INVESTMENT GRADE ENERGY AUDIT REPORT

of Centurion University of Technology & Management
Ramchandrapur, Bhubaneswar, Odisha

Submitted to:

Centurion University Of Technology & Management

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ACKNOWLEDGEMENT

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PTC acknowledges with gratitude the wholehearted support and encouragement given by all CUTM officials while carrying out the study at CUTM.

PTC acknowledges with gratitude and sincerely thanks all the officials and staff members of Centurion University of Technology & Management who have rendered their all possible co-operation and assistance to the study team during the entire period of the Audit.

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M/s. Power Tech Consultants
(Bibhu Charan Swain)
Authorised Signatory

Signature

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AUDIT TEAM DETAILS

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2. Mr. Barada Prasana Subudhi, Asst. Manager (Project)
3. Mr. Nirjhar Biswal (Project Associate)
4. Ms. Monika Kumari (Project Associate)
5. Mr. Suraj Kumar Bhujabal (Project Associate)

CERTIFICATE

We certify the following

- The data collection has been carried out diligently and truthfully.
- All data measuring devices used by the auditor are in good working condition, have been calibrated and have valid certificate from the authorized approved agencies and tampering of such devices has not occurred.
- All reasonable professional skill, care and diligence had been taken in preparing the energy audit report and the contents thereof are a true representation of the facts.
- The investment grade energy audit has been carried out in accordance with the BEE prescribed norms.

M/s. Power Tech Consultants
(Bibhu Charan Swain)
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EXECUTIVE SUMMARY

Centurion University of Technology & Management (CUTM) is the First Multi-Sector State Private University in Odisha, located in Ramchandrapur, P.O. Jatni, Dist-Khurda, Odisha. Established in August 2005, spread over 40 acres of land in the foothill of Barunei hills, near Jatni town, the campus is adjacent to National Institute of Science, Education and Research (NISER), Indian Institute of Technology (IIT), All India Institute of Medical Sciences (AIIMS) and Xavier University. The famous 11th century Lingaraj temple is about 20 kms from this campus. It is the only technological University in South Odisha. The complex includes School of Engineering & Technology, School of Management, School of Applied Science, School of Vocational, Education and Training, School of Pharmacy, School of Media & Communication, School of Paramedics & Allied Health Sciences, School of Forensic Sciences.

Energy Conservation is a major focus and requirement in Commercial and Government Buildings, and hence Centurion University of Technology & Management, officials has entrusted the work of conducting Investment Grade Energy Audit (IGEA) to Power Tech Consultants. The Energy Audit of CUTM was carried out in the period in December – January 2021.

Centurion University of Technology & Management has three distribution transformers of 1000kVA, 500kVA and 250kVA with contract demand of 444.44 kVA (Consumer no. 12125316), 888.88 kVA (Consumer no. 12107417) & 111.00 kVA (Consumer no. 201190008194) and it avails Power Supply from TPCODL, the local DISCOM at 33 kV voltage level. As per electricity bills analysis for FY 2018-19 and FY 2019-20, the monthly electrical energy consumption stands at about 324630 kWH and the monthly energy bill is around Rs.2393076, the average Power Factor is 0.95. The unit cost of Electricity for CUTM is found to be around Rs. 7.00 per unit.

The major Utility of CUTM are Electricity, Water and HSD. The electricity is utilized for lighting, Fans, pumping of water and AC. HSD is consumed in DG set and Transportation.

The various energy conservation option are listed in the report and it is recommended that CUTM may implement the same.

1.0 INTRODUCTION

The Government of India has enacted the Energy Conservation Act, 2001, with the objective of providing sustainable and more efficient management of our energy resources. The aim of EC Act 2001 is to provide the much-needed legal framework and other institutional arrangements so that various energy efficiency improvement drives can be easily launched at the state and national level. In order to implement the various provisions under the EC Act 2001, the Government of India established the Bureau of Energy Efficiency (BEE), to enact and enforce energy efficiency through various regulatory and promotional measures.

Energy Conservation has become a top most priority in today's scenario in order to have a sustainable growth, productivity, enhancement and Environmental Protection. Considering the vast potential of energy savings and benefits of energy efficiency as per the report prepared by National Development Council (NDC) Committee on power, Govt. of India enacted the Energy Conservation Act 2001. Accordingly, the Govt. of India set up the Bureau of Energy Efficiency (BEE) under the provision of the Energy Conservation Act 2001 for development of policies and strategies with a thrust on self regulation and market principles, with the primary objective of reducing energy intensity of the Indian Economy.

Buildings consume significant portion of Energy for lighting, Air Conditioning, Ventilation purpose and hence Energy Conservation is a major focus and requirement in Commercial and Government Buildings. Besides Building owners are focusing Energy Conservation and Energy Efficiency in a larger extent for a higher productivity. Efficient Energy management, Usage of Energy Efficient Technologies and adopting best-practices that would help a Building Owner to reduce their energy cost considerably. Hence in order to identify the energy conservation opportunities and reduce the present energy consumption, Odisha in consultation with CUTM officials has entrusted the work of conducting Investment Grade Energy Audit (IGEA) to Power Tech Consultants. The Energy Audit of CUTM was carried out on 1st February 2021. The scope of work includes collection of existing layout of Building., Collection of various data including lighting inventory, AC list, Pump, Motor and other electrical load list, Collection of Month wise Energy Bill for FY 2018-19 to 2019-20 and available period for FY 2018-20, Power measurement of all running Transformer, Panels, AC, Pump and Motor.

1.1. ABOUT THE SITE

Centurion University of Technology & Management (CUTM) is the First Multi-Sector State Private University in Odisha, located in Ramchandrapur, P.O. Jatni, Dist-Khurda. Established in August 2005, spread over 40 acres of land in the foothill of Barunei hills, near Jatni town, the campus is adjacent to National Institute of Science, Education and Research (NISER), Indian Institute of Technology (IIT), All India Institute of Medical Sciences (AIIMS) and Xavier University. The famous 11th century Lingaraj temple is about 20 kms from this campus. It is the only technological University in South Odisha. The complex includes School of Engineering & Technology, School of Management, School of Applied Science, School of Vocational, Education and Training, School of Pharmacy, School of Media & Communication, School of Paramedics & Allied Health Sciences, School of Forensic Sciences.

1.2. SCOPE OF WORKS

a) Review of present electricity consumption and fuel oil. Estimation of energy consumption in various loads like lighting, HVAC, DG Set etc in premises of the Building.

b) Electrical Distribution system:

- Review of present electrical distribution from the single line diagram (SLD). Study of operation/loading of distribution transformers, cable loading, normal and emergency loads, electricity distribution in various area/ floors and loss estimation.
- Study of reactive power management and option for power factor improvement, functioning of capacitor banks.
- Study of power quality, like harmonics, current unbalance, voltage unbalance etc.
- Exploring the energy conservation options (ENCON) in the electrical distribution system.

c) Lighting System

- Review of present lighting system, lighting inventories etc.
- Estimation of lighting load at various locations like different floors, outside (campus) light, pump house and other important locations.
- Detailed illuminations survey with measurement of LUX level at various locations and comparison with acceptable standards.
- Study of present lighting control system, lighting maintenance systems, present procedure for management of lighting spares and consumables and recommendation for improvement
- Analysis of lighting performance indices like LUX/m^2 LUX/Watt, LUX/Watt/m^2 and comparison of the same with benchmark.
- Exploring the possibility of retrofitting option with energy efficient lighting system like LED lamp, control Gears, sensors and automators, voltage regulators and solar based system.
- Developing a suitable lighting energy accounting and monitoring system.
- Exploring the energy conservation options (ENCON) in lighting system.

d) Heating Ventilation & Air conditioning system (HVAC system)

- Review of present HVAC system like Spilt AC, Window AC, water coolers and air heater etc.
- Performance assessment of window AC, and Split AC
- Analysis of HVAC performance like estimation of Energy Efficiency Ratio (EER) i.e. (KW/TR) and comparison of the operating data with the design data and recommendation for best prices/standard requirement.
- Exploring the energy conservation options (ENCON) in HVAC system

e) Diesel Generators (DG) sets

- Review of DG set operation
- Performance Assessment of DG sets in terms of specific fuel consumption (SFC i.e. KWH/Ltr.), Exploring the energy conservation options (ENCON) in lighting system.

- Exploring the energy conservation options (ENCON) in DG sets.

f) Water pumping system

- Review of water pumping, storage and distribution systems.
- Performance assessment of all major water pumps i.e. power consumption vs. flow delivered, estimation of pump efficiency etc and compare with best practices
- Study the flow control mechanism.
- Study of rational utilization of water pumping system, energy efficient retrofitting etc.
- Exploring the energy conservation option (ENCON) in water pumping system.

g) Motor Load survey

- Conducting the motor load survey.
- Survey of motor loading (% loading) for major electrical drives
- Measurement of all electrical parameters like voltage, current, PF & KW for all running motors and calculation of pump efficiency and suggestion for improvement.
- Study of mechanical power transmission system and suggest for energy efficiency
- Study of rational usage of drives for reducing electrical energy consumption.
- Exploring the ENCON options in electric drive systems

h) Energy Monitoring & Accounting System:

- Detail Review of present energy monitoring & accounting system in terms of metering, record keeping, data logging, periodic performance analysis etc.
- Suggest for procedures for improvement in energy monitoring and accounting system.

i) UPS

- Measurement and analysis UPS loading, redundancy, operating efficiency, load pattern to suggest measures for energy cost reduction, measurement and analysis of Harmonic.

j) Others:

- Review of present maintenance practice, replacement policies and building safety practices as applicable to high rising buildings and recommend for improvement.
- Cost benefit Analysis of each ENCON indicating simple payback period, return of investment (ROI) internal rate of return (IRR)

1.3. METHODOLOGY

The following step by step methodology and approach were adopted to carry out the Investment Grade Energy Audit Report of CUTM. Prior to energy audit, PTC team made a walk through survey of the Building and associated subsystems to assess the followings:-

- The existing layout of Building.
- Collection of various data including lighting inventory, AC list, Pump, Motor and other electrical load list.
- Collection of Month wise Energy Bill for FY 2018-19 to 2019-20.

The methodology was explained / discussed with CUTM officials and GED officials. The broad methodology adopted for the Energy Audit at CUTM is furnished below.

1. The program of visit of energy audit team to site for carrying out the IGEA work was informed to CUTM officials.
2. Data collection and Energy Bill Collection was carried out through discussions with the officials and from past records, log books.
3. Technical specification of equipments and their operating parameters were collected, while visiting the area. The data so collected were analyzed and the deviations were noted.
4. Performance of the major energy consuming equipments was analyzed.
5. Measurement of electrical energy parameters, wherever possible, using portable instruments were carried out.
6. Power Measurement of all running Transformer, Panels, AC was carried out using portable power analyzer brought by PTC for this purpose.
7. Review of present lighting system, lighting inventories collection were carried out. Estimate all lighting load at various locations like different parts of Building, outside area i.e. street lighting and area lighting and other important locations. Also detailed illuminations survey was determined with measurement of LUX level at various locations.
8. Ambient parameters (Temperature, Humidity) were measured using portable test instrument brought by PTC.
9. Energy Conservation option were identified and tabulated on the basis of priority.
10. Draft soft copy of energy audit report comprising of observations and recommendations with adequate financial justification, vendor support data, etc. was prepared and submitted to CUTM for acceptance.
11. Final energy audit report shall be submitted after acceptance of the draft energy audit report.

1.4. INSTRUMENTS USED

PTC have a wide array of latest, sophisticated, portable, diagnostic and measuring instruments to conduct energy audit investigations and analysis. The following special portable instruments are used to carry out various field measurements and analysis during the energy audit period.

- Three Phase Power Analyzer(ALM-30)
- Clamp on electrical power analyzers
- Infrared Non-Contact Thermometer
- Anemometer
- Hygrometer
- Lux meter

2.0. ENERGY SCENARIO

CUTM receives the electrical power supply from TPCODL at 33 kV. The available contract demand of the Building with TPCODL is 1170 KW. The energy fact file of the building is furnished below:

Table 2.1: Energy Fact File of CUTM

Location	:	CUTM
Areas of Utilization of Energy	:	ITOT Building, CENTRUIAN SCHOOL OF RURAL ENTERPRISES MANAGEMENT Building & CENTURIAN INDUSTRIAL TRAINING CENTRE Building
Source of Supply	:	33 KV Distribution Line of TPCODL
Total Contract Demand	:	111.00KVA,888.88KVA & 444.44KVA
Major Loads	:	Lighting & Power, Air Conditioning, Heating & Cooling, , Computers , Printers, Fans, Pump, Motor, DG Set , Household Appliances and Other loads
Usage Hours	:	Mainly 09.00 am to 6.00 pm on all working days
Monthly Energy Consumption	:	Avg. 27491 kWh, 114460 kWh & 38309 kWh per Month based on FY 2019-20
Monthly Energy Bill	:	Avg. Rs. 217552 ,Rs. 816715 & Rs. 422781 per month based on FY 2019-20

2.1. ANALYSIS OF ENERGY BILL

The energy bills details and tariff categorization of CUTM for FY 2018-19 to FY 2019-20 having consumer no- 201190008194, 12107417 & 12125316 are furnished below:

Consumer Name & Address	ITOT, AT-RAMCHANDRAPUR, JATNI, ODISHA	CENTRUIAN SCHOOL OF RURAL ENTERPRISES MANAGEMENT, C/O. SRI M.K. MISHRA. RAMACHANDRAPUR, JATNI, KHORDA, ODISHA	CENTURIAN INDUSTRIAL TRAINING CENTRE, RAMCHANDRAPUR, JATNI, KHORDA, ODISHA, 752055
Category	GPS	SPP	GPS
Consumer No.	201190008194	12107417	12125316
Contract Demand	111.00KVA	888.88KVA	444.44KVA
Tariff Code	HT/GPS/>=110	HT/SPP/>=110	HT/GPS/>=110
Supply Voltage	33 kV	33 kV	33 kV

Data source: Energy Bill of CUTM collected during the period of Energy audit.

