REPORT ON ENERGY AUDIT FOR ELECTRICAL INSTALLATIONS OF

Madhya Pradesh Bhoj (Open) University

Raja Bhoj Marg, Kolar Road, Bhopal (MP)

Registrar MP Bhoj (Open) University Bhopal Work Order No.: 7827, Dtd. 23.12.2022

AUDIT FIRM
OM ENERGY AUDITORS & ADVISORS
(Bhopal)

AMIT GUPTA
BE (Electrical), MBA (Personnel Administration), PGDBM (Energy Management), FIE, FIV
Certified Energy Auditor
Chartered Engineer (Electrical), Approved Valuer (Electrical, Plant & Machinery)

21 Mar 2023

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TABLE OF CONTENTS

WORK ORDER

मध्यप्रदेश भोज (मुक्त) विश्वविद्यालय
राजा भोज मार्ग (कोलार रोड) भोपाल–462016 (म.प्र.)
Madhya Pradesh Bhoj (Open) University
Raja Bhoj Marg (Kolar Road) Bhopal - 462016 India

क्रं./7827/ या.शा./मप्रभोमुविवि/2022 भोपाल, दिनांक 23/12/22

प्रति,

मेसर्स ओम एनर्जी आडिटर्स एंड एड्वाईजर्स
पर्णकुटी, ई-4/207, अरेरा कालोनी,
भोपाल- 462016

विषय:-मध्यप्रदेश भोज (मुक्त) विश्वविद्यालय मे एनर्जी आडिट करने बाबत।
संदर्भ:- आपका प्रस्ताव दिनाँक 13.12.2022

उपरोक्त विषयांतर्गत लेख है कि मध्यप्रदेश भोज (मुक्त) विश्वविद्यालय मे एनर्जी आडिट करने हेतु आपके द्वारा प्रस्तुत प्रस्ताव को विश्वविद्यालय ने स्वीकृत करते हुए आपकी फर्म का चयन किया है। नवीन एव नवकरणीय ऊर्जा विभाग, मंत्रालय म. प्र. शासन के द्वारा जारी पत्र क्रमांक 633/2010/60 भोपाल, दिनांक 02.12.2010 के अनुसार एनर्जी आडिट हेतु निर्धारित शुल्क संस्था के एक वर्ष के कुल विद्युत देयक राशि का 1% राशि देय होगा। ऊर्जा विभाग के उक्तानुसार निर्धारण के आधार पर भोज विश्वविद्यालय के एक वर्ष (12 माह) के कुल देयको के योग का 1% राशि रुपये 26583 + 18% जी एस. टी. के आंकलन अनुसार आपको विश्वविद्यालय की एनर्जी आडिट करने हेतु आदेशित किया जाता है एव यह भी लेख है कि एनर्जी आडिट की कुल फीस का 5% राशि म. प्र. ऊर्जा विकास निगम, भोपाल मे जमा कर देयक के साथ रसीद लगाकर प्रस्तुत करने पर भुगतान किया जायेगा।

आदेशानुसार

कुलसचिव

क्रं./ / या.शा./मप्रभोमुविवि/2022 भोपाल, दिनांक

प्रतिलिपि:-

1. माननीय कुलपति जी के निज सचिव की ओर सूचनार्थ।
2. वित्त नियंत्रक, मध्यप्रदेश भोज (मुक्त) विश्वविद्यालय, भोपाल
3. सहायक संचालक, आवासीय संपरीक्षा, मप्रभोमुविवि।

कुलसचिव

दूरभाष : +91 0755–2492093 (कार्यालय), फैक्स : 0755–2490072
ई–मेल : registraroffice.mpbou@gmail.com वेबसाइट : www.bhojvirtualuniversity.com

CERTIFICATE BY ENERGY AUDITOR

This is to certify that, for the execution of, Work Order No. 7827, **Dtd. 23.12.2022,** issued by Registrar, MP Bhoj (Open) University, Bhopal -

- The data collection has been carried out diligently and truthfully; the data used in the report are provided wholly by the authorized officials of Bhoj (Open) University, Bhopal.
- All measuring devices are in good working condition and have been calibrated or certified by approved agencies authorized and no tempering of such devices has 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.

Bhopal / Dtd 20.03.2023

Amit Gupta

Certified Energy Auditor

EA - 9472

AMIT GUPTA
Certified Energy Auditor
Regn. No. EA-9472

COMPLETTION CERTIFICATE

It is certified that the –

- Energy Audit of 'all electrical installations' of MP Bhoj (Open) University, Raja Bhoj Marg, Kolar Road Bhopal has been completed during 06 Jan to 17 Mar 2023 against our Work Order No. **7827, Dtd. 23.12.2022**.

- We acknowledge the facts given above and we are satisfied with the contents of the report.

- We have received two hard copies of the Energy Audit Report for further action.

- Name of the Energy Auditing firm: M/s OM Energy Auditors & Advisors, Bhopal
- Name of the Certified Energy Auditor (CEA): Mr. AMIT GUPTA

- **Signature of CEA:**
- **Registration Number of CEA: EA - 9472**

AMIT GUPTA
Certified Energy Auditor
Regn. No. EA-9472

- Name of the coordinating Executive: Er Rajesh Kumar, University Engineer, BOU, Bhopal

Dr Anil Kumar Sharma

Registrar

Madhya Pradesh Bhoj (Open) University

Kolar Road, Bhopal, MP

Bhopal / Dtd 21.03.2023

ACKNOWLEDGEMENT

We acknowledge with a sense of gratitude, the confidence reposed on us by **Prof. Dr Sanjay Tiwari**, **The Vice Chancellor**, Madhya Pradesh Bhoj (Open) University, Bhopal, MP, by awarding the work of conducting the Energy Audit of electrical installations of MP Bhoj (Open) University (BOU) premises at Raja Bhoj Marg, Kolar Road Bhopal.

As an Energy Audit firm and being Energy professionals, we appreciate the initiatives already taken by Bhoj (Open) University, Bhopal in the direction of Energy saving and Conservation.

We are thankful to the **Nodal Officer, MP Urja Vikas Nigam (MPUVN),** Bhopal, who has advised **Registrar, Bhoj (Open) University** to get Energy Audit conducted through one of the MPUVN empaneled Energy Auditing firms and forwarded her the list of empaneled firms. We, OM Energy Auditors & Advisors, are empaneled Energy Auditing firm with MPUVN, Bhopal for last 10 years.

We are especially thankful to **Er Rajesh Kumar, University Engineer, BOU** for his continuous cooperation and hand holding during the Energy Audit work. He has made all arrangements for premises inspection and made available all the possible documents to us.

We are also thankful to **Sh Sanjiv Singh, Electrician, BOU**, who accompanied Energy Audit team and showed all locations and facilitate for onsite measurements of electrical parameters.

At last, we are thankful to all the officials of Bhoj (Open) University who directly or indirectly helped in completing this assignment.

Rati Gupta

Partner

OM Energy Auditors & Advisors

Bhopal

Bhopal / Dtd 20.03.2023

ENERGY AUDITORS & ADVISORS BHOPAL

EXECUTIVE SUMMARY

i. Madhya Pradesh Bhoj (Open) University:

Madhya Pradesh Bhoj (Open) University, hereafter referred as BOU, is one of the prestigious Open University and Institution of Central India, at Raja Bhoj Marg, Kolar Road Bhopal, MP. It was established in the year 2008. The BOU, which is an institute of Distance Learning, has Graduation, Post-Graduation and Diploma Programs on following areas, with the duration of 6 months to 6 years, depending on the type of course.

The website 'mpbou.edu.in' of MP Bhoj Open University is not secure.

ii. Energy Audit:

The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect.

The basic philosophy of Energy Auditing is:

"Do not Estimate, when you can Calculate

Do not Calculate, when you can Measure"

iii. Work Order:

The Work Order for conduct of Energy Audit of 'all electrical installations' of Madhya Pradesh Bhoj (Open) University, Bhopal, MP, was placed on to our firm M/s OM Energy Auditors & Advisors, Bhopal by The Registrar BOU Order No. 7827, Dtd. 23.12.2022, for Rs. 26,583/- + GST @ 18%.

iv. Audit Team:

The audit team visited the premises during 06 Jan to 16 Jan 2023 for data collection and field inspection and measurements and further on 17 Mar for data verification.

Er Rajesh Kumar, University Engineer and Engineering In/Charge, is designated as single point of contact for arranging data and inhouse staff for field inspection with the auditing team.

v. Estimated Electrical Connected Load:

The premises is spread up in the area of around 50 acres.

The audit team has visited every room, library, offices, library, corridors of the building and counted the electrical load. The electrical load counting of residential blocks and bungalows is not done from inside field visit.

The Total estimated connected electrical load of the premises is 1,182 KW. The Load Centre-wise details are as below:

Total Estimated Connected Load of the premises	
Load Centre	**Total Load (Kw)**
Administrative Building	200
EMPRC Block	10
D Type Bunglows	40
E & F Type Flats	528
G & H Type Quarters	315
Guest House	53
Material Store	5
Miscellaneous Load	31
TOTAL	**1,182**

vi. Electric Power Supply:

The Electric Power to the BOU premises is catered by Madhya Pradesh Madhya Kshetra Vidyut Vitaran Co Ltd (MP MK VV CL) through one High Tension (HT) connection of 200 KVA Contract Demand, served on 11 KV. The name of the 11 KV Feeder is Yashoda Feeder. The premises comes under City Division West of City Circle Bhopal.

From Metering DP, 11 KV Feeder on pole is run in the campus, feeding to the two 11 / 0.4 KV, 315 KVA Transformers for the Distribution of Electric Power. The transformers are installed around 400 m apart catering to separate areas of the premises.

Transformer 1 caters to Administrative Building, EMPRC Block, Guest House, Registrar Bungalow, and Pump House.

Transformer 2 caters to Officers Residential Flats, VC Bungalow, Employees residential quarters Material Store and Street Lights. There is an ATM of SBI, which is also fed through this transformer.

Automatic LT Capacitor Banks of 150 KVAr are installed at the substation of both the Transformers.

vii. DG Sets:

As Back up supply, there are two DG Sets of 100 KVA and 82.5 KVA in the premises. The 82.5KVA DG set is not in operation and is lying unconnected.

viii. Solar Power:

There are Solar Panels of 100 Kw installed in the premises. These are 300 Panels of 320 W Pmax, installed by MP Urja Vikas Nigam Ltd under 'Grid Connected Roof Top Solar Project'. The solar panels were commissioned on 15.09.2018. The project cost was Rs.58,27,605/-

ix. Water:

Water is another secondary source which is being used for drinking, and horticulture purpose.

