iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** IV **Month of publication:** April 2023

DOI: https://doi.org/10.22214/ijraset.2023.50104

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

Energy and Electrical Audit

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Abstract: ***The energy audit is the key to a systematic approach to decision-making in the field of energy management. Energy efficiency is essential for the supply and use of energy throughout the sector through optimal management. Energy management and energy audit to reduce costs by saving energy for various types of industries, institutions, hospitals, residential areas, etc. KIIT University is one of such progressive University that for see the future that it hired EnerVision, a Private Third-Party company to conduct such an audit, and we as a Team of BEE Certified Energy auditors, accepted this proposal and conducted an audit in first week of March. The Key findings 0f the audit and the general procedure, Equipment's, Methodology and Synopsis is presented in the report. These management and audit discover areas where there is electricity waste and implement efficient and appropriate energy use through effective energy management and auditing methods, the environment too can be protected. Energy and money can be saved without affecting the natural and quality work performed in each department. This article briefly explains the process of energy audits and energy management in and around buildings.***
Keywords: Energy Management, energy audit, energy conservation, environment, electricity

I. INTRODUCTION

Energy is one of the main inputs for the economic growth of any country. One of such major form of energy is Electricity, as electricity being energy, it is necessary to see how the use, distribution and consumption is done, to better achieve this, energy audit is done. It is a comprehensive process of evaluating the energy usage of a building, process, or system, with the aim of identifying opportunities to reduce energy consumption and improve efficiency. The audit typically involves a detailed examination of energy flows within the system, including the energy inputs and outputs, as well as an analysis of the efficiency of various components such as lighting, heating, ventilation, and cooling systems. The goal of an energy audit is to identify areas where energy is being wasted and to recommend measures to reduce energy consumption, which can lead to significant cost savings and environmental benefits. An energy audit can be performed on residential, commercial, and industrial buildings, and can be conducted by qualified professionals or through self-assessment tools. The audit report typically includes recommendations for energy-efficient practices, such as upgrading equipment and systems, improving insulation, optimizing lighting and temperature controls, and incorporating renewable energy sources. Pressure on electric utilities is rising as the current transmission and distribution system tools.

II. OBJECTIVE OF THE STUDY

The Objective of the Electrical, safety, Power Quality and Energy audit include multiple phases;

A. Physical Parameters

1) Measuring all electrical Parameters like Voltage, Current, Power Factor, Power and compare the same with respect to IEC.
2) Physical Checking of electrical circuit and compare the same with respect to applicable Indian standard/ Indian Electricity Rule IS 732-2019, Code of Practice for electrical wiring installations, fourth revision.
3) Review & testing of protection system with respect to short circuit, leakage current and insulation damage and over voltage & current for all equipment and meters.
4) Checking the entire electrical distribution system at maximum load with the help of Thermal Imaging Camera and providing solutions to overcome the existing heating problem.
5) Checking and analyzing 24hrs power quality (Electrical parameters like voltage, current, harmonics, Power, Power Factor, Unbalancing, Earth neutral voltage) at main power supply to the office with the help of power Quality analyzer.
6) Thermography of all Electrical feeders and DB's on Load by TESTO German Make Thermal Imaging Camera
7) Insulation resistance test of all power cables for different utilities.
8) Checking of performances of Fire Alarm system, Fire Fighting system.
9) Review of the SOP of Fire Fighting system in case of emergency.
10) Review of the Fire Exit, all shafts, doors, Emergency lighting system, Signage.

B. System Safety

1) Grounding topology and efficacy of earth pits using Online earth resistance tester.
2) Detection of hot spots in the electrical power distribution using thermal imaging
3) Visual Inspection of major equipment and proper protective instruments and relays and safety interlocks
4) Assessment of Maintenance practices affecting safety
5) Study of AMCs for critical and major equipment and systems
6) Review of logs being maintained
7) Check on status of power Cables, routing and terminations
8) Taking Stock of redundancy, standby and source changeovers
9) Ascertaining that the SLD is on "as built' basis
10) Need and presence of integration of systems for safety

C. *Operational /Human Safety*

1) Inspection of PPE, other safety provisions (like rubber mats, instruction & escalation charts etc.)
2) Preparedness for emergency
3) Operational level skills, need for trainings and orientations
4) Provision of First Aid
5) Availability and coverage of fire detection
6) Provision and adequacy of fire-fighting measures

III. METHODOLOGY

Power Quality Monitoring at the Main LT source of Power at the service entrance and output of the UPS systems. The data logging to be done using EN 50160 compliant three phase, four wire power analyzers. The below mentioned parameters will get logged over time duration of 24 hours:

A. Power Quality Data Logging

1) Dips and Swells in the voltages
2) Brown outs/Interruption in the voltages
3) Rapid voltage changes in the voltages
4) Flicker in the voltages
5) RMS level voltage variations
6) Unbalance in the voltages
7) Harmonics in the voltages
8) Power Frequency variations
9) Review of the knowledge of existing facility staffs on emergency operation

B. Steps followed for the Electrical Audit

1) Physical Inspection of the Entire distribution system w.r.t Cable gland, Cable size, Panel body condition, inside terminal blocks, meter and indicating lamps etc.
2) Electrical Parameters measurement and comparing w.r.t design parameter/Connected load standard.
3) Thermal Scanning of the distribution system and analysis of the root cause of the hot spot.
4) Review of the Electrical safety and the protection system like Earthing circuits and Lightning arrestor.
5) Review of the performance of the APFC panel and its impact on the Electricity bills.

a) Energy Auditing Instruments (Tools)

- Frequency meter – used for measurement of power supply frequency.
- Digital Multimeter - used for measurement of voltage, current and resistance.
- Clamp on amp. Meter – used for measurement of current without interrupting the connection.
- Clip on Dig. PF Meter – used for measurement of power factor without interrupting the connection.
- Clip on Dig. Watt Meter – used for measurement of power without interrupting the connection.