The summary of Energy Bill Analysis of The ITOT Building is furnished below:

SUMMARY OF THE ENERGY BILLS FOR THE LAST THREE FINANCIAL YEARS							
Year	**Description**	**Electricity consumed in kWh**	**Avg. MD in kVA**	**Avg. Power Factor**	**Avg. Load Factor**	**Total Energy Bill in Rs.**	**Unit cost in Rs. per kWh**
For Financial year 2018-19	**Total**	**172280**	**0**	**0.92**	**0.00**	**1075132**	**6.24**
	Monthly average	**43070**	**0**	**0.92**	**0.00**	**268783**	**6.24**
	Daily Average	**1436**	**0**	**0.92**	**0.00**	**8959**	**6.24**
For Financial year 2019-20	**Total**	**324630**	**99**	**0.95**	**0.43**	**2053880**	**6.33**
	Monthly average	**27491**	**99**	**0.95**	**0.43**	**186716**	**6.33**
	Daily Average	**916**	**99**	**0.95**	**0.43**	**6224**	**6.33**

The summary of Energy Bill Analysis of Centurion School of Rural Enterprises Management Building is furnished below:

SUMMARY OF THE ENERGY BILLS FOR THE LAST TWO FINANCIAL YEARS							
Year	**Description**	**Electricity consumed in kWh**	**Avg. MD in kVA**	**Avg. Power Factor**	**Avg. Load Factor**	**Total Energy Bill in Rs.**	**Unit cost in Rs. per kWh**
For Financial year 2018-19	**Total**	**792612**	**289**	**0.99**	**0.21**	**4734575**	**5.97**
	Monthly average	**88068**	**289**	**0.99**	**0.21**	**526064**	**5.97**
	Daily Average	**2936**	**289**	**0.99**	**0.21**	**17535**	**5.97**
For Financial year 2019-20	**Total**	**1259064**	**454**	**0.99**	**0.36**	**8121703**	**6.45**
	Monthly average	**114460**	**454**	**0.99**	**0.36**	**812170**	**6.45**
	Daily Average	**3815**	**454**	**0.99**	**0.36**	**27072**	**6.45**

The summary of Energy Bill Analysis of Centurion Industrial Training Centre Building is furnished below:

SUMMARY OF THE ENERGY BILLS FOR THE LAST TWO FINANCIAL YEARS							
Year	**Description**	**Electricity consumed in kWh**	**Avg. MD in kVA**	**Avg. Power Factor**	**Avg. Load Factor**	**Total Energy Bill in Rs.**	**Unit cost in Rs. per kWh**
For Financial year 2018-19	**Total**	**217863**	**133**	**0.94**	**0.49**	**2094079**	**9.61**
	Monthly average	**58526**	**133**	**0.94**	**0.49**	**418816**	**9.61**
	Daily Average	**1951**	**133**	**0.94**	**0.49**	**13961**	**9.61**
For Financial year 2019-20	**Total**	**421397**	**101**	**0.93**	**0.31**	**3785710**	**8.98**
	Monthly average	**38309**	**101**	**0.93**	**0.31**	**344155**	**8.98**
	Daily Average	**1277**	**101**	**0.93**	**0.31**	**11472**	**8.98**

Table- 2.4: Energy Bills for the Financial Years 2018-2019 of ITOT Building

SUMMARY OF ENERGY BILL OF ITOT BUILDING FOR FINANCIAL YEAR 2018-19													
Month	**Energy Consumed in kWh**	**Av. Load Factor**	**Av. Power Factor**	**MD in kW**	**MD in kVA**	**Energy Charge in Rs.**	**Demand Charge in Rs.**	**PF Penalty (+ve) / PF Incentive (-ve)**	**Meter Rent in Rs.**	**Electricity Duty**	**Current Monthly Bill in Rs.**	**Energy Charge in Rs./kWh**	**Unit cost in Rs. per kWh**
Apr-18	55335	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
May-18	43070	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jun-18	43070	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jul-18	43070	N/A	0.92	N/A	N/A	230425	22200	N/A	N/A	18434	268783	6.67	6.24
Aug-18	43070	N/A	0.92	N/A	N/A	230425	22200	N/A	N/A	18434	268783	6.67	6.24
Sep-18	43070	N/A	0.92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oct-18	43070	N/A	0.92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nov-18	43070	N/A	0.92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec-18	43070	N/A	0.92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jan-19	43070	N/A	0.92	N/A	N/A	230425	22200	N/A	N/A	18434	268783	6.67	6.24
Feb-19	43070	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mar-19	43070	N/A	0.92	N/A	N/A	230425	22200	N/A	N/A	18434	268783	6.67	6.24
Total / Av.	**172280**	N/A	**0.92**	N/A	N/A	**921698**	**88800**	N/A	N/A	**73736**	**1075132**	6.67	6.24
Monthly Average	43070	N/A	0.92	N/A	N/A	76808	22200	N/A	N/A	18434	268783	6.67	6.24
Daily Average	1436	N/A	0.92	N/A	N/A	2560	740	N/A	N/A	614	8959	6.67	6.24

From the Energy Bill of FY 2018-19 it is observed that Average Demand in this year is Nil i.e. Nil with an Average Power Factor of 0.92. There is no Power Factor Penalty paid by the University.

The electricity bill of ITOT building for FY'2018-19 has been raised by the local DISCOM on average basis therefore the analysis of energy bill has been carried out for FY' 2019-20 and accordingly recommendation has been furnished.

Table -2.5: Energy Bills for the Financial Years 2019-2020 of ITOT Building

SUMMARY OF ENERGY BILL OF ITOT BUILDING FOR FINANCIAL YEAR 2019-20													
Month	**Energy Consumed in kWh**	**Av. Load Factor**	**Av. Power Factor**	**MD in kW**	**MD in kVA**	**Energy Charge in Rs.**	**Demand Charge in Rs.**	**PF Penalty (+ve) / PF Incentive (-ve)**	**Meter Rent in Rs.**	**Electricity Duty**	**Current Monthly Bill in Rs.**	**Energy Charge in Rs./kWh**	**Unit cost in Rs. per kWh**
Apr-19	22230	NA											
May-19	29010	0.81	0.93	48.35	52.2	147131	22200	0	1000	11770	165267	6.10	5.70
Jun-19	23820	0.40	0.97	82.00	84.9	127437	22200	0	1000	10195	159586	7.13	6.70
Jul-19	22290	0.26	0.97	113.34	117	119252	29250	0	1000	9540	159307	7.58	7.15
Aug-19	35100	0.47	0.97	100.29	103.2	187785	25800	-192	1000	15023	227530	6.91	6.48
Sep-19	30150	0.47	0.97	90.01	92.7	161303	23175	-92	1000	12904	196695	6.95	6.52
Oct-19	31470	0.38	0.96	112.00	116.7	168365	29175	0	1000	13469	211709	7.16	6.73
Nov-19	28530	0.60	0.96	66.21	69	152636	22200	0	1000	12211	186548	6.97	6.54
Dec-19	24150	0.55	0.91	59.48	65.1	129203	22200	477	1000	10336	161952	7.13	6.71
Jan-20	27000	0.29	0.92	124.74	135	144450	33750	0	1000	11216	190677	7.48	7.06
Feb-20	26700	0.26	0.94	146.30	156	142845	39000	0	1000	11386	205315	8.12	7.69
Mar-20	24180	0.22	0.93	145.53	156	129363	39000	0	1000	10299	189294	8.25	7.83
Total / Av.	**324630**	**0.43**	**0.95**	**99**	**104**	**1609767**	**307950**	**192**	**11000**	**128350**	**2053880**	6.72	6.33
Monthly Average	27491	0.43	0.95	99	104	146342	27995	17	1000	11668	186716	6.72	6.33
Daily Average	916	0.43	0.95	99	104	4878	933	1	33	389	6224	6.72	6.33

From the Energy Bill of FY 2019-20 it is observed that Average Demand in this year is 99KW i.e. 104 KVA with an Average Power Factor of 0.95. There is no Power Factor Penalty paid by the University.

Energy Conservation Option:

Increase of Contract Demand

Background:

The contract demand of ITOT building is 111KVA however in certain months the maximum demand has increased up to 156 KVA due to which the ITOT building has to pay overdrawl penalty charges to the local DISCOM. In view of the same it is recommended to increase the contract demand of ITOT building to 190 KVA. There will be saving in demand charge of around of Rs. 11250 per month and annual financial saving will be Rs. 135000 per annum. Investment required will be minor and payback period will be immediate.

Cost Benefit Analysis:

Cost Benefit Analysis for Increase of Contract Demand		
Particulars	**Unit**	**Value**
Present Contract Demand	kVA	111
Present Maximum Demand	kVA	156
Present Monthly Demand Charge	Rs. Per Month	50250
Future Contract Demand	KVA	195
Future Demand Charge	Rs. Per Month	39000
Monthly Saving in Demand Charge	Rs. Per Month	11250
Annual Saving by increasing the Contract Demand	Rs.	135000
Investment Required	Rs.	Minor
Simple Payback Period	Year	Immediate

Table- 2.6: Energy Bills for the Financial Years 2018-2019 of CSREM Building

SUMMARY OF ENERGY BILL OF CENTRUIAN SCHOOL OF RURAL ENTERPRISES MANAGEMENT FOR FINANCIAL YEAR 2018-19													
Month	**Energy Consumed in kWh**	**Av. Load Factor**	**Av. Power Factor**	**MD in kW**	**MD in kVA**	**Energy Charge in Rs.**	**Demand Charge in Rs.**	**PF Penalty (+ve) / PF Incentive (-ve)**	**Meter Rent in Rs.**	**Electricity Duty**	**Current Monthly Bill in Rs.**	**Energy Charge in Rs./kWh**	**Unit cost in Rs. per kWh**
Apr-18	92154	0.34	0.99	380.80	386.4	493023.9	177776	-5199	1000	39442	575128	6.67	6.24
May-18	83502	0.28	1.09	402.17	369	446735.7	177776	-9368	1000	35739	645888	8.16	7.74
Jun-18	75240	0.32	0.99	330.52	334.2	402534	177776	-5513	1000	32203	602447	8.44	8.01
Jul-18	85854	0.32	0.98	365.53	371.4	459318.9	177776	-4523	1000	36746	664197	8.16	7.74
Aug-18	84336	0.27	0.99	419.53	424.2	451197.6	177776	-5975	1000	36096	645074	8.08	7.65
Sep-18	79278	0.00		0.00								0.00	0.00
Oct-18	63540	0.19	0.98	447.84	454.8	339939	177776	-3805	1000	27195	539720	8.92	8.49
Nov-18	59604	0.00		0.00								0.00	0.00
Dec-18	37362	0.30	0.98	168.26	171	199886.7	177776	-2644	1000	15991	388495	10.83	10.40
Jan-19	23598	0.29	0.94	108.11	114.6	126249.3	177776	-1332	1000	9993	310921	13.60	13.18
Feb-19	32664	0.18	0.97	270.07	279	174752.4	177776	-1441	1000	13865	362705	11.53	11.10
Mar-19	68592	0.00		0.00	0			0	0			0.00	0.00
Total / Av.	**792611.7**	**0.21**	0.99	**289**	**323**	**3093637.5**	**1599984**	**-39800**	**9000**	**247269**	**4734575**	6.29	5.97
Monthly Average	88068	0.21	0.99	289	323	343738	177776	-4422	1000	27474	526064	6.29	5.97
Daily Average	2936	0.21	0.99	289	323	11458	5926	-147	33	916	17535	6.29	5.97

From the Energy Bill of FY 2018-19 it is observed that Average Demand in this year is 289KW i.e. 323 KVA with an Average Power Factor of 0.99. There is no Power Factor Penalty paid by the University.

