MANDATORY ENERGY AUDIT

BML MUNJAL UNIVERSITY

APRIL - 2022

67th KM Milestone, NH-8,
Dist. Gurugram 122413, Haryana

CONDUCTED BY:

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ABBREVIATIONS

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

Acknowledgement

M/s. A-Z Energy Engineers Pvt. Ltd., expresses sincere thanks to the Management of **"BML Munjal University,"** for their kind assistance and co-operation for carrying out the Energy Audit of their **BML Munjal University, Gurugram (H.R)**. The site visits for the Energy Audit have been conducted from April. 2022.

The Management is highly conscious about its Energy Efficiency Levels and they have initiated several measures to reduce the energy consumption, which include amongst others the use of LED lights, Star Rated AC, Solar Pv & APFC Panel etc. **A-Z Energy Engineers Pvt. Ltd., acknowledges and appreciates the commitment of the management towards conservation of Energy.**

The Audit team of A-Z Energy Engineers Pvt. Ltd. conveys their gratitude and thanks to the management of BML Munjal University, for their positive attitude in safety, reliability and energy conservation program through energy efficiency improvement and better utilization of available energy system infrastructures followed by their proactive role in conducting the energy audit study.

The Audit team would like to register their hearty thanks to BML Munjal University, Gurugram for their guidance, coordination, active support, participation during the audit and motivating the audit team.

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Highlights of the Energy Audit

M/s. A-Z Energy Engineers Pvt. Ltd. expresses sincere thanks to the Management of **"BML Munjal University, Gurugram"** for their kind assistance and co-operation for carrying out the Energy Audit of their University. The site visits for the Energy Audit have been conducted from April, 2022.

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

- **Review of Electricity Bills**, Contract Demand and Power Factor: for the last one year in which possibility will be explored for further reduction of contract demand an improvement of P.F.
- **Electrical System Network:** which would include detailed study of all the transformers of various rating / capacities their operational pattern, loading, no load losses, power factor measurement on the main power distribution boards and scope for improvement if any. the study would also cover possible improvement in energy metering systems for better control and monitoring
- **Study of Motors Pumps Loading** Study of motors above 10 KW in terms of measurement of Voltage (V), Current (I), Power (kW) and P.F. and thereby suggesting measure for energy saving like reduction in size of motors or installation of energy saving device in the existing motors. Study of Pumps and their flow, thereby suggesting measures for energy saving like reduction in size of Motors and Pumps of installation of energy saving device in the existing motors, optimization of pumps.
- **Chiller & Cooling tower:** Performance shall be evaluated as regards; their input power vis-à-vis TR capacity and performance will be compared to improve to the best in the category.
- **Lighting System: -** Study of type and fitting of lighting and suggest measures for improvements and energy conservation opportunity wherever feasible.

- **RO System: -** Study of type and fitting of R.O and suggest measures for improvements and energy conservation opportunity wherever feasible.
- **UPS System: -** Performance shall be evaluated of UPS System, improvements and energy conservation opportunity wherever feasible.

Key Points

- ➲ *The Detailed Energy Audit of BML Munjal University, Gurugram was carried out from April, 2022 to find out the energy saving potential and the performance level of BML Munjal University The report provides the major highlights on potential energy saving opportunities available in the University.*
- ➲ *BML Munjal University, Gurugram draws power from the Dakshin Haryana Vidyut Vitran Nigam Ltd., at 11 kV; subsequently the voltage is stepped down by three transformers 11 KV to 0.433 KV by 1250 KVA transformers. The Contract demand of plant is 1800 KVA. Billing is done on 11 KV.*
- ➲ *During the site visit, measurements were made to record the load profile of the building, which included the variations in the voltage, current, power factor, harmonics etc. Analysis of the recordings indicated that the average voltage level was around 242 Volts. This may be an adequate voltage for motive loads like motors etc, but for the lighting systems normally, the voltage should be around 220 volts (phase to neutral). A reduction of around 15% in the lighting voltage can reduce the power consumption by around 20%.*

  As the conventional light is replacing with LED lamps in phase manner, the effect of voltage reduction in terms of power saving will be almost negligible. However, reduction and stabilization of voltage will improve the life of lamps. Light saver transformer is already installed in plat used for control light load voltage.

- *The plant is being billed on KVAh basis; therefore, the effect of power factor is inbuilt in the billing structure. There are three capacitor bank panels (425 kVAr, 375 kVAr & 425 kVAr) is installed in the plant at LT Side. The building is being billed on KVAh basis; During the Year, the operating power factor varied from 0.971 to 1.00. However, if we look at the overall average power factor is around 0.990, which is satisfactory. In the billing last month March 2022 power factor is 0.971, which is slightly lower side. The effect of power factor is inbuilt in the billing structure so to be improves power factor is 0.999 APFC Panel or the capacitor banks wherein the delivery is poor (less than 70%) or out of order may be replaced, so that the overall system power factor is maintained at around 0.99 (lag). Improvement in the power factor would subsequently reduce the KVAh consumption, the resultant benefits in terms of energy savings. Most of the capacitor is de-rated & not in operation. The details of measurement in given Capacitor chapter.*
- *The measured efficiency of transformer-1 is 97.27, which is good. transformer-2 is 98.72, which is good and transformer-3 is 97.57, which is good*
- *The harmonics levels measured in main incomer. The details is given below table.*

Particulars	TR-1 (1250 KVA) (Average)	TR-2 (1250 KVA) (Average)	TR-3 (1250 KVA) (Average)
THD Phase1 (V)	1.7	1.6	2.9
THD Phase2 (V)	1.8	1.5	3.2
THD Phase3 (V)	1.6	1.6	2.7
THD Phase1 (A)	6.4	4.9	20.1
THD Phase2 (A)	5.4	2.8	22.2
THD Phase3 (A)	5.0	2.9	21.7

The average voltage harmonics levels were around below 4%, which is under limit. The current harmonics levels were around below 7% for Transformer-1&2, which is under limit and current harmonics levels were around above 20% for Transformer-3, which is higher side.

- *The Building Management is highly conscious about its Energy Efficiency and cost and has initiated several measures to reduce the energy consumption, which include replacement of conventional lamps with LEDs*
- *Although there is no simpler way to reduce the amount of energy consumed by lighting system than to manually turn OFF whenever not needed, this is not done as often as it could be. In response, automatic lighting control strategies like installation of occupancy sensors can be considered to Control light in response to the presence or absence of people in the space. Quantification of energy savings on this account is not possible.*
- *The calculate efficacy of chillers. SPC of Central AC Plant Chiller-1 (280Tr) is 1.50 KW/TR and Chiller-2 (180Tr) is 1.43 KW/TR, which is satisfactory,*
- *During the audit we have taken water flow, suction and discharge pressure of secondary Chilled water pump to calculate efficiency of water pump. The water pumps are running at their rated parameters and seen that,the efficiency of secondary water pumps-1, 2, 3, 4, 5, 6 & 7 is 70.41% , 65.19%, 74.52%, 70.44%, 69.55%, 83.67% & 73.48%. Respectively which are good as compared to design efficiency of pumps.*
- *During the audit we measured the specific fuel consumption (kWh/Ltr) of DG sets. The load profile of the electrical parameters was recorded by using a portable 3-phase power analyzer. The analysis of the different parameters recorded at the L.T incoming main supply and during this period the diesel consumption was also recorded empty tank method. The standard specific fuel consumption (SFC) of DG sets is in the range of 3.0 to 4.0 kWh/ltr and present SFC of DG-1,2 & 4 is 3.4, 3.5 & 3.4 kWh/Ltr, which is good.*
- **The Management is highly conscious about its Energy Efficiency Levels and they have initiated several measures to reduce the energy consumption, which include amongst others the use of LED lights, Star Rated AC, Renewable solar energy & Energy monitoring etc. A-Z Energy Engineers Pvt. Ltd., acknowledges and appreciates the commitment of the management towards conservation of Energy.**

Cumulative Energy Saving Opportunities in Kwh & Corresponding Monitory Benefits with Payback

ECO's	Quantity	Energy Savings per Annum		Estimated Investments	Simple Payback Period
	Nos.	KWh	Rs	(Rs)	(Months)
Replacing existing fans with 5 Star rated BEE label Fans	30	2880	23040	75000	39
Switch Off 1250 KVA Transformer (Save Load Losses)	1	13910	111283	Nil	Immediate
Proper Improvement of Power Factor to 0.999	-	6609	52872	100000	2-3
Total		**23399.00**	**187195.00**	**175000**	

CHAPTER-1 INTRODUCTION

1.1. THE PROJECT

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

It was with this objective that "**M/s. A-Z Energy Engineers Pvt. Ltd.,** Plot No.12, 4860-62, Harbans Singh Street, Kothi No. 24, Ward No. II, Darya Ganj, New Delhi-11002, was entrusted with the job of conducting Energy Audit of "BML Munjal University, Gurugram".

1.2. SCOPE OF WORK

The Broad Scope of work was to:

1. **Analysis of the Electricity bills**
   - (i) Analysis of the different section of the electricity bills.
   - (ii) Study of the fixed charges and variable charges and comments on the same.
   - (iii) Calculation of the load actor.
   - (iv) Comments on the contract demand and suggestions to reduced them
2. **Power factor and Harmonics Analysis**
   - (i) Measured of power factor/ harmonics analysis at the major loads.
   - (ii) Suggesting methods to improve the present power factor.
   - (iii) Suggesting method for improving power quality and reduction of Harmonics if any.
3. **Metering and Monitoring Status**
   - (i) Review of exiting metering system of the plant
   - (ii) Suggesting need and methods to improve the metering system, if required.
4. **Transformers**
   - (i) Study of major transformer in the plant.
   - (ii) Measuring of loading pattern and current efficiency of the transformer.
   - (iii) Data shall be collected using portable power analyzer and energy meter installed in plants.
   - (iv) Snapshot study for similar equipment.
5. **Water Pumps**

   Study of water pumps (15 KW and above) would be carried out:-
   - (i) Measured of flow and head using plant instruments if available.
   - (ii) Measured of power consumption.
   - (iii) Checking running hours of the pumps and optimization of the same.

(iv) Recommend measure to reduce the power consumption.
(v) Application of flow control methods.
(vi) Application of retrofit for energy savings.

6. **Lighting System**

Detailed audit in lighting system normally results in considerable saving. illumine readings with lux meter should act as a basis for comparative purpose. The study should cover measurement of lux level at works place and at various points of light usage. Application of retrofits such as: -

(i) Timer Control
(ii) Photocell control for street lighting
(iii) Use of energy efficient lighting

7. **DG Sets**

(i) Specific electricity generation ratio evaluation (based on the data).
(ii) Performance evaluation i.e., Energy balance efficiency calculations (based on the data).

1.3. OBJECT OF STUDY

The purpose of this study is to demonstrate the technical and financial feasibility of implementation of energy efficiency measures in M/s. BML Munjal University, Gurugram. The purpose of this report is: –

(i) to analyze the present energy consumption pattern
(ii) to investigate for energy conservation measures without compromising the production level
(iii) to assess the techno-economic feasibility of the energy conservation measure

1.4. METHODOLOGY

Methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and Energy savings include the following:

- Discussions with the concerned officials for identification of major areas of focus and other related systems.
- A team of engineers visited the Site and had discussions with the concerned officials/ supervisors to collect data/ information on the operations and Load Distribution within the Building. The data was analyzed to arrive at a **base line energy consumption pattern**.
- **Measurements and monitoring** with the help of appropriate instruments including continuous and/ or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.

- Computation and **in-depth analysis** of the collected data, including utilization of computerized analysis and other techniques as appropriate were done to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.

1.5. INSTRUMENTATION SUPPORT

Instruments used for undertaking the audit include the following:

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

CHAPTER-2 BASE LINE DATA

2.1. General Details

Contact Details		
Brief description of Assignment	:	Detailed Energy Audit of Electrical Systems & Utility Equipment's.
Name & Address of the Building	:	BML Munjal University 67th KM Milestone, NH-8, Dist. Gurugram 122413, (HR.)
Operational Days	:	330 Days per annum
Contact Officer	:	Mr. Raja A S Jamwal - DGM Project & Maintenance.
Power		
Source	;	Dakshin Haryana Bijli Vitran Nigam, Gurugram
AC No.	:	
Sanctioned Load	:	1,800 KW
Contracted Demand	:	1,800 KVA
Annual Purchased Power Consumption	:	
Apr. 2021 to Mar. 2022	:	11,07,660.00 KWH
Apr. 2021 to Mar. 2022	:	11,21,460.00 KVAh
Annual Purchased Power Bill	:	
Apr. 2021 to Mar. 2022	;	Rs. 1,11,18,003.00
Average Purchased Power Cost	:	
Apr. 2021 to Mar. 2022	;	Rs. 10.5 per KVAh
Apr. 2021 to Mar. 2022	:	Rs. 10.6 per KWh
Energy Charge	:	Rs. 6.65 per KVAh
Fixed Charge	:	Rs. 160-165 per KVA
Fuel Charges	:	Rs. 0.37 per KWh
Electricity Duty	:	Rs. 0.10 per KWh

CHAPTER-3 PRESENT ENERGY SCENARIO

3.1. Purchased Power

BML Munjal University, Gurugram draws power from the Dakshin Haryana Bijli Vitran Nigam, at 11 kV; subsequently the voltage is stepped down by three transformers 11 KV to 0.433 KV by 1250 KVA X 3 Nos. transformers. The Contract demand of plant is 1800 KVA. Billing is done on 11 KV.

3.2. Reactive Power Compensation

Based on the electricity bills, it was observed that the power factor from Apr. 2021 to Mar. 2022 varies from 0.971-1.00 i.e., average power factor was 0.990 which appears to be on good side. The building is being billed on KVAH basis; therefore, the effect of power factor is inbuilt in the billing structure. The minimum, maximum and average PF (Apr. 2021 to Mar. 2022) are a s follows.

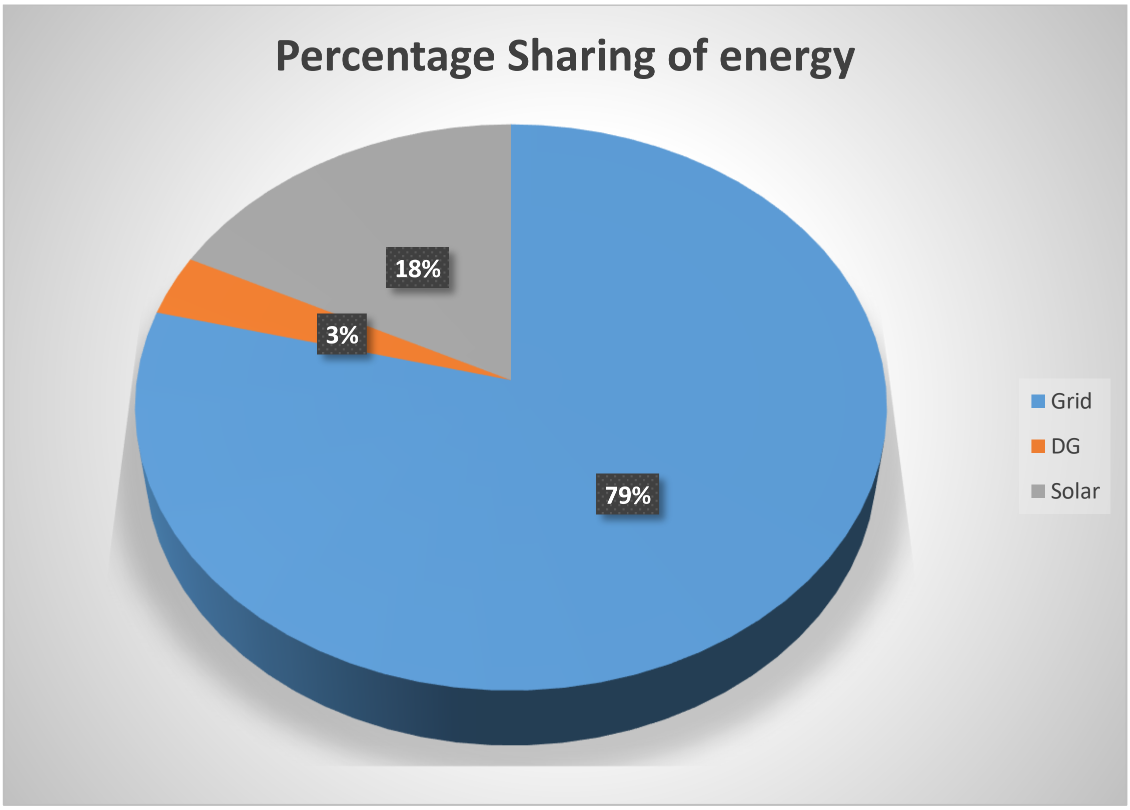
Description	Min. PF	Max. PF	Average PF
Power Factor	0.971	1.000	0.990

3.3. Self-generated Power

The university has 4 No's DG Sets of 1010 KVA X 2 Nos. & 500 KVA X 2 Nos. D.G installed for in-house power generation during power cut. The operation of the DG Sets is during in power cut & testing only.

3.4. Solar PV

254 kWp solar PV installed on roof top of building. Solar Photovoltaic Cell for Power Generation for lighting load & other load in the Building.

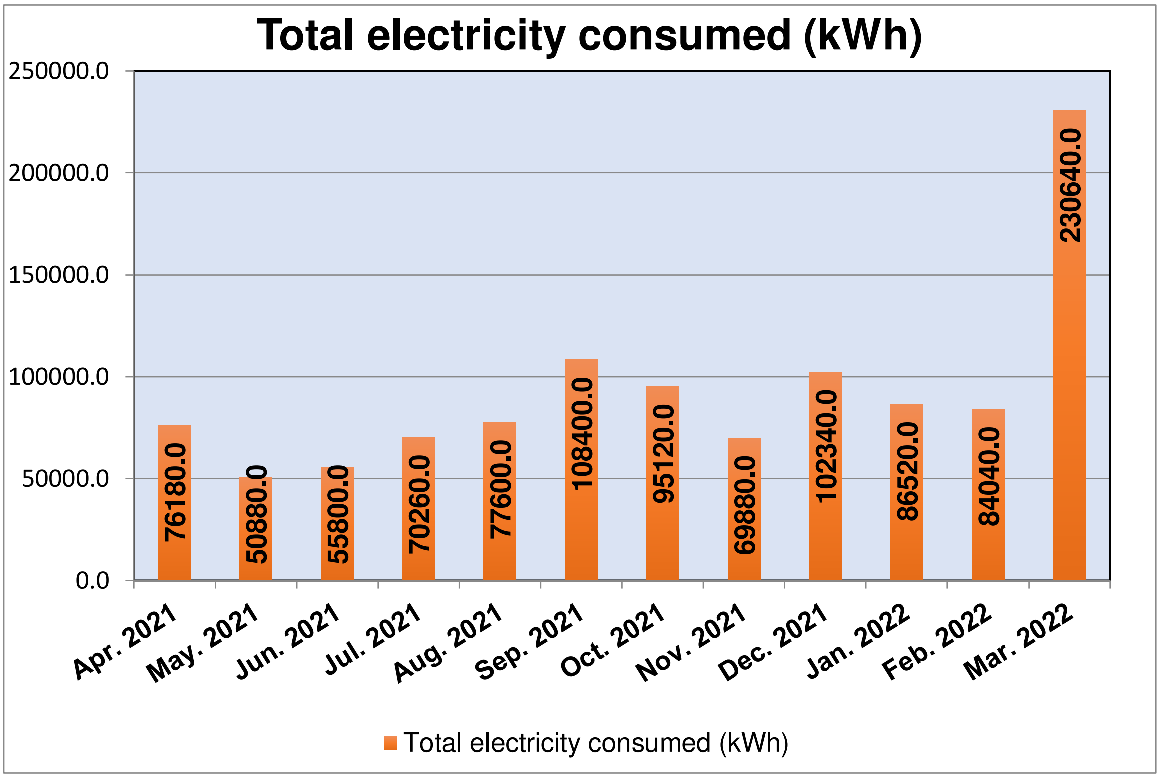

Percentage Sharing of energy
18%
3%
79%
Grid
DG
Solar

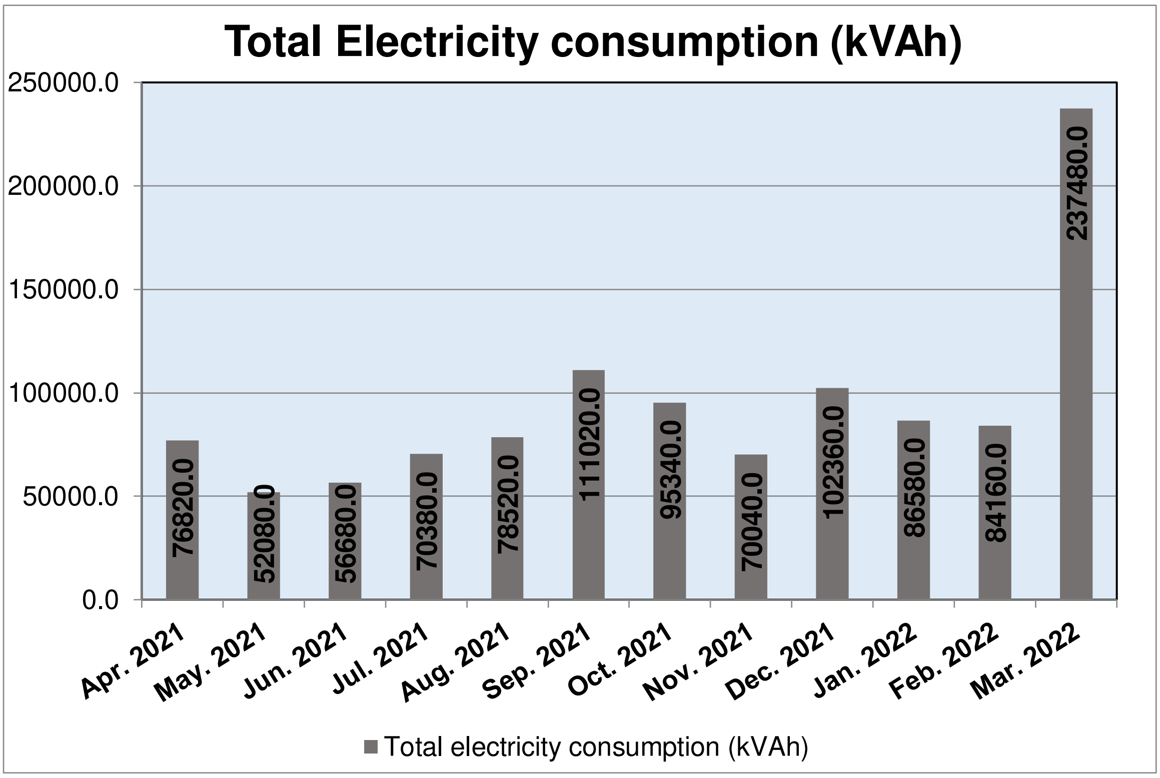
3.5. Purchased Power Consumption Pattern

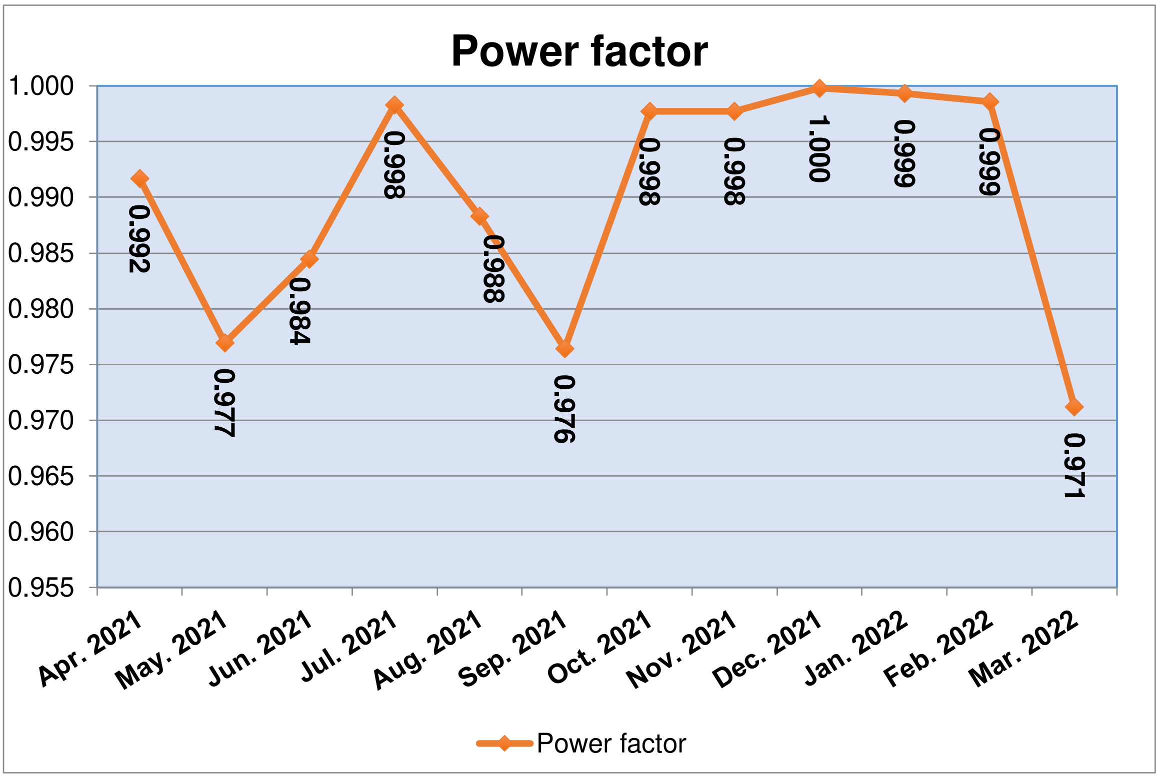
3.5.1. Apr 2021- Mar 2022

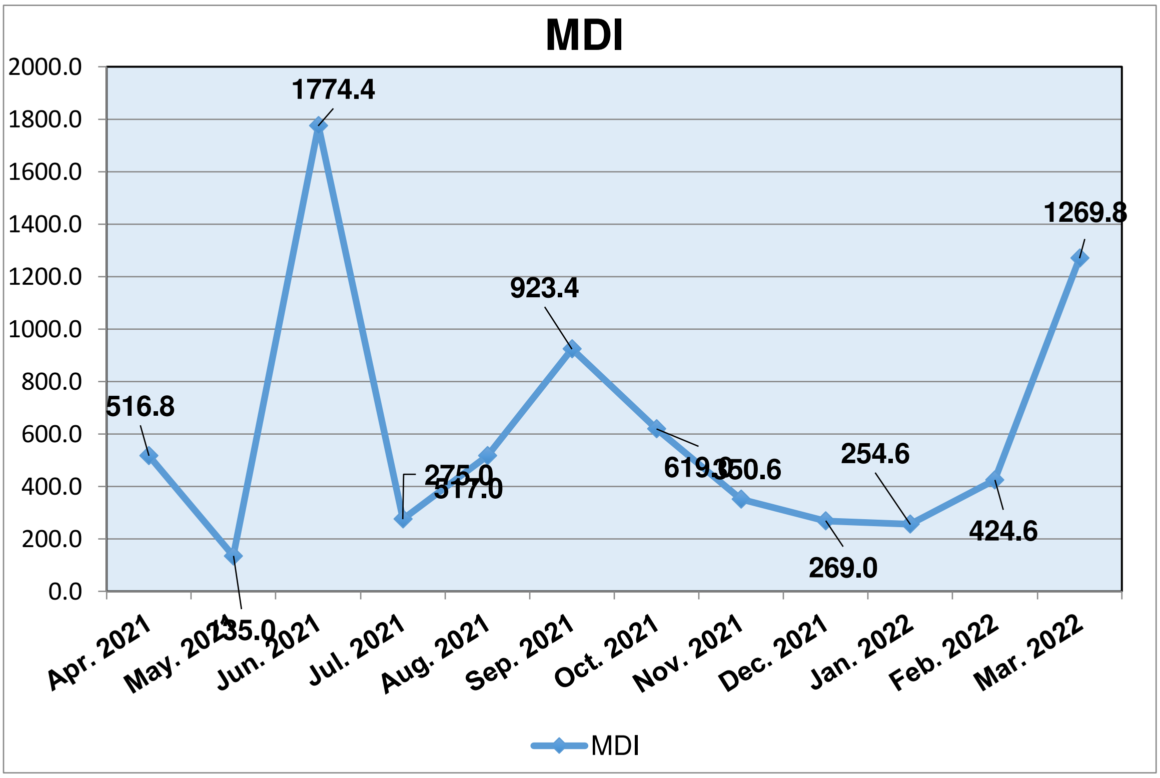
Sr. No.	Billing Month	MDI	Power factor	Electricity consumed (kWh)	Electricity consumption (kVAh)	Energy Charge	Fixed Charges	Fuel Surcharge	Meter Rent	Service rent /Charges
1	Apr. 2021	516.8	0.992	76180.0	76820.0	518535.00	288000.00	28186.60	1000.0	590.00
2	May. 2021	135.0	0.977	50880.0	52080.0	351540.00	288000.00	18825.60	1000.0	590.00
3	Jun. 2021	1774.4	0.984	55800.0	56680.0	376922.00	297000.00	20646.00	1000.0	590.00
4	Jul. 2021	275.0	0.998	70260.0	70380.0	468027.00	297000.00	25996.20	1000.0	590.00
5	Aug. 2021	517.0	0.988	77600.0	78520.0	522158.00	297000.00	0.00	0.00	0.00
6	Sep. 2021	923.4	0.976	108400.0	111020.0	738283.00	297000.00	0.00	0.00	0.00
7	Oct. 2021	619.0	0.998	95120.0	95340.0	634011.00	297000.00	0.00	0.00	0.00
8	Nov. 2021	350.6	0.998	69880.0	70040.0	465766.00	297000.00	0.00	0.00	0.00
9	Dec. 2021	269.0	1.000	102340.0	102360.0	680694.00	297000.00	0.00	0.00	0.00
10	Jan. 2022	254.6	0.999	86520.0	86580.0	575757.00	297000.00	0.00	0.00	0.00
11	Feb. 2022	424.6	0.999	84040.0	84160.0	559664.00	297000.00	0.00	0.00	0.00
12	Mar. 2022	1269.8	0.971	230640.0	237480.0	1579242.00	297000.00	0.00	0.00	0.00
	Total			**1107660.0**	**1121460.0**	**7470599.0**	**3546000.0**	**93654.4**	**4000.0**	**2360.0**
	Avg.	**610.8**	**0.990**	**92305.0**	**93455.0**	**622549.9**	**295500.0**	**7804.5**	**333.3**	**196.7**
	Max	**1774.4**	**1.000**	**230640.0**	**237480.0**	**1579242.0**	**297000.0**	**28186.6**	**1000.0**	**590.0**
	Min	**135.0**	**0.971**	**50880.0**	**52080.0**	**351540.0**	**288000.0**	**0.0**	**0.0**	**0.0**

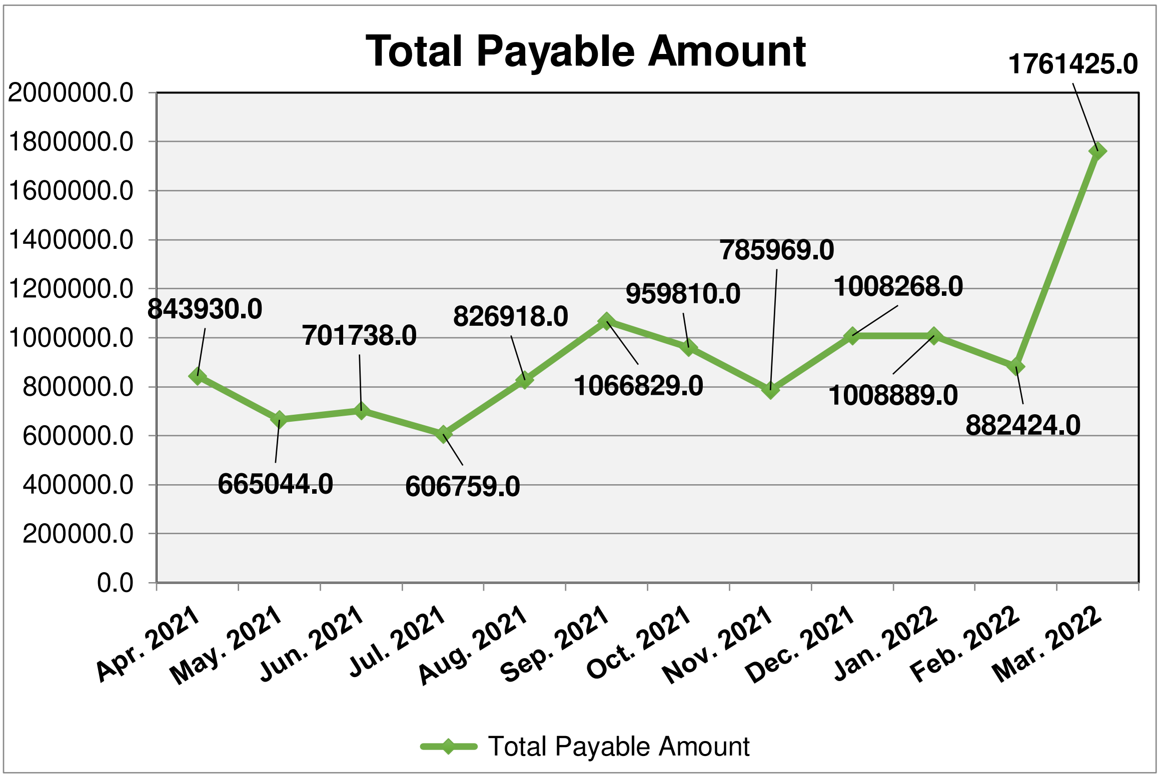
Sr. No.	Billing Month	Electricity Duty	Municipal Tax	Sundry Charge	Sundry Allowances	Rounded Amount	Total Payable Amount	Inr/Unit kvah	Inr/Unit kwh
1	Apr. 2021	7618.00	0.00	0.00	0.00	0.40	**843930.0**	11.0	11.1
2	May. 2021	5088.00	0.00	0.00	0.00	0.40	**665044.0**	12.8	13.1
3	Jun. 2021	5580.00	0.00	0.00	0.00	0.00	**701738.0**	12.4	12.6
4	Jul. 2021	7026.00	0.00	0.00	192880.00	0.20	**606759.0**	8.6	8.6
5	Aug. 2021	7760.00	0.00	0.00	0.00	0.00	**826918.0**	10.5	10.7
6	Sep. 2021	10840.00	20705.66	0.00	0.00	0.34	**1066829.0**	9.6	9.8
7	Oct. 2021	9512.00	18620.22	667.00	0.00	0.22	**959810.0**	10.1	10.1
8	Nov. 2021	6988.00	15255.32	960.00	0.00	0.32	**785969.0**	11.2	11.2
9	Dec. 2021	10234.00	19553.88	786.00	0.00	0.12	**1008268.0**	9.9	9.9
10	Jan. 2022	8652.00	17455.14	110024.36	0.00	0.50	**1008889.0**	11.7	11.7
11	Feb. 2022	8404.00	17133.28	223.00	0.00	0.28	**882424.0**	10.5	10.5
12	Mar. 2022	23064.00	37524.84	882.00	176288.32	0.48	**1761425.0**	7.4	7.6
	Total	**110766.0**	**146248.3**	**113542.4**	**369168.3**	**3.3**	**11118003.0**		
	Avg.	**9230.5**	**12187.4**	**9461.9**	**30764.0**	**0.3**	**926500.3**	**10.5**	**10.6**
	Max	**23064.0**	**37524.8**	**110024.4**	**192880.0**	**0.5**	**1761425.0**	**12.8**	**13.1**
	Min	**5088.0**	**0.0**	**0.0**	**0.0**	**0.0**	**606759.0**	**7.4**	**7.6**

