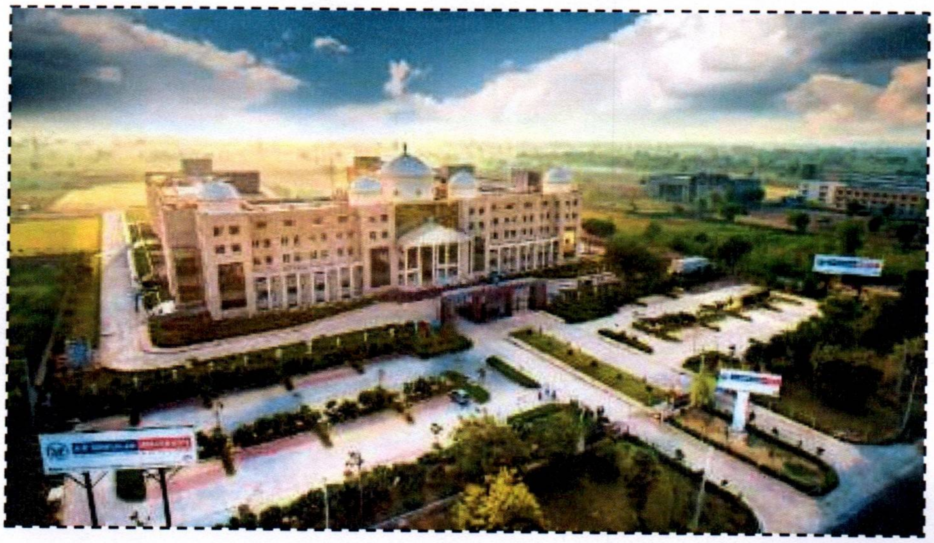
SAMARTH GROUP

Energy Audit Report



K. R. MANGALAM UNIVERSITY

K.R. MANGALAM UNIVERSITY SOHNA ROAD,

GURUGRAM, HARYANA 122103

Audit Date – 05 and 06 March 2021

Audit Conducted by:

SAMARTH GROUP

M/S Samarth Management Private Limited
212, Bhera Enclave, Paschim Vihar,
New Delhi, Delhi, 110087

For SAMARTH MANAGEMENT PRIVATE LIMITED
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K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

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CERTIFICATE OF EXCELLENCE

THIS IS CERTIFY THAT **K. R. MANGALAM UNIVERSITY** HAS SUCCESSFULLY

COMPLETED THE **ENERGY** AUDIT PROGRAM

CONDUCTED ON **05-06 MARCH 2021**

For SAMARTH MANAGEMENT PRIVATE LIMITED
Samarth Suri
Authorized Signatory

CERTIFICATE NO. **SMPL/2021/C-0006** DATE OF ISSUE **16-03-2021** AUTHORISED SIGNATORY

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ACKNOWLEDGEMENT

Samarth Management Private Limited is thankful to K.R. Mangalam University for providing us the opportunity to conduct an Energy Audit of their esteemed University. We are grateful to the Management, officers, and staff of K.R. Mangalam University for showing keen interest in the study and for the help and cooperation extended to the Samarth Management Private Limited team during the study.

We do hope that you will find the recommendations given in this report useful in helping you save energy. While we have made every attempt to adhere to high quality standards, in both data collection and analysis, as well as in presentation through the report, we would welcome any suggestions from your side as to how we can improve further.

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LIST OF ABBREVIATIONS

SEC	-	Specific Energy Consumption

LIST OF UNITS

°C	-	Degree Celsius
CFM	-	Cubic Feet per Minute
CMH	-	Cubic Meter per Hour
LPM	-	Liters Per Minute
Kg/cm^2	-	Kilogram per centimetre square
kW	-	Kilo watt
kWh	-	Kilowatt hour
KOE	-	Kg of Oil equivalent
$m^3/hr.$	-	Meter cube per hour
$Nm^3/hr.$	-	Normal Meter cube per hour
MW	-	Mega Watt
MWh	-	Megawatt Hour

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1. INTRODUCTION

The working details of assignment are as follows:

Project	**Energy Audit**
Client	**K.R. Mangalam University**
Industry	**Educational University**
Contact	**Registrar and Dr. Vineet Dahiya (8800697002) (9811911970)**
Site	**K.R. Mangalam University Sohna Road, Gurugram, Haryana 122103**
Consultant	**Samarth Management Private Limited**
Duration	05-03-2021 to 06-03-2021
Project Scope	Examination of detailed energy audit in the utility and process to assess the loss in the system.
Report	This document gives recommendations, details of findings and the way forward
Consultants involved	Mrs. Seema Suri (EA-0048) (Certified Energy Auditor) Mr. Samarth Suri (Audit Manager) Mr. Sagar Mahour (Engineer) Mr. Sanjeev Sharma (Engineer)
Notes	- The critical points are marked in red - The assumptions are marked in blue - The suggestions / alternatives in the audit report are based on the present operating conditions of equipment/systems and to the best of our knowledge. - Investment figures are estimated values and recommended to obtain cost from vendor

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1.1. Summary of Energy Conservation Measures

Table 1. Summary of Energy Conservation Measures

S. No	Energy Conservation Measure	Annual Savings Electricity		Investment	Payback
		kWh	Rs. Lakhs	Rs. Lakhs	Month
Payback 12-24 months					
1	It is recommended to reduce contract demand to 1200KVA from 2000 KVA as maximum demand is not more than 1000 KVA	-	16.0	Nil	0
2	Improvement in Power Factor by installation of Capacitor Bank	5031.31	1.13	1.0	11
3	Installation of BLDC Fans in place of normal Fans	10440	0.9396	4.35	4.6
Total		**15471.31**	**18.06**	**5.35**	**4 months**

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2. APPROACH AND METHODOLOGY

2.1. Approach

A team of 4 engineers were involved in carrying out the study, the general scope of which was as follows:

- Identify areas of opportunity for energy saving and recommend an action plan to bring down total energy cost
- Conduct energy performance evaluation and process optimization study
- Conduct efficiency test of equipment and make recommendations for replacement (if required) by more efficient equipment with projected benefits
- Suggest improved operation & maintenance practices
- Provide details of investment for all the proposals for improvement
- Evaluate benefits that accrue through investment and payback period
- Analyse various energy conservation measures and to prioritize based on the maximum energy saving & investment i.e. short, medium and long term.

Prioritization	Payback Period
Short Term Project	Less than 6 months
Medium Term Project	Between 6 to 12 months
Long Term Project	More than 12 months

- Discuss with the plant personnel, the individual Energy Saving Projects (ESPs) for agreement for implementation.

