INVESTMENT GRADE ENERGY AUDIT REPORT

of Centurion University of Technology & Management
Rayagada, Odisha

Submitted to:

Centurion University of Technology & Management

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Centurion UNIVERSITY

Power Tech
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Submitted by:

M/s. Swain and Sons Power Tech Pvt. Ltd.

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LIST OF ABBEREVIATIONS

AC	:	Air Conditioning
BEE	:	Bureau of Energy Efficiency
LED	:	Light Emitting Diode
CTR	:	CT Ratio
DB	:	Distribution Board
DG	:	Diesel Generator
ENCON	:	Energy Conservation
HRs	:	Hours
HT	:	High Tension
I	:	Current
kL	:	Kilo Liter
kV	:	Kilo Volt
KVA	:	Kilo Volt Ampere
kVAh	:	Kilo Volt Ampere Hour
kVAR	:	Kilo Volt Ampere Reactive
kW	:	Kilo Watt
kWh	:	Kilo 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

ACKNOWLEDGEMENT

M/s. Swain and Sons Power Tech Pvt. Ltd. (SSPTPL) places on record its sincere thanks to Centurion University of Technology & Management for entrusting the task of conducting the Investment Grade Energy Audit of Centurion University of Technology & Management (CUTM), Rayagada.

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

SSPTPL 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.

Our special thanks to Mr. Rajesh Kumar Padhi (Regional Director), Mr. Krushna Prasad Mohapatra (AO), Mr. R. K. Mohapatra (Principal, CPS), Mr. Chandra Sekhar Patra (Principal (SOP)and the Energy Conservation Cell Members for their whole hearted co-operation and guidance in carrying out the Investment Grade Energy Audit of CUTM, Rayagada.

Signature

Subhranshu Sekhar Rath
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AUDIT TEAM DETAILS

1. Mr. Subhranshu Sekhar Rath, General Manager
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3. Mr. Suresh Gurjar, Manager
4. Mr. Nirjhar Biswal, Assistant Manager (Project)
5. Mr. Suraj Kumar Bhujabala, Assistant Manager (Project)
6. Mr. Subash Mallick, Project Associate
7. Ms. Lalita Kumari Swain, Project Associate

We express our sincere thanks to the following students of CUTM, Bhubaneswar for showing their interest and involvement in conducting the energy audit of CUTM, Rayagada campus.

Sl.	Name	Enrolment No
1	Ms. Riya Saha	200301150006
2	Mr. Rohit Mishra	200301150002
3	Mr. Siddharth Singh	200301150003
4	Mr. Azharhul Haque	200301151016
5	Mr. Pradeepta Kumar Mohanta	200301150012
6	Mr. Chandrasekhar Maharana	200301151017
7	Mr. Anirban Hatui	200301150011
8	Mr. Papu Jagganath Rao	200301150007
9	Mr. B. Sai	200301151015

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.

Signature

Subhranshu Sekhar Rath
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Swain & Sons Power Tech Pvt. Ltd.
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EXECUTIVE SUMMARY

The journey of Centurion University of Technology and Management (CUTM) started with the takeover of Jagannath Institute for Technology and Management (JITM) in 2005. Subsequently, JITM was transformed into Centurion University of Technology and Management in August 2010, through an act of Odisha Legislative Assembly CUTM (Rayagada) is situated in the mineral rich southern part of Odisha, Rayagada is a district of meadows, forests, waterfalls and terraced valleys, inhabited by many primitive tribal groups. Spread over 15 acres of land this campus provides skill integrated education in the region.
The complex includes School of Applied Sciences, School of Vocational Education and Training and School of Pharmacy.

Goals and Objectives of the Energy Management Programme:

The Investment Grade Energy Audit of Centurion University of Technology & Management, Rayagada was carried out during the period in July 2022. Energy Conservation is a major focus and requirement in Institutional, Commercial and Government Buildings, and hence the management of Centurion University of Technology & Management, has entrusted the work of conducting Investment Grade Energy Audit (IGEA) of their entire campus to Swain and Sons Power Tech Pvt. Ltd. The main focus of the audit was to establish Specific Energy Consumption for all the Buildings & Vehicles for financial year 2021-22, collection of technical information like specification of the machines, details of all the buildings, Fuel consumption in all the DG, Water consumption details, etc.

Centurion University of Technology & Management, Rayagada is availing power supply from TPSODL, local DISCOM Connections at 11 kV Voltage level and through a 250kVA, 11/0.415kV power transformer with contract demand of 206 kVA (Consumer no. 311000000076). As per electricity bills analysis for FY 2021-22, the monthly average electrical energy consumption of whole campus stands at about 6409 kWh and the monthly average energy bill is around Rs. 79969, the average Power Factor is about 0.94.

Table 1: Summary of Energy Bill Analysis of CUTM, Rayagada

SUMMARY OF THE ENERGY BILLS FOR THE LASTFINANCIAL YEAR OF CUTM RAYAGADA							
Year	**Description**	**Electricity consumed in kWh**	**Avg. MD in kVA**	**Power Factor**	**Load Factor**	**Energy Bill in Rs.**	**Energy Charge in Rs./kWh**
For Financial year 2021-22	Monthly average	6409	30	0.94	0.34	39803	12.97
	Daily Average	214	30	0.94	0.34	1327	12.97

The major utilities of Centurion University of Technology & Management, Rayagada are Electricity, Water and HSD. The electricity is utilized for Lighting, Fans, pumping of water, Computer, Printer, Laboratory, Water cooler, Fridge, Projector, Speaker and AC. HSD is utilized in DG set and Transportation Vehicles. Water consumption is there in all the buildings for day-to-day domestic purposes and also for plantation, gardening and cleaning.

During the study, various energy conservation options were identified, their cost benefit analysis was found out and same is furnished below. It is recommended that CUTM may implement the Energy Conservation Option as suggested in the report.

Details of Energy Conservation measures / Recommendations of Accredited Energy Auditor for Improving Energy Efficiency						
[See rule 3(1) (c)]						
Energy Saving measures	**Anticipated Investment (In Lakh)**	**Anticipated Annual Savings (In Lakh)**	**Simple Pay Back Period in Year**	**Anticipated Annual Energy Savings**		
				Electricity in kWh	**Thermal Energy in mkCal**	**Equivalent Energy in TOE**
Installation of Roof top Solar Power Plant	19.00	3.70	5.1	63247.20		5
Replacement of Old 1.5 Ton AC with EESL 1.5 ton 5 Star Super Energy Efficient AC	1.38	0.94	1.461	16111		1
Replacing 75W Conventional Ceiling Fan with Super Energy Efficient Ceiling Fan	2.55	0.72	3.5	12348		1
Replacement of 36W FL Tube Fittings with 20 W	0.05	0.05	1.1	864		0

LED Tube						
Installation of Capacitor Bank to improve Power Factor	0.20	0.50	0.40	8539		1
Replacement of lighting Load in Class Room Lightpipe Fitting System at CUTM, Rayagada	4.03	1.73	2	29568		3
Replacement of lighting Load in Seminar Hall Lightpipe Fitting System at CUTM, Rayagada	1.15	0.22	5	3802		0
Replacement of 24W Street lights with 50W LED Solar Street Light with advance motion sensor facility	0.55	0.09	6	1577		0
Installation of Light Motion Sensor at Rare Occupancy area to reduce lighting load	0.04	0.02	3	285		0
Installation of Solar Water Heater at CUTM Canteen	0.70	0.59	1		7247899	1
Total	**23.18**	**8.57**	**2.71**	**136341**	**7247899**	**12**

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 Energy Conservation (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 has 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 Institutional, Commercial and Government Buildings. Besides Building owners are also focusing Energy Conservation and Energy Efficiency in large 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, the management of CUTM has entrusted the work of conducting Investment Grade Energy Audit (IGEA) to Swain and Sons Power Tech Pvt. Ltd. The Energy Audit of CUTM was carried out in the period of July 2022. The scope of work includes collection of existing layouts 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 2021-22, Power measurement of all running Transformer, Panels, AC, Pump and Motor and submission of Energy Audit Report along with details of Energy Conservation Opportunity.

1.1. About The Site

The journey of Centurion University of Technology and Management (CUTM) started with the takeover of Jagannath Institute for Technology and Management (JITM) in 2005. Subsequently, JITM was transformed into Centurion University of Technology and Management in August 2010, through an act of Odisha Legislative Assembly CUTM (Rayagada) is situated in the mineral rich southern part of Odisha, Rayagada is a district of meadows, forests, waterfalls and terraced valleys, inhabited by many primitive tribal groups. Spread over 15 acres of land this campus provides skill integrated education in the region. The complex includes School of Applied Sciences, School of Vocational Education and Training and School of Pharmacy.

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.

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.

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, Rayagada. Prior to energy audit, SSPTPL 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, Fan list, Motor and other electrical load list.
- Collection of Month wise Energy Bill for FY 2021-22.

The methodology was explained / discussed with CUTM, Rayagada 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, Rayagada 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 SSPTPL 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 SSPTPL.
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, Rayagada for acceptance.
11. Final energy audit report was submitted after acceptance of the draft energy audit report.

1.4. Instruments Used

SSPTPL 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
- Power Guard

2.0 BRIEF DESCRIPTION OF THE UNIVERSITY

Name & Address

Centurion University of Technology & Management Rayagada
Pitamahal, Rayagada, Odisha- 765002
Tel: 9437095990

Name & Details of Authorized Signatory of CUTM, Rayagada

Mr. Rajesh Kumar Padhi (Regional Director)
Mobile: 9437095990
E-mail: rajeshkumar.padhi@gmail.com

Name & Details of Project Coordinator
Mr. Krushna Prasad Mohapatara (AO)
Mobile: 7328810147

DESCRIPTION OF CAMPUS:

Centurion University of Technology & Management (CUTM) Rayagada is situated in the mineral rich southern part of Odisha. Rayagada is a district of meadows, forests, waterfalls and terraced valleys, inhabited by many primitive tribal groups. Spread over 15

acres of land this campus provides skill integrated education in the region. It is located at latitude 19°08'12"N & latitude 83°24'49"E. Nearest Railway station is Rayagada junction.

The complex includes School of Applied Sciences, School Of Vocational Education and Training and School of Pharmacy. University is having approximately 60 numbers of teaching staff members, 400 numbers of Students, 47 numbers of non-teaching staffs.

Centurion University of Technology & Management, Rayagada was availing power supply from TPSODL, local DISCOM Connections contract demand of 40kW (Consumer no. 311001080060). But from July 2021, CUTM, Rayagada is availing power supply with a contract demand of 206kVA (consumer No-311000000076). One number of DG Set i.e. DG Set-1 (125kVA) is also present for providing power supply in emergency situation.

(Google Earth View of CUTM, Rayagada)

2.1 Major Utility

- Electricity
- Water
- HSD

Electricity:
Electricity is utilized for Lighting, Fans, Pumping of water, Computer, Printer, Laboratory, Water cooler, Fridge, Projector, Speaker and AC, etc.

Water:
Water consumption is in all the Buildings for day to day usage and also utilized in plantation, gardening and cleaning.

HSD:
HSD is consumed in DG set and Transportation.

