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GROUP

Energy Audit Report

K.R. MANGALAM UNIVERSITY

Sohna Road, Gurugram,
Haryana 122103

Audit Date – 03rd - 04th April 2023

<u>Audit Conducted by:</u>

SAMARTH
GROUP

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

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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 **03-04 APRIL 2023**

For SAMARTH MANAGEMENT PRIVATE LIMITED

Samarth Suri

Authorized Signatory

CERTIFICATE NO. **SMPL/2023/C-0028** DATE OF ISSUE **13-04-2023** AUTHORISED SIGNATORY

CONDUCTED BY

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K.R. Mangalam University

Sohna Road, Gurugram, (Haryana)

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 centimeter 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	03-04-2023 to 04-04-2023
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	Mr. Samarth Suri (Audit Manager) Mrs. Seema Suri (EA-0048) (Certified Energy Auditor) 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 Time					
1.	It is recommended to reduce contract demand to 1200 KVA from 2000 KVA as maximum demand is not more than 1000 KVA	-	15 .0	Nil	0
2.	Improvement in Power Factor by installation of Capacitor Bank	139328	12.73	1.0	1
3.	Installation of BLDC Fans in place of normal Fans	10440	0.9396	4.35	4.6
4.	Install Daylight Tubes	2592	0.23328	3.78	16.2
Total		152360	28.9	9.13	**4 months**

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

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- 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.

2.2 Methodology

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

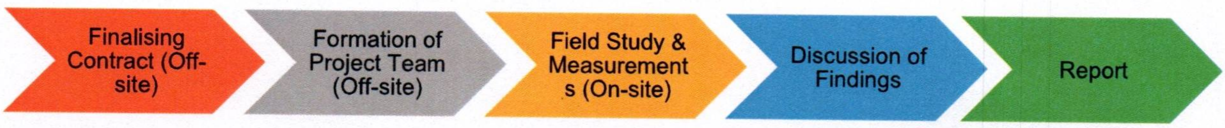

Figure 1 Methodology

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

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- 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 MOU with University of Portsmouth (London), University of Bialystok (Poland), Namangan Engineering Construction Institute (Uzbekistan), Houston University (Texas), Roehampton University (London), Delhi University (New Delhi), IIIT Manipur (Manipur) 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

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- 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 is developing with a motive of providing world class education in Indian Scenario and is started to fulfil the same purpose. The University is having Undergraduates, Post Graduates programmes and PhD Programs 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 & DESIGN
- JOURNALISM & MASS COMMUNICATION
- PHYSIOTHERAPY & REHABILITATION SCIENCES

3.2 Energy Sources and Cost

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

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- 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.

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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	9.14
Diesel	INR/Liter.	93.17

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 was

Total KWH: 22,80194.81

Electricity Charges: Rs. 20849512.19/-

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 Mar-22 to Feb-23 was

Total Diesel in Ltr. 79,656

Cost of Diesel: Rs. 74,21,549.52/-

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.

Total Solar Generated Electricity by University: 1099047 KWH

Table 3 Total Cost of Energy Consumed by University in the Last 12 Months

Electricity (INR)	Diesel (INR)	Total Cost of Energy	% of electricity	% of Diesel
20849512.19	7421550	28271061.71	73.74	26.25

