Energy Audit

Report of

Quantum University, Roorkee

Dehradun Highway, Mandawar, Roorkee Uttarakhand – 247167

Prepared & submitted by

INNOVATIVE ENERGY CONSERVATION SOLUTIONS

Audit Conducted by IECS, Mohali

Registrar
Quantum University

Audit Details

Report Title	= Energy Audit Report
Client Name	= Quantum University, Roorkee
Audit Report Month and Audit Dates	= May 2022 = 26 May 22 to 28 May 22
Location of the Plant	= Dehradun Highway, Mandawar, Roorkee, Uttarakhand 247167
Name of the Auditor	**Mr. Khalid Khan** Energy Audit Number: CEA: M. Tech in Energy & Environmental Study **Mr. Yashul Dehariya** Senior Consultant **Mr. Vishal** Engineer

Registrar
Quantum University

INNOVATIVE ENERGY CONSERVATION SOLUTIONS

A: 205, Eco Towers, Shivalik Enclave Sector 125, Greater Mohali-140301
E: Pankaj@iecsolutions.in
T: +91-9685613238

DATE
October 10, 2022
PLACE OF WORK: **CHANDIGARH**

Energy, Environment & Green Audit Certificate

Is Issued To

Quantum University, Mandawar, Roorkee (Uttarakhand)

for successful completion of Energy, Environment & Green Audit of the University for the Period FY 2022-23, conducted by **M/s Innovative Energy Conservation Solutions.** This Energy, Environment & Green Audit included Sectoral Audits in the reports i.e., Water, Energy, Waste cum Material, Air Quality & Noise, Bio-diversity, outdoor environment, Health & well-being, Activities and Institutional management aspect cover.

The University is certified to have done exceptionally well to conserve energy, environment and ensuring sustainable development for the assessment period.

Duration of Audit: Oct-22
Date of Issue: 10/09/22

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Innovative Energy Conservation Solutions

Thank You

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Pankaj Bhate

IECS

ACKNOWLEDGEMENT

Innovative Energy Conservation Solutions (IECS) extends its heartfelt gratitude to Quantum University, Roorkee, for bestowing upon us the privilege of conducting the "Energy Audit Study" in May 2022.

We wish to express our profound appreciation to the dedicated team at Quantum University, Roorkee, for their proactive support and unwavering courtesy shown to the IECS team throughout the field study. Additionally, we extend our gratitude to other esteemed officials from Quantum University, Roorkee, for their invaluable cooperation and support during the data collection process. Our sincere thanks also go to all individuals with whom we engaged during the audit, whose operational insights proved to be invaluable.

We are pleased to hereby present the Energy Audit Report for your reference and consideration.

Innovative Energy Conservation Solutions
Proprietor
+205, Eco Towers
Shivalik Enclave Kharar
Sector 125, Punjab- 140301

Registrar
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Executive Summary

Energy Audit is the key to a systematic approach for decision-making in the area of energy management as it attempts to evaluate the energy usage pattern in an establishment. Also, it serves to identify all the energy streams in an establishment, so that potential areas wherein energy savings are practically feasible are identified.

It was with this objective that Innovative Energy Conservation Solutions (IECS) was entrusted by Quantum University Roorkee, the energy audit of the Institute.

The study primarily covers the I) Present energy scenario of the building, ii) Detailed analysis of the data obtained through field visits, trial measurements by portable gadgets, discussions with concerned personnel etc., iii) Recommendations for energy savings options in all possible areas with cost benefit analysis.

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General Building Details & Energy Consumption

Sr. No.	Particulars	Value
1	Connected Load (kW)/Sanction load	250 kW/295 kVA
2	Electricity Consumption, purchased from Utilities / Grid (kWh) – April-21 to March 22	730381 kWh
3	Annual Cost of Electricity, purchased from Utilities/ Grid (Rs. 5.10/kWh -average of 11 months data from April-21 to Mar-22) -	3717721 INR
4	Working hours	General Lighting (7 hrs./day, 245 days a year)
		Air Conditioning (7 hrs./day, 150 days a year)
		Fans (7 hrs./day, 210 days a year)
5	Working days/week (e.g., 5/6/7 days per week)	06 days per week
6	Installed capacity of Air Conditioning System (TR)	Total no of AC Installed Approx. =45
7	Installed lighting load including Lights (kW) Total 1941	38.82 kW
8	Installed load of Fans (kW) Total – 1850 Nos	92.5 kW
9	Installed Load of Air conditioners	108 kW
10	Other miscellaneous electrical load also	

Total Energy Consumed in MTOE per annum

Source of Energy	Consumption	Calorific Value	Equivalent Lakhs kCal	Equivalent MTOE
	kWh/annum	kCal/ kWh		
Total Purchased Power	730381	860	6181.2	61.81
Total				**61.81**

Cumulative Energy Saving Opportunities

Particulars	Annual Savings				Estimated Investment
	kWh	ToE	CO2	Rs in Lakh	(Rs in Lakh)
Replace Existing Ceiling Fans with low wattage Ceiling Fans on Failure Replacement Basis	59829	5.1	53.8	2.69	64.75
Replace Existing old Conventional Lamps with LED Low wattage Lamps on Failure Replacement Basis	9986.47	0.85	8.9	0.44	3.67
Replace Existing 3 Star ACs with Inverter Technology 5 Star ACs on Failure Replacement Basis	30450	2.6	27	1.37	23
Install solar PV power plant of 140 kW	189000	1625	169.9	8.05	56
Total	**289265.47**	**1633.55**	**259.6**	**12.55**	**147.42**
Observation					
Install Light Control Sensor In Class Rooms To Switch Off Lamps					
Transformer Loading And Electrical System Study Lux Level Study Thermal Imaging Of Electrical Panels Electrical Safety Points					

Since the investment was on higher side, university can plan the energy saving on phase manner to take the advantage of both financial and energy benefits

CHAPTER:1 INTRODUCTION

1.1 THE PROJECT

According to energy Conservation Act, 2001, Energy Audit is the verification, monitoring, and analysis of the use of energy including submission of a technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption.

Energy Audit is the key to a systematic approach for decision-making in the area of energy management as it attempts to evaluate the energy usage pattern in an establishment. Also, it serves to identify all the energy streams in an establishment, so that potential areas wherein energy savings are practically feasible are identified.

It was with this objective that Innovative Energy Conservation Solutions (IECS) was entrusted by Quantum University, Roorkee the energy audit of the Institute.

1.2 GENERAL DETAILS

Particulars		Details
Name & Address of Institute	:	Quantum University, Roorkee
Contact	:	Mr. Karan Babbar
Annual Purchased Power Consumption (Period: April 21-Mar 22)	:	730381
Overall Purchased Power Rate including Fixed Demand and other Charges	:	Rs 5.10 per kWh

1.3 DELIVERABLES IN THE DETAIL PROJECT REPORT

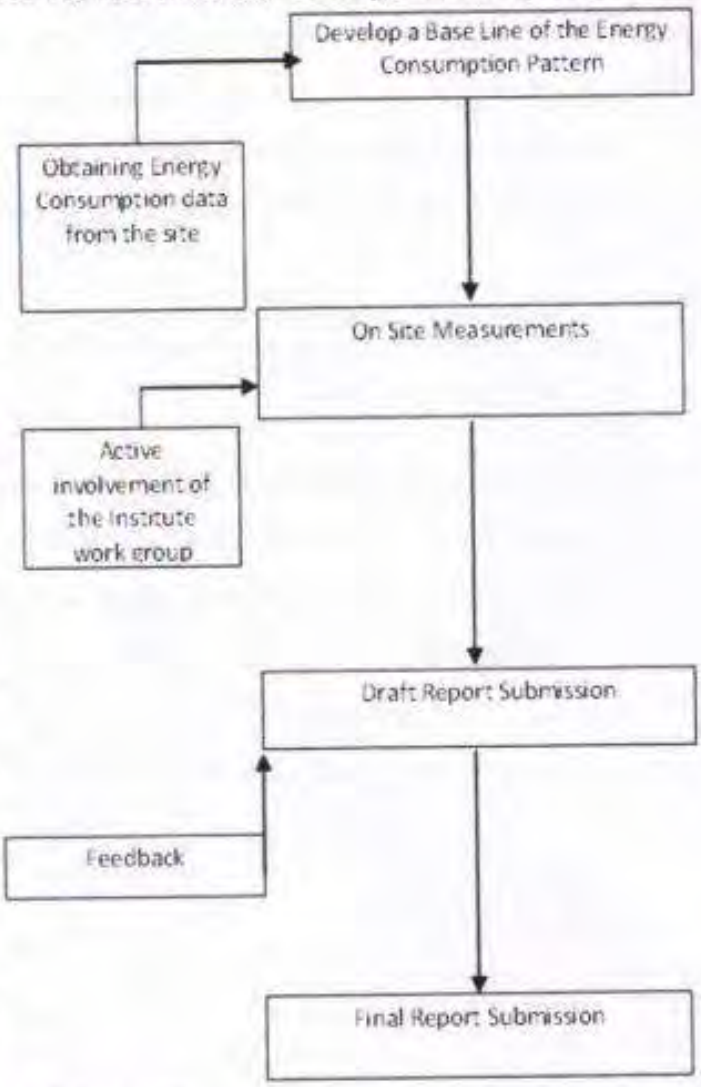
- Methodology adopted for the study
- Present energy scenario of the building
- Detailed analysis of the data obtained through field visits, trial measurements by portable gadgets, discussions with concerned personnel etc.
- Recommendations for energy savings options in all possible areas with cost benefit analysis.

- Technical specifications for any retrofit options

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 Institute premises and had discussions with the concerned officials/ supervisors to collect data/ information on the operations and energy distribution in 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.



- Draft Report submission on the findings of the audit.

  Final report submission after incorporating the observations/ comments made by the Institute.

CHAPTER:2 ABOUT THE COLLEGE

Quantum University is a private university in Uttarakhand, India. The University was earlier known as Quantum Global Campus Roorkee. The University campus is located in the town of Roorkee with its corporate office in Dehradun. Quantum University Roorkee was founded in 2017 by industrialist Shri Shyam Sunder Goyal. The core programs initially offered by the college were in the disciplines of Engineering and Management. In 2018 the university started programs in Graduate Studies.

The University is located outside the town of Roorkee on the Roorkee-Dehradun Highway. Well connected through road network of Delhi to Dehradun. Neatest Railway station is Saharanpur (30 Min) in UP and Roorkee (30 Min) in Uttarakhand. Nearest Airport is Jolly Grant (45 KM) Dehradun. Quantum University has Three boy's hostels (1200 seats) and One Girl Hostel (600 Seats). The campus spreads over an area of 30 acres.