Table- 2.7: Energy Bills for the Financial Years 2019-2020 of CSREM Building

SUMMARY OF ENERGY BILL OF CENTRUIAN SCHOOL OF RURAL ENTERPRISES MANAGEMENT FOR FINANCIAL YEAR 2019-20													
Month	**Energy Consumed in kWh**	**Av. Load Factor**	**Av. Power Factor**	**MD in kW**	**MD in kVA**	**Energy Charge in Rs.**	**Demand Charge in Rs.**	**PF Penalty (+ve) / PF Incentive (-ve)**	**Meter Rent in Rs.**	**Electricity Duty**	**Current Monthly Bill in Rs.**	**Energy Charge in Rs./kWh**	**Unit cost in Rs. per kWh**
Apr-19	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
May-19	82740	0.28	0.98	398.74	408	442659	177776	-2254	1000	35185	518602	6.69	6.27
Jun-19	127794	0.36	0.98	491.89	500.4	683697.9	177776	-5571	1000	54343	898517	7.46	7.03
Jul-19	111552	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aug-19	155070	0.35	0.98	593.06	602.4	829624.5	177776	-7267	1000	65969	1052321	7.21	6.79
Sep-19	150054	0.31	0.98	673.06	684	802788.9	177776	-6829	1000	63824	1024066	7.25	6.82
Oct-19	135264	0.33	0.99	558.14	565.2	723662.4	177776	-7848	1000	57529	938850	7.37	6.94
Nov-19	128118	0.36	0.99	488.42	494.4	685431.3	177776	-7686	1000	54482	911075	7.54	7.11
Dec-19	92364	0.50	0.99	246.04	249	494147.4	177776	-6050	1000	39258	696281	7.96	7.54
Jan-20	88554	0.40	0.99	295.92	300	473763.9	177776	-5317	1000	37653	675588	8.05	7.63
Feb-20	98568	0.40	0.99	356.11	360	527338.8	177776	-6735	1000	41905	731006	7.84	7.42
Mar-20	88986	0.27	0.99	438.33	441.6	476075.1	177776	-7347	1000	37794	675397	8.01	7.59
Total / Av.	**1259064**	**0.36**	**0.99**	**454**	**461**	**6139189.2**	**1777760**	**-62905**	**10000**	**487943**	**8121703**	6.84	6.45
Monthly Average	114460	0.36	0.99	454	461	613919	177776	-6291	1000	48794	812170	6.84	6.45
Daily Average	3815	0.36	0.99	454	461	20464	5926	-210	33	1626	27072	6.84	6.45

From the Energy Bill of FY 2019-20 it is observed that Average Demand in this year is 454KW i.e. 461 KVA with an Average Power Factor of 0.99. There is no Power Factor Penalty paid by the University.

Table- 2.8: Energy Bills for the Financial Years 2018-2019 of ITI Building

SUMMARY OF ENERGY BILL OF THE PRINCIPAL CENTURIAN INDUSTRIAL TRAINING CENTRE FOR FINANCIAL YEAR 2018-19													
Month	**Energy Consumed in kWh**	**Av. Load Factor**	**Av. Power Factor**	**MD in kW**	**MD in kVA**	**Energy Charge in Rs.**	**Demand Charge in Rs.**	**PF Penalty (+ve) / PF Incentive (-ve)**	**Meter Rent in Rs.**	**Electricity Duty**	**Current Monthly Bill in Rs.**	**Energy Charge in Rs./kWh**	**Unit cost in Rs. per kWh**
Apr-18	72861	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
May-18	41115	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jun-18	45138	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jul-18	63969	0.66	0.96	129.77	135.6	335790	88888	0	1000	26863	448545	7.43	7.01
Aug-18	71001	0.69	0.96	139.15	145.2	370202	88888	0	1000	29616	485365	7.25	6.84
Sep-18	74769	0.79	0.96	131.08	136	N/A	88888	0	1000	N/A	505409	N/A	6.76
Oct-18	51402	0.47	0.93	148.38	159.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nov-18	62031	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dec-18	43602	0.39	0.91	149.47	164.4	233271	88888	1740	1000	18662	340589	8.24	7.81
Jan-19	39291	0.46	0.94	114.28	121.2	210207	88888	0	1000	16817	314171	8.42	8.00
Feb-19	48147	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mar-19	69429	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total / Av.	**217863**	**0.49**	**0.94**	**133**	**142**	**1149470**	**444440**	**1740**	**5000**	**91958**	**2094079**	10.03	9.61
Monthly Average	58526	0.49	0.94	133	142	287367	88888	348	1000	18392	418816	10.03	9.61
Daily Average	1951	0.49	0.94	133	142	9579	2963	12	33	613	13961	10.03	9.61

Table- 2.10: Energy Bills for the Financial Years 2019-2020 of ITI Building

SUMMARY OF ENERGY BILL OF THE PRINCIPAL CENTURIAN INDUSTRIAL TRAINING CENTRE FOR FINANCIAL YEAR 2019-20													
Month	**Energy Consumed in kWh**	**Av. Load Factor**	**Av. Power Factor**	**MD in kW**	**MD in kVA**	**Energy Charge in Rs.**	**Demand Charge in Rs.**	**PF Penalty (+ve) / PF Incentive (-ve)**	**Meter Rent in Rs.**	**Electricity Duty**	**Current Monthly Bill in Rs.**	**Energy Charge in Rs./kWh**	**Unit cost in Rs. per kWh**
Apr-19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
May-19	73515	0.72	0.94	136.34	145.2	379460	88888	N/A	1000	30357	404502	5.92	5.50
Jun-19	462	0.01	0.94	68.59	72.6	2472	88888	N/A	1000	198	91894	199.33	198.90
Jul-19	35847	0.08	0.98	635.99	646.2	596803	177776	-5468	1000	47386	805566	23.79	22.47
Aug-19	47139	0.70	0.96	90.07	93.6	244464	88888	0	1000	19557	350826	7.86	7.44
Sep-19	45756.5	N/A	0.92	N/A	N/A	244797	88888	N/A	N/A	19584	350183	8.08	7.65
Oct-19	45756.5	N/A	0.92	N/A	N/A	244797	88888	N/A	N/A	19584	350183	8.08	7.65
Nov-19	45756.5	N/A	0.92	N/A	N/A	244797	88888	N/A	N/A	19584	350183	8.08	7.65
Dec-19	45756.5	N/A	0.92	N/A	N/A	244797	88888	N/A	N/A	19584	350183	8.08	7.65
Jan-20	31956.1	0.75	0.91	56.92	62.4	163696	88888	N/A	1000	12995	264056	8.67	8.26
Feb-20	23904	0.56	0.94	61.06	64.8	127886	88888	N/A	1000	10126	227075	9.92	9.50
Mar-20	25548	0.53	0.86	64.77	75.6	136682	88888	7094	1000	10820	241059	9.86	9.44
Total / Av.	**421397.1**	**0.48**	**0.93**	**159**	**166**	**2630652**	**1066656**	**1626.20**	**7000**	**209774**	**3785710**	9.48	8.98
Monthly Average	38309	0.48	0.93	159	166	239150	96969	148	636	19070	344155	9.48	8.98
Daily Average	1277	0.48	0.93	159	166	7972	3232	5	21	636	11472	9.48	8.98

Energy Conservation Option:
Reduction of Contract Demand

Background:
The contract demand of ITI building is 444.44KVA however in certain months the maximum demand has decreased up to 166 KVA due to which the ITI building is paying unnecessary demand charges to the local DISCOM. In view of the same it is recommended to decrease the contract demand of ITI building to 207.5 KVA. There will be saving in demand charge of around of Rs. 47388 per month and annual financial saving will be Rs. 568656 per annum. Investment required will be minor and payback period will be immediate.

Cost Benefit Analysis for Reduction of Contract Demand		
Particulars	**Unit**	**Value**
Present Contract Demand	kVA	444.44
Present Maxium Demand	kVA	166
Present Monthly Demand Charge	Rs. Per Month	88888
Future Contract Demand	KVA	207.5
Future Demand Charge	Rs. Per Month	41500
Monthly Saving in Demand Charge	Rs. Per Month	47388
Annual Saving by Decreasing the Contract Demand	Rs.	568656
Investment Required	Rs.	Minor
Simple Payback Period	Year	Immediate

2.2. BASE LINE ENERGY CONSUMPTION AND SPECIFIC ENERGY CONSUMPTION

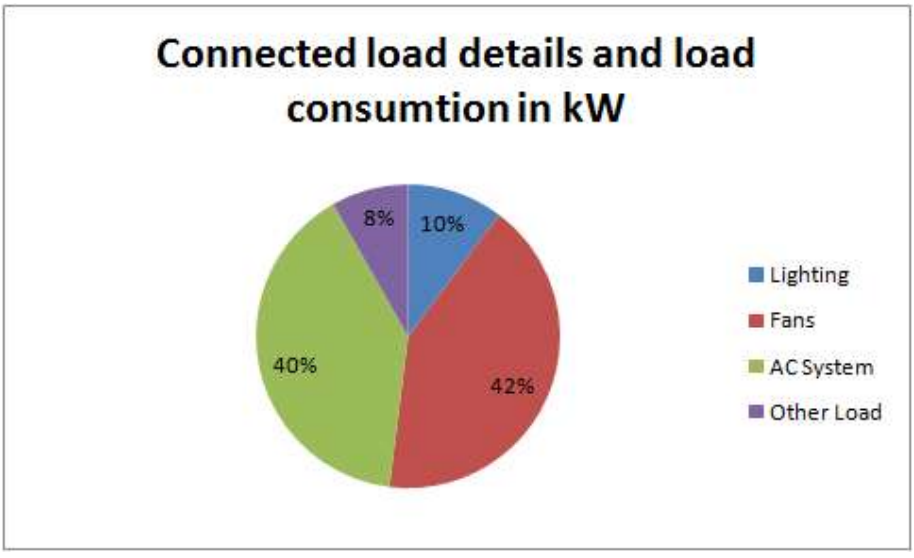
During our observation it is seen that the load drawl pattern of CUTM is typical of a unit functioning in day time but the Hostel and Admin building, are functioning in day time beyond office hours, at night time minimum illumination inside the building and full outside lighting with street-lights is maintained. The office working hours in CUTM is from 09 AM to 5PM normally for 350 days in a year. During the office period normal loads are room lighting, fans, ACs and office appliances. During the entire office working hours the load remains steady with small variations.

Connected load details & corresponding KW consumption

From the inventory survey, it is estimated that there is a connected load of about 1170 KW in CUTM. It may be seen that the lighting load constitutes about 10.3% of the total load, and air conditioning loads share about 40% of the total connected load. The following table indicates the estimated connected load details (KW)

Load Centre	Kilo Watt
Lighting	**120**
Fans	**488**
AC System	**466**
Other Load	**96**
TOTAL	**1170**

Chart 2.4 Connected load details & corresponding KW consumption



Detail inventory of all the units of CUTM

Lighting Inventory				
Area Name	**Types of Load**	**Wattage of each load in Watt**	**Nos. installed**	**Total connected Wattage in Watt**
Boy's Hostel	LED	9	257	2313
	LED	20	486	9720
	LED	40	64	2560
	LED	85	16	1360
	LED Tube	20	264	5280
	LED Tube	40	125	5000
	LED Tube	50	27	1350
	LED Tube	60	243	14580
	LED Tube	70	6	420
	LED Tube	80	119	9520
	LED Tube	100	69	6900
	LED Tube	160	24	3840
	LED Tube	180	27	4860
	LED Tube	200	10	2000
	Tube	120	6	720
	Tube	160	8	1280
Girl's Hostel	LED Tube	160	24	3840
	Tube	160	8	1280
MBA	LED	20	2	40
	LED	25	2	50
	LED Tube Light	40	123	4920
	LED Tube Light	25	71	1775
Main Building	LED	9	2	18
	LED Tube Light	20	75	1500
	C.LIGHT	20	25	500
	C.LIGHT	60	228	13680
	Tube Light	40	430	17200
Madhusudan Building	LED Tube light	18	206	3708
	Siling light	30	215	6450
	Fluroscent Tube light	40	348	13920
	Small Led	9	64	576
Other Units	LED	10	69	690
	LED	20	8	160

	LED	36	178	6408
	LED	100	1	100
	Tube Light	40	322	12880
	Halogen Light	50	10	500
	CFL	150	6	900
Total		1991	2947	120214

Detail Inventory of ACs of CUTM				
Type of Load	**Watt**	**Rated Tonnage**	**Number**	**Tonnage**
Air-conditioner	750	0.5	1	0.5
	1000	1	5	5
	1500	1.5	213	319.5
	2000	2	10	20
	3500	5	4	20
Total	25125		233	365

Detail Inventory of Fans of CUTM			
Type of Load	**Wattage of each load in Watt**	**Number**	**Total connected Wattage in Watt**
Fan	35	15	525
	40	153	6120
	75	316	23700
	80	3875	310000
	100	464	46400
	160	480	76800
	400	60	24000
Total		5363	487545

TOTAL OTHER LOAD			
Type	**Watt**	**Quantity**	**Total connected Wattage in Watt**
OTHER	15	28	420
	20	20	400
	40	10	400
	75	28	2100
	80	59	4720
	100	232	23200
	150	19	2850
	250	3	750
	765	4	3060
	1000	33	33000
	1180	2	2360
	1500	2	3000
	2000	1	2000
	2900	1	2900
	3000	4	12000
	28.4	1	28.4
	60	8	480
	200	4	800
	700	1	700
	1170	1	1170
TOTAL			96338.4

Energy Conservation Option:

Replacement of Old 1.5 & 2 Ton AC with EESL 1.5 ton 5 Star Energy Efficient AC

Recommendation:
It is recommended that after replacement of old Ac, the annual energy saving will be 228942 kWh, annual cost saving will be Rs. 1373652. There is Rs. 9277680 investment required and payback period will be 6.8 years.