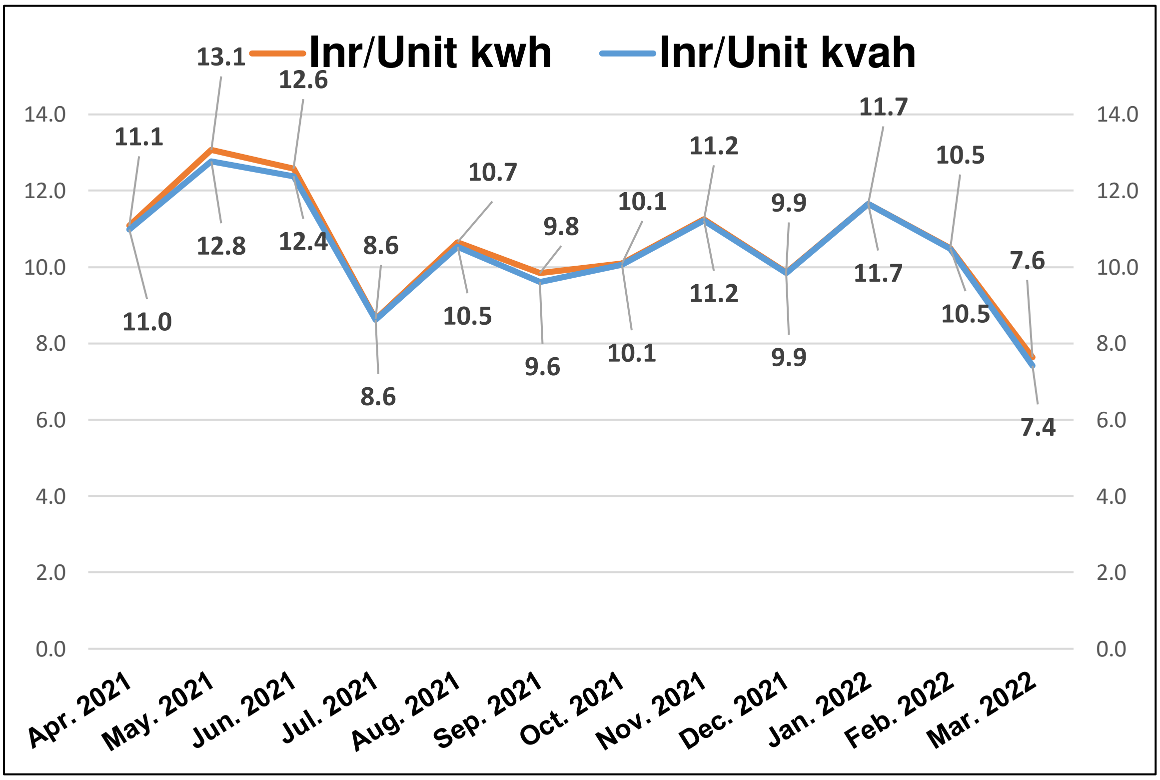

Total electricity consumed (kWh)
250000.0
200000.0
150000.0
100000.0
50000.0
0.0
76180.0
50880.0
55800.0
70260.0
77600.0
108400.0
95120.0
69880.0
102340.0
86520.0
84040.0
230640.0
Apr. 2021
May. 2021
Jun. 2021
Jul. 2021
Aug. 2021
Sep. 2021
Oct. 2021
Nov. 2021
Dec. 2021
Jan. 2022
Feb. 2022
Mar. 2022
Total electricity consumed (kWh)


Total Electricity consumption (kVAh)
250000.0
200000.0
150000.0
100000.0
50000.0
0.0
76820.0
52080.0
56680.0
70380.0
78520.0
111020.0
95340.0
70040.0
102360.0
86580.0
84160.0
237480.0
Apr. 2021
May. 2021
Jun. 2021
Jul. 2021
Aug. 2021
Sep. 2021
Oct. 2021
Nov. 2021
Dec. 2021
Jan. 2022
Feb. 2022
Mar. 2022
Total electricity consumption (kVAh)


Power factor
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
0.960
0.955
0.992
0.977
0.984
0.998
0.988
0.976
0.998
0.998
1.000
0.999
0.999
0.971
Apr. 2021
May. 2021
Jun. 2021
Jul. 2021
Aug. 2021
Sep. 2021
Oct. 2021
Nov. 2021
Dec. 2021
Jan. 2022
Feb. 2022
Mar. 2022
Power factor


MDI
2000.0
1800.0
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
516.8
135.0
1774.4
275.0
517.0
923.4
619.3
350.6
269.0
254.6
424.6
1269.8
Apr. 2021
May. 2021
Jun. 2021
Jul. 2021
Aug. 2021
Sep. 2021
Oct. 2021
Nov. 2021
Dec. 2021
Jan. 2022
Feb. 2022
Mar. 2022
MDI


Total Payable Amount
2000000.0
1800000.0
1600000.0
1400000.0
1200000.0
1000000.0
800000.0
600000.0
400000.0
200000.0
0.0
843930.0
665044.0
701738.0
606759.0
826918.0
1066829.0
959810.0
785969.0
1008268.0
1008889.0
882424.0
1761425.0
Apr. 2021
May. 2021
Jun. 2021
Jul. 2021
Aug. 2021
Sep. 2021
Oct. 2021
Nov. 2021
Dec. 2021
Jan. 2022
Feb. 2022
Mar. 2022
Total Payable Amount


Inr/Unit kwh
Inr/Unit kvah
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
11.1
13.1
12.6
8.6
10.7
9.8
10.1
11.2
9.9
11.7
10.5
7.6
11.0
12.8
12.4
8.6
10.5
9.6
10.1
11.2
9.9
11.7
10.5
7.4
Apr. 2021
May. 2021
Jun. 2021
Jul. 2021
Aug. 2021
Sep. 2021
Oct. 2021
Nov. 2021
Dec. 2021
Jan. 2022
Feb. 2022
Mar. 2022

- Average monthly consumption of the plant is 0.93 Lakhs kVAh /month, while total annual consumption of the plant is 11.21 Lakhs kVAh units. For fulfilling energy needs BML Munjal University, has been paying Rs. 9.27 lakhs/Month while annually BML Munjal University, is paying Rs 111.18 Lakhs.
- Incoming supply voltage is 11 kV which is further stepped down to 433 V with the help of transformer.
- Average demand of the plant is 610.8 KVA, while variation of M.D. is within 135.0 to 1774.4 KVA respectively.
- Maintenance department is doing a great job by maintaining the power factor within the range of 0.99, but last month March 2022 power factor is 0.971, which is slightly lower side. The effect of power factor is inbuilt in the billing structure so to be improves power factor is 0.999.

3.6. SUMMARY

Average Purchased Power Cost	:	
Apr. 2021 to Mar. 2022	:	Rs. 10.5 per KVAh
Apr. 2021 to Mar. 2022	:	Rs. 10.6 per KWh
Energy Charge	:	
Apr. 2021 to Mar. 2022	:	Rs. 6.65 per KVAh
Fixed Charge	:	Rs. 160-165 per KVA
Fuel Charges	:	Rs. 0.37 per KWh
Electricity Duty	:	Rs. 0.10 per KWh

CHAPTER-4 TRANSFORMER LOAD PROFILE

4.1. RATED SPECIFICATION OF TRANSFORMER

BML Munjal University, Gurugram draws power from the Dakshin Haryana Bijli Vitran Nigam, at 11 kV; subsequently the voltage is stepped down by three transformers 11 KV to 0.433 KV by 1250 KVA X 3 Nos. transformers. The Contract demand of plant is 1800 KVA. Billing is done on 11 KV.

Details of transformers, whose load profile has been taken during the audit,

Name Plate Data		TR-1	TR-2	TR-3
Rated	kVA	1250	1250	1250
Voltage	H. V	11000	11000	11000
	L.V	433	433	415
Amp.	H. V	65.61	65.61	65.61
	L.V	1666.72	1666.72	1739
Impedance Volt.	%	4.86	4.86	5
Phase	-	3	3	3
HZ	-	50	50	50
Cooling Type	-	ONAN	ONAN	ONAN
Vector Group	-	Dyn11	Dyn11	Dyn11
Mfg.	Year	2014	2014	2016
Make	-	Vltamp	Vltamp	ITE
Remarks	-			
Condition of Transformer	-	Good	Good	Good
Silica Gel	-	OK	OK	OK
Temperature	-	OK	OK	OK
Oil Level		OK	OK	OK

4.2. LOADING ON MAIN INCOMER

The total loading was recorded on 1250 KVA transformers and load profile of transformer was measured during the audit and the averaged-out readings are given here in:

4.2.1. Load Profile of Transformer-1 (1250 KVA)

Identification	TR-1 (1250 kVA)		
Voltage (Volts) P-P	Max.	Min.	Avg.
"R" Phase	429.0	414.6	420.9
"Y" Phase	433.4	419.2	425.2
"B" Phase	429.2	415.3	421.8
Voltage (Volts) P-N			
"R" Phase	247.0	238.8	242.6

Identification	TR-1 (1250 kVA)		
"Y" Phase	249.3	240.9	244.4
"B" Phase	249.4	241.3	244.9
Current (Amps)			
"R" Phase	493.3	318.9	416.2
"Y" Phase	480.9	329.4	390.8
"B" Phase	537.7	362.0	453.4
Power Factor			
"R" Phase	0.917	0.775	0.863
"Y" Phase	0.922	0.826	0.882
"B" Phase	0.911	0.794	0.868
Power Drawn (KW)			
"R" Phase	108.29	59.94	87.53
"Y" Phase	107.03	66.30	84.46
"B" Phase	119.47	70.55	96.69
Total	**334.79**	**196.79**	**268.68**
Power Drawn (KVA)			
"R" Phase	117.88	76.94	101.00
"Y" Phase	115.98	80.03	95.55
"B" Phase	132.87	88.81	111.07
Total	**366.72**	**245.78**	**307.62**
Voltage Harmonics (THD %)			
"R" Phase	2.1	1.3	1.7
"Y" Phase	2.3	1.3	1.8
"Y" Phase	2.0	1.2	1.6
Current Harmonics (THD %)			
"R" Phase	7.9	4.3	6.4
"Y" Phase	7.7	3.8	5.4
"B" Phase	6.4	4.0	5.0
Frequency	50.0	49.5	49.7

4.2.2. Load Profile of Transformer-2 (1250 KVA)

Identification	TR-1 (1250 kVA)		
Voltage (Volts) P-P	Max.	Min.	Avg.
"R" Phase	430.4	413.7	422.9
"Y" Phase	428.6	411.4	420.8
"B" Phase	427.1	409.6	419.3
Voltage (Volts) P-N			
"R" Phase	247.1	237.2	242.7
"Y" Phase	248.4	238.7	244.0
"B" Phase	247.1	236.9	242.5
Current (Amps)			

Identification	TR-1 (1250 kVA)		
"R" Phase	973.1	788.7	923.6
"Y" Phase	960.8	755.1	897.2
"B" Phase	908.3	736.9	868.7
Power Factor			
"R" Phase	0.920	0.901	0.911
"Y" Phase	0.927	0.906	0.917
"B" Phase	0.916	0.891	0.904
Power Drawn (KW)			
"R" Phase	217.82	170.45	204.46
"Y" Phase	213.83	165.58	200.85
"B" Phase	199.52	158.82	190.60
Total	**631.18**	**494.85**	**595.91**
Power Drawn (KVA)			
"R" Phase	238.65	187.05	224.19
"Y" Phase	231.78	180.18	218.92
"B" Phase	221.43	174.54	210.68
Total	**691.86**	**541.76**	**653.79**
Voltage Harmonics (THD %)			
"R" Phase	1.9	1.3	1.6
"Y" Phase	1.7	1.3	1.5
"Y" Phase	1.9	1.3	1.6
Current Harmonics (THD %)			
"R" Phase	6.3	3.7	4.9
"Y" Phase	3.5	1.6	2.8
"B" Phase	3.4	2.0	2.9
Frequency	50.1	49.7	49.9

4.2.3. Load Profile of Transformer-3 (1250 KVA)

Identification	TR-1 (1250 kVA)		
Voltage (Volts) P-P	Max.	Min.	Avg.
"R" Phase	424.1	414.7	418.9
"Y" Phase	428.9	418.8	423.0
"B" Phase	425.4	416.1	420.2
Voltage (Volts) P-N			
"R" Phase	244.5	239.2	241.7
"Y" Phase	246.4	240.7	243.1
"B" Phase	247.1	241.4	243.9
Current (Amps)			
"R" Phase	526.4	303.6	472.4
"Y" Phase	522.1	316.2	472.5
"B" Phase	528.1	312.3	479.3

Identification	TR-1 (1250 kVA)		
Power Factor			
"R" Phase	0.991	0.953	0.968
"Y" Phase	0.980	0.941	0.966
"B" Phase	0.979	0.950	0.966
Power Drawn (KW)			
"R" Phase	122.63	71.79	110.61
"Y" Phase	123.43	73.98	111.10
"B" Phase	125.78	73.84	113.05
Total	**371.84**	**219.60**	**334.76**
Power Drawn (KVA)			
"R" Phase	126.29	73.71	114.18
"Y" Phase	127.79	77.10	114.90
"B" Phase	128.51	76.49	116.92
Total	**382.60**	**227.30**	**346.00**
Voltage Harmonics (THD %)			
"R" Phase	3.8	2.3	2.9
"Y" Phase	4.9	2.5	3.2
"Y" Phase	3.1	1.7	2.7
Current Harmonics (THD %)			
"R" Phase	24.8	11.6	20.1
"Y" Phase	36.1	16.6	22.2
"B" Phase	30.2	17.9	21.7
Frequency	50.1	49.5	49.9

4.3. GRAPHICAL LOAD PROFILE OF TRANSFORMER

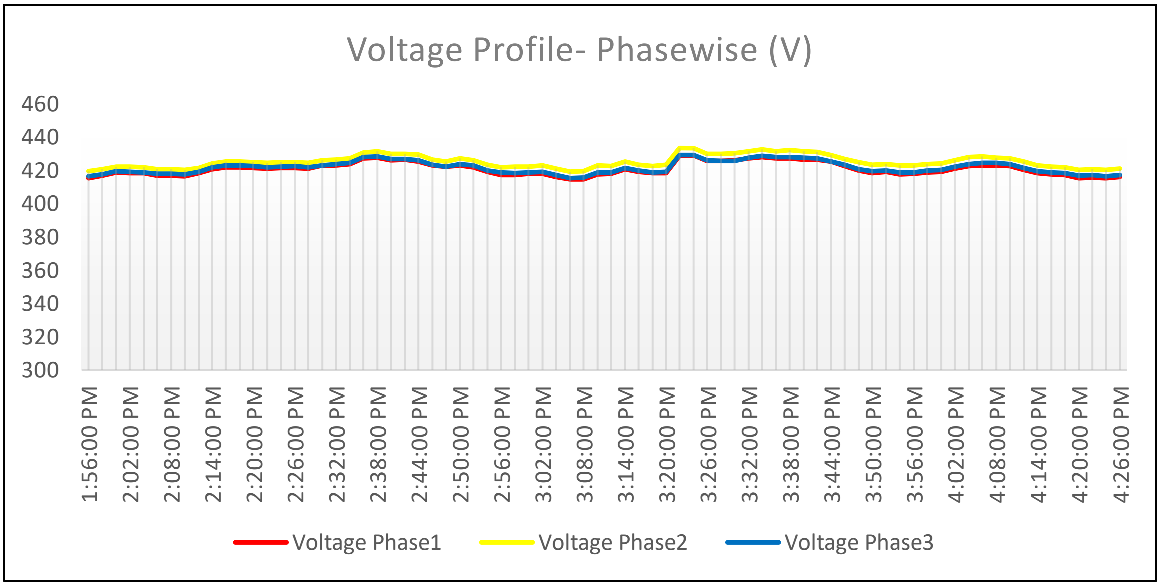
The load profile of the electrical parameters was recorded by using a portable 3-phase power analyzer. During the recording, the power analyzer recorded all the electrical parameters for further detailed analysis. The analysis of the different parameters recorded 24 hours reading at the LT incoming main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

4.3.1. Graphical Load profile of LT Panel Transformer-1

A) Graphical Voltage Profile (Volt)

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

Voltage Profile- Phase wise (V)



The observations taken from the above graphs:

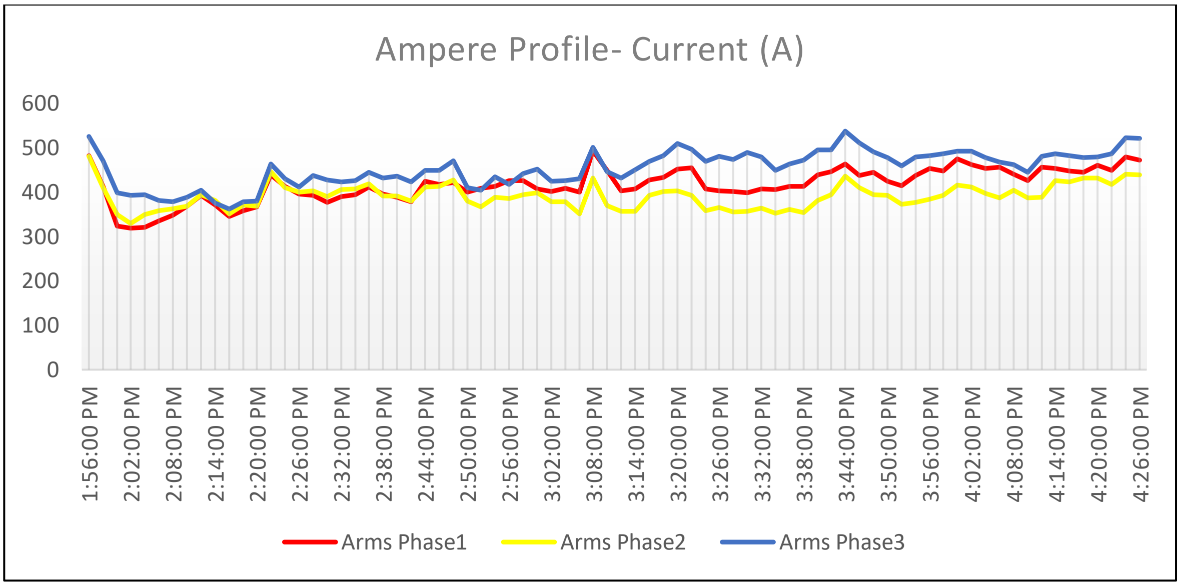
- There was a slight variation in phase-to-phase voltage.
- The average voltage recorded

	Voltage (R) Phase	Voltage(Y) Phase	Voltage(B) Phase
Max.	429.0	433.4	429.2
Min.	414.6	419.2	415.3
Ave.	420.9	425.2	421.8

B) Graphical Current Profile (Amp)

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

Current Profile- Phase wise of the main Supply for 24 hours



The observations taken from the above graphs:

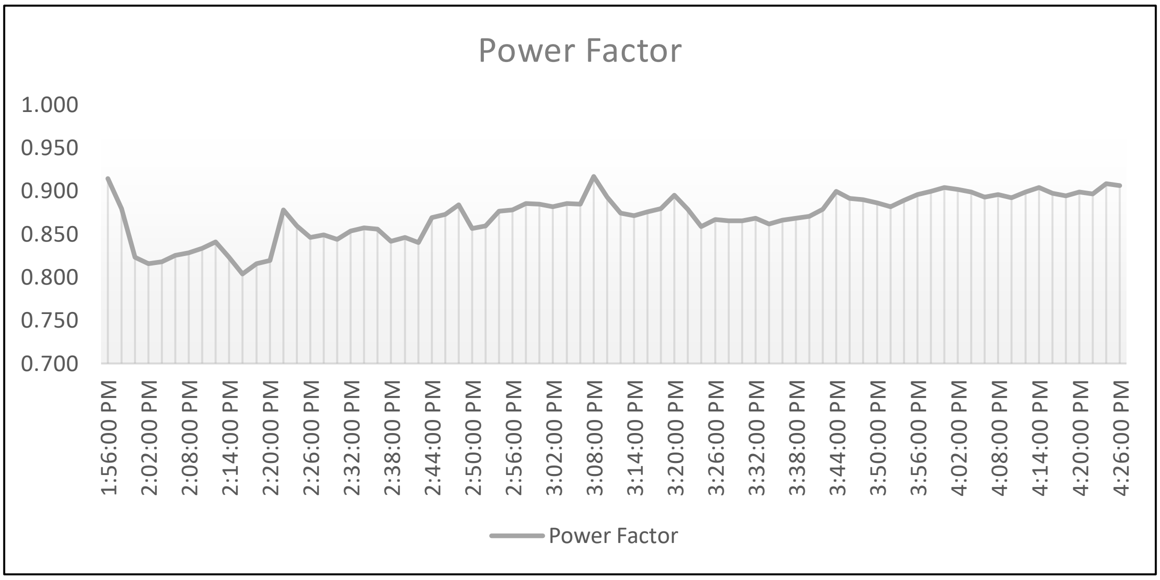
There is a considerable current variation in the different phases and hence the phase-to-phase load is not balanced. The Current variation during the 24 hours of measurement period

	Amp. Phase (R)	Amp. Phase (Y)	Amp. Phase (B)
Max.	493.3	480.9	537.7
Min.	318.9	329.4	362.0
Ave.	416.2	390.8	453.4

C) Graphical Power Factor Profile

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

Power factor profile for the main Incomer



The observations taken from the above graphs:

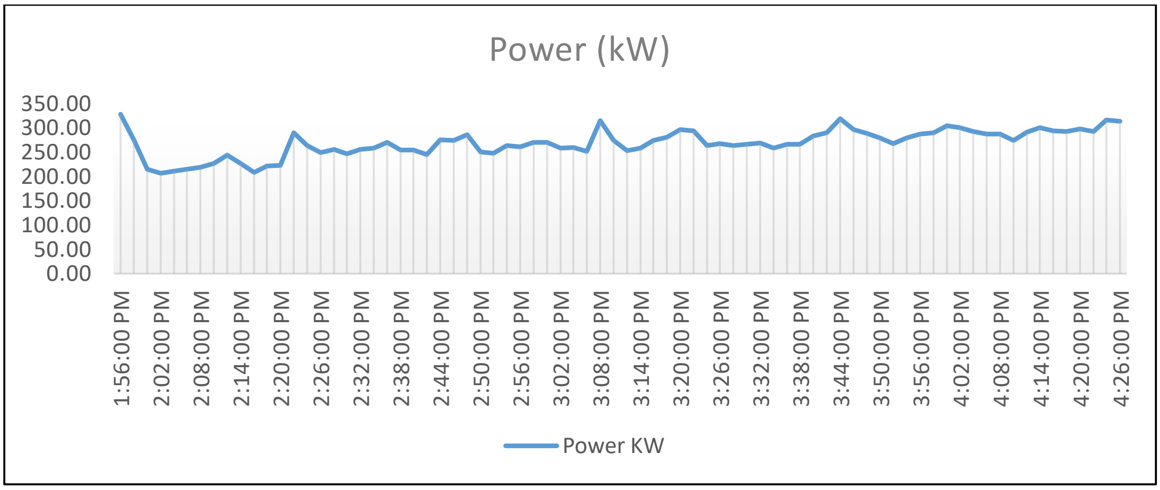
- The Power factor varied from 0.798 to 0.917 during the load hours of measurement period and average 0.871.

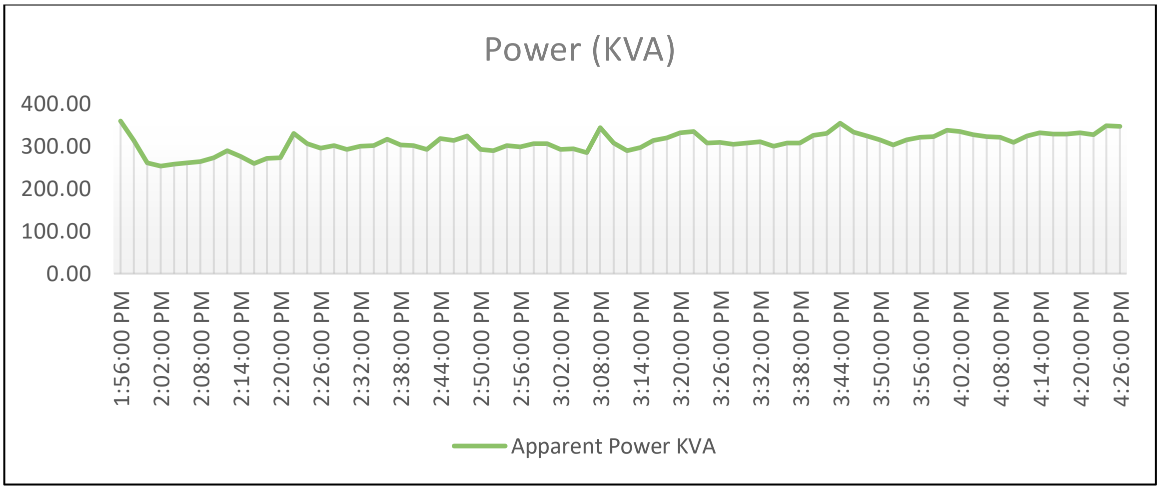
D) Graphical Load Profile (KW & KVA)

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 premises:

Load Profile Real power (kW & kVA) profile of 24 Hr. main incomer





The observations taken from the graph:

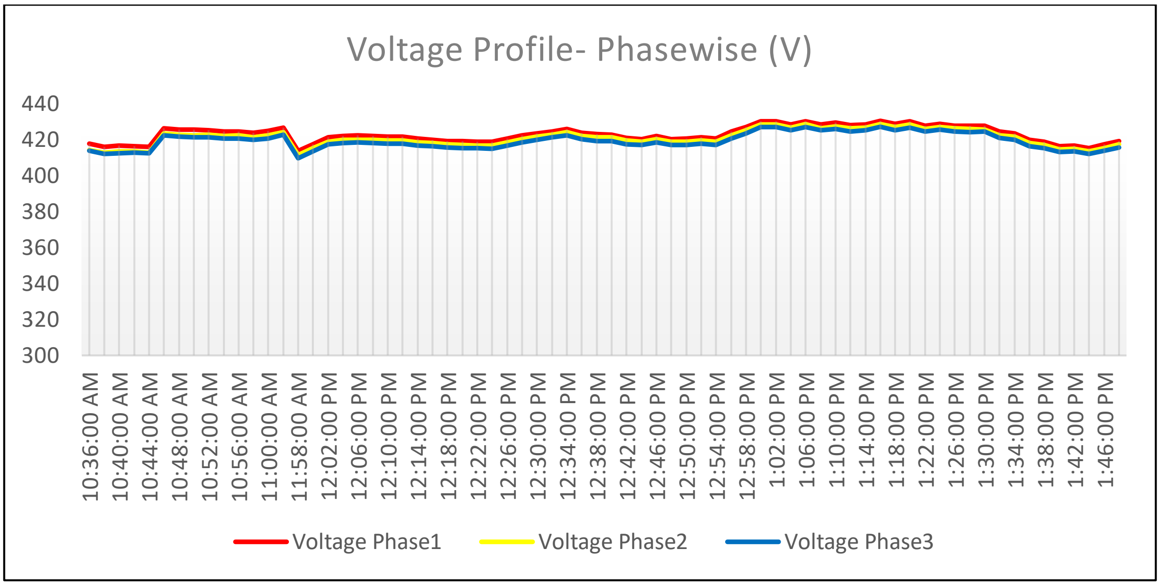
- The load (kW) variation ranges from 196.79 kW to 334.79 kW during the load hours of measurement period and Average 268.68 kW.
- The apparent power (kVA) varies from 245.78 kVA to 366.72 kVA during the Load hours of measurement period and Average 307.62 kVA.
- The maximum loading on the transformer during the load hours of measurement period was 29.34% and the average loading on the transformer was 24.61%. To achieve the best efficiency point of any transformer, the loading value should be around 50 percent.

4.3.2. Graphical Load profile of LT Panel Transformer-2

E) Graphical Voltage Profile (Volt)

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

Voltage Profile- Phase wise (V)



The observations taken from the above graphs:

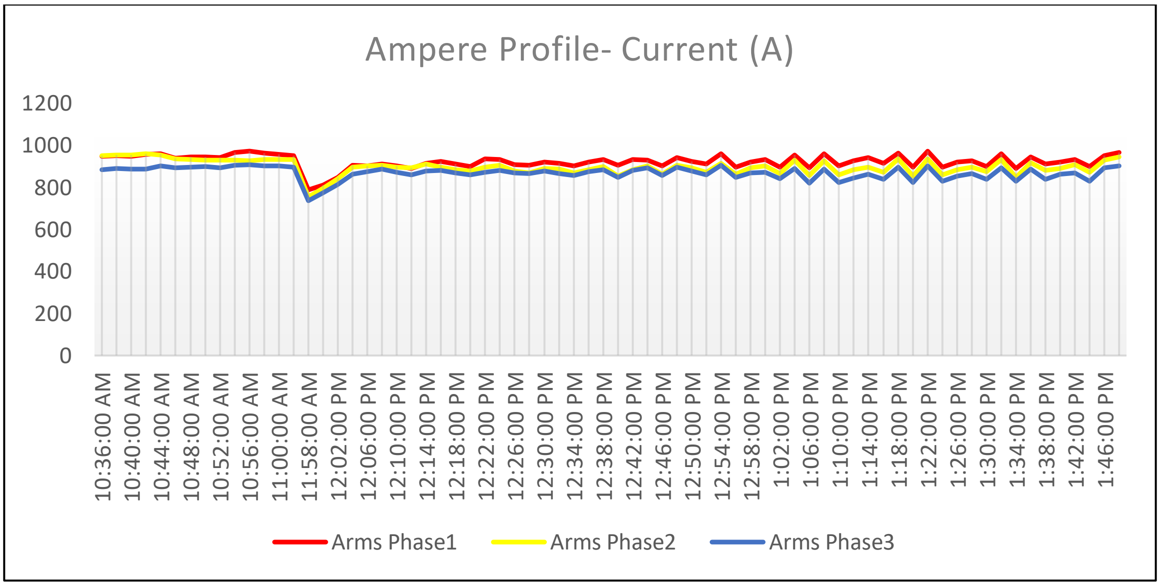
- There was a slight variation in phase-to-phase voltage.
- The average voltage recorded

	Voltage (R) Phase	Voltage(Y) Phase	Voltage(B) Phase
Max.	430.4	428.6	427.1
Min.	413.7	411.4	409.6
Ave.	422.9	420.8	419.3

F) Graphical Current Profile (Amp)

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

Current Profile- Phase wise of the main Supply for 24 hours



The observations taken from the above graphs:

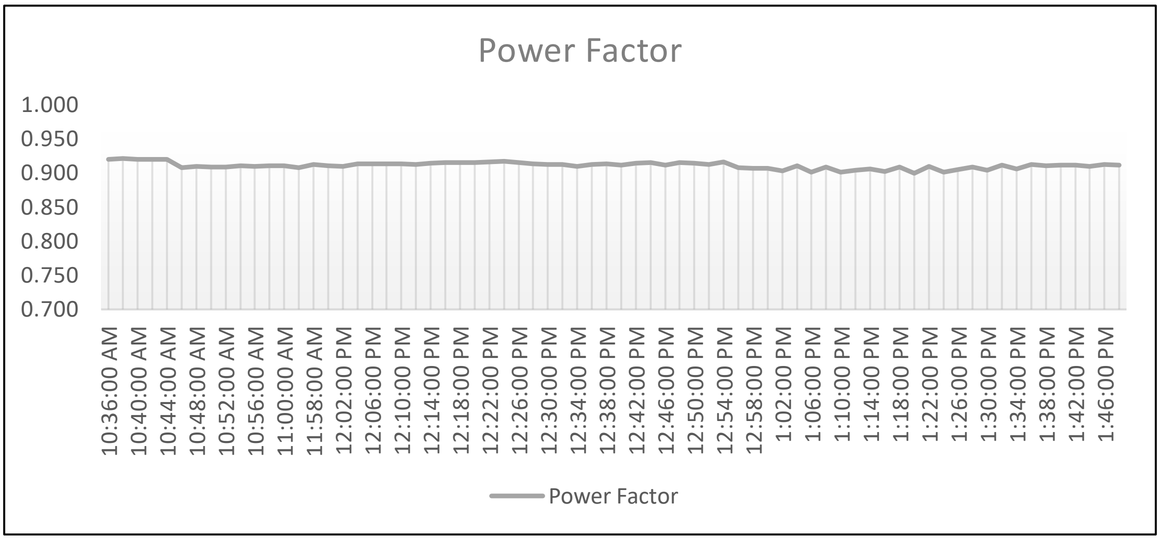
There is a considerable current variation in the different phases and hence the phase-to-phase load is not balanced. The Current variation during the 24 hours of measurement period

	Amp. Phase (R)	Amp. Phase (Y)	Amp. Phase (B)
Max.	973.1	960.8	908.3
Min.	788.7	755.1	736.9
Ave.	923.6	897.2	868.7

G) Graphical Power Factor Profile

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

Power factor profile for the main Incomer



The observations taken from the above graphs:

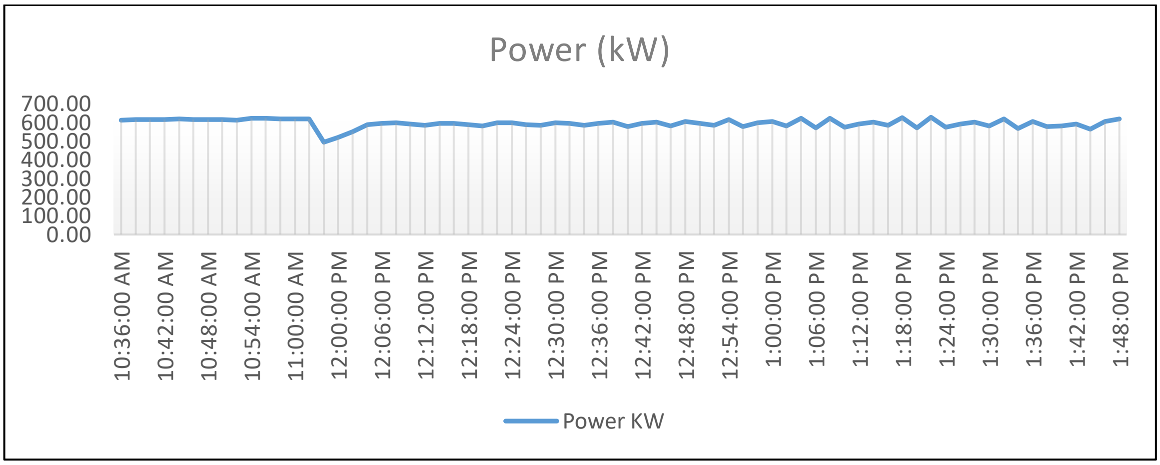
- The Power factor varied from 0.899 to 0.921 during the load hours of measurement period and average 0.911.