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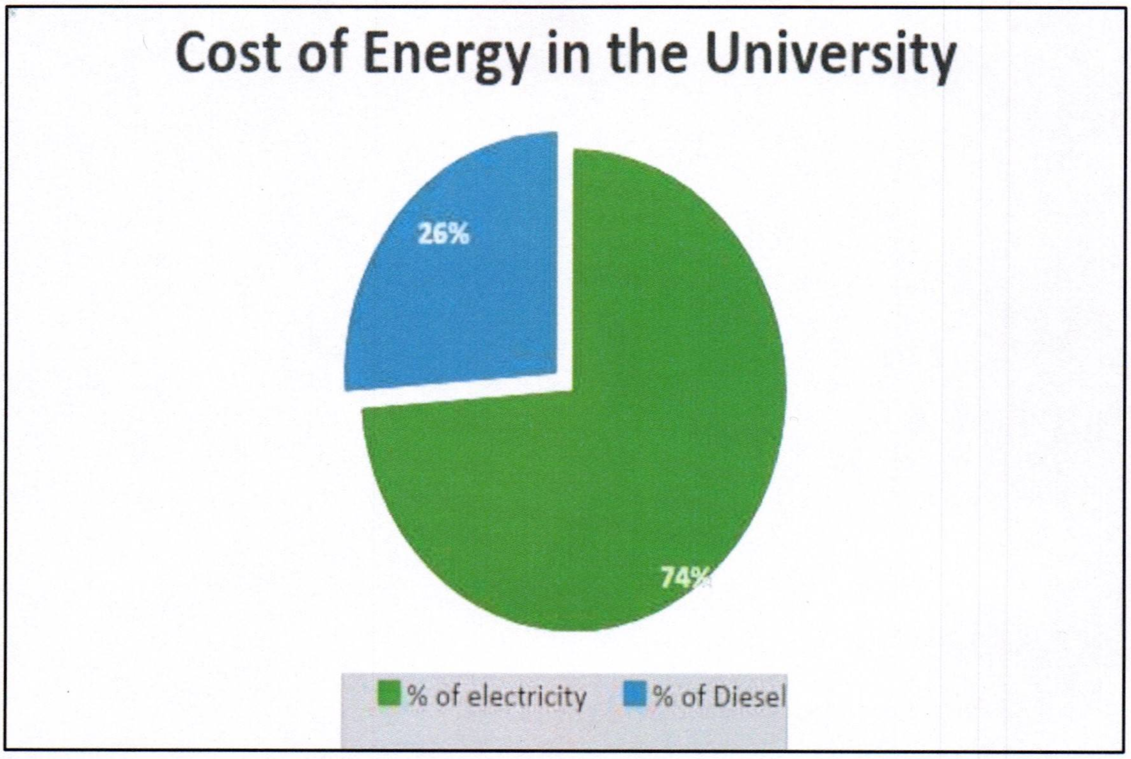

Figure 2 Share of Energy Cost (Graph)

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

ELECTRIC	DIESEL	IN TJ		TOTAL	% OF ELECTRIC	% OF DIESEL
2080195	79656	7.488702	2.72	10.2087	73.35606	26.64394

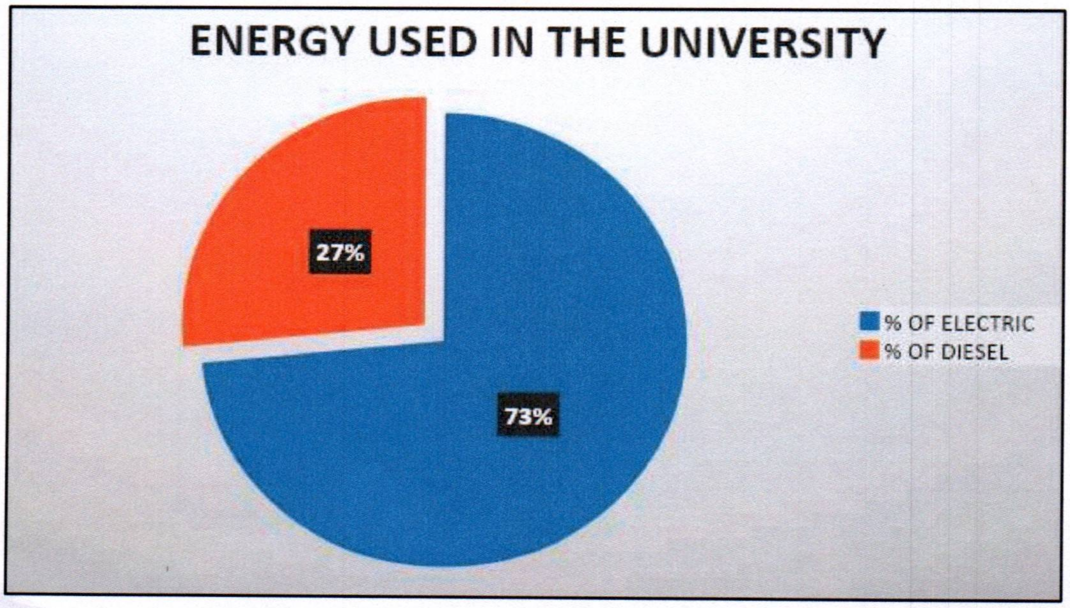

Figure 3 Energy Type Used in the University

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4.2 Analysis of Electricity Bills: Mar-22 To Feb-23