There are 2 No. Tube wells for catering to drinking and residential use of water. The water from these tube wells is pumped in to a Sump Well, in front of Pump House. The capacity of sump well is 1.5 Lakh

Lt. From this sump well, the water is pumped to different water storage tanks installed at the roof top of all the buildings like administrative building, Guest House, Quarters, Bungalows, Blocks etc.

x. Fire Fighting:

There are adequate arrangements of fire fighting with hand operated fire extinguishers. 6 No. 4.5 Kg CO2 type fire extinguishers are for electric substation and electric panel rooms and DG Room. Around 39 No. 5 Kg ABC Powder type fire extinguishers are for other areas of administrative building, Guest House, EMPRC Block and Material store.

xi. Electricity Bill Analysis:

The Electricity Bill details of last one year have been tabulated in a specific format, for analysis. The period of consideration is from Dec 2021 to Nov 2022.

Month	Units Consumed (KWh)	Solar Units Export	Net Units Billed	Maximum Demand	Billing Demand	Load Factor	Power Factor	Current Electricity Bill	Electricity Rate
	Total	KwH	KWh	KVA	KVA	%	%	Rs	Rs / KWh
Dec-21	19,916	1,484	18,432	98.52	180	14	72.84	2,58,257	14.01
Jan-22	26,267	839	25,428	91.56	180	17	97.87	2,18,381	8.59
Feb-22	18,561	2,607	15,954	89.76	180	11	96.22	2,14,524	13.45
Mar-22	12,576	4,859	7,717	51.72	180	6	95.37	2,09,334	27.13
Apr-22	22,148	2,438	19,710	89.40	180	13	98.20	2,16,369	10.98
May-22	26,525	1,133	25,392	95.52	180	17	98.86	2,60,457	10.26
Jun-22	26,129	1,091	25,038	101.64	180	16	99.14	2,56,686	10.25
Jul-22	19,353	1,283	18,070	75.24	180	12	96.72	2,09,096	11.57
Aug-22	14,700	1,800	12,900	48.12	180	9	93.96	1,70,066	13.18
Sep-22	14,669	2,748	11,921	46.20	180	8	94.49	2,11,702	17.76
Oct-22	13,334	4,991	8,343	53.64	180	6	86.80	2,23,122	26.74
Nov-22	12,302	4,713	7,589	61.32	180	5	82.03	2,24,215	29.54
Total Annual	**2,26,480**	**29,986**	**1,96,494**					**26,72,209**	
Monthly Average	**18,873**	**2,499**	**16,375**	**75.22**	**180**	**11**	**92.71**	**2,22,684**	**16.12**

- The average annual expenditure on electricity bills is Rs. 26.72 Lakh (~ monthly expenditure Rs. 2.23 Lakh)
- Annual consumption is 2.26 Lakh units ~ monthly consumption of 18,873 Units.
- Annual Generation of Electricity from 100 Kw Solar Plant is 29,986 Units which is equivalent to 2,499 Units per Month ~ 83 Units per Day against industry best practice norms of 500 Units per day
- The average cost of electricity is Rs. 16.12 Unit. (On Net Energy Units Billed)
- The average Power Factor of the premises is 92.71%. This is appreciable.
- The Load Factor of the premises is just 11% against the total estimated connected load of 1,176 KW.

xii. Break up of Electricity Bill Analysis:

Month	Net Units Billed	Maximum Demand	Billing Demand	Power Factor	Power Factor Surcharge	ToD Rebate	Electricity Duty	Surcharge on Arrears	Current Electricity Bill
	KWh	KVA	KVA	%	Rs	Rs	Rs	Rs	Rs
Dec-21	18,432	98.52	180	72.84	39,448	-11,278	20,404	3,113	2,58,257
Jan-22	25,428	91.56	180	97.87	-5,737	-13,205	28,683		2,18,381
Feb-22	15,954	89.76	180	96.22	-2,399	-11,745	17,996	2,695	2,14,524
Mar-22	7,717	51.72	180	95.37	-580	-6,190	8,705		2,09,334
Apr-22	19,710	89.40	180	98.20	-7,452	-8,540	22,356		2,16,369
May-22	25,392	95.52	180	98.86	-9,662	-9,570	28,985		2,60,457
Jun-22	25,038	101.64	180	99.14	-13,338	-8,757	28,581		2,56,686
Jul-22	18,070	75.24	180	96.72	-2,765	-6,770	20,735		2,09,096
Aug-22	12,900	48.12	180	93.96		-5,732	14,803		1,70,066
Sep-22	11,921	46.20	180	94.49		-5,584	13,679		2,11,702
Oct-22	8,343	53.64	180	86.80	1,940	-3,528	9,699		2,23,122
Nov-22	7,589	61.32	180	82.03	6,470	-6,023	8,822		2,24,215
Total Annual	**1,96,494**				**5,925**	**-96,922**	**2,23,448**	**5,808**	**26,72,209**
Monthly Average	**16,375**	**75.22**	**180**	**92.71**	**494**	**-8,077**	**18,621**	**484**	**2,22,684**

- The 'Time Of the Day' (ToD) Rebate is Rs 96,922/- which is equivalent to Rs 18,621/- per month. This is appreciable.

- The Electricity Duty of Rs 2,23,448/- has been paid to State Govt during the year. This amount is 8.36% of the Electricity Bill.

xiii. Observations and Findings:

From Energy Audit point of view, there are no major concerns because there are no heavy electrical loads / machineries installed in the premises. The premises is operating on very low average annual Load Factor of 11%. The Billing Demand is just 75 KVA against Contract Demand of 200 KVA.

However, there are some points / areas of concern, which are mentioned as below:

- The Contract Demand of premises with the Discom is 200 KVA. This is high in comparison to the average Monthly demand, which is for the period from Dec 2021 to Nov 2022 is just 75.22 KVA against the minimum Billing Demand of 180 KVA. And the consumer is paying excessively on account of Fixed Charges associated with the Contract and Billing Demand.

- There is one DG set of 82.5 lying un functional since years. This is wastage of an asset.

- The regular annual visit of Engineer from Electrical Inspectorate, GoMP is not made in last few years. And the Electricity Duty on Units generated by DG sets are not paid to State Govt. This may attract penalty from MP Electrical Inspectorate in monetary terms as well the seize of DG sets.

- The premises has 100 KW Solar Plant operating, which indicates the University concern for Green Energy and reduction in Carbon Foot prints. This is appreciable. But the operation of Solar Plant at very low efficiency is a serious concern.

  Annual Generation of Electricity from 100 Kw Solar Plant is 29,986 Units which is equivalent to 2,499 Units per Month ~ 83 Units per Day.

  Considering that the Units generated from solar plant is of the order of 4 Units per day per Kw, it can be concluded that the Solar Plant is underutilised or is operating at very low efficiency. This is considered as wastage of an asset and mis-utilisation of government fund.

- The Main Panel Box of Transformer - 2 has burnt out Cables at its Distribution Box. It should be immediately get maintained and replaced as per requirement. It may cause Power Outage at any time. Since there is very less load on transformer, it seems that burning of cables may be due to lose connection or unbalancing of the load.

xiv. Recommendations:

After a careful analysis of the primary and secondary data collected and the information received, several energy saving measures have been identified which can help bring down the energy consumption.

The recommendations have been grouped under the following heads:

- No Cost / Immediate Measures
- Low Cost / Immediate Measures
- Low Cost / Short Term Measures
- Medium Cost / Medium Term Measures
- High Cost / Medium Term Measures
- High Cost / Long Term
- Measures which are explored but not recommended due to being non-viable and having very high pay back periods
- Other Measures

Some of the major recommendations are mentioned as below:

- The Contract Demand of the connection (with MP MK VV CL) be reduced to 80 KVA only from 200 KVA.
- It is recommended to engage an 'A' Class Electrical Contractor and get Substation Single Line Diagram (SLD) and LT Distribution SLD prepared, and Electrical Safety Charts installed in DG and Control Room.
  On behalf of BOU, this contractor would then apply for permission of DG sets installation and operation from MP Electrical Inspectorate, Govt of MP.
- Proper Log of units generated by DG set should be maintained in a register /log book. A similar log of diesel consumption should also be maintained on month-to month basis.
- Monthly deposition of Electrical Duty on Units generated by DG sets should be ensured.
- It is recommended that the Solar Panels be cleaned every day by the maintenance agency. This would result in to the most optimal utilisation of Solar Plant. The scope of work would mainly cover the daily log of Units generated, daily cleaning of Solar Panels with water and duster and replacement of worn out or damaged solar panels.
- Transformer DP and Distribution Box should be maintained by an authorised person or competent agency on regular basis.
- Electrical Load Balancing should be regularly checked and rectified on periodical basis (say, monthly) in the LT Distribution Panels.
- For increasing the reliability of Power Supply, there should be interconnection arrangement at LT level between the two Distribution Transformers, to increase the reliability of Power supply.
- Replacement of old window ACs by 5 Star rated Inverter technology Split ACs

- Submeters may be installed for every building, Load Centre, Guest Houses, Residential complex in bulk etc., to keep account for section-wise energy consumption. It will help in increasing awareness towards Energy Efficiency and energy conservation.
- Rain Water Harvesting should be done wherever possible and feasible.
- Energy Audit study should be conducted once in three years by BEE Certified and MPUVN empanelled Energy Auditors
- Solar Energy Audit should be conducted at definite periodicity from a competent agency.

xv. Abstract of Savings and Payback for Capital Intensive works:

S. No.	Recommendation	Qty	Expenditure (Rs)	Annual Energy Savings (KWh)	Annual Monetary Savings (Rs)	Pa Back Period (Years / Months)
i	Reduction of Contract demand from 200 KVA to 80 KVA	1			4,85,000	
ii	Up Keep of Solar Plant	1	1,20,000	1,14,000	18,37,460	1 Month
iii	Replacement of FTL by LED	200	90,000	5,300	85,423	1 Year
iv	Replacement of 200-Watt Sodium Lamp of Street Light by 120-watt LED	40	52,000	11,520	1,85,700	3 Months
v	Replacement of old coolers by energy efficient	50	2,50,000	11,520	1,85,700	1 Year 4 Months
vi	Replacement of Window AC by 5 Star Inverter technology Split AC	20	7,80,000	15,840	2,55,341	3 Years
vii	Replacement of old lifts by VFD	2	38,00,000	3,700	59,600	Very High **Not Recommended**
	Total Annual (Excluding VFD)		**12,92,000**	**1,58,180**	**30,34,624**	**5 Months**

xvi. Abstract of Budgetary provisions for all the recommendations:

S. No.	Particular	Qty	Estimated Unit Rate Including labour (Rs)	Amount (Rs)	Periodicity
1	Upkeep of Substation and its Equipment (Breather, Silica gel, Lightning arrestors, Earth Pit framing, gitti laying etc	2	50,000	1,00,000	One Time and then on need base

S. No.	Particular	Qty	Estimated Unit Rate including labour (Rs)	Amount (Rs)	Periodicity
2	Transformer Oil filtration and top up	2	50,000	1,00,000	
3	Safety equipment at SS Panel, and LT Main Panels, Safety Charts, SLD etc	LS		20,000	One Time
4	Watering arrangement for SS Earthing		Inhouse		Fortnightly
5	Separate earth pits for each building / block, and main Electric panels (where ever required)	5	15,000	75,000	One Time
6	Running of Earth wire at all the switch Boards and earth strip from earth pits	LS		30,000	One Time
7	Energy Efficiency and Electrical safety awareness Posters	20	500	10,000	One Time
8	Replacement of FTL by LED Lights	200	450	90,000	One Time Pay Back
9	Replacement of Sodium Vapour Lamps by 120 Watt LED	40	1,300	52,000	One Time
10	Replacement of old air coolers by new energy efficient	50	5,000	2,50,000	One Time
11	Replacement of old window ACs by new energy efficient 5 star rated inverter technology split ACs	20	41,000	7,80,000	One Time
12	Replacement of Old lift by VFD lifts	2	19,00,000	38,00,000	Not recommended
13	Interconnection Provision between two Transformers	LS		6,50,000	One Time
14	Miscellaneous	LS		1,00,000	Annual
	Total Capital Expenditure Excluding VFD Lifts			**21,57,000**	

- Total Investment (Mostly one Time) = Rs 21,57,000/-
- Total Annual saving = Rs 30,34,600/-
- Pay Back Period = 8 Months

The rates in the above table are estimated as per the present market rates. However, the exact budgetary provision to be made as per the actual market rate at the time of execution of works.

All the works shall be executed by respective authorised agency like 'A' Class electrical Contractor, 'B' Class electrical contractor under the supervision of skilled Electrical Engineer and licensed electrician.

xvii. Funding:

There are no major or Capital-intensive works proposed in the Report. There are some mid cost proposals of replacement of Tube Lights and Sodium Vapour Lamps, old Coolers and old window ACs, the funds for which may be easily met out from the savings proposed in the Report.

The cost for the interconnection arrangement between the two transformers is an investment required for enhancing the Power Supply reliability in the campus and to increase the utilisation of Power assets.

The cost for the maintenance of substation, transformer and the Electric panels are routine maintenance costs and may be met out from the savings proposed in the Report.

1. Introduction

1.1 Madhya Pradesh Bhoj (Open) University, Bhopal:

Madhya Pradesh Bhoj (Open) University, hereafter referred as BOU, is one of the prestigious Open University and Institution of Central India, at Raja Bhoj Marg, Kolar Road Bhopal, MP. It was established in the year 2008.

The National Policy of Education (NPE) 1986, emphasized that distance education is an important medium for the development and promotion of higher education. In this context, for the expansion and promotion of distance education the Central Advisory Board of Education (CABE), Government of India took an important decision that in the VIII year plan every state should establish a state open university following the distance education pattern. On this basis Madhya Pradesh Bhoj (Open) University (MPBOU) was established under an Act of State Assembly in 1991 with the following **objectives: -**

- To Extend and Expand Higher Education by reaching the un-reached through various flexible means suited to the open and distance education mode using emerging information and communication technology.
- To promote national integration and the integrated development of human personality for the well-being of the community.
- To determine/maintain standards and promote Distance Education.

1.2 Energy Audit:

The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect.

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

An Energy Audit is a study of a plant or facility to determine how and where energy is used and to identify methods for energy savings.

Energy Auditing can help in understanding more about the ways in which energy is used in any organisation and help in identifying the areas where wastefulness of resources can occur and the scope for consequent improvement. Such an audit programme will help to keep focus on variations which occur in the energy costs, identify energy conservation technologies, retrofit for energy conservation equipment etc.

The basic philosophy of Energy Auditing is:

"Do not Estimate, when you can Calculate

Do not Calculate, when you can Measure"

1.3 WORK ORDER:

The Work Order for conduct of Energy Audit of 'all electrical installations' of Madhya Pradesh Bhoj (Open) University, Bhopal, MP, was placed on to our firm M/s OM Energy Auditors & Advisors, Bhopal by The Registrar BOU Order No. 7827, Dtd. 23.12.2022, for Rs. 26,583/- + GST @ 18%.

1.4 CONDUCT OF ENERGY AUDIT:

The audit team visited the premises during 06 Jan to 16 Jan 2023 for data collection and field inspection and measurements and further on 17 Mar for data verification. Interviews and discussions with the concerned officials of BOU were also made, to understand the Energy Systems and the initiatives taken in the past for Energy Efficiency and Conservation.

After presentation of Draft Report, a discussion was held with The Vice Chancellor and the University Engineer. The VC suggested some valuable modifications in the structure of the Report and to include in the Report the values of certain field measurements. The same was compiled to and the Final Report is prepared.

The timelines of the work were distributed among different major activities as below:

S. No.	Activity	Scheduled Time Period (Days)
i	Site visit and System Study	1
ii	Data collection and load counting	1
iii	Field Measurement	3
iv	Data analysis	2
v	Preparation of Draft Report	3
vi	Discussion on Draft Report	1
	Submission of Final report	1

1.5 DETAILS OF ENERGY AUDITING FIRM AND TEAM:

'M/s OM Energy Auditors & Advisors' Bhopal is an Energy Auditing and Management Consultancy firm established in Feb 2012. The firm is empaneled in MP Urja Vikas Nigam, Bhopal, MP Consultancy Ltd., Bhopal, Petroleum Conservation & Research Association (PCRA), Mumbai and with various organisation.

Sh. Amit Gupta (BE, MBA, PGDBM), the team leader is a partner in this firm and is Bureau of Energy Efficiency (BEE) Certified Energy Auditor. He is also a Chartered Engineer (Electrical) and Approved Valuer for Electrical Plant & Machinery. He has worked as Executive Engineer, MP State Electricity Board (MP Madhya Kshetra Vidyut Vitaran Co. Ltd. Bhopal) and after serving there for 21 years, made

early separation with the Board in the year 2012. He has international experience of more than 3 decades in Energy sector especially in Power Distribution and Energy Auditing.

His Mobile No. is 9425015715 and e-mail id is amitgupta_65@yahoo.co.in

The names of the other professionals who took active part in this work are as below:

Mrs. Rati Gupta: She is the other partner of the auditing firm. Academically she is Master of Philosophy (MPhil) in English Linguistics and Masters from Arts (MA) background. She contributed to overall management of assignment and report printing of the report.

Mr. Divyam Sharan Gupta: He is MBA-Tech (Computer Science & Operations) and is responsible for Data Analysis.

Mr. Gagan Sharma: He is a Civil Engineering and a Solar Energy Expert. He is responsible for all field measurements and supervising the Audit team on field.

Mr. Abrar Khan: He is pursuing graduation in Mechanical Engineering and is responsible for all field measurements.

Mr. Anwar Khan: He is very experienced electrician, with over 35 years of industrial and commercial experience. He contributed for Data Collection, load counting and for taking field measurements.

All the team members have adequate field experience and requisite academic qualifications.

1.6 NAME OF CONTACT PERSON FROM CLIENT SIDE (BOU):

Er Rajesh Kumar, **University Engineer** and Engineering In/Charge, is designated as single point of contact for arranging data and inhouse staff for field inspection with the auditing team. His contact number is 9893304356.

Er Rajesh deputed **Sh. Sanjiv Singh, Electrician** BOU for coordinating with Audit Team on field and for facilitating all measurements of electrical parameters and load counting. The Cell of Sh Singh is 9098222811. All the institution staff have extended their full support in the best possible way for successful completion of this assignment.

1.7 LIST OF ENERGY AUDITING INSTRUMENTS:

Following energy auditing equipment were used for this assignment:

S. N.	Instrument	Rating / Capacity	Make
1	Power Analyser	15 V to 750 V, 40 A to 1000 A, 0.6 to 750 KW / KVA / KVAr, 0.3 to 1 pf, 0 to 90 Deg., Phase Angle, 1 to 9999 KWh	EN 61010-1
2	Digital Clamp-On Power Meter	0 to 750 V, 0 to 1000 V DC, 0 to 1000 A, 200 KOhm	RE 266
3	Lux Meter LX-101	0 to 2 Lakh Lux	Escorp / 204 TES 1332A 100402735
4	Infrared Remote Thermometer	-20 DC to 500 DC Class II Laser	Centre 350 Series
5	Digital thermometer		Escorp / Metrix 900 xL 003460786

2. Premises

The BOU, which is an institute of Distance Learning, has Graduation, Post-Graduation and Diploma Programs on following areas, with the duration of 6 months to 6 years, depending on the type of course:

- Management & Commerce
- Information Technology & Computer Science
- Basic Science
- Health Science
- Humanities & Social Sciences
- Need based Programs
- Education

The website 'mpbou.edu.in' of MP Bhoj Open University is not secure.

2.1 Premises Landscape:

The premises is spread up in the area of around 50 acres.

In the premises of BOU, besides university buildings, there are 2 Bunglows (D Type) each for Vice Chancellor and Registrar, One Guest House (with 9 rooms), 4 No. Residential Blocks (Each block having 5 No. E Type and 6 No. F Type quarters), and residential blocks for employees having 45 No. G & H type quarters.

The premises has administrative building, Electronic Media Production Research Centre (EMPRC Block) and a Material store building. In the administrative buildings are Class rooms, library and offices of VC, Registrar and other Departments.

There is a SBI ATM in the premises, fed through the same power supply of BOU. There is no sub meter installed for this ATM.