The university is approved by the Government of Uttarakhand and by the University Grants Commission (UGC)

Quantum University provides undergraduate, postgraduate and integrated courses, as well as diploma programmers, through the following schools and departments: It specialized in IR4.0 Based technology having world class infrastructure in Cyber Security, AI&ML, Data Analytics, Robotics, IoT, Electrical Vehicle Technology, Smart Agriculture, IT Enablement in Management specially CRM and Finance, Graphic Design and VFX. The university enjoys technological support from leading giants like Xebia, Palo alto, Certiport US, Salesforce, Automation Anywhere, Microsoft, Oracle, Amazon etc.

COURSES OFFERED:

- School of Technology
  - Department of Engineering
  - Department of Computer Applications
- School of Business

- School of Graduate Studies
  - Department of Commerce & Finance
  - Department of Sciences
  - Department of Humanities & Social Sciences
- School of Agricultural Studies
- School of Media Studies & Design
- School of Health Sciences
- School of Hospitality & Tourism
- School of Law

Google Map – Satellite View of Campus

Table 1: General Building Details & Energy Consumption

Sr. No.	Particulars	Value
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6	Installed capacity of Air Conditioning System (TR)	Total no of AC Installed Approx. =45
7	Installed lighting load including Lights (kW) Total 1941	38.82 kW
8	Installed load of Fans (kW) Total – 1850 Nos	92.5 kW
9	Installed Load of Air conditioners	108 kW
10	Other miscellaneous electrical load also	

2.1 Energy Conservation Activity Taken by the College

We appreciate the College for their steps taken to reduce the energy consumption in proactive manner. In the last year there were many energies conservation point taken by the College.

- Training to staff and students for energy conservation which will create awareness and general knowledge for energy conservation
- College also took an initiative to replace old lights with energy efficient LED lights
- Inverter Type Air Conditioners installed for energy conservation
- Solar water heating was also installed in hostel for hot water generation
- Few Occupancy Sensors installed in university for energy conservation

CHAPTER:3 POWER SUPPLY SYSTEM AND ENERGY CONSUMPTION PATTERN

3.1 POWER SUPPLY SYSTEM

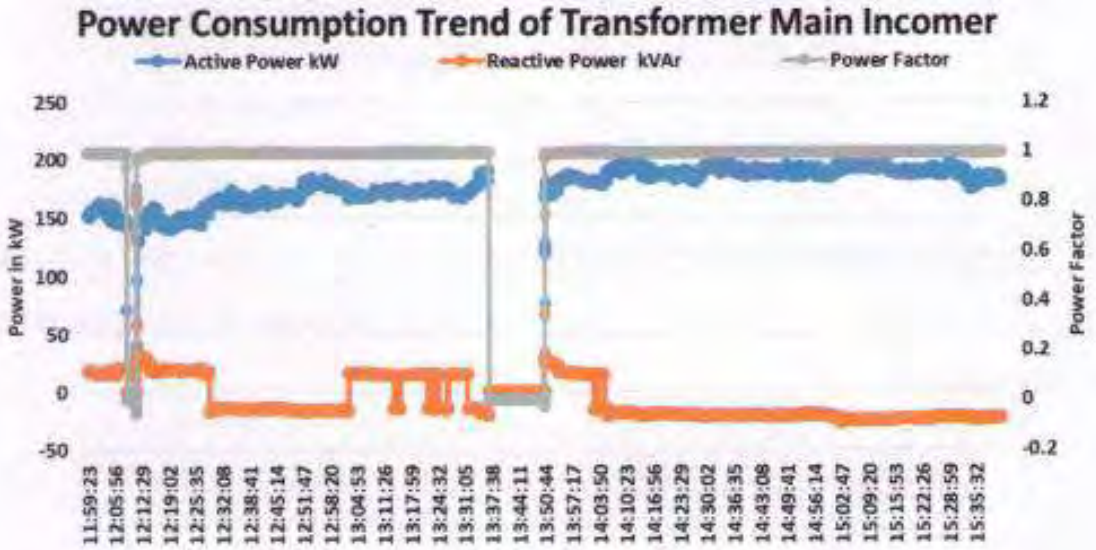
The Power supply to the university is single sourced from the Uttarakhand Power Corporation Limited at 11 kV. The voltage is stepped down to 433 V using one transformer . Facility has installed contract demand is 250 kW.

Table 2: Electricity Bill Analysis – 01

Months	Contract Demand in kVA	MDI in kVA	Energy in kVAh	Energy in kWH	Power factor	Fixed charge in Rs	Energy charge in Rs	Total pay amount in Rs	Unit Rate in Rs
Apr-21	295	125.16	52360	49624	0.948	25075	230384	267481	5.1
May-21	295	96.12	40404	36636	0.907	25075	177777.6	203682	5.0
Jun-21	295	96.2	39156	36660	0.936	25075	172286.4	200025	5.1
Jul-21	295	114.8	39840	37396	0.939	25075	175296	205475	5.2
Aug-21	295	193.72	57568	55372	0.962	25075	253299.2	291130	5.1
Sep-21	295	268.56	93396	90536	0.969	25075	410942.4	464753	5.0
Oct-21	295	247	80372	78680	0.979	25075	353636.8	410240	5.1
Nov-21	295	140	55992	55980	1.000	25075	246364.8	292470	5.2
Dec-21	295	193.84	80304	79576	0.991	25075	353337.6	411476	5.1
Feb-22	295	136	52972	52784	0.996	25075	233076.8	272563	5.1
Mar-22	295	202	77152	75604	0.980	25075	339468.8	388616	5.0
Total of 11 months			**669516**					**3407911**	**5.10**
Total of 12 months			**730381**					**3717721**	**5.10**

3.1.1 Auditor Observations

During the audit, the energy meter was installed at main incoming of transformer for recording the actual energy consumption scenario. The log of power data at the incoming of transformer was recorded using portable three phase power analyzer on HT side of the transformer. During the audit, maximum load, average load and minimum load registered on transformer is presented below. In following graph active, reactive power and power factor trend is shown below.



Main Incomer Details	UOM	Active Power in kW	Power Factor	Reactive Power in kVAr	Apparent Power in kVA
11/0.433 kV Incomer from UCL	Avg	164.62	0.922	-7.11	165.65
	Min	120.56	0.978	-27.03	123.27
	Max	203.72	1.0000	67.23	204.76

From the above graph, active power is on positive side and reactive power is also between positive side of the graph. It means that active power is consumed from Uttarakhand Corporation Limited (UCL) connection and reactive power is consuming from UCL. If kVAr is negative means the APFC panel working properly and reactive power requirement is fulfilled but if kVAr value was positive means there was need of reactive power and APFC was able to

fulfilled the demand. In the standard practices, Reactive power is generated by capacitors and delivered to UCL for maintaining power factor to unity. After finding variation in power factor value at main incoming, we have done the health check-up of installed capacitor bank.

Note: - During the audit time it was observed that the facility team has installed APFC panel. But APFC is not working during the Audit.

Total Energy Consumption Share from Grid is tabulated below

Table 3:Energy consumption share from Grid and PV Panels

Energy Share		
Particulars	**Values in kWh**	**Percentage**
Electricity from Grid	730381	100%

Note: facility only using one source and very few litre of diesel in generation set

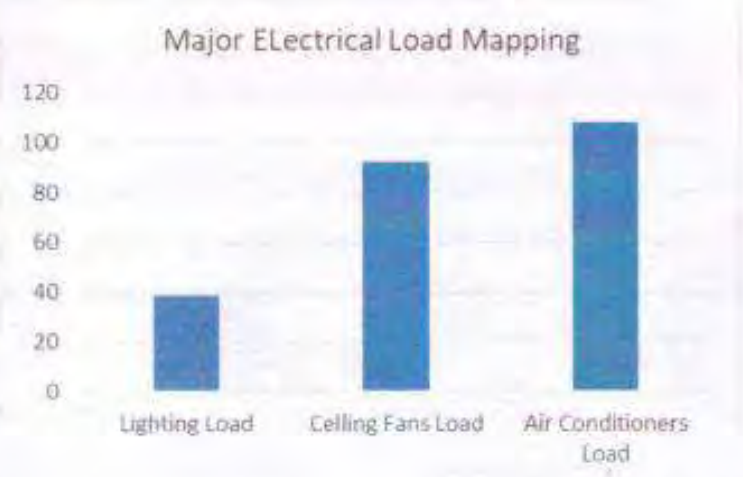
Total Energy generation & consumption pattern

Period Feb-21 to Mar-22

Particulars	Values in kWh
Total Energy Purchased from Grid in kWh	730381

Connected Load Distribution and Mapping

Electrical Load	Connected Values in kW
Lighting Load	38.82
Celling Fans Load	92.5
Air Conditioners Load	108
Total	**239.32**



CHAPTER:4 STUDY OF CEILING FANS SYSTEMS

4.1 CELLING FANS DETAILS

The College have around 1850 no. of ceiling fans with the wattage of 50. These fans were very old or some of them was not working. These fans can be replaced with new technology ceiling fans.

It is suggested to install new technology ceiling fans in the place of existing fans. The rating of these fan will be 28 watts. Thus, it will reduce the power Consumption.