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	Units Consumed, kWh	Units Consumed, kVAH	Solar Generated	Solar Exported	Net Billed Units	MDI	Arrears	Average P.F.	Surcharge	Fixed Charge (Rs)	Energy Charge (Rs.)	Electricity Duty (Rs.)	Panel Demand charge (Rs.)/Fuel Surcharge Adjustment	Total Bill, Rs.
Mar-22	121129.8	135337.2	20159.2	3525	131812.20	Not Mentioned in the	0.49	0.90	18086	336328.64	876551.13	11763.73	24257.6	1248902
Apr-22	204506.2	228350	806909.8	128	228222.00		-0.36	0.90	27540	325479.33	1517676.3	20444.22	36863.11	1900463
May-22	258865.8	280701.2	35834.4	28	280673.20		-0.40	0.92	32935	336328.64	1866476.8	25884.98	44056.11	2272746
Jun-22	303373	333718.08	26609.6	9	333709.08		0.11	0.91	35062	325479.33	2219165.4	30377.2	50857	2625879
Jul-22	271641.2	300125	17197.2	12	300113.00		-0.2	0.91	34874	336328.64	1995751.5	27263.92	46641.6	2405985
Aug-	26636	277262	31834.6	0.07	277261.		0.41	0.9	3259	336328.	1843791	26636	43602.41	2250359

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22	0		2		93	bills		6	4	64	.8			
Sep-22	311182	331497	28174.8	14	331483.00		0.18	0.94	32850	336328.6	2204362.0	29048	41906	2611645
Oct-22	168190	178349	30076.4	2014	176335.00		0.22	0.94	22535	336328.64	1172627.8	16636.3	30189.31	1555782
Nov-22	74566	75109	29503	1045.6	74063.40		0.48	0.99	12163	325479.33	492521.6	7352.8	16360.02	841714
Dec-22	54085	54140	24141	426	53714.00		853877.2	1.00	26913	336328.64	357201.89	5366	13870.61	1844343
Jan-23	55082	55157	19055.2	160	54997.00		0.38	1.00	10423	336328.64	365730.05	5492.20	14040.15	721591
Feb-23	40037	40106	29552.4	2291	37811.00		0.09	1.00	8221	303780.71	251443.15	3774.6	11104	570103
Sum/Avg.	**2129018**	**2289851.48**	**1099047.62**		**2280194.81**			**0.93**		**3970847.78**	**15163299.28**			**20849512.19**