Though as per Electricity Supply Act the Electric Power from grid cannot be sold to third party. However, as learnt from BOU authorities, University is not charging any Electricity charges from SBI. SBI is also not making any commercial transactions from this unit but the ATM is just for the facilities of university staff and students.

2.2 Uses of Energy in the Premises:

The electricity is used in the University premises for the following purposes:

- For Light & Fan of administrative building, which houses offices, class rooms, library etc, and the cooling / heating inside the University building.

- Computers, Printers, Photocopy machines and other similar office equipment.
- Water coolers
- Water Pumps
- Boundary / Street Lights (for night lighting)
- Guest House and Residential Purpose
- Gardening & Horticulture

2.3 ELECTRICAL CONNECTED LOAD OF THE PREMISES:

The audit team has visited every room, library, offices, library, corridors of the building and counted the electrical load. The electrical load counting of residential blocks and bungalows is not done from inside field visit.

The main electrical load of the premises is, Light and Fan Loads which includes Tube Lights, CFLs, LEDs, Fans, Exhaust fans, Computers, printers etc. These buildings have low electrical load equipment and are in bulk and some of the rooms are found locked during inspection. The focus of load counting is on high consumption electrical loads and the quantity mentioned may vary with-in permissible limit. The slight variation in the quantity would in no way going to impact the result of the audit.

The equipment-wise electrical load of the University campus integrated from different sections of the premises, as per Field inspection is tabulated as below:

The Total estimated connected electrical load of the premises is 1,182 KW. The Load Centre-wise details are as below:

Total Estimated Connected Load of the premises	
Load Centre	**Total Load (Kw)**
Administrative Building	200
EMPRC Block	10
D Type Bunglows	40
E & F Type Flats	528
G & H Type Quarters	315
Guest House	53
Material Store	5
Miscellaneous Load	31
TOTAL	**1,182**

2.4 ELECTRICAL CONNECTED LOAD – BUILDING-WISE:

The estimated connected load details of individual buildings are as below:

2.4.1 Administrative Building

This is the main building of the premises and houses all the Class rooms, Library and Offices. It has 3 floors – G +2. Each floor has 3 wings – A, B & C.

It gets power supply from Transformer 1 and from DG Set. There are 7 DBs on each floor; 2 for A wings, 3 for B wings and 2 for C wings. From here the power is distributed to respective Switch Boards / Sections. Power and Lighting DBs are separate. Lighting DB is catered through DG set as backup supply. The DBs at Ground Floor have separate earthing pits and the earth wire runs from this GF DB for First and Second floor respective DBs.

It has two lifts. During audit, one of the lifts is not operating.

Administrative Building			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Air Conditioner 1.5 T	30	2.20	66.00
Air Cooler	15	0.30	4.50
Water Cooler	3	0.75	2.25
Photocopy Machine	7	1.50	10.50
Room Heater / Convector	35	2.00	70.00
Lifts	2	5.50	11.00
Miscellaneous Load (Light, Fan and Computers etc)	LS	LS	35.75
Total Load			**200**

2.4.2 EMPRC Block

EMPRC Block			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Air Conditioner 1.5 T	2	2.20	4.40
Projector	1	1.50	1.50
Miscellaneous Load (Light, Fan and Computers etc)	LS	LS	4.10
Total		**KW**	**10.00**

2.4.3 D Type Bunglows

D Type Bunglows			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Air Conditioner 1.5 T	3	2.20	6.60
Fridge	1	0.50	0.50
Geyser	2	2.00	4.00
Coolers	3	0.30	0.90
Kitchen Equipment	LS	LS	4.00
Miscellaneous Load (Light, Fan, TV and Computers etc)	LS	LS	4.00
Total		**KW**	**20.00**
Total for 2 Bunglows	**2**	**20.00**	**40.00**

2.4.4 E & F Type Flats – 4 Blocks, 11 Flats in 1 Block

E & F Type Flats			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Air Conditioner 1.5 T	1	2.20	2.20
Fridge	1	0.50	0.50
Geyser	1	2.00	2.00
Coolers	2	0.30	0.60
Kitchen Equipment	LS	LS	4.00
Miscellaneous Load (Light, Fan, TV and Computers etc)	LS	LS	2.70
Total		**KW**	**12.00**
Total for 44 Flats	**44**	**12.00**	**528.00**

2.4.5 G & H Type Quarters – 1 BHK Type, 45 No. s

G & H Type Quarters			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Fridge	1	0.30	0.30
Geyser	1	2.00	2.00
Coolers	1	0.30	0.30
Kitchen Equipment	LS	LS	2.00
Miscellaneous Load (Light, Fan, TV and Computers etc)	LS	LS	2.40
Total		**KW**	**7.00**
Total for 45 Quarters	**45**	**7.00**	**315.00**

2.4.6 Guest House – 9 Rooms

Guest House			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Air Conditioner 1.5 T	9	2.20	19.80
Geyser	9	2.00	18.00
Kitchen Equipment	LS	LS	5.00
Miscellaneous Load (Light, Fan, TV and Computers etc)	LS	LS	10.20
Total		**KW**	**53.00**

2.4.7 Material Store

Material Store			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Miscellaneous Load (Light, Fan, TV and Computers etc)	LS	LS	5.00
Total		**KW**	**5.00**

2.4.8 Miscellaneous

Miscellaneous Loads			
Electric Load	**~ Qty (No.)**	**Unit Load (Kw)**	**Total Load (Kw)**
Street Lights - LED	20	0.08	1.60
Sodium Vapour	40	0.15	6.00
Tube Well	1	2.25	2.25
	1	1.15	1.15
Sump Well	1	3.75	3.75
	2	2.25	4.50
Garden Tube well	2	1.50	3.00
SBI ATM	LS		5.00
Other Un accounted	LS	LS	3.75
Total		**KW**	**31.00**

2.5 ILLUMINATION LEVEL:

As per Indian Standard 3646.1.1992, clause 4.2.2.1, Lighting requirements are based on the following lighting engineering criteria:

- Lighting level,
- Luminance distribution,
- Glare restriction,
- Direction of incidence of light and shadow effect,
- Colour appearance and colour rendering.

In order to be able to discern features of the human face, a luminance of approximately 1 Candle / sq-m is necessary. This can be achieved under normal lighting conditions with a horizontal illuminance of approximately 20 Lux. So, 20 Lux is regarded as the minimum illuminance for non-working interiors.

The recommended Lux levels for offices is 300, for interior parking area is 20 to 30, for public rooms 200-300, and for auditorium is 50 to 100.

For Education Institutes, the recommended Lux levels are mentioned in **section 21 of BIS 3646.1.1992**

- Computer Work Stations – 300 Lux
- Corridors – 100 to 150 Lux
- Libraries – 200 to 300 Lux
- Book Shelves – 100 Lux
- Assembly Hall – 200 to 300 Lux
- Lecture Hall – 200 to 300 Lux
- Seminar room – 300 to 500 Lux
- Laboratories – 300 to 500 Lux
- Rest Rooms -100 to 150 Lux

3 Power Supply and Energy Sources

Electricity is the major form of energy being consumed in the buildings.

3.1 Main Power Supply:

The Electric Power to the BOU premises is catered by Madhya Pradesh Madhya Kshetra Vidyut Vitaran Co Ltd (MP MK VV CL) through one High Tension (HT) connection of 200 KVA Contract Demand, served on 11 KV. The name of the 11 KV Feeder is Yashoda Feeder. The premises comes under City Division West of City Circle Bhopal.

The Energy Meter is installed at the front garden of administrative building. The Energy Meter No. is XG437006with Multiplying Factor (MF) of 3.0

From Metering DP, 11 KV Feeder on pole is run in the campus, feeding to the two 11 / 0.4 KV, 315 KVA Transformers for the Distribution of Electric Power. The transformers are installed around 400 m apart catering to separate areas of the premises.

Transformer 1 caters to Administrative Building, EMPRC Block, Guest House, Registrar Bungalow, and Pump House.

Transformer 2 caters to Officers Residential Flats, VC Bungalow, Employees residential quarters Material Store and Street Lights. There is an ATM of SBI, which is also fed through this transformer.

3.1.1 Rating of Distribution Transformers

Both the Transformers have similar rating and make.

- Make: Awadh Transformers Bhopal
- 315 KVA, 11/0.433 KV, 17 / 420 Amp
- ONAN Cooling
- 4.5% Impedance Voltage
- DY-11 Vector Group

Automatic LT Capacitor Banks of 150 KVAr are installed at the substation of both the Transformers.

3.2 Other Sources of Energy:

3.2.1 Diesel Generating Sets:

As Back up supply, there are two DG Sets of 100 KVA and 82.5 KVA in the premises. The 82.5KVA DG set is not in operation and is lying unconnected.

The 100 KVA DG set is used only for the Light and Fan (and not Power) Electrical Load of Administrative building. The same supply is sometimes used for the internal functions of the BOU as well.

The 100 KVA DG Set is of Kirloskar Make, Bhaskar Model, 3 Phase, with noise limit of < 75 db (A) at 1 meter.

82.5 KVA DG set is also of the same specifications.

It is informed by the Electrician BOU, who is maintaining DG sets also, that the hourly consumption of diesel for 100 KVA DG set is around 11 Lt/hr. But since there is no log of units generated or the diesel consumption, the efficiency of DG set could not be ascertained.

Energy Meter is installed at 100 KVA DG set outgoing but periodic log of units generated or Diesel Consumption is not maintained. Record of running hours of DG set and procurement of Diesel is properly maintained.

It is learnt that inspection of officials of MP Electrical Inspectorate is also due for 2-3 years. The Electricity Duty on the units generated by DG set is also not being paid to Government of MP.

3.2.2 Solar Power:

There are Solar Panels of 100 Kw installed in the premises. These are 300 Panels of 320 W Pmax, installed by MP Urja Vikas Nigam Ltd under 'Grid Connected Roof Top Solar Project'. The solar panels were commissioned on 15.09.2018. The project cost was Rs.58,27,605/-

The Solar Panels are of Adani make – Mundra Solar PV Ltd., Kutch, Gujarat. Each plate is of 320 Watt Max Power, with Open Circuit Voltage of 45.5 V and Power Current of 8.9 Amp, Weight 22 Kg and Application Class is 'A'.