Table 4: Details of eexisting Installed Fans in the campus

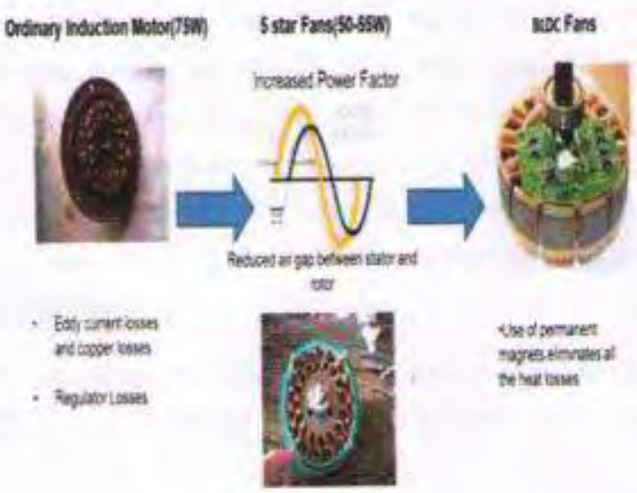
S No	Location	Rated Wattage	Quantity	Total Power in kW
1	A Block	50	340	17
2	B Block	50	352	17.6
3	C block	50	130	6.5
4	D Block	50	55	2.75
5	E Block	50	48	2.4
6	Boys Hostel-I	50	440	22
7	Boys Hostel old	50	250	12.5
8	Girls Hostel	50	235	11.75
	Total Power Consumption			**92.5**

4.2 ECM#1 REPLACE EXISTING CEILING FANS WITH LOW WATTAGE CEILING FANS ON FAILURE REPLACEMENT BASIS

With technological advancements, new energy efficient BLDC fans consumed much less power for the same air flow, besides offering allied benefits like lesser noise and enhanced life,

New Technology Energy Efficient BLDC Fans

A brushless DC (BLDC) motor is a synchronous electric Motor powered by direct-current (DC) electricity and having an

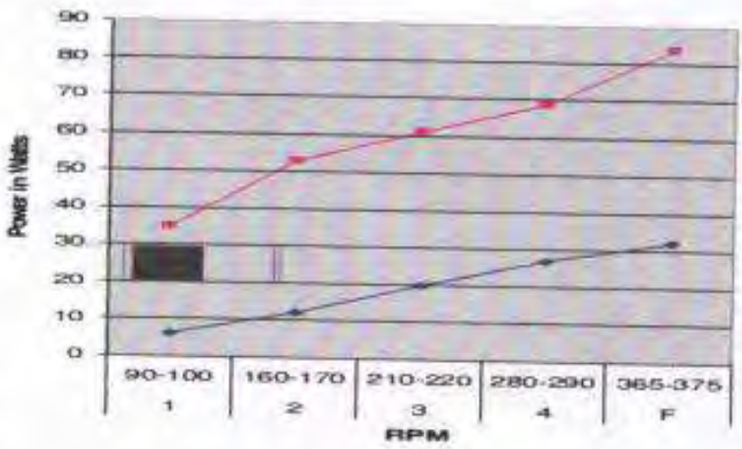


electronic commutation system, rather than mechanical commutator and brushes. In BLDC motors, current to torque and voltage to rpm are linear relationships. This linearity provides an excellent opportunity to use the BLDC motor in the conventional ceiling fans.

This paper presents practical implementation of such BLDC motor for ceiling fan application along with the actual power measurements in comparison with conventional ceiling fans. Complete electronics and the associated advantages and disadvantages of this BLDC ceiling fans are also presented.

Why BLDC Fans?

Today the typical ceiling fan is based on AC motors which are more power consuming. Along with this the typical AC motor-based fans have the rpm control through the capacitor or resistor-based regulators and is not efficient as there is loss in the regulator itself to some extent. In addition, the RPM control is by controlling the voltage and the voltage fluctuations of the mains make it very challenging to have constant RPM based on the AC mains supply. Further, existing AC motor solution, results in power factor (PF) degradation with no improvement for PF and there are other side effects like harmonics injection to the AC mains, etc.



The total amount of air flow or displacement is based on the blade size & rpm and does not change due to any other factor. The proposed solution is to keep the same air flow or displacement with less of energy usage along with improving the PF using the BLDC motor-based ceiling fans. Typical BLDC motor-based ceiling fan has much better efficiency and excellent constant RPM control as it operates out of fixed DC voltage. The proposed BLDC motor and the control electronics operates out of 24V DC through an SMPS (switched mode power supply) having input AC which can vary from 90V to 270V. Following graph shows the comparison between BLDC and conventional ceiling fans

The power consumption is less than half at full speed and is about 20% at low speed for the BLDC motor compared to the conventional motor-based ceiling fan, as can be seen from the

graph above. The Power Supply (PS) used is at 85% efficiency and the electronics circuit consumes less than 0.5 Watt. Generally, 210-220 RPM conventional fans are used which consumes almost 50-Watt power. From graph, as can be seen that same RPM BLDC motor consumes almost half power.

Rated specifications of various sizes is given below for ready reference:

	Gorilla 900 mm	Gorilla 1050 mm	Gorilla 1200 mm	Gorilla 1400 mm	Gorilla Premium Earth brown	Gorilla Premium Sand Grey
Power Consumption (Watts)	28	32	28	35	28	28
Air Delivery (CMM)	175	210	220	270	220	220
RPM	450	430	350	270	350	350
Service Value	7.1	6.6	7.8	7.7	7.8	7.8
Power Factor	0.98	0.98	0.98	0.99	0.98	0.98
Blade Span (mm/inch)	900/36	1050/42	1200/48	1400/56	1200/48	1200/48

We recommend to,

- Replace existing fans with energy efficient fans in failure replacement or by phase manner
- Replace existing ceiling fans of 70 -80 Watts with 28 watts BLDC fan.

4.3 Saving Calculation of ECM#1 Replace Existing Ceiling Fans with Low Wattage Ceiling Fans on Failure Replacement Basis

Table 5: Energy and Cost Saving Calculation for ECM#1

Particulars	Parameters	Future Scenario
Type of Recommendations	Install new technology BLDC ceiling fan	
Present Ceiling fan	Nos	1850
Present Ceiling fan Power	Watts	50

Particulars	Parameters	Future Scenario
Annual Operational Days	Days/Annum	210
Daily Operational Hours	Hours/Day	7
Plant's Present ceiling fan energy Consumption	kWh/Annum	135975
Proposed New Ceiling Fan Power	Watts	28
Proposed Ceiling fan Energy Consumption	kWh/Annum	76146
Annual Energy Saving Potential	kWh/Annum	59829
Unit cost	Rs/Unit	4.5
Savings in Energy Bill Per Annum	Rs. Lakh/Annum	2.69
Investment	Lakhs Rupees	64.75

CHAPTER:5 STUDY OF LIGHTING SYSTEMS

5.1 INSTALLED LIGHTING STUDY & PERFORMANCE ANALYSIS

The College has already taken an energy efficient step to replace the FL tube lights with the LED tube light. College has around 1941 no. of LED light of 20 watts. Following are the details of building wise this.

Table 6 Existing Installed Lighting System Details

S No	Location	Total No Tube Lights	Wattage	Power Consumption in kW
1	A Block	388	20	7.76
2	B Block	392	20	7.84
3	C block	148	20	2.96
4	D Block	65	20	1.3
5	E Block	64	20	1.28
6	Boys Hostel-I	329	20	6.58
7	Boys Hostel old	280	20	5.6
8	Girls Hostel	275	20	5.5
	Total	**1941**		**38.82**

Table 7: Total nos of different lighting fixtures are tabulated below

Type of Lamp	Wattage	Quantity
Tube Light (LED)	20 Watt	1941

5.2 ECM#2 REPLACE EXISTING OLD CONVENTIONAL LAMPS WITH LED LOW WATTAGE LAMPS ON FAILURE REPLACEMENT BASIS

New technology LED lighting

An LED lamp is a light-emitting diode (LED) product that is assembled into a lamp (or light bulb) for use in lighting fixtures. LED lamps have a lifespan and electrical efficiency that is several times better than incandescent lamps, and significantly better than most fluorescent lamps, with some chips able to emit more than 100 lumens per watt. General-purpose lighting needs

white light. LEDs emit light in a very narrow band of wavelengths, emitting light of a colour characteristic of the energy band-gap of the semiconductor material used to make the LED.

The comparison of power consumption for conventional fluorescent lamp and the energy efficient LED lamp is given below:

Advantages of Energy Efficient LED Lamps

- High efficacy (Lumens / Watt)
- Environmentally friendly
- Reduces work related headaches
- Reduces sick building syndrome
- Operates at low voltage

We recommend to

- Replace existing fluorescent lights with new energy efficient lights to reduce energy consumption. The details of proposed lighting fixture as mentioned in Table No-8
- It was observed that campus do not have flood lights for surveillance during night hours. Thus, it is recommended to install flood lights at proper places in the campus for safety and security of Institute campus assets.

5.3 Saving Calculation ECM#2 Replace Existing old Conventional Lamps with LED

Table 8: Energy and Cost Saving Calculation for ECM#2

Particulars	Parameters	Future Scenario
Type of Recommendations	Install new technology LED Lights	
Present LED light	Nos	**1941**
Present LED light Power	Watts	20
Annual Operational Days	Days/Annum	245
Daily Operational Hours	Hours/Day	7
Plant's Present Light Energy Consumption	kWh/Annum	59918
Proposed New LED Tube light Power	Watts	15

Particulars	Parameters	Future Scenario
Proposed LED Tube light Energy Consumption	kWh/Annum	49932
Annual Energy Saving Potential	kWh/Annum	9986.47
Unit cost	Rs/Unit	4.45
Savings in Energy Bill Per Annum	Rs. Lakh/Annum	0.44
Investment	Lakhs Rupees	5.67

CHAPTER:6 STUDY OF AIR CONDITIONING SYSTEMS

6.1 Air Conditioning Study & performance Analysis

The College have Splits ACs of 1.5 TR to 2 TR are installed in the building. During the audit measurement of Air conditioning system to calculate the SEC. Thus, Details of the ACs in building are collected and based on star rating by BEE of Existing Air conditioners we suggest to change the existing ACs with new 5 Star ACs:

Table 9: Air Conditioning installed at Institute

S No	Location	Cooling Capacity	Brand Name	Inverter(I)/Non-Inverter Ac(NI)
1	VC Sir Office	2 Ton	Carrier	N I
2	Registrar Office	2 Ton	Totaline	I
3	Director Office	2 Ton	Carrier	I
4	Chairman Sir	2 Ton	Carrier	I
5	Vice Chairman Sir	2 Ton	Carrier	I
6	Conference Room	1.5 Ton	LG	N I
7	Conference Room	1.5 Ton	LG	N I
8	Admin Office	2 Ton	Carrier	I
9	Room A005	2 Ton	Godrej	I
10	Director QSB Office	2 Ton	Blue Star	I
11	Exam Cell	2 Ton	Carrier	I
12	Conference Hall I Floor	2 Ton	Blue Star	I
13	Conference Hall I Floor	2 Ton	Blue Star	I
14	Dean Office	2 Ton	Blue Star	I
15	Accounts	1.5 Ton	Cruise	I
16	DEEPRO Office	2 Ton	Blue Star	I
17	ExPro VC Room	2 Ton	Blue Star	I
18	Shyamji Auditorium	10 Ton	Dakin	NA
19	Shyamji Auditorium	11 Ton	Dakin	NA
20	Shyamji Auditorium	12 Ton	Dakin	NA
21	Shyamji Auditorium	13 Ton	Dakin	NA