3.0 ENERGY SCENARIO

CUTM receives the electrical power supply from TPSODL at 11kV. The present contract demand of the Building with TPSODL is 206 kVA. The energy fact file of the building is furnished below:

Table 2: Energy Fact File of CUTM, Rayagada

Location	Centurion University of Technology & Management (CUTM), Pitamahal, Rayagada, Odisha-765002
Areas of Utilization of Energy	CUTM, Rayagada
Source of Supply	11KV Distribution Line from Rayagada Substation of TPSODL
Total Contract Demand	206kVA
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. 6409 kWh per Month based on FY 2021-22
Monthly Energy Bill	Avg. Rs. 79969 per month based on FY 2021-22

Table 3: Building Audit Data of CUTM, Rayagada

Building Audit Data Sheet			
Sl. No.	**Item**		**Value**
Size, Age & Construction of the building			
1	Connected Load or Contract Demand in kVA		206 kVA
2	Installed Capacity: DG Sets (KVA or KW)		125
3	a)Annual Electricity Consumption ,Purchased From Utilities(kWh)		64089
	Annual Electricity Consumption, Through Diesel Generating DG Set (kWh)		NA
	c) Total Annual Electricity Consumption, Utilities + DG Sets (kWh)		64089
4	a) Annual Cost Electricity Purchased from Utilities (Rs.)		
5	Working hours (Mainly day working but Library is 24 hour working)	Built Up Area (sq m) (Excluding Basement Area)	6216
6	Working days/week (e.g. 5/6/7 days per week)		6
7	Installed lighting load(kW)		5
8	Installed capacity of Air Conditioning System (TR)		25.50
9	Existing EPI(Energy performance Index) in kWh/sq. m/year Energy includes		10.35
	Electricity Purchased & Generated (Excluding Electricity from any Renewable Source)		64089
10	No. of Floors in the building		2
11	HSD		24003.35
	consumption in DG/GG sets		770.866
12	Occupancy Information	Daily Visitors	45
		Staff Members	107

3.1 Analysis of Energy Bill

The energy bills details and tariff categorization details of CUTM, Rayagada for FY' 2021-22 having consumer no- 311000000076 is furnished below:

Table 4: Consumer details of the Building

Consumer Name & Address	SRI RAJESH KUMAR PADHI, CENTURION ITC(JITM)TRUST PITAMAHAL, RAYAGADA
Tariff Category	GENERAL PURPOSE>=110KVA
Consumer No.	311000000076
Contract Demand	206kVA
Supply Voltage	11kV

Data source: Energy Bills of CUTM were collected during the period of Energy audit. The summary of Energy Bill Analysis of CUTM, Rayagada is furnished below:

Table 5: Summary of Energy Bill Analysis of CUTM, Rayagada

The summary of Energy Bill Analysis of CUTM, Rayagada Building is furnished below:

SUMMARY OF THE ENERGY BILLS FOR THE LAST FINANCIAL YEAR OF CUTM RAYAGADA							
Year	**Description**	**Electricity consumed in kWh**	**Avg. MD in kVA**	**Power Factor**	**Load Factor**	**Energy Bill in Rs.**	**Energy Charge in Rs./kWh**
For Financial year 2021-22	Monthly average	6409	30	0.94	0.34	39803	12.97
	Daily Average	214	30	0.94	0.34	1327	12.97

Note: We collected the bill for FY' 2021-22 for the purpose of analysis as in earlier financial year the consumption was low due to COVID-19 and institution is in partial closed condition.

Table 6: Energy Bill of CUTM, Rayagada for FY' 2021-22

SUMMARY OF ENERGY BILL OF THE CUTM FOR FINANCIAL YEAR 2021-22																				
Month	Energy Consumed in kWh	Energy Consumed in kVAh	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)	Rebate	CSC	TOD Incentive	Overdrawl Penalty	Delay Payment Surcharge	Interest on Security	Meter Rent in Rs.	Electricity Duty	Current Monthly Bill in Rs.	Energy Charge in Rs./kWh	Unit cost in Rs. per kWh
Apr-21	9556	10619	0.32	0.90	40.00	44.444	61206.18	11111	0	727	250	0	0	585	0	150	4896	78199	9	8.2
May-21	3093	3299	0.10	0.94	41.67	44.444	19299.15	11111	0	308	250	0	0	696	971	150	1544	33050	11	10.7
Jul-21	3816	4082	0.27	0.93	18.70	20	23879.7	41200	0	662	250	176	0	0	0	1000	1896	68050	18	17.8
Aug-21	5532	5855	0.41	0.94	18.14	19.2	34195.18	41200	0	764	250	275	0	174	0	1000	2714	79257	15	14.3
Sep-21	7054	7364	0.33	0.96	29.89	31.2	43079.17	41200	0	852	250	317	0	541	0	1000	3421	89174	13	12.6
Oct-21	6416	6736	0.23	0.95	38.10	40	39402.91	41200	0	816	250	300	0	1542	0	1000	3128	86323	14	13.5
Nov-21	7280	7661	0.39	0.95	25.70	27.04	44813.4	41200	0	869	250	317	0	2665	0	1000	3560	93171	13	12.8
Dec-21	6040	6495	0.47	0.93	17.41	18.72	37991.07	41200	0	801	250	330	0	2726	0	1000	3013	85850	15	14.2
Jan-22	4392	4779	0.46	0.92	12.79	13.92	27952.7	41200	0	701	250	260	0	825	0	1000	2215	73182	17	16.7
Mar-22	10910	11320	0.39	0.96	37.78	39.2	66214.22	41200	0	1082	250	493	0	0	0	1000	5258	113429	11	10.4
Total / Av.	**64089**	**68209**	**0.34**	**0.94**	**28**	**30**	**398033.68**	**351822**	**0**	**7582**	**2500**	**2468**	**0**	**9754**	**971**	**8300**	**31645**	**799687**	13	12
Monthly Average	6409	6821	0.34	0.94	28	30	39803	35182	0	758	250	247	0	975	97	830	3165	79969	13	12
Daily Average	214	227	0.34	0.94	28	30	1327	1173	0	25	8	8	0	33	3	28	105	2666	13	12

From the Energy Bill of FY 2021-22 it is observed that Average Demand in this year is 28kW with an Average Power Factor of 0.94.

Figure 1: Trend of Energy Consumption of CUTM, Rayagada

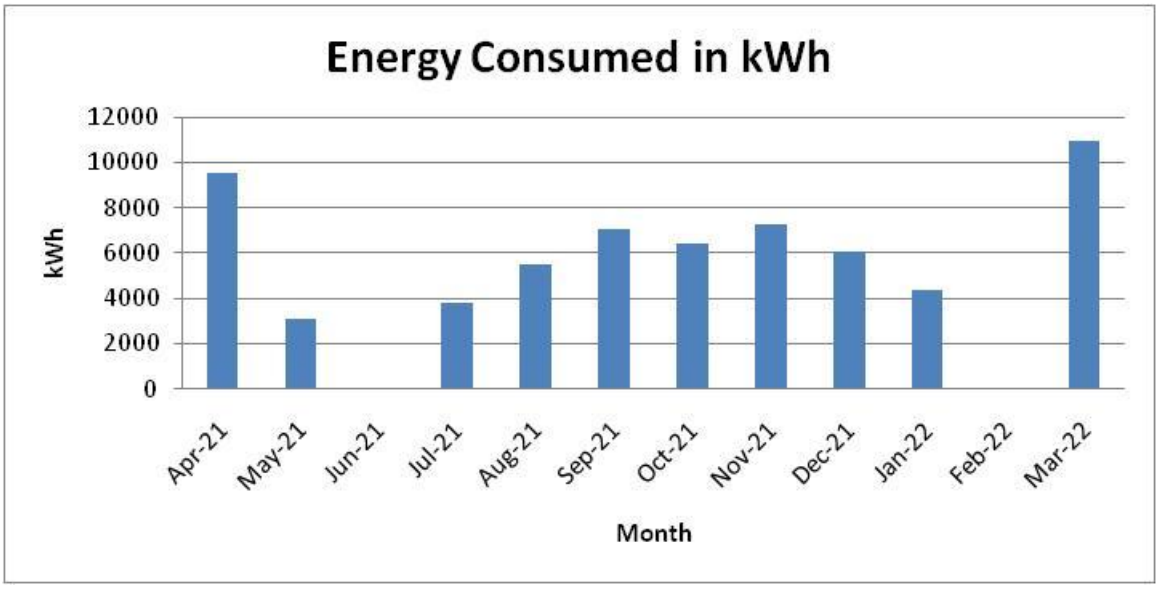
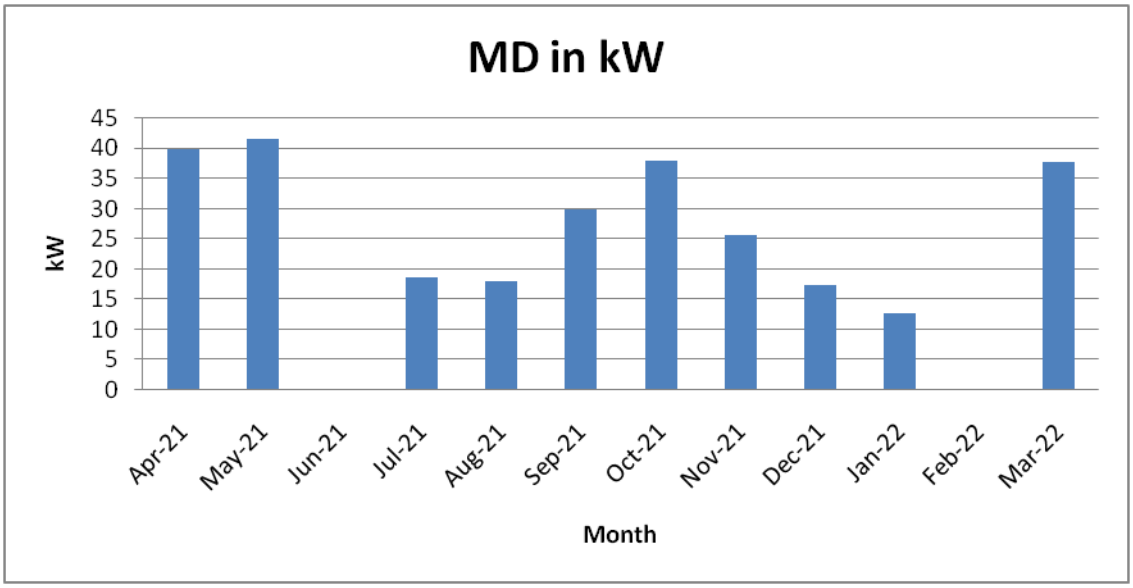


Figure 2: Trend of MD of CUTM, Rayagada



Energy Conservation Option:

Background:

Based on analysis of electricity bill it was observed that the power factor of CUTM, Rayagada is 0.94.So it is recommended to install capacitor bank to improve the power factor. In this project the annual energy saving will be 8539 kWh, investment required will be 0.2 lacs and annual financial savings will be 0.5 lacs with simple payback period around 4months.

