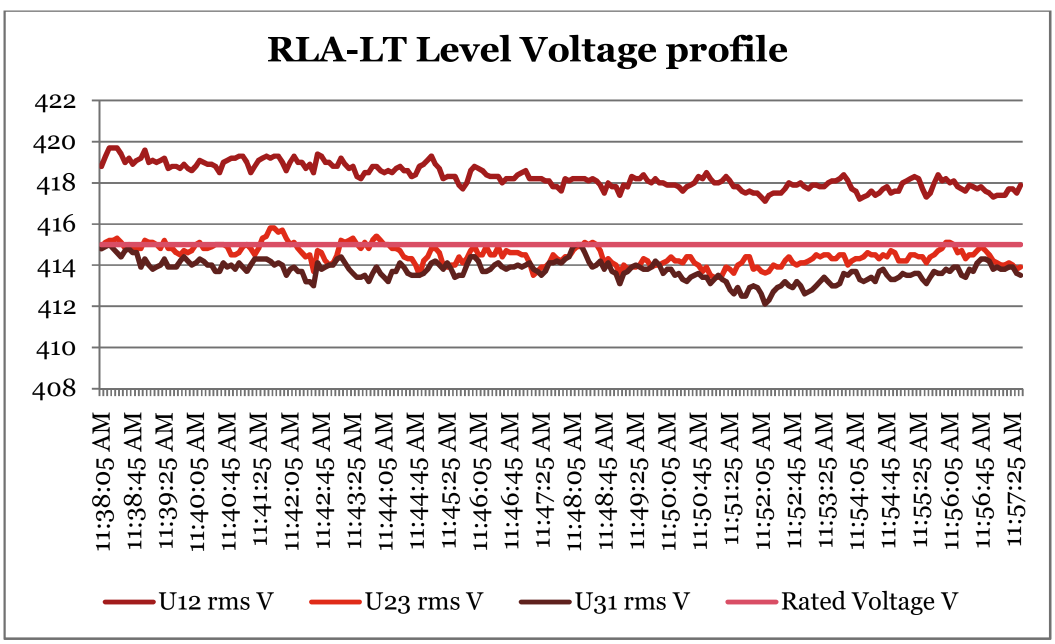






4.1.1. Voltage profile

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 panel of the transformer. The graphs below depict the variations in the voltage:



<u>From Voltage</u> profile it is established that the peak voltage is 420 volts which is ok, this happens at the time of early morning when there is minimum load in club as well as on electricity distribution system.

Generally the voltage is within acceptable range.

4.1.2. Total Harmonic Distortion (THD) Analysis

<u>HARMONICS</u>

- 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.