Cost Benefit Analysis:

Cost Benefit Analysis for Replacement of Old 1.5 & 2 Ton AC with EESL 1.5 ton 5 Star Energy Efficient AC		
Particular	Unit	Value
Present 1,1.5, 2 & 5 Ton AC	Nos.	233
Total Capacity	TR	365
Present Load before Replacement	kW	1283.65
Annual Energy consumption without Energy Efficient AC @350*12hr	kWh	5391330
After installing 1.5 Ton EESL Energy Efficient AC	TR	348
EESL Energy Efficient AC	kW	1229.14
Annual Energy consumption with EESL AC @365*12hr	kWh	5162388
Annual Energy Saving due to EESL AC	kWh	228942
Annual Cost of Savings @ Rs.6.0/unit	Rs	1373652
Investment required	Rs.	9277680
Simple payback period	Years	6.8

EESL-SEAC BOQ (Voltas)		
S.No.	**Descriptions of Item**	
1	Supply of 1.5 TR split inverter AC, Rated ISEER 5.4. energy efficient 5 Star AC. (indoor unit, outdoor unit, remote control)	1 Nos
a	Refrigeration Piping(Copper) for 1.5 TR Hi wall Unit- (RMT)	3
b	Electrical Cable - (RMT)	3
c	Drain Pipe - (RMT)	3
2	No of Preventive Maintenance Service in a Year	2

Star Rating	**Stars**	5
Cooling Capacity Full Load (100%)	W	5280
Cooling Capacity Half Load (50%)	W	2640
Cooling Power Full Load (100%)	W	1310
Cooling Power Half Load (50%)	W	433
ISEER		5.4
Power Supply	V/Hz/Ph	230 / 50 / 1 Phase
Air Flow Volume - Indoor	CMH	950
***Noise Level - Indoor**	..dB(A)	≤46
Operation		LCD Remote
Compressor Type		High EER Twin Rotary - BLDC
Wide Operating Voltage Range	V	145~270
Max operating Ambient Temp Range	Deg C	52^0 C
Refrigerant Gas		R32
Indoor Unit Dimension (WxHxD)	mm	990x315x242
Indoor Unit Net / Gross Weight	Kg	13.5/16.5
Outdoor Unit Dimension (WxHxD)	mm	870x600x355
Outdoor Unit Net / Gross Weight	Kg	33.5/39
Connecting Pipe	type	Cu-Cu(12.5mm & 6.35mm)
Connecting Pipe Length	Metre	3.0
Connecting Cable	Metre	3.0
Condenser Coil		Fin & Tube
No of boxes	ODU	1 Box
	Connecting Tube	
	IDU	1 Box
Features **Filter**	Anti Dust	Yes
	Catechin Filter	Yes
	Acaro Bacterium	Yes
	Silver Ion	Yes

	IDU Fin	Hydrophylic Aluminium	Blue
	Copper tubes	Inner Grooved	Yes
	IDU	LED Display	Yes
		Self Diagnosis	Yes
		Anti Fungal	Yes
		5D Concept	Yes
		Auto Restart	Yes
	Remote	Sleep Mode	Yes
		Turbo	Yes
		Swing	Yes
		LCD Remote	Yes
		Lock	Yes
		Timer	Yes
		Glow Buttons	Yes
		Dual Temp Display	Yes
	Air Vent	Cross Flow	Yes

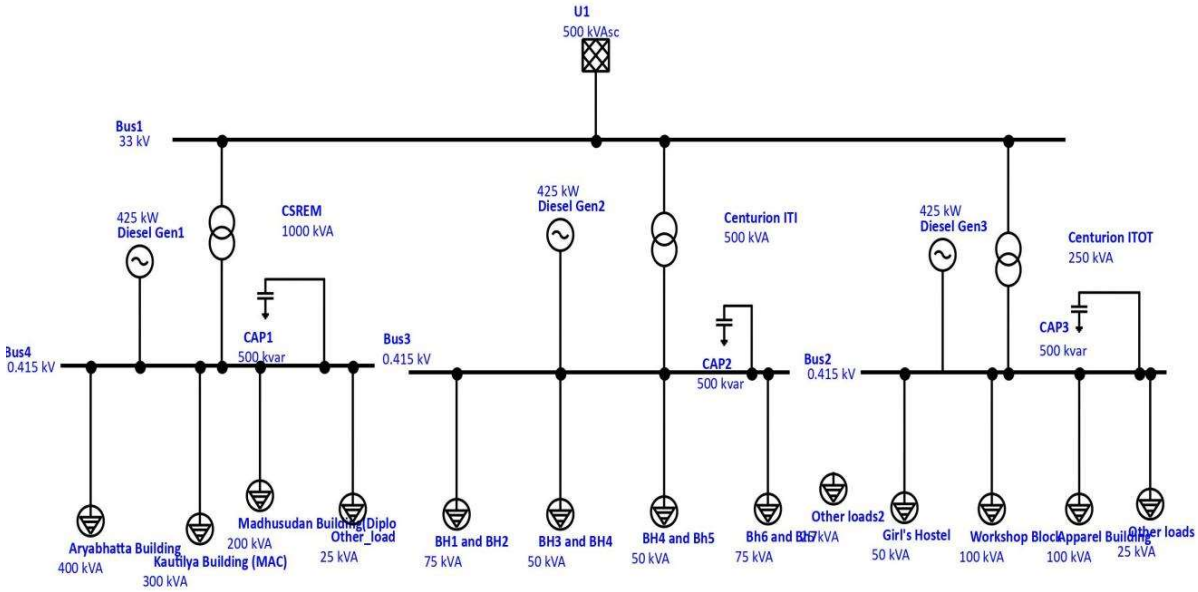
* Noise level reflects the levels in Anechoic Chamber
All above performance data are as per IS 1391 Rated conditions

No Derating in cooling capacity at 43 degree Celsius

	Cost per AC (For Consumer) in INR – (1 Year Comprehensive Warranty & 5 Year Warranty on Compressor)			**39990**
	Miscellaneous Cost			**Voltas**
1	Additional warranty for one year i.e. for 2nd year post the expiry of the standard one year warranty ; inclusive of GST	Unit		**2200**
2	Additional warranty for one year i.e. for 3rd year post the expiry of the standard one year warranty ;inclusive of GST	Unit		**2400**
3	Copper Pipe ; inclusive of GST	Per Meter		**600**
4	EPPDM Rubber Insulation for refrigerant piping ; inclusive of GST	Per Meter		**90**
5	Power Cable ; inclusive of GST	Per Meter		**120**
6	Drain Pipe ; inclusive of GST	Meter		**100**
7	Buyback of old Acs ; inclusive of GST	Unit		**2500**
8	Additional warranty for 4 year (Inclusive of GST)			**4000**

3.0. ELECTRICAL DISTRIBUTION SYSTEM AND TRANSFORMER DETAILS

The Power Supply system of CUTM was studied and based on the observations, the single Line Diagram of Existing Electrical distribution system of CUTM is drawn and enclosed below.



3.1. TRANSFORMER DETAILS

The technical specification of transformer and its % loading is furnished below:

Table 3.1: Technical specification of transformer

Technical data sheet of CUTM Transformers			
Particulars	**TRF-1**	**TRF-2**	**TRF-3**
Make	Gram Tarang Employability Training Services Pvt. Ltd.	ALFA Transformers Ltd.	ALFA Transformers Ltd.
Transformer rated in kVA	250.00	500.00	1000.00
Rated voltage ratio in kV	33/0.433	33/0.433	33/0.433
Rated current ratio in Amp	4.37/333.34	8.75/666.60	17.49/1333.3
No. of phase	3.00	3.00	3.00
Vector diagram	Dyn-11	Dyn-12	Dyn-13
Type of cooling	ONAN	ONAN	ONAN
Measured voltage at LT side in kV	0.43	0.41	0.41
Measured current LT Side in Amp	17.80	233.09	79.68
Measured Power Factor	0.791	0.99	0.91

The power measurement of each transformer is carried out by 3 phase power analyzer. The results are attached in Annexure. Based on Average Power measurement data the transformer loadings and efficiency are calculated and furnished below.

Transformer Performance Assessment

Transformer Performance Assessment			
Details	**TRF-1**	**TRF-2**	**TRF-3**
Transformer Rating in KVA	250.00	500.00	1000.00
Measured voltage at LT side in kV	0.43	0.41	0.41
Measured current in LT Side Amp	17.80	233.09	79.68
No Load Loss (kW)	0.64	0.90	1.80

Full Load Loss of Transformer (kW)	4.45	6.45	13.30
Measured load (kVA)	13.26	167.14	57.13
% Loading on the Transformer (Measued kVA/ Rated kVA)	5.30%	33.43%	5.71%
Actual Losses of Transformer (kW)	0.64	0.90	1.80
Operating Power Factor	0.79	0.987	0.905
Total Actual Power Delivered by Transformer in kW	10.49	164.96	51.71
Transformer Efficiency, %	94.25%	99.46%	96.64%
Transformer performance	Not satisfactory	Satisfactory	Not satisfactory

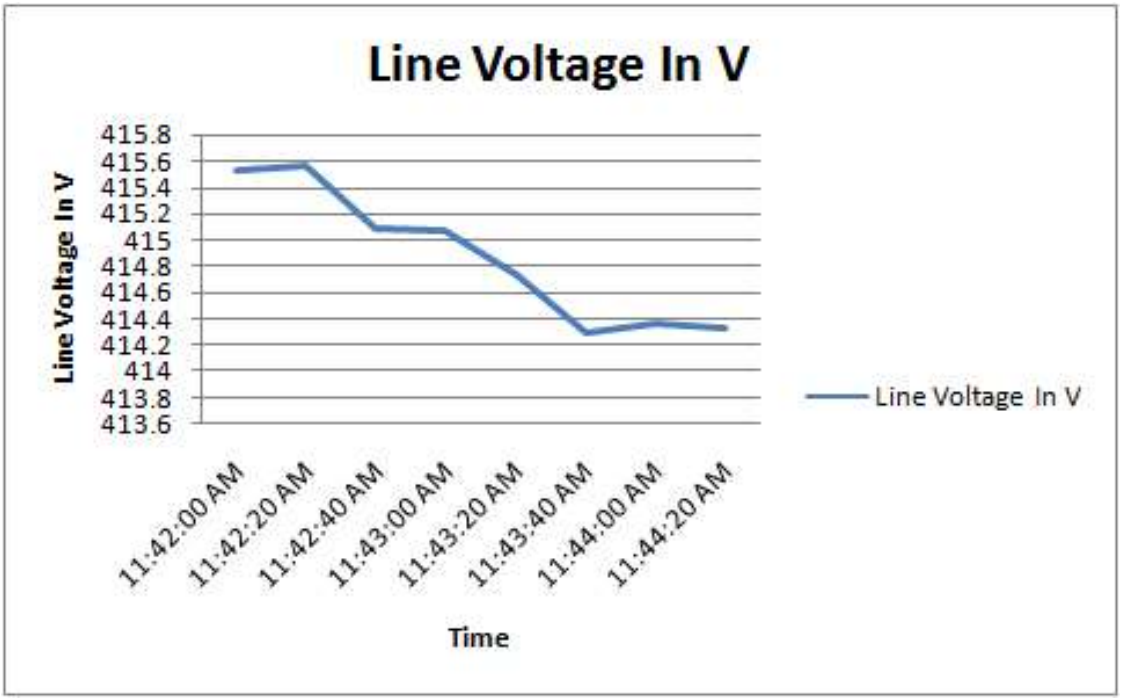
Power measurement was carried out at the various outgoing cable emanating from the distribution board of each transformer and the results are tabulated.

3.2. STUDY OF VOLATAGE, CURRRENT, POWER FACTOR PROFILE

Trend of Output voltage profile, Current profile, Output Power profile, Power Factor profile, Voltage Unbalance and Current unbalance of Transformer 1, 2 and 3 are furnished below.