There are 2 Inverters of Sungrow make, Model SG50CX

The rated output power of each inverter is 50 KW, Maximum Input Voltage is 1100 Volts DC and the Output Voltage is 3 Phase 400 / 230 V, 83.6 Amp

The Power supply of Solar is connected with the Grid Supply at the Electric Panel of Administrative Building.

Secure make Energy meter, S. No.X1068170 is installed at the roof top of administrative building. The units of Solar Generations are being adjusted in the monthly HT Electricity Bills.

3.2.3 Water:

Water is another secondary source which is being used for drinking, and horticulture purpose.

There are 2 No. Tube wells for catering to drinking and residential use of water.

The main pump is of 3 HP installed near the administrative building and the other pump of 1.5 HP is installed near Sump well and Pump House. The main 3 HP pump runs for around 18 hours a day; morning 10 am to 4 pm and then from 6 pm to next day 6 am. The 1.5 HP pump has low water level and is run intermittently for around 2-3 hrs during working hours from 8 am to 4 pm.

The water from these tube wells is pumped in to a Sump Well, in front of Pump House. The capacity of sump well is 1.5 Lakh Lt. From this sump well, the water is pumped to different water storage tanks installed at the roof top of all the buildings like administrative building, Guest House, Quarters, Bungalows, Blocks etc.

The water is pumped through 3 Mono Block pumps. At present one pump of 5 HP and one pump of 3 HP are in operation. One pump of 3 HP is out of order.

There are two 2 HP tube wells also, located at the front garden of the administrative building. These tube wells are used for the gardening purpose.

3.3 POWER SUPPLY ARRANGEMENT:

For Transformer 1, the main LT cable is of 3-1/2 core 300 sqmm size terminating in to an Outdoor Distribution panel installed inside the Sub Station compound. From this panel, there are 5 No. 3-1/2 core 185 sqmm cables emanating.

One Cable is terminating at EMPRC Block Electric Panel.

The other 4 cables are reaching to a Panel Room adjacent to the DG Room. Out of this one cable is terminating at the Electric panel for administrative building, one cable is terminating at electric panel of EMPRC block and the remaining two cables are lying unconnected and are as stand by.

The Power Supply from Solar is also connected with the Grid supply at the Electric panel for administrative building.

The administrative block electric panel is actually two ways. Main panel caters to Power Load of the Administrative Block while the Light & Fan Loads are catered through a separate electric panel, which also have power supply from the 100 KVA DG set. 3-1/2 core 150 sqmm cable is used for power circuit and 4 core 16 sqmm cable is used for Lighting circuit.

Normally the MCB of DG set incomer is kept off and Light & fan power to administrative building is catered through Discom grid supply. In case of power failure from grid, the grid MCB is switched off and DG Incomer is switched ON and power is restored.

There is no proper manual changeover supply system between the MP MK VV CL Grid Power and DG set supply.

For Transformer 2 also, the main LT cable is of 3-1/2 core 300 sqmm size terminating in to an Outdoor Distribution panel installed inside the Sub Station compound. From this panel, there are 3 No. 3-1/2 core 185 sqmm cables emanating.

One of the cables is terminating at the Electric Panel of Material Store.

The other two cables are terminating at a pole with two overhead LT Circuits. One of the LT feeder feeds to the Electric panel of employee's quarters and the other LT circuit is terminating at electric panel of Officer's residential block. In between this circuit feeds to VC Bungalow and Street Lights as well.

3.4 POWER SUPPLY PARAMETERS:

The voltage between the Phase to Phase and Phase to earth are measured at all the electric Panels and are found to be in permissible range of 400 to 400 Volts for Line and 215 to 240 Volts for Phase.

All the electric panels and DG set panels have separate earth pits. The voltage between phase and earth and between neutral and earth is checked at every panel and is found satisfactory, within permissible limits.

Outdoor LT Capacitor Bank of 150 KVAr is installed at both the substation, with the capacitor combinations as below:

- 20 KVar – 3 No.
- 10 KVAr – 5 No.
- 15 KVAr – 3 No.
- 20 KVAr – 2 No.

3.5 FIRE FIGHTING ARRANGEMENT:

There are adequate arrangements of fire fighting with hand operated fire extinguishers.

6 No. 4.5 Kg CO2 type fire extinguishers are for electric substation and electric panel rooms and DG Room.

Around 39 No. 5 Kg ABC Powder type fire extinguishers are for other areas of administrative building, Guest House, EMPRC Block and Material store.

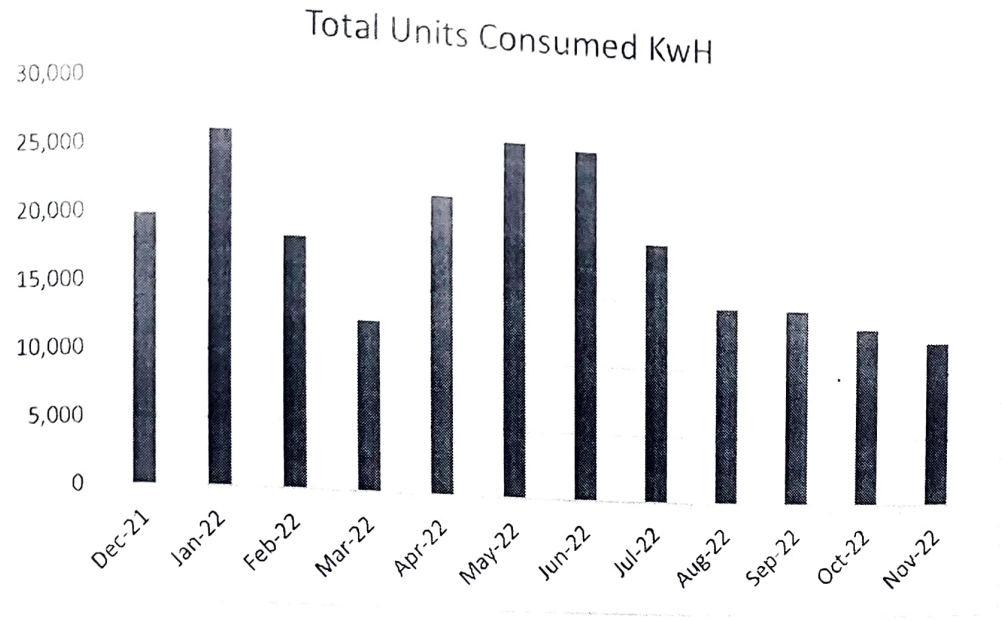
4 Analysis of Electricity Bills and Tariff

4.1 Details and Analysis of Electricity Bills:

The Electricity Bill details of last one year have been tabulated in a specific format, for analysis. The period of consideration is from Dec 2021 to Nov 2022.

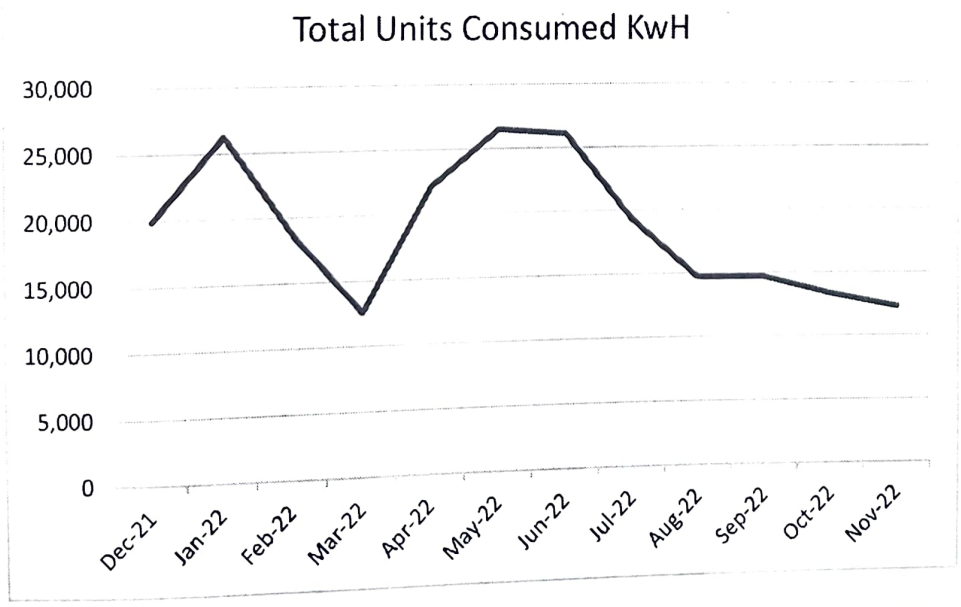
Month	Units Consumed (KWh)	Solar Units Export	Net Units Billed	Maximum Demand	Billing Demand	Load Factor	Power Factor	Current Electricity Bill	Electricity Rate
	Total	KwH	KWh	KVA	KVA	%	%	Rs	Rs / KWh
Dec-21	19,916	1,484	18,432	98.52	180	14	72.84	2,58,257	14.01
Jan-22	26,267	839	25,428	91.56	180	17	97.87	2,18,381	8.59
Feb-22	18,561	2,607	15,954	89.76	180	11	96.22	2,14,524	13.45
Mar-22	12,576	4,859	7,717	51.72	180	6	95.37	2,09,334	27.13
Apr-22	22,148	2,438	19,710	89.40	180	13	98.20	2,16,369	10.98
May-22	26,525	1,133	25,392	95.52	180	17	98.86	2,60,457	10.26
Jun-22	26,129	1,091	25,038	101.64	180	16	99.14	2,56,686	10.25
Jul-22	19,353	1,283	18,070	75.24	180	12	96.72	2,09,096	11.57
Aug-22	14,700	1,800	12,900	48.12	180	9	93.96	1,70,066	13.18
Sep-22	14,669	2,748	11,921	46.20	180	8	94.49	2,11,702	17.76
Oct-22	13,334	4,991	8,343	53.64	180	6	86.80	2,23,122	26.74
Nov-22	12,302	4,713	7,589	61.32	180	5	82.03	2,24,215	29.54
Total Annual	**2,26,480**	**29,986**	**1,96,494**					**26,72,209**	
Monthly Average	**18,873**	**2,499**	**16,375**	**75.22**	**180**	**11**	**92.71**	**2,22,684**	**16.12**

- The average annual expenditure on electricity bills is Rs. 26.72 Lakh (~ monthly expenditure Rs. 2.23 Lakh)
- Annual consumption is 2.26 Lakh units ~ monthly consumption of 18,873 Units.