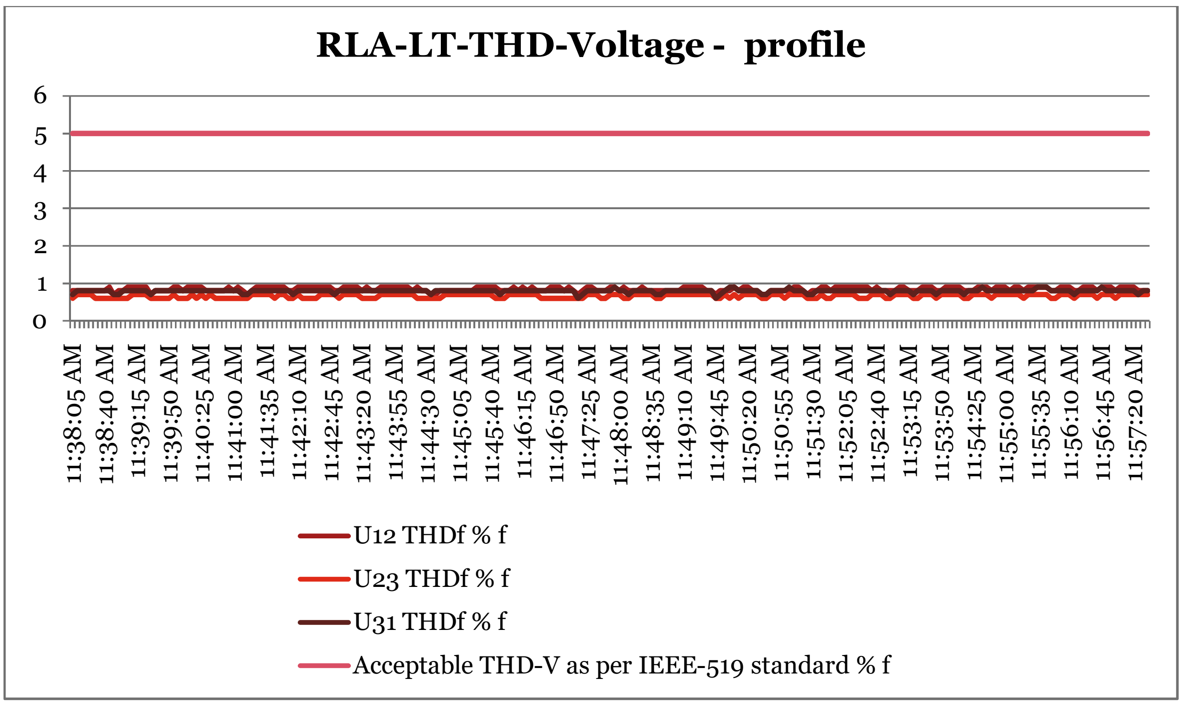
  The Effects of the Harmonics current are :
    - Additional copper losses
    - Increased core losses
    - Incresed electromagnetic interference with communication circuits.

  The Effects of the Harmonics Voltage are :
    - Increased dielectric stress on insulation
    - Electro static interference with communication circuits
    - Resnance between reactance and capcitance
- **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 centers etc. etc.**
- **Effects:** Overheating of electrical equipment; random breakers tripping, High Neutral current due to 3^{rd} Harmonics, interference with communication, non-proper recording of metering, increase in cooper loss, heating of equipments 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 5^{th} order 27% 7^{th} order 5%, 11^{th} order – 2 % and 13^{th} order 1%.

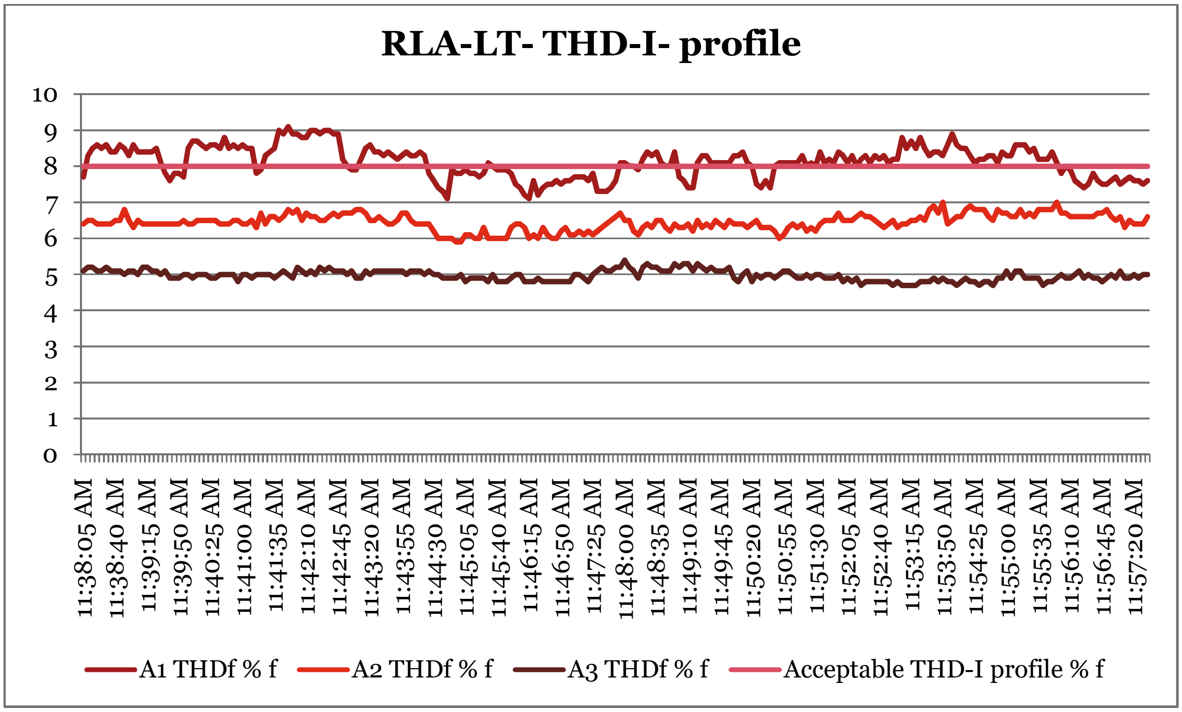
Solutions: Harmonics filters employ the use of power electronic technology, which monitors the nonlinear load and dynamically corrects a wide range of harmonics, such as the 3rd to 51st harmonics orders. By the injection of a compensating current into the load, the waveform is restored which dramatically 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 solution. 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:



The observations taken from the above graphs:

- The percentage of average voltage THD is in the range of 0.6 % to 1%. This is well within the recommended limits as per IEEE Standards i.e. 3% variation for voltage & 8% variation for current.



The percentage of average current THD is in the range of 5.0 % to 9.0%. The current harmonics in the system are more than the recommended limits as per IEEE Standards.

4.1.3. Overall power quality

The analysis of various power quality parameters given above indicates that the overall quality of power received by the facility is good and most of the parameters are within the desired range except the current harmonics in the system.

Power Quality is also maintained with in required limits except minimal transcending the limit in one of the phases.

5. Detailed study of following systems ENCON measures/ options

5.1. Lighting system

Table 20: Common Light level outdoor

Condition	Illumination	
	(ftcd)	(lux)
Sunlight	10,000	107,527
Full Daylight	1,000	10,752
Overcast Day	100	1075
Very Dark Day	10	107
Twilight	1	10.8
Deep Twilight	.1	1.08
Full Moon	.01	.108
Quarter Moon	.001	.0108
Starlight	.0001	.0011
Overcast Night	.0001	.0001

Common and Recommended Light Levels Indoor

The outdoor light level is approximately 10,000 lux on a clear day. In the building, in the area closes to windows, the light level may be reduced to approximately 1,000 lux. In the middle area it may be as low as 25- 50 lux.

Earlier the light levels used to be in the range of 100 -300 lux for normal activities but today the lux levels are more and are in the range 500 – 1000 lux depending on the activities. For precision and detailed works, the lux levels may even approach 1500 – 2000 lux.

Table 21: Standard lux level in different areas

Activity	Illumination (lux, lumen/m²)
Public areas with dark surroundings	20 -50
Simple orientation for short visits	50 -100
Working areas where visual tasks are only occasionally performed	100 -150
Warehouse, Homes, Theaters, Archives	150
Easy Office work, classes	250
Normal Office work, PC work, Study library, Groceries, show room, laboratories	500
Supermarkets, Mechanical Clubs, Office landscapes	750
Normal Drawing work, very detailed mechanical works	1000
Detailed drawing work, very detailed mechanical works	1500 -2000
Performance of visual tasks of low contract and very small size for prolonged periods of time	2000 -5000
Performance of visual tasks of low contract and very small size for prolonged period of time	2000 -5000
Performance of very prolonged and exacting visuals tasks	5000 – 10000
Performance of very special visual tasks of extremely low contract and small size	10000 - 20000