Cost Benefit Analysis:

Table 7: Cost Benefit Analysis for Installation of Capacitor Bank to improve Power Factor

Cost Benefit Analysis for Installation of Capacitor Bank to improve Power Factor		
Particulars	**Unit**	**Value**
Average Power	kW	28.02
Present Power Factor		0.94
To be Power Factor		1
Phi-1	Degree	20.10
Phi-2	Degree	0.00
Required Capacitor Bank	kVAR	10.25
Capacitor Required	kVAR	10.00
Initial KVA	kVA	29.83
Final kVA	kVA	28.02
Run Hour / Day	HR/Day	13.00
Annual kVAh Saved	kVAh	8626
Annual kWh Saved Considering @ PF 0.99	kWh	8539
Annual Energy Saving	TOE	1
Annual Financial Savings due to Capacitor Bank	Lacs	0.5
Investment Required	Lacs	0.2
Simple Pay Back Period	Years	**0.4**

3.2 Base Line Energy Consumption and Specific Energy Consumption

During our audit it is seen that the load drawl pattern of CUTM, Rayagada is typical of a unit functioning in day time but the Hostel and Admin building, are functioning beyond office hours. At night time minimum illumination inside the building and full outside lighting with street-lights are maintained. The office working hours in CUTM, Rayagada is from 9 AM to 6PM normally for 300 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 49.85 kW in CUTM, Rayagada. It may be seen that the lighting load constitutes about 10 % of the total load, the Fan load constitutes about 30% of the total load, the other load constitutes about 9% of the total load and air conditioning loads share about 51% of the total connected load. The following table indicates the estimated connected load details.

Table 8: Connected load details & corresponding kW

Summary of Electrical Load	
Load Centre	**Killo Watt**
Lighting	4.927
Fan	14.76
AC	25.500
Other Load	4.665
Total	**49.852**

Figure 3: Pie Chart of Connected Load Details & Corresponding kW Consumption

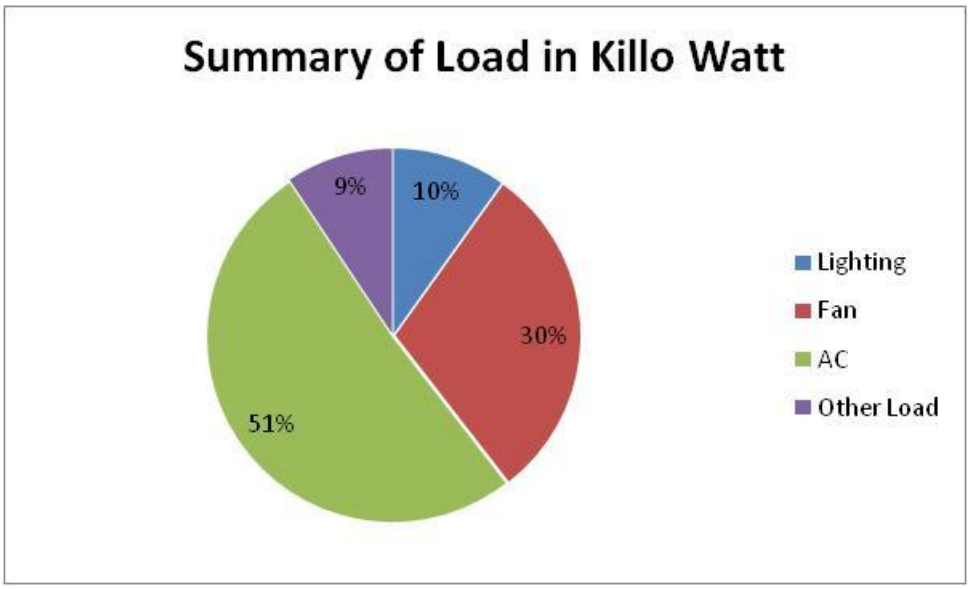


Table 9: Detail lighting inventory of all the units of CUTM, Rayagada

Lighting Inventory				
Area Name	**Types of Load**	**Wattage of each load in Watt**	**Nos. installed**	**Total connected Wattage in Watt**
Old Building Ground Floor	Led Tube Light	20	30	600
	Fluorescent Light	36	11	396
Old Building First Floor	Pendant Light	40	14	560
	LED Tube Light	16	14	224
	Fluorescent Light	43	1	43
Pharmacy Ground Floor	LED Bulb	9	42	378
Pharmacy First Floor	LED Bulb	9	30	270
Pharmacy Second Floor	LED Bulb	9	26	234
Kids(Boys Hostel-1)	Fluorescent Light	36	4	144
	LED Tube Light	20	17	340
Boys Hostel-2	LED Tube Light	20	32	640
Canteen	LED Tube Light	20	23	460
	LED Bulb	9	2	18
Seminar Hall	Ceiling Spot Light	9	20	180
	LED Spot Light	100	2	200
Street	Street Light	24	10	240
Total			**278**	**4927**

Table 10: Detail Inventory of ACs

AC Inventory					
Area Name	**Watt**	**Rated Tonnage**	**Number**	**Tonnage**	**Total load in kW**
Old Building Ground Floor	1500	1.5	9	13.50	13.50
Old Building 1st Floor	1500	1.5	1	1.50	1.50
Pharmacy Building Ground floor	1500	1.5	2	3.00	3.00
Pharmacy Building 1st Floor	1500	1.5	1	1.50	1.50
Seminar Hall	1500	1.5	4	6.00	6.00
Total			**17**	**25.50**	**25.50**

Table 11: Detail Inventory of All Types of Fan

Fan Inventory				
Area Name	**Types of Load**	**Wattage of each load in Watt**	**Nos. installed**	**Total connected Wattage in kW**
Old Building Ground Floor	Ceiling Fan	75	40	3
Old Building 1st Floor	Ceiling Fan	75	14	1.05
	Wall Fan	35	8	0.28
Pharmacy Ground floor	Ceiling Fan	75	29	2.175
Pharmacy 1st Floor	Ceiling Fan	75	24	1.8
Pharmacy 2nd Floor	Ceiling Fan	75	20	1.5
Kids hostel -1	Stand Fan	50	7	0.35
	Ceiling Fan	75	9	0.675
Boys hostel 02	Ceiling Fan	75	32	2.4
Canteen	Wall Fan	35	3	0.105
	Ceiling Fan	75	13	0.975
Street light around the campus	Ceiling Fan	75	6	0.45
Total			**90**	**14.76**

Table 12: Detail Inventory of other appliances

Other Inventory of CUTM RAYAGADA				
Building Name	**Equipment**	**Watt**	**Quantity**	**Total connected Wattage in kW**
Kids Hostel 01	CCTV	15	2	0.03
	Cooler	150	1	0.15
Canteen	CCTV	15	6	0.09
	Exhaust	35	1	0.035
	Vacuum Cleaner	100	1	0.1
	Potato Chopper	450	1	0.45
	Mixer Grinder	500	2	1
	Oven	2000	1	2
	Cooler	150	2	0.3
Seminar Hall	Projector	150	1	0.15
	Smart Screen	150	1	0.15
	CCTV	15	2	0.15
	Speaker Sound System	30	2	0.06
Total				**4.7**

3.3 Electrical Distribution System and Water Distribution System

The Power Supply system of CUTM, Rayagada was studied and based on the observations; the Single Line Diagram of Existing Electrical distribution system of CUTM is drawn and furnished below.

Figure 4: Electrical Distribution System

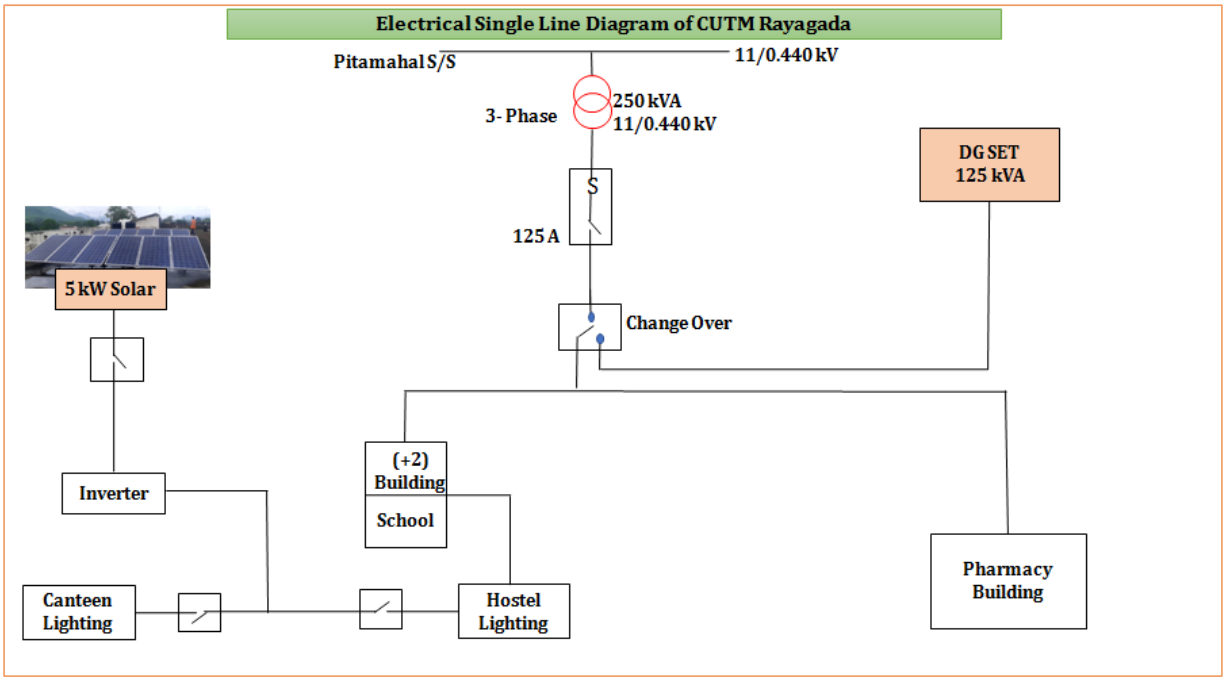
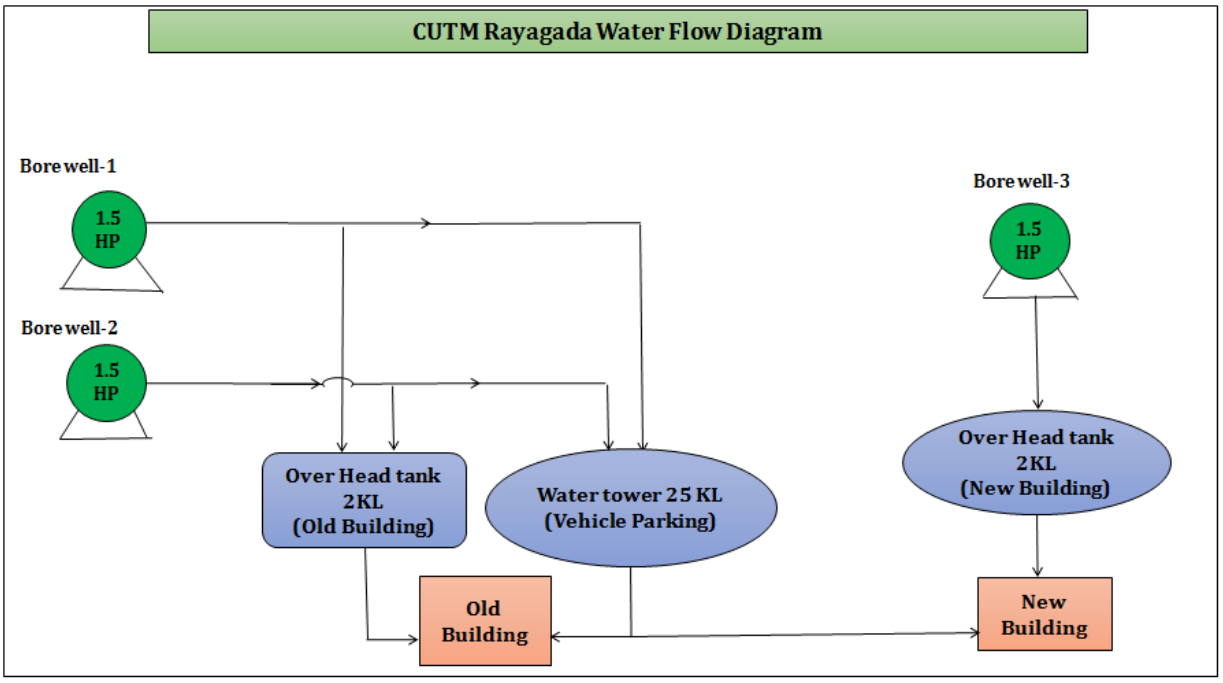