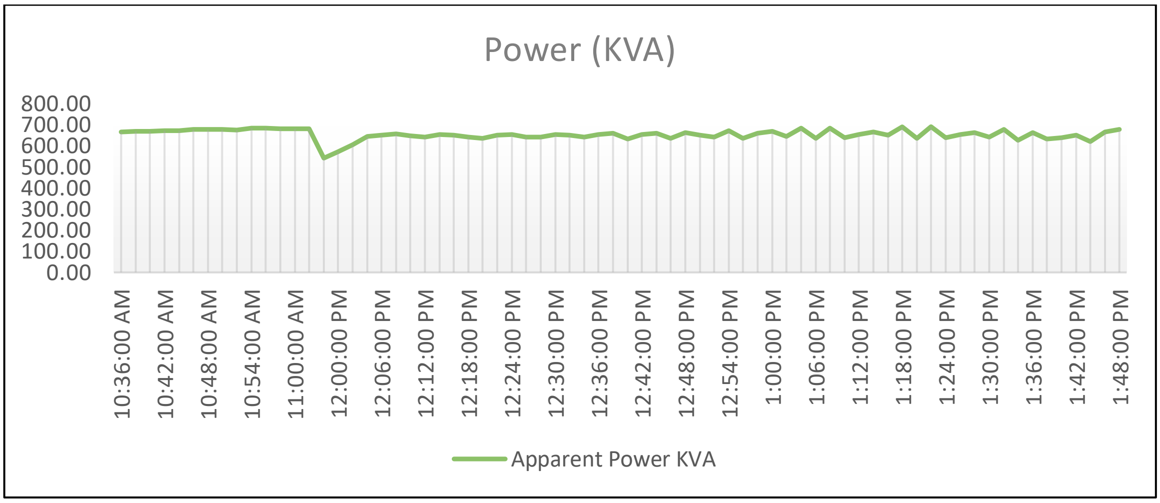
H) Graphical Load Profile (KW & KVA)

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 premises:

Load Profile Real power (kW & kVA) profile of 24 Hr. main incomer





The observations taken from the graph:

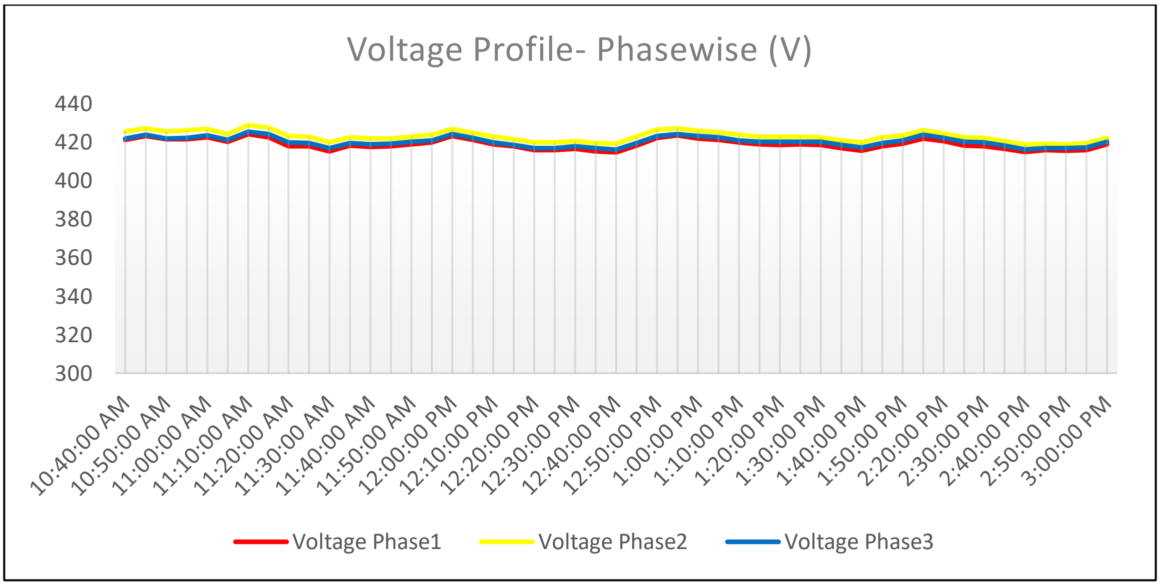
- The load (kW) variation ranges from 494.85 kW to 631.18 kW during the load hours of measurement period and Average 595.91 kW.
- The apparent power (kVA) varies from 541.76 kVA to 691.86 kVA during the Load hours of measurement period and Average 653.79 kVA.
- The maximum loading on the transformer during the load hours of measurement period was 55.35% and the average loading on the transformer was 52.30%. To achieve the best efficiency point of any transformer, the loading value should be around 50 percent.

4.3.3. Graphical Load profile of LT Panel Transformer-3

I) Graphical Voltage Profile (Volt)

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

Voltage Profile- Phase wise (V)



The observations taken from the above graphs:

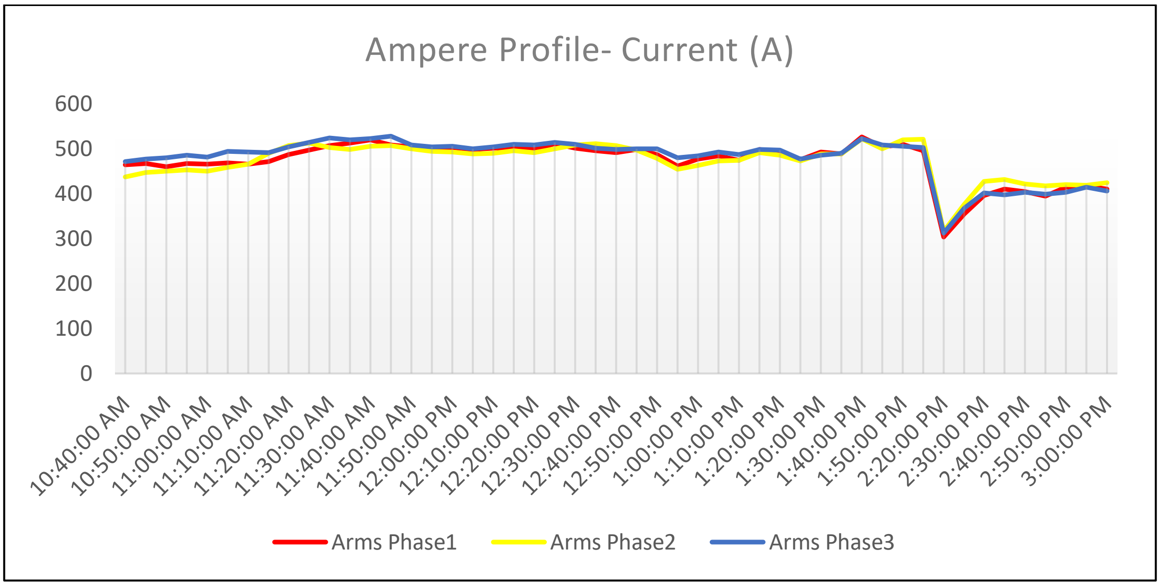
- There was a slight variation in phase-to-phase voltage.
- The average voltage recorded

	Voltage (R) Phase	Voltage(Y) Phase	Voltage(B) Phase
Max.	424.1	428.9	425.4
Min.	414.7	418.8	416.1
Ave.	418.9	423.0	420.2

J) Graphical Current Profile (Amp)

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

Current Profile- Phase wise of the main Supply for 24 hours



The observations taken from the above graphs:

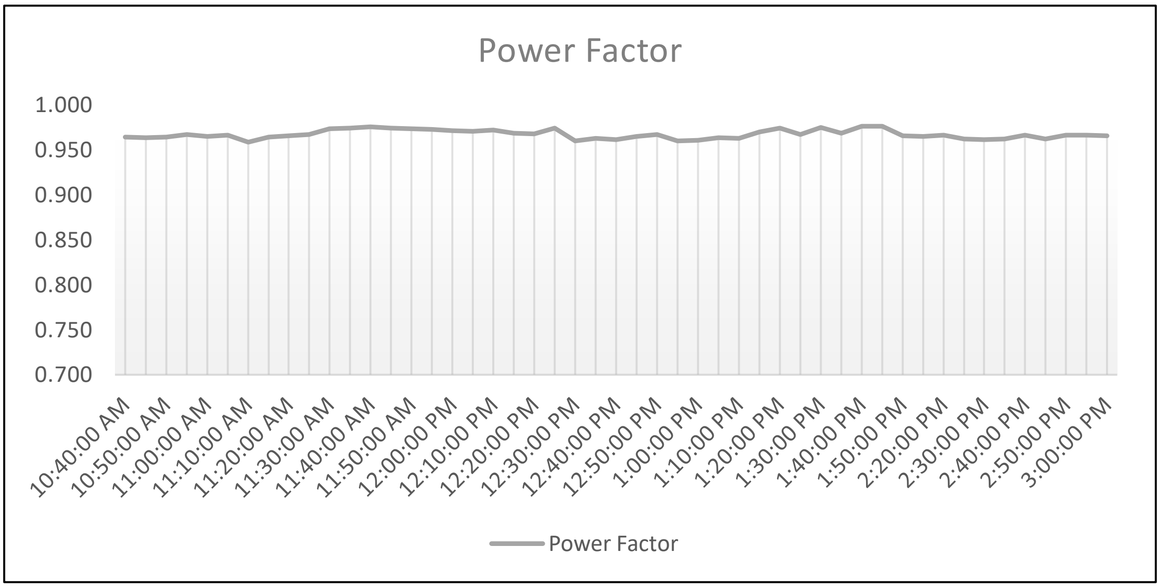
There is a considerable current variation in the different phases and hence the phase-to-phase load is not balanced. The Current variation during the 24 hours of measurement period

	Amp. Phase (R)	Amp. Phase (Y)	Amp. Phase (B)
Max.	526.4	522.1	528.1
Min.	303.6	316.2	312.3
Ave.	472.4	472.5	479.3

K) Graphical Power Factor Profile

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

Power factor profile for the main Incomer



The observations taken from the above graphs:

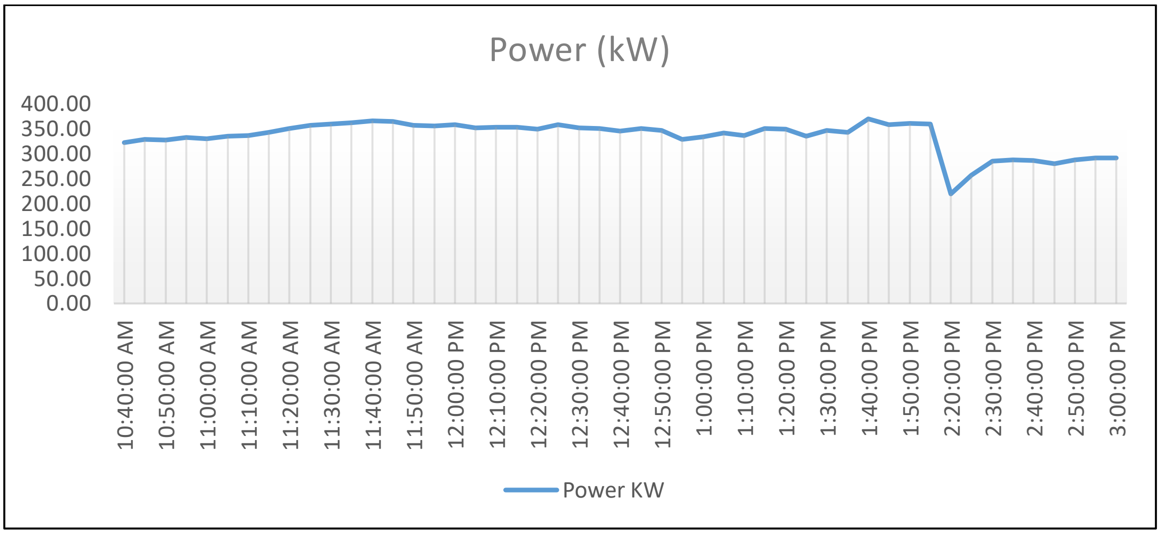
- The Power factor varied from 0.948 to 0.983 during the load hours of measurement period and average 0.967.

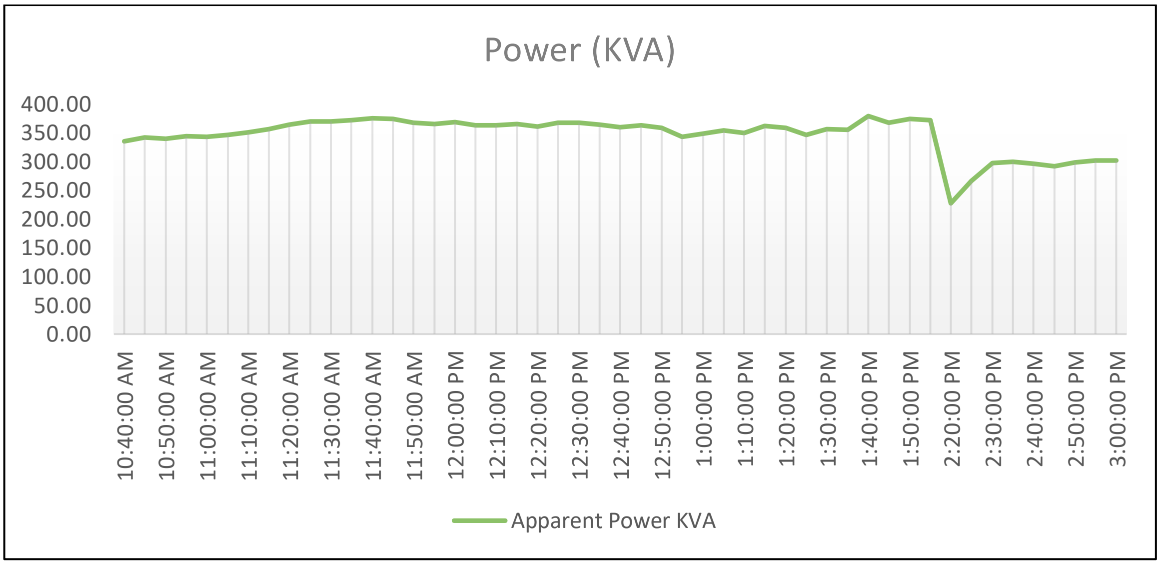
L) Graphical Load Profile (KW & KVA)

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 premises:

Load Profile Real power (kW & kVA) profile of 24 Hr. main incomer





The observations taken from the graph:

- The load (kW) variation ranges from 219.60 kW to 371.84 kW during the load hours of measurement period and Average 334.76 kW.
- The apparent power (kVA) varies from 227.30 kVA to 382.60 kVA during the Load hours of measurement period and Average 346.00 kVA.
- The maximum loading on the transformer during the load hours of measurement period was 30.61% and the average loading on the transformer was 27.68%. To achieve the best efficiency point of any transformer, the loading value should be around 50 percent.

4.4. Efficiency of Transformer

The % loading & efficiency calculation is done on the both transformers which are on load at the time of audit. Transformer normally operate in the best efficiency range when loading percentage is around 50-70%. These transformers are running under loaded. The Running efficiency of Transformers-1, 2 & 3 are 97.27%, 98.72% & 97.57.

Performance Analysis of Transformer		TR-1 Main Incomer	TR-2 Main Incomer	TR-3 Main Incomer
Sr. No.	Rated Specifications			
1	Date	19/04/2022	19/04/2022	20/04/2022
2	Transformer Rating in KVA	1250	1250	1250
3	Avg. Load in KVA	307.6	653.8	346.0
4	Present % Loading	24.6	52.3	27.7
5	Total Losses of Transformer(kW)	8.4	8.4	8.4
6	Operating Power Factor	0.873	0.911	0.968
7	Total Loss (KVA)	9.62	9.22	8.68
8	Transformer Efficiency, %	97.27	98.72	97.57
9	Avg. Load in KW	268.68	595.91	334.76
10	Max Load in KW	334.79	631.18	371.84
11	Min. Load in KW	196.79	494.85	219.60

Remarks: Transformer normally operate in the best efficiency range when the loading percentage is around 50-70% of the rated capacity.

4.5. Switch of Transformer 1250 KVA

There are three nos. transformers of 1250 KVA capacities each installed at Sub-station. Only two transformer (1250 KVA X 2 Nos.) is sufficient for university load, so we suggest 1250 transformer should be switch off primary (H.T. side) in winter season to save load loss. Hence it is recommended that one 1250 KVA transformer should be isolated from 11 kV side to avoid load losses.

Load Measurements transformer show in below table.

Identification	TR-1	TR-2	TR-3	Total Load
Power Drawn (KW)	**Max**	**Max**	**Max**	
"R" Phase	108.29	217.82	122.63	448.74
"Y" Phase	107.03	213.83	123.43	444.29
"B" Phase	119.47	199.52	125.78	444.77
Total	**334.79**	**631.18**	**371.84**	1337.81
Power Drawn (KVA)				
"R" Phase	117.88	238.65	126.29	482.82
"Y" Phase	115.98	231.78	127.79	475.55
"B" Phase	132.87	221.43	128.51	482.81
Total	**366.72**	**691.86**	**382.6**	1441.18

During the winter season HVAC plant & split & window AC not in operation so load is decrease. We suggest 1250 transformer should be switch off primary (H.T. side) in winter season to save load losses.

Assumptions and Input parameters		
Cost parameters	**Unit**	**Value**
Transformer of 1500 kVA is kept in completely off Position at all time.	Number	1
load losses of 1500 kVA Transformer	kW	3.22
Operating parameters	**Unit**	**Value**
Number of idling hours	Per day	24
Number of operating days	Per year	180
Average electricity tariff	INR/kVAh	8
Energy and financial savings	**Unit**	**Value**
Annual Energy Saving	kWh/year	13910
Annual monetary saving	INR/year	111283
Total investment requirement	INR	Nil
Simple payback period	Months	Immediate

4.6. OTHER FEEDER LOADS

Particulars	Apartment-A (Boys Hostel)	Solar Load	Tower Hostel	Apartment-B	Solar Load	Apartment-C	Solar Load	Apartment-D	MDB-1 Kitchen	T-5	Facility House	E-2 Building	Gate Way-A & B	Gate way-B	Library	Workshop	Solar Panel
Voltage (Volts)																	
"R" Phase	413.2	415.4	407	420.7	421.6	431.6	420.1	412	409	425	421.5	421.2	421	416	399	399	401
"Y" Phase	415.4	416.4	402	421.6	422	430	418.1	414	408	424	420.1	422	424	416	403	403	407
"B" Phase	413.2	421.1	412	423.7	421	428	419.5	412	412	423	421.5	421.1	421	415	407	407	412
Voltage (Volts)																	
"R" Phase	238.6	239.8	235.0	242.9	243.4	249.2	242.6	237.9	236.1	245.4	243.4	243.2	243.1	240.2	230.4	230.4	231.5
"Y" Phase	239.8	240.4	232.1	243.4	243.6	248.3	241.4	239.0	235.6	244.8	242.6	243.6	244.8	240.2	232.7	232.7	235.0
"B" Phase	238.6	243.1	237.9	244.6	243.1	247.1	242.2	237.9	237.9	244.2	243.4	243.1	243.1	239.6	235.0	235.0	237.9
Current (Amps)																	
"R" Phase	10.0	22.4	232	23.11	19	18.7	18.1	35.0	89	108.6	2.1	280	270	45	217	15	77
"Y" Phase	12.0	23	237	27.8	12.6	9.6	20.2	42.0	72	56	38.2	361.2	186	54	218	22	78
"B" Phase	8.6	24	218	26.4	22.4	12.4	17.4	56.0	104	48	9.8	368.1	165	43	188.5	17	81
Power Factor																	
"R" Phase	0.78	0.98	0.77	0.628	0.89	0.724	0.86	0.84	0.858	0.851	0.78	0.927	0.832	0.92	0.85	0.85	0.97
"Y" Phase	0.8	0.97	0.82	0.712	0.9	0.842	0.84	0.81	0.854	0.864	0.821	0.947	0.845	0.93	0.84	0.84	0.96
"B" Phase	0.81	0.96	0.81	0.742	0.92	0.745	0.84	0.83	0.845	0.847	0.81	0.928	0.835	0.93	0.83	0.83	0.97
Power Drawn (KW)																	
"R" Phase	1.86	5.26	41.98	3.53	4.12	3.37	3.78	6.99	18.03	22.68	0.40	63.12	54.60	9.94	42.49	2.94	17.29
"Y" Phase	2.30	5.36	45.11	4.82	2.76	2.01	4.10	8.13	14.48	11.84	7.61	83.34	38.48	12.06	42.61	4.30	17.60

Particulars	Apartment-A (Boys Hostel)	Solar Load	Tower Hostel	Apartment-B	Solar Load	Apartment-C	Solar Load	Apartment-D	MDB-1 Kitchen	T-5	Facility House	E-2 Building	Gate Way-A & B	Gate way-B	Library	Workshop	Solar Panel
"B" Phase	1.66	5.60	42.00	4.79	5.01	2.28	3.54	11.06	20.90	9.93	1.93	83.05	33.49	9.58	36.77	3.32	18.69
Total	**5.83**	**16.23**	**129.09**	**13.14**	**11.89**	**7.66**	**11.41**	**26.18**	**53.42**	**44.45**	**9.94**	**229.52**	**126.57**	**31.59**	**121.86**	**10.55**	**53.58**
Power Drawn (KVA)																	
"R" Phase	2.39	5.37	54.52	5.61	4.62	4.66	4.39	8.33	21.02	26.65	0.51	68.09	65.63	10.81	49.99	3.46	17.83
"Y" Phase	2.88	5.53	55.01	6.77	3.07	2.38	4.88	10.04	16.96	13.71	9.27	88.01	45.53	12.97	50.72	5.12	18.33
"B" Phase	2.05	5.84	51.86	6.46	5.44	3.06	4.21	13.32	24.74	11.72	2.38	89.50	40.11	10.30	44.30	3.99	19.27
Total	**7.32**	**16.74**	**161.38**	**18.84**	**13.14**	**10.11**	**13.48**	**31.69**	**62.72**	**52.08**	**12.16**	**245.59**	**151.27**	**34.08**	**145.01**	**12.57**	**55.42**

CHAPTER-5 REACTIVE POWER COMPENSATION

5.1. Capacitor Bank Installed

The plant is being billed on KVAh basis; therefore, the effect of power factor is inbuilt in the billing structure. In plant different rating LT capacitor banks are installed. The actual KVAr delivery of individual Capacitor banks were measured during the Energy Audit. Results are given in the table.

5.2. Capacitor Bank

The plant is being billed on kVAh basis; therefore, the effect of power factor is inbuilt in the billing structure. In plant three APFC panels (425 kVAr, 375 kVAr & 425 kVAr) capacitor bank panels are installed on main incomer. Details of capacitor measurement are given in the below table.

TR-2 (APFC-425kVAr)							
Sr. No.	Capacity (kVAr)	Rated (amp)	Measured			Remark	% Loading
			Measured-R	Measured-Y	Measured-B		
CB-1	25	32.8	0.0	0.0	0.0	De-rated	0.0
CB-2	25	32.8	0.0	0.0	0.0	OK	0.0
CB-3	50	65.5	1.8	32.4	31.5	De-rated	33.4
CB-4	50	65.5	1.8	0.0	0.4	De-rated	1.1
CB-5	50	65.5	50.0	52.0	54.0	OK	79.4
CB-6	25	32.8	17.6	12.5	1.0	De-rated	31.7
CB-7	25	32.8	24.0	22.0	21.0	OK	68.2
CB-8	25	32.8	25.2	25.1	25.5	OK	77.2
CB-9	25	32.8	0.0	0.0	0.0	De-rated	0.0
CB-10	50	65.5	2.1	2.3	2.3	De-rated	3.4
CB-11	50	65.5	2.1	2.2	1.7	De-rated	3.1
CB-12	25	32.8	3.1	3.2	3.4	De-rated	9.9
Total	**425**						

TR-3 (APFC-375 kVAr)							
Sr. No.	Capacity (kVAr)	Rated (amp)	Measured			Remark	% Loading
			Measured-R	Measured-Y	Measured-B		
CB-1	100	131.0	117.0	110.0	112.0	OK	86.3
CB-2	100	131.0	103.0	108.0	112.0	OK	82.2
CB-3	25	32.8	26.0	0.0	0.0	De-rated	26.5
CB-4	25	32.8	27.0	26.0	28.0	OK	82.4
CB-5	25	32.8	0.5	0.6	0.7	De-rated	1.8
CB-6	50	65.5	25.5	24.3	1.3	De-rated	26.0

TR-3 (APFC-375 kVAr)							
Sr. No.	Capacity (kVAr)	Rated (amp)	Measured			Remark	% Loading
			Measured-R	Measured-Y	Measured-B		
CB-7	50	65.5	27.1	26.4	25.3	De-rated	40.1
Total	375						

TR-1 (APFC-425kVAr)							
Sr. No.	Capacity (kVAr)	Rated (amp)	Measured			Remark	% Loading
			Measured-R	Measured-Y	Measured-B		
CB-1	25	32.8	-	-	-	Not In Operation	-
CB-2	25	32.8	-	-	-		-
CB-3	50	65.5	-	-	-		-
CB-4	50	65.5	-	-	-		-
CB-5	50	65.5	-	-	-		-
CB-6	25	32.8	-	-	-		-
CB-7	25	32.8	-	-	-		-
CB-8	25	32.8	-	-	-		-
CB-9	25	32.8	-	-	-		-
CB-10	50	65.5	-	-	-		-
CB-11	50	65.5	-	-	-		-
CB-12	25	32.8	-	-	-		-
Total	425						

5.3. RECOMMENDATIONS

5.3.1. Improvement in the Operating Power Factor

The plant is being billed on KVAh basis; therefore, the effect of power factor is inbuilt in the billing structure. In plant LT capacitor banks are installed. The minimum, maximum and average PF (Apr 2021 to Mar 2022) as per electricity bill are as follows

Description	Avg. Power Factor
Min. PF	0.971
Max. PF	1.000
Average PF	0.990

There are three capacitor bank panel is installed in the building at LT Side. The building is being billed on KVAh basis; therefore, the effect of power factor is inbuilt in the billing structure. Based on the electrical bills (11 KV) for Apr 2021 to Mar 2022, the operating power factor on the main incomer varied from 0.971 to 1.000. However, if we look at the overall average power factor is around 0.990, which is satisfactory. In the billing last month

March 2022 power factor is 0.971, which is slightly lower side. The effect of power factor is inbuilt in the billing structure so to be improves power factor is 0.999

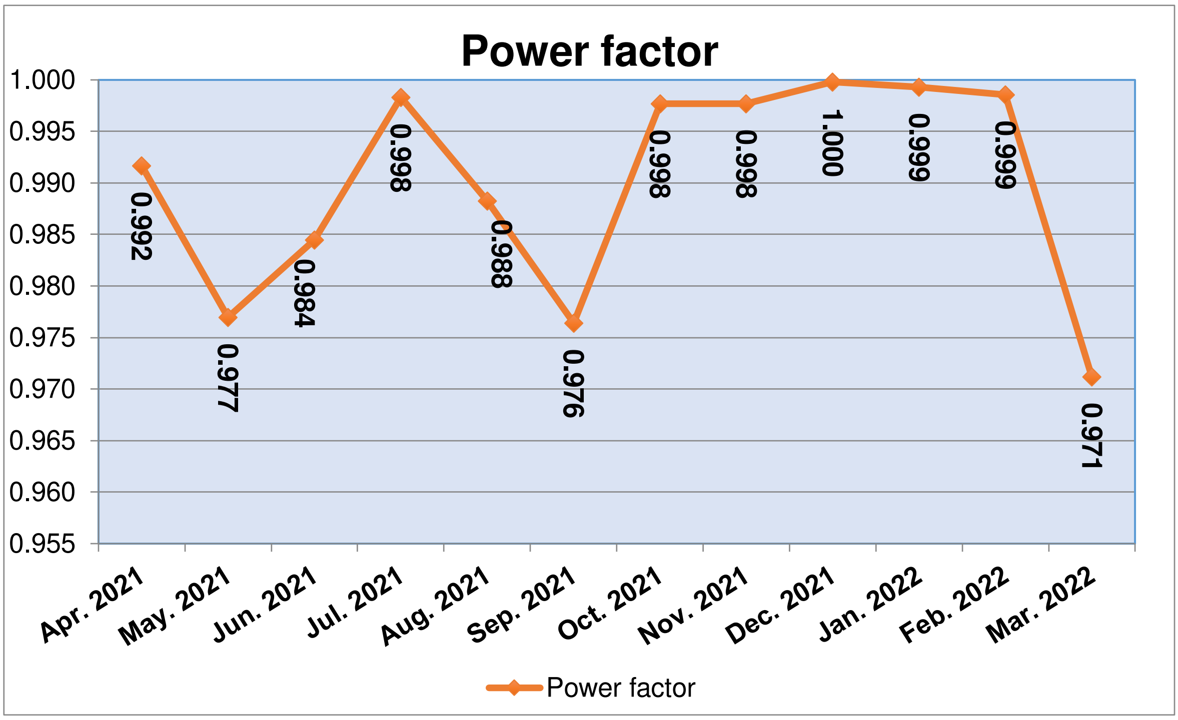
It is thus recommended to the capacitor banks wherein the delivery is poor (less than 70%) or out of order may be replaced, so that the overall system power factor is maintained at around 0.99 (lag). Improvement in the power factor would subsequently reduce the KVAh consumption, Since the plant management is maintaining Power factor 0.99, so no specific recommendation has been made on PF improvement.

Particulars	Value
Power Factor (Mar. 2022)	**0.971**
Average Power Consumption at Present	230640.0 KWh
Average Power Consumption at Present	237480.0 KVAh
Average Operating Power factor at present	0.971
Average Power Consumption post improvement of power factor from 0.971 to 0.999	230871 KVAh
Net Reduction in Power Consumption per month	6609 KVAh
Total Monitory Benefit per annum	Rs. 52872 Lakhs
Estimated Investments [for replacement of dead Capacitor]	Rs 1.0 Lakhs
Simple Payback Period	2-3 months

Implementation of this measure needs an investment of INR 1.0 Lakhs and will have a simple payback period of 2-3 months.

5.3.2. Actual P.F from Electricity bill

Month	Power Factor
Apr. 2021	0.992
May. 2021	0.977
Jun. 2021	0.984
Jul. 2021	0.998
Aug. 2021	0.988
Sep. 2021	0.976
Oct. 2021	0.998
Nov. 2021	0.998
Dec. 2021	1.000
Jan. 2022	0.999
Feb. 2022	0.999
Mar. 2022	0.971
Avg.	**0.990**



5.3.3. Advantages of Power Factor Improvement

- Reactive components of the network are reduced and so also the total current in the system from the source end.
- I2R power losses are reduced in the system because of reduction in current.
- Voltage level at the load end is increased.
- kVA loading on the source generators as also on the transformers and line up to the capacitors reduce giving capacity relief. A high-power factor can help in utilities the full capacity of the electrical system.

5.3.4. Cost benefits of Power Factor Improvement

- Reduced kVA (Maximum Demand) charges in electricity bill
- Reduced distribution losses (kWh) within the plant network
- Better voltage at motor terminals and improved performance of motors
- A high-power factor eliminates penalty charges imposed when operating with low power factor

CHAPTER-6 POWER QUALITY

6.1. Power Quality & Harmonics

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

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

The Harmonics Level on the LT side of the Transformers was measured, details of which is as under: -

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

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

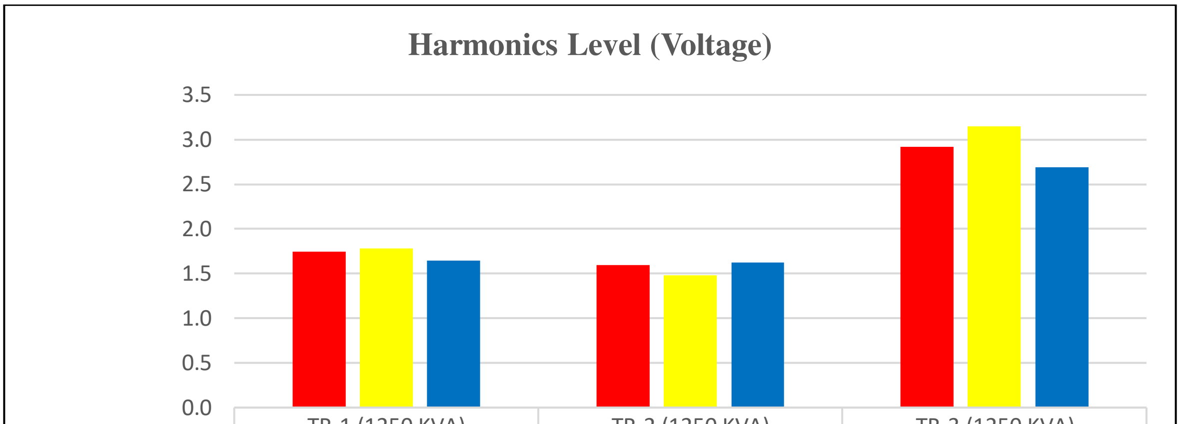
harmonic current limitations

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

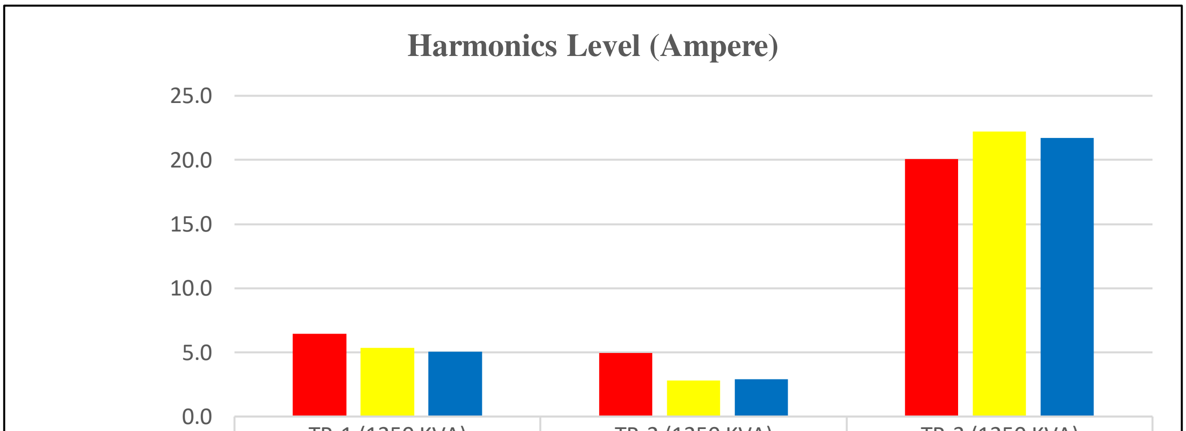
ISC/IL	h<11	11<h<17	17<h<23	23<h<35	35<h	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

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

Particulars	Transformer-1 (1250 KVA)	Transformer-2 (1250 KVA)	Transformer-3 (1250 KVA)
	Overall (Average)	Overall (Average)	Overall (Average)
Voltage Harmonics (V THD)			
"R" Phase	1.7	1.6	2.9
"Y" Phase	1.8	1.5	3.2
"B" Phase	1.6	1.6	2.7
Current Harmonics (A THD)			
"R" Phase	6.4	4.9	20.1
"Y" Phase	5.4	2.8	22.2
"B" Phase	5.0	2.9	21.7



	TR-1 (1250 KVA)	TR-2 (1250 KVA)	TR-3 (1250 KVA)
THD Phase1 (V)	1.7	1.6	2.9
THD Phase2 (V)	1.8	1.5	3.2
THD Phase3 (V)	1.6	1.6	2.7



	TR-1 (1250 KVA)	TR-2 (1250 KVA)	TR-3 (1250 KVA)
THD Phase1 (A)	6.4	4.9	20.1
THD Phase2 (A)	5.4	2.8	22.2
THD Phase3 (A)	5.0	2.9	21.7

As detailed above, the average voltage harmonics levels were around below 4%, which is under limit. The current harmonics levels were around below 7% for Transformer-1&2, which is under limit and current harmonics levels were around above 20% for Transformer-3, which is higher side. **The Overall Voltage harmonics for Transformer are within limit and current harmonics for Transformer-1 &2 are within limit.**

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

Different technologies are available mitigating the harmonics from the system. These include:

Detuned or broadband harmonic filters: these filter banks are tuned to a frequency just below the predominant harmonic frequency. If the predominant harmonic frequency is said, 5th, it is normal practice to tune the filters to 189 Hz, or 3.78th harmonic, in 50 Hz systems.
Active Harmonic Filters: these units are designed in such manner that, they will inject harmonic frequencies in the system, which will be in anti-phase of the load harmonic frequencies. This will effectively free the source being loaded due to harmonics.