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2.2. Methodology

- The general methodology followed is captured in the following figure –

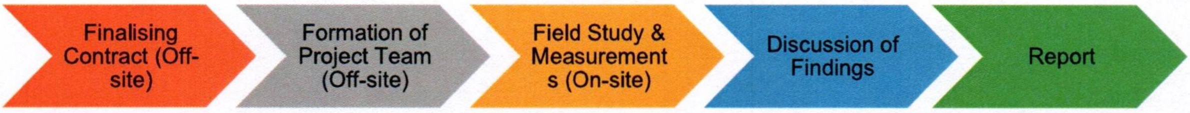

Figure 1. Methodology

The study was conducted in 3 stages:

- Stage 1: Walk through audit to understand process energy drivers, measurability and formulation of audit plan
- Stage 2: Detailed Energy audit
- Stage 3: Off-site work for data analysis and report preparation

2.3. Instruments Used for Energy Audit

The following portable instruments were used for data measurement:

- 3 – phase Power Analyzer
- Single phase Power Analyzer
- Ultrasonic Water Flow Meter
- Anemometer
- Hygrometer
- Sling Hygrometer
- Digital Thermometer
- Infrared Thermometer
- Pressure gauge
- Thermal Imager
- Flue Gas Analyzer
- Lux Meter

3. UNIVERSITY DESCRIPTION AND ENERGY SOURCES

3.1. About University

K.R. Mangalam University is the fastest-growing higher education University in Gurugram, India. Since its inception in 2013, the University has been striving to fulfil its prime objective of transforming young lives through ground-breaking pedagogy, global collaborations, and world-class infrastructure.

As we have stepped into the innovative world, we have gained exposure to unlimited learning and employment opportunities beyond the social and geographical boundaries. K.R. Mangalam University being a progressive learning platform is a host to knowledge-seekers from across the globe. KRMU has signed an MOU with University of Portsmouth (London), Middlesex University (London), Roehampton University (London), Jiangxi Administration Institute, Jinggangshan University, Cardiff Metropolitan University, University of Houston Department of Mathematics and University of Houston Department of Physics and many more under which many articulations are being designed for advanced learning programmes.

KR Mangalam University aspires to become an internationally recognized institution of higher learning through excellence in interdisciplinary education, research and innovation, preparing socially responsible life-long learners contributing to nation building.

- Foster employability and entrepreneurship through futuristic curriculum and progressive pedagogy with cutting-edge technology
- Install notion of lifelong learning through stimulating research, Outcomes-based education and innovative thinking
- Integrate global needs and expectations through collaborative programs with premier universities, research centres, industries and professional bodies.
- Enhance leadership qualities among the youth having understanding of ethical values and environmental realities.

K. R. Mangalam University education carries a strong emphasis on foundational knowledge, thorough academic research based on rigorous pedagogy and hands-on experience with real-world challenges. The synthesizing nature of the curriculum allows the student to learn by making connections between ideas and concepts across different disciplinary boundaries. The interdisciplinary structure at K. R. Mangalam University is designed to enable the integration of ideas & the characteristics from across disciplines. At the same time, it addresses students' individual differences and helps to develop important, transferable skills. K. R. Mangalam University, owned by K. R. Mangalam Group is developing 'K. R. Mangalam University ' with a motive of providing world class education in Indian Scenario and K. R. Mangalam University started to fulfill the same purpose. The University is having Undergraduate,Postgraduate and PhD programme for

- BASIC AND APPLIED SCIENCES
- ENGINEERING AND TECHNOLOGY
- MEDICAL AND ALLIED SCIENCES
- MANAGEMENT AND COMMERCE
- LEGAL STUDIES
- HUMANITIES
- EDUCATION
- HOTEL MANAGEMENT & CATERING TECHNOLOGY
- AGRICULTURAL SCIENCES
- ARCHITECTURE AND PLANNING
- FASHION DESIGN
- JOURNALISM & MASS COMMUNICATION

3.2. Energy Sources and Cost

Electricity, Solar & fuel (Diesel) are major energy sources of the University.

- Electricity is supplied from DHBVN (Dakshin Haryana Bijli Vitran Nigam)
- The Diesel as a thermal energy source is used mainly in DG Sets of 1X625 KVA, 1X380 KVA and 1X250 KVA
- The University has a solar power generating system of 310 KW on the rooftop of the academic building A, B, C blocks, DG room and the hostel building. The solar system is wheeled to the grid.

The energy cost from various sources of energy is given below:

Table 2. Energy cost component of energy sources

Source of energy	Unit	Cost
Electricity (Grid)	INR /kWh	22.52
Diesel	INR/Liter.	69.58

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4. OBSERVATION AND ANALYSIS

4.1. Electricity Supply and Network

Electricity & fuel (Diesel) are major energy sources of the University. Electricity is supplied from DHBVN (Dakshin Haryana Bijli Vitran Nigam)

Total Consumption of Electricity from Grid in the period of March 2020 to February 2021 was

Total KWH: 2,35,875

Electricity Charges: Rs. 53,13,362

The Diesel as a thermal energy source is used mainly in DG Sets of 1X625 KVA, 1X380 KVA and 1X250 KVA

Total Consumption of Diesel in the period of Mar 20 to Feb 21 was

Total Diesel in Ltr. 9,079

Cost of Diesel: 69.58

The University has a solar power generating system of 310 KW on the roof top of the academic building A, B, C blocks, DG room and the hostel building. The solar system is wheeled to grid.

Total Solar Generated Electricity Generated by University: 1,17,393

Total Exported Solar Generated Unit by University: 1,17,393

Note: All the Generated Solar Units are exported to the DHBVN because the University work shifted to Virtual space due to COVID-19 Pandemic.

Table 3. Total Cost of Energy Consumed by University in the period of Mar 20 to Feb 21

Electricity (INR)	Diesel (INR)	Total Cost of Energy	% of electricity	% of Diesel
5313362	631716.8	5945079	89.37	10.63

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Cost of Energy in the University

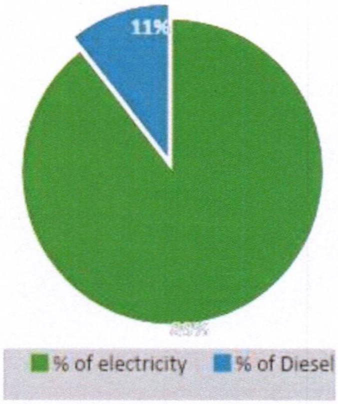

Figure 2. Share of Energy Consumption Cost (Graph)