- Lux meter – used for measurement of illumination level.
- Harmonic Analyzer – used for analysis of harmonics in power system.
- Power Analyzer - used for measurement and analysis of electrical power Electrical Distribution System
- Non-contact Tachometer – used for measurement of speed of rotation equipment.
- Digital Manometer – used for measurement of differential pressure.
- Thermo-hygrometer – used for measurement of air velocity and humidification, ventilation, Airconditioning and Refrigeration systems etc.
- pH meter – used for on-the-spot analysis of effective acidity or alkalinity of a solution/ water.
- Infrared Thermometer – used for measuring temperatures from distance using infrared technology.
- Temperature indicators – used for measuring of gases/ air, liquid, semi solids, powders etc. using
- different types of probes.
- Flue gas analyzers – used for optimizing the combustion efficiency by measuring the oxygen and CO
- levels in the flue gas of boilers, furnaces etc. and calculation of CO2 percentage in excess air level and
- efficiency.
- Stream Trap Monitor – used for performance evaluation of steam Traps.

b) Site Details

KIIT University Campus-16 is receiving power from a single source of State's Electricity supply board at 33 KV and its main feeder is located in the campus-6 control room main LT panel.

There is one Oil cooled type transformer of Universal Transformers Make of rating. The transformers were maintained well and no leakage of oil from the transformer was noticed. The records were checked and found satisfactory.

Feeder and Cable are capable of catering power to the respective loads. As per the record all feeders and protection devices are tested annually. However, most of the feeders are found heating.

Power factor is maintained at the source with the help of Automatic power factor correction system which is operating in auto mode. Hence it is recommended to have a real time power factor correction panel in place of the Existing Power Factor correction system. This will help in improving the power quality along with power factor and reduce TD losses.

LT Panel and rooms need to be kept clean. Breakers are serviced on a yearly basis. Panels are properly earthed at two points. Cable's end terminations are in good condition and no heating was noticed at the cable termination. Transformers winding temperature is normal.

There are a total four buildings in the campus-16 to which the electrical supply is provided from campus-16 LT panel.

IV. OBSERVATION

A. Transformer

Physical observation

1) One 750 KVA Oil cooled transformer is installed and is catering power to hostel and admin buildings.
2) The Foundation of Transformer found normal.
3) Transformer is free from oil leak.
4) Silica gel found normal.
5) PM & Oil filtration of all the transformers are done annually.
6) Body and neutral earthing are in good condition.

B. PQ & Harmonics Analysis

1) Avg Voltage 242 V.
2) Max voltage recorded 247.5 V at the 4:22 AM Morning.
3) Voltage found normal.
4) VNG is normal < 1 Volts.
5) Avg Vthd- 2-3 % Normal.
6) Avg Athd < 10%. Which is normal. Except in the B-phase which is 15% little on the higher side.
7) Voltage profile is free from abnormal drops.

8) Thistransformer is for campus-1 academic, admin and hostel buildings.
9) Load percentage on transformer – 48.4%.
10) Load is uniformly distributed.
11) Temperature found was normal.

C. Main Electrical Room

One main LT panel is installed in the main electrical room and this LT panel has an incoming supply from the transformer. All the sections in the panel are connected by one Bus-Coupler. One separate power factor correction system is installed.
Supply to all the other panels in the campus-6 building is provided from this LT panel. Sub panels are installed in each building and on each floor.

D. Power factor correction system:

The Details of the Power factor correction system is as follows:
Power factor correction system for transformer of 750 KVA is 250KVA
1) Total 6 Steps. (5 KVAR x 1 nos, 10 KVAR x 12nos, 50 KVAR x 2 nos, 100 KVAR x1 nos)
2) Total 11 capacitors 25KVARx8, 10 KVARx2 & 5KVAR x 1nos rating.
3) Total capacity= 250 KVAR The present running conditions of the transformer is;
4) 5 Steps are ON
5) 5 KVARx1, 10KVARx2
6) 50 KVAR x 2 are ON
7) All the capacitor bank currents are within the rating.
8) Capacitors are working normally.
Load on Transformer R-558 Amp, Y-541 Amp, B-528 Amp
At present, APFC Panel is working normally.

E. Campus-16 Main LT Panel (Transformer output):

1) Vrms

Voltage of single phase is given in the table for the date of 2nd march 2023 of duration 1 hour using power quality meter

Table 1: Vrms – Average voltage is good and within the limit.