6.2. OBSERVATIONS & SUGGESTIONS:

It is clear from the above data that the voltage & Current harmonics are within limit.

6.3. MAJOR CAUSES OF HARMONICS

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

Electronic Switching Power Converters

- Computers, Uninterruptible power supplies (UPS), Solid-state rectifiers
- Electronic process control equipment, PLC's, etc
- Electronic lighting ballasts, including light dimmer
- Reduced voltage motor controllers

Arcing Devices

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

Appliances

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

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

Percentage of the load in industrial power systems.

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

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

CHAPTER-7 CHILLER

7.1. RATED SPECIFICATIONS OF COOLING TOWERS & PUMPS

7.1.1. Central AC Plant

In BML College there are three Central AC Plant 280 TRX2Nos & 80TRX1Nos. Capacity (Screw Type) air cooled chiller installed in plant. Chiller no-1 & 2 (280TR) is in operation & chiller 3 (80TR) is standby. At the time of audit, we have measured the chilled water flow, primary & secondary water flow, & temperature drop across the chiller. The Plant has installed the VFD in secondary Pumps. Specifications of chiller are as follows:

Sr. No.	Particulars	Chiller-1	Chiller-2	Chiller-3
Rated Specification		Non Drive	Non Drive	Non Drive
1	Make	Climaveneta	Climaveneta	Voltas
2	Rated TR	280	280	80
3	Gross Cooling Input Power (KW)	416	416	136
4	Refrigerant	R134a	R134a	R134a
5	Voltage	415	415	415
6	Cooling Type	Air Cooled	Air Cooled	Air Cooled
7	Remark	Running	Running	Standby

7.1.2. Chiller water pumps

There are three chiller water pumps are installed for chiller 280TRX2Nos. & two chiller water pumps are installed for chiller 80TRX1 Nos. Two chiller water pumps are running for 280TRX2 Nos chiller and other is standby. Flow, power & pressure measurement of running pumps has been done. The rated details of pumps are:

Particulars	Primary Pump-1	Primary Pump-2	Primary Pump-3	Primary Pump-1	Primary Pump-2
Motor	280TR			80TR	
Make	Crompton Greeves	Crompton Greeves	Crompton Greeves	Groundfos	Groundfos
Rating (KW)	9.3	9.3	9.3	2.2	2.2
Voltage (V)	415	415	415	380-415	380-415
Amp (A)	17.5	17.5	17.5	4.9	4.9
RPM	1460	1460	1460	1450	1450
Eff %	87	87	87	86.7	86.7
P.F	-	-	-	0.79	0.79

Particulars	Primary Pump-1	Primary Pump-2	Primary Pump-3	Primary Pump-1	Primary Pump-2
Pump					
Make					
Flow (M3/hr.)				43.9	43.9
Head (m)					
Design Eff%				77.6	77.6

7.1.3. Secondary Water Pumps

There are Nine secondary water pumps are installed in BML. Seven secondary water pumps are installed for 280TRX2nos chiller & two Secondary water pumps are installed for 80TR chiller. Secondary pumps of 280TR chiller are in operation Flow, power & pressure measurement of running pumps has been done. The rated details of pumps are:

Particulars	Secondary Pump-1	Secondary Pump-2	Secondary Pump-3	Secondary Pump-4	Secondary Pump-5
Motor	280TR				
Make	CG	CG	CG	CG	CG
Rating (KW)	11	11	15	15	15
Voltage (V)	415	415	415	415	415
Amp (A)	21	21	27	27	27
RPM	1460	1460	1460	1460	1460
Eff %	89	89	90	90	90
P.F	-	-	-	-	-
Pump					
Make	Armstrong	Armstrong	Armstrong	Armstrong	Armstrong
Flow (M3/hr.)	87.012	87.012	108	108	108
Head (m)	25	25	25	25	25
Design Eff%					

Particulars	Secondary Pump-6	Secondary Pump-7	Secondary Pump-8	Secondary Pump-9
Motor	280TR		80TR	
Make	CG	CG	Groundfos	Groundfos
Rating (KW)	5.5	5.5	7.5	7.5
Voltage (V)	415	415	380-415	380-415
Amp (A)	11	11	14.4	14.4
RPM	1445	1445	2910	2910
Eff %	85.7	85.7	90.1	90.1
P.F	-	-	0.88	0.88
Pump				
Make	Armstrong	Armstrong	Groundfos	Groundfos
Flow (M3/hr.)	47.988	47.988	43.9	43.9
Head (m)	25	25	36	36
Design Eff%			75.9	75.9

7.2. PERFORMANCE EVALUATION: CHILLER & PUMPS

7.2.1. TR Calculation

During the audit we have measured the, power, and inlet /outlet chilled water temperature flow have been measured to calculate the SPC of Chillers.

The performance of chiller-1 & 2 is calculated. Flow of chiller water pump &temperature difference across the chiller is measured. The performance of chiller is shown below:

Particulars	Unit	Chiller-1 (280TR)	Chiller-2 (280TR)
Flow Rate of Chilled Water	M3/Hr	162.48	156
Specific Heat	Kcal/KgC	1000	1000
Chilled Water Temperature at Chiller Inlet	Deg. C	16.8	13.1
Chilled Water Temperature at Chiller Outlet	Deg. C	14.5	10.9
Temperature Difference	Deg. C	2.3	2.2
Net Refrigeration Capacity	TR	123.58	113.49
Compressor Input Power	KW	185.32	162.49
Coeff. Of Performance		2.34	2.46
Energy Efficiency Ratio		8.00	8.38
Power per Ton	KW/Ton	**1.50**	**1.43**

Observation and Recommendation:

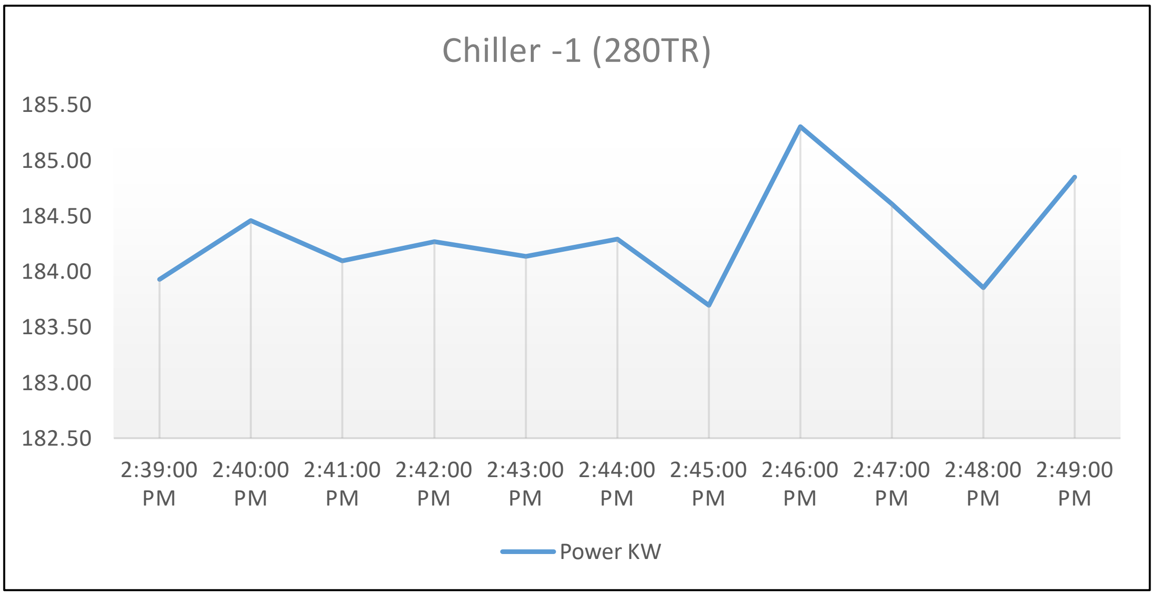
1. SPC of chiller is good i.e. 1.5 KW/TR & 1.43 KW/TR, as compared to its design SPC.

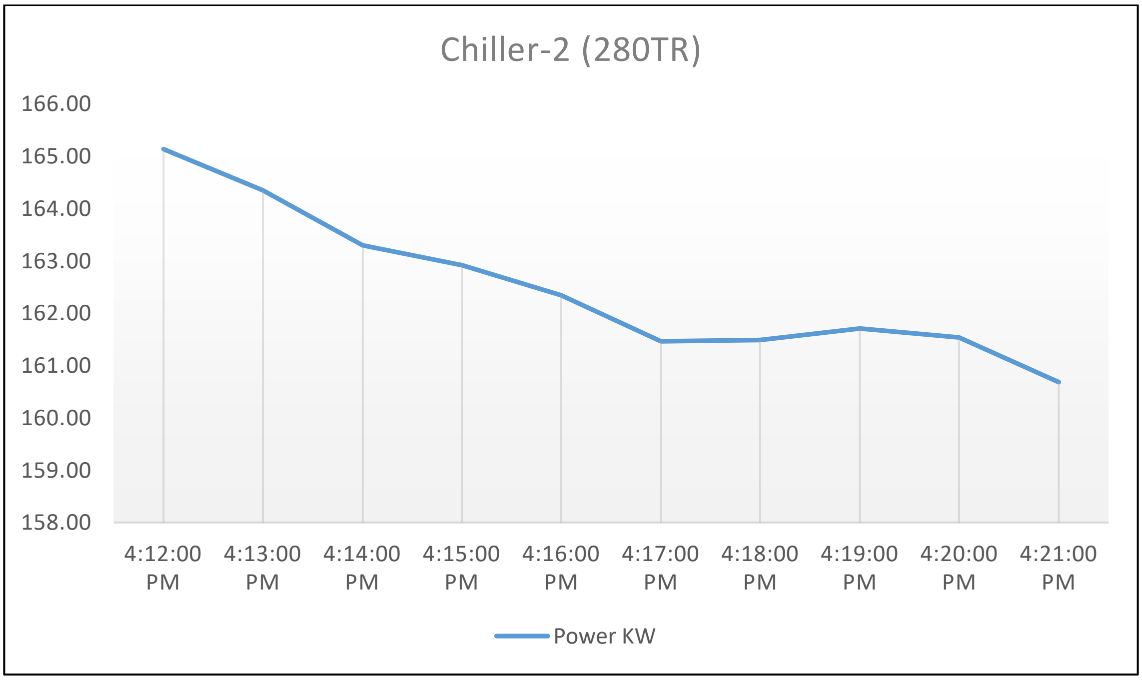
7.2.2. Power Measurement

Power measurement of running chiller has been done shown in below table:

Identification	Chiller-1	Chiller-2
Voltage (Volts)		
"R" Phase	390.5	391.4
"Y" Phase	393.6	390.9
"B" Phase	391.4	387.2
Current (Amps)		
"R" Phase	302.4	265.6
"Y" Phase	325.7	308.7

Identification	Chiller-1	Chiller-2
"B" Phase	301.8	269.8
Power Factor		
"R" Phase	0.876	0.861
"Y" Phase	0.874	0.852
"B" Phase	0.875	0.855
Power Drawn (KW)		
"R" Phase	60.97	52.48
"Y" Phase	65.16	58.66
"B" Phase	59.19	51.35
Total	**185.32**	**162.49**
Power Drawn (KVA)		
"R" Phase	68.17	59.67
"Y" Phase	73.79	69.98
"B" Phase	68.51	60.47
Total	**210.47**	**190.12**
Voltage Harmonics (THD %)		
"R" Phase	1.8	2.0
"Y" Phase	1.9	1.7
"Y" Phase	1.8	1.8
Current Harmonics (THD %)		
"R" Phase	2.3	2.8
"Y" Phase	2.0	2.5
"B" Phase	2.2	2.4
Frequency	50.1	50.0





7.2.3. Pump efficiency calculation

The efficiency of chiller water pump & secondary water pump is calculated. Seven secondary pumps are running for chiller-1 & 2. The efficiency of pump is shown below

Particulars	Unit	Secondary Pump-1	Secondary Pump-2	Secondary Pump-3	Secondary Pump-4
Flow	(m3/hr.)	83.14	77.6	189.091	158.673
Suction Pressure	(Kg/cm^2)	0.00	0.00	0.00	0.00
Discharge Pressure	(Kg/cm^2)	3.20	3.30	2.00	2.20
Head	(meter)	32.00	33.00	20.00	22.00
Density of Fluid	(Kg/m3)	1000	1000	1000	1000
Acceleration due to gravity	(Kg/m^3)	9.81	9.81	9.81	9.81
Hydrolic Power	(KW)	7.25	6.98	10.31	9.51
Actual Power Consumption	(KW)	11.44	11.90	15.37	15.01
Motor Efficiency	%	90	90	90	90
System Efficiency	%	63.37	58.67	67.07	63.39
Pump Efficiency	%	**70.41**	**65.19**	**74.52**	**70.44**
Discharge throttle valve position % open		100.0	100.0	100.0	100.0
Mode of operation		Drive	Drive	Drive	Drive

Particulars	Unit	Secondary Pump-5	Secondary Pump-6	Secondary Pump-7
Flow	(m3/hr.)	152.5	47.44	48.57
Suction Pressure	(Kg/cm^2)	0.00	0.00	0.00
Discharge Pressure	(Kg/cm^2)	2.20	2.00	1.80
Head	(meter)	22.00	20.00	18.00
Density of Fluid	(Kg/m3)	1000	1000	1000
Acceleration due to gravity	(Kg/m^3)	9.81	9.81	9.81
Hydrolic Power	(KW)	9.15	2.59	2.38
Actual Power Consumption	(KW)	14.61	3.43	3.60
Motor Efficiency	%	90	90	90
System Efficiency	%	62.59	75.30	66.13
Pump Efficiency	**%**	**69.55**	**83.67**	**73.48**
Discharge throttle valve position % open	%	100.0	100.0	100.0
Mode of operation		Drive	Drive	Drive

Observation and Recommendation:

1. The efficiency of secondary water pumps-1, 2, 3, 4, 5, 6 & 7 is 70.41%, 65.19%, 74.52%, 70.44%, 69.55%, 83.67% & 73.48%. Respectively which are good as compared to design efficiency of pumps.

7.2.4. Motor Load

The running load of motor is given below:

Identification	Secondary Pump-1	Secondary Pump-2	Secondary Pump-3	Secondary Pump-4
Mode of Operation	Drive	Drive	Drive	Drive
Voltage (Volts)				
"R" Phase	419.0	421.0	410.0	411.0
"Y" Phase	418.0	422.0	411.0	413.0
"B" Phase	419.6	421.5	409.0	415.0
Current (Amps)				
"R" Phase	17.7	18.1	23.8	23.6
"Y" Phase	17.2	18.0	23.6	23.1
"B" Phase	17.1	17.8	24.1	23.4
Power Factor				
"R" Phase	0.870	0.872	0.847	0.842
"Y" Phase	0.864	0.861	0.846	0.841
"B" Phase	0.861	0.871	0.842	0.842
Power Drawn (KW)				
"R" Phase	3.91	4.01	5.12	5.05
"Y" Phase	3.79	3.95	5.09	4.95

"B" Phase	3.74	3.94	5.15	5.00
Total	11.44	11.90	15.37	15.01
Power Drawn (KVA)				
"R" Phase	4.50	4.60	6.05	5.99
"Y" Phase	4.39	4.59	6.02	5.89
"B" Phase	4.34	4.52	6.12	5.94
Total	13.23	13.71	18.18	17.83

Identification	**Secondary Pump-5**	**Secondary Pump-6**	**Secondary Pump-7**
Mode of Operation	**Drive**	**Drive**	**Drive**
Voltage (Volts)			
"R" Phase	412.0	416.0	417.0
"Y" Phase	415.0	415.0	418.0
"B" Phase	416.0	417.0	415.0
Current (Amps)	414.3	416.0	416.7
"R" Phase	22.5	5.4	5.9
"Y" Phase	23.4	5.6	5.6
"B" Phase	22.6	5.6	5.7
Power Factor	22.8	5.5	5.7
"R" Phase	0.841	0.814	0.824
"Y" Phase	0.834	0.812	0.821
"B" Phase	0.841	0.814	0.826
Power Drawn (KW)			
"R" Phase	4.81	1.12	1.23
"Y" Phase	4.98	1.16	1.17
"B" Phase	4.83	1.16	1.20
Total	14.61	3.43	3.60
Power Drawn (KVA)			
"R" Phase	5.72	1.37	1.50
"Y" Phase	5.97	1.43	1.43
"B" Phase	5.74	1.42	1.45
Total	17.42	4.22	4.37

CHAPTER-8LIGHTING SYSTEMS

8.1. LIGHTING

8.1.1. Systems Installed

Various types of lighting fixtures are installed in different Area as and locations. Premises has already installed energy Efficient LED Lights at most of the places.

Energy Efficient LED Lights offer reduction in the power consumption besides excellent color rendering properties and high luminous efficacy. The detail of lighting fixtures is given below:

LED Light, Street Light, Flood Light, PL, etc. Energy Efficient LED Lights offer reduction in the power consumption besides excellent color rendering properties and high luminous efficacy. The detail of lighting fixtures is given below:

8.1.2. Types of Lighting fitting Fixtures

Sr. No	Fixture	Power Rating (Watt)
1	LED Tube Light	18/20
2	LED Tube Light	10
3	Panel Light 2'x2'	36
4	LED Bulb	15
5	Office Cobe Light	18
6	Street/ Outside LED Light	60/80/90

Different types of Light various watts are installed in plant. As units has already installed LEDs lights, still further saving in light could be achieved by taking following steps.

8.1.3. Time based control or Daylight linked control

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

8.1.4. Localized Switching

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

8.1.5. Ilumination & Lux level

To study, analyze and identify energy conservation options in lighting, a study of the unit lighting load was conducted. The purpose of the study was to determine the lighting load and its distribution in various sections of the buildings, determine the quality of illumination provided, and recommend measures to improve illumination and reduce electricity consumption.

A high quality and accurate digital LUX meter was used to measure the illumination level at various sections of the building during working hours. Other performance indicators such as type of lamps used, luminaries, mounting height, physical condition of lamps, use of day lighting, etc. were also noted down

Major reasons for poor illumination levels at selected locations of the building are as follows:

- Poor reflectors/no reflector installed for the tube lights.
- Large height of installed fittings from the working plane.
- Reduction in illumination due to ageing.
- Very old fittings and dust deposition on luminaries

8.1.6. Lux Level Measurements

Location	Area	LUX				Average Lux
Apartment-B	Wing-2 Room-7	150	75	65	80	93
	Wing-2 Room-2	130	80	60	95	91
Apartment-C	Room-4	150	120	90	100	115
	Room-5	160	90	100	80	108

Location	Area	LUX				Average Lux
	Lobby	120	150	105	110	121
Apartment-D	4th Floor Room-412	106	130	120	140	124
	Lobby	120	180	120	150	143
Tower-5	Room -212	160	135	140	150	146
Facility House	Lobby	180	160	100	120	140
	Security Area/ Lift Lobby	90	110	70	80	88
E-2 Building	2nd Floor N/B 208	220	160	180	200	190
	Corridor	150	120	110	130	128
	2nd Floor N/B 209	240	260	220	180	225
	2nd Floor N/B 211	305	418	400	390	378
	2nd Floor N/B 222	320	310	290	330	313
Gateway-A	G/A L01	72	62	80	90	76
	G/A L02	85	90	95	100	93
	G/A L03	81	70	65	88	76
	G/A 101	76	90	120	136	106
	G/A 105	90	130	145	80	111
Gateway-B	Lower Ground, Corridor	320	290	340	300	313
	2nd Floor Cabin	680	590	610	625	626
Library	Library	340	280	300	265	296
	Library	320	310	400	320	338
	Physics Lab	280	290	390	400	340
	Corridor	180	150	210	165	176
Work Shop		120	190	80	220	153

8.1.7. Assessment of lighting system

Example: Room

Lux Measured = Average Lux = 286

287 284

Length of the Room = 18ft.

Width of the Room = 14ft

Working Place Height = 10ft

STEP 1	Measure the Floor area of the interior :	Area = 18x14 = 252 sqft
STEP 2	Calculate the Room Index 18 x 14 / 10 (18 + 14) = .78	RI = .78
STEP 3	Determine the total circuit watts of the installation by a power meter if a separate feeder for lighting is available. If the actual value is not known a reasonable approximate can be obtained by totaling up the lamp wattage including the ballasts	Total Circuit watts 54 W x 16 = 864 32 W x 4 = 128 TOTAL = 992W
STEP 4	Calculate Watts per square meter, Value of Step 3 ÷ Value of Step 1	W/m^2 = 3.9
STEP 5	Ascertain the average maintained luminance by using Lux Meter, Eav. Maintained	Eav.maint = 286
STEP 6	Divide 5 by 4 to calculate Lux per Watt per square Meter	$Lux/W/m^2$ = 72.77
STEP 7	Obtain target Lux/W/M2 lux for type of the type of interior/ application and RI (2)	Target $Lux/W/m^2$ = 36
STEP 8	Calculate Installed Load Efficacy Ratio (6 ÷ 7)	ILER = 2.02

ILER 0.75 or over = Satisfactory to Good

Measuring Units Light Level – illuminance

Illuminance is measured in foot candles (ftcd, fc, fcd) or lux in the metric SI system). A foot candle is actually one lumen of light density per square foot, one lsux is one lumen per square meter.

- 1 lux = 1 lumen / sq meter = 0.0001 phot = 0.0929 foot candle (ftcd, fcd)
- 1 phot = 1 lumen / Sq centimeter = 10000 lumens / sq meter = 10000 lux
- 1 foot candle (ftcd, fcd) = 1 lumen / sqft = 10.752 lux

Common Light Level Outdoor

Common light levels outdoor at day and night can be found in the table below :

Lux level of different natural occasions

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

8.1.8. 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 its may be as low as 25- 50 lux. Additional lighting equipment is often necessary to compensate the low levels.

Earlier it was common with light levels in the range 100 -300 lux for normal activities. Today the light level is more common in the range 500 – 1000 lux – depending on activity. For precision and detailed works, the light level may even approach 1500 – 2000 lux.

The table below is a guidance for recommended light level in different work spaces:

Activity	Illumination (lux, lumen/m^2)
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 workshops, 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

8.2. RECOMMENDATIONS

8.2.1. Optimization of the Main Incomer Voltage on Main Panel

The average voltage on LT side of Transformers was around 242 V. This may be an adequate voltage for motive loads like motors etc, but for the lighting systems normally, the voltage should be around 220 volts (phase to neutral). A reduction of around 15% in the lighting voltage can reduce the power consumption by around 20%.

As the conventional light was replaced with LED lamps in phase manner the effect of voltage reduction in terms of power saving will be almost negligible. However, reduction and stabilization of voltage will improve the life of lamps.

CHAPTER-9 D.G SETS

9.1. D.G. Rated Specifications

The plant has installed 04 No's DG Set of 1010 KVA X 2Nos. & 500 KVA X 2Nos. for in-house power generation. The DG is run during power cut and testing only. All DG set synchronize together. The rated specification of DG is as follows

Name Plate Data	UoM	DG-1	DG-2	DG-3	DG-4
Rated	kVA	500	500	1010	1010
	kW	400	400	808	808
Voltage	V	415	415	415	415
Amp.	I	696.0	696.0	1405.0	1405.0
Phase		3	3	3	3
PF		0.8	0.8	0.8	0.8
RPM		1500	1500	1500	1500
Hz		50	50	50	50

9.2. Performance Assessment of D. G

During the audit we measured the specific fuel consumption (kWh/Ltr) of DG sets. Analyses of last one-year DG log book details for Apr. 2021 to Mar. 2022. Specific energy consumption shows in below table as per standard

The analysis of the different parameters recorded reading at the L.T incoming main supply and during this period the diesel consumption was also recorded empty tank method

Particulars	DG-1	DG-2	DG-4
Time (18/04/2022)	03:07	01:07	6.3
Unit Generation (kWh)	964	380	3260
Fuel Consumption	280	110	950
SFC (kWh/Ltr)	**3.4**	**3.5**	**3.4**

The standard specific fuel consumption (SFC) of DG sets is in the range of 3.0 to 4.0 kWh/ltr. Present Average SFC of DG is 3.4 to 3.5 kWh/Ltr, which is good as per design value.

9.3. HISTORICAL FUEL ANALYSES DATA

Analyses of last one-year DG log book details for Apr. 2021 to Mar. 2022. Specific energy consumption shows in below table as per standard.

DG-1 (500 KVA)							
Srl.	**Date**	**Unit Generated (kWh)**	**Diesel Consumption Ltr**	**Running Hr.**	**Diesel Cost (Rs./Ltr.)**	**Specific kWh Generation kWh/Ltr**	**Cost of HSD**
1	Apr. 2021	134	95	2:54:00	79.27	1.4	7530.65
2	May. 2021	0	0	0:00:00	79.27	-	0.00
3	Jun. 2021	0	0	0:00:00	79.27	-	0.00
4	Jul. 2021	0	0	0:00:00	79.27	-	0.00
5	Aug. 2021	5444	1785	53:48:00	79.27	3.0	141496.95
6	Sep. 2021	1300	395	13:00:00	79.27	3.3	31311.65
7	Oct. 2021	841	340	10:24:00	79.27	2.5	26951.80
8	Nov. 2021	1506	595	19:36:00	79.27	2.5	47165.65
9	Dec. 2021	347	130	3:30:00	79.27	2.7	10305.10
10	Jan. 2022	3402	1300	72:54:00	79.27	2.6	103051.00
11	Feb. 2022	2734	780	19:24:00	79.27	3.5	61830.60
12	Mar. 2022	4021	1153	18:06:00	79.27	3.5	91398.31
	Total	**19729.00**	**6573.00**	**213:36:00**	**951.24**		**521041.71**
	Maximum	**5444.00**	**1785.00**	**72:54:00**	**79.27**	**3.5**	**141496.95**
	Minimum	**0.00**	**0.00**	**0:00:00**	**79.27**	**1.4**	**0.00**
	Average	**1644.08**	**547.75**	**17:48:00**	**79.27**	**2.8**	**43420.14**

DG-2 (500 KVA)							
Srl.	**Date**	**Unit Generated (kWh)**	**Diesel Consumption Ltr**	**Running Hr.**	**Diesel Cost (Rs./Ltr.)**	**Specific kWh Generation kWh/Ltr**	**Cost of HSD**
1	Apr. 2021	3061	1420	39:00:00	79.27	2.2	112563.40
2	May. 2021	1812	930	35:48:00	79.27	1.9	73721.10
3	Jun. 2021	3195	1860	69:36:00	79.27	1.7	147442.20
4	Jul. 2021	2204	924	32:12:00	79.27	2.4	73245.48
5	Aug. 2021	496	185	5:42:00	79.27	2.7	14664.95
6	Sep. 2021	964	515	17:30:00	79.27	1.9	40824.05
7	Oct. 2021	27	40	1:42:00	79.27	0.7	3170.80
8	Nov. 2021	43	15	0:18:00	79.27	2.9	1189.05
9	Dec. 2021	54	25	0:24:00	79.27	2.2	1981.75
10	Jan. 2022	38	20	0:36:00	79.27	1.9	1585.40
11	Feb. 2022	29	30	0:36:00	79.27	1.0	2378.10
12	Mar. 2022	487	145	12:32:00	79.27	3.4	11494.15
	Total	**12410.00**	**6109.00**	**215:56:00**	**951.24**		**484260.43**
	Maximum	**3195.00**	**1860.00**	**69:36:00**	**79.27**	**3.4**	**147442.20**
	Minimum	**27.00**	**15.00**	**0:18:00**	**79.27**	**0.7**	**1189.05**
	Average	**1034.17**	**509.08**	**17:59:40**	**79.27**	**2.1**	**40355.04**

DG-3 (1010 KVA)							
Srl.	**Date**	**Unit Generated (kWh)**	**Diesel Consumption Ltr**	**Running Hr.**	**Diesel Cost (Rs./Ltr.)**	**Specific kWh Generation kWh/Ltr**	**Cost of HSD**
1	Apr. 2021	189	80	0:43:12	79.27	2.4	6341.60
2	May. 2021	0	0	0:00:00	79.27	-	0.00
3	Jun. 2021	1330	315	5:42:00	79.27	4.2	24970.05
4	Jul. 2021	0	0	0:00:00	79.27	-	0.00
5	Aug. 2021	0	0	0:00:00	79.27	-	0.00
6	Sep. 2021	121	30	0:30:00	79.27	4.0	2378.10
7	Oct. 2021	0	0	0:00:00	79.27	-	0.00
8	Nov. 2021	0	0	0:00:00	79.27	-	0.00
9	Dec. 2021	0	0	0:00:00	79.27	-	0.00
10	Jan. 2022	0	0	0:42:00	79.27	-	0.00
11	Feb. 2022	0	0	0:00:00	79.27	-	0.00
12	Mar. 2022	16	40	0:06:00	79.27	0.4	3170.80
		1656.00	**465.00**	**7:43:12**	**951.24**		**36860.55**
		1330.00	**315.00**	**5:42:00**	**79.27**	**4.2**	**24970.05**
		0.00	**0.00**	**0:00:00**	**79.27**	**0.4**	**0.00**
		138.00	**38.75**	**0:38:36**	**79.27**	**2.8**	**3071.71**

DG-4 (1010 KVA)							
Srl.	Date	Unit Generated (kWh)	Diesel Consumption Ltr	Running Hr.	Diesrl Cost (Rs./Ltr.)	Specific kWh Generation kWh/Ltr	Cost of HSD
1	Apr. 2021	2963	1560	10:12:00	79.27	1.9	123661.20
2	May. 2021	0	0	0:00:00	79.27	-	0.00
3	Jun. 2021	0	0	0:00:00	79.27	-	0.00
4	Jul. 2021	0	0	0:00:00	79.27	-	0.00
5	Aug. 2021	0	0	0:00:00	79.27	-	0.00
6	Sep. 2021	3077	860	10:42:00	79.27	3.6	68172.20
7	Oct. 2021	0	0	0:00:00	79.27	-	0.00
8	Nov. 2021	0	0	0:00:00	79.27	-	0.00
9	Dec. 2021	0	0	0:00:00	79.27	-	0.00
10	Jan. 2022	0	0	0:00:00	79.27	-	0.00
11	Feb. 2022	0	0	0:00:00	79.27	-	0.00
12	Mar. 2022	8460	2390	19:36:00	79.27	3.5	189455.30
		14500.00	**4810.00**	**40:30:00**	**951.24**		**381288.70**
		8460.00	**2390.00**	**19:36:00**	**79.27**	**3.58**	**189455.30**
		0.00	**0.00**	**0:00:00**	**79.27**	**1.90**	**0.00**
		1208.33	**400.83**	**3:22:30**	**79.27**	**3.01**	**31774.06**

Sr. No	Date	Total UNIT Generation (DG-1,2,3&4)	Total Fuel Consumption (DG-1,2,3&4)	Issue to other DG Set	Total HSD Consumed	Total Hr.	Specific kWh Generation kWh/Ltr	Total Cost of HSD
1	Apr. 2021	6347.00	3155.00	0.00	3155.00	52:49:12	2.0	237080.00
2	May. 2021	1812.00	930.00	10.00	940.00	35:48:00	1.9	74514
3	Jun. 2021	4525.00	2175.00	0.00	2175.00	75:18:00	2.1	172412
4	Jul. 2021	2204.00	924.00	20.00	944.00	32:12:00	2.4	74831
5	Aug. 2021	5940.00	1970.00	0.00	1970.00	59:30:00	3.0	156162
6	Sep. 2021	5462.00	1800.00	0.00	1800.00	41:42:00	3.0	142686
7	Oct. 2021	868.00	380.00	5.00	385.00	12:06:00	2.3	30519
8	Nov. 2021	1549.00	610.00	0.00	610.00	19:54:00	2.5	48355
9	Dec. 2021	401.00	155.00	0.00	155.00	3:54:00	2.6	12287
10	Jan. 2022	3440.00	1320.00	0.00	1320.00	74:12:00	2.6	104636
11	Feb. 2022	2763.00	810.00	0.00	810.00	20:00:00	3.4	64209
12	Mar. 2022	12984.00	3728.00	0.00	3728.00	50:20:00	3.5	295519
		48295.00	**17957.00**	**35.00**	**17992.00**	**477:45:12**		**1413209.0**
		12984.00	**3728.00**	**20.00**	**3728.00**	**75:18:00**	**3.48**	**295518.56**
		401.00	**155.00**	**0.00**	**155.00**	**3:54:00**	**1.95**	**12286.85**
		4024.58	**1496.42**	**2.92**	**1499.33**	**39:48:46**	**2.62**	**117767.42**

9.4. OBSERVATION AND RECOMMENDATIONS

The plant has installed 04 No's DG Set of 1010 KVA X 2Nos. & 500 KVA X 2Nos for in-house power generation. The DG is run during power cut and testing only. Specific power generation is dependent on the DG loading and its overall condition.

1. D.G sets are neat & clean
2. DG set area should have Proper Ventilation
3. DG Log book proper maintain

9.5. GENERAL RECOMMENDATIONS FOR ENERGY MEASURED IN DG SETS

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.
7. Carryout regular field trials to monitor DG set performance, and maintenance planning as per requirements.
8. Efficiency of DG Set can be increase by loading 70-80% load
9. The starting current of squirrel cage induction motor is as much as six times the rated current for a few seconds with direct-on-line starters. In practice, it has been found that the starting current value should not exceed 200% of the full load capacity of the alternator. The voltage and frequency throughout the motor starting interval recovers and reaches rated values usually much before the motor has picked up full speed
10. It is always 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.
11. The electricity rules clearly specify that two independent earths to the body and neutral should be provided to give adequate protection to the equipment in case of an earth fault and to drain away any leakage of potential from the equipment to the earth.