- Annual Generation of Electricity from 100 Kw Solar Plant is 29,986 Units which is equivalent to 2,499 Units per Month ~ 83 Units per Day

Considering that the Units generated from solar plant is of the order of 4 Units per day per Kw, it can be concluded that the Solar Plant is underutilised or is operating at very low efficiency.



- Accordingly Net Energy Billed Units after subtracting Solar Generated Units are 1.96 Lakh Unit `~ 16,375 Units per Month
- **The average cost of electricity is Rs. 16.12 Unit.** (On Net Energy Units Billed)
- The average **Power Factor** of the premises is 92.71%. This is appreciable.

(Power Factor (PF) is a technical term, which can be brought up to 1.0 by suitable corrective means. Low PF attracts penalty from the Utility.)

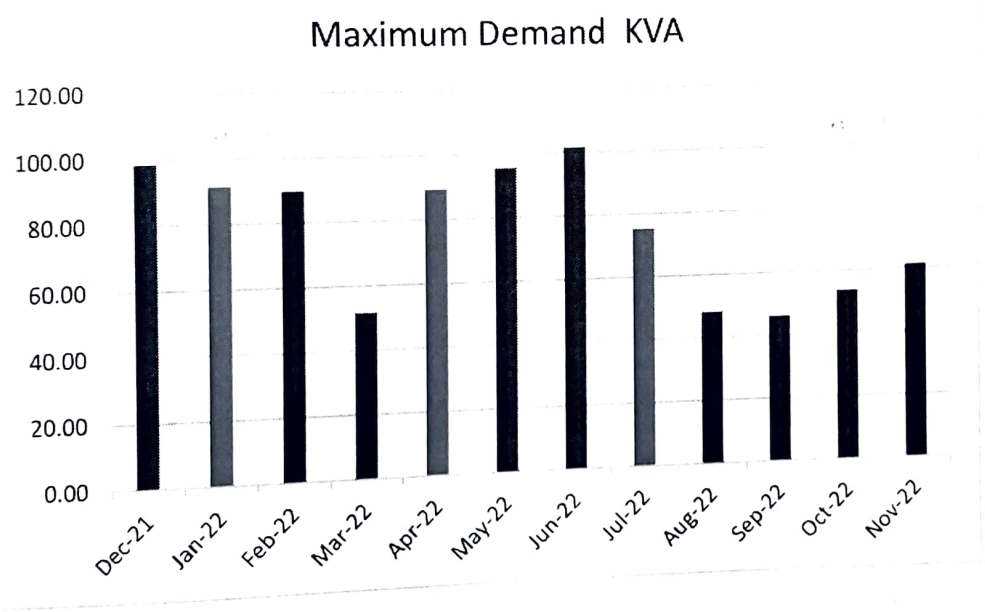
- The premises has the Contract Demand with MP MK VV CL for 200 KVA while the average Monthly demand for the period from Dec 2021 to Nov 2022 is just 75.22 KVA against the minimum Billing Demand of 180 KVA

  The customer has to pay minimum demand (90% of the Contract Demand, which is 180 KVA in this case. on which the electricity charges are required to be paid.

- The **Load Factor** of the premises is just 11% against the total estimated connected load of 1,176 KW.

  Load Factor = Monthly Consumption / (720 X PF X Billing Demand)

- ***Considering the Maximum Demand as just 75 KVA and Load Factor as 11 %, it is concluded that the consumer is paying excessively on account of Fixed Charges associated with the Contract and Billing Demand.***



4.2 BREAK UP OF ELECTRICITY BILLS:

Month	Net Units Billed	Maximum Demand	Billing Demand	Power Factor	Power Factor Surcharge	ToD Rebate	Electricity Duty	Surcharge on Arrears	Current Electricity Bill
	KWh	KVA	KVA	%	Rs	Rs	Rs	Rs	Rs
Dec-21	18,432	98.52	180	72.84	39,448	-11,278	20,404	3,113	2,58,257
Jan-22	25,428	91.56	180	97.87	-5,737	-13,205	28,683		2,18,381
Feb-22	15,954	89.76	180	96.22	-2,399	-11,745	17,996	2,695	2,14,524

Month	Net Units Billed	Maximum Demand	Billing Demand	Power Factor	Power Factor Surcharge	ToD Rebate	Electricity Duty	Surcharge on Arrears	Current Electricity Bill
	KWh	KVA	KVA	%	Rs	Rs	Rs	Rs	Rs
Mar-22	7,717	51.72	180	95.37	-580	-6,190	8,705		2,09,334
Apr-22	19,710	89.40	180	98.20	-7,452	-8,540	22,356		2,16,369
May-22	25,392	95.52	180	98.86	-9,662	-9,570	28,985		2,60,457
Jun-22	25,038	101.64	180	99.14	-13,338	-8,757	28,581		2,56,686
Jul-22	18,070	75.24	180	96.72	-2,765	-6,770	20,735		2,09,096
Aug-22	12,900	48.12	180	93.96		-5,732	14,803		1,70,066
Sep-22	11,921	46.20	180	94.49		-5,584	13,679		2,11,702
Oct-22	8,343	53.64	180	86.80	1,940	-3,528	9,699		2,23,122
Nov-22	7,589	61.32	180	82.03	6,470	-6,023	8,822		2,24,215
Total Annual	**1,96,494**				**5,925**	**-96,922**	**2,23,448**	**5,808**	**26,72,209**
Monthly Average	**16,375**	**75.22**	**180**	**92.71**	**494**	**-8,077**	**18,621**	**484**	**2,22,684**

- Although the average power factor is 92.71 % but still the University has paid Low PF Penalty of Rs 5,925/- during Dec 2021 to Nov 2022. However, this is due to the exceptionally low PF (72.81%) during Dec 2021, for which the imposed penalty was Rs.39,448/-
- The 'Time Of the Day' (ToD) Rebate is Rs 96,922/- which is equivalent to Rs 18,621/- per month. This is appreciable and contributes directly in the reduction of Energy Bill.
- The Electricity Duty of Rs 2,23,448/- has been paid to State Govt during the year. This amount is 8.36% of the Electricity Bill.

4.3 ELECTRICITY TARIFF:

The Power supply to the premises is fed on 3 Phase, 11 KV High Tension System by MP Madhya Kshetra Vidyut Vitaran Co. Ltd (MPMKVVCL) – the Discom. It is billed on HT Tariff 3.2 A, Non-Industrial tariff as per Tariff Order, passed by M.P. Electricity Regulatory Commission (MPERC).

The tariffs for different categories for the year 2022-23 (as per MP Electricity Regulatory Commission (MPERC) Bhopal, Order dtd 31.03.2022) are as below:

Category	Tariff No.	Monthly Fixed Charges (On Billing Demand)	Energy Charge (For Load Factor below 50%)	Energy Charge (For Load Factor above 50 %)
		Rs / KVA	**Rs / Unit**	**Rs / Unit**
Non-Industrial, 11 KV	HV 3.2 A	**337**	**7.55**	**6.65**

Annual Minimum Consumption (KWh) per KVA of Contract Demand is 600 Units.

For 200 KVA Contract Demand, it is 1,20,000 Units. The annual consumption of BOU is 2,26,480 Units. So, no excess on minimum consumption is being paid.

4.3.1 Power Factor:

Power Factor	Percentage incentive payable on billed energy charges
Above 95 % and Below 96 %	1%
Above 96 % and Below 97 %	2%
Above 97 % and Below 98 %	3%
Above 98 % and Below 99 %	5%
Above 99%	7%
Above 90 % and Below 95 %	Nil
Power Factor	**Percentage Surcharge payable on billed energy charges**
Below 90 % and Above 85 %	5%
Below 85 % and above 70 %	5 % + 2 % additional on each one percent fall below 85 %, subjected to maximum of 35%
Below 70 %	MP MK VV CL reserves the right to disconnect the Power Supply, till steps are taken to improve PF

4.3.2 Time Of the Day (ToD) Tariff:

Peak / Off Peak Period	Surcharge / Rebate on Energy Charges
Months: April to October	
Normal Hours (i.e. Hours excluding Peak Load Hours)	Normal Tariff
Off Peak Hours (Between 10.00 PM to 6.00 AM Next day)	10 % Rebate
Months: November to March	
Normal Hours (i.e. Hours excluding Peak Load Hours)	Normal Tariff
Off Peak Hours (Between 10.00 PM to 6.00 AM Next day)	20 % Rebate

4.3.3 Specific Terms and Conditions of Tariff:

- Billing Demand in case of Demand Based Tariff should be actual demand or 90% of the Contract Demand, whichever is higher.
- Fixed charges for Excess Demand over and above the 120 % to 130 % of contract demand shall be charged at 1.3 times the normal fixed charges. Fixed charges for Excess Demand over and above the 130 % of contract demand shall be charged at 1.3 times the normal fixed charges for up to 120% to 130% and 2 Times for above 130%
- No extra charges are applicable on the energy charges due to the excess demand.
- Rebate of 1% on advance payments. Rebate of 0.5% on 'On Line' Payment, subjected to maximum of Rs.1,000/- and Rebate of 0.25% on Prompt Payment i.e. more than 7 days before the due date
- Surcharge at the rate of 1.25 % per month or part thereof on the amount outstanding (including arrears) will be payable if the bills are not paid up to due date.
- In case the cheque(s) presented by the consumer are dishonoured, a service charge at the rate of Rs. 1000/- plus applicable GST per cheque shall be levied in addition to delayed payment surcharge as per rules.
- No Metering Charges shall be levied
- **Green Energy Tariff** of Rs. 1.13/ kWh, which is over and above the normal tariff of the respective category as per this Tariff Order, be levied to consumers opting for meeting their demand by 100% Renewable Energy from Distribution Licensee.

5 Observations and Findings

From Energy Audit point of view, there are no major concerns because there are no heavy electrical loads / machineries installed in the premises. The premises is operating on very low average annual Load Factor of 11%. The Billing Demand is just 75 KVA against Contract Demand of 200 KVA.