Name	Date	Time	Avg	Min	Max	Unit	Duration	Units
V1 rms	02-03-2023	12:46 PM	231.30	212.00	238.60	V	1:00:00:00	(d:h:min: s)
V2 rms	02-03-2023	12:46 PM	232.78	216.60	240.30	V	1:00:00:00	(d:h:min: s)
V3 rms	02-03-2023	12:46 PM	232.56	223.80	239.90	V	1:00:00:00	(d:h:min: s)
VNE rms	02-03-2023	12:46 PM	0.00	0.00	0.00	V	1:00:00:00	(d:h:min: s)

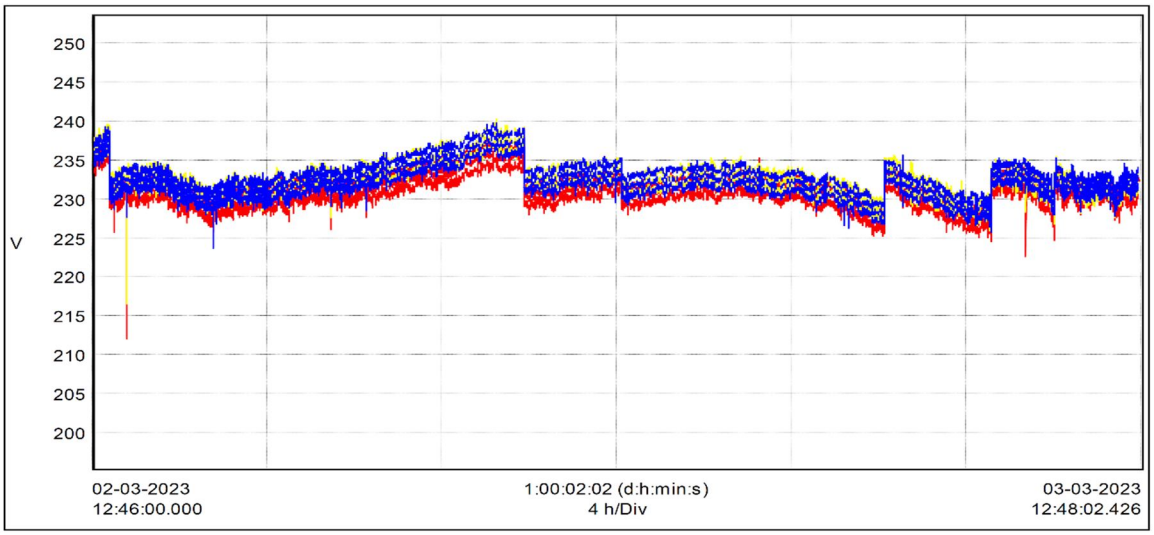


Figure 1; Graph of Single-phase voltage

2) Urms

Voltage of 3 phase is given in the table for the date of 2nd march 2023 of duration 1 hour using power quality meter

Table 2; Urms –Average voltage is good and within the limit

Name	Date	Time	Avg	Min	Max	Units	Duration	Units
U12 rms	02-03-2023	12:46 PM	401.61	364.10	414.10	V	1:00:00:00	(d:h:min:s)
U23 rms	02-03-2023	12:46 PM	403.69	387.80	417.20	V	1:00:00:00	(d:h:min:s)
U31 rms	02-03-2023	12:46 PM	401.38	381.40	413.20	V	1:00:00:00	(d:h:min:s)

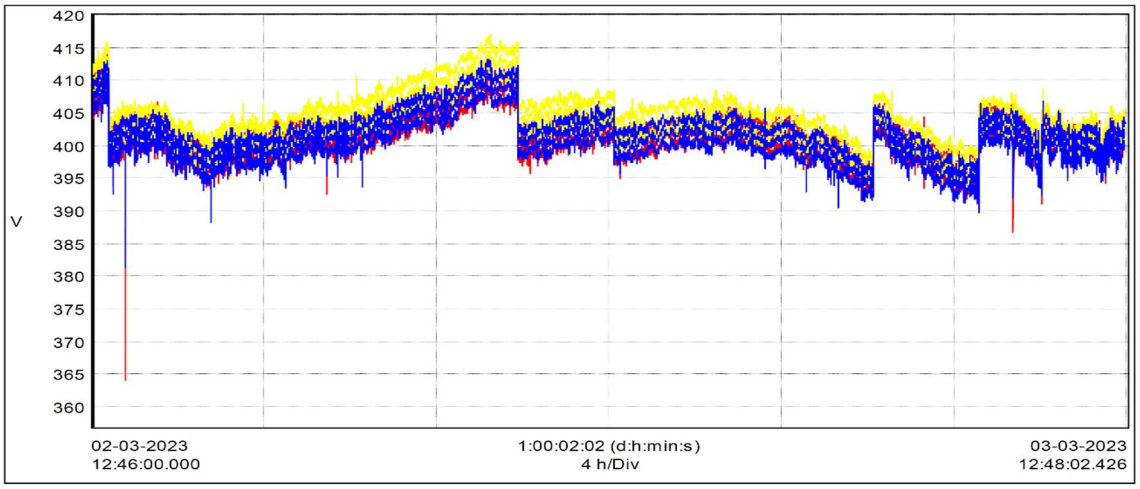


Figure 2; Graph of 3-phase voltage

3) Arms

The Current distribution of 3 phase is given in the table for the date of 2nd march 2023 of duration 1 hour using power quality meter

Table 3; Current distribution along 3 phases

Name	Date	Time	Avg	Min	Max	Units	Duration	Units
A1 rms	02-03-2023	12:46 PM	290.22	129.00	652.00	A	1:00:00:00	(d:h:min:s)
A2 rms	02-03-2023	12:46 PM	282.17	118.00	688.50	A	1:00:00:00	(d:h:min:s)
A3 rms	02-03-2023	12:46 PM	271.94	120.00	632.50	A	1:00:00:00	(d:h:min:s)
AN rms	02-03-2023	12:46 PM	50.22	18.80	113.50	A	1:00:00:00	(d:h:min:s)