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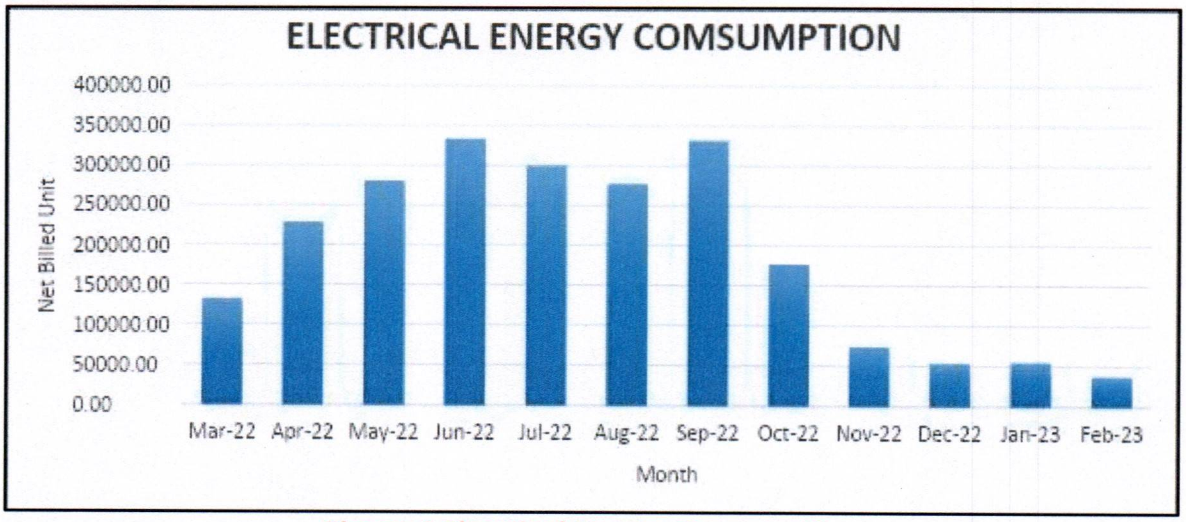

Figure 4 Electrical Energy Consumption

- It can be seen from figure 1, that electricity consumption in the month of Jun 22' is the highest.