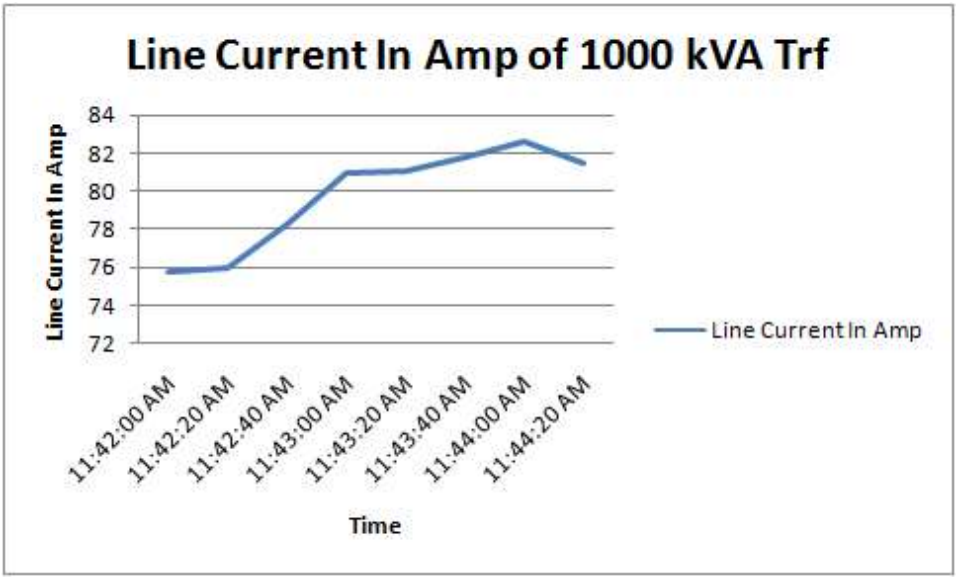
Voltage Variation and %Unbalance of 1000 kVA Transformer						
Date	**Time**	**Frequency**	**Phase-1 RMS**	**Phase-2 RMS**	**Phase-3 RMS**	**Vunb**
		Hz	V	V	V	%
1/30/2021	11:42:00 AM	50.08	413	417.4	416.2	0.5
1/30/2021	11:42:20 AM	50.09	412.9	417.6	416.2	0.6
1/30/2021	11:42:40 AM	50.07	412.2	417.4	415.7	0.6
1/30/2021	11:43:00 AM	50.06	412.3	417.2	415.7	0.6
1/30/2021	11:43:20 AM	50.06	411.7	417.2	415.3	0.7
1/30/2021	11:43:40 AM	50.06	411.1	417	414.8	0.8
1/30/2021	11:44:00 AM	50.04	410.8	417.4	414.9	0.8
1/30/2021	11:44:20 AM	50.03	410.7	417.3	415	0.8
Average Voltage & %Unbalance			**414.8812379**			**0.68**

Voltage Profile of 1000 kVA Transformer



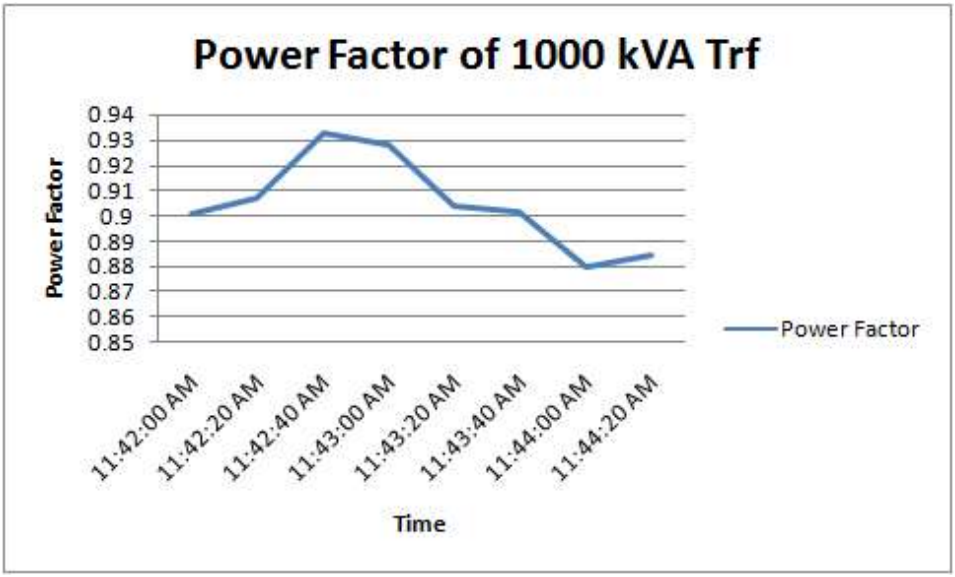
Current Variation and %Unbalance of 1000 kVA Transformer						
Date	**Time**	**Frequency**	**A1 RMS**	**A2 RMS**	**A3 RMS**	**Aunb**
		Hz	A	A	A	%
1/30/2021	11:42:00 AM	50.08	97.3	63.4	66.5	15.9
1/30/2021	11:42:20 AM	50.09	97.9	63	67	16.2
1/30/2021	11:42:40 AM	50.07	101.4	66.1	67.1	16.5
1/30/2021	11:43:00 AM	50.06	98.7	72.9	71	11.5
1/30/2021	11:43:20 AM	50.06	99.4	71.5	72	11.8
1/30/2021	11:43:40 AM	50.06	102.5	70.2	72.5	10.5
1/30/2021	11:44:00 AM	50.04	104.8	69.9	73	9.2
1/30/2021	11:44:20 AM	50.03	104.3	69.9	70.2	7.9
Average Current & %Unbalance			**79.6875**			**12.4**

Current Profile of 1000 kVA Transformer



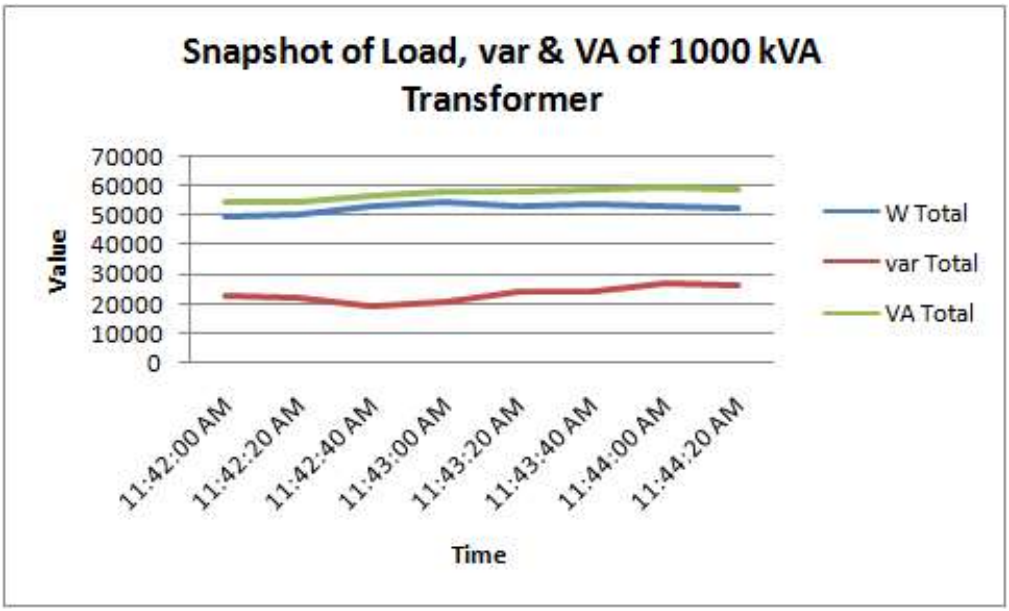
Average Power Factor of 1000 kVA Transformer						
Date	**Time**	**Frequency**	**PF1**	**PF2**	**PF3**	**PF Mean**
		Hz	Ph-1	Ph-2	Ph-3	Avg.
1/30/2021	11:42:00 AM	50.08	0.934	0.869	0.902	0.901
1/30/2021	11:42:20 AM	50.09	0.94	0.873	0.91	0.907
1/30/2021	11:42:40 AM	50.07	0.955	0.908	0.937	0.933
1/30/2021	11:43:00 AM	50.06	0.945	0.917	0.924	0.928
1/30/2021	11:43:20 AM	50.06	0.929	0.887	0.899	0.904
1/30/2021	11:43:40 AM	50.06	0.931	0.88	0.897	0.902
1/30/2021	11:44:00 AM	50.04	0.919	0.851	0.873	0.88
1/30/2021	11:44:20 AM	50.03	0.926	0.849	0.881	0.885
Average Power Factor						**0.9**

Power Factor Profile of 1000 kVA Transformer



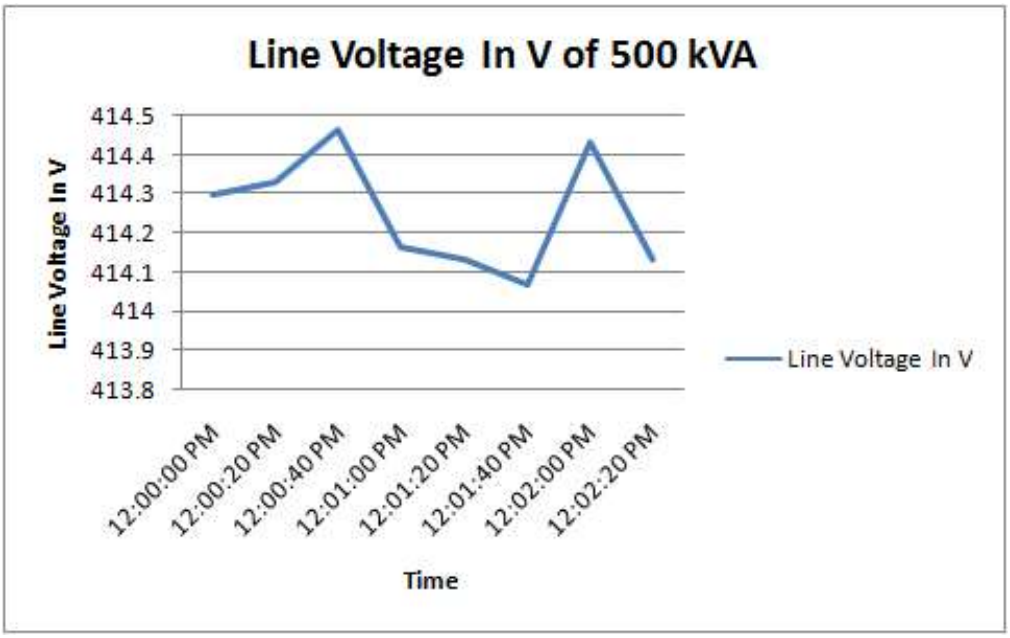
Snapshot of Load, var & VA of 1000 kVA Transformer					
Date	**Time**	**Frequency**	**W Total**	**var Total**	**VA Total**
		Hz	W	var	VA
1/30/2021	11:42:00 AM	50.08	49412.11	22600.36	54522.5
1/30/2021	11:42:20 AM	50.09	49926.29	21908.03	54704.7
1/30/2021	11:42:40 AM	50.07	52702.52	19350.03	56231
1/30/2021	11:43:00 AM	50.06	54149.3	21115.51	58167.1
1/30/2021	11:43:20 AM	50.06	52850.82	24006.6	58184.7
1/30/2021	11:43:40 AM	50.06	53156.86	24430.38	58651.1
1/30/2021	11:44:00 AM	50.04	52543.69	27127.1	59256.2
1/30/2021	11:44:20 AM	50.03	52103.82	26152.97	58455.3
Average			**52105.68**	**23336.37**	**57271.58**

Snapshot of Load, var & VA of 1000 kVA Transformer



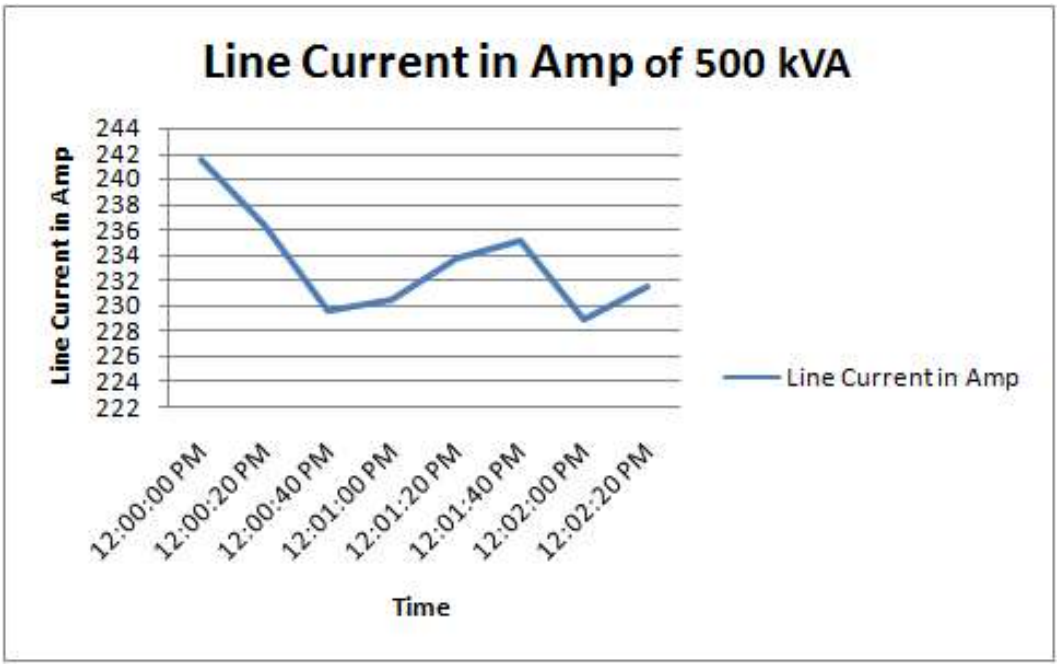
Voltage Variation and %Unbalance of 500 kVA Transformer						
Date	**Time**	**Frequency**	**Phase-1 RMS**	**Phase-2 RMS**	**Phase-3 RMS**	**Vunb**
		Hz	V	V	V	%
1/30/2021	12:00:00 PM	50.09	412.2	416	414.7	0.4
1/30/2021	12:00:20 PM	50.1	412.1	416.1	414.8	0.5
1/30/2021	12:00:40 PM	50.09	411.7	416.4	415.3	0.6
1/30/2021	12:01:00 PM	50.09	410.9	416.4	415.2	0.7
1/30/2021	12:01:20 PM	50.08	410.5	416.5	415.4	0.8
1/30/2021	12:01:40 PM	50.08	410.6	416.2	415.4	0.7
1/30/2021	12:02:00 PM	50.07	411.9	416.3	415.1	0.6
1/30/2021	12:02:20 PM	50.06	411.5	416	414.9	0.6
1/30/2021	12:02:40 PM	50.06	411.9	416.2	415	0.5
Average Voltage & %Unbalance			**414.2716239**			**0.63**