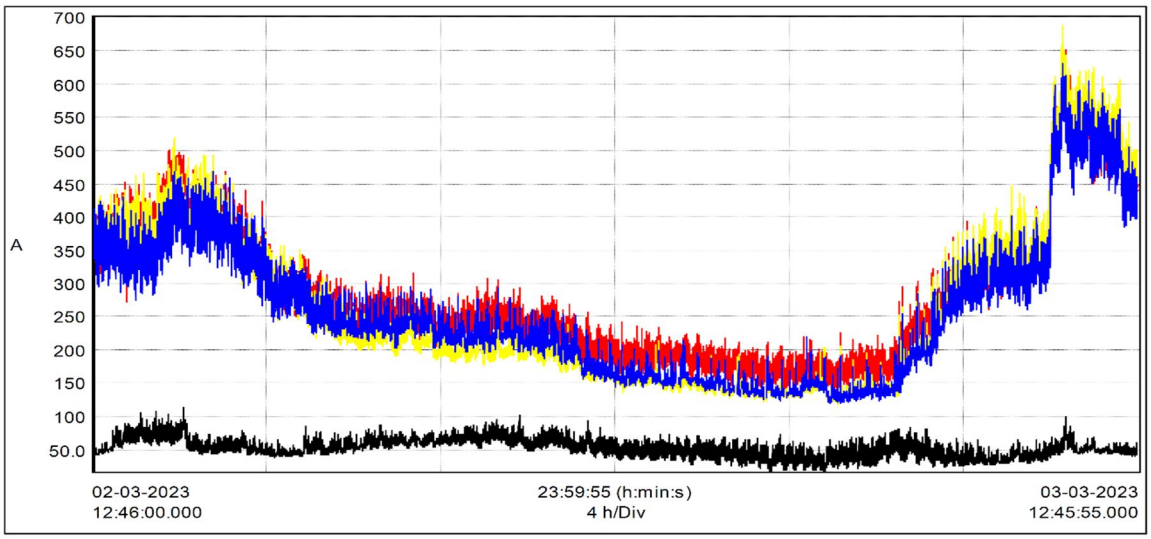


Figure 3; Current distribution along 3 phases, Load is distributed uniformly in all the phases.

4) VThdr

Voltage Harmonics are the result of nonlinear loads that convert AC line voltage to DC. Harmonics flow into the electrical system because of nonlinear electronic switching devices, such as variable frequency drives (VFDs), computer power supplies and energy-efficient lighting**.** Voltage Harmonics looks good in the table for the date of 2nd march 2023 of duration 1 hour using power quality meter

Table 4; Voltage Harmonics

Name	Date	Time	Avg	Min	Max	Units	Duration	Units
V1 THDr	02-03-2023	12:46 PM	1.571	1	2.3	% r	1:00:00:00	(d:h:min:s)
V2 THDr	02-03-2023	12:46 PM	1.584	0.9	2.3	% r	1:00:00:00	(d:h:min:s)
V3 THDr	02-03-2023	12:46 PM	1.592	0.9	2.2	% r	1:00:00:00	(d:h:min:s)

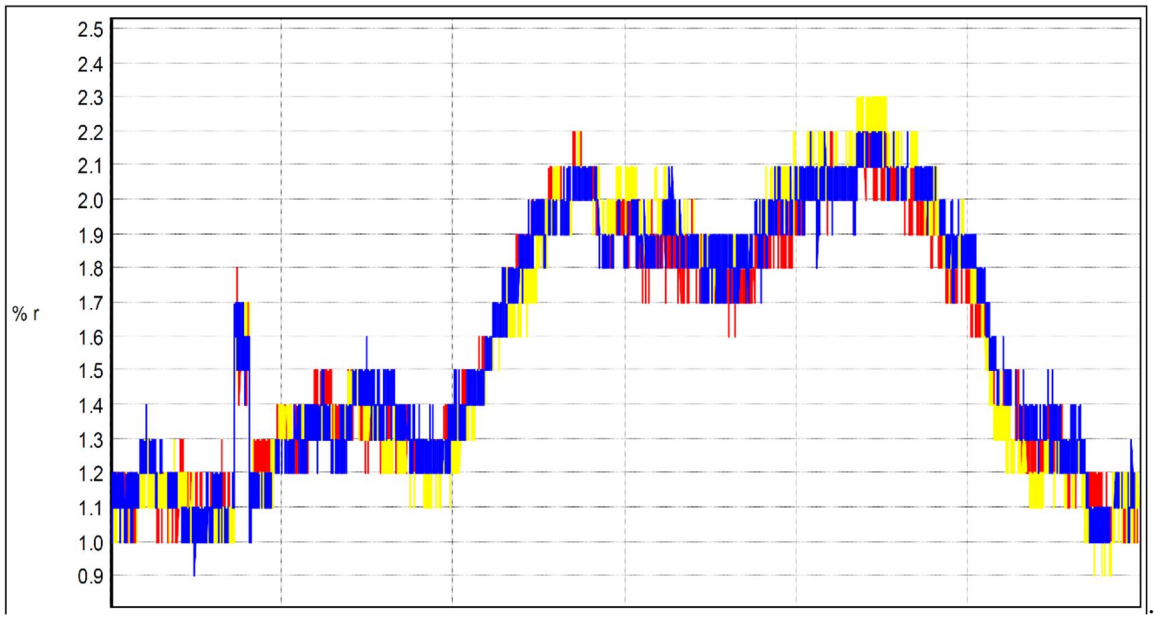


Figure 4; Voltage Harmonics, the values are normal and are within the limit

5) AThdr

Current harmonics originate because of the presence of non-linear loads like variable speed drives, inverters, UPS, television sets, PCs, semiconductors. Current Harmonics looks good in the table for the date of 2nd march 2023 of duration 1 hour using power quality meter