Figure 5: Water Distribution System



3.4 Transformer Details

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

Table 13: Technical Specification of Transformer

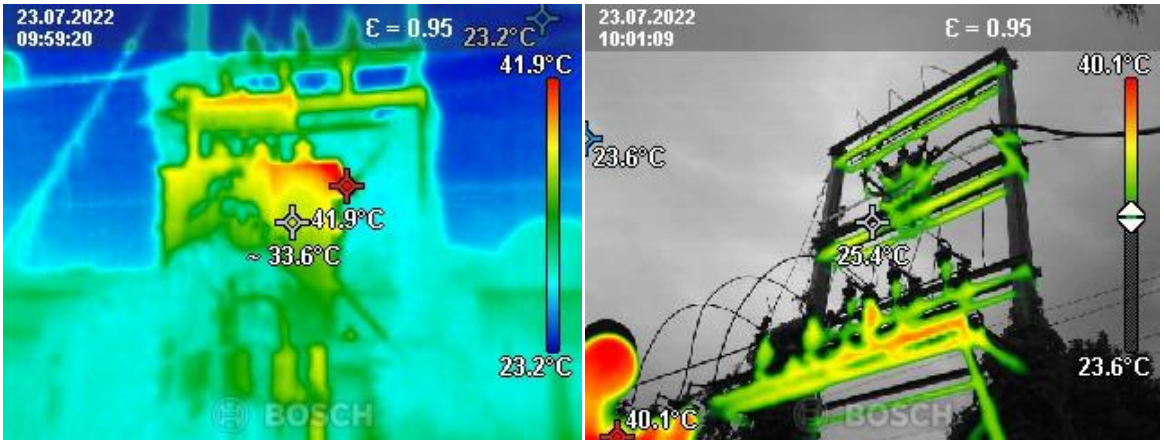
Technical data sheet of CUTM, Rayagada Transformers	
Particulars	**Main Transformer**
Make	M/s. Gram Tarang Employability Training Services Pvt. Ltd.
Transformer rated in kVA	250
Rated voltage ratio in kV	11/0.44
Rated current ratio in Amp	13.12/333.34
No. of phase	3.00
Vector diagram	Dyn-11
Type of cooling	ONAN

250kVA Transformer

***Note:** (The transformer area should be cleaned properly and also fencing is not done)

(Transformer Earthing Point)

***Note:** The transformer area earthing point is not clean. It should be maintained properly.



(Thermography photograph of Transformer)

The power measurement of the 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.

Table 14: Transformer Performance Assessment

Technical data sheet of CUTM, Rayagada Transformers	
Particulars	**TRF 250kVA**
Make	M/s. Gram Tarang Employability Training Services Pvt. Ltd.
Transformer rated in kVA	250
Rated voltage ratio in kV	11/0.440
Rated current ratio in Amp	13.12/333.34
No. of phase	3.00
Vector diagram	Dyn-11
Type of cooling	ONAN
Measured voltage at LT side in kV	0.41
Measured current LT Side in Amp	17.32
Measured Power Factor	0.93
No Load Loss (kW)	0.64
Full Load Loss of Transformer (kW)	4.45
Measured load (kVA)	12.34
% Loading on the Transformer (Measured kVA/ Rated kVA)	4.94
Actual Losses of Transformer (kW)	0.65
Total Actual Power Delivered by Transformer in kW	11.47
Transformer Efficiency, %	94.63
Transformer performance	Satisfactory

Table 14: Power Data

BUILDING POWER MEASUREMENT									
SL. No.	**Area**	**Incoming/ Outgoing**	**Phase**	**Voltage in (V)**	**Current in (A)**	**PF**	**kW**	**Unbalance Voltage (V) in %**	**Unbalance Current (I) in %**
1	Main Building	Outgoing	R	230.2	23.9	0.99	**18.37**	**0.07%**	**54.19%**
			Y	230.4	12.8	0.99			
			B	230.5	9.8	0.99			
2	School of Pharmacy	Outgoing	R	228.5	12.6	0.99	**6.23**	**0.07%**	**137.74%**
			Y	228.6	0	0.99			
			B	228.8	3.3	0.99			
3	Transformer	Outgoing	R	410.1	9.4	0.98	**29.87**	**0.62%**	**34.11%**
			Y	413.8	16.6	0.98			
			B	409.8	16.8	0.98			
4	DG Set	Outgoing	R	407.1	24.8	0.98	**52.93**	**0.60%**	**34.20%**
			Y	406.4	17.7	0.98			
			B	403.1	34.4	0.98			

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

3.5 Study of Voltage, Current, Power Factor Profile

Trend of Output voltage profile, Current profile, Output Power profile, Power Factor profile, Voltage Unbalance of Load Distribution is furnished below.

Table 15: Voltage Variation and %Unbalance of 250 kVA Transformer- CUTM, Rayagada

Voltage Variation and %Unbalance of 250 kVA Transformer- CUTM , Rayagada						
Date	Time	Frequency	Phase-1 RMS	Phase-2 RMS	Phase-3 RMS	Vunb
		Hz	V	V	V	%
7/23/2022	10:24:00 AM	50.03	410.1	413.8	409.8	0.006
7/23/2022	10:24:05 AM	50.03	410.4	413.5	410.3	0.005
7/23/2022	10:24:10 AM	50.03	410.7	413.7	410.6	0.005
7/23/2022	10:24:15 AM	50.02	410.7	413.5	410.4	0.005
7/23/2022	10:24:20 AM	50.03	410.7	413.6	410.6	0.005
7/23/2022	10:24:25 AM	50.03	410.7	413.3	410.7	0.004
7/23/2022	10:24:30 AM	50.03	410.6	413.3	410.5	0.004
7/23/2022	10:24:35 AM	50.03	410.7	413.4	410.6	0.004
7/23/2022	10:24:40 AM	50.02	410.6	413.1	410.9	0.004
7/23/2022	10:24:45 AM	50.02	410.8	413.2	411.1	0.004
7/23/2022	10:24:50 AM	50.02	410.6	413.2	411	0.004
7/23/2022	10:24:55 AM	50.01	410.4	412.9	410.7	0.004
7/23/2022	10:25:00 AM	50.01	410	412.6	410.1	0.004
7/23/2022	10:25:05 AM	50.01	409.9	412.6	409.9	0.004
7/23/2022	10:25:10 AM	50	409.5	412.5	409.6	0.005
Average Voltage & %Unbalance			**411.37**			**0.004**

Figure 6: Trend of Voltage Variation of 250 kVA Transformer- CUTM Rayagada

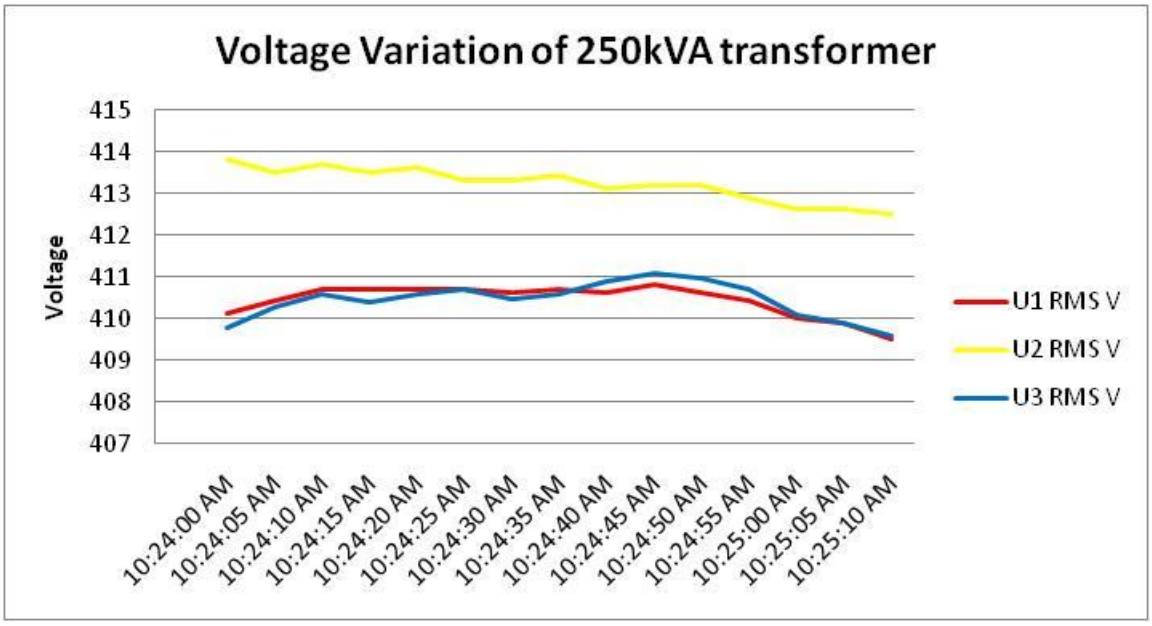


Table 16: Current Variation and %Unbalance of 250kVA Transformer- CUTM, Rayagada

Current Variation and %Unbalance of 250 kVA Transformer -CUTM Rayagada						
Date	**Time**	**Frequency**	**A1 RMS**	**A2 RMS**	**A3 RMS**	**Aunb**
		Hz	A	A	A	%
7/23/2022	10:24:00 AM	50.03	9.4	16.6	16.8	4.9
7/23/2022	10:24:05 AM	50.03	9.3	16.6	16.7	4.9
7/23/2022	10:24:10 AM	50.03	9.3	16.8	16.7	5.0
7/23/2022	10:24:15 AM	50.02	9.8	17.0	16.8	4.7
7/23/2022	10:24:20 AM	50.03	9.3	16.8	16.8	5.0
7/23/2022	10:24:25 AM	50.03	9.3	16.8	18	5.4
7/23/2022	10:24:30 AM	50.03	9.9	16.8	18.3	5.1
7/23/2022	10:24:35 AM	50.03	11.8	16.8	18.6	3.9
7/23/2022	10:24:40 AM	50.02	12.8	16.7	27.5	6.2
7/23/2022	10:24:45 AM	50.02	15.9	16.7	28.3	4.4
7/23/2022	10:24:50 AM	50.02	18.5	16.7	27.8	4.3
7/23/2022	10:24:55 AM	50.01	17.2	16.7	27.5	3.8
7/23/2022	10:25:00 AM	50.01	17.4	16.7	27.3	3.8
7/23/2022	10:25:05 AM	50.01	18.9	16.7	27.4	4.3
7/23/2022	10:25:10 AM	50	17.4	16.7	27.6	3.9
Average Current & %Unbalance			**17.72**			**4.6**