S No	Location	Cooling Capacity	Brand Name	Inverter(I)/Non-Inverter Ac(NI)
22	B Tech Auditorium	2 Ton	Godrej	I
23	B Tech Auditorium	2 Ton	Godrej	I
24	B Tech Auditorium	2 Ton	Godrej	I
25	Mini Auditorium	2 Ton	Blue Star	I
26	Mini Auditorium	2 Ton	Blue Star	I
27	Mini Auditorium	2 Ton	Blue Star	I
28	Moot Court	2 Ton	Blue Star	I
29	Moot Court	2 Ton	Blue Star	I
30	IT Office Computer Lab	2 Ton	Cruise	I
31	Server Store Computer Lab	2 Ton	Blue Star	I
32	Computer Lab 1 &2	NA	Blue Star	NA
33	Principal Office	2 Ton	Blue Star	I
34	Room B006	1.5Ton	Carrier	I
35	Room B006	1.5Ton	Carrier	I
36	Estate Officer Office	1.5Ton	Carrier	I
37	Boys Hostel G Floor (G 17)	1 Ton	Blue Star	I
38	Boys Hostel New(G06)	1 Ton	Blue Star	I
39	Girls Hostel G Floor	1 Ton	Blue Star	I
40	VC Residence	2 Ton	Godrej	I
41	VC Residence	2 Ton	Godrej	I
42	VC Residence	2 Ton	Godrej	I
43	Guest House	2 Ton	Blue Star	I
44	Guest House	2 Ton	Blue Star	I
45	Guest House	2 Ton	Blue Star	I

6.2 ECM#3 Replace Existing 3 Star ACs with Inverter Technology 5 Star ACs on Failure Replacement Basis

The lower the kW/TR value, lower will be the power consumption AC and hence lower will be impact on energy cost. So, if we can see in above table 5 STARs ACs, having lower SEC i.e., kW/ TR as compared to 3-star ACs of the same rating. Thus, obviously it is recommended to install 5-star AC preferably to reduce operational cost.

Now -a – Days new star rated inverter-based air conditioners are coming in market having lower values of kW/ TR. this means lower specific energy consumption for the same output. The rated Specific energy consumption of split Air conditioner is in the range of 0.90-1.0 kW/ TR. this is much lower than the specific energy consumption of installed air conditioner. In addition to this these air conditioners are coming with inverter-based technology.

What is inverter technology?

A regular air conditioner will always run at peak power requirement when the compressor is running. An air conditioner with inverter technology will run continuously but will draw only that much power that is required to keep the temperature stable at the level desired. So, it's kind of automatically adjusts its capacity based on the requirement of the room it is cooling. Thus, drawing much less power and consuming lesser units of electricity.

Thus, it is advisable to replace air conditioners which are old and having higher specific energy consumption. Since the operational hours of air conditioners are very less, it will be beneficial if facility team replace old air conditioner having higher running hours on priority basis.

We recommend to

- Replace old air conditioner having higher running hours on priority on failure replacement basis
- Procure new air conditioner based on energy efficiency ratings provided by Bureau of energy efficiency.
- Replace rest other non-energy efficient air conditioner based on failure basis.

6.3 Saving calculation of ECM#3 for Air CONDITIONING

Table 10: Energy and Cost Saving Calculation for ECM#3

Particulars	Parameters	Future Scenario
Type of Recommendations	-	5-Star Split AC
Present Split AC	Nos	41

CHAPTER:7 RENEWABLE ENERGY POTENTIAL

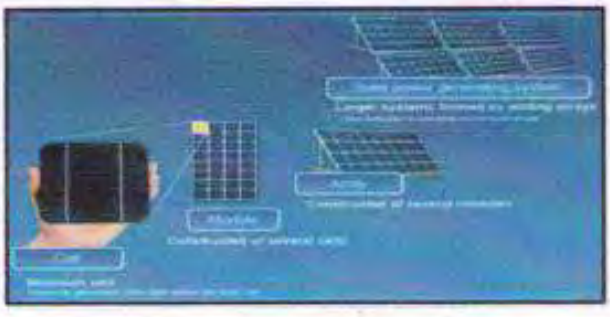
During the visit, it was study and found that facility have enough space in rooftop to install the solar PV power plant. The details of study are describe in energy saving proposal

7.1 ECM#4: INSTALL ROOF TOP SOLAR PV PANEL OF 140 KWP

During the audit opportunity for solar energy was also explored. The plant Building has substantial roof top area, which could also be utilized for the installation of a Solar Photovoltaic Plant.

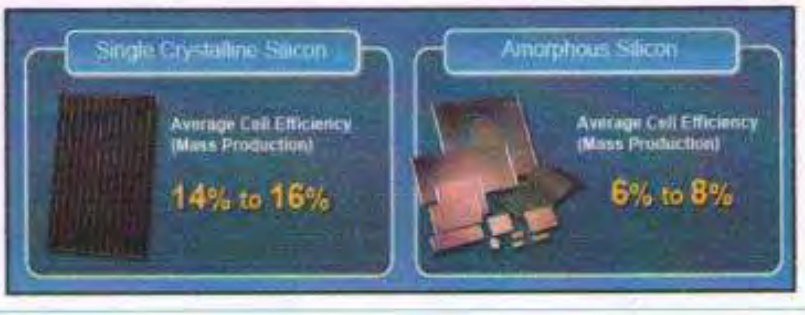
Solar Photovoltaic Technology converts the sunlight into DC electricity through solar cells. The generated electricity can be used directly during the day. Batteries would not be required as the utilization is only during the daytime. Some of the salient features are listed below:

- Provides uninterrupted & Stable DC / AC Power Supply to dedicated load
- No noise and Easy to install
- Simple to operate and Pollution free working
- Low maintenance cost with the generating panels having a long life
- Soft loan available



Major Components & Cell Efficiency

- PV Module
- MS Galvanized Mounting Structure
- Array / Sub-Main / Main Junction Box
- Power Conditioning Unit
- Cable and Hardware
- Earthing Kit



Area Requirements for SPV

Capacity	Estimated Number of modules Quantity (pcs)	Approx. Weight (Kgs)	Approx. Area (sqm)
5 kW System	32	500	40.7
6.5 kW System	42	650	52.9
140 kW Solar System	896	14, 00, 0	1140

7.1 SAVING CALCULATION OF ECM#4 FOR SOLAR PV POWER PLANT

Table 11: Energy and Cost Saving Calculation for ECM#4

Particulars	Values
Rated capacity of the Solar PV System	140 kWp
Average power generation per day	4 to 5 kWh per kW per day (say 4.5 kWh per kW per day)
No. of sunny days	300 days per annum
Average Power Generation through SPV system	18, 90, 00 kWh/Annum
Power Rate	4.5 per kWh
Cost Savings per annum	**Rs 8.50 Lacs**
Estimated Investments bench mark cost Rs 0.40 Lacs per kWp (without battery backup)	Rs 56 Lacs
Simple Payback Period	79 months

CHAPTER:8 LUX LEVEL STUDY

The lux level study of different areas or rooms were done during the audit in the College. Some area has good lux level but some has to improve.

Table 12: Lux Level Measured Values

Sr No	Location	Lux Level					
		1	2	3	4	Average	Recommended
1	Auditorium	102	150	170	130	138	500-700
2	Corridor GF	28	36	28	32	31	100-150
3	Chemistry Lab D Block	111	119	146	21	99	300-400
3	D Block Corridor	80	60	58	62	65	150-200
4	D 001 Civil Lab	74	135	400	300	227	300-400
5	E Block Workshop GF	46	6	33	28	28	100-150
6	Stairs	40	42	39	28	37	100
7	Library C Block	80	170	130	240	155	500-600
8	Students Sitting area	70	130	100	30	83	400-500
9	Reception	233	180	200	192	201	250-350
10	Admin Office	84	92	96	80	88	300-400
11	Kitchen	122	130	133		128	100-150
12	Conference Room	162	628	22	200	253	200-250
13	Accounts E Block	50	172	168	152	136	300-350
14	Computer Lab E Block	76	59	83	156	94	400-450
15	Wash Room GF	20	15	10	18	16	100-150
16	Seminar Hall	128	240	112	86	142	600-700
17	Pharmacy Lab	44	56	62	50	53	300-400
18	Faculty Room	60	42	38	39	45	250-300
19	B 111 Office Room	60	75	65	74	69	200-300
20	D Pharma Principal Office	102	414	86	109	178	350-450
21	Auditorium Entry	111	119	146	21	99	150-250

Sr No	Location	Lux Level					
		1	2	3	4	Average	Recommended
22	GD Office	203	222	119	200	186	300-400
23	1st Floor 102 Room	76	80	72	55	71	300-400
24	Faculty Room - 01	56	76	80	45	64	200-300
25	Sports Room 107	60	65	78	49	63	400-500
26	Heat Transfer Lab	31	33	34	30	32	300-400
27	Admission cell	103	81	86	80	88	300-400
28	B block Faculty Room	40	41	38	39	40	200-300
29	E Block Faculty Room	38	40	26	29	33	200-300
30	G floor Corridor	34	36	40	28	35	100-150
31	Director office	111	110	108	102	108	300-350
32	GF B 006	37	40	43	32	38	250-350
33	Mess	69	45	42	42	50	250-350

Lux Level in some areas was found very low, it recommended to increase lux level by installed suitable LED light system for the area.

8.1 Install the Occupancy Sensor in Classrooms and Hall to Save Energy

During the study, it was found that university have so many lectures room and class room has lighting working during the non- working hours/ lunch time/ after finishing lecture to evening time.

Lighting use constitutes about 20% of the total energy consumption in commercial buildings. Adding lighting controls is a simple retrofit option than can save on energy costs while helping facility for energy savings mandates.

Lighting controls that reduce or turn off the lighting when a space is not in use can save a significant amount of energy. Studies have shown that adding lighting controls can reduce lighting energy use 10% to 90% or more depending on the use of the space in which the sensors are installed.

Install Occupancy sensor

Occupancy sensors are one kind of devices used for detecting whenever space is empty then it is automatically deactivated the light so that the energy can be conserved. This sensor may also activate the lights. Occupancy sensors increase lighting energy savings by turning of or turning down the lights when rooms are unoccupied. Lighting energy savings of 10% to 90% are possible depending on room usage.