5.1 Observations of Concern:

i. The Contract Demand of premises with the Discom is 200 KVA. This is high in comparison to the average Monthly demand, which is for the period from Dec 2021 to Nov 2022 is just 75.22 KVA against the minimum Billing Demand of 180 KVA. And the consumer is paying excessively on account of Fixed Charges associated with the Contract and Billing Demand.

ii. There is one DG set of 82.5 lying un functional since years. This is wastage of an asset.

iii. The regular annual visit of Engineer from Electrical Inspectorate, GoMP is not made in last 3 years. And the Electricity Duty on Units generated by DG sets are not paid to State Govt. This may attract penalty from MP Electrical Inspectorate in monetary terms as well the seize of DG sets.

iv. The premises has 100 KW Solar Plant operating, which indicates the University concern for Green Energy and reduction in Carbon Foot prints. This is appreciable. But the operation of Solar Plant at very low efficiency is a serious concern. Annual Generation of Electricity from 100 Kw Solar Plant is 29,986 Units which is equivalent to 2,499 Units per Month ~ 83 Units per Day.
Considering that the Units generated from solar plant is of the order of 4 Units per day per Kw, it can be concluded that the Solar Plant is underutilised or is operating at very low efficiency. This is considered as wastage of an asset and mis-utilisation of government fund.

v. The Main Panel Box of Transformer 2 has burnt out Cables at its Distribution Box. It should be immediately get maintained and replaced as per requirement. It may cause Power Outage at any time. Since there is very less load on transformer, it seems that burning of cables may be due to lose connection or unbalancing of the load.

5.2 Major Observations:

The major observations and findings during field visits and analysis of data as regards to electricity bills, Solar Generation, DG sets and as gathered during discussion with concerned officials of BOU are as below:

5.2.1 Sub Station

i. There is grass and vegetation in the substation / below transformer – It should be cut regularly, and the SS ground should be clear, free from garbage and properly covered with stone gitti. In the HT Yard of the consumer, there are stone blocks, which cause slippage in rains and at places of oil spread. The stone metaling has been removed in recent years as the cleanliness and cutting of grass etc in the yard could not be maintained.

ii. No Lighting fixtures are installed in S/s. This would cause difficulty in night operations.

iii. The earth pit pipe is also seen. The Earth pits should be properly framed from the top with regular watering. Presently the earth pit pipes are open.

iv. There is leakage of oil from both the Transformer tanks and the tanks have very low oil level. The Oil level in the conservator should be maintained as per desired level. The filtration of transformer oil is not done since its commissioning.

v. The Lightning Arrestors, fitted on the Double Pole (DP) structure of (both the) Transformer are either damaged or missing out. The same should be installed immediately. Otherwise, any lightning stroke falling on the 11 KV feeder may cause the transformer damage.

vi. Silica gel in the breather of both the Transformer breather needs drying up and top up or replacement.

vii. There are no sleeves on 11 KV Jumpers connecting to Transformer. Since the clearance of these jumpers with earth is very low, non – sleeving is like an electrical hazard.

viii. There is no approach road to Sub Station No. 1

ix. The average cost of electricity is Rs. 16.12 Unit. (On Net Energy Units Billed). This is very High and mainly on account of higher Contract Demand.

x. The Load Factor of the premises is just 11% against the total estimated connected load of 1,176 KW. This is due to the inclusion of residential and Guest House load with the main university load.

xi. The average Power Factor of the premises is 92.71%. This is appreciable.

xii. There are two distribution transformers each of 315 KVA, 11 / 0.4 KV are installed in the premises. The capacity of each transformer is sufficient to cater the premises full load. But there is no means of any interconnection between them. Which means they cannot supplement each other and in case of outage of one of the transformers (for maintenance purpose or due to failure), the other transformer cannot feed power to the load connected with the 'out of network' transformer, though it has sufficient capacity to take load.

5.2.2 DG Sets and Control Room

i. The Log record of Units generated by DG set is not maintained. Nor the diesel consumption record is maintained. Without these records the DG set efficiency, fuel consumption and the cost of Unit power generation from DG set could not be ascertained. However, the running hours of DG set and Diesel purchase record is properly maintained.

ii. The Electricity Duty on units generated by DG set is not being paid to State Government.

iii. There are no Single Line Diagram, no safety charts and no first aid charts for electrical shock in the main electric panel room and DG panel room.

iv. There are some concerns as regards to Electrical Safety norms in terms of improper earthing and non-availability of safety mattings and Personal Protection Equipment (PPE) before main LT panels and DG set.

v. There are no measuring instruments and indicating lamps found in proper working condition even in the HT Switch yard and Control room. There is no method or mechanism of maintaining log register in control room.

5.2.3 Solar Power Plant

There is lot of dirt and dust over the solar panels. This reduces the efficiency of Solar Plant. It should be cleaned on daily basis.

5.2.4 Earthing and Cabling

i. At some panels like Material Store Panel, the earth wire from earth pit is found broken. At no places the armour of the cable is found connected to electric panel and is loss of opportunity to use an additional earth protection by way of cable armouring. The cable Armor should be used as an alternate earth.

ii. The switch Boards needs to be checked for proper earthing and shall be redone wherever required.

5.2.5 Premises Lighting

i. The premises already have LEDs installed for its Administrative Building, Class Rooms, Offices & Street Lights. This is a very good step towards energy conservation and hence reduction in electricity bills.

ii. Though the exact counting of Lighting fixtures is not made but it is observed that still some 40 % of the Lighting of official campus have Tube Lights. These tube lights consume more power than what Lumen they deliver, in comparison to other lighting elements like CFLs and LEDs. Similarly, around 40 No. Street Light fixtures have 150-Watt Sodium Vapour Lamp. Presently there are more energy efficient street lightings are available in the form of LED.

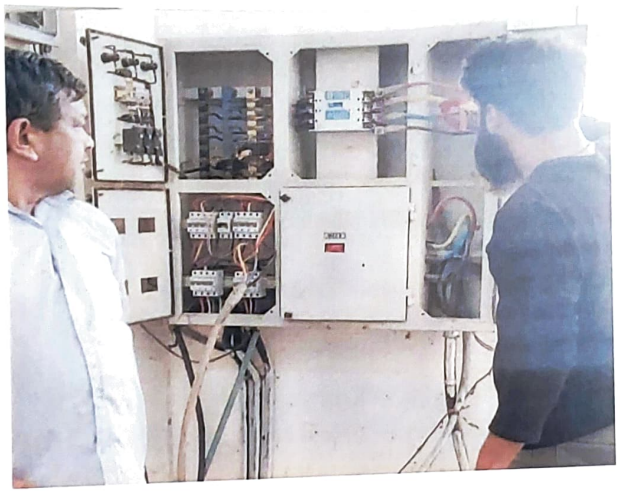
iii. It is seen at almost every panel that there is unbalance in the electrical load.

At Transformer 1: Phase Voltage: R, Y and B - 239 / 241 / 234 Volts-OK
Line Voltage: RY, YB and BR – 416 / 409 / 417 Volts -OK

At Transformer 2: The Main Cable connectors at Distribution box are burnt out. Could not take the measurements

Current at Main Building GF Panel: R, Y, B, Neutral – 14.1 Amp / 4.2 Amp / 3.4 Amp / 12.1 Amp

Current in Neutral shows unbalancing, which is otherwise also obvious from the readings of current at different phases. – Unbalancing of current is Not advisable



iv. There are no sub-meters for recording energy consumption of each office / electric panel / Unit. This may cause energy insensitivity among the officials of the buildings.

v. **Illumination Level**: Illumination level is measured at different places in the hospital and medical college building and for street lights. *These are slightly less than the limits as prescribed in BIS 36. 46.1.1992*

VC Room Table – 134 Lux
VC Office Table – 94

Registrar Table – 265 Lux (adequate)
Registrar Office – 135 Lux

University Engineer table – 151 Lux
University Engineer Office – 97 Lux

Professor's Chamber (Sh LP Jhariya) – 235 Lux (adequate)
Professor's Chamber (Sh LP Ratan Suryavanshi) – 268 Lux (adequate)
Professor's Chamber (Ms Sadhna Singh Bhasin) – 164 Lux

Reception Area – 82 Lux
Library – 60 Lux

5.2.6 General Administrative

i. The record keeping of Bills and Records is very good except for the DG set generating units, diesel consumption and Solar Power Generation. Though their records are maintained but they are not readily retrievable for monitoring.

ii. The book keeping is also not adequate. The schematic electrical distribution network is not found available.

iii. There is no Energy Manager designated or no formation of Energy Management Cell or any centralised nodal body to look after the needs of occupants holistically, for such a large office establishment.

iv. There is shortage of electrical maintenance staff (only 1 electrician) for HT Switch yard, DG, control room and internal lighting of university and residential campus for looking after the day-to-day maintenance and electrical trouble shooting of the premises. It is only this reason that the Substation equipment, transformer LT connections are in poor condition. For the same reasons the log of DG set operation and daily record of Solar generation is not being kept.

It is informed that the HT Switch Yard is maintained by external electrician who is called as per need.

6 Recommendations

Based on our findings, we have suggested certain measures, which will not only reduce the energy cost of the facility but will also lead to promotion of a culture of Energy Conservation amongst the faculties and officials working in the premises. In the long run this will spread into their homes and help the overall cause of Energy & Resource Conservation.

After a careful analysis of the primary and secondary data collected and the information received, several energy saving measures have been identified which can help bring down the energy consumption. The recommendations have been grouped under the following heads:

i. No Cost / Immediate Measures

ii. Low Cost / Immediate Measures

iii. Low Cost / Short Term Measures

iv. Medium Cost / Medium Term Measures

v. High Cost / Medium Term Measures

vi. High Cost / Long Term

vii. Measures which are explored but not recommended due to being non-viable and having very high pay back periods

viii. Other Measures

6.1 No Cost / Immediate Measures

6.1.1 Reduction in Contract demand with MP MK VV CL:

The Average Monthly Demand is just 75 KVA against Contract Demand of 220 KVA. The maximum Demand has reached only up to 102 KVA in the month of May 2022 (Peak summer period) and only thrice more in one year, it has crossed 90 KVA.

The Load factor of the premises is also very low and is just 11%

It is recommended that the Contract Demand of the connection (with MP MK VV CL) be reduced to 80 KVA only, from 200 KVA.

6.1.2 Permission of DG set operation from MP Electrical Inspectorate:

It is found that no permission for installation and operation of DG sets of 100KVA and 82.5 KVA is sought from MP Electrical Inspectorate. Nor the Electricity duty on DG generation is being paid to MP

State Government. This is violation of norms and would attract penalty which can be monetary and / or seize of DG sets.