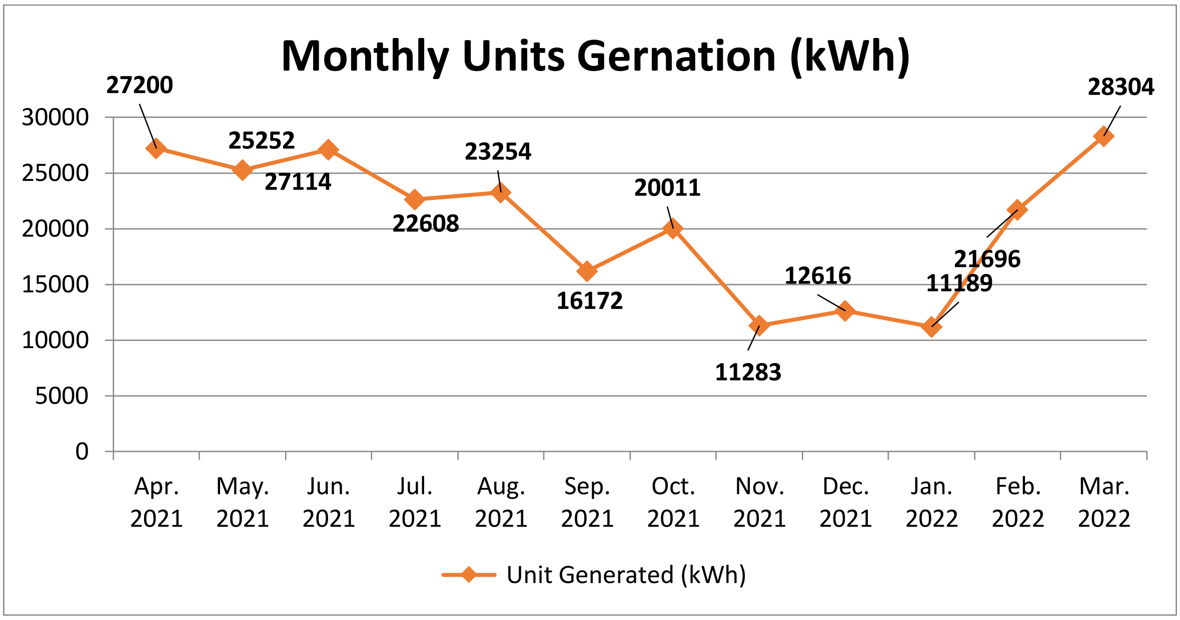
CHAPTER-10 SOLAR PHOTOVOLTAIC CELL

10.1. INSTALLATION OF SOLAR PHOTOVOLTAIC CELL (SPV)

The 254 kWp solar PV installed on roof top of building. Solar Photovoltaic Cell for Power Generation for lighting load & other load in the Building, **Solar photovoltaic technologies** convert solar energy into useful energy forms by directly absorbing solar photons—particles of light that act as individual units of energy—and either converting part of the energy to electricity. **A-Z Energy Engineers Pvt. Ltd. acknowledges and appreciates the commitment of the management towards conservation of Energy.**

10.2. UNIT GENERATION BY SOLAR PV

Sr No.	Month	Days of the Month	Unit Generated (kWh)	CUF (%)	Average per day generation (KWp)
1	**Apr. 2021**	30	27200	14.9	3.6
2	**May. 2021**	31	25252	13.4	3.2
3	**Jun. 2021**	30	27114	14.8	3.6
4	**Jul. 2021**	31	22608	12.0	2.9
5	**Aug. 2021**	31	23254	12.3	3.0
6	**Sep. 2021**	30	16172	8.8	2.1
7	**Oct. 2021**	31	20011	10.6	2.5
8	**Nov. 2021**	30	11283	6.2	1.5
9	**Dec. 2021**	31	12616	6.7	1.6
10	**Jan. 2022**	31	11189	5.9	1.4
11	**Feb. 2022**	28	21696	12.7	3.1
12	**Mar. 2022**	31	28304	15.0	3.6
		365	**246699.00**	**11.1**	**2.7**



Capacity Utilization Factor (C.U.F) = (Actual energy from the plant (kWh))

(Plant Capacity (kwp) x 24 x 365)

The performance of Solar PV plant is less than national average of 19%. It is therefore, suggested to regularly clean these panels for better performance

The units or kWh output of a solar panel will depend on the panel efficiency and availability of sunlight in a location. The factor that defines this output is called CUF (or Capacity Utility Factor). For India, it is typically taken as 19% and the calculation of units goes as:

Units Generated Annually (in kWh) = System Size in Kw * CUF * 365 * 24.

So typically, a 1 kW capacity solar system will generate 1600-1700 kWh of electricity per year. This can provide electricity for 25 years.

10.3. OBSERVATION AND RECOMMENDATIONS

However, the less generation of units is due to poor maintenance of Solar panel, as dust, deposited on the surface of solar plates, which act as shield from sun rays thus effecting the power generation badly. it is recommended that the solar panel inspect the structure at regular intervals for dirt or some other things that might have piled on top. It is important that the panels should be kept clean.

CHAPTER-11 WATER SYSTEM

11.1. Raw Water

At BML College Gurugram, the main source of water is ground water which is supplied through pumps to the entire plant which includes, water consumption at Domestic, RO Plant, and Utility also for college office purposes. The water supplied to the RO plant is filtered using the RO Plant and is stored into the filtered water storage tank and the rejected water is used for flushing.

11.2. Performance evaluation Submersible Pump

College has installed two submersible pumps One pump is 7.5 Hp & other is 12.5 HP. The efficiency of submersible pump is

Location		Submersible-1	Submersible-2
Particulars	**Unit**	**Near Workshop**	**Near Apartment-C**
Flow	(m3/hr.)	12.6	18.6
Suction Pressure	(Kg/cm^2)	-3.05	-3.05
Discharge Pressure	(Kg/cm^2)	2.00	1.60
Head	(meter)	50.48	46.48
Density of Fluid	(Kg/m3)	1000	1000
Acceleration due to gravity	(Kg/m^3)	9.81	9.81
Hydrolic Power	(KW)	1.73	2.36
Actual Power Consumption	(KW)	4.74	5.68
Motor Efficiency	%	87	87
System Efficiency	%	36.59	41.49
Pump Efficiency	**%**	**42.05**	**47.69**

11.3. Performance evaluation Filter feed Pump

College has two filter feed pumps of 11kW each. The performance of pumps is given below:

Location		Filter Feed Pump-1	Filter Feed Pump-2
Particulars	**Unit**	**Pump House**	**Pump House**
Flow	(m3/hr.)	45	53
Suction Pressure	(Kg/cm^2)	0.45	0.45
Discharge Pressure	(Kg/cm^2)	4.00	3.50
Head	(meter)	35.50	30.50
Density of Fluid	(Kg/m3)	1000	1000

Location		Filter Feed Pump-1	Filter Feed Pump-2
Particulars	**Unit**	**Pump House**	**Pump House**
Acceleration due to gravity	(Kg/m^3)	9.81	9.81
Hydrolic Power	(KW)	4.35	4.40
Actual Power Consumption	(KW)	7.10	7.08
Motor Efficiency	%	84	84
System Efficiency	%	61.35	62.24
Pump Efficiency	**%**	**73.04**	**74.09**

11.4. Performance Evaluation Domestic Pump

Two domestic pumps are installed to supply the filter water to the entire plant. The performance of pump is given below

Location		Domestic Pump-1	Domestic Pump-2
Particulars	**Unit**	**Pump House**	**Pump House**
Flow	(m3/hr.)	30.5	33.2
Suction Pressure	(Kg/cm^2)	0.30	0.30
Discharge Pressure	(Kg/cm^2)	5.40	5.20
Head	(meter)	51.00	49.00
Density of Fluid	(Kg/m3)	1000	1000
Acceleration due to gravity	(Kg/m^3)	9.81	9.81
Hydrolic Power	(KW)	4.24	4.43
Actual Power Consumption	(KW)	9.81	10.08
Motor Efficiency	%	84	84
System Efficiency	%	43.19	43.99
Pump Efficiency	**%**	**51.42**	**52.37**

11.5. Power Measurement of Pump House Pumps

Electrical measurement of each pump is done with three phase power analyser, instantaneous reading is given below:

Location	Rated Kw	Voltage (Volts)	Current (Amps)	Power Factor	Power Drawn (kW)
Submersible-1	5.5	408.3	8.7	0.77	4.74
Submersible-2	9.3	406.9	10.6	0.76	5.68
Filter Feed Pump-1	11	408.30	12.70	0.79	7.10
Filter Feed Pump-2	11	405.60	12.90	0.78	7.08
Domestic Pump-1	11	408.30	18.26	0.76	9.81
Domestic Pump-2	11	408.30	18.27	0.78	10.08

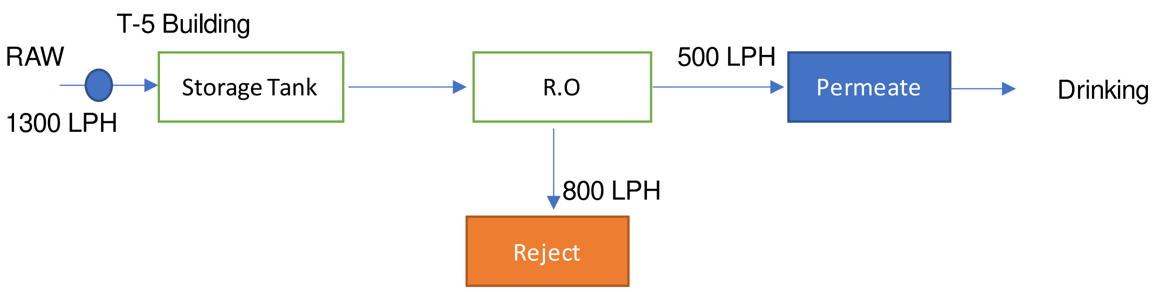
11.6. R.O SYSTEM

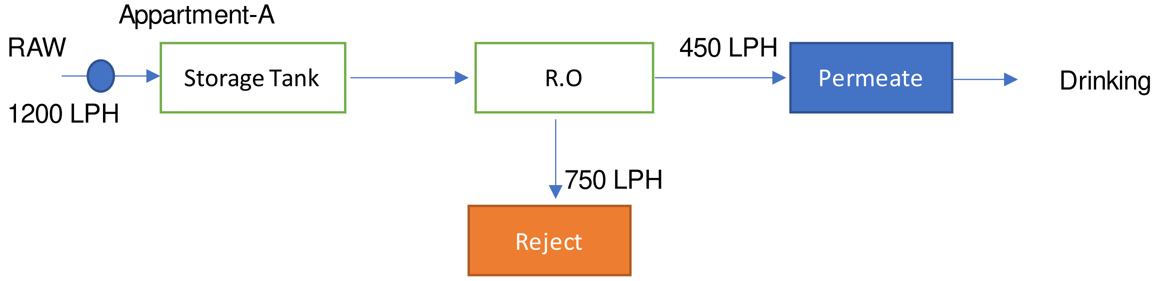
College has installed five R.O Plant. R.O-1 ,2,3 & 4 is 500LPH respectively & R.O-5 is of 1000LPH. The details of R.O System is shown below:

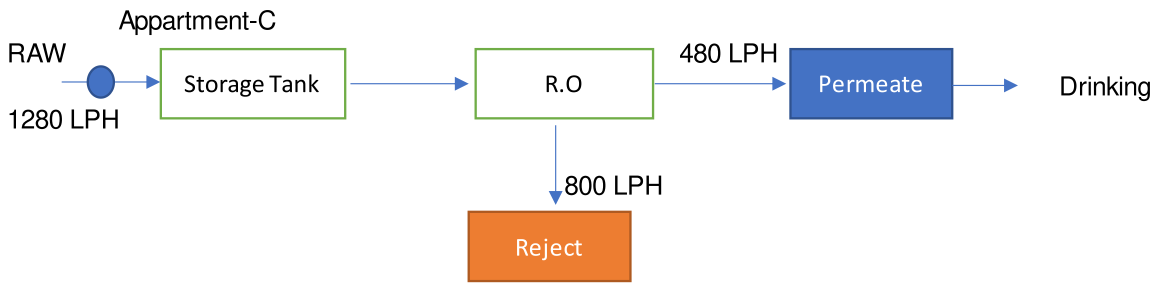
Identification	Location	Capacity (LPH)
R.O-1	T-5	500
R.O-2	Apartment-A	500
R.O-3	Apartment-c	500
R.O-4	Apartment-D	500
R.O-5	Tower Hostel	1000

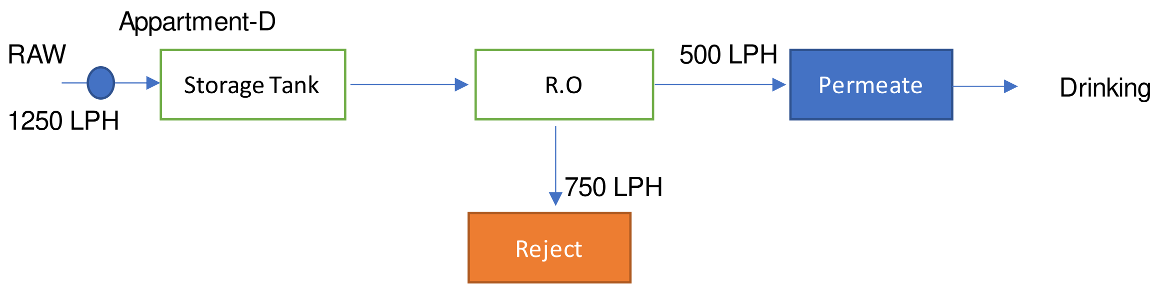
11.6.1. Performance of R.O Plant

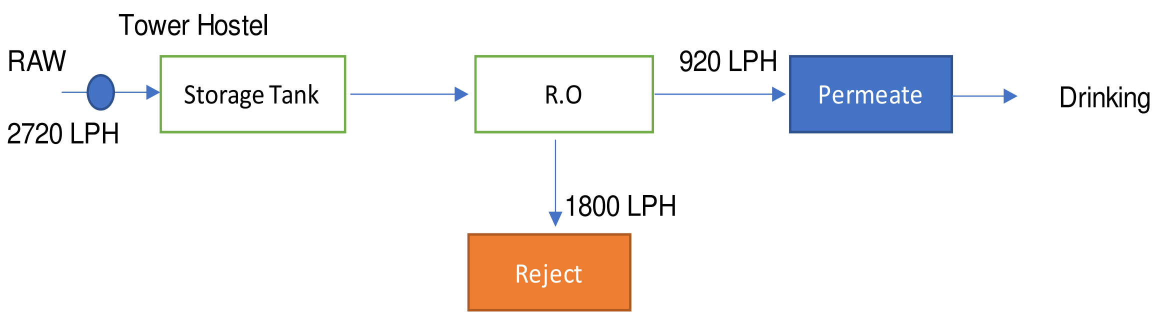
BML College, has five R.O plant installed, all is used for drinking purpose & also used for chiller make up water. R.O -1 is installed in T-5 Building of 500LPH having permeate of around 500 LPH & reject water is around 800 LPH. R.O -2 is installed in Apartment-A of 500LPH is having permeate flow around 450LPH & reject is around 750 LPH. R.O-3 is installed in Apartment-C of 500LPH is having permeate flow 480LPH & Reject is around 800LPH. R.O -4 is installed in Apartment-D of 500LPH is having permeate flow 500LPH & reject is around 750LPH. R.O-5 is installed in tower hostel of 1000LPH is having permeate flow around 920LPH & reject is around 1800LPH. The reject water of all these R.O Plant is used in flushing Permeate water is used for utility & other is used for domestic use (Drinking Purpose). The detail shown below:




Appartment-A
RAW
1200 LPH
Storage Tank
R.O
450 LPH
Permeate
Drinking
750 LPH
Reject


Appartment-C
RAW
1280 LPH
Storage Tank
R.O
480 LPH
Permeate
Drinking
800 LPH
Reject

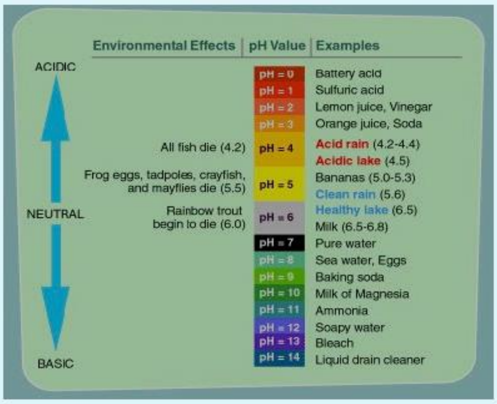

Appartment-D
RAW
1250 LPH
Storage Tank
R.O
500 LPH
Permeate
Drinking
750 LPH
Reject


Tower Hostel
RAW
2720 LPH
Storage Tank
R.O
920 LPH
Permeate
Drinking
1800 LPH
Reject

Identification	Location	Capacity (LPH)	Raw Water TDS	Permeate TDS	Permeate Flow	Reject Flow
R.O-1	T-5	500	425	125	500	800
R.O-2	Apartment-B	500	425	130	450	750
R.O-3	Apartment-c	500	425	125	480	800
R.O-4	Apartment-D	500	425	136	500	750
R.O-5	Tower Hostel	1000	425	140	920	1800

TDS stands for total dissolved solids, and represents the total concentration of dissolved substances in water.

The pH value of a water source is a measure of its acidity or alkalinity. The pH level is a measurement of the activity of the hydrogen atom, because the hydrogen activity is a good representation of the acidity or alkalinity of the water. The pH scale, as shown below, ranges from 0 to 14, with 7.0 being neutral. Water with a low pH is said to be acidic, and water with a high pH is basic, or alkaline. Pure water would have a pH of 7.0, but water sources and precipitation tend to be slightly acidic, due to contaminants that are in the water.



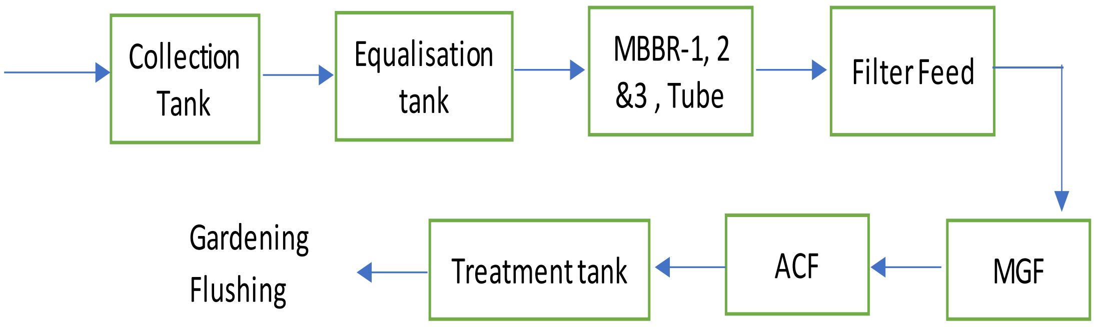
pH Scale

11.7.S.T.P

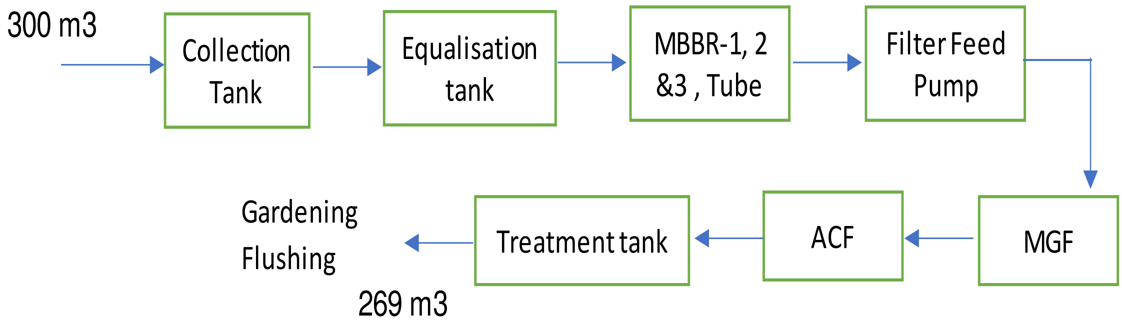
As per discussion with the concerned officials, three STP plant is installed one is 100 KLD, second is 200KLD & third is 500KLD.

Particulars	Capacity (KLD)	Remarks
STP-1	100	Dismantle
STP-2	200	Not in operation
STP-3	500	Running

200KLD



500KLD



CHAPTER-12 THERMOGRAPHY

12.1. THERMAL IMAGINE

Thermography is a term used to describe a type of photography that uses infrared radiated wavelengths to make pictures as opposed to visible light as in normal photographs. It can be also referred to as 'thermal imaging' or 'infrared'. Objects that have a temperature above absolute zero (-273.15°C or 0 Kelvin) emit infrared wavelengths. Thermography is the production of thermal (heat) pictures from these wavelengths, whereby temperature measurements or comparative analysis can be made.

This survey and report combine images to provide a general thermo graphic overview of the Cables, panels & motors, together with a selection of close-up observations of areas with particular interest. Whilst care has been taken to record temperatures as accurately as possible, the absolute values obtained should be treated with a degree of caution. Variable environmental conditions together with changes in camera angle, distance, material change and emissivity can all adversely affect the result. However, by combining images with equal parameters the 'relative' change of temperature across a selected material will be accurate and therefore useful analysis can be made.

From discussions prior to the survey, the following points have been incorporated into the methodology of data collection and presentation of findings.

- The survey to be a combination of general scanning and capturing of selected images that may fairly represent the situation. (Qualitative Survey).
- Anomalies noted to be identified either within the narrative or on the image.
- In order to classify the severity of the thermal anomalies recorded, atmospheric site temperature was used as a rated temperature.
- Emissivity is set as per the contact probe meter. For setting a emissivity following method was used.

12.2. SUMMARY OF SCANNED EQUIPMENT

In appendix A section of this report contains the actual thermo graphic images of the anomalies. For all anomalies, we have included a control photograph identifying the equipment (regular photograph) and a thermo graphic image (thermal image) of the area where the anomaly was found.

12.3. General Recommendations and Comments

In general, after taking a number of thermal images, we have seen various spots are over the safe temperature limit. You should take appropriate action to capture the heat loss. It creates harmful area for human beings and we can avoid the injuries.

Note: Where temperature is on higher side reason

1) Lose connection
2) Under size cable

CHAPTER-18 OTHER POSSIBLE AREAS FOR ENERGY SAVINGS

18.1. DAY LIGHT HARVESTING

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

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

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

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

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

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

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

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

18.2. TIMED BASED CONTROL OR DAYLIGHT LINKED CONTROL

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

18.3. LOCALIZED SWITCHING

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

CHAPTER-19 GENERAL TIPS FOR ENERGY CONSERVATION IN DIFFERENT UTILITIES SYSTEMS

19.1. ELECTRICITY

- Schedule your operations to maintain a high load factor
- Minimize maximum demand by tripping loads through a demand controller
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

19.2. MOTORS

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

19.3. DRIVES

- Use variable-speed drives for large variable loads.
- Use high-efficiency gear sets.
- Use precision alignment.
- Check belt tension regularly.
- Eliminate variable-pitch pulleys.
- Use flat belts as alternatives to v-belts.
- Use synthetic lubricants for large gearboxes.
- Eliminate eddy current couplings.
- Shut them off when not needed.

19.4. FANS

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed.

19.5. BLOWERS

- Use smooth, well-rounded air inlet ducts or cones for air intakes.
- Minimize blower inlet and outlet obstructions.
- Clean screens and filters regularly.
- Minimize blower speed.
- Use low-slip or no-slip belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable blower loads.
- Use energy-efficient motors for continuous or near-continuous operation.
- Eliminate ductwork leaks.
- Turn blowers off when they are not needed.

19.6. PUMPS

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

19.7. LIGHTING

- Reduce excessive illumination levels to standard levels using switching, delamping, etc. (Know the electrical effects before doing delamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapor lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapor, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider daylighting, skylights, etc.
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED.

19.8. DG SETS

- Optimize loading

- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

19.9. BUILDINGS

- Seal exterior cracks/openings/gaps with caulk, gasketing, weatherstripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

19.10. WATER & WASTEWATER

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Eliminate once-through cooling with water.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blowdown to minimize it.
- Provide proper tools for wash down -- especially self-closing nozzles.
- 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.
- Use the lowest possible hot water temperature.

- Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.
- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Use freeze protection valves rather than manual bleeding of lines.
- Consider leased and mobile water treatment systems, especially for deionized water.
- Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
- Install pretreatment to reduce TOC and BOD surcharges.
- Verify the water meter readings. (You'd be amazed how long a meter reading can be estimated after the meter breaks or the meter pit fills with water!)
- Verify the sewer flows if the sewer bills are based on them

19.11. MISCELLANEOUS

- Meter any unmetered utilities. Know what normal efficient use is. Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Consider buying utilities from neighbors, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high-pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

Annexure-1

Certification

This part shall indicate certification by Accredited Energy Auditor stating that:

(i) The data collection has been carried out diligently and truthfully;

(ii) All data monitoring devices are in good working condition and have been calibrated or certified by approved agencies authorized and no tempering of such devices has occurred

(iii) All reasonable professional skill, case and diligence had been taken in preparing the energy audit report and the contents thereof are a true representation of the facts;

(iv) Adequate training provided to personnel involved in daily operations after implementation of recommendations; and

(v) The energy audit has been carried out in accordance with the Bureau of Energy Efficiency (Manner and Intervals of Time for the Conduct of Energy Audit) Regulations, 2010.

(Dr. P.P. Mittal)

Accredited Energy Auditor AEA-011

Annexure-2

Certificate of Accreditation

ENERGY IS LIFE
BEE
CONSERVE IT

BUREAU OF ENERGY EFFICIENCY

Examination Registration No. : EA-6851

Accreditation Registration No.: AEA-0011

Certificate of Accreditation

This is to certify that Mr./Ms. Prem Prakash Mittal having its trade/registered office at Delhi has been given accreditation as accredited energy auditor. The certificate shall be effective from 26th day of February 2013

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0011 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 26th day of May 2014

Secretary,
Bureau of Energy Efficiency
New Delhi

Annexure-3

Recommended Lux Levels for different locations

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

Annexure-4

Transformers Standard Losses in watts

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ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)

BUREAU OF ENERGY EFFICIENCY

(Government of India, Ministry of Power)

19th December, 2016

Important Instructions to all Distribution Transformer manufacturers and permittee:

This is with reference to the amendment notification, S.O. No. 4062 (E) for Distribution Transformer dated 16th December, 2016. Amendments in the star rating programs as follows:

Table 2 (Effective from 1st January, 2017 onwards)

Standard Losses in watts up to 11 KV Class (For ratings below 200 kVA & for 200 kVA)										
Rating (kVA)	Star 1		Star 2		Star 3		Star 4		Star 5	
	50 Per cent. Load	100 Per cent. Load	50 Per cent. Load	100 Per cent. Load	50 Per cent. Load	100 Per cent. Load	50 Per cent. Load	100 Per cent. Load	50 Per cent. Load	100 Per cent. Load
16	135	440	120	400	108	364	97	331	87	301
25	190	635	175	595	158	541	142	493	128	448
63	340	1140	300	1050	270	956	243	870	219	791
100	475	1650	435	1500	392	1365	352	1242	317	1130
160	670	1950	570	1700	513	1547	462	1408	416	1281
200	780	2300	670	2100	603	1911	543	1739	488	1582

Table 3 (Effective from 1st January, 2017 onwards)

Standard losses in watts up to 11 KV Class (For ratings above 200 kVA)											
Rating (kVA)	Per Cent. Impe dance	Star 1		Star 2		Star 3		Star 4		Star 5	
		50 Per Cent. Load	100 Per Cent. Load	50 Per Cent. Load	100 Per Cent. Load	50 Per Cent. Load	100 Per Cent. Load	50 Per Cent. Load	100 Per Cent. Load	50 Per Cent. Load	100 Per Cent. Load
250	4.5	980	2930	920	2700	864	2488	811	2293	761	2113
315	4.5	1025	3100	955	2750	890	2440	829	2164	772	1920
400	4.5	1225	3450	1150	3330	1080	3214	1013	3102	951	2994
500	4.5	1510	4300	1430	4100	1354	3909	1282	3727	1215	3554

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of Self and Nation

चौथा तल, सेवा भवन, आर० के० पुरम, नई दिल्ली-110 066 वेबसाईट/Website : www.beeindia.in
4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066 टेली/Tel.: 26179699 (5 Lines) फैक्स/Fax : 91 (11) 26178352

630	4.5	1860	5300	1745	4850	1637	4438	1536	4061	1441	3717
1000	5	2790	7700	2620	7000	2460	6364	2310	5785	2170	5259
1250	5	3300	9200	3220	8400	3142	7670	3066	7003	2991	6394
1600	6.25	4200	11800	3970	11300	3753	10821	3547	10363	3353	9924
2000	6.25	5050	15000	4790	14100	4543	13254	4309	12459	4088	11711
2500	6.25	6150	18500	5900	17500	5660	16554	5430	15659	5209	14813"

Manufacturers/permittee should consider the following for getting star rating approvals:

1. Manufacturers/Permittee are allowed to renew their existing models as per table 2 w.e.f 22nd December, 2016.
2. All the existing models will be valid till 31st December 2016 and after this, these models will be made expired automatically by BEE.
3. Manufacturers/Permittee are allowed to register their fresh models as per table 2 & table 3 w.e.f 22nd December, 2016.

Read the following instructions carefully for those manufacturers who wish to continue the existing model.

A. Renewal of Existing Model:

If the existing model is continued to comply with revised star level, then the following shall apply:

1. A renewal option (i.e., from table 1 to table 2) will be available on manufacturers/permittee's web portal from 22nd December, 2016. If any of the permittee willing to continue their existing model, a declaration on company letter head (with stamp & sign of authorised signatory) needs to be submitted to the Bureau Along with Renewal fee of **five hundred rupees**. (Renewal fee may be paid through Online Banking or Demand Draft).
2. **After verification, approval letter will be send to permittee for the renewed model with revised star level and it will directly appear in Search & Compare page of BEE star label website (http://www.beestarlabel.com/Home/Searchcompare).**

Cases in which continuation is applicable:

Case 1: A 100 KVA distribution transformer with Brand name.....DEF.......and model no. ...ABC/x/y/z...... is registered with BEE as per existing table 1 (valid up to 31st December,2016) and its Total Losses (at 50% loading- 435 W & at 100% loading- 1500 W) i.e. **5 star as per existing table.**

So after revision, for the same brand & model with the Total Losses (at 50% loading- 435 W & at 100% loading- 1500 W) i.e. **2 star as per revised table** (Table 2).

Case 2: A 100 KVA distribution transformer with Brand name.....DEF.......and model no. ...ABC/x/y/z...... is registered with BEE as per existing table 1 (valid up to 31st December,2016) and its Total Losses (at 50% loading- 317 W & at 100% loading- 1130 W) i.e. **5 star as per existing table.**

So after revision, for the same brand & model with the Total Losses (at 50% loading- 317 W & at 100% loading- 1130 W) i.e. **5 star as per revised table** (Table 2).

In both the cases, old test reports would be applicable and BEE would consider the old test report for granting renewal approvals. Declaration is applicable even for *Case 2,* if there is no technical modification in order to comply with revised energy performance standards (i.e. table 2).

B. How to apply:

Renewal: All these expired models will appear in manufacturer's portal and in order to renew the model, the following link (marked in red colour) needs to be clicked. Where renewal form will be generated. The link (marked in red colour) would directly appear in manufacturer's portal w.e.f 22nd December, 2016.

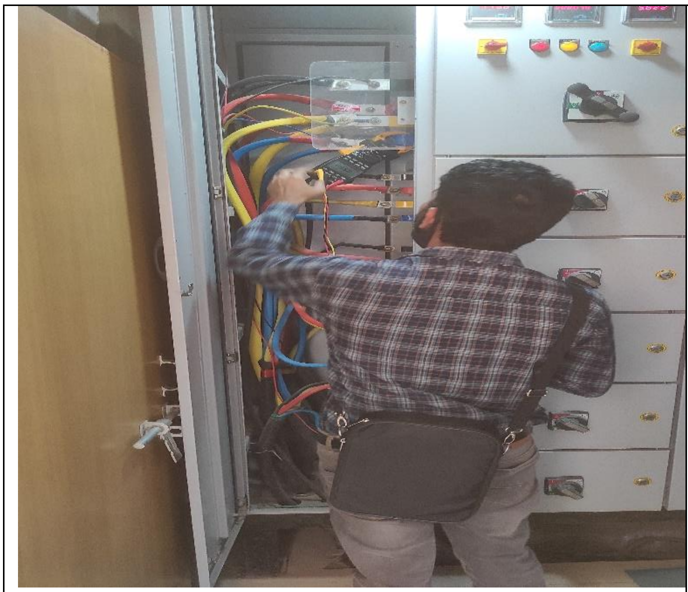
Renewal

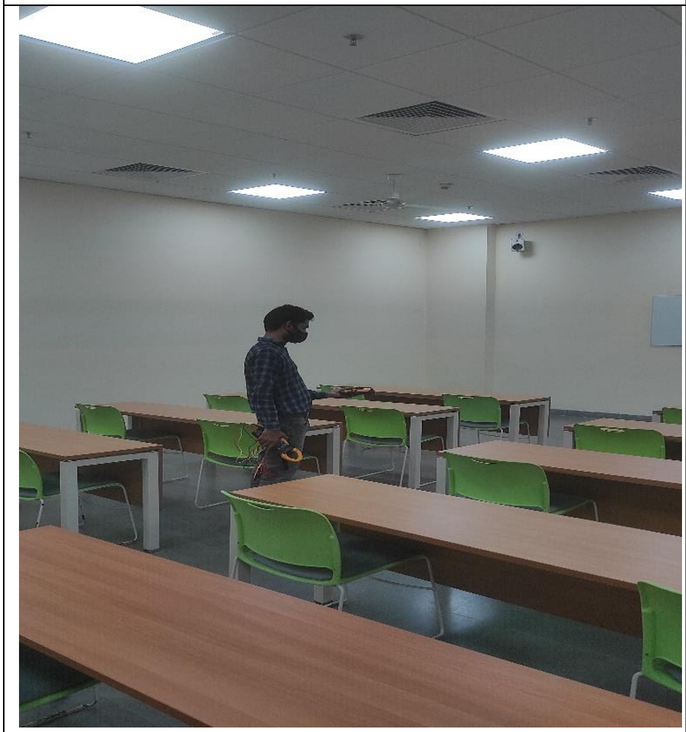
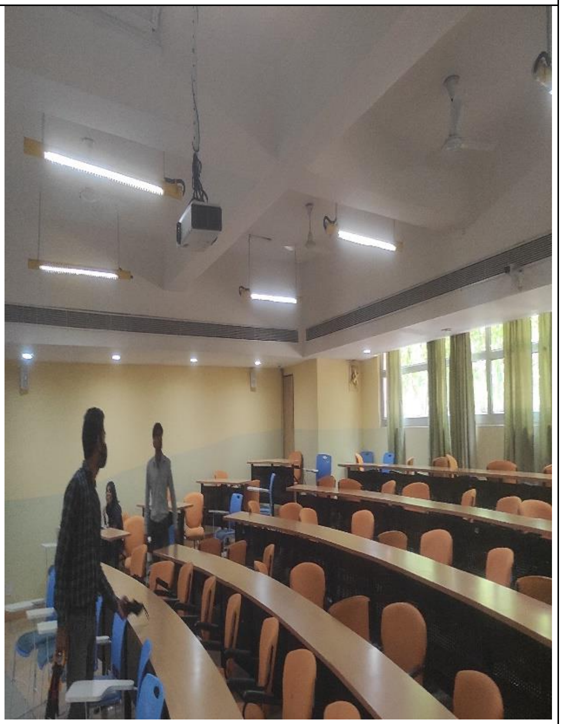
Saurabh Diddi
(Energy Economist)
19th December, 2016

For further queries write to: helpdesk@beenet.in , mkhiriya@beenet.in

Annexure-5

Sites Photographs




Switch me Off
when you leave!
computers
fans
lights
air-conditioning
television
other appliances that consume electricity


SAVE ENERGY
THIS MEANS YOU!


बिजली की बचत
आपकी बचत
आसान है तरीका, अधिक है फायदा
बिजली बचाइये बिजली पाइये
ऊर्जा कार्यकुशलता ब्यूरो

Energy Audit Certificate

This is to certify that the Energy Audit of BML MUNJAL University , 67 k.m. Stone, NH-8, Gurugram- 122413 (Haryana), had been carried out in the month of April 2022.

The Energy Audit team was headed by Dr. P.P. Mittal, Accredited Energy Auditor, Director, A-Z Energy Engineers Pvt. Ltd.;

(i) the energy audit has been carried out in compliance of Haryana Govt. notification dt. 9-11-2016.

(ii) the data collection had been carried out diligently and truthfully. All reasonable professional skill, case and diligence had been taken in preparing the energy audit report and the contents thereof are a true representation of the facts.

(iii) that the interval of time for conduct and completion of subsequent energy audit shall be three years, hence this certificate is valid upto May 2025.

M/s A-Z Energy Engineers Pvt. Ltd. Dr. P.P. MITTAL Accredited Energy Auditor AEA-011 Faridabad

16th May **2022**

Dr. P. P. MITTAL
Director

ENERGY AUDIT REPORT

OF

BML MUNJAL UNIVERSITY

National Highway 8, 67 KM Milestone, Gurgaon, Haryana 122413

Audited Period: 22nd Sept to 23rd Oct, 2019

Conducted by

INVENTUM POWER PVT. LIMITED.