Table 4. Distribution of Energy Types in the University in the Last 12 Months

ELECTRICITY	DIESEL	IN TJ		TOTAL	% OF ELECTRICITY	% OF DIESEL
235875	9079	0.84915	0.31	1.15915	73.25627	26.74373

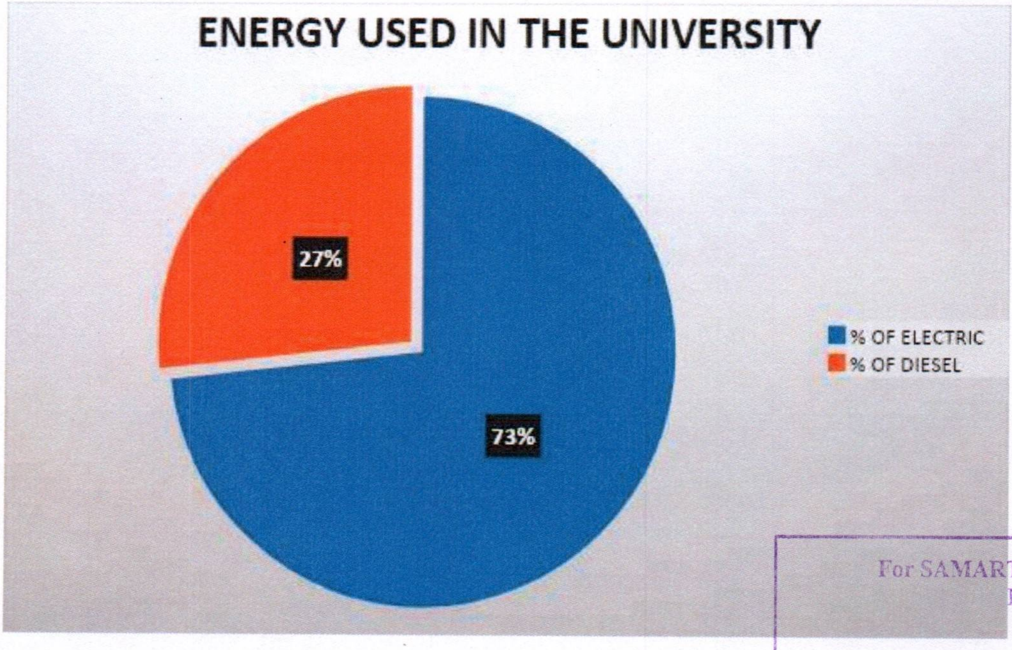

Figure 3. Share of Energy Types (Graph)

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4.2. Analysis of Electricity Bills: March 2020 – Feb 2021

K.R. Mangalam University has only one electrical connection with a total contract demand of 2000 KVA. Power Supply is received from DHBVN (Dakshin Haryana Bijli Vitran Nigam). Monthly Electricity Billing has been studied for a period of one year. All parameters have been studied & tabulated in **Table 5.**

Table 5. Month wise electrical energy consumption (12 Months data)

Billing Month	Sanctioned Load, Kw/CD	Units Consumed, kWh	Units Consumed, kVAH	Solar Generated	Net Billed Units	MDI	Average P.F.	Surcharge	Fixed Charge (Rs)	Rebate	Sundry Charges	Energy Charge (Rs.)	Panel Demand charge (Rs.)/Fuel Surcharge Adjustment	Electricity Duty (Rs.)	Total Bill, Rs.
Mar-20	2000	23000	23026	22607	419	168.4	1.00	4893	320000	0	0	2828.25	3365.2	909.5	327103
Apr-20	2000	17716	17980	26475	0	158	0.99	0	320000	320000	0	0.00	0.0	0.0	-100
May-20	2000	22270	22718	24391	0	793.2	0.98	542	320000	320000	36259	0.00	0.0	0.0	36159
Jun-20	2000	15258	15400	7507	7893	78.4	0.99	6008	320000	0	80000	0.00	0.0	0.0	400542

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Jul-20	2000	16064	16370	5145	11225	137.2	0.98	5456	320000	100000	80000	60412.50	3329.6	899.9	364642
Aug-20	2000	27406	28920	4936	23984	689.6	0.95	8490	320000	0	80000	157842.00	8144.0	2201.0	568187
Sep-20	2000	76888	80962	2634	78328	726.4	0.95	14344	320000	0	80000	528714.00	27528.7	7440.2	963683
Oct-20	2000	42978	43628	3738	39890	439.6	0.99	10258	320000	0	80000	269257.50	14620.2	3951.4	687829
Nov-20	2000	18484	18750	10328	8422	86.8	0.99	6901	320000	0	80000	56848.50	3188.7	861.8	460899
Dec-20	2000	24842	25060	4078	20982	184.8	0.99	7041	320000	0	0	141628.50	7773.7	2102.0	471504
Jan-21	2000	21604	21746	2084	19662	97.2	0.99	6900	320000	0	0	132718.50	7277.2	1966.8	461963
Feb-21	2000	28178	28450	3470	24980	120	0.99	8377	320000	0	60643	168615.00	9239.6	12454.3	570952
Sum/Avg.		**334688**	**343100**	**117393**	**235875**	**793.3 (MAX)**	**0.975**								**5313362**

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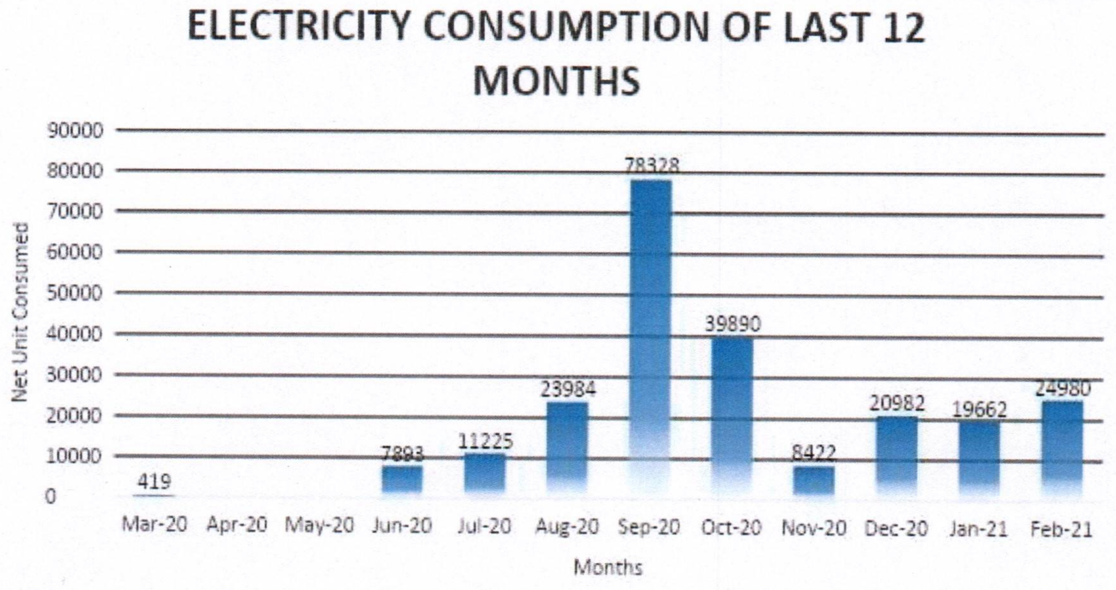

Figure 4. Electrical Energy Consumption

- It can be seen from figure 1, that electricity consumption in the month of Sep 20' is the highest.