The table above is guidance for recommended light level in different area

5.1.1. Exploring the energy conservation options (ENCON) in lighting system

5.1.1.1. Replacement of Existing Ceiling Fans (70W) with Super Efficient Ceiling Fans (28 W)

Existing-Ceiling fans -70 Watts to be replaced with Super energy efficient fans-28 Watts		
Particulars	**Unit**	**Value**
Existing Ceiling fans to be replaced-70 Watts	Number Watts)	20
Total Wattage-	kW	1.4
Cost of Super Energy Efficient Ceiling Fans after considering retrieval cost	INR/Piece	1850
Operating parameters		
Particulars	**Unit**	**Value**
Number of running hours	Per Day	10
Number of operating Days	Per Year	225
Average life of Energy Efficient Ceiling Fans	Years	10
Average Electricity tariff	INR/KWH	8
Parameters	**Unit**	**Value**
Power consumption of Existing Ceiling Fans	**Watts/Fixture**	70
Power consumption of Energy Efficient Ceiling Fans	**Watts/Fixture**	28
Total Power consumption of Existing Ceiling Fans	**kW**	1.4
Total power consumption of Energy Efficient Ceiling Fans	**kW**	0.56
Power Savings	**kW**	0.84
Annual energy savings	**kWh/year**	1890
Annual monetary savings	**INR/year**	15120
Installation charges	**@5%**	1850
Total investment required	**INR**	38850
Simple payback period	**Months**	30.83

Existing-Ceiling fans -60 Watts to be replaced with Super energy efficient fans-28 Watts		
Particulars	**Unit**	**Value**
Existing Ceiling fans to be replaced-70 Watts	Number Watts)	145
Total Wattage-	kW	8.7
Cost of Super Energy Efficient Ceiling Fans after considering retrieval cost	INR/Piece	1850
Operating parameters		
Particulars	**Unit**	**Value**
Number of running hours	Per Day	10
Number of operating Days	Per Year	225
Average life of Energy Efficient Ceiling Fans	Years	10
Average Electricity tariff	INR/KWH	8
Parameters	**Unit**	**Value**
Power consumption of Existing Ceiling Fans	**Watts/Fixture**	70
Power consumption of Energy Efficient Ceiling Fans	**Watts/Fixture**	28
Total Power consumption of Existing Existing Ceiling Fans	**kW**	8.7
Total power consumption of Energy Efficient Ceiling Fans	**kW**	4.06
Power Savings	**kW**	4.64
Annual energy savings	**kWh/year**	10440
Annual monetary savings	**INR/year**	83520
Installation charges	**@5%**	13412.5
Total investment required	**INR**	281662.5
Simple payback period	**Months**	40.47

5.1.1.2. Reduction of Distribution Losses with Over-all balancing and reduction of Neutral current to 25 % of present value Avoidance of Cost due to effect of reduced Power on peak Load Tariff

Reduction of Distribution Losses with Over-all balancing and reduction of Neutral current to 25 % of present value		
Particulars	**Unit**	**Value**
Annual Energy consumption	kWh/kVAh	337698
Estimated Annual losses	Percent	3
Estimated Annual losses	kWh	10130.94
Losses in Neutral due to Half conductror - Est.-Present	kWh	4052.376
Savings in losses with balancing-Reduction of Current in Neutral current	kWh	253.27
Annual reduction in distribution losses	kWh	3799.10
Expenditure on Balancing	Lot	25000
Operating parameters		
Particulars	**Unit**	**Value**
Number of running hours	Per Day	24
Number of operating Days	Per Year	365
Average Electricity tariff	INR/KWH	8
Parameters	**Unit**	**Value**
Total Energy savings with balancing	**kWh**	3799.10
Annual energy savings	**kWh/year**	3799.10
Annual monetary savings	**INR/year**	30392.82
Total investment required	**INR**	25000
Simple payback period	**Months**	9.87

5.2. *Air conditioning system*

The College has two types of air conditioning systems with High wall and Cassette type indoor unit.