An occupancy sensor is an electronic sensor, used for different purposes like to improve the security of the office as well as home, reduces the energy utilization for lights in empty spaces. Generally, this sensor unites a motion detector using a timer as well as a light switch to activate and deactivate the lights as they are not required. These sensors can be connected to an alarm for the purpose of security. By using these sensors, one can conserve the energy without needing main changes. This sensor can be used to detect the vacant to deactivate the lights after a specific time period based on the used sensor. There are different kinds of motion-detecting sensors available in the market, but these sensors fall under one of these categories like active & passive.

We recommend, the facility to install the sensor for all the classrooms and hall to save energy in light distribution.

CHAPTER:9 SUMMARY

9.1 Cumulative Energy Saving Opportunities

Cumulative Energy Saving Opportunities

Particulars	Annual Savings				Estimated Investment
	kWh	ToE	CO2	Rs in Lakh	(Rs in Lakh)
Replace Existing Ceiling Fans with low wattage Ceiling Fans on Failure Replacement Basis	59829	5.1	53.8	2.69	64.75
Replace Existing old Conventional Lamps with LED Low wattage Lamps on Failure Replacement Basis	9986.47	0.85	8.9	0.44	3.67
Replace Existing 3 Star ACs with Inverter Technology 5 Star ACs on Failure Replacement Basis	30450	2.6	27	1.37	23
Install solar PV power plant of 140 kW	189000	1625	169.9	8.05	56
Total	**289265.47**	**1633.55**	**259.6**	**12.55**	**147.42**
Observation					
Install Light Control Sensor In Class Rooms To Switch Off Lamps					
Transformer Loading And Electrical System Study Lux Level Study Thermal Imaging Of Electrical Panels Electrical Safety Points					

Since the investment was on higher side, university can plan the energy saving on phase manner to take the advantage of both financial and energy benefits

CHAPTER:10 THERMAL IMAGES OF ELECTRICAL SYSTEM

Main Electrical Panels Thermal images

IR002932

IR002932_Real Image

Location :- Transformer Main incomer LT Bus bar

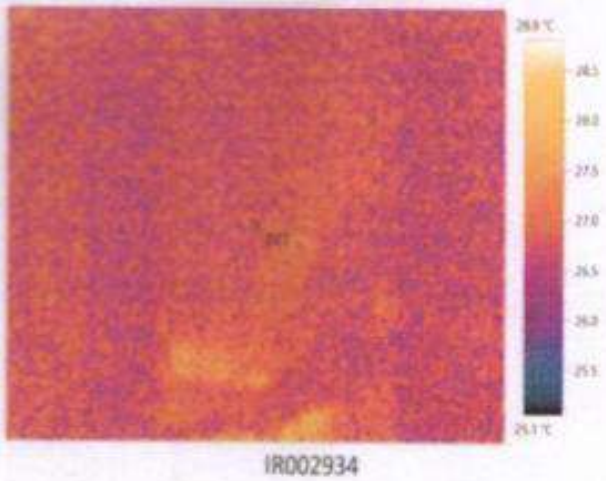
Main Electrical Panels Thermal Images

IR002933

IR002933_Real image

Location Transformer Main incomer LT Bus bar

Main Electrical Panels Thermal Images

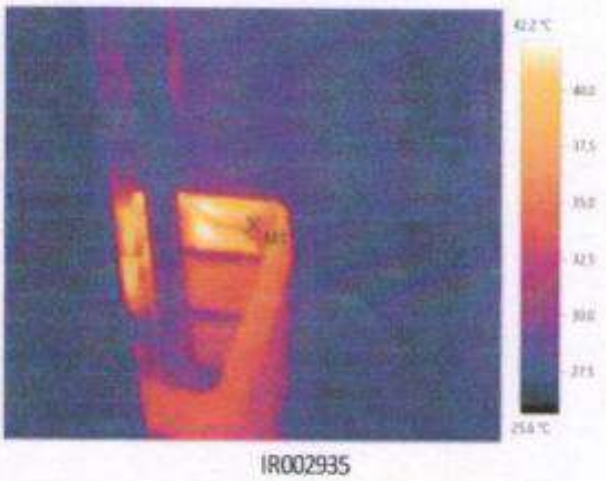


IR002934

IR002934_Real image

Location :- Transformer Main incomer LT Bus bar

Main Electrical Panels Thermal Images

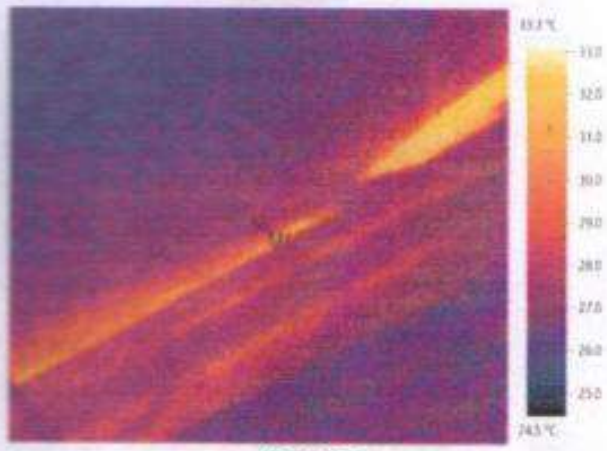


IR002935

IR002935_Real image

Location :- Transformer Main incomer LT Bus bar

Main Electrical Panels Thermal Images

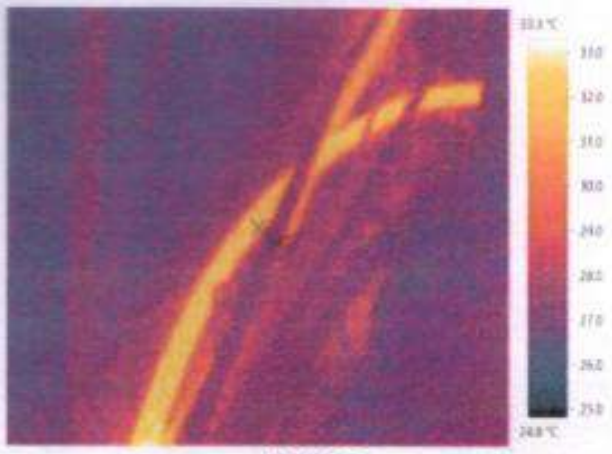


IR002937

IR002937_Real Image

Location :- **Transformer to LT Panel incoming Cables**

Main Electrical Panels Thermal Images

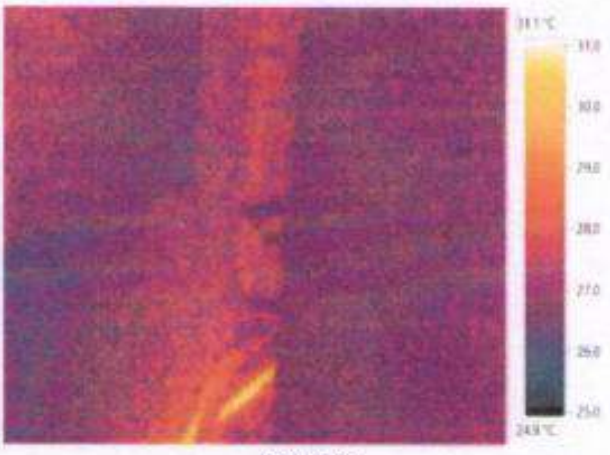


IR002938

IR002938_Real image

Location :- Transformer to LT Panel incoming Cables

Main Electrical Panels Thermal Images

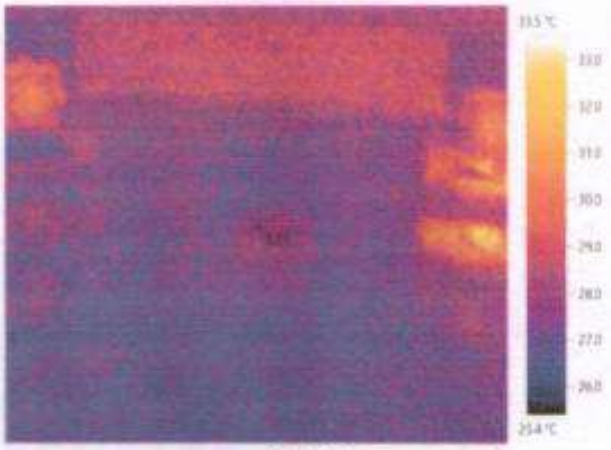


IR002939

IR002939_Real image

Location :- Transformer to LT Panel incoming Cables

Main Electrical Panels Thermal Images

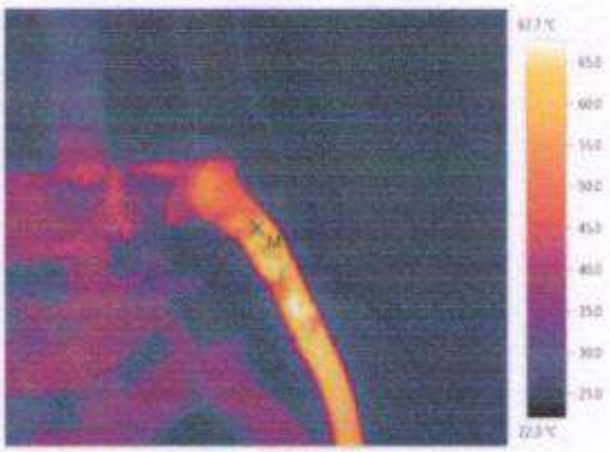


IR002940

IR002940_Real image

Location :- Transformer to LT Panels

Main Electrical Panels Thermal Images

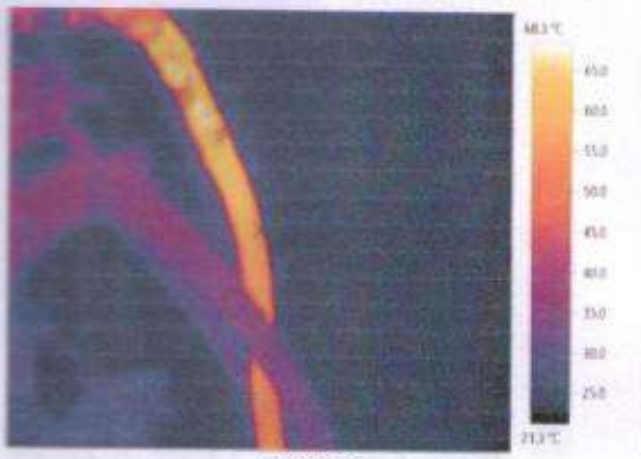


IR002941

IR002941_Real image

Location :- LT Panel Feeder outgoing to College buildings R Phase Feeder
Observation :- Please Check the cable size and Retight the cable thimble