Table 5; Current Harmonics

Name	Date	Time	Avg	Min	Max	Units	Duration	Units
A1 THDr	02-03-2023	12:46 PM	7.092	4.3	10.9	% r	1:00:00:00	(d:h:min:s)
A2 THDr	02-03-2023	12:46 PM	9.081	4.4	18.8	% r	1:00:00:00	(d:h:min:s)
A3 THDr	02-03-2023	12:46 PM	10.905	6.4	19.9	% r	1:00:00:00	(d:h:min:s)

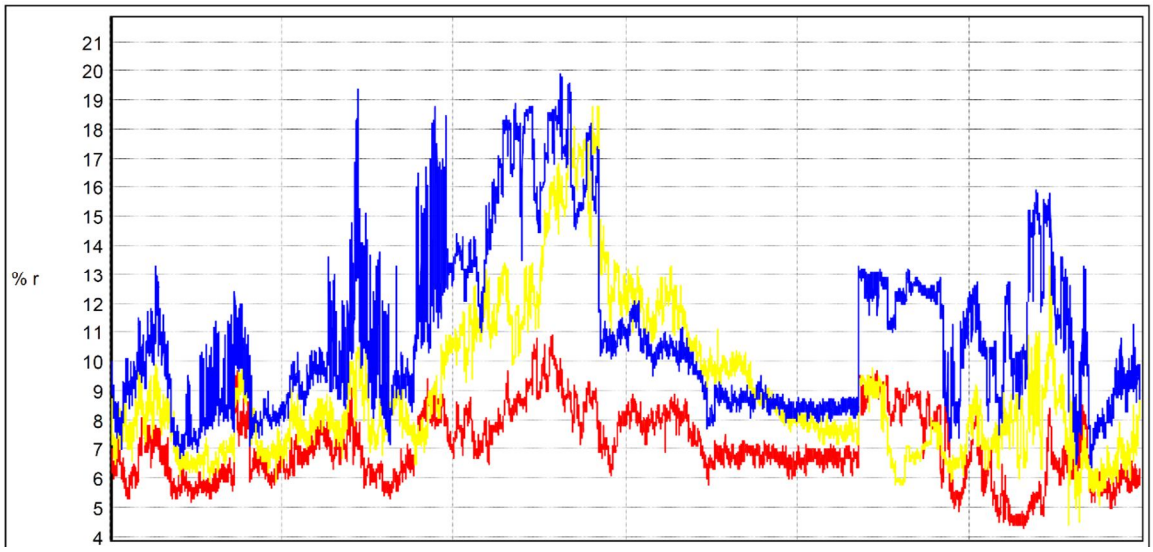


Figure 5; Current harmonic values are low and within the limit except in the B-phase which is little on the higher side.

6) Power (KW)

Power measures the rate of electrical energy transfer by an electric circuit per unit of time. Denoted by P and measured using the SI unit of power which is watt or one joule per second. The power consumption is given in the table for the date of 2nd march 2023 of duration 1 hour using power quality meter

Table 6; Power Consumption

Name	Date	Time	Avg	Min	Max	Units	Duration	Units
P1 (W)	02-03-2023	12:46 PM	62.679	30.357	140.982	W	1:00:00:00	(d:h:min:s)
P2 (W)	02-03-2023	12:46 PM	59.606	28.056	147.763	W	1:00:00:00	(d:h:min:s)
P3 (W)	02-03-2023	12:46 PM	58.362	27.946	136.284	W	1:00:00:00	(d:h:min:s)
PT (W)	02-03-2023	12:46 PM	180.647	87.125	421.175	W	1:00:00:00	(d:h:min:s)

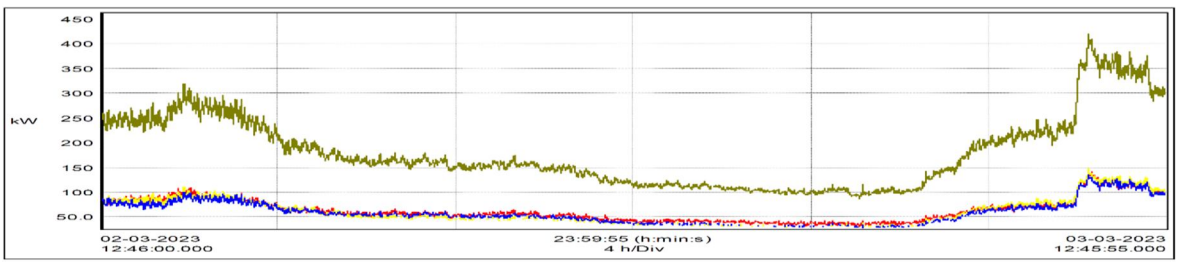


Figure 6; Power Consumption

7) Power Factor

Power factor (PF) is the ratio of working power, measured in kilowatts (kW), to apparent power, measured in kilovolt amperes (kVA). Apparent power, also known as demand, is the measure of the amount of power used to run machinery and equipment during a certain period. It is found by multiplying (kVA = V x A). The power Factor is given in the table for the date of 2nd march 2023 of duration 1 hour using power quality meter

Table 7; Power factor of the panel across 1 hour span

Name	Date	Time	Avg	Min	Max	Duration	Units
PF1	02-03-2023	12:46 PM	1.00	0.98	1.00	1:00:00:00	(d:h:min:s)
PF2	02-03-2023	12:46 PM	0.99	0.97	1.00	1:00:00:00	(d:h:min:s)
PF3	02-03-2023	12:46 PM	1.00	0.97	1.00	1:00:00:00	(d:h:min:s)
PFT	02-03-2023	12:46 PM	1.00	0.98	1.00	1:00:00:00	(d:h:min:s)