Voltage Profile of 500 kVA Transformer



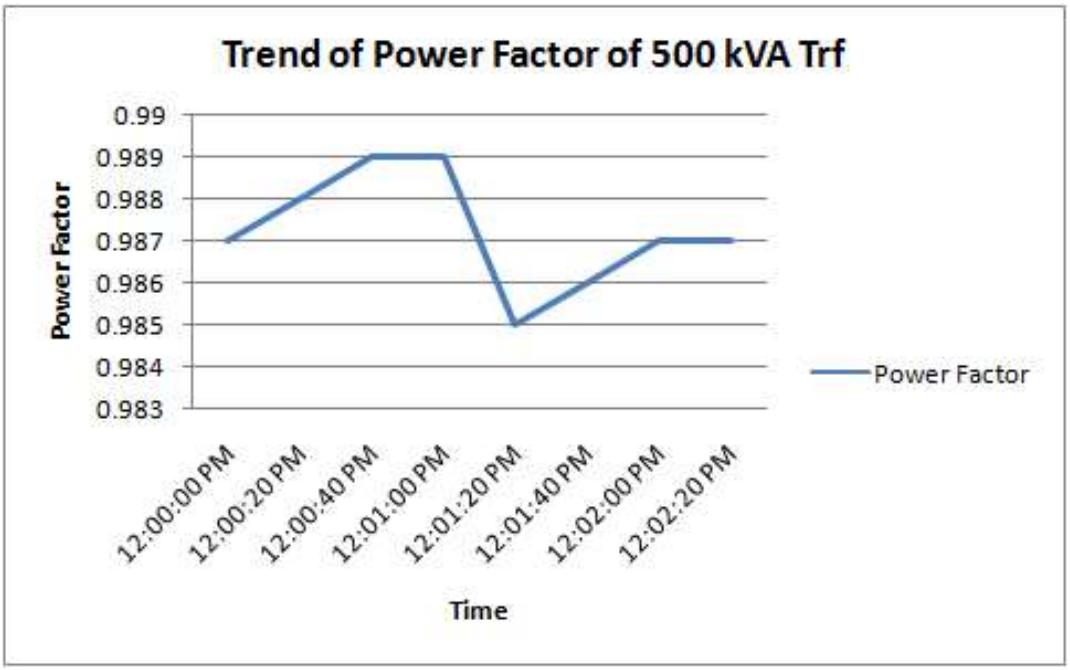
Current Variation and %Unbalance of 500 kVA Transformer						
Date	Time	Frequency	A1 RMS	A2 RMS	A3 RMS	Aunb
		Hz	A	A	A	%
1/30/2021	12:00:00 PM	50.09	267.7	208.8	248.1	3.7
1/30/2021	12:00:20 PM	50.1	266.3	204.3	238.6	3.9
1/30/2021	12:00:40 PM	50.09	262.5	194	232.1	4.9
1/30/2021	12:01:00 PM	50.09	263.7	192.8	235.1	5.3
1/30/2021	12:01:20 PM	50.08	273.4	190.5	237.5	7
1/30/2021	12:01:40 PM	50.08	268	201.9	235.3	4.5
1/30/2021	12:02:00 PM	50.07	269.6	188.6	228.5	6.3
1/30/2021	12:02:20 PM	50.06	272.5	191.2	230.9	6.2
1/30/2021	12:02:40 PM	50.06	269.7	193	228.9	5.7
Average Current & %Unbalance			**233.0925926**			**5.2**

Current Profile of 500 kVA Transformer



Average Power Factor of 500 kVA Transformer						
Date	**Time**	**Frequency**	**PF1**	**PF2**	**PF3**	**PF Mean**
		Hz	Ph-1	Ph-2	Ph-3	Avg.
1/30/2021	12:00:00 PM	50.09	0.99	0.99	0.98	0.987
1/30/2021	12:00:20 PM	50.1	0.99	0.99	0.98	0.988
1/30/2021	12:00:40 PM	50.09	0.99	1	0.98	0.989
1/30/2021	12:01:00 PM	50.09	0.99	1	0.98	0.989
1/30/2021	12:01:20 PM	50.08	0.99	0.99	0.98	0.985
1/30/2021	12:01:40 PM	50.08	0.99	0.99	0.97	0.986
1/30/2021	12:02:00 PM	50.07	0.99	0.99	0.98	0.987
1/30/2021	12:02:20 PM	50.06	0.99	0.99	0.98	0.987
1/30/2021	12:02:40 PM	50.06	0.99	1	0.98	0.989
Average Power Factor						**0.987**

Power Factor Profile of 500 kVA Transformer



4.0. LIGHTING SYSTEM

LIGHTING INVENTORY

Adequate and proper lighting contributes both directly and indirectly towards productivity and safety, and towards providing an improved work atmosphere. In fact, all these are inter-related and complimentary to each other. There are several factors, which contribute towards proper lighting. However, all efforts were made to study and include these factors during audit of CUTM for lighting loads.

To study, analyze and identify energy conservation options in lighting, a study of the building lighting load was conducted. The purpose of the study was to determine the lighting load and its distribution in various sections of the Building, 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, type of luminaries, physical condition of lamps and luminaries, use of day lighting, etc. was also noted down.

During the study, measurement of lighting loads, voltage conditions, phase balancing in the facility areas were carried out. The illumination level was also measured primarily at various classrooms and common areas of the building. Care was taken to reduce the effect of day lighting while taking the measurements. The recorded inventory is enclosed in tabular form.

To determine the quantity of lighting load a physical count of the light fittings in CUTM was carried out. Further, the inputs from the officials and maintenance log books were taken into consideration for calculating the inventory of total light fittings of the CUTM. The total connected load of lighting in CUTM is about 120.21KW. The summarized lighting installations are furnished below.

Table 4.1: Total individual lighting calculation of CUTM

Lighting Inventory				
Area Name	**Types of Load**	**Wattage of each load in Watt**	**Nos. installed**	**Total connected Wattage in Watt**
Boy's Hostel	LED	9	257	2313
	LED	20	486	9720
	LED	40	64	2560
	LED	85	16	1360
	LED Tube	20	264	5280
	LED Tube	40	125	5000
	LED Tube	50	27	1350
	LED Tube	60	243	14580
	LED Tube	70	6	420
	LED Tube	80	119	9520
	LED Tube	100	69	6900
	LED Tube	160	24	3840
	LED Tube	180	27	4860
	LED Tube	200	10	2000
	Tube	120	6	720
	Tube	160	8	1280
Girl's Hostel	LED Tube	160	24	3840
	Tube	160	8	1280
MBA	LED	20	2	40
	LED	25	2	50
	LED Tube Light	40	123	4920
	LED Tube Light	25	71	1775
Main Building	LED	9	2	18
	LED Tube Light	20	75	1500
	C.LIGHT	20	25	500
	C.LIGHT	60	228	13680
	Tube Light	40	430	17200

Madhusudan Building	LED Tube light	18	206	3708
	Siling light	30	215	6450
	Fluroscent Tube light	40	348	13920
	Small Led	9	64	576
Other Units	LED	10	69	690
	LED	20	8	160
	LED	36	178	6408
	LED	100	1	100
	Tube Light	40	322	12880
	Halogen Light	50	10	500
	CFL	150	6	900
Total		1991	2947	120214

4.1. O & M PRACTICE, ENERGY ACCOUNTING AND MONITORING FOR LIGHTING SYSTEM

CUTM electrical maintenance team looks after the operation & maintenance of electric supply, ventilation & air conditioning, lighting system etc. The works involves maintenance of Lighting system, Light replacement, Switching on/off of street light. Solar street light system installed and maintained by CUTM engineers. But now days the Timer are and the electricians are switching on/off the street lighting by manually. It is recommended to install Timer in the Street Light Circuit.

It is observed that there is no proper document available for keeping the records of lighting maintenance, lux survey, lighting inventory list, area wise lighting consumption etc. A set of well designed format for lighting system record keeping may be developed and maintained at the earliest.
Proper lighting inventory list to be maintained, further during any replacement of lighting system, same may be simultaneously updated in the inventory.

The Monitoring and Targeting programs have been so effective that they show typical reductions in annual energy costs between 5% and 20%.

The essential elements of M&T system are

- Recording: Measuring and recording energy consumption.
- Analyzing: Correlating energy consumption to actual energy consumption
- Comparing:-Comparing energy consumption to an appropriate standard or benchmark.
- Setting Targets: Setting targets to reduce or control energy consumption.
- Monitoring: Comparing energy consumption to the set target on a regular basis.
- Reporting: Reporting the results including any variances from the targets which have been set.
- Controlling:-Implementing management measures to correct any variances, which may have occurred.

4.2. ILLUMINATION SURVEY AND LUX LEVEL MEASUREMENT

The Illumination survey and Electrical Equipment Inventory List of the CUTM Building including Corridor was carried out by measuring the Lux of the different area, Chemistry Lab, office

chambers, Smart class room(R-218) and Class Room (R-219) using Lux meter, by physical counting of inventory and the results are tabulated below.

Lux Measurement		
Area	**Measured Lux**	**Recommended Lux**
Chemistry Lab	65,89,55,73,88	200-300-500
office chambers	82,85,71,76,180	50-100-150
Smart class room(R-218)	20,40,82,90,92,85	200-300-500
Class Room (R-219)	70,91,77,83,86,79	200-300-500

Sample Calculation of ILER

$$\text{Installed Load Efficacy Ratio (ILER)} = \frac{\text{Actual, lux/W/M}^2}{\text{Target, lux/W/ M}^2}$$

Step-1	Measure the floor area of the interior:	Area in m^2
Step-2	Calculate the Room Index	RI
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 approximation can be obtained by totaling up the lamp wattages including the ballasts:	Total circuit watts
Step-4	Calculate Watts per square meter, Value of step 3 ÷ value of step 1	W/m^2
Step-5	Ascertain the average maintained luminance by using lux meter, Eav. Maintained	Eav.maint.
Step-6	Divide 5 by 4 to calculate lux per watt per square Meter	$Lux/W/m^2$
Step-7	Obtain target $Lux/W/m^2$ lux for type of the type of interior/application and RI (2):	Target $Lux/W/m^2$
Step-8	Calculate Installed Load Efficacy Ratio (6 ÷ 7).	ILER

Considering classroom number of 217, 218, chemistry Lab and Admin Room,

Step-1: Calculation of Room Area

Room Length in Meter=6.1m
Room Width in Meter=5.1m
Room Height in Meter=3.5m
Room Area in Sq. Meter= 6.1x5.1= 31.11 M^2

Step-2: Calculation of Room Index (RI)

$$\text{Room Index (RI)} = \frac{L \times W}{Hm \times (L+W)}$$

Hm= Mounting Height which is the height of the lighting fittings above the horizontal working plane, L= Length of Room, W= Width of Room

Hm=3.5-0.9= 2.6 Meter

Room Index= 31.11/ (3.5-0.9) x31.11= 1.07

Step-3: Total Wattage of Light Fittings

Total wattage of light fittings of Dhauli Suite Bed Room= 12 Wx 8 = 84 Watt

Step-4: Calculate Watts/ M^2

W/ M^2 = 84/31.11= 2.7

Step-5: Average Lux level of Room

At the time audit Period the lux was measured at Lux meter = 58

Step-6: Calculate Lux/Watts/ M^2

Lux/Watts/ M^2 = 58/2.7= 21.48

Step-7: Obtain Targeted Lux/Watts/ M^2

Target lux/W/m² (W/m²/100lux) values for maintained illuminance on horizontal plane for all room indices and applications			
Room Index	***Commercial Lighting) Offices, Retail stores, etc.) & very clean industrial applications, Standard or good color rendering. Ra:40-85***	***Industrial lighting (Manufacturing areas, workshops, warehousing etc.) Standard or good color rendering. Ra:40-85***	***Industrial lighting installations where standard or good color rendering is not essential but some color discrimination is required. Ra: 20-40***
5	53 (1.89)	49 (2.04)	67 (1.49)
4	52 (1.92)	48 (2.08)	66 (1.52)
3	50 (2.00)	46 (2.17)	65 (1.54)
2.5	48 (2.08)	44 (2.27)	64 (1.56)
2	46 (2.17)	42 (2.38)	61 (1.64)
1.5	43 (2.33)	39 (2.56)	58 (1.72)
1.25	40 (2.50)	36 (2.78)	55 (1.82)
1	36 (2.78)	33 (3.03)	52 (1.92)

Ra: Color rendering index

From the above BEE guideline table targeted Lux/Watts/ M^2 = 40

Ref: Guide Book for National Certification Examination for Energy Managers and Energy Auditors-Book 4

Step-8: Calculation of Installed Load Efficacy Ratio (ILER)

$$\text{ILER} = \frac{\text{Lux/Watts/ M}^2}{\text{Target Lux/Watt/M}^2} = 21.48/40 = 0.53$$

As per BEE Guidelines if ILER is less than 0.5 urgent actions are required.