Main Electrical Panels Thermal Images

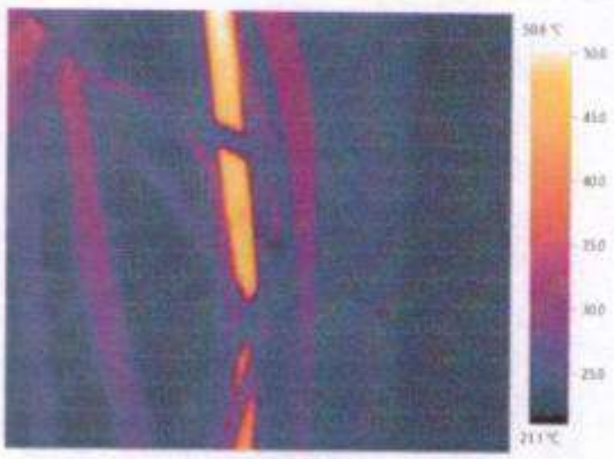


IR002942

IR002942_Real image

Location :- LT Panel Feeder outgoing to College buildings R Phase Feeder
Observation :- Please Check the cable size and Retight the cable thimble

Main Electrical Panels Thermal Images



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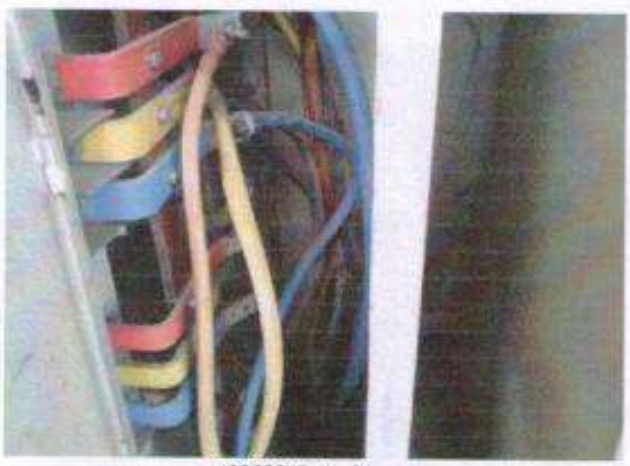
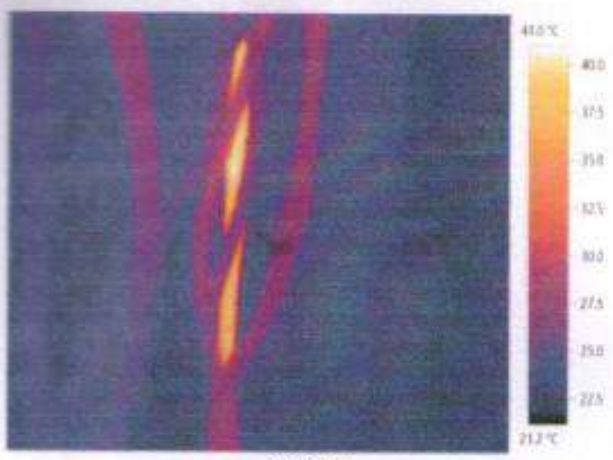


IR002943_Real image

Location :- LT Panel Feeder outgoing to College buildings R Phase Feeder
Observation :- Please Check the cable size and Retight the cable thimble

Main Electrical Panels Thermal Images



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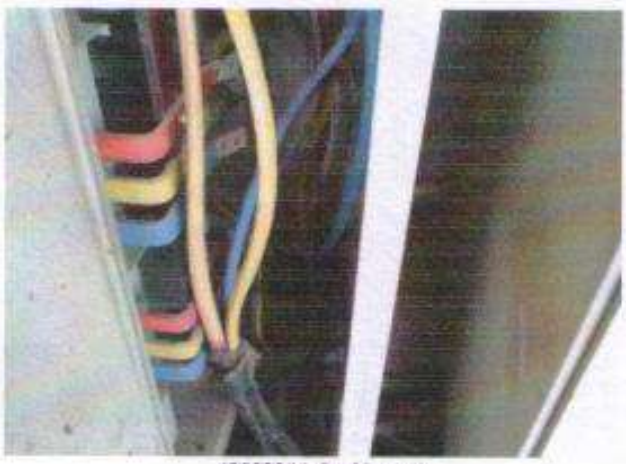
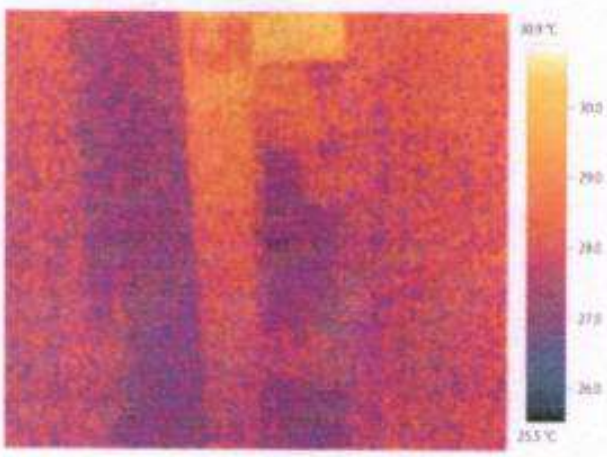


IR002944_Real image

Location :- LT Panel Feeder outgoing to College buildings R Phase Feeder
Observation :- Please Check the cable size and Retight the cable thimble