- Split ACs
- Window ACs

Table 30: Details of the AC unit

S.No.	Location	No. of Air Conditioners	Type of Air-Conditioners
1	Room No. 2 (laptop Room)	1	Split
2	Room No. 15 (General Computer)	2	Split
3	Room No.18-FM -Media	4	Split
4	Room No.37	1	Window
5	Room No.42 (Commerce lab)	1	Split
6	Room No. 43 (Computer Science Lab)	3	Window
7	Room No. 45 (Statistics department)	1	Split
8	Room No. 46 (Statistics Department)	3	Split
9	office and Admn. Block	8	Split
10	Library	32	30 -Cassette (Indoor Unit)-2 Split
11	Room No.21	1	Split
12	Room No.22	1	Split
13	Room No. 1-A	1	Split
14	Room No.27	2	Split
15	Room No.19-NCC office	1	Split
16	Room NO. 29	1	Split
17	Room NO. 30	1	Split
18	Room NO. 32	1	Split
19	Room NO. 34	1	Split
20	Room NO. 39	1	Split
21	Sports Room	1	Split
22	Conference Room-	2	Split
23	Principal Room	1	Split
24	Principal-PA Room	1	Window
25	A.O Room	1	Split
26	IQAC/Ecell	2	Split
27	Medical room	1	Split
28	Seminar room	3	Split
29	Staff room	3	Split
30	Auditorium-Ground floor	6	Central
31	Auditorium-First floor	3	Outdoor

32	Research Lab Ground Floor	1	Tower
33	Reading room	2	Split
34	Examination/Committee Room	2	Split
35	Room No. 36	2	Split
36	Room No. 35	1	Split
37	Research Lab-2 First Floor	1	Split
38	Staff room -2	1	Split
39	Server Room (Library)	2	Split
	Total	**103**	

5.2.1. Exploring the energy conservation options (ENCON) in Window type and Split type AC Units

5.2.1.1. Replacement of existing unitary AC's with higher energy efficient five star split ACs

As per energy audit study/survey, split and window type which are old are recommended to be replaced with BEE 5-star rated ACs. The old A/C s performance analysis showed very poor performance in terms of actual.

Recommendation

The following parameters and assumptions have been considered while estimating the energy savings and probable financial returns of this recommendation:

Energy and financial savings

The following parameters and assumptions have been considered while estimating the energy savings and probable financial returns of this recommendation:

Replacement of Old Split AC with 5 star Inverter type Air-conditioners

Assumptions and Input parameters		
Cost parameters		
Particulars	Unit	Value
Total TR proposed to be replaced	TR	15
Power Consumption of Old AC's more than 7 years old	kW	1.35
Price of Split AC after considering retrieval cost of existing scrap	TR	22,500.00
Power Consumption of new 5 star split AC -Inverter type	kW	0.850
Installation Cost	% of capital cost	5
Operating parameters		
Particulars	Unit	Value
Average -Annual hours of operation	Hours	2250
Average electricity tariff	INR/kVah	8.00
Energy and financial savings		
Parameters	**Unit**	**Value**
Savings of power with replacement Air conditioners	kW	7.50
Annual Savings of kWh with replaced Split AC	kWh/Year	16,875
Annual monetary saving	INR/year	135000
Total investment requirement for replacement of Air Conditioners	INR	337,500
Pay-Back period-Effective	Months	30.00

5.3. *Diesel Generator (DG) sets*

There is one DG Set i.e 160 kVA installed in premises. Diesel Generator (DG Set) has been provided for power-backup in case of power failure. These DG Sets are operated rarely, as these is regular power supply from Grid.

Through the past pattern of operation, it has been observed that operation of DG sets is minimal and EB supply is reliable.

Exploring the Energy Conservation Option (ENCON) in DG sets

The housekeeping measures for energy conservation options in DG sets are provided below:

1. Ensure steady load condition on the DG set and avoid idle running.
2. Improve air filtration.
3. Ensure fuel oil storage, handling and preparation as per manufacturers' guidelines/oil company data.
4. Calibrate and overhaul fuel injectors and injection pumps regularly as recommended by manufacturer.
5. Ensure compliance with maintenance checklist.
6. Ensure steady load conditions, avoiding fluctuations, imbalance in phases, harmonic loads.
8. Carryout regular field trials to monitor DG set performance, and maintenance planning as per requirements.
9. Efficiency of DG Set can be increased by maintaining 70-80% loading
10. It is suggested that the frequency of trial run should be reduced from daily basis to every third day.
11. It is recommended to have the load as much balanced as possible, since the unbalanced loads can cause heating of the alternator, which may result in unbalanced output voltage. The maximum unbalanced load between phases should not exceed 10% of the capacity of the generating sets.