Figure 7: Trend of Current Variation and %Unbalance of 250 kVA Transformer-CUTM Rayagada

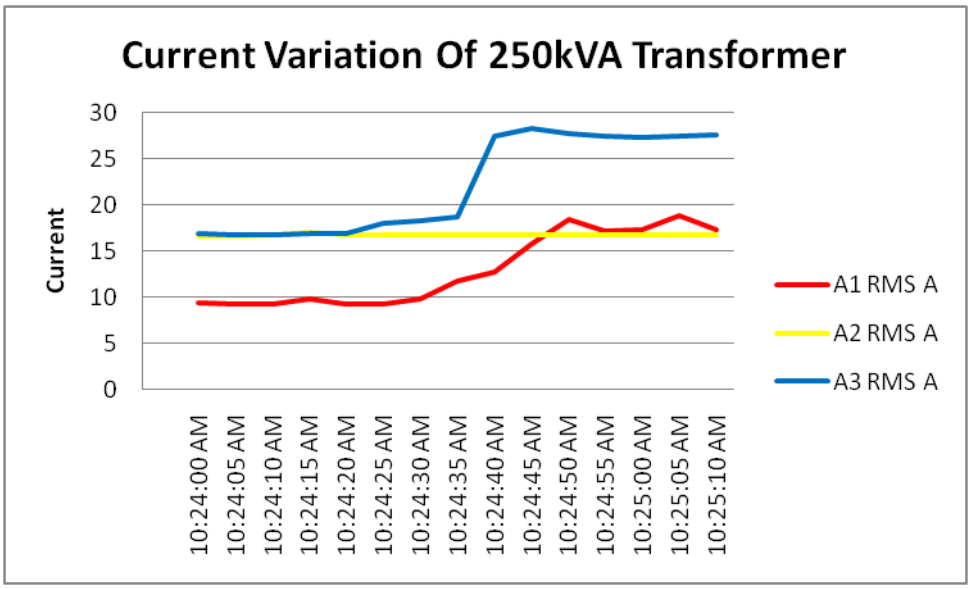


Table 17: Average Power Factor of 250 kVA Transformer –CUTM Rayagada

Average Power Factor of 250 kVA Transformer -CUTM Rayagada						
Date	**Time**	**Frequency**	**PF1**	**PF2**	**PF3**	**PF Mean**
		Hz	Ph-1	Ph-2	Ph-3	Avg.
7/23/2022	10:24:00 AM	50.03	0.96	0.96	0.83	0.917
7/23/2022	10:24:05 AM	50.03	0.96	0.96	0.83	0.916
7/23/2022	10:24:10 AM	50.03	0.96	0.96	0.83	0.914
7/23/2022	10:24:15 AM	50.02	0.95	0.96	0.83	0.914
7/23/2022	10:24:20 AM	50.03	0.95	0.96	0.82	0.913
7/23/2022	10:24:25 AM	50.03	0.95	0.96	0.83	0.915
7/23/2022	10:24:30 AM	50.03	0.95	0.96	0.82	0.911
7/23/2022	10:24:35 AM	50.03	0.97	0.96	0.82	0.917
7/23/2022	10:24:40 AM	50.02	0.98	0.97	0.9	0.949
7/23/2022	10:24:45 AM	50.02	0.96	0.97	0.92	0.95
7/23/2022	10:24:50 AM	50.02	0.99	0.97	0.92	0.957
7/23/2022	10:24:55 AM	50.01	0.99	0.97	0.91	0.955
7/23/2022	10:25:00 AM	50.01	0.98	0.97	0.91	0.953
7/23/2022	10:25:05 AM	50.01	0.98	0.97	0.91	0.953
7/23/2022	10:25:10 AM	50	0.98	0.97	0.91	0.953
Average Power Factor						**0.93**

Figure 8: Trend of Power Factor of 250kVA Transformer –CUTM Rayagada

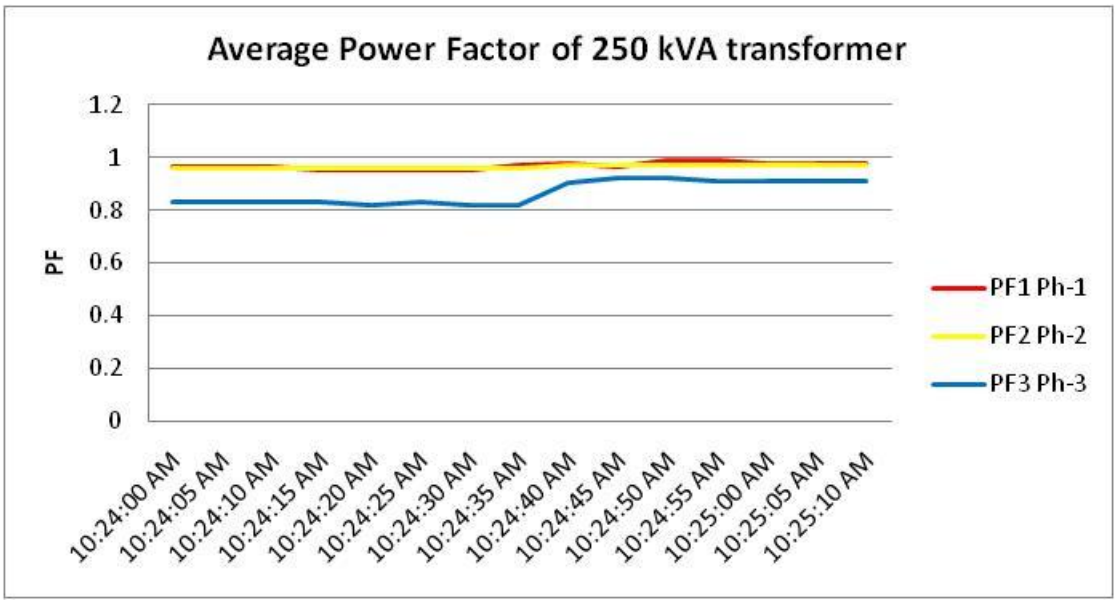
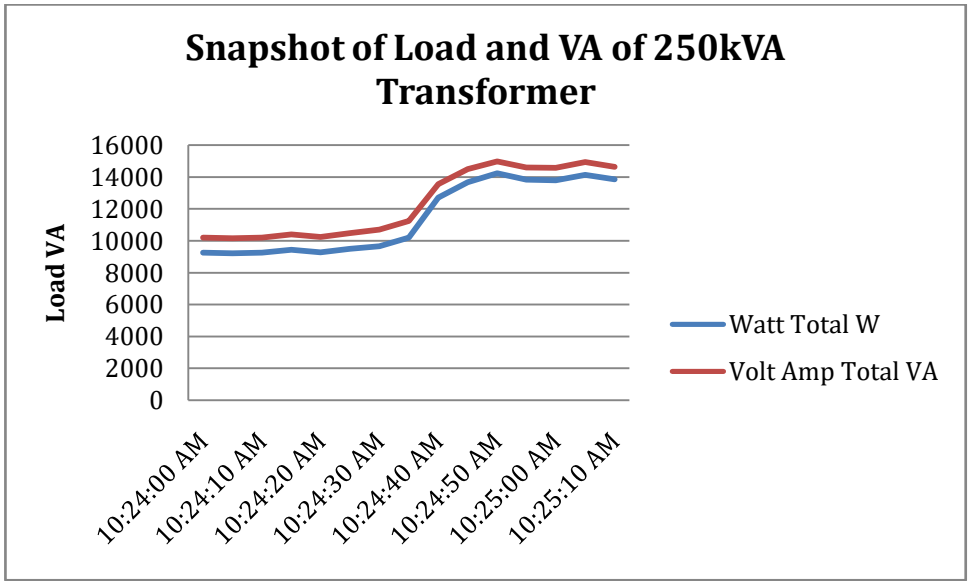


Table 18: Snapshot of Load in (W & VA) of 250 kVA Transformer-CUTM Rayagada

Snapshot of Load in (W & VA) of 250 kVA Transformer-CUTM Transformer				
Date	**Time**	**Frequency**	**Watt Total**	**Volt Amp Total**
		Hz	W	VA
7/23/2022	10:24:00 AM	50.03	9270.9	10186
7/23/2022	10:24:05 AM	50.03	9222	10155
7/23/2022	10:24:10 AM	50.03	9255.3	10198
7/23/2022	10:24:15 AM	50.02	9436.7	10395
7/23/2022	10:24:20 AM	50.03	9284.3	10236
7/23/2022	10:24:25 AM	50.03	9505	10483
7/23/2022	10:24:30 AM	50.03	9663.1	10700
7/23/2022	10:24:35 AM	50.03	10202	11234
7/23/2022	10:24:40 AM	50.02	12724	13552
7/23/2022	10:24:45 AM	50.02	13683	14506
7/23/2022	10:24:50 AM	50.02	14248	14981
7/23/2022	10:24:55 AM	50.01	13837	14595
7/23/2022	10:25:00 AM	50.01	13807	14578
7/23/2022	10:25:05 AM	50.01	14153	14944
7/23/2022	10:25:10 AM	50	13866	14649
Average			**11477**	**12359**

Figure 9: Trend of Load & VA of 250kVA Transformer-CUTM, Rayagada



4.0 LIGHTING SYSTEM

4.1 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, Rayagada 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 4.90kW. The summarized lighting installations are furnished below.