Main Electrical Panels Thermal Images

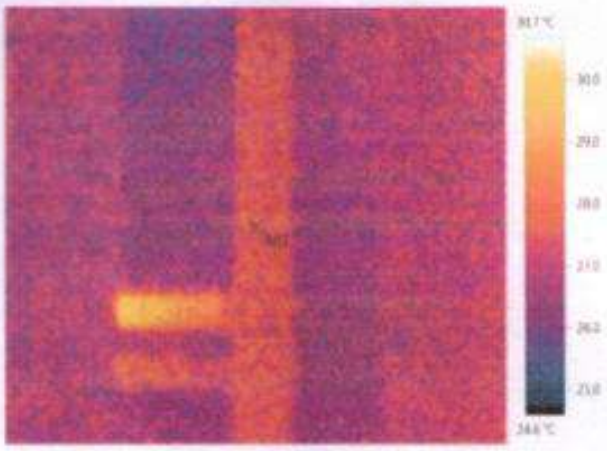


IR002945

IR002945_Real image

Location :- Main Electrical LT Panel

Main Electrical Panels Thermal Images

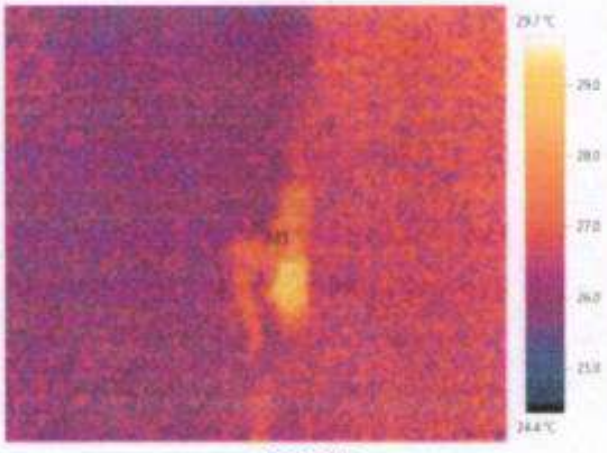


IR002946

IR002946_Real image

Location :- Main Electrical LT Panel

Main Electrical Panels Thermal Images

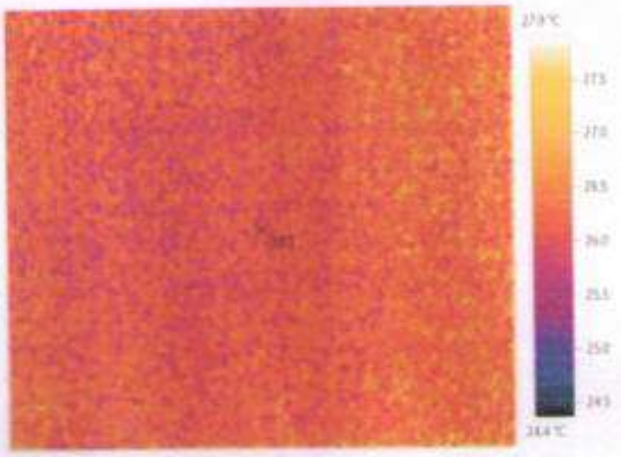


IR002947

IR002947_Real image

Location :- Main Electrical LT Panel

Main Electrical Panels Thermal Images

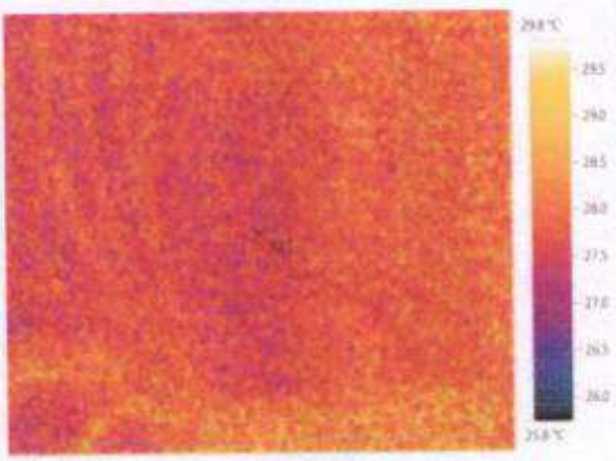


IR002948

IR002948_Real image

Location :- Electrical Panels E Block Building

Main Electrical Panels Thermal Images

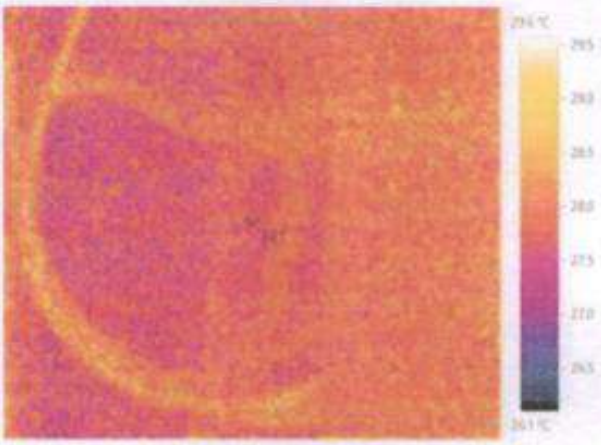


IR002949

IR002949_Real image

Location :- Electrical Panels E Block Building

Main Electrical Panels Thermal Images



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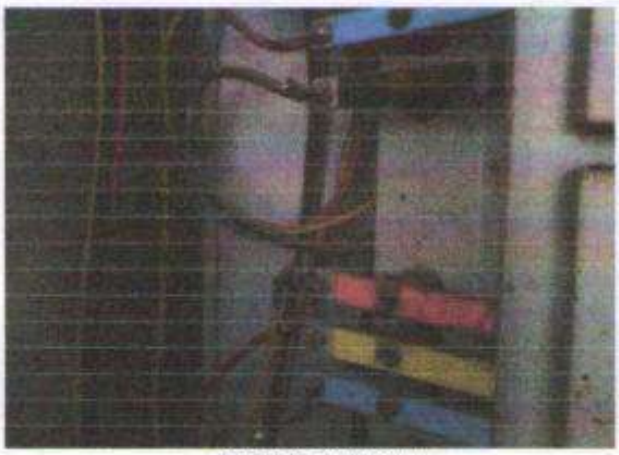
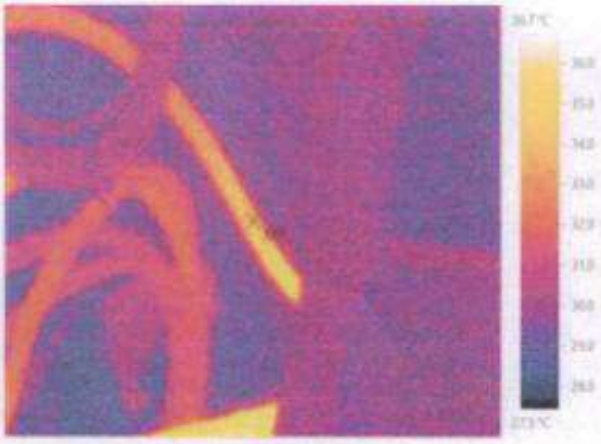


IR002950_Real image

Location :- Electrical Panels E Block Building

Main Electrical Panels Thermal Images

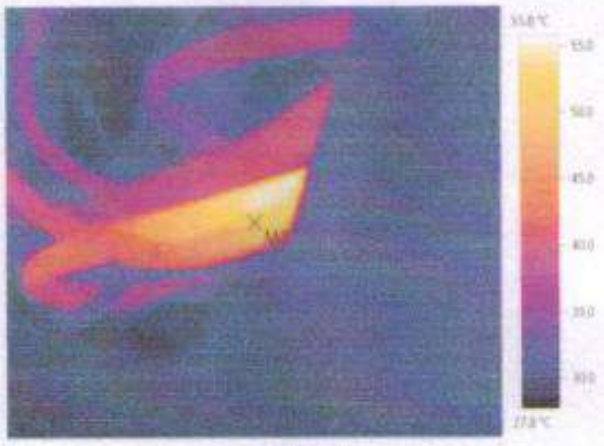


IR002951

IR002951_Real image

Location :- Electrical Panels E Block Building

Main Electrical Panels Thermal Images

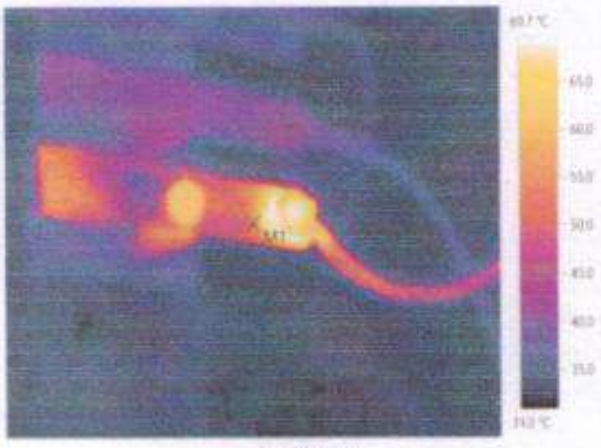


IR002952

IR002952_Real image

Location :- E Block Building panels outgoing to E block
Observations :- Please Check the cable size

Main Electrical Panels Thermal Images

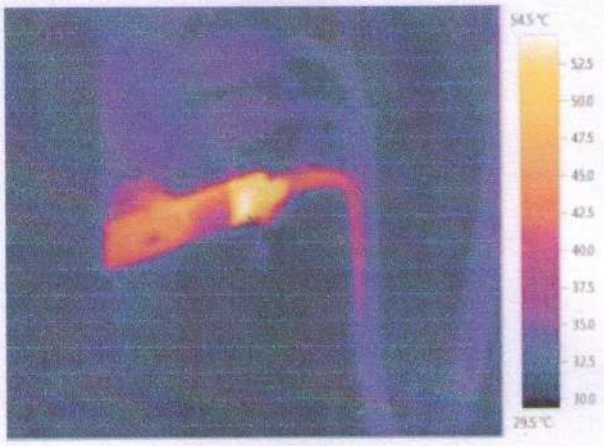


IR002953

IR002953_Real image

Location :- E Block Building panels outgoing to E block Y phase
Observations :- Please Check the cable size Retight the thimble

Main Electrical Panels Thermal Images



IR002954

IR002954_Real image

Location :- E Block Building panels outgoing to D block Y phase
Observations :- Please Check the cable size Retight the thimble

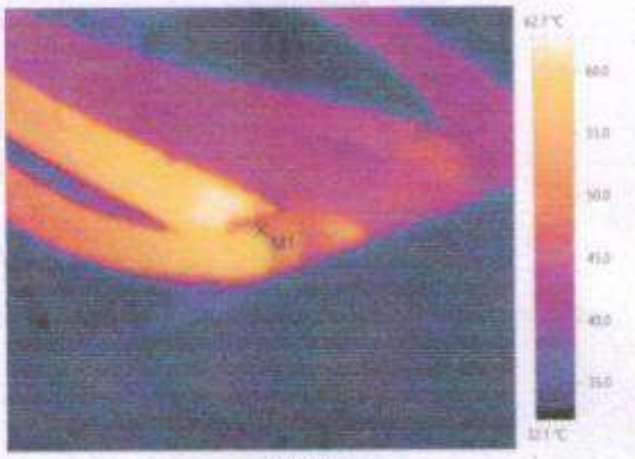
Main Electrical Panels Thermal Images

IR002955

IR002955_Real image

Location :- E Block Building panels outgoing to B block
Observations :- Please Check the cable size Retight the thimble

Main Electrical Panels Thermal Images

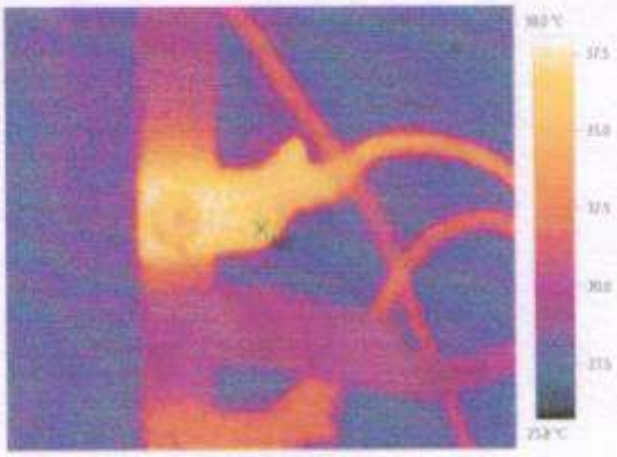


IR002956

IR002956_Real image

Location :- E Block Building panels outgoing to E block Y phase
Observations :- Please Check the cable size Retight the thimble

Main Electrical Panels Thermal Images

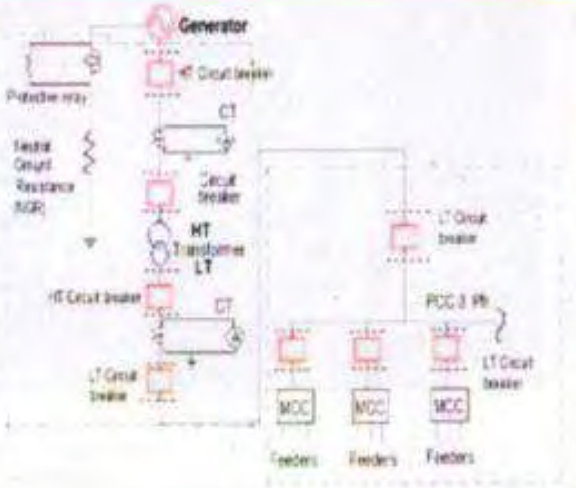


IR002957

IR002957_Real image

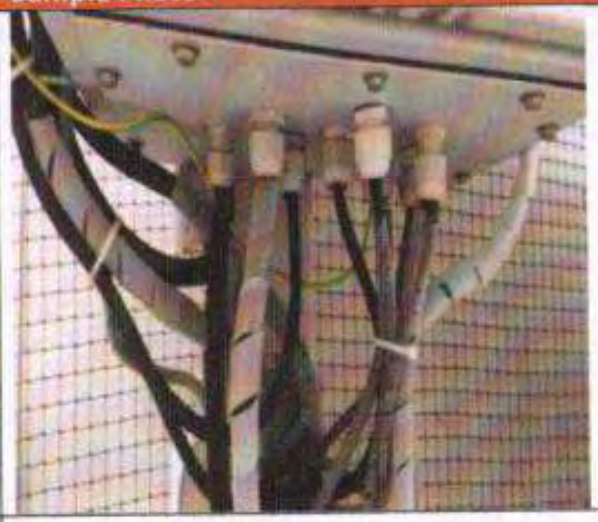
Location :- E Block Building panels outgoing to B block R phase
Observations :- Please Check the cable size Retight the thimble

CHAPTER:11 ELECTRICAL SAFETY POINTS

Gaps if Any	Site Photographs	Recommendation	Sample Photo
No Single Line diagram at main DB. No Voltage Indication stickers for voltage level.		Provide and display single line diagram near electrical distribution room. Provide voltage level indication sticker on main DB	
No information list of DB, Panel and Sockets received during audit at facility.		The list of DB, Panel and Socket should be prepared for better understanding as per standards NFPA 70E	

Gaps if Any	Site Photographs	Recommendation	Sample Photo
No list of authorized persons provided at main D.B.		Provide list of authorized persons at main D. B	
Safety mats was not found at main D.B.		Please installed safety mats for this area as per ISO standard.	