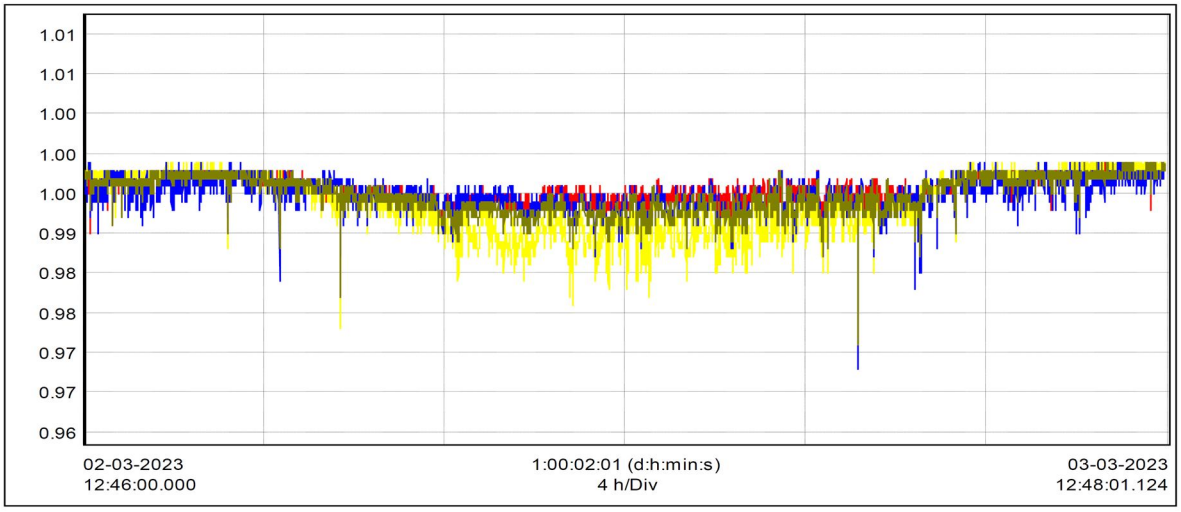


Figure 7; Power factor of the panel across 1 hour span, Avg Power factor values are good.

8) Energy

Energy is the capacity to do work, so electrical energy determines the capacity provided for the electricity consumed per unit time. Cumulating the total Energy consumed, it can be calculated that Werther the loads are matched and distributed promptly or not, this will also give a brief idea how much energy we are consuming and may help in getting possible measures to save it. The whole aspect of this work is to inspect and analyze the power system in the site and check Werther any faults and or any imbalances are seen, this will help to improve the process on how the energy is consumed. For such the whole loads needs to be balanced and the power consumption needs to be recorded,

It also provides a method on how energy flow changes during time, which will allow us to check Whether there are any faulty systems that are taking unnecessary power. For instance, if compressor of a HVAC is faulty, The graph can give us an idea that when the compressor is on, multiple energy than required than normal consumption, Allowing us to know the fault in it.

Table 8; The Energy consumption for the date of 2nd march 2023 of duration 1 hour using power quality meter. The total unit consumption during this recording session that is for one day is 4335 units

Name	Date	Time	Max	Units	Duration	Units
Ep1 (Wh)	02-03-2023	12:46 PM	1.50	Wh	1:00:00:00	(d:h:min:s)
Ep2 (Wh)	02-03-2023	12:46 PM	1.43	Wh	1:00:00:00	(d:h:min:s)
Ep3 (Wh)	02-03-2023	12:46 PM	1.40	Wh	1:00:00:00	(d:h:min:s)
EpT (Wh)	02-03-2023	12:46 PM	4.34	Wh	1:00:00:00	(d:h:min:s)

9) Connected Load Details &Air-Condition System

Table 9; Load Details of Campus-16 (Transformer -750 KVA)

Load Details of Campus-16 (Transformer -750 KVA)				
S. N	Name of the Item	Quantity	Wattage	Total wattage
1	2 X 11 Watt PL-S fitting	722	22	15884
2	15-Watt LED Panel Light(325x215) mm	52	15	780
3	2x18 PL-C Watt Fitting	203	36	7308
4	T-5 28-Watt fitting	61	28	1708
5	T-5 14-Watt fitting	4	14	56
6	2X400 Watt Metal Halide Light	1	800	800
7	1200mm Ceiling Fan	1	80	80
8	450mm Wall Mounting Fan	3	80	240
9	400mm Wall Mounting Fan	30	80	2400
10	300mm Wall Mounting Fan	2	80	160
11	300mm Exhaust fan	15	80	1200
12	6HP Submersible Motor	1	4476	4476
		Total		35092
				35.45 KW

Table 10; AC Details of Campus – 16

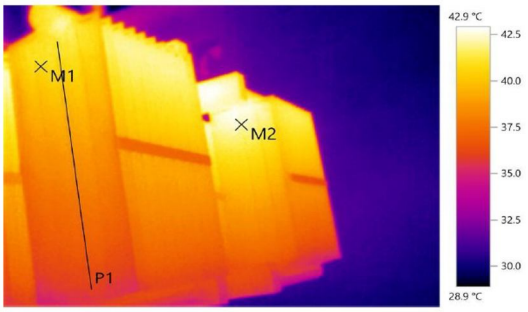
AC Details of Campus - 16				
S. N	Name of the Item	Quantity	Capacity (Ton)	Total Wattage
1	Split	7	1.5	14000
2	Split	22	2	55000
3	Cassette	15	3	52500
4	Cassette	66	4	297000
5	Window	3	1.5	6000
6	Duct able	10	11	115000
		123	Total	539500
				539.5KW