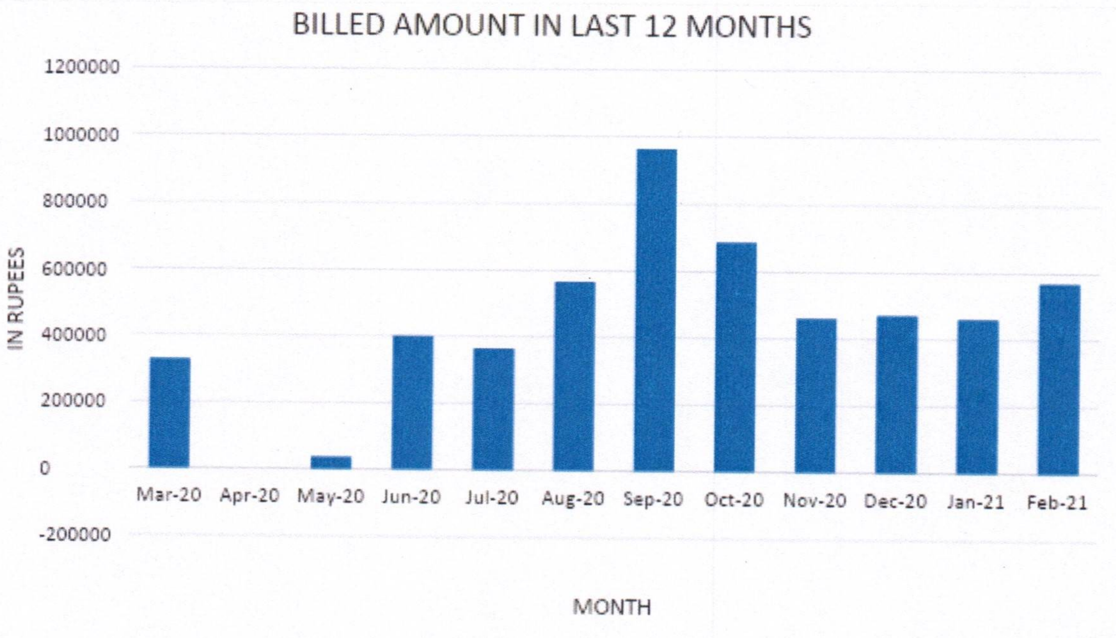

Figure 5. Billed Amount in last 12 Month Period

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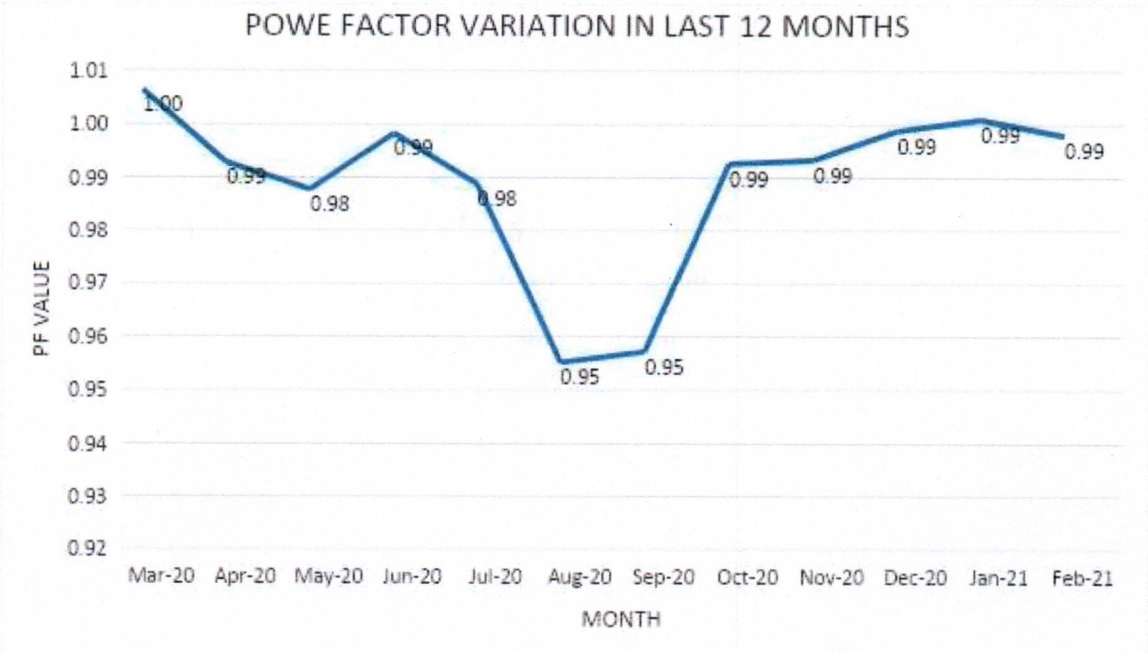

Figure 6. Power Factor Variation

- It can be seen from figure 6, that Recorded Highest Power Factor is 1.00 in Mar 2020 and Lowest is 0.95 in Aug 2020. Average Power Factor from March 2020 Feb. 2021 is 0.975.
- **It is recommended to install Automatic Power Factor Control Panel to achieve Power Factor near to 1.00.**

4.3. Solar Power System

The University has a solar power generating system of 310 KW on the rooftop of the academic building A, B, C blocks, DG room and the hostel building. The solar system is wheeled to the grid.

Data for Solar Panels						
Sr. No	Building	No. of Panels	Total no. of solar panels	Capacity	Total capacity	Rebate rate
1	A	157	984	310 Kw/day	41850 units/month	0.25
2	B	375				
3	C	204				
4	DG	120				
5	Hostel	128				

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Table 6. Month-wise Solar Generated Units in the last 12 Months

Sr. No.	Billing Month	Solar Generated KWH
1	Mar-20	22607
2	Apr-20	26475
3	May-20	24391
4	Jun-20	7507
5	Jul-20	5145
6	Aug-20	4936
7	Sep-20	2634
8	Oct-20	3738
9	Nov-20	10328
10	Dec-20	4078
11	Jan-21	2084
12	Feb-21	3470
Sum/Avg.		**117393**