Gaps if Any	Site Photographs	Recommendation	Sample Photo
Unwanted material was lying at main D.B.		Do not keep unwanted material near main D. B	
Cables/ wires are lying all over the places in Main D.B.		Please Provide proper cable tray in main. D.B	

Gaps if Any	Site Photographs	Recommendation	Sample Photo
Open area as found at main D.B. Cables glands not found main D.B.		Please provide the proper cables gland at main D.B. Please cover this open area.	
Main D.B was found in open area.		Please provide the separate room for D.B panels.	

11.1 ANNEXURE-1: ENERGY EFFICIENT EQUIPMENT SUPPLIERS

Product/ Equipment	Name	Website
Capacitors and APFC Panels	Standard Capacitors	www.standardcapacitors.com
Capacitors and APFC Panels	Ashish Consultant	www.ashishconsultant.com
Capacitors/ Switch Gears/ Reactors etc.	Shreem Electric Ltd	www.shreemelectric.com
Lighting Systems	Asian Electronics Ltd.	www.aelgroup.com
Lighting Systems	Philips India Ltd	www.india.philips.com
Lighting Systems	OSRAM India Ltd.	www.osram.in
Lighting Systems	Wipro Lighting	www.wiprolighting.com
Solar Products	Synergy Solar (P) ltd	www.synergysolar.net
Solar Products	Inter Solar Systems (P) Limited	www.intersolarsystems.com
Energy Efficient Pumps	Danfoss Industries Pvt. Ltd.	www.danfoss.com
Energy Efficient Pumps	Mather & Platt Pumps Ltd.	www.matherplatt.com
Energy Efficient Pumps	Xylem Water Solutions India Pvt. Ltd. (Distributor of Lowara, Italy)	www.lowara.com

Note: - The suppliers mentioned above are not the only ones or the best in the market. The management may contact other suppliers for competitive rates/ specifications.

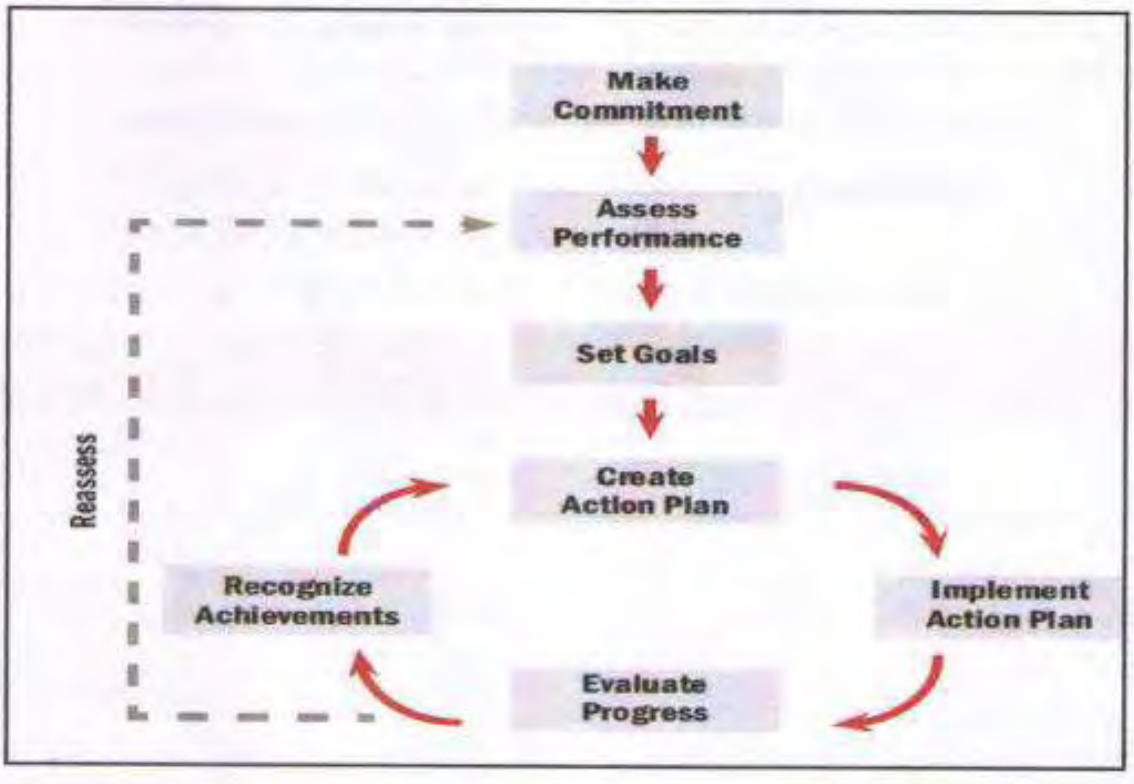
11.2 ANNEXURE-2: RECOMMENDED LUX LEVELS

➢ **Entrance**		
Entrance halls, lobbies, waiting rooms	=	200
Enquiry Desks	=	500
Guest Houses	=	200
➢ **Circulation Areas**		
Lifts	=	100
Corridors, passageways, stairs	=	100
Escalators, revelators	=	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
➢ **Communication**		
Switch board rooms	=	300
Telephone, apparatus rooms	=	150
Telex room, post rooms	=	500
Reprographic room	=	300
➢ **Education**		
Assembly Halls	=	200-500 (average 300)
Teaching Places	=	200-500 (average 300)
Lecture Theatres	=	200-500 (average 300)
Seminar Rooms	=	300-750 (average 500)
Art Rooms	=	300-750 (average 500)
Needle Work Rooms	=	300-750 (average 500)
Laboratories	=	300-750 (average 500)
Libraries	=	200-500 (average 300)
Music Rooms	=	200-500 (average 300)
Sports Halls	=	200-500 (average 300)
Workshops	=	200-500 (average 300)

11.3 ANNEXURE-3: ENERGY MONITORING AND ACCOUNTING

Present Energy Monitoring & Accounting System: There is a proper metering system for the purchased power. However, the data related to the power generated using DG sets is not being monitored on a monthly basis. There are no prescribed formats available to maintain such records. As a result of this, there is no periodic performance analysis of the energy consumption in the building.

Recommended Energy Monitoring & Accounting System



Energy Management should be seen as a continuous process. Strategies should be reviewed annually and revised as necessary. The key activities suggested have been outlined below:

- Clear **accountability for energy consumption** needs to be established, appropriate financial and staffing resources must be allocated and reporting procedures initiated. An energy management programme requires commitment from the whole organization in order to be successful.
- A **record of Energy consumption** both Electrical and Thermal must be kept and monitored on a regular basis. For this, sub meter on the DG set is required. This will enable an overview of energy use and its related costs, as well as facilitating the identification of savings that might otherwise not be detected. The system

needs to record both historical and ongoing energy use, as well as cost information from billing data, and capable of producing summary reports on a regular basis. This information will provide the means by which trends can be analyzed and reviewed for corrective measures.

- Some facts and figures related with energy may be displayed on boards or **posters in the premises**, to create awareness among the workmen and staff. A key ingredient to the success of an energy management program is maintaining a high level of awareness among staff. This can be achieved in a number of ways, including formal training, newsletters, posters and publications. It is important to communicate program plans and case studies that demonstrate savings, and to report results at least at 12-month intervals. As an incentive, new ideas and implementation of energy saving point must be recognized and awarded.
- The findings and **implementation status of Energy audits** should be reviewed periodically/annually for further action plan.

*Figure 1: **Format for Maintaining a Monthly Record of the Purchased Power Consumption***

Particulars	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Actual Demand (KVA)												
KWH Consumption												
KVAh Consumption												
Operating Power factor												
Fixed Demand Charges (Rs)												
Energy Charges (Rs)												
Penalty / Rebate, if any (Rs)												
Other Charges (Rs)												
Total Amount Payable (Rs)												

11.4 Annexure-4: Checklist for Preventive Maintenance

➲ Building Envelope

Windows and Skylights

- Replace broken or cracked window panes
- Replace worn weather stripping and caulking
- Replace defective sealing gaskets and cam latches

Doors

- Replace worn weather stripping and caulking

Exterior Surfaces

- Replace worn weather stripping, caulking, and gaskets at exterior joints and at openings for electrical conduits, piping through-the-wall units, and outside air louvers

Stairwells and Shafts

- Replace worn seals and weather stripping in stairwells on penthouse machine-room doors, in elevator shafts in vertical service shafts and on basement and roof equipment room doors when they are connected by a vertical shaft that serves the building

➲ Self-Contained Units (Such as Window and Through-The-Wall Units and Heat Pump

- Clean evaporator and condenser coils
- Clean air intake louvers, filters, and controls
- Keep airflow from units unrestricted
- Replace worn caulking in openings between the units and windows or wall furnace
- Check the voltage to ensure that the unit is operating at full power
- Follow applicable maintenance guidelines for compressors, condensers and fans.

➲ Motors, Fans, Pumps, Engines and Turbines

Motors

- Check the alignment of the motor to the equipment it drives. Align and tighten as necessary
- Check for and repair loose connections and bad contacts regularly

- Determine the cause of excessive vibration and repair as necessary
- Clean motors regularly
- Lubricate the motor and drive bearings regularly
- Tighten belts and pulleys
- Check for overheating. If overheating is present, check for functional problems or inadequate ventilation and repair as necessary
- Balance three-phase power sources to motors
- Check for over voltage or low-voltage conditions and correct as necessary

Fans

- Check for excessive noise and vibration and correct as necessary
- Clean fan blades & Inspect and lubricate bearings regularly
- Inspect drive belts for proper tension. Adjust or replace as necessary to ensure proper operation
- Keep inlet and discharge screens on fans free of dirt and debris

Pumps

- Check for packing wear and repack as necessary. Replace glandular packing with mechanical seals
- Inspect bearings and drive belts for wear and binding. Adjust, repair, or replace as necessary

Lighting

- Wipe lamps clean at regular intervals. Lamps that are exposed to substantial amounts of dirt, dust, grease, or other contaminants should be cleaned more frequently than lamps in a relatively clean atmosphere
- Maintain luminary efficiency by properly cleaning the reflecting surfaces and shielding media
- Replace lens shielding that has yellowed or become hazy with a clear acrylic lens with good non-yellowing properties. A clear glass lens can be considered if it is compatible with the luminary and does not present a safety hazard
- Clean ceilings, walls, and floors frequently to improve reflective qualities
- If day lighting contributes to lighting, wash windows frequently to maintain illumination levels

- Replace all lamps used for area illumination after they have been in service for a substantial portion (approximately 70 percent) of their rated life, instead of simply replacing lamps one at a time as they burn out.

Registrar
Quantum University