Table 19: Total individual lighting calculation of CUTM, Rayagada

Lighting Inventory				
Area Name	**Types of Load**	**Wattage of each load in Watt**	**Nos. installed**	**Total connected Wattage in Watt**
Old Building Ground Floor	LED Tube Light	20	30	600
	Fluorescent Light	36	11	396
Old Building First Floor	Pendant Light	40	14	560
	LED Tube Light	16	14	224
	Fluorescent Light	43	1	43
Pharmacy Ground Floor	LED Bulb	9	42	378
Pharmacy First Floor	LED Bulb	9	30	270
Pharmacy Second Floor	LED Bulb	9	26	234
Kids(Boys Hostel-1)	Fluorescent Light	36	4	144
	LED Tube Light	20	17	340
Boys Hostel-2	LED Tube Light	20	32	640
Canteen	LED Tube Light	20	23	460
	LED Bulb	9	2	18
Seminar Hall	Ceiling Spot Light	9	20	180
	LED Spot Light	100	2	200
Street	Street Light	24	10	240
Total			**278**	**4927**

Energy Conservation Option:

Background:

It is observed that there is a scope in energy conservation in lighting system by replacing 36W FL Tube Fittings with 20W LED Tube light. The annual energy saving will be 864 kWh and financial saving will be around Rs. 0.5 Lakh & investment required will be Rs.0.54 Lakh with simple payback period of 1.1 Year.

Table 20: Cost Benefit Analysis for Replacement of 36W FL Tube Fittings with 20 W LED Tube light

Cost Benefit Analysis for Replacement of 36W FL Tube Fittings with 20 W LED Tube		
Particulars	**Unit**	**Value**
Total no. of 36 W FL Tube Fittings	Nos.	15
Total no. of 20W LED Tube Fittings Required	Nos.	15
Present Lighting Load	kW	1
Future Lighting Load After Implementation	kW	0.30
Saving in Load	kW	0.240
Run Hour/day	hr	12
Annual Energy Saving	kWh	864
Annual Energy Saving	TOE	0.1
Annual Cost of Savings @ Rs. 5.85/unit	Rs.	5054
Investment Required	Rs.	5460
Simple Payback Period	Year	1.1

Background:

It is observed that there is a scope in energy conservation in lighting system by installation of Light pipe Fitting System in class room. By using light pipe system the annual energy saving will 29568 kWh and financial saving will be around Rs.1.73 Lakh & investment required will be Rs. 4.03 Lakh with simple payback period of 2 Years.

Table 21: Cost Benefit Analysis Replacement lighting Load in Class Room Light pipe Fitting System

Cost Benefit Analysis Replacement of lighting Load in Class Room Light pipe Fitting System at CUTM, Rayagada		
Particulars	Unit	Value
Nos. of Rooms	Nos.	14
Total Nos. of 20W Light Fittings in Class Room and Labs	Nos.	70
Operating Hour	Hours	8
Avoidance of expected Lighting Load per Annum	kW	11.2
Nos. of Light Pipe System to be Installed	No.	35
Nos. of Light Pipe System to be Installed in each room	Nos.	3
Annual Energy Saving @330 Days	kWh	29568
Annual Energy Saving	TOE	2.54
Annual Financial Saving	Rs. in Lakh	1.73
Investment Required	Rs. in Lakh	4.03
Simple Payback Period	Year	2

Background:

It is observed that there is a scope in energy conservation in lighting system by Installation of Light pipe Fitting System in Seminar Hall. By using light pipe system the annual energy saving will 3801 kWh and financial saving will be around Rs.0.22 Lakh & investment required will be Rs. 1.15 Lakh with simple payback period of 5.2 Years.

Table 22: Cost Benefit Analysis Replacement of lighting Load in Seminar Hall Light pipe Fitting System

Cost Benefit Analysis Replacement of lighting Load in Seminar Hall Light pipe Fitting System at CUTM, Rayagada		
Particulars	Unit	Value
Total Nos. of 9W Light Fittings in Seminar Hall	Nos.	20
Operating Hour	Hours	8
Avoidance of expected Lighting Load per Annum	kW	1.44
Nos. of Light Pipe System to be Installed	No.	10
Annual Energy Saving @330 Days	kWh	3801.6
Annual Energy Saving	TOE	0.33
Annual Financial Saving	Rs. in Lakh	0.22
Investment Required	Rs. in Lakh	1.15
Simple Payback Period	Year	5.2

Background:

It is observed that there is a scope in energy conservation in lighting system by replacement of 24W street lights with 50W LED solar lights with motion sensor technology. By using solar light with motion sensor the annual energy saving will be 1577 kWh and financial saving will be around Rs.9224 & investment required will be Rs. 0.55 Lakh with simple payback period of 6 Years.

Table 24: Cost Benefit Analysis for Replacement of 24W Street lights with 50W LED Solar Street Light with advance motion sensor facility

Cost Benefit Analysis for Replacement of 24W Street lights with 50W LED Solar Street Light with advance motion sensor facility		
Particulars	**Unit**	**Value**
Total no. of 24 W Street Lights	Nos.	10
Total no. of Solar Street Lights Required	Nos.	10
Present Lighting Load	kW	0.36
Future Lighting Load After Implementation	kW	0.00
Saving in Load	kW	0.360
Run Hour/day	hr	12
Annual Energy Saving	kWh	1577
Annual Energy Saving	TOE	0.14
Annual Cost of Savings @ Rs. 5.85/unit	Rs.	9224
Investment Required	Rs.	55330
Simple Payback Period	Year	6

Background:

There is a scope in energy conservation in lighting system by installing Light Motion Sensor at Rare Occupancy area which shall reduce lighting load. By using motion sensor, the annual energy saving will 285 kWh and financial saving will be around Rs. 1668 & investment required will be Rs. 4248 with simple payback period of 2.55 Years.

Table 25: Cost Benefit Analysis for Installation of Light Motion Sensor at Rare Occupancy area to reduce lighting load

Cost Benefit Analysis for Installation of Light Motion Sensor at Rare Occupancy area to reduce lighting load		
Particulars	**Unit**	**Value**
Total no. of existing 20 W LED fitting at Dining hall, Kitchen store	Nos.	21
Total no. of existing 9 W LED fitting at Skill Lab	Nos.	12
Present Lighting Load	kW	0.53
Future Lighting Load After installation motion sensor considering @15% saving	kW	0.4
Saving in Load	kW	0.1
Run Hour/day	hr	12
Annual Energy Saving	kWh	285
Annual Energy Saving	TOE	0.02
Annual Cost of Savings @ Rs. 5.85/unit	Rs.	1668
Investment Required	Rs.	4248
Simple Payback Period	Year	2.55

4.2 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 Timers are available 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.

4.3 Illumination Survey and LUX Level Measurement

The Illumination survey and Electrical Equipment Inventory List of the CUTM Building including Corridor were carried out by measuring the LUX of the different area, Lab, Office Room, Auditorium, Street Light and Class Room using LUX meter, by physical counting of inventory and the results are tabulated below.

Table 17: LUX Measurement

LUX Measurement		
Area	**Measured LUX**	**Recommended LUX**
Dining Hall	55	200-300-500
Staff Room	65	50-100-150
Class Room	50-55-60-70	200-300-500
Principal Office	65,70	50-100-150
AO Office	65,70	50-100-150
Computer LAB	65,70	200-300-500
Chemistry LAB	70,75	200-300-500
Skill LAB	70,75	200-300-500
Seminar Hall	75,80	200-300-500
Street Light	45	50-100-150

4.4 Energy Conservation Option

It was observed that LUX level of street lights at different location are between 5 to 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

The periodic checking of load unbalances should be carried out so as to limit the unbalance less than 10%.

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.

4.5 Electrical Load Distribution

In CUTM, Rayagada 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 26: Details of Total Connected Electrical Load

Summary of Electrical Load	
Load Centre	**Kilowatt**
Lighting	4.927
Fan	14.76
AC	25.500
Other Load	4.665
Total	**49.85**

4.6 UPS & Ventilation

At the time of audit period it is observed that there is no major 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 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 utilize the power. The inverter synchronizes 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

It is recommended that after installation of Roof Top at CUTM, Rayagada, the annual energy generation will be 63247 kWh, annual cost saving will be Rs. 4 Lakh. Around Rs. 19 Lakh of investments will be required and payback period shall be 5.1 years.

Table 27: Cost Benefit Analysis of Establishment of Solar Power Project in CUTM, Rayagada

Installation of Roof top Solar Power Plant		
Units Generation	**Unit**	**Value**
Total Annual Energy Consumed from TPCODL in FY 2021-22	kWh	64089
Average Base Demand from TPCODL	kW	7
Proposed capacity of the Solar Power Project to be installed	kW	38.506
Total Area Required	Sq. ft.	4620.69
Total Area Available	Sq. ft.	8751
Maximum Solar Project feasible	kW	73
Proposed capacity of the Solar Power Project to be installed	kW	38
Total Project Cost Required	Rs. Lakh	19
Capacity Utilization Factor	%	0.19
Net Annual Generation	kWh	63247
Annual Energy Saving	TOE	5.44
Weighted Average Rate of Electricity	Rs./kWh	5.85
Annual Saving in Energy Bills due to Consumption from own solar power	Rs. Lakh	4
Simple Payback Period	Years	5.1

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 38 kW Solar Project in CUTM, Rayagada.

5.0 HVAC System

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

There are around 17 numbers of air conditioning systems present in CUTM, Rayagada

It is estimated that there is about 25.50 kW of AC load in CUTM contributing to about 51% of the total connected load.

Installed Air conditioning System of CUTM are furnished below:

Table 28: Detail Inventory of ACs of CUTM, Rayagada

AC Inventory					
Area Name	**Watt**	**Rated Tonnage**	**Number**	**Tonnage**	**Total load in kW**
Old Building Ground Floor	1500	1.5	9	13.50	13.50
Old Building 1st Floor	1500	1.5	1	1.50	1.50
Pharmacy Building Ground floor	1500	1.5	2	3.00	3.00
Pharmacy Building 1st Floor	1500	1.5	1	1.50	1.50
Seminar Hall	1500	1.5	4	6.00	6.00
Total			**17**	**25.50**	25.50

5.1 Energy Conservation Option

Installation of AC Saver for old 1.5 ton AC

Recommendation:

It is recommended to install AC Saver for the existing 1.5 Ton ACs. After installation of AC Saver, the annual energy saving will be 16111kWh, annual cost saving will be Rs. 0.942 Lakh. Around Rs. 1.4 Lakh of investment will be required and payback period shall be 1.5 years.

Table 29: Cost Benefit Analysis of AC

Cost Benefit Analysis for Installation of AC Saver for Old 1.5 Ton AC		
Particular	**Unit**	**Value**
Present nos. of 1.5 Ton AC	Nos.	17
Total Capacity	TR	25.5
Av. Electrical Load of each existing AC before Replacement	kW	1.755
Total Av. Electrical Load before Replacement	kW	29.835
Annual Energy consumption before implementation	kWh	107406
Annual Energy consumption after implementation of AC Saver assuming @15% saving	kWh	91295
Annual Energy Saving due to Installation of AC Saver	kWh	16111
Annual Energy Saving	TOE	1.39
Annual Cost of Savings @ Rs.5.85/unit	Rs. Lakh	0.942
Investment required	Rs. Lakh	1.4
Simple payback period	Years	1.5

Based on future requirements, the old 1.5 Ton ACs should be replaced with EESL Super Efficient ACs.

Table 30: EESL-SEAC BOQ (Voltas)

EESL-SEAC BOQ (Voltas)		
Sl.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 No.s
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	mm	990x315x242

(WxHxD)			
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		Meter	3.0
Connecting Cable		Meter	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 Aluminum	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**

5.2 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 0.3 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.