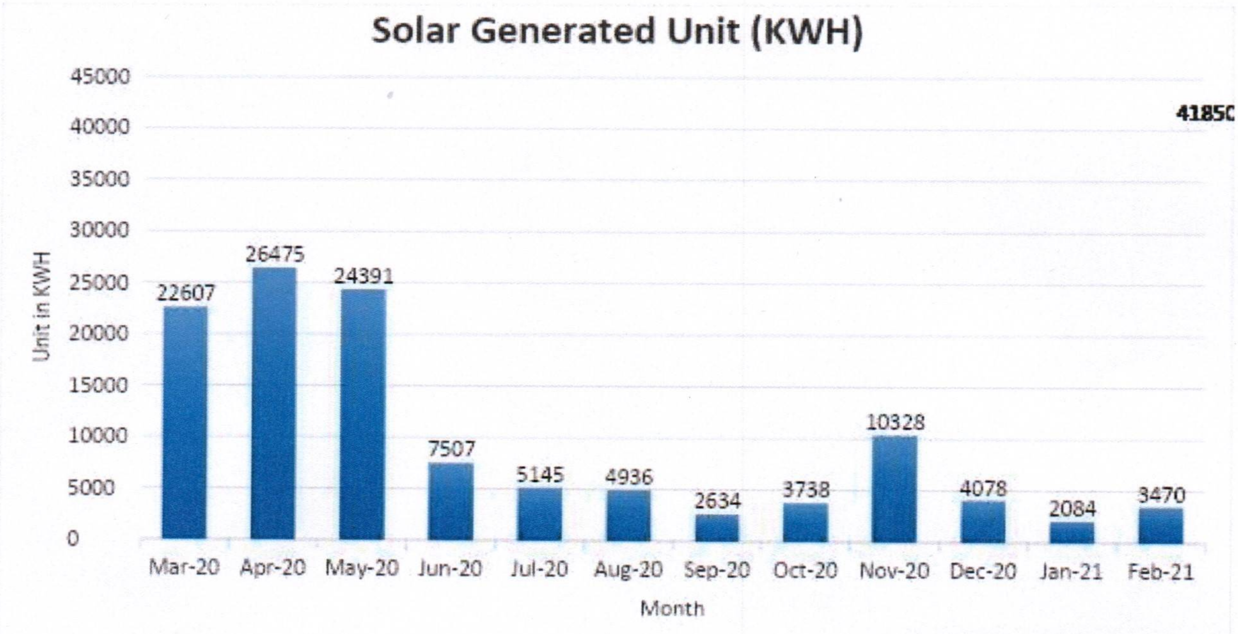

Figure 7. Solar Generated Unit (KWH)

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Table 7. Average Sunshine data of Gurugram

Month	Temperature	Average Sunshine (Hours)
December	15.00	8.3
January	13.33	10.6
February	17.22	11.2
March	23.33	12.0
April	30.00	12.9
May	33.89	13.6
June	33.89	13.9
July	30.56	13.7
August	31.11	13.1
September	30.00	12.3
October	26.67	11.5
November	21.11	10.7

4.4. Transformer

K. R. Mangalam University draws power from DHBVN (Dakshin Haryana Bijli Vitran Nigam) at 11 KV. Subsequently, the voltage is stepped down by one (1) transformer of 2000 kVA from 11 kV to 0.433 kV. Transformer rated specifications are shown below.

Transformer Rated Details

Table 8. TR Rated Details

Sr. No.	Particulars	TR # 1
1	Make	NA
2	KVA	2000
3	Volts at HV/LV	11000/415
4	Phases	3
5	Frequency	50

Transformer Load Survey (TR 2000 kVA)

During the site visit, 24-hour log of Transformer (2000 kVA) (5th March to 6th March 2021) was made to record the load profile of Transformer, which includes the variations in the voltage, current, power factor, kW, kVA, Vthd, Ithd etc. Details of the load profile are provided in the below table and figure.

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Table 9. TR-1 2000 kVA Load Measurement Data

Main Incomer LT Side		Transformer (2000 kVA)
Particulars	Phase	Average Measured Values
Voltage (Volts) (L-L)	Phase "R"	407
	Phase "Y"	419
	Phase "B"	422
Current (Amps)	Phase "R"	1277
	Phase "Y"	1289
	Phase "B"	1065
	Neutral	**12**
Load (KW)	Phase "R"	276.37
	Phase "Y"	293.74
	Phase "B"	241.58
	Total	**811.70**
Apparent Power (KVA)	Phase "R"	300.08
	Phase "Y"	311.83
	Phase "B"	259.49
	Total	**871.40**
Power Factor (P.F.)	Phase "R"	0.921
	Phase "Y"	0.942
	Phase "B"	0.931
Voltage THD %	Phase "R"	3.1
	Phase "Y"	3.2
	Phase "B"	3.1
Current THD %	Phase "R"	18.1
	Phase "Y"	16.9
	Phase "B"	16.8

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5. OBSERVATIONS BASED ON RECORDINGS

- The measurement taken at the transformers includes data logging for every 5 seconds for 24 hours and during the logging period it was found that the average Voltage (L-L) for the transformer **is** 419 V, which is slightly on the higher side. Therefore, it is suggested to maintain the Voltage level at 400 ± 10 by changing the tap position of the transformer.

- The average P.F. is 0.931, which is on the lower side. This can be increased up to 0.99 by adding or replacing de-rated capacitors with the new capacitors.

Effects of High and Low Voltage

- Wide Voltage fluctuation is a common phenomenon all over the country. Generally, the voltage is very low during the daytime and high during night hours. Therefore, Industrial Units running round the clock, face the problem of both Low and High Input Voltage. Also, voltage fluctuation is a seasonal phenomenon and increases in the summer season. Moreover, on holidays, peak hours, rainy days and when the agricultural load is switched off, the voltage rises sharply in the feeder lines. There are few consumers of electricity, during such days, leading to comparatively lower voltage drop in the feeder lines; as a result consumers suffer from high voltage which is more dangerous.
- Most electrical equipment is designed for 230 volts (single-phase) or 410 volts (3-phase) and operates with optimum efficiency at its rated voltage. 50% of industrial load consists of motors. Due to continuously varying voltage and especially during peaks, electric motors draw considerably high current at high voltage **which increases energy consumption**, increases MDI and reduces power factor etc. These excessive power losses of motors generated at higher voltage results in premature failure of electrical equipment.
- Similar is the case with single-phase equipment such as bulbs and tubes, when voltage increases above 230 volts. For example, at 270 volts, the power consumption of 60 W bulb

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increase by almost 40% and the life of the bulb reduces from normal 1000 Hours to mere 100 Hours only (as per analysis report of ISI marked bulb manufacturers)

Transformer Loading and Efficiency

The efficiency of the transformers not only depends on the design but also, on the effective operating load. The variable losses depend on the effective operating load on the transformer. The maximum efficiency of the transformer occurs at a condition when the constant loss is equal to variable loss. For distribution transformers, the core loss is 15 to 20% of full load copper loss. Hence, the maximum efficiency of the distribution transformers occurs at a loading between 40 – 60%. For power transformers, the core loss is 25 to 30% of full load copper loss. Hence, the maximum efficiency of the power transformers occurs at a loading between 40 – 60%.