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DOCUMENT CONTROL:

Document Title	**Energy Audit of BML Munjal University, Haryana**
Reviewed and Approved By	JK Sharma Head- Technical, Energy Audit Md. Shahrukh Khan Head- Business Development
Prepared By	Vishal Venkatesh Senior Executive Naveen Tyagi Executive Abhishek Kumar Executive

DISCLAIMER

This report is based on the information provided by the management of **BML MUNJAL UNIVERSITY, HARYANA** & on-site observations on specific dates. We certify that this information and following analysis is correct to the best of our knowledge and ability. The validity of the recommendations is dependent on the accuracy of log books and historical data supplied to us. This report (including any enclosures and attachments) has been prepared for the exclusive use and benefit of the addressee(s) and solely for the purpose for which it is provided. Unless we provide express prior written consent, no part of this report should be reproduced, distributed or communicated to any third party. We do not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report. The recommendations and findings are to be used by client at their own accord and Inventum Power Private Limited or its associates would not be responsible for any material or non-material losses (if any) occurring in any way due to their implementation.

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ACKNOWLEDGEMENT

INVENTUM POWER PVT. LTD. express our sincere thanks to the management of **"BML Munjal University"** for giving us the opportunity to conduct energy audit and give our findings to them.

INVENTUM POWER PVT. LTD. acknowledges and appreciates the commitment of the management towards conservation of Energy. It needs to be stated here that the **BML Munjal University** has been very supportive and cooperative resulting in expeditious completion of the energy audit.

We hereby also express our thanks to all other staff for their support during field study & data collection. We hope that the recommendations/suggestions given in this report will help to reduce the present energy consumption of the plant with reduced cost & improved productivity

TEAM MEMBERS MUNJAL UNIVERSITY

Mr Subir Mondal	-	Technical Head (Promind)
Mr Rakesh Bharadwaj	-	Manager Admin

TEAM MEMBERS FROM INVENTUM POWER PVT. LTD

Mr Vishal Venkatesh	-	Senior Executive
Mr. Naveen Tyagi	-	Executive
Mr. Abhishek Kumar	-	Executive

REPORT SUMMARY TABLE

Sr. No	Particulars	Page No
1	**Health Check-up of electrical distribution system and power Quality Analysis:** • THD V is within the limit as per IEEE standard. • **THD I is captured at higher side.** • According the electricity bill of last 12 months the average pf is 0.99. • Some of the MCB in the capacitor banks were faulty. These should be replaced.	16-22
2	**Chiller:** • SPC of chiller is found to be satisfactory. • Scope of energy saving by replacement of chilled water pumps.	23-25
3	**Cooling tower:** • Effectiveness of the Cooling towers is found to be satisfactory. • Scope of energy saving by replacement of CT blades	26
4	**Unitary AC System:** • By automation of AC significant energy saving can be achieved.	27
5	**DG performance:** • DG performance is satisfactory. • Operating hours of DG is very low so energy saving potential in DG is not feasible.	29-38
6	**AHU:** • Scope of energy saving by replacement of belt.	28
7	**Thermography:** • All the points are found okay.	41-44

1.EXECUTIVE SUMMARY

Energy is one of the major inputs in any industry and is the mainstay of the economic development of the country. Rising Electricity & fuel costs coupled with increased global competition is forcing players to slash the energy costs. Energy Audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating & maintenance practices of the system. It is instrumental in coping with the situation of variation in energy cost availability, reliability of energy supply, decision on appropriate energy mix, decision on using improved energy conservation equipment's, instrumentation's and technology.

The total expenditure in Electrical energy cost is about **3.4 Crore from Sept'18 to Sept'-19(Extrapolating for the months Electricity bill has not been provided).** It was aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities.

Energy conservation is a continuous process and there is always scope for further improvements, with this objective the Energy Audit team with the active involvement of **Munjal University,** have identified the following Energy Conservation Opportunities (ECO's). Implementation of the ECO's can further help reduce the energy consumption.

Electrical Energy Saving potential is 11%, accordingly we have enumerated the energy savings measures with reference to their payback periods. However, few measures are with larger payback periods but then there are certain initiatives which are necessary from modernization, energy conservation & corporate social responsibility point of view.

To review the reasons for excess energy consumption and Measures undertaken to improve Energy Efficiency, the following table would be helpful. Accordingly, we have enumerated the energy savings measures with reference to their payback periods.

1.1 ENERGY SAVING SUMMARY:

Sr.No	Energy Conservation Projects	Annual Energy Saving (KVAh)	Annual Monetary Saving in Rs.	Investment Rs.	Payback Period in Months	Co2 Emission Reduction in Ton	Page No
1	Energy saving achieved by replacement of Chilled water pump	3,454	27,631	1,00,000	43	2.8	25
2	Energy saving achieved by replacement of CT Blades	7,987	63,898	1,50,000	28	6.5	26
3	Energy saving achieved by installing V belt with synchronous belt in AHU	1,944	15,552	20,000	15	1.6	27
4	Energy saving achieved by installing Energy efficient fan	93,312	7,46,496	22,50,000	36	76.5	28
5	Energy saving by automation of AC	2,61,906	20,48,103	32,50,000	19	214.8	28
6	Energy saving by maintaining Voltage at 390V at all 3 transformers	85,103	6,80,822.4	Nil	Immediate	69.8	22
Total		3,68,603	35,82,501	57,70,000	19	302	

Table 1 : Energy Saving Summary

2. INTRODUCTION

2.1 OBJECTIVE OF ENERGY AUDIT:

Energy audit is the key to a systematic approach for decision-making in the area of energy management and gives a positive orientation to the energy resource cost reduction. The primary objective of the energy audit is to determine ways to reduce energy consumption to lower operating costs.

The Energy audit is conducted with the following Objectives:

- Detailed studies of the intended energy consuming equipment including historical and present energy performance trends
- Quantification of Energy Losses, and Energy Saving Potential
- Presentations of Energy Efficiency Measures with cost benefit analysis
- Identifying potential areas of electrical energy economy.

This energy audit assumes significance due to the fact that Munjal University**, total energy bill has crossed about 3.4 Crore from Dec'18 to Sept'19(Excluding Feb-19 & Aug-19)**and it was aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities.

2.2 ABOUT MUNJAL UNIVERSITY:

BML Munjal University is a fully residential and co-educational private university located in Sidhrawali, Gurgaon district, Haryana, India. The University was founded in 2014 by the promoters of the Hero Group, and is named after the group's chairman and founder Brij Mohan Lal Munjal.

2.3 ABOUT AUDIT TEAM MEMBERS:

We have dedicated and expert team for services. Your first point of contact with Inventum Power care will be with our dedicated customer services team. We are highly skilled, motivated and fully trained to assist you. Our services team includes our expert, highly experienced advisors for power factor correction systems, harmonic filter and others Energy and Power Quality problems who have over 40 years combined experience for the same. Each team member is dedicated to offering a high level of customer care and also strives for excellence to ensure that you receive the perfect service.

2.4 SCOPE OF ENERGY AUDIT WORK:

Electrical Distribution System:

- Study of Reactive Power Management and option for power factor improvement.
- Study of power quality issues like Power Factors, Voltages, Currents, Active Powers, Reactive Powers, Apparent Powers, THD & Harmonics at various load feeders.
- Capacitor bank health check-up
- Exploring the Energy Conservation Options (ENCON) in electrical distribution system to optimize transformer loading & improvement in level metering.
- Exploring the solutions for improving the power quality.

HVAC System

- Review the performance of the refrigeration & air conditioning systems including AHU, Chillers, Cooling tower, Air conditioners, find out Energy Efficiency Ratio, kW/TR, Specific TR loading and Kwh Calculation, available TR in the area through measuring velocity of air flow & temp. & humidity requirement as per existing & the proposed recommendation to suggest energy conservations means to improve the same.
- Collection of Inventory data of Air conditioners / Sample size selection and testing of power consumption and capacity (TR) delivered under the existing weather conditions / Air-conditioned floor area.

Pumps & Motors

- Performance assessment of HVAC pumps via Head/pressure, flow, power and determination of pump/motor loading based on measured parameters.
- Exploring the Energy Conservation Options (ENCON) in water pumping system. All saving & recommendation.

Lighting:

- Measurements of light intensity, lux levels at all locations covering all the type of rooms.
- Collection of inventory data of fixtures / Lux measurement and power consumption measurement at each location.
- Energy Conservation opportunity in lighting system

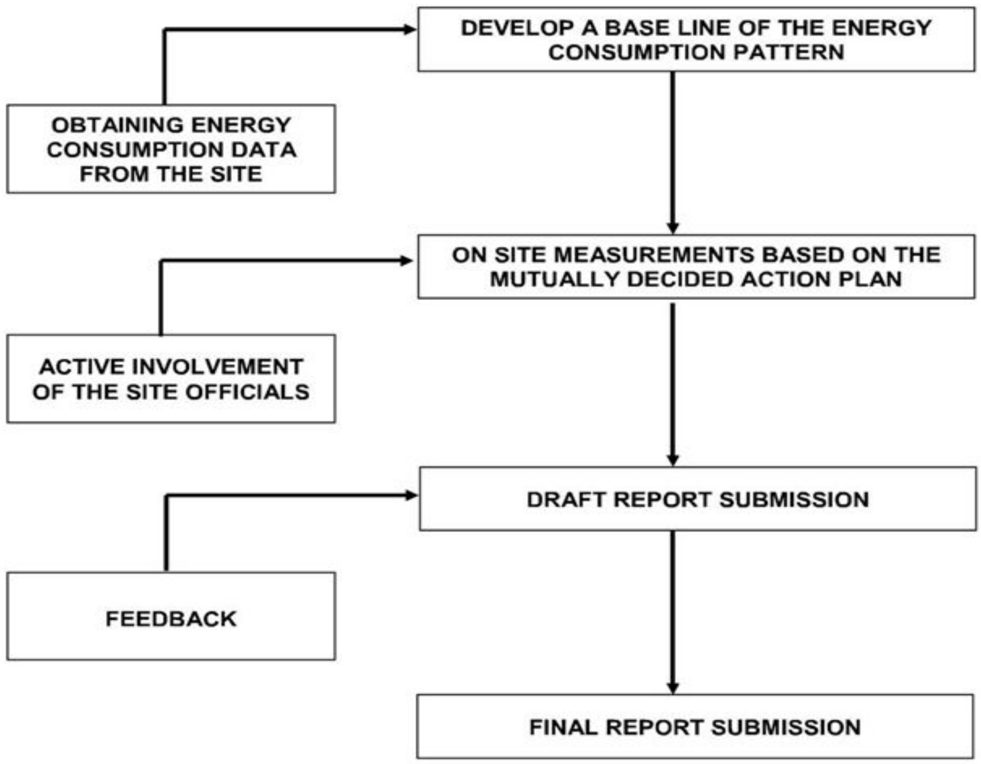
DG Sets:

- Review of the operation and performance of DG set through units generated, diesel consumption
- Specific fuel consumption in terms of KWh/Ltr and suggest for energy conservation opportunity.

2.5 METHODOLOGY OF WORK:

The methodology adopted for this audit was

- A preliminary energy audit has been conducted to establish the energy consumption of the organization by analyzing the available past energy consumption data, identification of the areas requiring more detailed study and measurements.
- Visual inspection and data collection.
- Identification/verification of energy consumption and other parameters by measurements.
- Computation and in-depth analysis of the collected data, including utilization of computerized analysis and other techniques as appropriate were done to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.
- Potential energy saving opportunities
- Flow Chart for Methodology for report preparation



This report is just first step, a mere mile marker towards our destination of achieving energy efficiency and we would like to emphasize that an energy audit is a continuous process. We have compiled a list of possible actions to conserve and efficiently utilize our scarce resources and identified their savings potential.

2.6 LIST OF INSTRUMENTS

- 3 Phase Power Analyzer-Fluke 1736
- Ultrasonic water Flow Meter
- Power Clamp
- Distance Meter
- Anemometer
- Hygrometer
- Thermal Camera
- Lux meter

3. GENERAL INFORMATION ABOUT UNIT

3.1 GENERAL DETAILS:

Name & Address of the Unit	BML Munjal University
Operational Days	360 Days per annum
Contact Officer	Mr. Rakesh Bharadwaj
Electricity Connection Details & Consumption	
Connection Type	HT 11KV
Contract demand	1800 KVA
Average Max. Demand (Dec'18 to Sept'19)	1163 KVA
Annual Energy Purchased (Sept'18 to Sept'19)	42,55,140 KVAh
Annual Energy Purchased Cost (Sept'18 to Sept'19)	3.40 Crore

Table 2: General details of the unit

3.2 ASSUMPTIONS:

For calculation purpose, we have considered following:

Type of Energy Resources	UOM	Value
No. of operating hrs in a day	hours	16
Avg. Electric Rate	Rs. /kVAh	8

Table 3: Assumption for calculation

4. PERFORMANCE ASSESSMENT AND ENERGY SAVING SCOPE

4.1 ELECTRICAL DISTRUBUTION SYSTEM:

4.1.1 POWER QUALITY STUDY OF TRASFORMER AND APFC HEALTH CHECK-UP REPORT:

Figure 1:Transformer at Munjal University

Three Transformer of 1250 KVA each are installed and rated parameter details is given below table:

Sr. No	Particulars	TR 1	TR 2	TR 3
1	Rated KVA	1250	1250	1250
2	HV/LV-Voltage	11000/415	11000/415	11000/415
3	Make	Volt-Amp	Volt-Amp	Indian Transformers
4	Phase	3	3	3
5	Impedance	4.65%	4.65%	-

Table 4: Transformer name plate details

The 3-phase analyser is installed at Transformer-3 locations to captured Power quality parameters which are illustrated below tables:

Power Quality Summary of Transformer-3:

Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-L)	Volt	419	419	422	-
2	Average Current	kAmp	1284	1057	1228	-
3	Apparent power	kVA	312	255	299	869
4	Active power	kW	308	252	296	857
5	Reactive power	kVAr	49.6	37.9	39.7	144.5
6	Power Factor		0.99	0.99	0.99	-
7	THD-V	%	3.1	2.8	2.9	-
8	THD-I	%	11.5	10.7	9.1	-

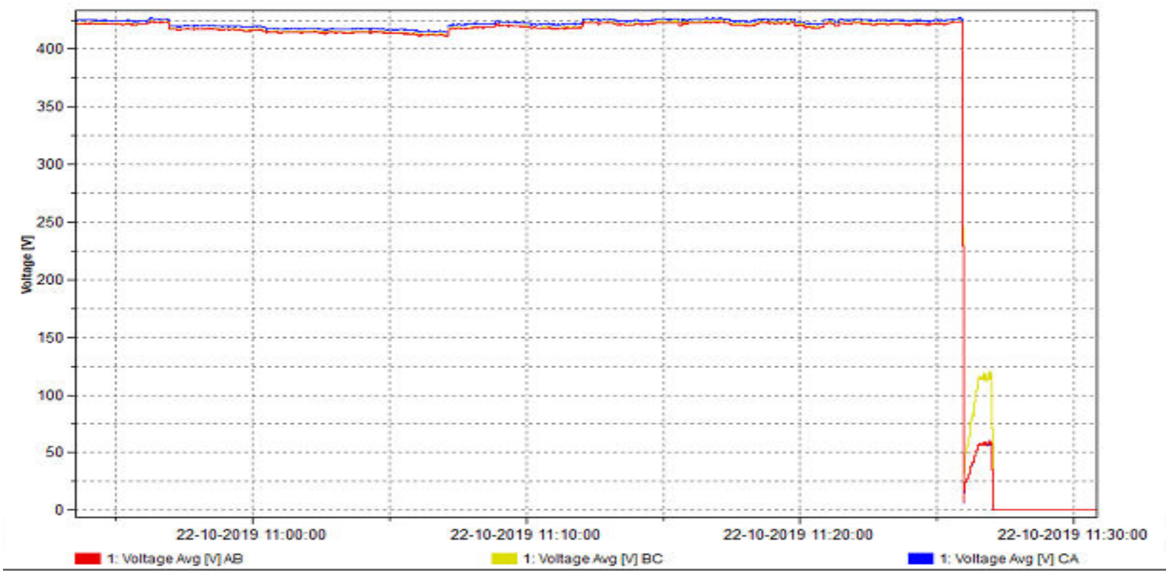
Table 5: PAQ Summary of Transformer-3 Incomer

Remark-

- **THD V is within the range as per IEEE Standard. The IEEE Standard is given at Annex. 1.**
- **THD I is slightly on the higher side.**

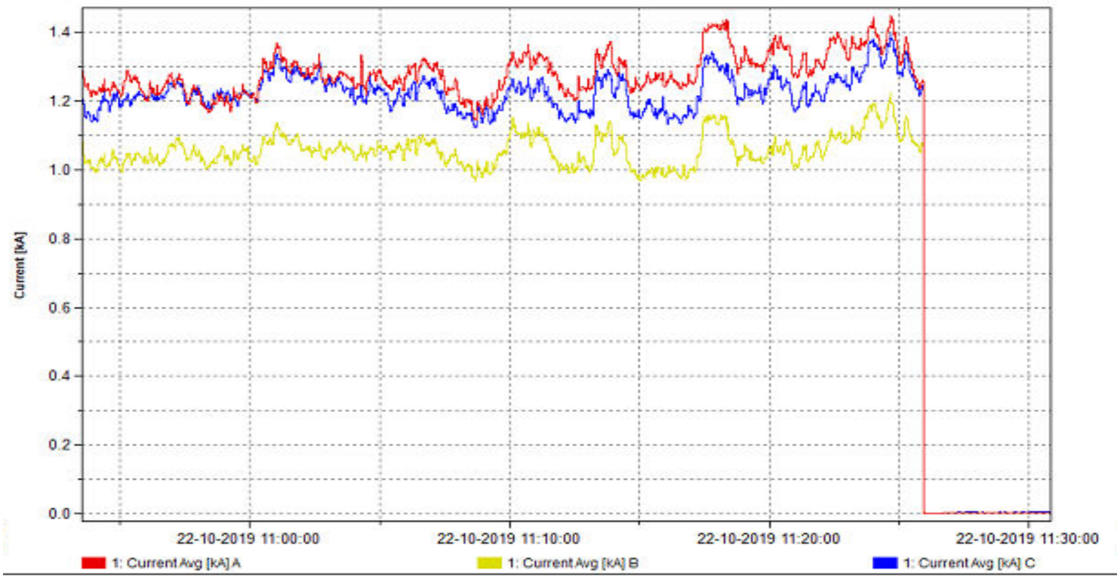
GRAPHICAL TREND OF DIFFERENT PARAMETERS AT MAIN TRANSFORMER:

Trend of RMS Voltage-



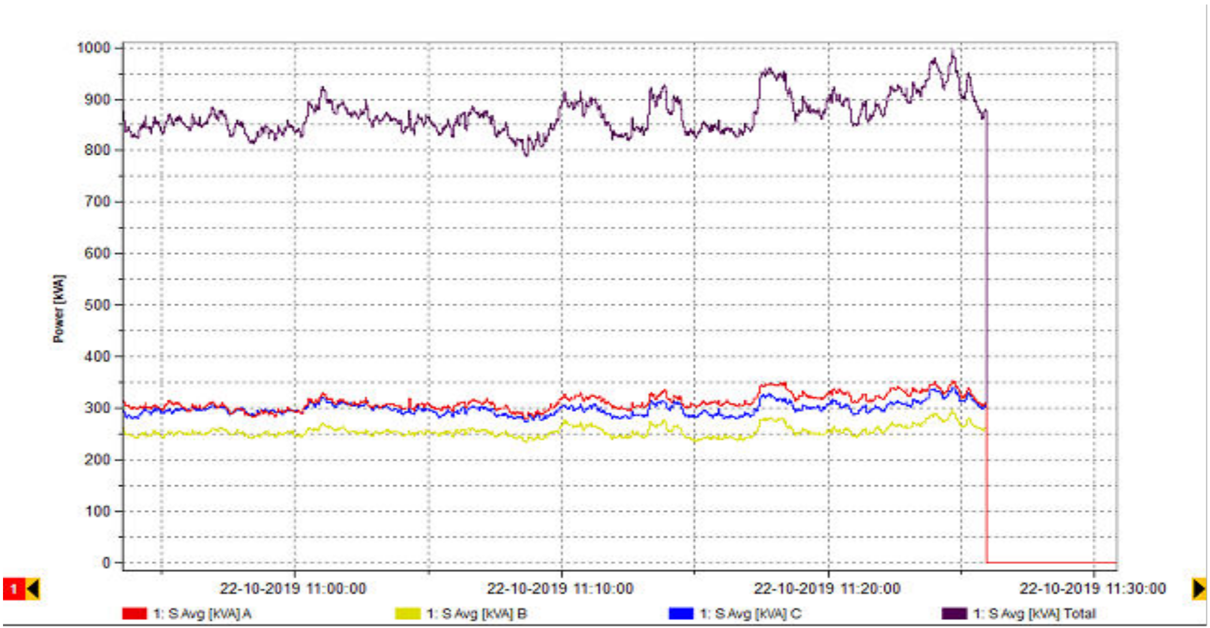
Parameter	UOM	Min	Max	Average
RMS V12 (Auto)	V	409	424	419
RMS V23 (Auto)	V	408	425	419
RMS V31 (Auto)	V	413	427	422

Trend of RMS Current-



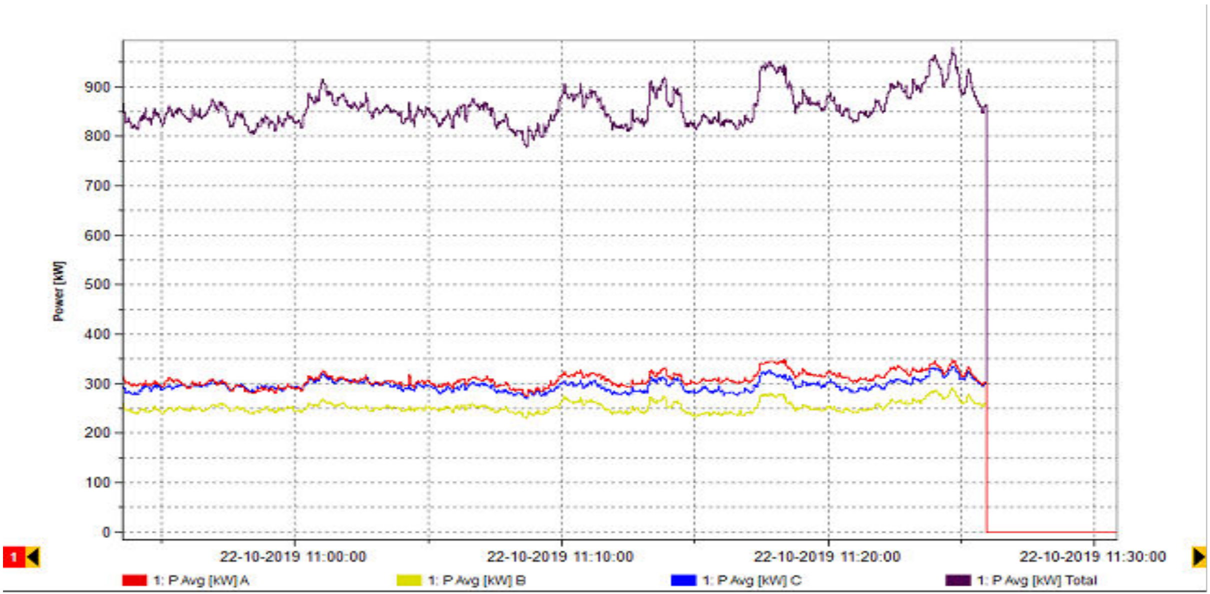
Parameter	UOM	Min	Max	Average
RMS I1 (Auto)	A	1087	1514	1284
RMS I2 (Auto)	A	946	1263	1057
RMS I3 (Auto)	A	1094	1437	1228

Trend of Apparent Power-



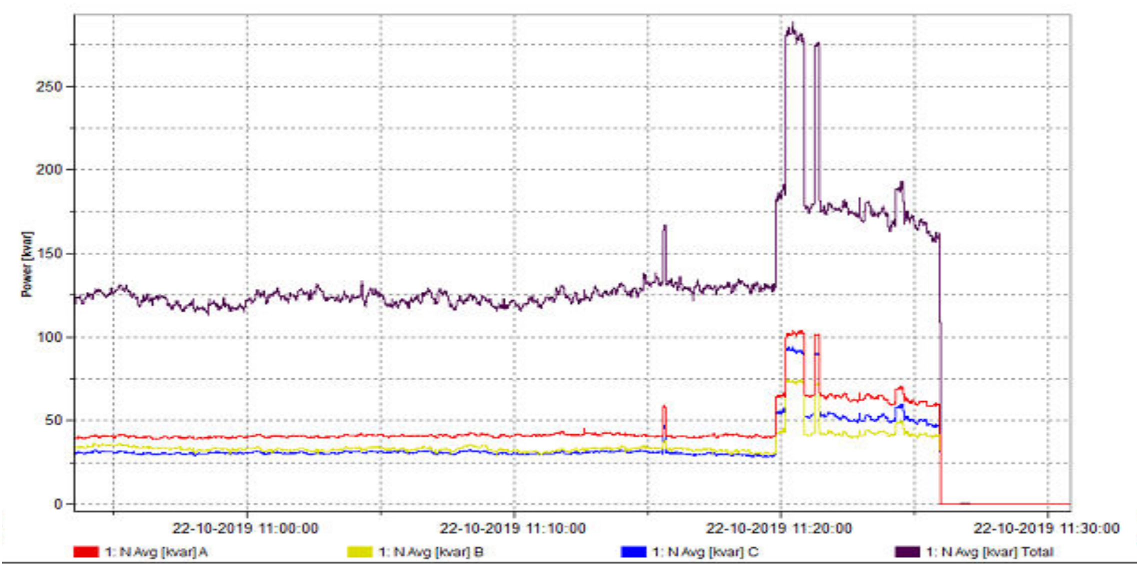
Parameter	UOM	Min	Max	Average
Apparent Power 1 (Auto)	kVA	278	354	312
Apparent Power 2 (Auto)	kVA	232	297	255
Apparent Power 3 (Auto)	kVA	272	342	299
Apparent Power Total (Auto)	kVA	786	996	869

Trend of Active Power-



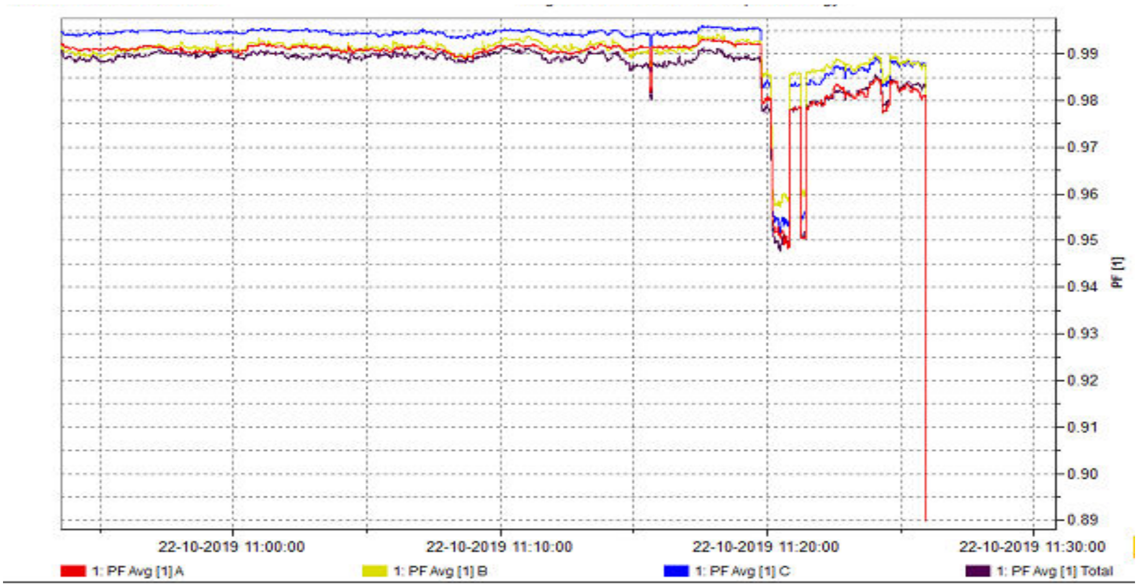
Parameter	UOM	Min	Max	Average
Active Power 1 (Auto)	kW	275	350	308
Active Power 2 (Auto)	kW	230	294	252
Active Power 3 (Auto)	kW	271	338	296
Active Power Total (Auto)	kW	777	980	857

Trend of Reactive Power-



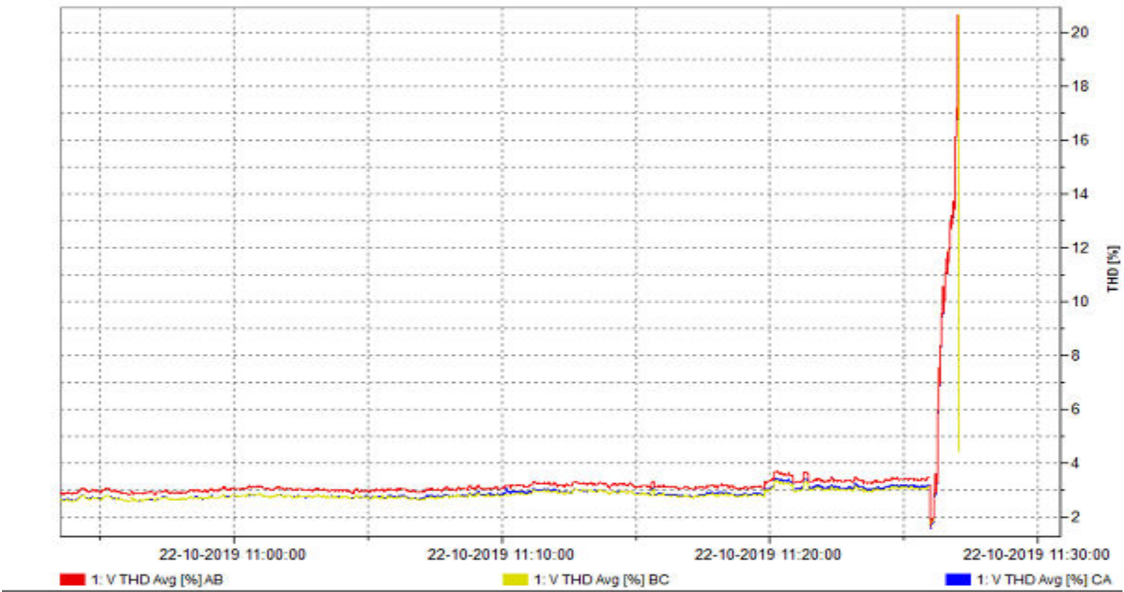
Parameter	UOM	Min	Max	Average
Reactive Power 1 (Auto)	KVAr	38.5	105.4	49.6
Reactive Power 2 (Auto)	KVAr	28.3	76	37.9
Reactive Power 3 (Auto)	KVAr	27.9	95.4	39.7
Reactive Power Total (Auto)	KVAr	112.4	292.3	144.5

Trend of Power Factor-



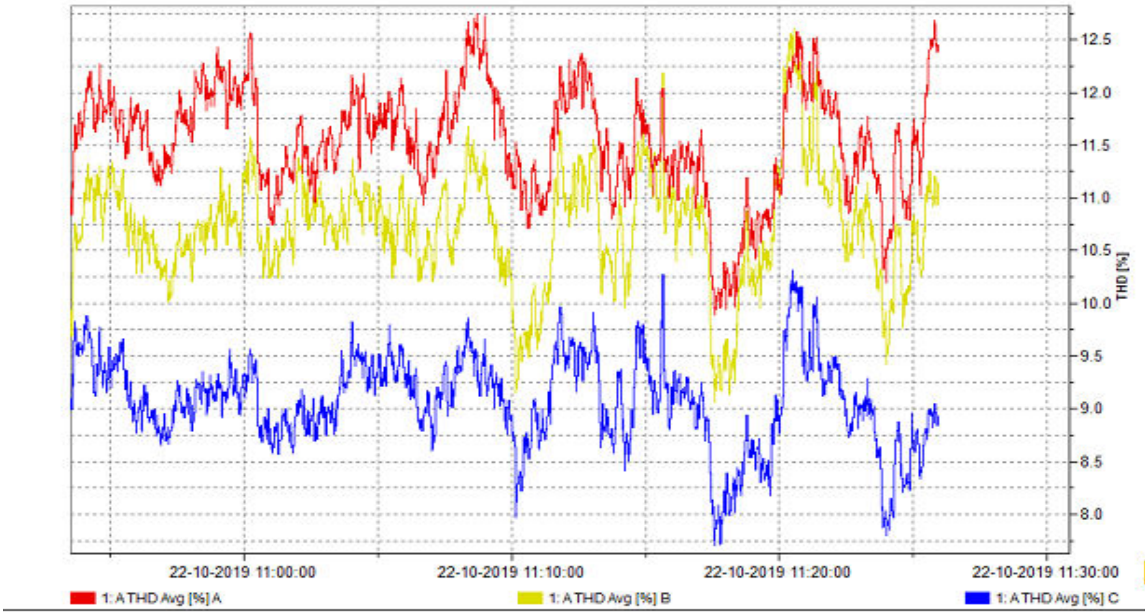
Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.95	0.99	0.99
Power Factor 2 (Auto)	0.96	0.99	0.99
Power Factor 3 (Auto)	0.95	1.00	0.99
Power Factor Total (Auto)	0.99	0.99	0.99

Trend of THD Voltage-



Parameter	UOM	Min	Max	Average
THD V12 (Auto)	%	2.8	3.7	3.1
THD V23 (Auto)	%	2.5	3.4	2.8
THD V31 (Auto)	%	2.6	3.4	2.9

Trend of THD Current-



Parameter	UOM	Min	Max	Average
THD I1 (Auto)	%	9.8	13	11.5
THD I2 (Auto)	%	9.0	13.1	10.7
THD I3 (Auto)	%	7.7	11.4	9.1

4.1.2 APFC HEALTH CHECH-UP:

375 KVAr APFC panel is installed on Transformer-3 for reactive power management. Our team check the performance of each capacitor bank which is tabulated below table:

HEALTH CHECKUP OF APFC 3: 375 KVAR

SR NO	BANK RATING	CURRENT			REMARKS
		R	Y	B	
1	100 KVAR	138	137	138	Okay
2	100 KVAR	133	135	135	Okay
3	25 KVAR				Contactor Faulty
4	25 KVAR				Not in Operation
5	25 KVAR	34	33	32	Okay
6	50 KVAR				MCB Faulty
7	50 KVAR	58	57	58	Okay

Table 6: Health Check-up of APFC Panel

Note: Our team observed the many of the wires were in burnt condition. This is a point of concern and should be rectified as soon as possible.