5.3 Maintenance Tips for Split / Window AC

- Make sure 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 the home efficiently.
- Install a programmable thermostat, it will lead to 10-15% energy saving.
- Set the 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
- A good air filter will extend the life of the 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 air-conditioner to cool faster, not really, all it does, is make air-conditioner operate for longer. Moreover, it will result in unnecessarily chilly room and wasted power. Every degree lower on the temperature setting results in an extra 3-4% of power consumed. Hence, once a comfortable temperature found then 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 new unit is installed, 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 Fan Inventory

Table 31: Fan Inventory

Fan Inventory				
Area Name	**Types of Load**	**Wattage of each load in kW**	**Nos. installed**	**Total connected Wattage in kW**
Old Building Ground Floor	Ceiling Fan	75	40	3
Old Building 1st Floor	Ceiling Fan	75	14	1.05
	Wall Fan	35	8	0.28
Pharmacy Ground floor	Ceiling Fan	75	29	2.175
Pharmacy 1st Floor	Ceiling Fan	75	24	1.8
Pharmacy 2nd Floor	Ceiling Fan	75	20	1.5
Kids hostel -1	Stand Fan	50	7	0.35
	Ceiling Fan	75	9	0.675
Boys hostel 02	Ceiling Fan	75	32	2.4
Canteen	Wall Fan	35	3	0.105
	Ceiling Fan	75	13	0.975
Street light around the campus	Ceiling Fan	75	6	0.45
Total			**90**	**14.76**

6.1 Energy Conservation Option

It is observed that there is a scope in energy conservation in fan system by replacing Conventional Ceiling Fans with 26W Energy Super Efficient Fans. By using recommended fan the annual energy saving will be 12348 kWh and financial saving will be around Rs. 72236& investment required will be Rs. 2.54 Lakh with simple payback period of 3.5Years.

Table 32: Cost Benefit Analysis of Fan

Cost Benefit Analysis for replacing 75W Conventional Ceiling Fan with Super Energy Efficient Ceiling Fan		
Particulars	**Unit**	**Value**
Total No.of Fans Operating	Nos.	90
Present Load before Replacement @ 75W per Fan	kW	6.8
Load after Replacement @ 26 W Energy Efficient Super Fan	kW	2.3
Saving in Load	kW	4.4
Run hour /Day	hr	8.0
Annual Energy Saving Assuming 350 Days	kWh	12348.0
Annual Energy Saving	TOE	1.1
Annual Cost of Savings @ Rs. 5.85/unit	Rs.	72236
Total Investment Required	Rs.	254790
Simple Payback Period	Years	3.5

7.0 DIESEL GENERATING (DG) SET

7.1 Observation & Analysis for DG Set

There is one no. of DG sets of 125 kVA capacity installed in CUTM to meet the power requirement of the major areas of the building in case of power supply failure from TPSODL.

The technical specification of the DG Set is furnished below**:**

Table 33: Technical specification of the DG set

Technical Specification of DG	
Particulars	**DG Set 1**
Make	GENESIS
Capacity in kVA	125
Phase	3
Rated Voltage in Volt	440
Rated Current in Amp	173.91
Rated PF	0.8
Rated Speed in RPM	1500
Date of Mfg	19-08-2011
Rated Fuel Consumed in Liter/Hour	3

Diesel Consumption of 125 kVA DG Set for the last year is furnished bellow:

Table 34: Diesel Consumption of 125 kVA DG Set for FY 2021-22

Month	Diesel Consumption in KL
Apr-21	0.098
May-21	0.052
Jun-21	NA
Jul-21	NA
Aug-21	0.145
Sep-21	0.084
Oct-21	0.074
Nov-21	0.144
Dec-21	0.063
Jan-22	0.006
Feb-22	NA
Mar-22	0.105
Total	**0.771**

7.2 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 to 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.

8.0 TRANSPORTATION

It is observed that the University has 4 numbers of buses, 2 numbers of four-wheelers for transportation. The fuel consumption of the vehicles for the last year is mentioned bellow.

Table 35: Vehicle Fuel Detail of CUTM, Rayagada

Vehicle fuel Summary 21-22			
Month	**Monthly Fuel Expenses**	**Monthly Unit Price**	**Monthly Oil Consumption in Liters**
Apr-21	136496	88	1551.09
May-21	6382	87	73.36
Jun-21	64318	92	699.11
Jul-21	101577	96	1058.09
Aug-21	168811	97	1740.32
Sep-21	167165	96	1741.30
Oct-21	143613	98	1465.44
Nov-21	169271	107	1581.97
Dec-21	195529	91	2148.67
Jan-22	103042	91	1132.33
Feb-22	133227	91	1464.03
Mar-22	230348	91	2531.30
TOTAL			**17187.01**

Recommendation:

It is recommended that either replace the lower efficiency vehicles with Electric Vehicles or they may be operated for smaller distances.

9.0 WATER PUMPING SYSTEMS

9.1 Water Pumping Storage and Distribution System

CUTM meets its water requirement from Ground water through sump storage facility, the pump motors is having various connections like both single and 3-phase connection.

9.2 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 3 nos. of 1.5 HP bore well pumps,

9.3 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 of 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.

9.4 Rain Water Harvesting System

The rainwater harvesting system is one of the best methods practiced and followed to support the conservation of water. Today, scarcity of good quality water has become a significant cause of concern. It is recommended that RWH system may be installed for water conservation.

9.5 Sewage Treatment Plant

The campus has no sewage treatment plants for the primary Treatment and management of sewage generated in the campus including its hostel and residential area. It is recommended to install Sewage treatment plant so that treated water can be used for gardening purposes inside the campus. The use of treated water will reduce the ground water use and additionally the treated sludge will be very useful increasing the fertility of the soil.

9.6 Financial Benefit by Installation of Solar Water Heater

It is recommended to install Solar Water Heater for500 Liters of water. By installing Solar Water Heater, annual LPG saving @300days will be 630kg, annual cost saving will be Rs. 0.59 Lakh. Around Rs. 0.70 Lakh of investment will be required and payback period shall be 1.19 years.

Table 36: Cost Benefit Analysis by Installation of Solar Water Heater

Cost Benefit Analysis of Installation of Solar Water Heater at CUTM Canteen		
Particulars	**Unit**	**Value**
Hot Water for Canteen per Day by Solar Water Heater	Ltr	500
Consumption of LPG for heating Water	Kg	2.10
Annual LPG Consumption for heating water	Kg	630
Annual Thermal Energy Saving	kCal/kg	7247899
Annual Energy Saving	TOE	1
Annual expenditure due to LPG consumption for solar water heating @ 93.2/Kg	Rs.	58746
Installation Cost of 500 LPD Solar Water Heater	Rs.	70000
Annual financial saving due to reduction in LPG consumption	Rs. Lakh	0.59
Investment required	Rs. Lakh	0.70
Simple Payback Period	Year	1.19

9.7 Operation and Maintenance of CUTM

CUTM Electrical Maintenance team 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 4 nos. of Electricians working in CUTM. The work involves maintenance of lift, AC, motor, normal Fuse call Attending, Light replacement, Switching on/off of street light.

9.8 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 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

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, and Resource conservation may also be formed to review the related activities.

10.0 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
Split AC (1.5 Ton)	
Cooling Capacity (Watt)	5280
Max Power Consumption (Watt)	1310
Preferable BEE Star Rating	5
Energy Efficiency Ratio (EER)	5.41W/W
Preferable Compressor Type	Rotary/reciprocating
Preferable Refrigerant Gas	R-32

4. 50 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	50
Nos. of Tubes	8

5. 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 IN ROOM AIR CONDITIONERS

For Unitary Type Air Conditioner

(From 1st January, 2021 to 31st December, 2023)

Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star level	Minimum	Maximum
1 Star	2.7	2.89
2 Star	2.9	3.09
3 Star	3.1	3.29
4 Star	3.3	3.49
5 Star	3.5	

For Split Type Air Conditioner

(From 1st January, 2021 to 31st December, 2023)

Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star level	Minimum	Maximum
1 Star	3.3	3.49
2 Star	3.5	3.79
3 Star	3.8	4.39
4 Star	4.4	4.99
5 Star	5.0”;	

STAR RATING IN DISTRIBUTION TRANSFORMERS

Permissible Limit for Dry Type Transformers

Rating kVA	Max. Losses at 50% loading W*	Max. Losses at 100% loading W*	Max. Losses at 50% loading W*	Max. Losses at 100% loading W*
	Up to 22 kV class		33 kV class	
100	940	2400	1120	2400
160	1290	3300	1420	3300
200	1500	3800	1750	4000
250	1700	4320	1970	4600
315	2000	5040	2400	5400
400	2380	6040	2900	6800
500	2800	7250	3300	7800
630	3340	8820	3950	9200
800	3880	10240	4650	11400
1000	4500	12000	5300	12800
1250	5190	13870	6250	14500
1600	6320	16800	7500	18000
2000	7500	20000	8880	21400
2500	9250	24750	10750	26500

Permissible Limit for Oil Type Transformers

Rating (kVA)	Impedance (%)	Max. Total Loss (W)					
		BEE 1 Star		BEE 3 Star		BEE 5 Star	
		50 % Load	100% Load	50 % Load	100% Load	50 % Load	100% Load
16	4.5	135	440	108	364	87	301
25	4.5	190	635	158	541	128	448
63	4.5	340	1,140	270	956	219	791
100	4.5	475	1,650	392	1,365	317	1,130
160	4.5	670	1,950	513	1,547	416	1,281
200	4.5	780	2,300	603	1,911	488	1,582
250	4.5	980	2,930	864	2,488	761	2,113
315	4.5	1,025	3,100	890	2,440	772	1,920
400	4.5	1,225	3,450	1,080	3,214	951	2,994
500	4.5	1,510	4,300	1,354	3,909	1,215	3,554
630	4.5	1,860	5,300	1,637	4,438	1,441	3,717
1,000	5.0	2,790	7,700	2,460	6,364	2,170	5,259
1,250	5.0	3,300	9,200	3,142	7,670	2,991	6,394
1,600	6.25	4,200	11,800	3,753	10,821	3,353	9,924
2,000	6.25	5,050	15,000	4,543	13,254	4,088	11,711
2,500	6.25	6,150	18,500	5,660	16,554	5,209	14,813

STAR RATING IN PUMP SETS

Star Rating	Performance Factor of the Pump Set
1 Star	≥1.00 & <1.10
2 Star	≥1.10 & <1.20
3 Star	≥1.20 & <1.30
4 Star	≥1.30 & <1.40
5 Star	≥1.40

11.0 MOU Format with EESL

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU"), effective from _____ is to confirm discussions between Energy Efficiency Services Ltd (EESL), a company organized under the laws of India; with its corporate office at 5th & 6th Floor, Core-3, SCOPE Complex, 7-Lodhi Road, New Delhi-110003 and Centurion University of Technology & Management (CUTM) Pitamahal, Rayagada, Odisha 765002.

Article 1: Purpose and Scope

This MOU confirms the preliminary discussions between CUTM and EESL regarding their intention to enter into transactions or services pertaining to implementation of energy efficiency measures at premises of CUTM.