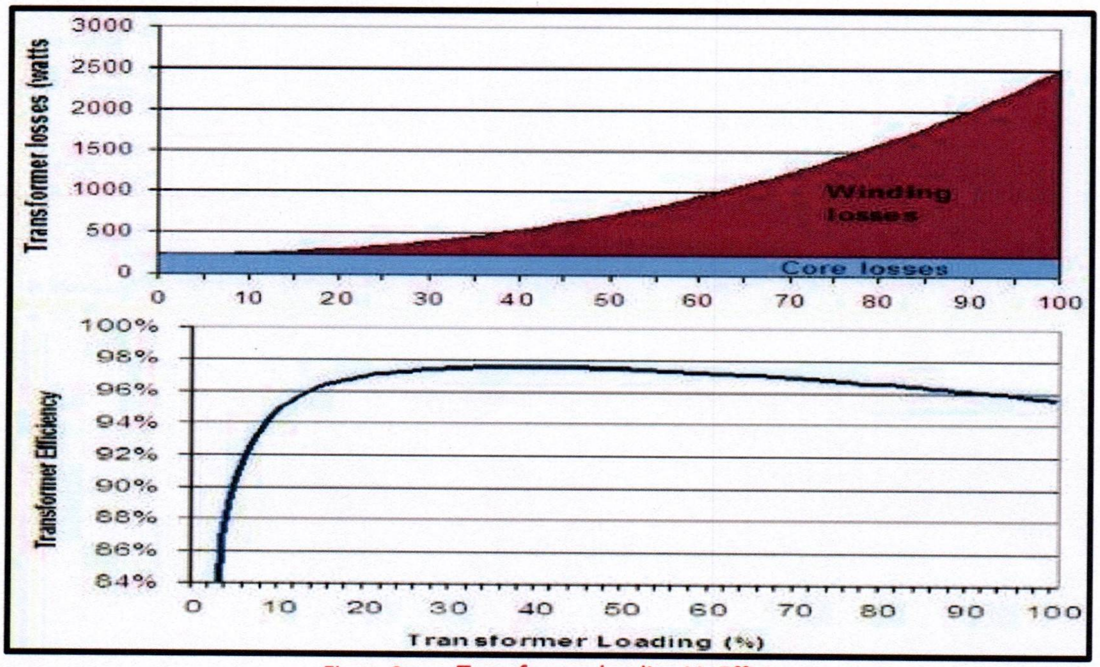

Figure 8. Transformer loading Vs Efficiency

All the electrical parameters required evaluating percentage loading & losses of Transformers were recorded for old building transformers.

No load and full load losses of the transformer are obtained from standards to calculate the transformer losses as follows.

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Note: Total loss = No load loss + Full load loss*(% Loading ^{2})

The efficiency of the transformers not only depends on the design but also, on the effective operating load. The variable losses depend on the effective operating load on the transformer.

Table 10. **Transformer loading**

Description	Transformer Capacity	Power factor	Maximum Apparent power	Average Apparent Power	Max Loading	Average Loading
	kVA	PF	kVA	kVA	%	%
TR1	2000	0.931	959.7	871.40	47.98	43.57

6. TOTAL CONSUMPTION

The University has facilities of HVAC, Lighting system, Fans, Lifts and Fire Fighting System in the Block A, Block B, Block C and Hostel of the University.

Table 11. **Distribution of Load in the University**

Load (KW) Distribution in the University						
Facility Operated	Block				Total	%age
	Block - A	Block - B	Block - C	HOSTEL		
AC	18.4	19.4	21.4	26.9	86.1	20.19
LIGHTING	11.23	8.6	9.73	11.04	40.6	9.52
FAN	32.4	30.4	32.8	40.2	135.8	31.84
LIFT AND FIRE SYSTEM	0	0	144	0	144	33.76
COMPUTER & LAPTOP	6	6	8	0	20	4.69
Total	68.03	64.4	215.93	78.14	426.5	100.00
%age	15.95	15.10	50.63	18.32		

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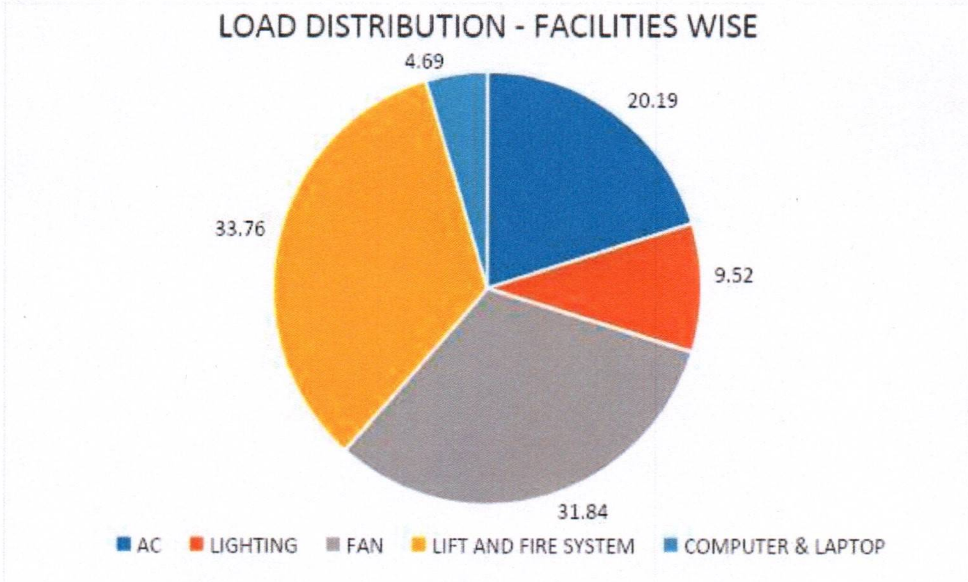

Figure 9. Load Distribution – Facilities-wise

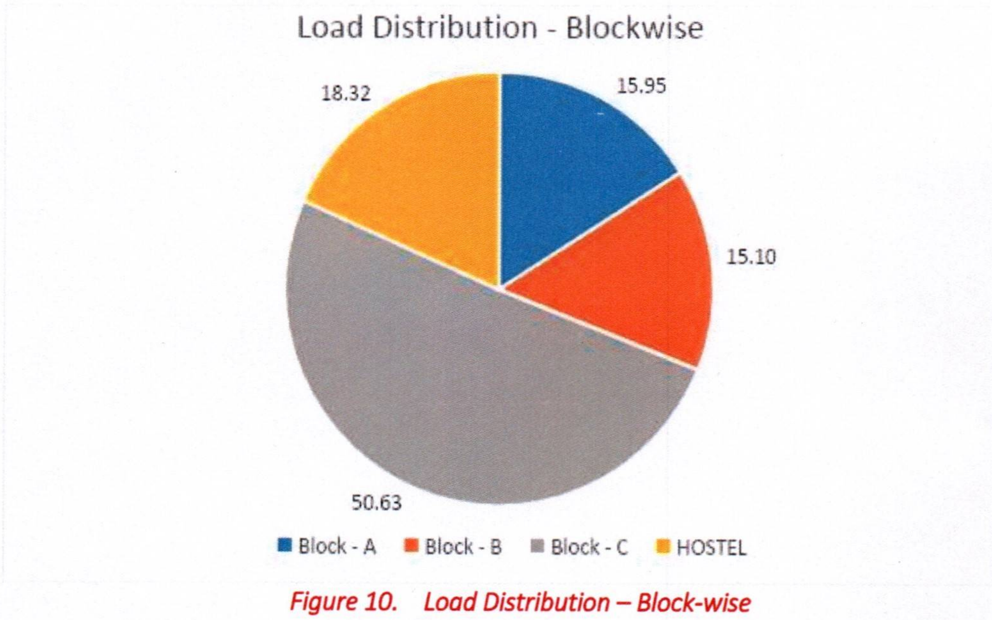

Figure 10. Load Distribution – Block-wise

- **Observation:** Block A consumption is approx. 50% of the total consumption.