5.4. *Water pumping system*

Water pumping systems meet the daily water requirement for various functions such as Drinking water, Watering of Ground, cleaning, washroom, kitchen and cooling tower purposes and .There are 12 nos. pumps of different type capacity are installed i.e. 15 HP-1 HP.

5.4.1. Review of water pumping, storage and distribution systems

Water is mostly used for Human use and Watering of Turf and to be used for testing of Fire fighting system under installation.

5.4.2. Details of Energy Consumption of Water Pumps

Sr. no.	Location	Rated Kw	Rated Efficiency	Voltage			Avrg Voltage	Amps			Avrg Amps
			%	R	Y	B		R	Y	B	
1	Submersible Pump-01	2.2	.....	410	410	414	411	4.8	5.1	5.2	5.03
2	Submersible Pump-02	2.2	.....	410	410	414	411	6.2	7.4	7.2	6.93
3	Raw Water Supply Pump	5.5	.....	410	410	413	411	6	7.3	8.2	7.17

Sr. no.	Location	Rated Kw	Rated Efficiency	PF			Avrg	Actual Power	% of Motor Loading	Remarks
			%	R	Y	B		kW		
1	Submersible Pump-01	2.2	.....	0.72	0.7	0.73	0.72	2.56989	116.81	8 Hrs/ Day Running
2	Submersible Pump-02	2.2	.....	0.7	0.72	0.73	0.72	3.53998	160.90	8 Hrs/ Day Running
3	Raw Water Supply Pump	5.5	.....	0.76	0.75	0.74	0.75	3.8262	69.56	8 Hrs/ Day Running

Replacement of 3 HP Submersible pump-20 years old

Assumptions and Input parameters		
Cost parameters		
Particulars	Unit	Value
Existing power recorded for Pump	kW	3.54
Estimated Rated hydraulic power of Motor	kW	1.35
Combined Pump and Motor Efficiency	Percent	38.14
Target Efficiency of Energy Efficient pump	Percent	75.000
Estimated Cost of Submersible pump including installation		35,000
Installation Cost	% of capital cost	5
Operating parameters		
Particulars	Unit	Value
Average -Annual hours of operation	Hours	2500
Average electricity tariff	INR/kVah	8.00
Energy and financial savings		
Parameters	**Unit**	**Value**
Savings of power with replacement Submersible pumps	%	0.49
Annual Savings of kWh with replaced Submersible pump	kWh/Year	4,350
Annual monetary saving	INR/year	34800
Total investment requirement for replacement Submersible Pump	INR	36,750
Pay-Back period	Months	12.67

Other recommendations include:

1. As water in itself is a precious commodity, its wastage should be avoided. There should always be potential for reduction, re-cycle and re-use of water. Avoided wastage would also lead to energy conservation.
2. Automation should be practiced and over flowing of water should be managed effectively.
3. Low flow fixtures including cisterns should be used for lowering consumption of water.
4. Rain-Water harvesting pits should be provided as per standards and existing if any should be maintained.
5. Modern techniques for watering of Grass should be used.

5.5. *Use of Renewable Energy Sources*

At the premises 130.3 kWp Solar PV system is installed but day to day generation is not monitored.

It is recommended that Solar PV generation be compared with target generation on day to day basis to tap ful potential of the installed capacity of Solr PV system

EM PROJECT SERVICES

A-615 Shastri Nagar-Delhi-110052

CERTIFICATE OF ENERGY AUDIT

This is to certify that Ram Lal Anand College – University of Delhi, 5, Benito Juarez Marg, South Campus, Anand Niketan, New Delhi, Delhi 110021 has successfully undergone Energy Audit during June-2024 to assess the Energy Conservation Initiatives planning and efforts carried out in the campus to establish optimization of energy foot print through awareness and technological interventions. The efforts and initiatives by the stake holders were found satisfactory.

ssmaan

Dated: 19-06-2024

Satvinder Singh

Principal Auditor