Figure 2:Burnt wires in APFC panel

We suggest to Maintain voltage at 390V on all 3 transformers. Energy saving analysis is given below

Sr. No	Particulars	UOM	Value
1	Total Energy consumption per year	KVAH	42,55,140
2	Running Voltage	Volt	420
3	Reduction in Volt	Volt	30
4	Saving by voltage reduction annually	%	2%
5	Annual Energy saving	KVAh	85,103
6	Unit Rate	Rs.	8
7	Annual Monetary Saving (in Lakhs)	Rs.	6,80,822.40
8	Investment	Rs.	Nil
9	Payback		Immediate

Table 7: Saving analysis on transformer

4.2 HVAC SYSTEM:

4.2.1 Chillers

There are 2 Air chillers at Munjal Electronics that are used for Human Cooling. Out of these 2, only 1 is running. We measured the performance of the chiller and the analysis is given below-

Figure 3: Chillers installed at Elin

Sr.no	Particulars	UOM	Chiller-1	Chiller-2
1	Company		Climaveneta	Climaveneta
2	Model		CA3902	CA3902
3	Y.O.M		2014	2014
4	Rated TR		280	270
5	Rated kW		416	-
6	Rated kW/TR		1.49	-
7	Evaporator In	°C	11.4	OFF
8	Evaporator Out	°C	9.8	
11	Set Point	°C	9.8	
12	Measured Ampere	A	65	
13	Delta T	°C	1.6	
14	Measured TR	TR	57	
15	Measured kW	KW	39	
16	Measured kW/TR	kW/TR	1.46	

Table 8: Chiller efficiency table

As seen above, the SPC of the chiller is found to be satisfactory but this SPC is calculated only a 30% loading, and should be revaluated.

4.2.2 Chilled water pumps:

There are 3 Chilled water pumps used for water circulation in Munjal university. Out of these 2 were running at the time. We measured the electrical parameters that are tabulated below

Figure 4:Chilled water pumps

Sr.no	Particulars	UOM	CWP Pump-1	CWP Pump-2	CWP Pump-3
1	Make		Groundfos	Groundfos	Groundfos
2	Rated KW	kW	9.3	9.3	9.3
3	Rated Current	A	17.5	17.5	17.5
4	Rated Flow	m3/hr	-	-	-
5	Rated Head	m	-	-	-
6	Rated Efficiency	%	88	88	88
7	Remarks		On	On	Off
8	Voltage	V	415	415	
9	Current	A	9.5	9.8	
10	P. F	-	0.78	0.79	
11	Active Power	KW	5.33	5.56	
12	Discharge Head	m	20	Broken	

Table 9: Chilled water pump

We observed that the chilled water motor is non energy efficient. We suggest to replace these motors by energy efficient motor-

Sr.no	Particulars	UOM	Value
1	Average consumption of non-Efficient Chilled water pump	kW	5.33
2	% Saving by installation of new energy efficient pump	%	15
3	No. to be replaced	No	2
4	Operating hours	Hours	9

5	Annual Operation days	Days	240
6	Annual Energy saving	KVAh	3453.84
7	Unit Price	Rs	8
8	Annual Monetary Saving	Rs	27,631
9	Investment	Rs	1,00,000
10	Payback period	Months	43

Table 10: Energy saving analysis for CWP

4.2.3 Cooling Tower:

There are 2 cooling towers of 450TR each in Munjal university with 2 fans for each one. We measured the water in and water out temp as well as the electrical parameters for each cooling tower. The data is given below:

Sr.No	Particulars	UOM	CT-1	CT-2
1	Capacity	TR	450	450
2	Cooling Tower In	°C	18.4	18.4
3	Cooling Tower Out	°C	17	17.1
4	DBT	°C	14.8	14.7
5	WBT	°C	18.5	18.4
6	RH	%	52.8	53.3
7	Range	°C	1.4	1.3
8	Approach	°C	1.9	1.9
9	CT Effectiveness	%	42%	41%
10	Remark		Satisfactory	Satisfactory

Table 11: Cooling tower data

Sr.no	Particulars	UOM	CT-1		CT-2	
			Fan-1	Fan-2	Fan-1	Fan-2
1	Rated KW	KW	7.5	7.5	7.5	7.5
2	Voltage	V	415	415	415	415
3	Current	A	8.6	8.3	8.5	8.7
4	P. F	-	0.83	0.85	0.82	0.83
5	Active Power	KW	5.13	5.07	5.01	5.19

Table 12: Cooling tower fans data

Currently the cooling tower utilises Metallic blades for CT Fans. We suggest to replace these metallic blades by FRP Blade for energy saving:

Sr.no	Parameters	UOM	Value
1	Energy consumption of Metallic blades	kWh	5.2
2	Energy saving potential	%	20
3	Operating hours	Hours	10
4	Annual operation days	Days	240
5	No of units to be replaced	No	4
6	Annual energy saving	KVAh	9984
7	Unit Rate	Rs.	8
8	Annual monetary saving	Rs.	79,872
9	Investment	Rs	1,50,000
10	Payback	Months	23

Table 13: Energy saving analysis for CT

4.2.4 UNITARY AC SYSTEM

The average EER of the window ac is 2.36 which is low compared to 3-star Ac's EER 3.50 in the market. For energy saving is AC we suggest:

1. Maintain the set point between 24^{O}C to 27^{O}C.
2. Prevent Air Leakage from the envelops.
3. Replace Non star rating ac with new energy efficient inverter ac. The payback period will be depending 2 to 3 years base on the operating hours of the AC's.
4. Install automation system in AC's to control the compressor off/on cycle by. The energy saving analysis is captured below table:

Sr. No	Particulars	UOM	Value
1	Average Energy Consumption	KWh	1.6
2	% Energy Saving	%	17
3	Operating Hour per day	hour	8
4	No of Days	No	240
5	No of Unitary Systems	No	500
6	Annual Energy Saving	KVAh	261906
7	Cost of electricity	Rs/unit	7.82
8	Annual Monetary Saving	Rs	20,48,103
9	Investment	Rs.	32,50,000
10	Payback	Months	19

Table 14: Energy saving Analysis by AC's Automation

Ceiling Fan: The existing fan are old types of fan, currently in the market energy efficient fan (**Gorilla make**) are available in the market which can save significant of energy. Although the payback period is high, the unit can plant for long term goal. **The energy saving analysis is given below:**

Sr.no	Parameters	UOM	Value
1	Wattage of each fan	W	60
2	Wattage of energy efficient fan	W	28
3	Wattage saved	kW	0.032
4	Operating hours	Hours	12
5	Total no of fans to be replaced	No	900
6	Annual operation days	Days	270
7	Annual Energy saving	KVAh	93312
8	Unit rate	Rs/unit	8
9	Annual Monetary Saving	Rs	7,46,496

10	Investment	Rs	22,50,000
11	Payback period	Months	36

Table 15: Energy saving Analysis of energy efficient fan

AIR HANDLING UNIT:

We evaluated the efficiency of 3 main AHU in the university that are given below:

Sr.no	Location	Rated CFM	Rated Kw	Measured Kw	Measured CFM	Remark
1	MPH	15000	7.5	7.43	14406	Satisfactory
2	MPH	15000	7.5	7.49	14202.0	Satisfactory
3	Auditorium	8000	7.5	6.66	7716.2	Satisfactory

We observed that the belt in the AHU is of V belt type. Our suggestion is to replace this V belt with Synchronous belt for Energy saving:

Figure 5:V belt in AHU

Sr.no	Parameters	UOM	Value
1	AHU load		21.6
2	% Energy saving	%	3
3	Annual operating hours	Hours	3000
4	Annual energy saving	KVAh	1944
5	Unit Rate	Rs.	8
6	Annual monetary saving	Rs.	15,552
7	Investment	Rs	20,000
8	Payback	Months	15

Table 16: Energy saving analysis for AHU

4.4 DIESEL GENERATING SETS:

Four DG sets rated 500KVA x2 and 1010KVA x2 are present to supply the energy during power cut/load shading. We tested the performance the DG set with the help of analyser and fuel measurement. Below table represents the performance assessment of the DG

Figure 6: DG Present at Munjal University

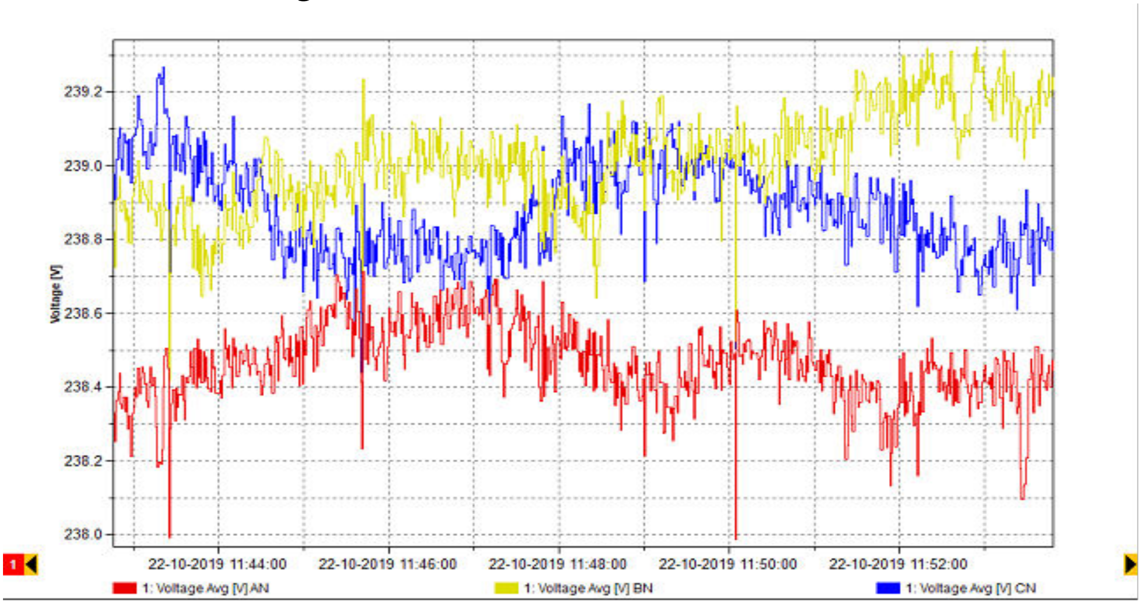
Sr.no	Particulars	UOM	DG-1(500 KVA)	DG-2(500 KVA)	DG-3(1010 KVA)	DG-4(1010 KVA)
1	Energy Consumption	kWh	44.4	OFF	133.5	OFF
2	Diesel consumed	Litre	12.8		36.9	
3	kWh/Ltr		3.47		3.62	
4	Remark		Satisfactory		Satisfactory	

Table 17: Performance assessment of DG.

500 KVA DG Measurement details:

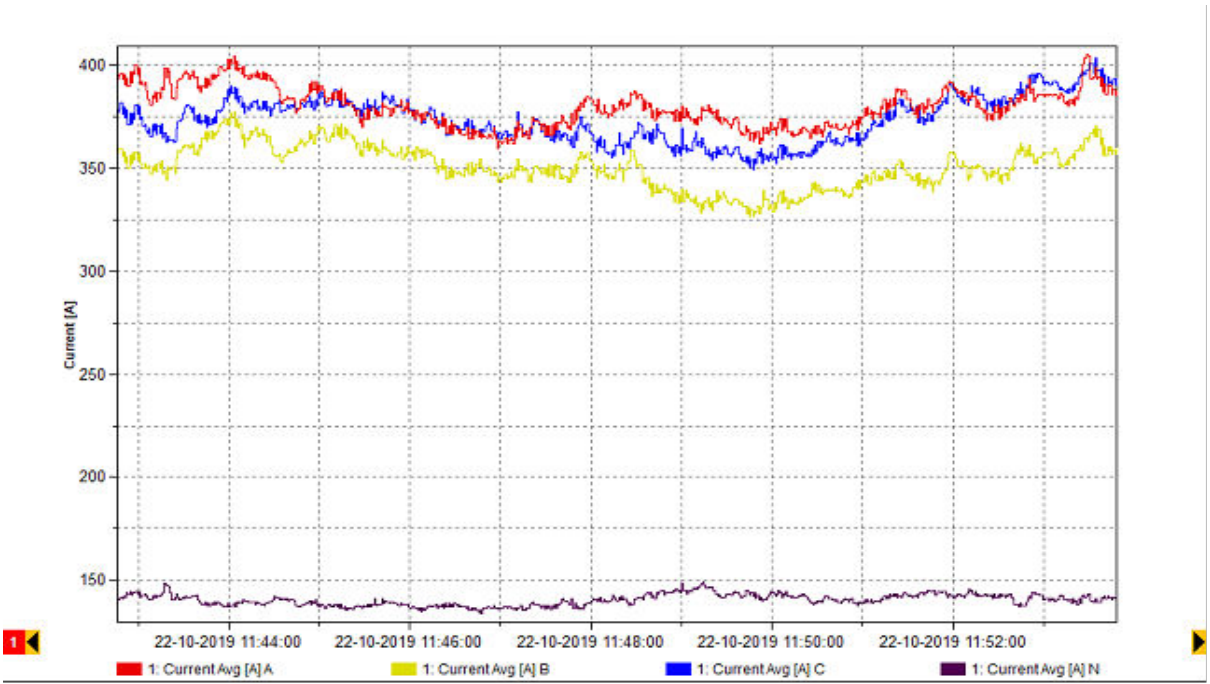
Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-N)	Volt	239	239	238	-
2	Average Current	Amp	380	350	373	-
3	Apparent power	kVA	90.64	83.84	89.26	270.21
4	Active power	kW	84.04	76.59	80.7	241.34
5	Reactive power	kVAr	33.95	34.11	38.12	121.52
6	Power Factor		0.93	0.91	0.9	0.89
7	THD-V	%	3.6	3.7	3.3	-
8	THD-I	%	15.5	17.3	15.3	-

Trend of RMS Voltage-



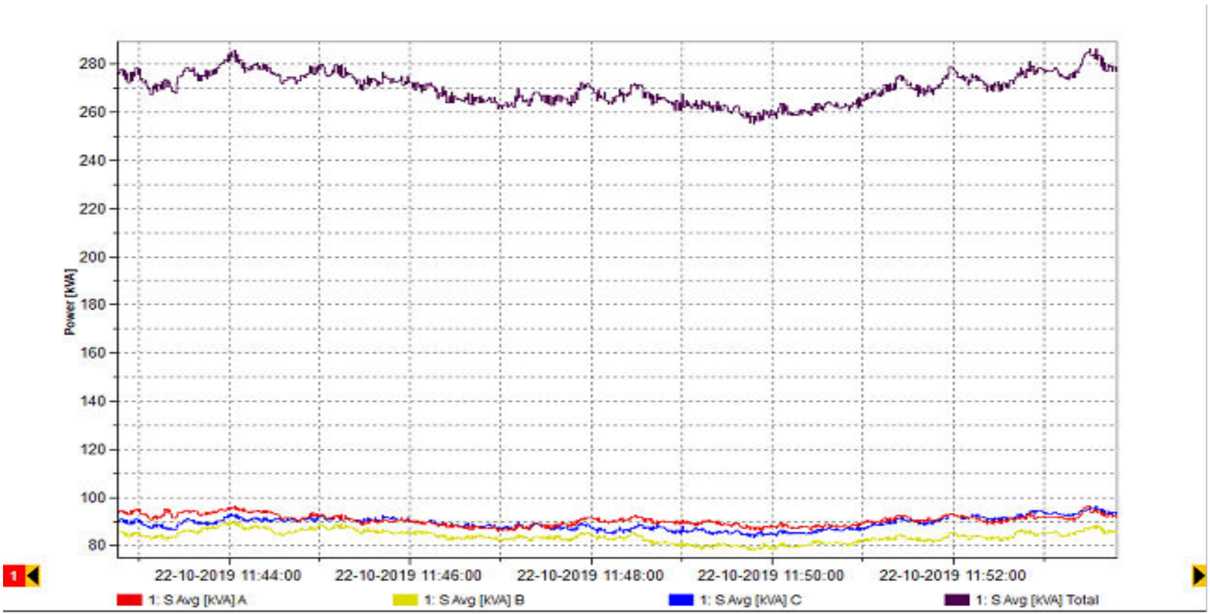
Parameter	UOM	Min	Max	Average
RMS V12 (Auto)	V	236	238	239
RMS V23 (Auto)	V	237	239	239
RMS V31 (Auto)	V	237	239	238

Trend of RMS Current



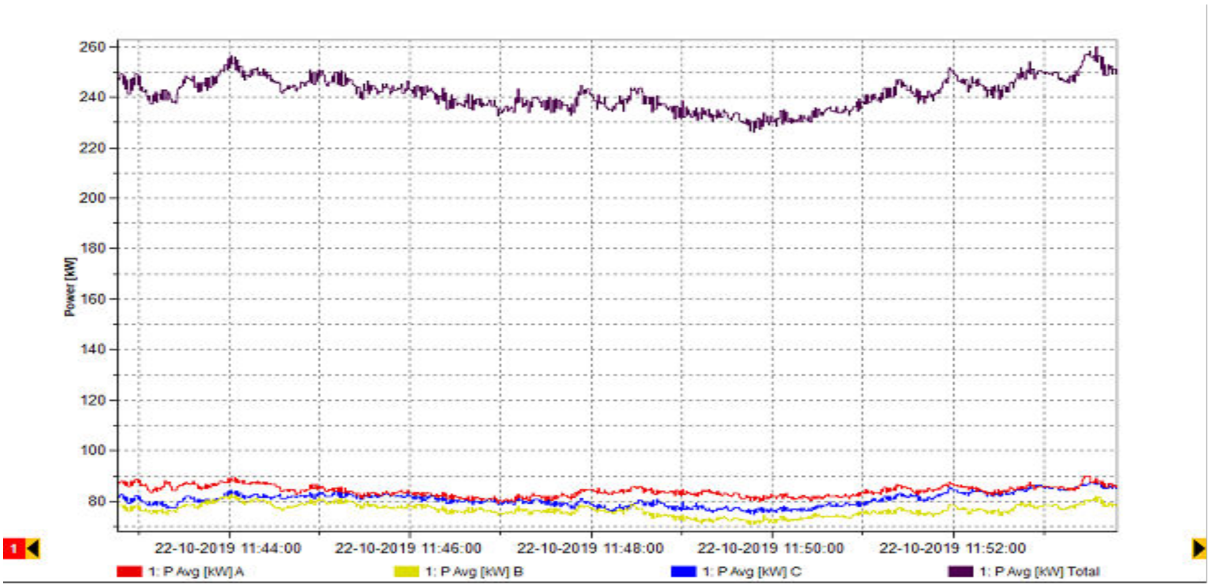
Parameter	UOM	Min	Max	Average
RMS I1 (Auto)	A	346	419	380
RMS I2 (Auto)	A	311	390	350
RMS I3 (Auto)	A	336	420	373

Trend of Apparent Power



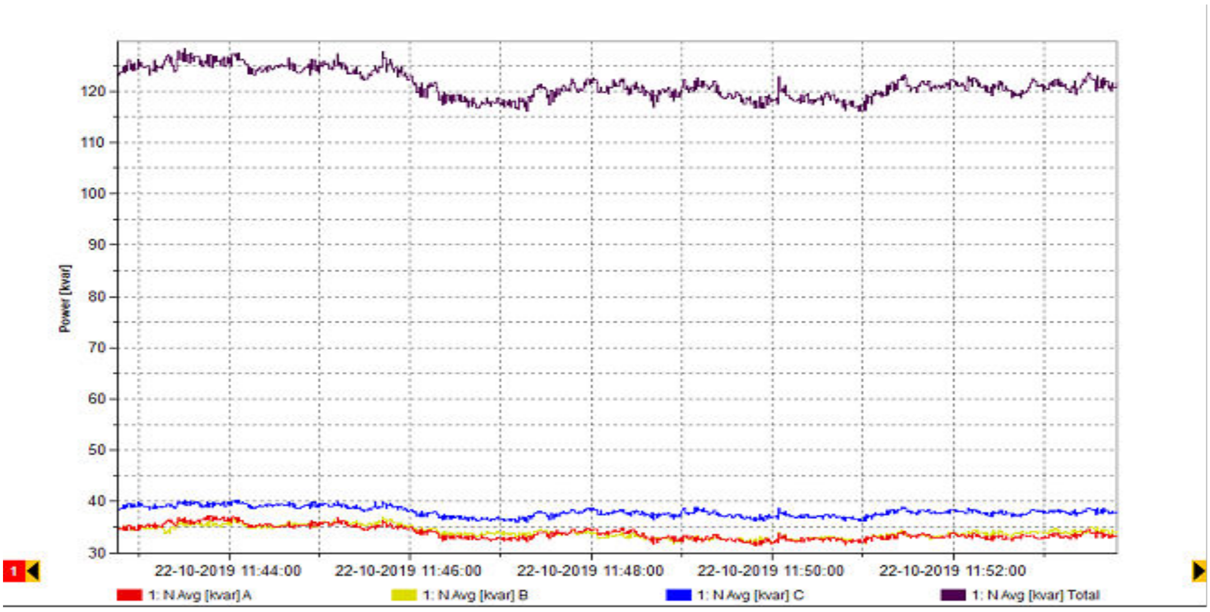
Parameter	UOM	Min	Max	Average
Apparent Power 1 (Auto)	kVA	85.37	97.74	90.64
Apparent Power 2 (Auto)	kVA	77.21	90.43	83.84
Apparent Power 3 (Auto)	kVA	82.77	96.91	89.26
Apparent Power Total (Auto)	kVA	252.9	289.14	270.21

Trend of Active Power



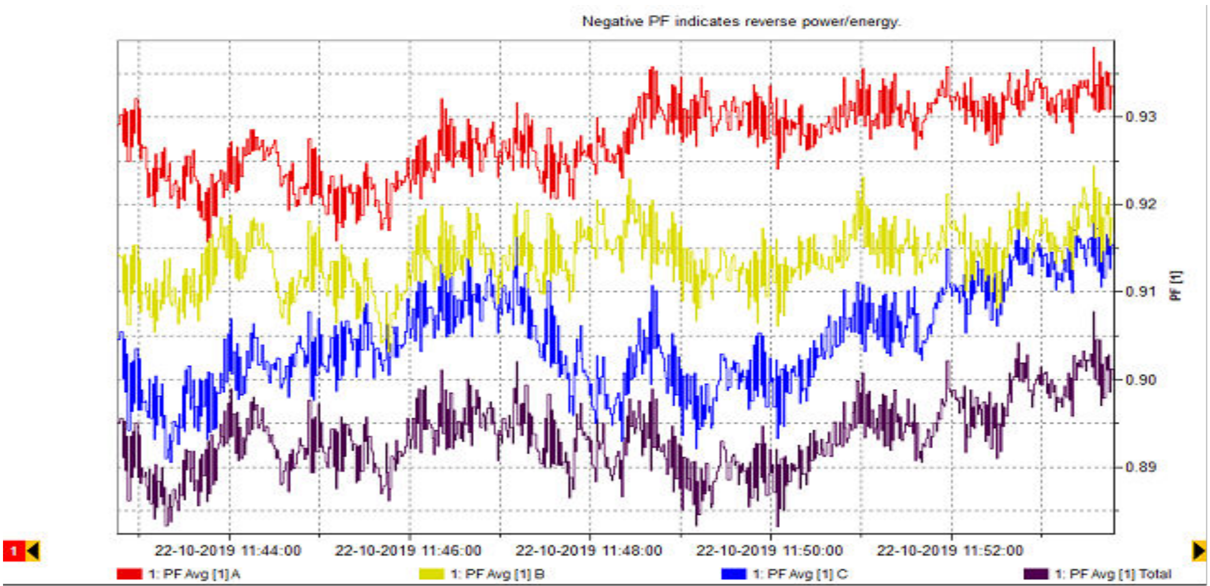
Parameter	UOM	Min	Max	Average
Active Power 1 (Auto)	kW	78.78	91.7	84.04
Active Power 2 (Auto)	kW	70.11	83.36	76.59
Active Power 3 (Auto)	kW	74.22	89.25	80.7
Active Power Total (Auto)	kW	223.85	261.52	241.34

Trend of Reactive Power



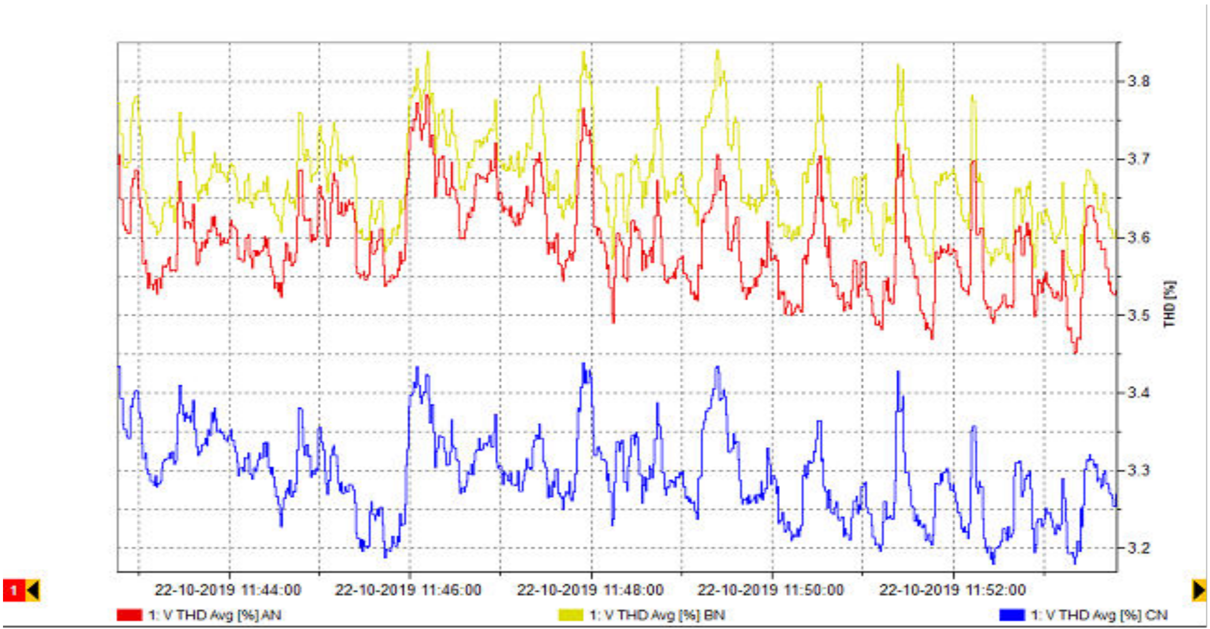
Parameter	UOM	Min	Max	Average
Reactive Power 1 (Auto)	KVAr	30.28	37.79	33.95
Reactive Power 2 (Auto)	KVAr	30.6	38.01	34.11
Reactive Power 3 (Auto)	KVAr	35.2	41.14	38.12
Reactive Power Total (Auto)	KVAr	114.5	130.38	121.52

Trend of Power Factor



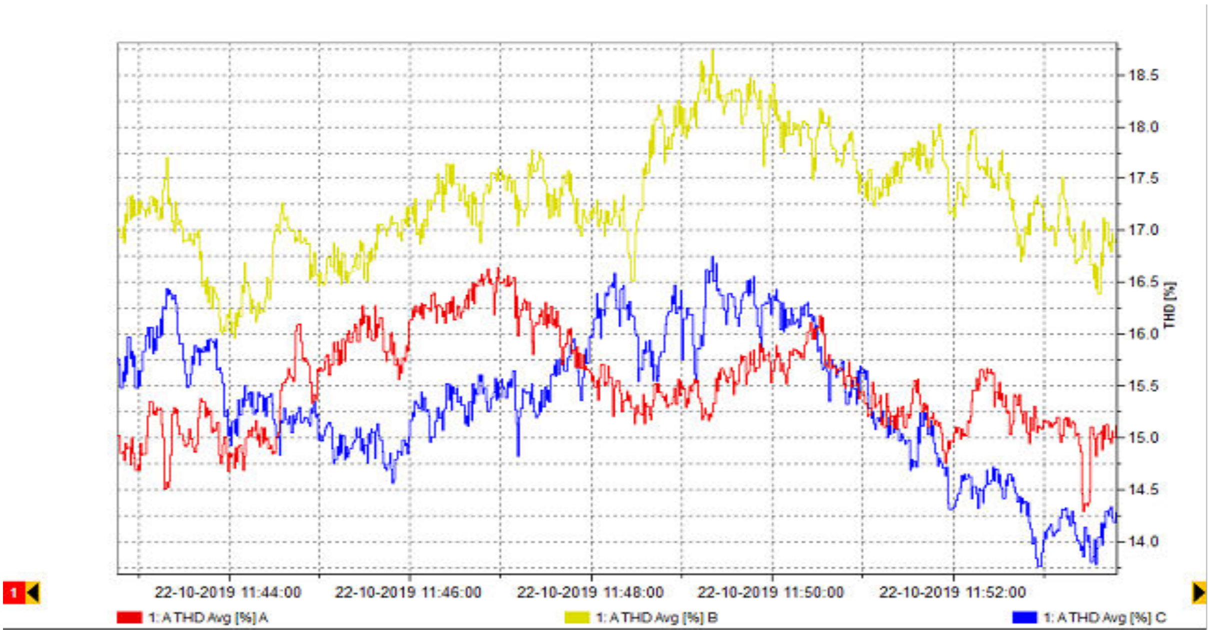
Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.92	0.94	0.93
Power Factor 2 (Auto)	0.9	0.92	0.91
Power Factor 3 (Auto)	0.89	0.92	0.9
Power Factor Total (Auto)	0.88	0.91	0.89

Trend of THD Voltage



Parameter	UOM	Min	Max	Average
THD V12 (Auto)	%	3.4	3.8	3.6
THD V23 (Auto)	%	3.5	3.9	3.7
THD V31 (Auto)	%	3.2	3.4	3.3

Trend of THD Current

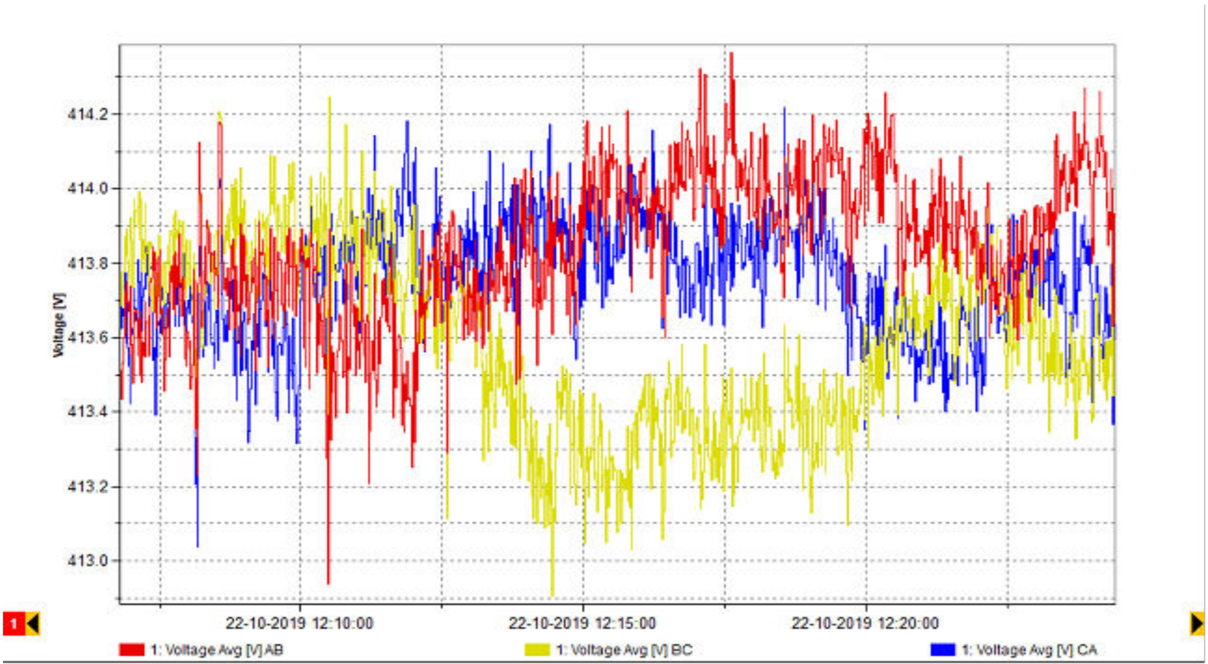


Parameter	UOM	Min	Max	Average
THD I1 (Auto)	%	14.2	16.9	15.5
THD I2 (Auto)	%	15.7	19	17.3
THD I3 (Auto)	%	13.6	16.9	15.3

1010 KVA DG Set Measurement details:

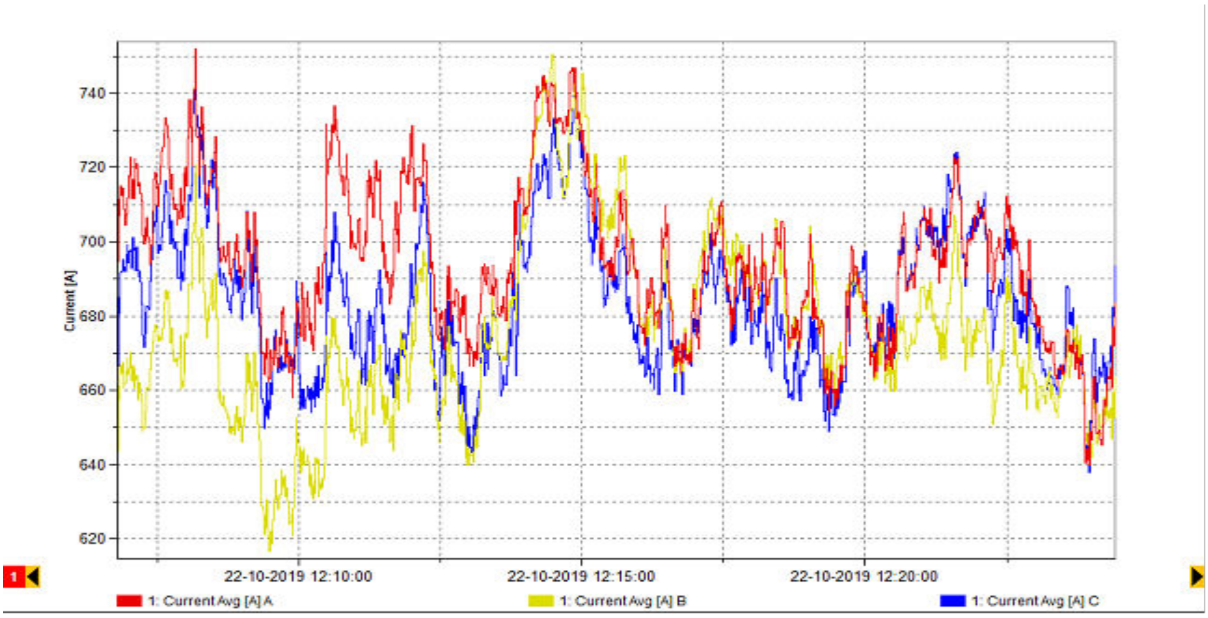
Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-L)	Volt	413	413	413	-
2	Average Current	Amp	694	676	684	-
3	Apparent power	kVA	166.01	161.52	163.36	490.94
4	Active power	kW	155.11	150.96	150.12	456.20
5	Reactive power	kVAr	59.18	57.44	64.41	181.40
6	Power Factor		0.93	0.93	0.92	0.93
7	THD-V	%	3.4	3.2	3.3	-
8	THD-I	%	15.8	13.4	13.9	-