Table 11; Units' consumption in KWH (including Hostel and Academic)

Date	Units' consumption in KWH (including Hostel and Academic)
28th Feb	4326
1st March	4867
2nd March	4325
3rd March	4115
4th March	3945
5th March	4335
6th March	4126
7th March	4032

10) Thermal Report

a) Transformer



Picture data:	**Date:**	02-03-2023	**Emissivity:**	0.93
	Time:	17:54:44	**Refl. temp. [°C]:**	20.0
	File:	IR014670.BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	40.6	0.93	20.0	Temperature recorded on the radiator
Measure point 2	42.1	0.93	20.0	Temperature recorded on the radiator

Profile line:

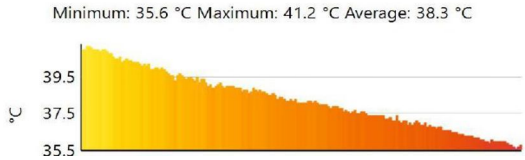
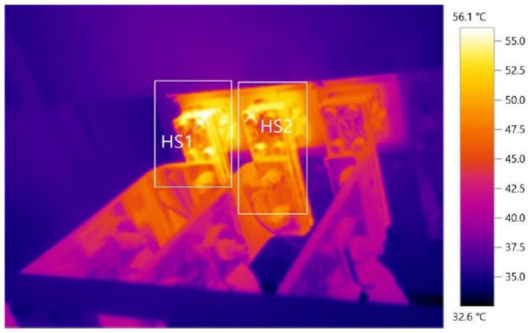


Figure 8; Thermal of Transformer

b) Main incomer ACB



Picture data:	**Date:**	03-03-2023	**Emissivity:**	0.93
	Time:	17:09:10	**Refl. temp. [°C]:**	20.0
	File:	IR014857.BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Hot spot 1	56.1	0.93	20.0	Temperature recorded at the B-phase terminations
Hot spot 2	55.1	0.93	20.0	Temperature recorded at the Y-phase terminations

Figure 9; Main Incomer MCCB Termination

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

V. RESULTS AND DISCUSSION

Based on the study analysis and calculations, an energy audit can provide valuable insights into the energy usage patterns of a building, process, or system. The audit provided the collection of data on energy inputs and outputs, as well as an examination of the efficiency of various components such as lighting, HVAC systems, and appliances. The data collected during the audit is analyzed to identify areas where energy is being wasted or used inefficiently. This analysis may include calculations of energy consumption and cost, as well as comparisons of energy usage to industry benchmarks or best practices. The results of the energy audit can be used to develop a comprehensive plan for improving energy efficiency and reducing energy consumption. This may include recommendations for upgrading equipment and systems, optimizing lighting and temperature controls, improving insulation, and incorporating renewable energy sources. By implementing the recommendations of an energy audit, building owners and managers can potentially achieve significant cost savings on their energy bills, as well as contribute to environmental sustainability by reducing greenhouse gas emissions. Overall, an energy audit is a valuable tool for assessing and improving energy efficiency in buildings, processes, and systems. It can help identify opportunities for cost savings and environmental benefits, and provide a roadmap for achieving energy efficiency goals. Based on the key findings, certain remarks and recommendations are provided so that some necessary changes can be made for better energy efficiency.

A. Main Panel Room

Table 12; Summary Sheet of Remarks

S. N	Panel	Observations	Recommendations
1	Main LT Panel	Panel Meter is not calibrated	calibrate the meters
		Heavy dust is noticed in the panel	Clean and service the entire panel
		Cable entry openings in the cable chamber is not closed	Close all the unwanted openings
		Main LT panel body earthing termination found loose	Tight the same
		Nut bolts washers found rusted at some terminals.	Service the same.
		Smoke detector is absent in the main panel room	Install smoke detector
		Safety rubber mat is not placed for the entire panel front side	Place the rubber for entire panel
		SLD is not updated and not fixed for all the panels in the campus	Place the Updated SLD
		Fire extinguisher signages are absent	Install fire extinguishers signages
2	APFC Panel	Heavy dust is noticed in the panel	Clean and service the entire panel

B. Fire safety

Table 13; Fire System Summary Sheet

S. N	Observations	Recommendation
1.	Safety Signages: Danger signages are absent at the electrical room doors as well as at the transformer yard gate. Fire exit signages in all the buildings are provided. Fire extinguisher signages are absent in all the buildings.	Place the danger signages with auto glow type on all the electrical room doors. Place the auto glow type fire extinguisher signages in all the locations.
2.	Fire Extinguishers: ABC dry powder type, Co2 type & K type fire extinguishers are installed in all the locations of the campus-6.	It is recommended to install a high-pressure fire suppression system for the data center.