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7. HVAC SYSTEM

KRMU has installed 5 Air cooled Chillers on the terrace for fulfilling the requirement of Air conditioning of the space.

2 Nos 300 TR Hitachi
2 Nos. 150 TR Blue Star
1 No. 150 TR Hitachi

At a time 600TR to 750 TR load is required depending upon weather conditions.
The performance of the chillers was evaluated:

Table 12. Chiller Performance 300 TR Hitachi

Phase	Volt	Ampere	PF	Power
R	226	310	0.86	60.26
Y	238	340	0.74	59.8
B	239	322.4	0.96	73.97
Total				**194.03**
Cooling effect		248.6	TR	
COP in kW/TR		0.78	kW/TR	
The COP is satisfactory				
Considering the whole system				
COSP in kW/TR		0.88		
Coefficient of System Performance is good				

Table 13. Chiller Performance 300 TR Hitachi

Phase	Volt	Ampere	PF	Power
R	225	316	0.96	68.26
Y	240	326	0.84	65.72
B	232	312.4	0.95	68.85
Total				**202.83**
Cooling effect		268.6	TR	
COP in kW/TR		0.75	kW/TR	
Considering the whole system				
COSP in kW/TR			0.88	
Coefficient of System Performance is good				

Table 14. **Chiller Performance 150 TR Blue Star**

Phase	Volt	Ampere	PF	Power
R	225	156	0.76	26.67
Y	240	126	0.89	26.91
B	232	202.4	0.90	42.26
Total				**95.84**
Cooling effect		128.6	TR	
COP in kW/TR		0.745	kW/TR	
Considering the whole system				
COSP in kW/TR			0.78	
Coefficient of System Performance is good				

8. WATER PUMPS

KRMU has supply from Municipal water to meet the requirement for usage in University, Hostel and Washrooms. All the pumps are running as per the requirement. The detailed operating parameters of these pumps were measured to analyze the performance and it is given below.

The following parameters have been measured / recorded to assess the performance of pumps:

1. Suction pressure
2. Discharge pressure
3. Power consumption
4. Flow rate

2.1.1 Water Pumps

Table 15. **Performance Analysis of water pumps.**

Water Pumps - Secondary						
Description	UOM	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5
Design						
Make		Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar
Capacity	m^3/hr.	150	150	150	150	150
Head	M	30	30	30	30	30

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Water Pumps - Secondary						
Description	**UOM**	**Pump 1**	**Pump 2**	**Pump 3**	**Pump 4**	**Pump 5**
Power	KW	25	25	25	25	25
Operating Parameter						
Suction head	m	12.5	12.5	12.5	12.5	12.5
Discharge head	m	45	45	45	45	45
Flow rate	m^3/hr.	96.76	106.76	100.08	116.26	106.72
Power consumption	kW	18.8	18.2	16.6	15.2	18.1
Combined efficiency	%	51%	61%	55%	65%	65%
Pump Efficiency (ŋ Motor=91%)	%	59%	67%	63%	70%	70%

- **Pump performance found satisfactory.**

Water Pumps - Primary						
Description	**UOM**	**Pump 1**	**Pump 2**	**Pump 3**	**Pump 4**	**Pump 5**
Design						
Make		Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar
Capacity	m^3/ hr.	120	120	120	120	120
Head	M	25	25	25	25	25
Power	KW	15	15	15	15	15
Operating Parameter						
Suction head	m	10.5	9.5	11.0	10.8	10.0
Discharge head	m	32	32	33	31.8	31.8
Flow rate	m^3/ hr.	96.76	106.76	100.08	116.26	106.72
Power consumption	kW	14.8	14.2	14.6	15.2	15.1
Combined efficiency	%	54.5%	63%	69%	70%	68%
Pump Efficiency (ŋ Motor=91%)	%	59%	67%	63%	70%	70%

- **Pump performance found satisfactory.**

9. LIGHTING SYSTEM

The University has already implemented energy efficient measures in lighting areas at different places. All conventional lamps are replaced by LED Lamps.

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Table 16. LED Consumption in the University

Blocks	LED Consumption (KWH)	%age
A - Block	6.78	13.21
B - Block	2.03	3.95
C - Block	14.74	28.72
Hostel	15.35	29.90
Outer Area	12.43	24.22
Total Consumption (KWH)	51.33	

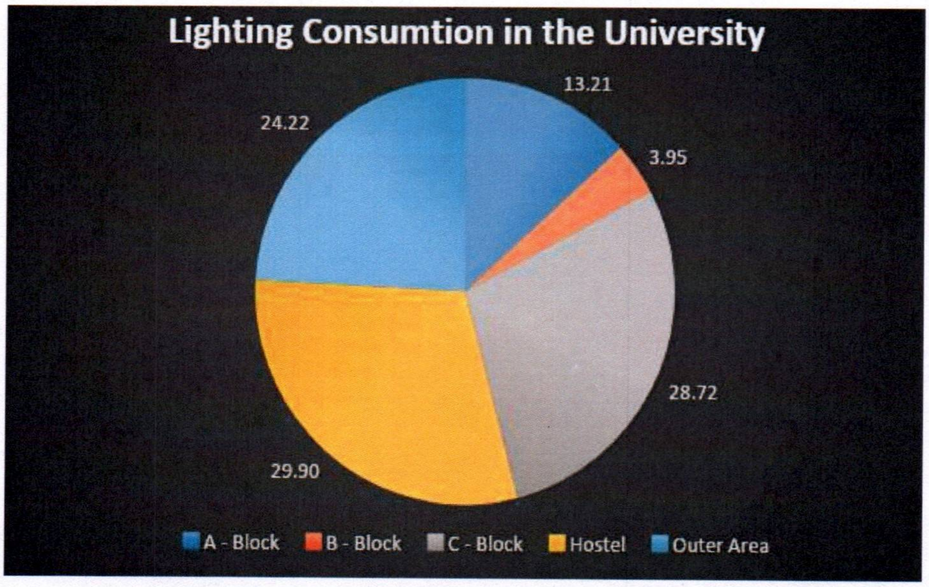

Figure 11. Lighting Consumption in the University

Observation:

- It is recommended to install occupancy sensors ex. restroom, offices, lobby, staircases, panel room etc.
- University has opted for the latest LED technology for lighting.
- Lux was found satisfactory in many palaces but in some places, it differed with standard. It can be maintained as per University requirement.

Recommended value of illumination given as per National Building Code of India, 2005 clause 4.1.3, 4.1.3.2, 4.3.2 and 4.3.2.1

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Table 17. Details of measured lux in University

S.NO.	LOCATION NAME	MIN LUX	MAX LUX	Recommendation
1	Ground Floor – A-Block	120	126	100-200
2	Basement – C-Block	101	115	100-200
3	DG Room - Terrace	150	260	100-200
4	Classrooms – C-block	300	403	300
5	Lecture rooms (including Demonstration areas)	301	432	300
6	Reading rooms	250	450	300-500
7	Laboratories	538	639	500-750
8	Corridors	150	170	150
9	Libraries	315	370	300
10	Moot court	245	450	300-500
11	Stage area	125	325	300
12	Canteen	80	120	100
13	Staff Room	155	185	150

Computers and Other Power Devices

University is using approximately 350 nos. of computer and other power electronic devices.