Trend of RMS Voltage-



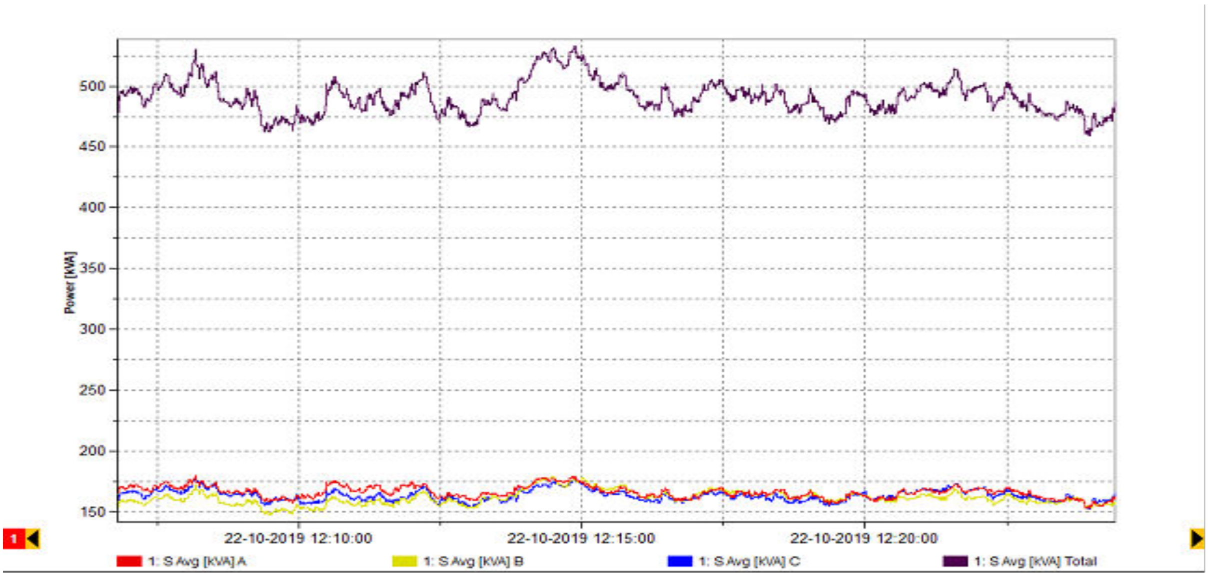
Parameter	UOM	Min	Max	Average
RMS V12 (Auto)	V	410	414	413
RMS V23 (Auto)	V	410	414	413
RMS V31 (Auto)	V	410	414	413

Trend of RMS Current-



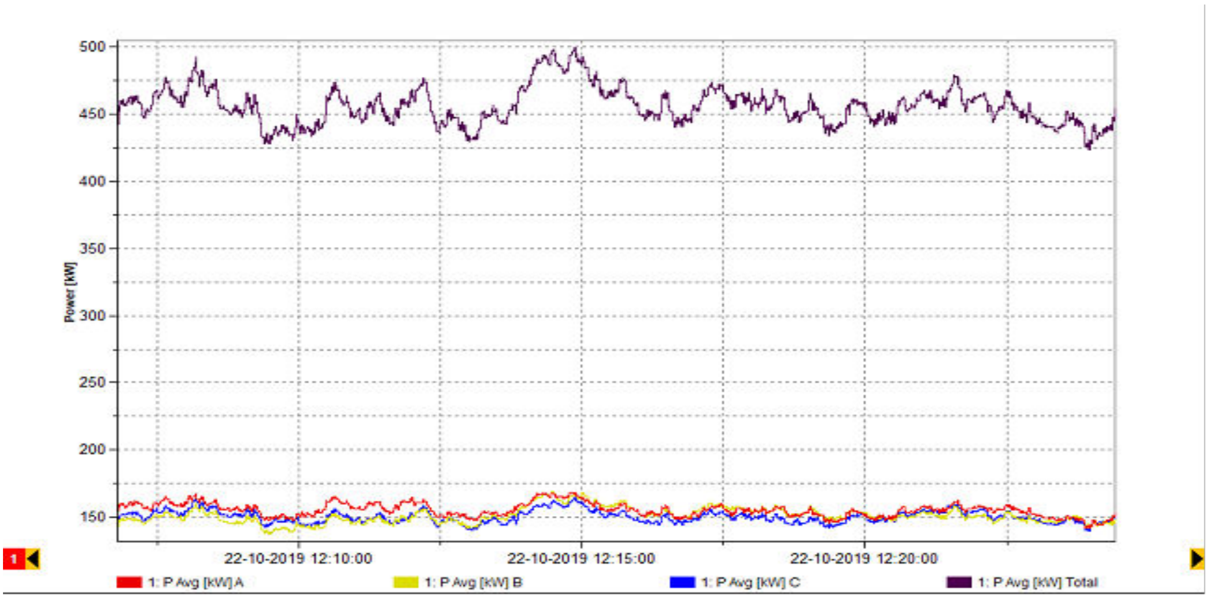
Parameter	UOM	Min	Max	Average
RMS I1 (Auto)	A	625	785	694
RMS I2 (Auto)	A	602	763	676
RMS I3 (Auto)	A	624	793	684

Trend of Apparent Power



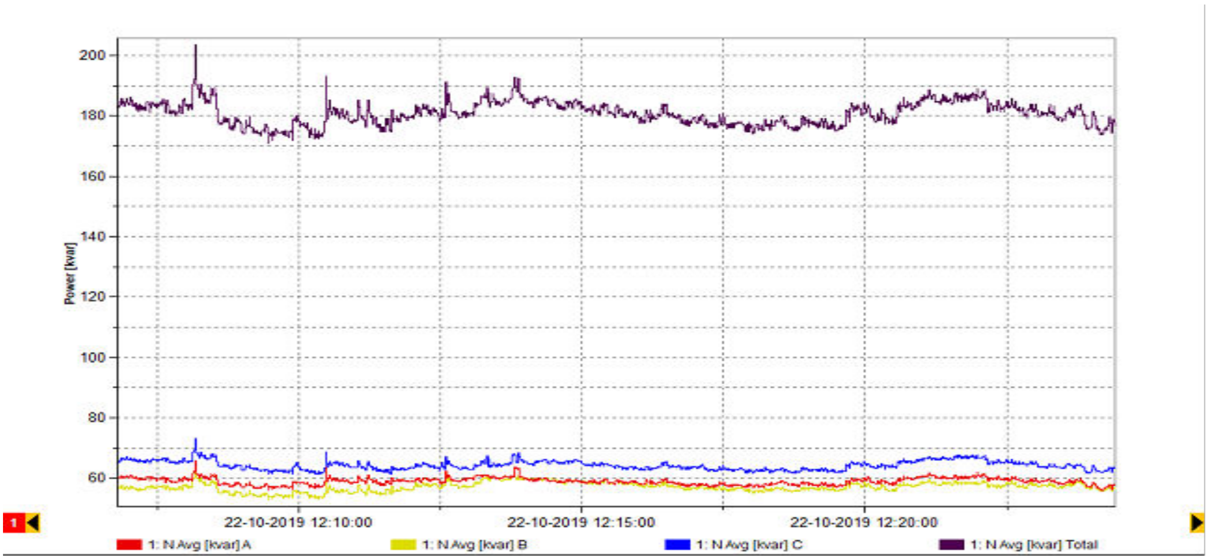
Parameter	UOM	Min	Max	Average
Apparent Power 1 (Auto)	kVA	152.38	181.71	166.01
Apparent Power 2 (Auto)	kVA	145.92	180.07	161.52
Apparent Power 3 (Auto)	kVA	151.77	181.97	163.36
Apparent Power Total (Auto)	kVA	456.98	538.65	490.94

Trend of Active Power



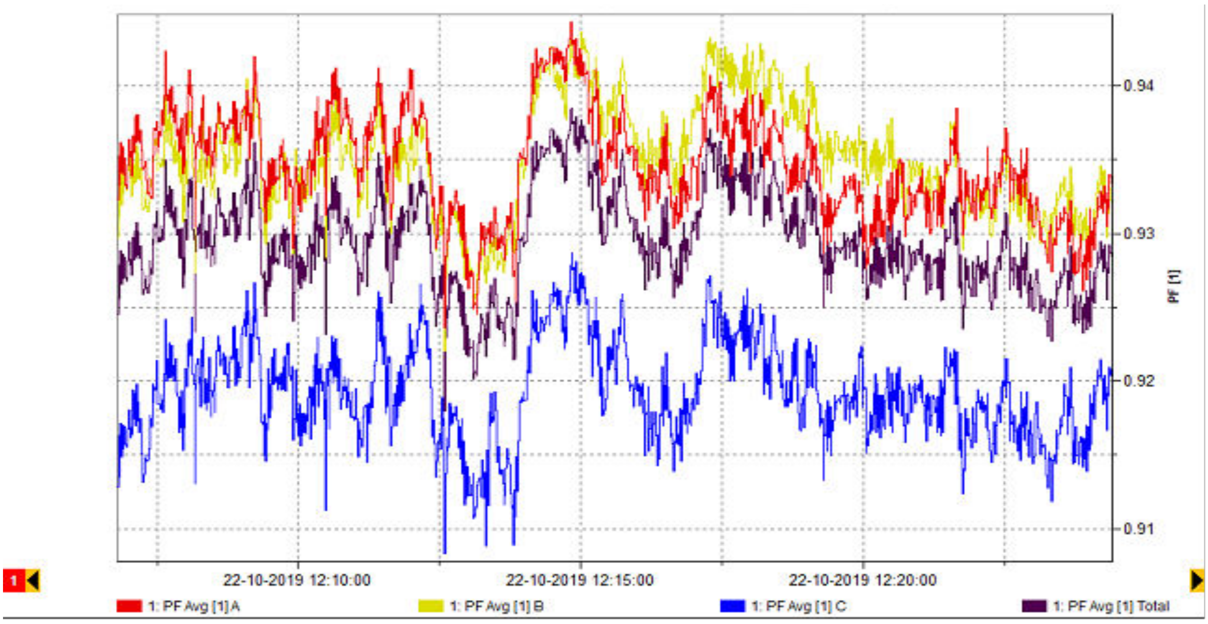
Parameter	UOM	Min	Max	Average
Active Power 1 (Auto)	kW	140.99	169.86	155.11
Active Power 2 (Auto)	kW	135.80	169.93	150.96
Active Power 3 (Auto)	kW	138.69	166.09	150.12
Active Power Total (Auto)	kW	422.29	502.38	456.20

Trend of Reactive Power



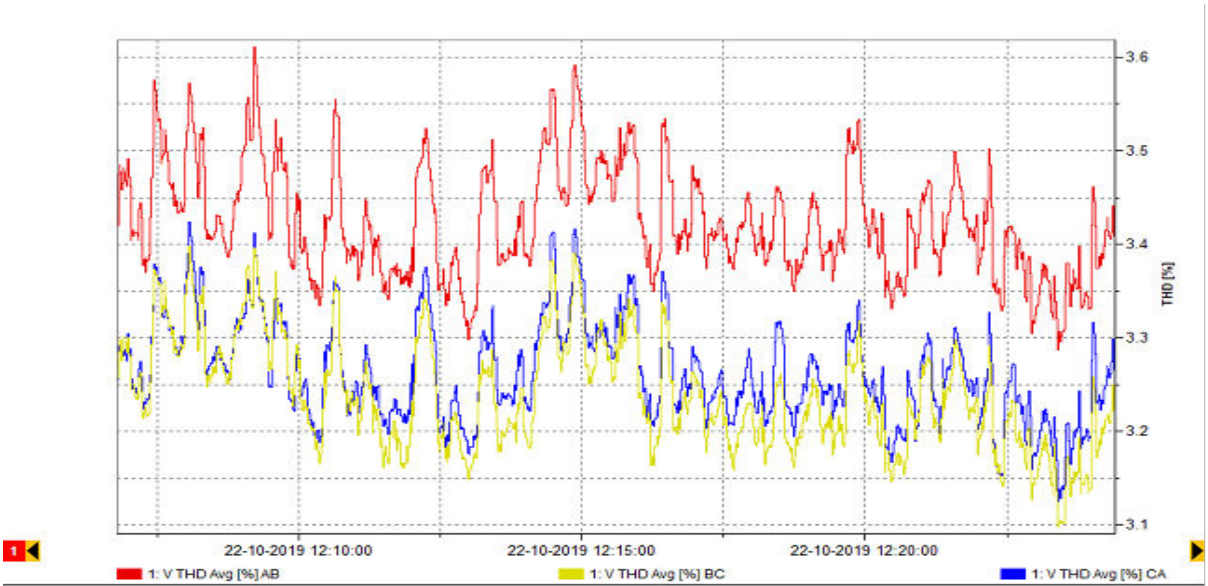
Parameter	UOM	Min	Max	Average
Reactive Power 1 (Auto)	KVAr	55.56	68.00	59.18
Reactive Power 2 (Auto)	KVAr	52.47	66.20	57.44
Reactive Power 3 (Auto)	KVAr	60.37	75.36	64.41
Reactive Power Total (Auto)	KVAr	170.20	210.15	181.40

Trend of Power Factor



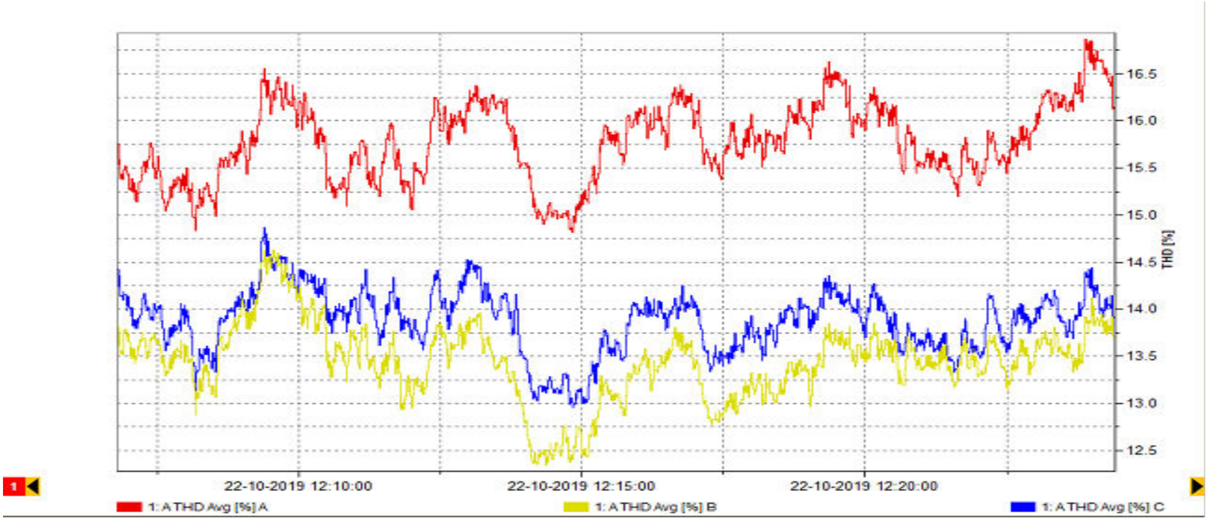
Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.92	0.94	0.93
Power Factor 2 (Auto)	0.92	0.94	0.93
Power Factor 3 (Auto)	0.91	0.93	0.92
Power Factor Total (Auto)	0.92	0.94	0.93

Trend of THD Voltage



Parameter	UOM	Min	Max	Average
THD V12 (Auto)	%	3.3	3.6	3.4
THD V23 (Auto)	%	3.1	3.4	3.2
THD V31 (Auto)	%	3.1	3.4	3.3

Trend of THD Current



Parameter	UOM	Min	Max	Average
THD I1 (Auto)	%	14.6	16.9	15.8
THD I2 (Auto)	%	12.2	14.7	13.4
THD I3 (Auto)	%	12.9	14.9	13.9

5. ELECTRICITY BILL ANALYSIS

5.1 MONTHLY ELECTRICITY CONSUMPTION TREND:

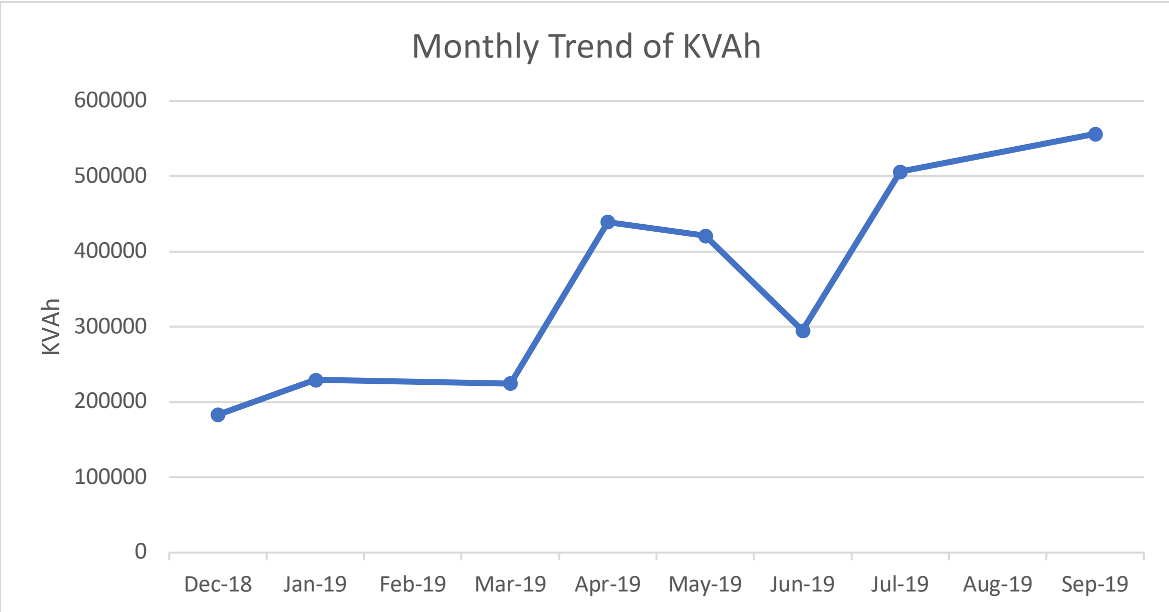


Figure 7: Monthly Electricity Consumption Trend (KVAH)

5.2 MONTHLY ELECTRICITY COST TREND:

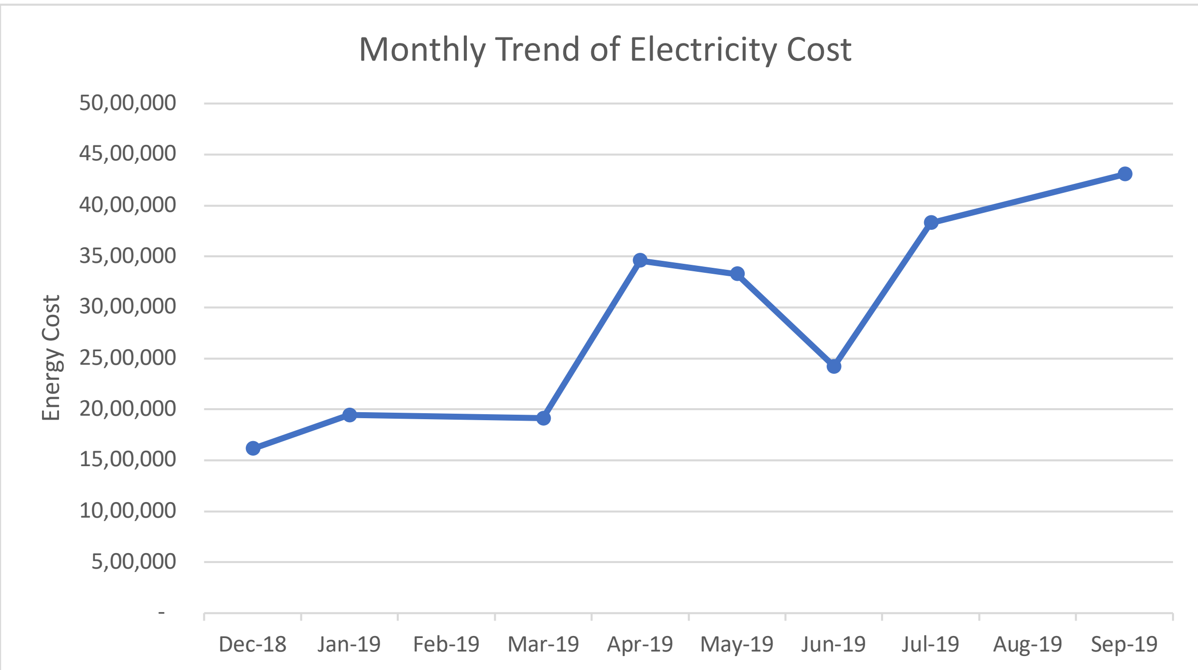


Figure 8: Monthly Electricity Cost Trend

5.3 MONTHLY POWER FACTOR TREND:

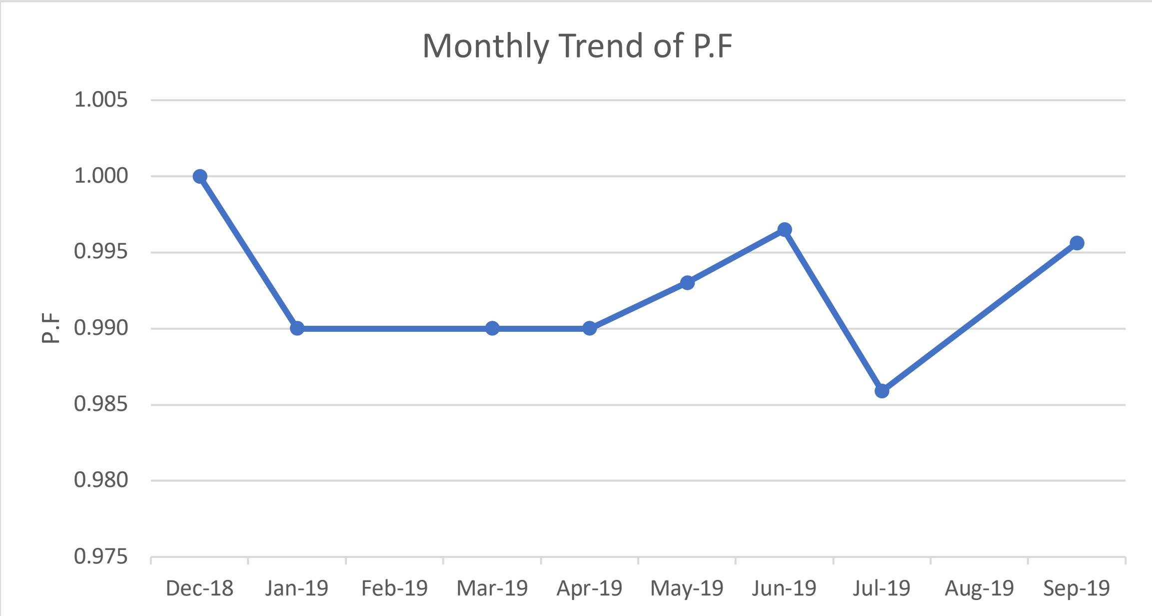


Figure 9: Monthly PF Trend

5.4 MONTHLY CON. DEMAND VS MAX.DEMAND TREND:

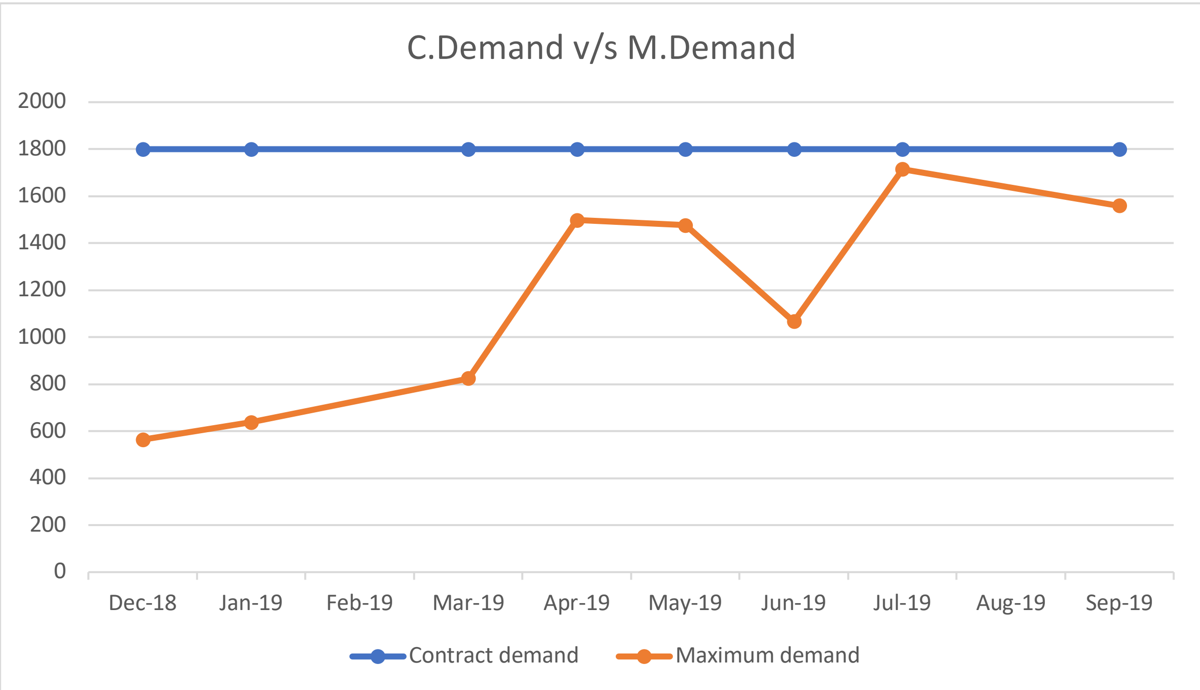


Figure 10: Monthly Contract demand vs Maximum demand trend

6. Thermography

Each thermography is given a Subjective Fault Category Ratings, which is determined on risk of failure, based upon our opinion, of how critical the subject item is to the energy

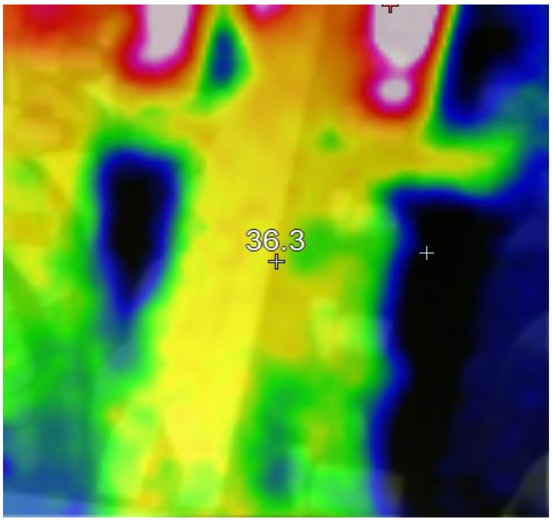
Fault Category	Temperature Rise Above Ambient	Recommendations
Normal	1 ^{O}C to 11 ^{O}C	No need to repair
Beginning of Problem	>11 ^{O}C to 21 ^{O}C	Monitor Routinely
First Stage of Overheating	>21 ^{O}C to 41 ^{O}C	Repair as soon as possible
Excessive Overheating	>41 ^{O}C	Repair Immediately

Table 18: Fault Category Rating Logic

Anomaly Summary:

Sr. No	Location	Measured Temperature (^{O}C)	Remark
1	LT Room-TF Incomer-3	36.3	No Need to repair
2	LT Room-E2 Building 1R	26.6	No Need to repair
3	LT Room-Main Panel-1B	28	No Need to repair
4	LT Room-9B Villa	30.5	No Need to repair
5	LT Room-Gateway BLDG	30.3	No Need to repair
6	LT Room-Substation	27.7	No Need to repair

1.LT Room-TF Incomer-3



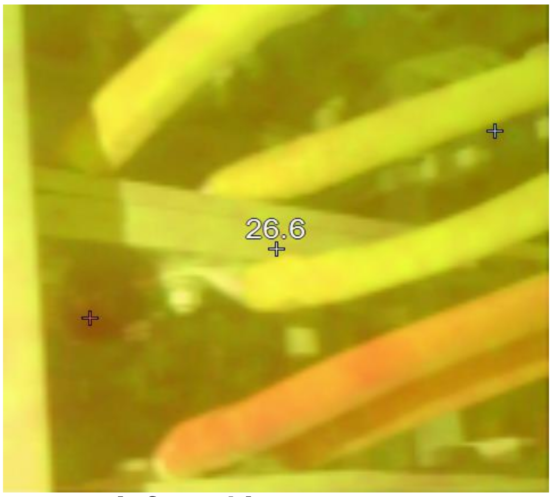
Infrared Image

Visible Light Image

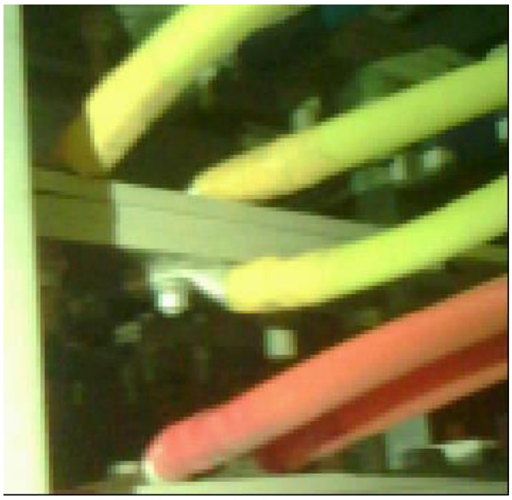
Image Info

Background temperature	32.0°C
Emissivity	0.95
CenterPoint	36.3°C

2. LT Room-E2 Building 1R.



Infrared Image

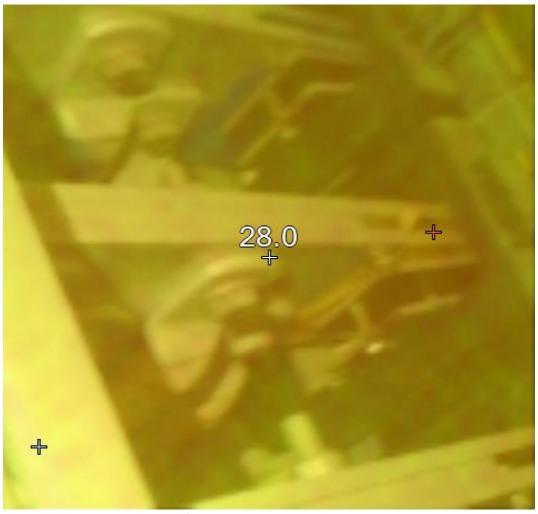


Visible Light Image

Image Info

Background temperature	32.0°C
Emissivity	0.95
CenterPoint	26.6°C

3. LT Room- To Main Panel 1B.



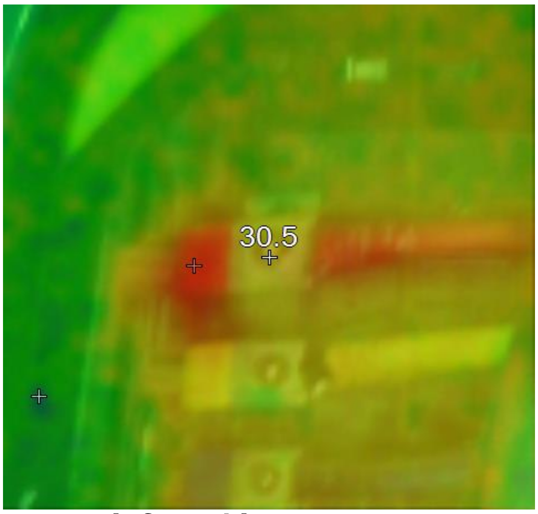
Infrared Image

Visible Light Image

Image Info

Background temperature	32.0°C
Emissivity	0.95
CenterPoint	28.0°C

4. LT Room-9B Villa(w-07B).



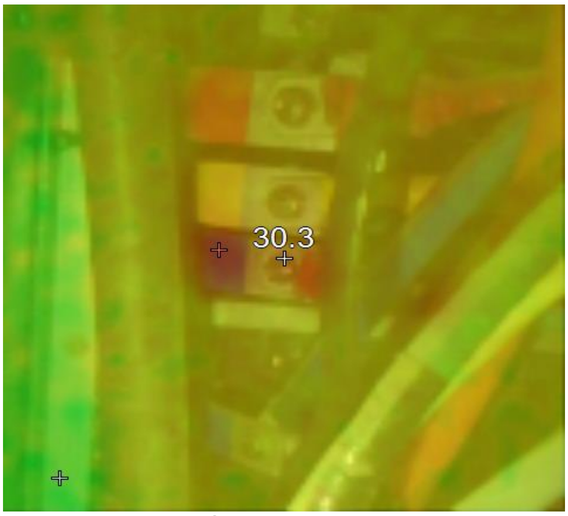
Infrared Image

Visible Light Image

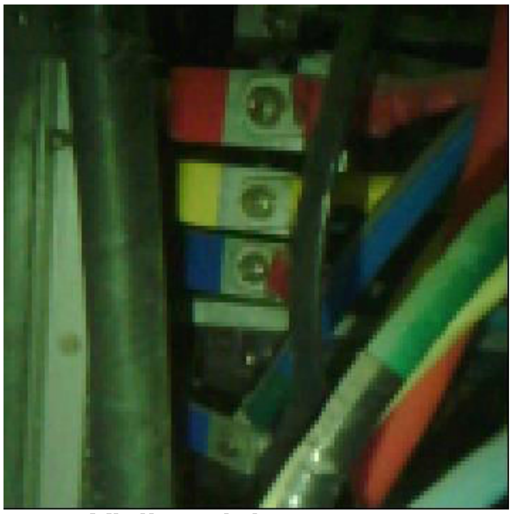
Image Info

Background temperature	32.0°C
Emissivity	0.95
CenterPoint	30.5°C

5. LT Room-9C Gateway Panel



Infrared Image

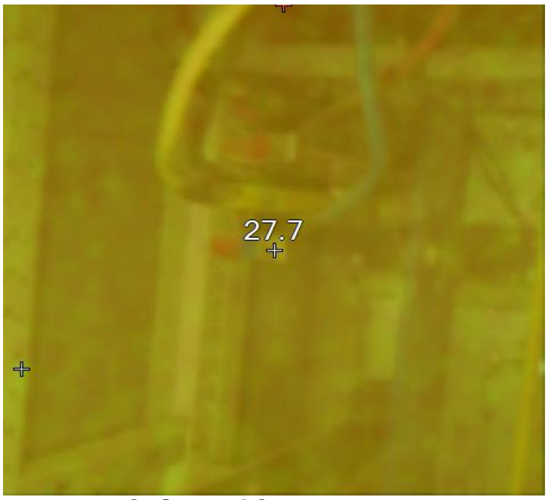


Visible Light Image

Image Info

Background temperature	32.0°C
Emissivity	0.95
CenterPoint	30.3°C

6. LT Room-Substation.



Infrared Image

Visible Light Image

Image Info

Background temperature	32.0°C
Emissivity	0.95
CenterPoint	27.7°C

7. ENERGY CONSERVATION TIPS

Electricity:

- Schedule Your Operations to Maintain A High Load Factor
- Minimize Maximum Demand by Tripping Loads Through A Demand Controller
- Use Standby Electric Generation Equipment for On-Peak High Load Periods.
- Correct Power Factor To At Least 0.99 Under Rated Load Conditions.
- Set Transformer Taps to Optimum Settings.
- Shut Off Unnecessary Computers, Printers, And Copiers at Night.

Motors:

- Properly size to the load for optimum efficiency.
- **High efficiency motors offer of 4-5% higher efficiency than standard motors**
- Check alignment.
- Provide proper ventilation
- (For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- An Imbalanced voltage can reduce 3 - 5% in motor input power
- Demand efficiency restoration after motor rewinding.

Pumps:

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Repair seals and packing to minimize water waste.

HVAC (Heating / Ventilation / Air Conditioning):

- Maintain set point between 24^{O}C to 27^{O}C
- Prevent leakage of cold air through the envelope.
- Use appropriate AC thermostat setback.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.

Lighting:

- Replace existing T8, CFL by LED (Store & other places)
- Reduce excessive illumination levels to standard levels using switching, de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapour lighting, etc. Efficiency (lumen/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapour, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider 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.

DG sets:

- Optimize loading
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

Buildings:

- Seal exterior cracks/openings/gaps with caulk, gasketting, weather stripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.

- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.

THANK YOU

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