INDICATORS OF PERFORMANCE	
ILER	***Assessment***
0.75 or Over	Satisfactory or Good
0.51 - 0.74	Review Suggested
0.5 or Less	Urgent action Required

Here ILER = 0.53, so here review suggested.

Annual energy Wastage (kWh/annum)= (1-ILER) x (watts/1000) x operating hours per annum

= (1-0.53) x (84/1000) x (12 x 300)
= 142.12 kWh/annum

4.3. ENERGY CONSERVATION OPTION

It is observed in some locations like Reception Area etc. the light fittings are found switched on even if it is not required. These should be switched off during the non working hours and day time.

It was observed that LUX level of street lights at different location are between 5-8 which is not satisfactory. Since there is less occupancy & less movement in the street light area during night time, so the low LUX level is not causing any difficulties

It is suggested to adopt the following energy conservation measure in the street lights. It is observed that there is a mix of 40 W, 60W and 70W LED installed in the Building. As LUX level required is around of 22 lumens, it is suggested to replace 20 W LED Tube lights with 60W LED fittings, due to which there will be wattage per lamp savings and standardisation of inventory can be ensured. The periodic checking of load unbalances should be carried out so as to limit the unbalance less than 10%.

We could not find any timer for switching on / off of the street light, it is being carried out manually. The timer installation and setting and operation in the street light and area lights need to be ensured all the times in different seasons so as conserve energy in lighting circuit and increase productivity of the electrician.

It is suggested to conduct periodic Lux level survey (preferably once in 3 months) and maintain record properly. Necessary corrective actions should be taken periodically.

Awareness among staff, student and control room operators is to be created for improvement in all aspects of energy conservation especially relating to lighting in their respective wings.

4.4. ENCON OPTION IN LIGHTING SYSTEM

Advantage of LED

LEDs are ideal for use in applications that are subjects to frequent on-off cycling, unlike fluorescent lamps that burn out more quickly when cycled frequently, or HID lamps that require a long time before restarting. LEDs can very easily be dimmed or strobe. These light up very quickly. A typical red indicator LED achieves full brightness in microseconds. These do not contain mercury, unlike compact fluorescent lamps.

4.5. ELECTRICAL LOAD DISTRIBUTION

In CUTM apart from lighting load there are different types of electrical load likes fans, Computers, Printers, TVs, Geyser, Fridge and other home appliance etc. The summary of connected electrical load is furnished below.

Table- 4.2 Details of Other Connected Electrical Load

Load Centre	Kilo Watt
Lighting	120
Fans	488
AC System	466
Other Load	96
TOTAL	1170

UPS & Ventilation

At the time of audit period it is observed that there is no measure power consuming UPS system in CUTM.

Energy saving Opportunity:
It is recommended to keep the monitors of the computers in standby mode rather in screen saver mode to reduce the power consumption of the computers when not in use. It is difficult to quantify the saving on account of this measure. The investment will be zero and simple payback period will be immediate.

ENCON Option by replacement of Kitchens Geysers with solar Water Heater

The Geysers in kitchens can be replaced with solar water heater and a savings can be achieved.

4.6. ENCON OPTION FOR INSTALLATION OF SOLAR POWER PLANT IN NET METERING CONCEPT

Concept of Net Metering:
Net metering is the concept which records net energy between export of generated energy and import of DISCOM energy for a billing month. Alternatively, the meter, having the feature of recording both the import and export values, also are generally allowed for arriving net energy for the billing period.

Principle of Net metering:
Based on available roof area / ground area solar PV panels will be installed. The output of the panels (DC electricity) will be connected to the power conditioning unit / inverter which converts DC to AC. The inverter output will be connected to the control panel or distribution board of the

building to utilise the power. The inverter synchronises with grid and also with any backup power source to produce smooth power to power the loads with preference of consuming solar power first. If the solar power is more than the load requirement, the excess power is automatically fed to the grid. For larger capacity systems connection through step up transformer and switch yard will be used to feed the power to grid.

Advantages of Net metering:

The grid connected roof top / ground mounted solar PV system would fulfill the partial / full power needs of large scale buildings. The following are some of the benefits of roof top SPV systems:

- Generation of environmentally clean energy
- Consumer becomes generator for his own electricity requirements
- Reduction in electricity consumption from the grid
- Reduction in diesel consumption wherever DG backup is provided
- Feeding excess power to the grid

Implementation:

1. The total project cost to be borne by the consumer, however consumer is eligible for any subsidy / grant from State Govt./ Central Govt. / MNRE as applicable from time to time Implementation of net metering facility shall be made applicable for the consumers having 3-phase supply service connection.
2. Protection system including its switch gear to be certified by concerned Ex. Engineer and harmonic suppressive device to be installed by such SPV generator to suppress the harmonics injection as harmonics is more in case of solar plants where conversion of DC to AC is taking place. Islanding protection requirements to be provided.
3. The SPV generator shall provide the indication of solar PV plant at the injection point for easy identification to the operating personnel.
4. The SPV generator needs to get statutory approvals from appropriate authority like Electrical Inspector for the connected equipment including its solar panels.
5. The proposed generator shall submit the prescribed application to the concerned Executive Engineer of local DISCOM who should be nodal authority for approval of the same.
5. The net meter / meter to be used for arriving net energy shall have the specifications prescribed.
6. Concerned JE of DISCOM shall issue a technical feasibility certificate and witness the synchronization of SPV plant with distribution network.
7. 0.5 class accuracy, tri-vector based energy meter, non ABT having the MRI downloading facility along with related accessories shall have to be installed by the SPV generator as per the specifications of DISCOM.
8. Spot billing is to be arranged by concerned DISCOM as per the billing period. DISCOM shall arrange to develop suitable software and incorporate in the billing instrument for such billing.

It is recommended to install 44 kW Solar Project in ITOT Building, 195 kW in CSREM Building and 68 kW in ITI Building, total 307 kW Solar rooftop Project is recommended.

5.0. HVAC SYSTEM

At present, the air conditioning system in the CUTM is met through window /split AC of following number.

There is around 233 numbers air conditioning system in CUTM

It is estimated that there is about 365 KW of AC load in CUTM contributing to about 40% of the total connected load.
Installed Air conditioning System of CUTM are furnished below.

Detail Inventory of ACs of CUTM				
Type of Load	**Watt**	**Rated Tonnage**	**Number**	**Tonnage**
Air-conditioner	750	0.5	1	0.5
	1000	1	5	5
	1500	1.5	213	319.5
	2000	2	10	20
	3500	5	4	20
Total	25125		233	365

Advantages of Inverter Air Conditioner

The latest and the most efficient technology that is available in market today is the Inverter Technology for air conditioners. Inverter technology is designed in such a way that it can save 30-50% of electricity (units consumed) over a regular air conditioner.
Inverter air conditioners are more powerful, offer great savings and are better at maintaining temperature compared to non-inverter air conditioners. When compressor needs more power, it gives it more power. When it needs less power, it gives less power. With this technology, the compressor is always on, but draws less power or more power depending on the temperature of the incoming air and the level set in the thermostat. The speed and power of the compressor is adjusted appropriately.

Let's take an example of 1.5 Ton inverter air conditioner versus non-inverter air conditioner

A 1.5 Ton inverter air conditioner works initially at 1.7 Ton and as the desired temperature is achieved it reduces its capacity to 1.5, 1 or .3 Ton based on room conditions.

A 1.5 Ton non-inverter air conditioner on the other hand works at 1.5 Ton all the times.

Every air conditioner is designed for a maximum peak load. So a 1.5ton AC is designed for a certain size of room and 1 ton for a different size. But not all rooms are of same size. A regular air conditioner of 1.5ton capacity 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 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.

5.1. MAINTENANCE TIPS FOR SPLIT / WINDOW AC

- Make sure your AC doesn't get overloaded; check the fuse or circuit breaker if it doesn't operate.
- Remember to replace or clean the filter and have your mechanic clean the evaporator and condenser coils regularly, for the air conditioner to cool your home efficiently.
- Install a programmable thermostat, it will lead to 10-15% energy saving.
- Set your thermostat as high as possible comfortable.
- Set the fan speed on high except on very humid days, when humidity is high set the fan speed on low for more comfort.
- Install units in shade, it will lead to 10% saving in energy consumption.
- Use sun films on windows. That will cut heat entry by 70% of the building.
- If the AC makes noise it needs to be checked by the mechanic
- Giving your air conditioning system a good electrostatic air filter is the best thing you can do for your air conditioner. A good air filter will extend the life of your air conditioner because the important parts, like the cooling coil, and other inner parts will stay cleaner, operate more efficiently and last longer.
- Avoid frequent opening of doors/windows. A door kept open can result in doubling the power consumption of your AC.
- Ensure direct sunlight (and heat) do not enter the air-conditioned space, particularly in the afternoons.
- Most people believe that a thermostat set to a lower temperature than desired, will force your air-conditioner to cool faster, not really, all it does, is make your air-conditioner operate for longer. Moreover, you will have an unnecessarily chilly room and wasted power. Every degree lower on the temperature setting results in an extra 3-4% of power consumed. Hence, once you've found yourself a comfortable temperature and set the thermostat at that level, avoid touching the thermostat thereafter.
- Once an air-conditioning system has been designed and installed avoid any major change in the heat-load on the AC. This will add to wasted power.
- Always ensure that whenever you install new unit, make sure its EER (12/(kW/TR)) should be between 9.5 to10.5.
- No gap should be left during installing units for cool air escape.

6.0. DIESEL GENERATING (DG) SET

Observation & Analysis for DG Set:

- There are two nos. of DG sets of 125 KVA capacity and 25 KVA capacity installed in CUTM to meet the power requirement of the major areas of the building in case of power supply failure from TPCODL.
- The technical specification of the DG Set is furnished below:

Table- 6.1. Technical specification of the DG set

Technical Specification of DG			
Particulars	**DG Set 1**	**DG Set 2**	**DG Set 3**
Name of DG Set	KOEL	KOEL	Koel Green
Capacity in kVA	200	400	500
Phase	3	3	3
Rated Voltage in Volt	415	415	415
Rated Current in Amp	278.2	556.5	695.56
Rated PF	0.8	0.8	0.8
Rated Speed in RPM	1500	1500	1500
Rated Fuel Consumed in Litre/Hour	34.4	46	107.5

Data Sheet of 200kVA DG Set for FY 2017-18	
Month	**Diesel Consumption in kL**
Apr-17	0.934
May-17	0.801
Jun-17	0.597
Jul-17	1.067
Aug-17	1.561
Sep-17	0.739
Oct-17	1.214
Nov-17	0.364
Dec-17	1.651
Jan-18	0.718
Feb-18	1.034
Mar-18	0.871
Total	**11.550**

Data Sheet of 400kVA DG Set for FY 2017-18	
Month	**Diesel Consumption in kL**
Apr-17	3.234
May-17	2.303
Jun-17	2.626
Jul-17	4.099
Aug-17	5.766
Sep-17	2.660
Oct-17	2.940
Nov-17	2.813
Dec-17	3.054
Jan-18	3.544
Feb-18	2.509
Mar-18	2.941
Total	**38.489**

Data Sheet of 500kVA DG Set for FY 2017-18	
Month	**Diesel Consumption in kL**
Apr-17	NA
May-17	NA
Jun-17	NA
Jul-17	NA
Aug-17	NA
Sep-17	NA
Oct-17	NA
Nov-17	NA
Dec-17	NA
Jan-18	NA
Feb-18	NA
Mar-18	0.152
Total	**0.152**

Data Sheet of 200kVA DG Set for FY 2018-19	
Month	**Diesel Consumption in kL**
Apr-18	0.637
May-18	1.065
Jun-18	0.456
Jul-18	0.784
Aug-18	0.617
Sep-18	14.312
Oct-18	0.285
Nov-18	NA
Dec-18	NA
Jan-19	NA
Feb-19	NA
Mar-19	NA
Total	**18.157**

Energy Data Sheet of 400kVA DG Set for FY 2018-19	
Month	**Diesel Consumption in kL**
Apr-18	3.496
May-18	4.440
Jun-18	2.139
Jul-18	2.488
Aug-18	3.296
Sep-18	1.917
Oct-18	1.333
Nov-18	0.328
Dec-18	0.380
Jan-19	0.260
Feb-19	0.533
Mar-19	0.611
Total	**21.222**

Energy Data Sheet of 500kVA DG Set for FY 2018-19	
Month	**Diesel Consumption in kL**
Apr-18	NA
May-18	0.953
Jun-18	NA
Jul-18	2.026
Aug-18	1.305
Sep-18	1.463
Oct-18	0.825
Nov-18	0.068
Dec-18	0.336
Jan-19	0.265
Feb-19	0.648
Mar-19	0.355
Total	**8.243**

Energy Data Sheet of 200kVA DG Set for FY 2019-20	
Month	**Diesel Consumption in KL**
Apr-19	0.400
May-19	1.777
Jun-19	0.231
Jul-19	1.866
Aug-19	0.704
Sep-19	NA
Oct-19	0.240
Nov-19	0.115
Dec-19	0.063
Jan-20	0.134
Feb-20	0.102
Mar-20	0.110
Total	**5.742**

Energy Data Sheet of 400kVA DG Set for FY 2019-20	
Month	**Diesel Consumption in KL**
Apr-19	1.210
May-19	9.892
Jun-19	0.961
Jul-19	0.503
Aug-19	NA
Sep-19	NA
Oct-19	NA
Nov-19	NA
Dec-19	0.145
Jan-20	0.376
Feb-20	0.009
Mar-20	0.353
Total	**13.449**

Energy Data Sheet of 500kVA DG Set for FY 2019-20	
Month	**Diesel Consumption in KL**
Apr-19	0.495
May-19	8.962
Jun-19	2.945
Jul-19	10.429
Aug-19	3.959
Sep-19	5.740
Oct-19	1.921
Nov-19	0.473
Dec-19	0.785
Jan-20	0.576
Feb-20	0.402
Mar-20	0.954
Total	**37.642**

Recommendation:

- The DG sets are normally operated in power failure condition and in any emergency load requirement case.
- The details of energy generated and consumption of Diesel for both the DG set is not being recorded presently for which the specific energy consumption of DG set could not be evaluated.
- So it is recommended that the DG set generation and HSD consumption details are be noted monthly basis in log book for future reference and evaluation of SEC.
- Both the DG set should be inspected by Electrical Inspector, Energy Meter should be installed across the DG set and sealed properly in consultation with Chief Electrical Inspector.
- The record of energy generated in DG set is not available. It is to be recommended that energy meter is to be installed in each DG set and the energy generated in each DG set has to be recorded to calculate the specific energy consumption of DG set.