It is recommended to engage an 'A' Class Electrical Contractor and get Substation Single Line Diagram (SLD) and LT Distribution SLD prepared, and Electrical Safety Charts installed in DG and Control Room.

On behalf of BOU, this contractor would then apply for permission of DG sets installation and operation from MP Electrical Inspectorate, Govt of MP.

6.1.3 UPKEEP OF DG SET RECORD AND PAYMENT OF ELECTRICITY DUTY TO MP GOVERNMENT:

Proper Log of units generated by DG set should be maintained in a register /log book, to be maintained by the DG Operator / Electrician. The Energy Meter Reading should be noted every time the DG set is put in operation and the units generated at that tenure be mentioned in that log book. Or alternatively, Energy Meter Reading on month – to month basis may also be maintained.

A similar log of diesel consumption should also be maintained on month-to month basis starting with opening stock of diesel in the DG set, quantity of top up during the month and the balance stock of diesel in DG Set.

This type of accounting is very essential for proper energy accounting and ascertaining the fuel consumption of DG set or otherwise to check if there is any misuse or pilferage of diesel.

Monthly deposition of Electrical Duty on Units generated by DG sets should be ensured.

Month:	Unit	DG Set – 1 100 KVA	DG Set – 2 82.5 KVA	Total
Units Generated	KWh			
Running Hours	Hr			
Diesel Consumption	Lt			

6.1.4 Non- essential loads like water pumps etc should be run during off peak hours preferably (between 10 pm to 6 am), to utilise the ToD tariff.

6.1.5 The AC air filter should be cleaned regularly, every month. Keeping thermostat setting of Air conditioners not below 22 degrees centigrade and periodical check-up and maintenance of thermostat, coil insulation and machine.

6.1.6 At peak summers, operation of air conditioners with ceiling fans.

6.1.7 Reduce excessive illumination by de-lamping or switching off excess luminaries.

6.1.8 Optimum utilization of day sun light.

6.2 Low Cost / Immediate Measures

i. Transformer DP and Distribution Box should be maintained by an authorised person or competent agency on regular basis.

ii. All Substation / Transformer equipment (Lightning Arrestors, Switches, Silica Gel etc.) should be properly installed and maintained in healthy and operational condition.

iii. The Transformer tanks have very low oil level. The Oil level in the conservator should be maintained as per desired level. Top Up of Transformer oil with due filtration of transformer oil is required.

iv. Silica gel in the breather of both the Transformer breather needs drying up and top up or replacement.

v. Substation earthing pit should be casted and watered regularly

vi. Substation grass should be regularly cut and cleaned by an authorised person.

vii. The Substation ground should be clear, free from garbage and properly covered with stone gitti. Stone metaling should be spread in the HT yard with proper lighting arrangements.

viii. The cable armour should be firmly connected with main LT panels. The cable Armor should be used as an alternate earth.

ix. The switch Boards needs to be checked for proper earthing and shall be redone wherever required. Separate Earth pits to be provided for every Electric Panel and Distribution Board. Proper arrangement for regular watering of SS earthing pits should be made.

x. Placement of CO2 Type fire extinguishers, Safety Mattings and PPE in main electric LT panel room and DG set Room.

xi. Power Factor of the premises should be regularly checked on monthly basis. If at any month the pf falls below 90%, this would indicate the failure of some of the capacitors from capacitor bank. This should immediately be attended and replaced, if required.

xii. **Electrical Load Balancing in the LT Distribution Panels:**

There is some unbalancing of electrical loads in the three phases. This unbalancing of load is due to the fact that the individual offices / buildings keep on adding their office equipment like computers and printers and air conditioners without consulting the nodal agency. The unloading could not be checked due to the fact that there are no measuring instruments available on LT panels. It is recommended to install Smart Energy Meters at each individual office, street light panels and at each LT Distribution panel.

6.2.1 Audit and upkeep of Solar Plant:

It is seen that the 100 KW solar plant Annual Generation of Electricity is 29,986 Units which is equivalent to 2,499 (2,500 Units) Units per Month ~ 83 Units per Day.

As per thumb rule a Solar Plant should generate at least 4 Units a day per KW. With this rule there should be at least (100 X 4) 400 Units of Solar generated per day which is equivalent to 12,000 Units **per Month.**

It is recommended that the Solar Panels be cleaned every day by the maintenance agency. This would result in to the most optimal utilisation of Solar Plant. The scope of work would mainly cover the daily log of Units generated, daily cleaning of Solar Panels with water and duster and replacement of worn out or damaged solar panels. This would ensure the most optimal utilisation of Solar Plant.

Month	
Units Generated (KWh)	
Units Exported to Discom (KWh)	

6.3 Low Cost / Short Term Measures

i. Separate Earth pits to be provided for every Electric Panel and Distribution Board. Proper arrangement for regular watering of SS earthing pits should be made.

ii. Existing Tube Light fittings in the University official buildings should be replaced by LED Lights or CFLs of appropriate rating / wattage.

iii. The 200-Watt Sodium Vapour Lamps should be replaced by 120 Watt LED. The wattage of LED is proposed more because the street light poles are 11 m long. The average life of these lamps is 3 years; that is every year one third of the lamps need to be replaced.

iv. All the conventional regulators of fan should be replaced by electronic regulators. This is a well-known measure as the electronic regulators save about 40% in lower speeds. The electronic regulators of 'Step' type shall be installed instead of 'Step-less' type.

v. Provision of sun sheds for all out-door air conditioner units.

vi. Installation of LT capacitors at Motor terminal of Water Pumps.

vii. Replacement of old Air Coolers by new coolers with energy efficient pumps and fans.

6.4 Medium Cost / Medium Term Measures

6.4.1 Interconnection of two Distribution Transformers

There should be interconnection arrangement at LT level between the two Distribution Transformers, to increase the reliability of Power supply. In case of annual maintenance or repair works, the entire load may be transferred on one transformer. The capacity of each transformer (315 KVA) is sufficient to cater the full load of the premises.

It is recommended to lay a 3-1/2 core 300 sqmm Cable connecting the main electric panel of both the transformers. There would be 400 Amp MCB at both the ends and in between. The MCB between the two panels shall remain open and when one transformer is under outage, that MCB may be switched on to cater the load through the other transformer. This whole arrangement shall be outdoor and may be housed in any of the substation.

6.4.2 False roof or under deck insulation:

The top floor of the building, which is exposed to direct solar heat and where ACs are in use may be provided with Under-deck insulation to reduce the heat gain. The energy savings due to this measure is likely to be 15% of the energy consumed by ACs as 40 % of the heat load during summer months comes from the roof.

6.4.3 Installation of Occupancy Sensors in University:

It is seen that many times there are no Officers / staffs in the office chambers / cabins but still the light and fans of the rooms remain On. Installation of Occupancy Sensors in such rooms is a good option. These energy savers have in-built sensors that turn off the AC / power when no one is present in the room and automatically turns it on when the occupier returns to the room. This way about 20 % of energy is saved during normal office hours when the occupants leave the rooms to attend meeting/ personal works/Lunch etc. This also helps in avoiding energy losses in case the AC is left ON during Holidays/ Tour periods due to negligence.

6.4.4 Providing Building-wise / Section-wise / Unit-wise Energy Meters

Providing Building-wise / Section-wise / Unit-wise Energy Meters for keeping record and account of energy consumption of that particular Load Centre. It is seen that there are around 15 different buildings but there is no energy metering installed for taking proper care of energy accounting and recording individual energy consumption of each building. Due to this arrangement, individual office / building owners remain unaware and rather unconcerned about the electricity consumption in their office and hence do not care for energy saving and conservation at large. It is thus recommended to install LT CT sub-metering arrangement at each individual office, street light panels and at each LT Distribution panel.

6.5 High Cost / Medium Term Measures

i. There are around 45 ACs of Window type and Split Units are installed in the premises. Their life is assessed as 15 years. These machines are of old technology and consume high power. Presently energy efficient 5 star rated and inverter technology based split units of similar capacity are available, which although costly consumes less power and are very energy efficient due to technology.

   All old ACs especially window AC shall be replaced with new split ACs of inverter technology belonging to at least 4 Star rating (preferred is 5 Star) assigned by Bureau of Energy Efficiency (BEE). The ACs whose running hours are more should be of 5 Star rating.

ii. **Rain Water Harvesting** should be done wherever possible, under the supervision of a qualified professional. These measures will not only help in better availability of water but will also help save energy. Such measures are not only mandatory now but also help in energy conservation as the requirement of pumping of water from large distances gets reduced and also increases per capita availability of water. These measures need further study.

6.6 High Cost / Long Term Measures

i. Any water pump or motor, if required to be replaced in future shall be replaced by Energy Efficient Motor – Pump sets.

6.7 High Cost / Long Term Measures but not financially viable

i. The Lift Motors may be equipped with Variable Frequency Drive (VFD). This would result in savings of Energy, by way of running the Lift Motor at required capacity only, depending on the load inside the lift.

6.8 Other Measures:

i. Proper up-keeping and maintenance of Records:

It should be streamlined in such a way that the retrieval and analysis of the same can be carried out quickly.

ii. Formation of Energy Management Cell:

It is recommended to designate one of the competent staff members as 'Energy Manager' (EM). In order to get maximum cooperation from the employees, it is suggested to have an Energy Management Cell with the EM as its convener. The cell members can be assigned some specific tasks of monitoring and updating of energy management activities. The cell shall be responsible for implementation of the recommendations given in this report. The EM shall work as 'Conscience Keeper of the office on all matters related to energy'.

iii. Energy Audit:

Energy Audit study should be conducted once in three years by BEE Certified and MPUVN empanelled Energy Auditors to give a real account of existing efficiency of energy usage. This also provides means to cross check the strategies which have been adopted in the previous year and facilitates in establishing a Cost Centre approach on the basis of records of specific energy consumption calculated for each activity separately.

iv. Solar Energy Audit

Solar Audits should be conducted at definite periodicity from a competent agency.

v. To enhance the awareness level of the students, employees and visitors and as well as to sensitize them, it is recommended to fix motivational and educational posters related to Energy saving and

energy modesty at strategic locations like reception area, Library, gallery etc. Such posters will also help as a regular reminder to the students and teachers to use energy judiciously in the college as well as in their homes.

To start with 20 such posters may be posted. Each poster will cost about Rs.500/- only. Thus, the total investment will be only Rs. 50,000/-.