An average desktop computer uses between 60 and 300 watts. It is very difficult to know exactly how much computers use on average because there are so many different hardware configurations. We estimate that an average modern desktop PC will use approximately 100 watts of power per day approximately 4-6 hrs. working per day.

Total consumption of electricity for 350 computers per day = 38.5 KWH= 770 KWH per month
Considering 250 days of working power consumption = 250 X 38.5 = 9625 KWH
Which is a substantial consumption.

To save energy, turn off the computer when it is not being used or enable power saving features such as hibernate, standby or sleep mode. Power saving modes will allow you to turn on a computer quickly when

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you need to use it. Sleep mode typically uses only 1-5 watts of power and can be set to turn on automatically after a set time of inactivity.

DG Performance

- Three DG installed of ratings – 625, 380 and 250 KVA
- DGs were running for power cuts. No major power cuts were observed
- Total diesel consumed = 9079 Litres.

10.General Tips for Energy Conservation in Different Utilities

Conserving energy in various utilities within a university can significantly reduce operational costs, carbon emissions, and environmental impact. Here are some general tips for energy conservation in different utilities of a university:

- **Lighting**
  - Use energy-efficient lighting options like LED bulbs and fixtures.
  - Install occupancy sensors to automatically turn off lights in unoccupied areas.
  - Make use of natural daylight by utilizing windows and skylights.
  - Regularly clean and maintain light fixtures to maximize efficiency.
- **Heating, Ventilation, and Air Conditioning (HVAC)**
  - Set HVAC systems to appropriate temperatures (e.g., slightly warmer in summer and cooler in winter).
  - Implement programmable thermostats to adjust temperatures based on occupancy schedules.
  - Seal windows, doors, and ducts to prevent heat/cooling loss.
  - Conduct regular maintenance of HVAC systems, including cleaning filters and checking for leaks.
- **Water Usage**
  - Fix leaks promptly in faucets, toilets, and other water fixtures.
  - Install low-flow faucets, showerheads, and toilets to reduce water consumption.
  - Implement irrigation systems with moisture sensors and timers to optimize outdoor water usage.
- **Appliances and Electronics**

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- Encourage energy-efficient practices among staff and students (e.g., turning off lights and electronics when not in use).
- Choose Energy Star certified appliances and electronics.
- Activate power management settings on computers and other devices.
- Unplug chargers and electronics that are not in use to prevent phantom power consumption.

- **Energy Management**
  - Conduct regular energy audits to identify areas of high energy consumption.
  - Utilize building automation systems to monitor and control energy usage remotely.
  - Implement energy-efficient building designs for new constructions and renovations.
  - Set up energy consumption tracking and reporting systems to monitor progress.

- **Renewable Energy Sources**
  - Invest in on-site renewable energy sources like solar panels and wind turbines.
  - Consider purchasing renewable energy from external sources to offset non-renewable energy consumption.
  - Incorporate educational components to raise awareness about renewable energy among students and staff.

- **Transportation**
  - Encourage biking, walking, carpooling, and the use of public transportation among students and staff.
  - Provide charging stations for electric vehicles (EVs) to promote their adoption.
  - Implement a bike-sharing program or provide incentives for using sustainable transportation methods.

- **Waste Management**
  - Implement effective recycling and composting programs to reduce landfill waste.
  - Promote a "reduce, reuse, recycle" culture within the university community.
  - Properly dispose of hazardous materials to prevent environmental damage.

- **Education and Engagement**
  - Raise awareness about energy conservation through workshops, campaigns, and educational materials.
  - Involve students and staff in energy-saving initiatives through contests and challenges.

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- Showcase the university's energy-saving efforts as a way to inspire others to adopt similar practices.

- **Continuous Improvement**
  - Regularly review and update energy conservation strategies based on performance data.
  - Stay updated on emerging technologies and practices for more efficient energy usage.
  - Foster a culture of sustainability within the university community for long-term success.

Remember that energy conservation is an ongoing effort that requires commitment from all members of the university community. By implementing these tips and customizing them to the specific needs of your university, you can make a significant positive impact on energy consumption and environmental stewardship.

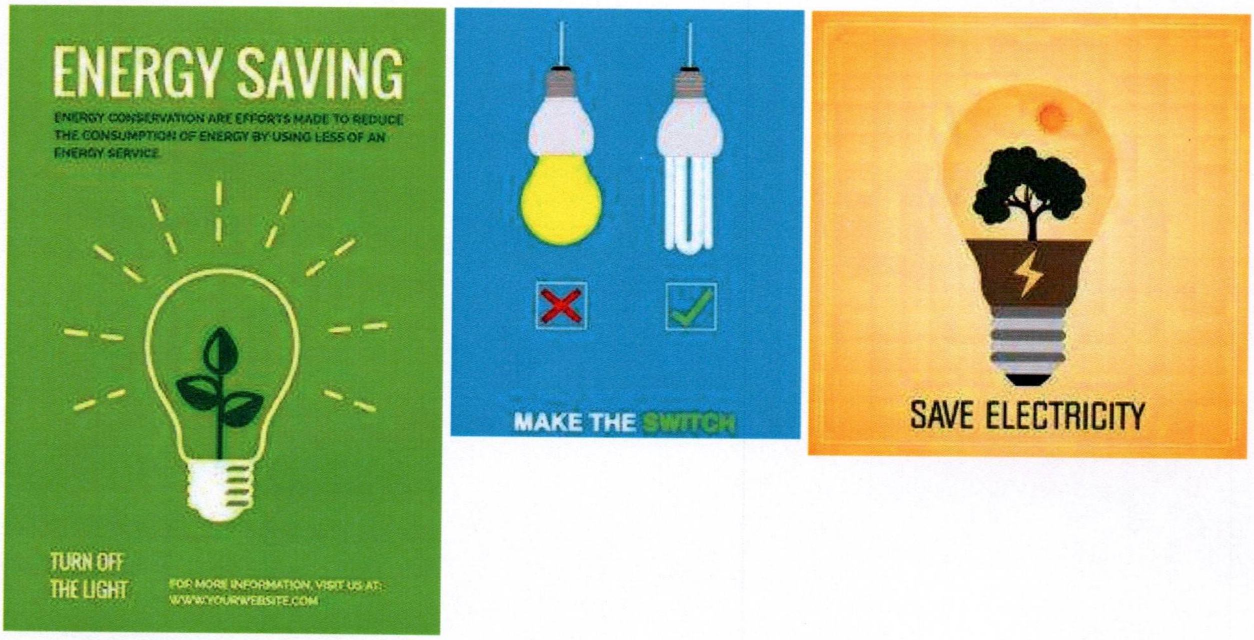

Figure 12. Awareness Posters

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