7.0. WATER PUMPING SYSTEMS

7.1. WATER PUMPING STORAGE AND DISTRIBUTION SYSTEM

CUTM meets its water requirement from the PHD Department from the nearby water storage facility, the pump house is having different electrical connection and not linked with CUTM Power distribution system, it only supplies required portable water to CUTM.

Utilization of water Pumping System

There are submersible types of pumps installed in CUTM for the auxiliary consumption of water like housekeeping, gardening etc. There are 12 nos. of 3 HP submersible pump, 5nos. of 2 HP pumps.

Mechanical Power Transmission Study and Rational Usages of Drives

There are submersible types of pumps installed in CUTM for the auxiliary consumption of water like housekeeping, gardening etc. Though these are submersible type pump, hence the study mechanical power system could not be carried out and hence no recommendation is furnished for the same. It is recommended that in future flow meter to be installed and water consumption to be monitored.

8.0. FINANCIAL ANALYSIS OF THE IMPLEMENTED ENERGY CONSERVATION PROJECT

DETAILS OF ENERGY EFFICIENCY IMPROVEMENT MEASURES IMPLEMENTED, UNDER IMPLEMENTATION, INVESTMENT MADE, SAVINGS IN ENERGY ACHIEVED AND THE PROGRESS MADE IN THE IMPLEMENTATION OF OTHER RECOMMENDATIONS									
A. Implemented:									
Sl. No.	Details of energy efficiency improvement measure	Category	Investment in Rs.	Verified Savings in Rs	Verified Energy Savings	Units	Fuel	Equivalent Verified Energy Savings in TOE	Remarks
1	Optimization of lighting load by operating 8 hour (Celling light & Celling light ring type fitting)	Lighting	Nil	13648080	37392	kWh		3.216	
2	Optimization of lighting load by operating 12 hour (Street light & LED tube light type fitting)	Lighting	Nil	18658800	51120	kWh		4.396	
Total			Nil	32306880	88512	kWh		7.61203	

9.0. OPERATION AND MAINTENANCE OF CUTM

CUTM Electrical Maintenance looks after the operation & maintenance of electric supply, ventilation & air conditioning, lighting system etc. of the entire building to ensure proper work environment and comfort of its residents and officials. There are 10 nos. of technicians and one Junior Engineer in CUTM Electrical. The works involves maintenance of lift, AC, motor, normal Fuse call Attending, Light replacement, Switching on/off of street light. Earlier Timer was installed in street light system. But now days the Timer are not functioning and the electricians are switching on/off the street lighting by manually. It is recommended to install Timer in the Street Light Circuit.

10.0. ENERGY MONITORING & ACCOUNTING SYSTEM

Energy monitoring and targeting (M & T) is primarily a management technique that uses energy information as a basis to eliminate waste, reduce and control current level of energy use and improve the existing operating procedures. It builds on the principle "you can't manage what you don't measure". It essentially combines the principles of energy use and statistics.

While, monitoring is essentially aimed at establishing the existing pattern of energy consumption, targeting is the identification of energy consumption level which is desirable as a management goal to work towards energy conservation.

Monitoring and Targeting is a management technique in which all plant and building utilities such as fuel, refrigeration, water, effluent, and electricity are managed as controllable resources in the same way that inventory, building occupancy, personnel and capital are managed. It involves a systematic, disciplined division of the facility into Energy Cost Centers. The utilities used in each centre are closely monitored. Once this information is available on a regular basis, targets can be set, variances can be spotted and interpreted, and remedial actions can be taken and implemented.

The Monitoring and Targeting programs have been so effective that they show typical reductions in annual energy costs in various industrial sectors between 5 and 20%.

The essential elements of M&T system are:

- Recording: Measuring and recording energy consumption.
- Analyzing: Correlating energy consumption to actual energy consumption
- Comparing:-Comparing energy consumption to an appropriate standard or benchmark.
- Setting Targets: Setting targets to reduce or control energy consumption.
- Monitoring: Comparing energy consumption to the set target on a regular basis.
- Reporting: Reporting the results including any variances from the targets which have been set.
- Controlling:-Implementing management measures to correct any variances, which may have occurred.

The energy used by any business varies with production processes, volumes and input. Determining the relationship of energy use to key performance indicators will allow the Building owner to determine:

- Whether the current energy is better or worse than before
- Trends in energy consumption that reflects seasonal, weekly, and other operational parameters
- How the future energy use is likely to vary Specific areas of wasted energy
- Comparison with other business with similar characteristics - This "benchmarking" process will provide valuable indications

The CUTM Electrical Maintenance looks after the operation and maintenance of the utilities. The Shift Technician maintains only the daily complain register. However it is proposed that department should maintain and update the log book for transformer electrical parameter measurement, Diesel Consumption, DG set Energy Generation, list of inventory like LED light, fan, AC, Equipment etc.

The House hold office should also maintain the detailed Energy Bill Analysis in Excel file in its Computer for reference and review purposes. The Energy Bill copy should be kept serially in files.

Electrical Safety:

It is observed that the Single Line Diagram (SLD) of the entire electrical system is to be displayed at concerned places. This will help in identifying the fault easily and doing the maintenance job more effectively. The SLD should be reviewed once in year to put necessary changes.
At Panel rooms, the following points are suggested as per safety & electricity rules.

- Rubber mats should be placed on the floor around the PDB panels in each switch room.
- No panel door should be kept open in both sides.
- Proper bunching of cables should be ensured at each switch room. The cables should be clearly tagged at starting & ending points which would help for easy the identification of cables for fault finding & maintenance work.
- Danger plates should be displayed at concerned places.
- Proper naming of loads should be done on each panel.

Awareness and attitude of occupants toward energy efficiency:

It is suggested to create energy conservation awareness among the staff by observing Energy Conservation Day, encouraging & recognizing energy conservation efforts made by any individual

or groups. A core committee on Energy Conservation, Electrical Safety, Resource conservation may also be formed to review the related activities.

11.0. TECHNICAL SPECIFICATIONS FOR ENERGY EFFICIENT PRODUCT

1. Capacitor Bank

Standard parameter	Valve/Feature
Total rating of capacitors	60 kVAr
Rated AC Voltage	440Volt
Frequency	50 HZ
No. of Phases	3 phase
Standard	IS 13340-1993
APFC relay	Microprocessor Based
Losses	< 0.2 W/kVAr

2. Lighting

Standard Parameter	Feature
Voltage	220 - 240 V
Shape	Bulb
Lifetime of lamp	15000 hour(s)
Lumen maintenance factor	0.7
Average life (at 2.7 hrs/day)	15.2 year(s)
Number of switch cycles	50000
Rated luminous flux	1400 lm
Rated lifetime	15000 hour(s)
Rated beam angle	150 degree
Light output	1400 lumen
Beam angle	150 degree
Colour temperature	6500 K
Light effect/finish	Cool Daylight
Colour rendering index (CRI)	80
Starting time	<0.5 s
Warm-up time to 60% light	Instant full light
Colour	Cool Daylight

3. Air Conditioner

Standard Parameter	Feature
Window AC (1.5 Ton)	
Cooling Capacity (Watt)	5265
Max Power Consumption (Watt)	1847
Preferable BEE Star Rating	3
Energy Efficiency Ratio (EER)	2.85 W/W
Preferable Compressor Type	Rotary/reciprocating

Preferable Refrigerant Gas	R-22
Window AC (2 Ton)	
Cooling Capacity (Watt)	7020
Max Power Consumption (Watt)	2463
Preferable BEE Star Rating	3
Energy Efficiency Ratio (EER)	2.85 W/W
Preferable Compressor Type	Rotary/reciprocating
Preferable Refrigerant Gas	R-22
Split AC (1.5 Ton)	
Cooling Capacity (Watt)	5265
Max Power Consumption (Watt)	1815
Preferable BEE Star Rating	4
Energy Efficiency Ratio (EER)	2.90 W/W
Preferable Compressor Type	Rotary/reciprocating
Preferable Refrigerant Gas	R-22
Split AC (2 Ton)	
Cooling Capacity (Watt)	7020
Max Power Consumption (Watt)	2420
Preferable BEE Star Rating	4
Energy Efficiency Ratio (EER)	2.90 W/W
Preferable Compressor Type	Rotary/reciprocating
Preferable Refrigerant Gas	R-22

3. 100 LPD Solar Water Heater

Standard Parameter	**Feature**
Specification	S.S 0.8mm THICKNESS INNER TANK 47mm X 1500mm ETC GLASS TUBES
System Capacity in LPD	100
Nos. of Tubes	15

4. Energy Efficient Fan

Model Name	E1-1200
Reversible Rotation	No
Remote	Yes
Blade Material	Aluminum
Leaf	3

Weight (kg)	4
Dimensions	120 x 140 cm
Down rod Height	30.48 cm
Span (mm/inch)	1200/48
Rated Voltage *	140 - 285

Rated Frequency	48 - 52
Input Power (typical)	28
Power Factor (typical)	0.95
Air Delivery	230

STAR RATING PLAN IN ROOM AIR CONDITIONERS

New BEE Energy Efficiency Ratings (EER) for Room Air Conditioners					
STAR RATING LEVELS - Jan 1, 2014 - Dec 31, 2015					
EER (W/W)					
WINDOW AC			SPLIT AC		
Star Rating	Minimum	Maximum	Star Rating	Minimum	Maximum
1 Star ★	2.50	2.69	1 Star ★	2.70	2.89
2 Star ★★	2.70	2.89	2 Star ★★	2.90	3.09
3 Star ★★★	2.90	3.09	3 Star ★★★	3.10	3.29
4 Star ★★★★	3.10	3.29	4 Star ★★★★	3.30	3.49
5 Star ★★★★★	3.30	-	5 Star ★★★★★	3.50	-

STAR RATING PLAN IN DISTRIBUTION TRANSFORMERS

Rating	1 Star		2 Star		3 Star		4 Star		5 Star	
kVA	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)	Max Losses at 50% (Watts)	Max Losses at 100% (Watts)
16	200	555	165	520	150	480	135	440	120	400
25	290	785	235	740	210	695	190	635	175	595
63	490	1415	430	1335	380	1250	340	1140	300	1050
100	700	2020	610	1910	520	1800	475	1650	435	1500
160	1000	2800	880	2550	770	2200	670	1950	570	1700
200	1130	3300	1010	3000	890	2700	780	2300	670	2100

STAR RATING PLAN IN PUMP SETS

Star Rating	Overall Efficiency of the Pump Set*
1 Star	>=1.00 & <1.05
2 Star	>=1.05 & <1.10
3 Star	>=1.10 & <1.15
4 Star	>=1.15 & <1.20
5 Star	>=1.20

LIST OF ABBEREVIATIONS

AC	:	Air Conditioning
BEE	:	Bureau of Energy Efficiency
CFL	:	Compact Fluorescents Lamp
LED	:	Light Emitting Diode
FTL	:	Fluorescents Tube Light
HPMV	:	High Pressure mercury
HPSV		High Pressure Sodium
CTR	:	CT Ratio
DB	:	Distribution Board
DG	:	Diesel Generator
ENCON	:	Energy Conservation
HRS	:	Hours
HT	:	High Tension
I	:	Current
KL	:	Kilo Litre
KV	:	Killo Volt
KVA	:	Killo Volt Ampere
KVAH	:	Kilo Volt Ampere Hour
KVAR	:	Killo Volt Ampere Reactive
KW	:	Killo Watt
KWH	:	Killo Watt Hour
THD		Total harmonic distortion
LT	:	Low Tension
PF	:	Power Factor
PTR	:	PT Ratio
SEC	:	Specific Energy Consumption
TF	:	Transformer
UF	:	Utilization Factor
V	:	Voltage