	Fire suppression system is absent in the data center. All the fire extinguishers refilling date is within the period. All the fire extinguishers are well maintained.	
3.	Hydrant system & Sprinkler system: Hydrant system is installed only for the Auditorium building. All the locations are installed with Hose reel and Hose pipe of appropriate length as per the IS standards. Sprinkler system is installed only for the Auditorium building. Both the hydrant and sprinkler system are pressurized and charged. Only one electric pump is installed for both the hydrant and sprinkler system. One underground tank of 25000 lit capacity is provided as a fire tank.	It is better to have a Diesel driven pump for the hydrant and sprinkler system.
4.	Fire Alarming System: Smoke detectors are installed for the Auditorium building and Data center and in the rest of the building locations it is absent. In both locations the fire alarm panel was normal and healthy. In both locations the fire alarm panel is provided by UPS power supply.	Fire alarm system has to be implemented in all of the campus-6 buildings.
5.	Emergency lights are provided in the main control panel room and in all the building's lobby area. Fire buckets in front of the main electrical control rooms near DG set are not as per standard.	All the sand buckets should be filled ¾ of its capacity with good granule sand.

VI. CONCLUSION

In conclusion, the energy audit has revealed several opportunities for energy savings and efficiency improvements in the campus building. By implementing the recommended measures, the building can significantly reduce its energy consumption, lower its carbon footprint, and save on energy costs in the long run. The findings of the energy audit suggest that the building can benefit from improvements in lighting, HVAC systems, insulation, and other areas. The recommendations provided in the report are based on careful analysis and consideration of the building's energy usage patterns, as well as industry best practices and standards.

It is recommended that the building owner or manager consider implementing the recommended measures in a phased manner, starting with the ones that offer the highest return on investment. A thorough review of the energy audit report with a qualified energy consultant can provide further guidance on prioritizing the recommendations based on their potential benefits and feasibility. Overall, the energy audit report provides a roadmap for the audited building to improve its energy efficiency, reduce its environmental impact, and increase its overall sustainability. As we all know, energy efficiency is the wave of the future. The world is quickly moving towards energy sustainability. At the same time the mankind is trying to re-establish the connection it once had with the nature. An energy efficient building is a step toward the direction of renewable energy, environmental protection, and sustainable living.

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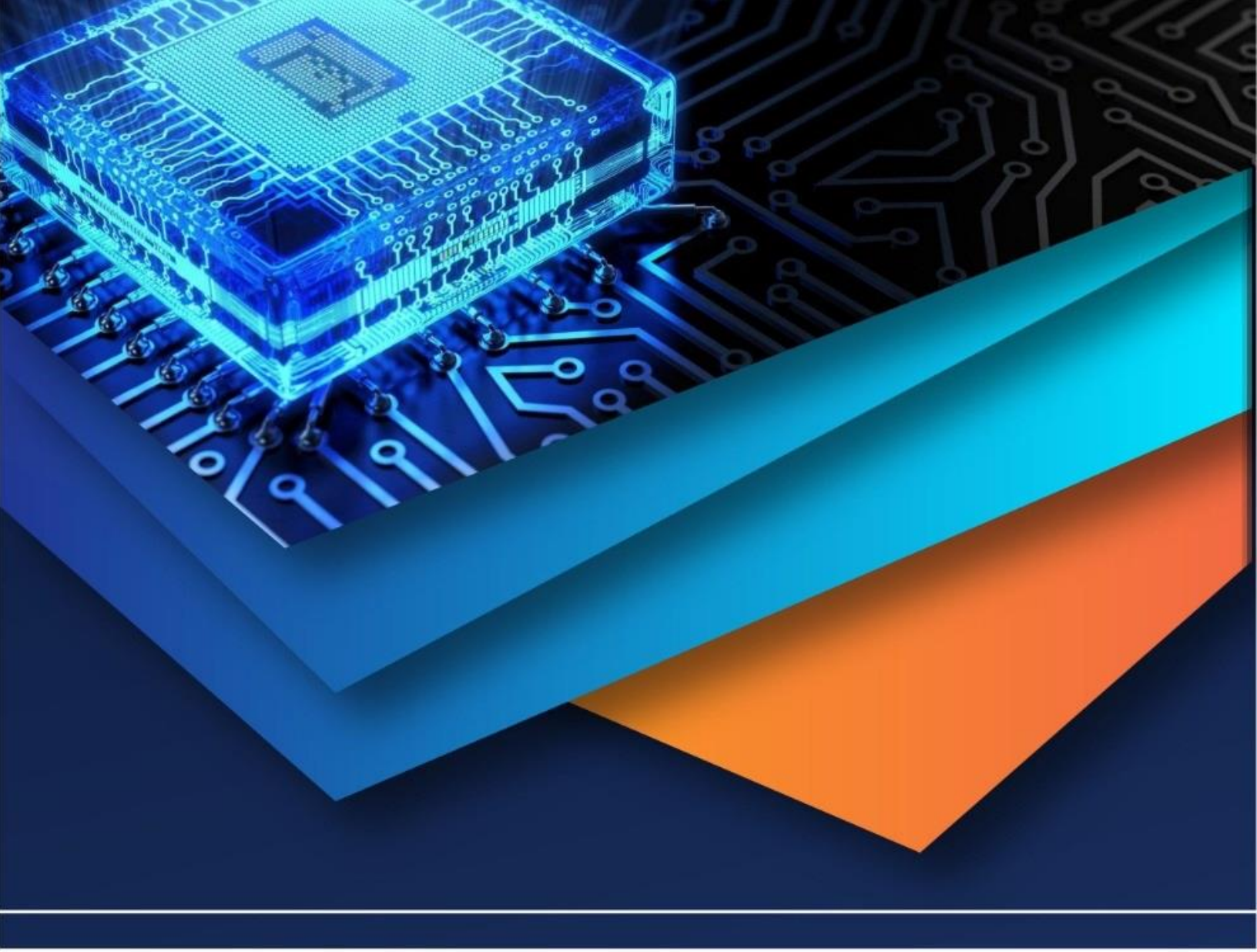

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