A. Diagnostic Studies & Pilot Projects

1) Energy audits for entire campus to identify avenues for energy saving in electrical and thermal utilities
2) Water audits to identify areas/means to reduce specific water consumption
3) Lubricant and diesel Conservation Studies
4) Pilot studies on Cross-Cutting technologies

B. Implementation of Energy Efficiency Projects through innovative financial models

1) Installation/distribution of LED Lights and Energy Efficient appliances (Fans and / or Air Conditioners) across the facilities of CUTM.
2) Installation of energy efficient motors (IE3 type) in place of conventional motors
3) Installation of Smart Meters
4) Installation of Solar PV Power Projects

C. Capacity Building & Training

1) Technical training to campus executives on various topics pertaining to Energy Management, Maintenance Management, Water Management and Safety Engineering
2) Organizing suitable study tours and Guest Lectures on suitable topics
3) Creating cadre of energy professionals i.e. certified energy managers and auditors
4) Facilitating in Certification and Recognition: National Energy Conservation Award, Green Building etc.

EESL in consultation with CUTM shall execute the implementation of Energy Efficiency projects on ESCO Model (Energy Servicing Company). Under this activity, CUTM would provide the inventory list of their facilities / buildings and EESL would submit the Business and Financial proposal based on deemed savings principle leading to signing of Contract Agreements (s).

The activities are advisory services which EESL will provide with consultancy charges after mutual agreement between the Parties. EESL will submit proposals or annual work plans depending upon the requirement from CUTM.

Article 2: Non-Binding MOU for Future Cooperation

This MOU describes the general conditions and arrangements for further discussions between the parties and is non-obligatory. The exact terms and conditions of this future cooperation will be negotiated in due course and delineated in one or more separate and definitive agreements in the future, should circumstances warrant. Neither party shall be liable to the other for any claim, loss, cost, liability or investment opportunities arising out of directly or indirectly related to the other Party's decision to terminate this MOU, the other Party's performance under this MOU, or any other decision with respect to proceeding or not proceeding with the definitive agreement(s) or the Project(s). Further, each party acknowledges and agrees that the decision to enter into definitive agreement is the sole and absolute discretion of the other party.

Article 3: General Terms and Conditions

A) Term: This MOU shall remain in full force and effect for a period of thirty-six (36) months from the effective date, unless it is: (i) superseded by any or all of the definitive documents contemplated in Article 2 (or such other definitive documents as the parties may agree to enter into for their mutual benefit), or (ii) earlier terminated for convenience by the parties in writing by giving 30 (thirty) calendar days' notice.

B) Modification; Waiver; Severability; Assignment: No waiver of any right or remedy on one occasion by either party shall be deemed a waiver of such right or remedy on any other occasion, if any provision of this MOU is held invalid under any applicable law, such holding shall not affect the validity of remaining provisions and same shall continue in full force and effect. Neither party may assign this MOU, in whole or in part, without the prior written consent of both the non-assigning party.

C) Headings: Headings used in this MOU are for reference purposes only and shall not be used to modify the meaning of the terms and conditions of this MOU.

D) Entire Agreement: This MOU represents the entire understanding and MOU between the parties with respect to the subject matter hereof, and supersedes all prior and contemporaneous communications, representations or agreements, oral or written, regarding the subject matter hereof.

E) Counterparts: This MOU may be executed in two or more counterparts, each of which shall be deemed an original but all of which shall constitute the same MOU. This MOU and any document or schedule required hereby may be executed by facsimile signature that shall be considered legally binding for all purposes.

F) Confidentiality: In recognition of the confidential nature of this MOU and information developed or received hereunder Receiving Party shall not disclose or convey without the prior written consent of Disclosing Party any such technical information received from Disclosing Party or developed under this Agreement to any other party for the duration of the project and for a minimum period of ten (10) years from the date of project completion, termination or short closure. Receiving Party shall establish adequate procedures to prevent such transmittal of such technical information by its current employees.

The undertakings in Articles F shall not apply to the following:

i. Information which is necessarily disclosed to third parties to enable the performance of work to be carried out in connection with this MOU, provided that the third party receiving the information enters into an agreement to keep the information confidential in accordance with this Article F;
ii. Information which is ordered to be disclosed by a court of competent jurisdiction;
iii. Information which is already in the public domain (except because of any breach of this undertaking);
iv. Information which the party receiving the information can demonstrate from written records was already known to it at the time of receipt of such information from the party disclosing the information.

AGREED AND ACCEPTED:

Centurion University of Technology & Management, Rayagada

Energy Efficiency Services Limited

Name:
Designation:
Address:

Name:
Designation:
Address:
5th & 6th Floor, Core-3
SCOPE Complex, 7-Lodhi Road
New Delhi-110003

WITNESS

12.0 ENERGY MANAGEMENT POLICY

Energy management policy provides the foundation for setting performance goals and integrating energy management into an organization's culture. It is a well-known fact that a formal written energy policy acts both as: A public expression of an organization's commitment to energy management and working document to guide energy management practices and provides continuity.

It is the organization's best interest that support for energy management is expressed in a formal written declaration of commitment accompanied by a set of stated objectives, an action plan for achieving them and clear specifications of responsibilities.

The format of energy policy statement is various, but it usually includes the goal or objective of the organization and the more concrete targets in the field of Energy Management (or Energy Conservation). It often shows the major measures and time tables. The statement shall match the organization's mission statement or overall management strategy plan.

The guiding principle of the proposed energy conservation policy should include

- To endeavor for reduction in Specific Consumption of Energy is all forms and in all areas of operations.
- To ensure availability of information and necessary resources for achieving objectives and targets.
- To comply with all applicable legal, regulatory and other requirements related to energy use, consumption and efficiency.
- To espouse Energy Efficient Technology encompassing procurement of Energy Efficient Products and services and design for Energy Performance Improvement.
- To carry out Energy Audits and Energy Reviews at planned intervals to improve Energy performance.

Actual drafting / reviewing of energy policy will depend upon an organizations corporate culture and management style. We feel that the policy will get wider acceptance if all the concerned parties have been given the opportunity to contribute to the proposed amendment. All departmental representatives should be invited to make submission when the policy is reviewed. After the policy is reviewed, it should be approved by the Board and it should be formally adopted. Further it is recommended to form a energy conservation cell in CUTM in which faculty members from electrical department, utility managers, finance manager and senior management representative to be there. They should organize regular monthly meeting and awareness program in the campus. They should also explore possibilities for implementation of energy efficiency and renewable energy project.

Annexure:

1. **Format of Energy Bill:**

SUMMARY OF ENERGY BILL OF ----- FOR FINANCIAL YEAR -----																			
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)	Rebate	CSC	TOD Incentive	Overdrawl Penalty	Delay Payment Surcharge	Interest on Security	Meter Rent in Rs.	Electricity Duty	Current Monthly Bill in Rs.	Energy Charge in Rs./kWh	Unit cost in Rs. per kWh
Apr																			
May																			
Jun																			
Jul																			
Aug																			
Sep																			
Oct																			
Nov																			
Dec																			
Jan																			
Feb																			
Mar																			
Total / Av.																			
Monthly Average																			
Daily Average																			

2. **Technical Specification of DG Set & Energy Data Sheet of DG:**

Energy Data Sheet of -----kVA DG Set for FY -----			
Month	**Diesel Consumption in kL**	**Total Energy Generated in DG Set in kWh**	**SEC in Liter/kWh**
Apr			
May			
Jun			
Jul			
Aug			
Sep			
Oct			
Nov			
Dec			
Jan			
Feb			
Mar			
Total			

3. **Technical data sheet of ----- Transformers & Transformer Performance Assessment:**

Technical data sheet of ------ Transformers	
Particulars	**TRF no.----**
Make	
Transformer rated in kVA	
Rated voltage ratio in kV	
Rated current ratio in Amp	
No. of phase	
Vector diagram	
Type of cooling	
Measured voltage at LT side in kV	
Measured current LT Side in Amp	
Measured Power Factor	

Transformer Performance Assessment	
Details	**TRF no.----**
Transformer Rating in KVA	
Measured voltage at LT side in kV	
Measured current in LT Side Amp	
No Load Loss (kW)	
Full Load Loss of Transformer (kW)	
Measured load (kVA)	
% Loading on the Transformer (Measured kVA/ Rated kVA)	
Actual Losses of Transformer (kW)	
Operating Power Factor	

Total Actual Power Delivered by Transformer in kW	
Transformer Efficiency, %	
Transformer performance	

4. **LUX Measurement**

LUX Measurement		
Area	**Measured LUX**	**Recommended LUX**

5. Energy Management Training Program Log Sheet

Energy Management Training Program of CUTM, Paralakhemundi															
Sl. No.	Energy Committee Members	Designation	Ph. No.	April	May	June	July	August	September	October	November	December	January	February	March

13.0 Vender Details of Projects

Vender details for CUTM						
Sl. No.	**Vendor Name**	**Service**	**Address**	**Phone Number**	**Email**	**Website**
1	Star Enterprises	Solar Water Heater	205A, Snehalata Apartment, Vivekananda Marg, Bhubaneswar-751002	9040310328/ 7008527362	starenterprisesbbsr@gmail.com	
2	Lavancha Renewable Energy Pvt.	Solar Water Heater	Ltd. Regus CBD, Level 9, East Wing, Raheja Towers, MG Road, Bengaluru – 560 001	99006 66885 / 7348907677	niranjan.patil@lavancha.in / info@lavancha.in	https://www.lavancha.in/
3	Sky shade Daylights Pvt Ltd	Light Pipe system	#401, Jyothi Flora, Plot no. 240, B-Block, Kavuri hills, Madhapur, Hyderabad-500081	91-40 4020 4022/33	marketing@skyshade.in	www.skyshade.in
4	Tanstate Global	Light Pipe system	Regulus, S No 1/10/2, B 801, Balewadi Near PMC School Pune 411045	7219700559	tanstateglobal@gmail.com / tsg@tanstateglobal.com	http://www.tanstateglobal.com
5	KRISHNA ENGINEERS & CONSULTANTS	Biogas Plant	Plot No: 4723, Laxmi Vihar, Lane-3, Sainik School, Bhubaneswar, Odisha, India-751005	09114160231, 09437256123	krishnaenergy@gmail.com / krishnaenergy2@gmail.com	www.krishnaenergy.com
6	Energy Efficiency Services Limited	AC Replacement	Ground Floor, House No. 409/B, Sahid Nagar, Bhubaneswar, Dist. Khordha Odisha – 751007.	9861486746	info@power-tech.group	

7	Energy Efficiency Services Limited	28W Super Energy Efficient Ceiling Fan	Ground Floor, House No. 409/B, Sahid Nagar, Bhubaneswar, Dist. Khordha Odisha – 751007.	9861486746	info@power-tech.group	
8	Solar Sack (A unit of Nemhans Solution Pvt. Ltd)	Solar Rooftop Project	N4/234,IRC Village, Nayapalli,Bhubaneswar	9238412384	quotation@solarsack.in	
9	UNIFY SOLAR	Solar Rooftop Project	DELHI	9212560106, 9667966755	unifysolar@gmail.com	http://www.unifysolar.in