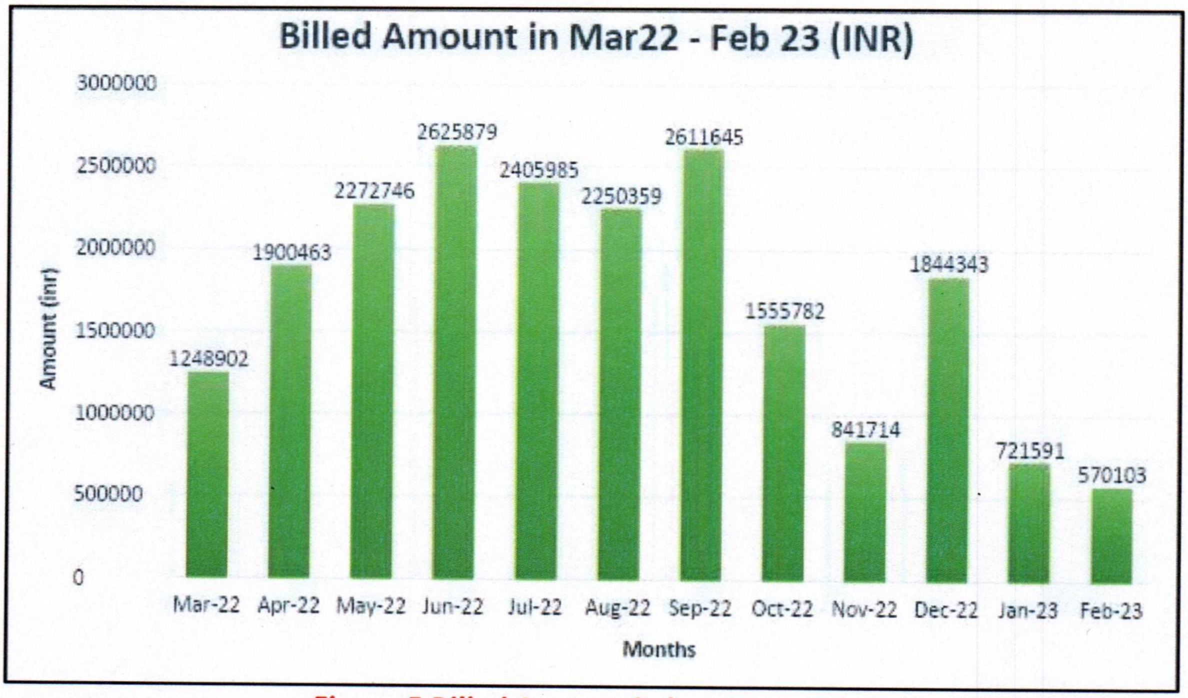

Figure 5 Billed Amount in last 12 months

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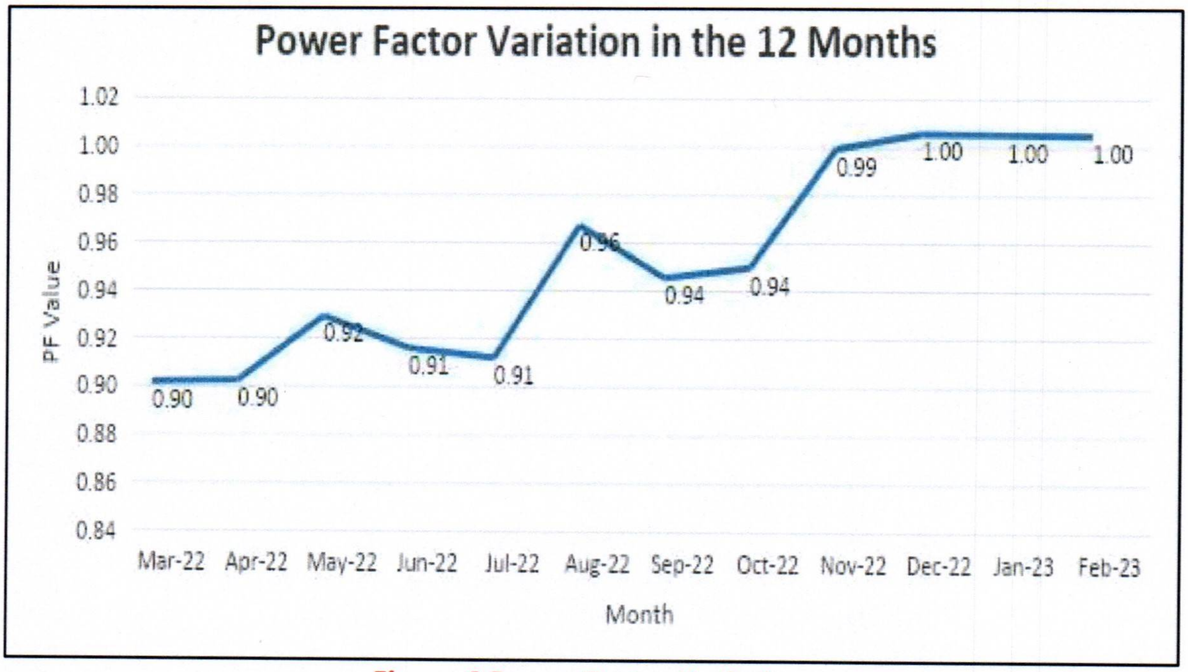

Figure 6 Power Factor Variation

- It can be seen from figure 3, that Recorded Highest Power Factor is 1.00 in Dec 2022 and Lowest is 0.90 in March and April 2022. Average Power Factor in the period of Mar-22 to Feb-23 is 0.93.

- It is recommended to install Automatic Power Factor Control Panel to achieve Power Factor near to 1.00. **Approximate cost saving during the last 12 months would have been Rs 1273460/- if University could have maintained 0.99 Power Factor.**

- It is recommended to have a regular check on the Power Factor to maintain it. Capacitors shall be tested every quarter and replaced if not working properly.

4.3 Solar Power System

The University consists of a solar power generating system of 310 KW on the rooftop of the academic building A, B & C as well as on the hostel building. Additional benefit comes in the form of rebate in property tax under 'Green Building' norms and uninterrupted energy is available for use during daytime all around the year. Apart from this, solar power generating system is provided in the hostels for power generation and hot water requirement

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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				

Table 6 Month-wise Solar Generated Units (Mar-22 To Feb-23)

Sr. No.	Billing Month	Solar Generated KWH
1	Mar-22	20159.2
2	Apr-22	20909.8
3	May-22	35834.4
4	Jun-22	26609.6
5	Jul-22	17197.2
6	Aug-22	31834.62
7	Sep-22	28174.8
8	Oct-22	30076.4
9	Nov-22	29503
10	Dec-22	24141
11	Jan-23	19055.2
12	Feb-23	29552.4
Sum/Avg.		**255096.42**

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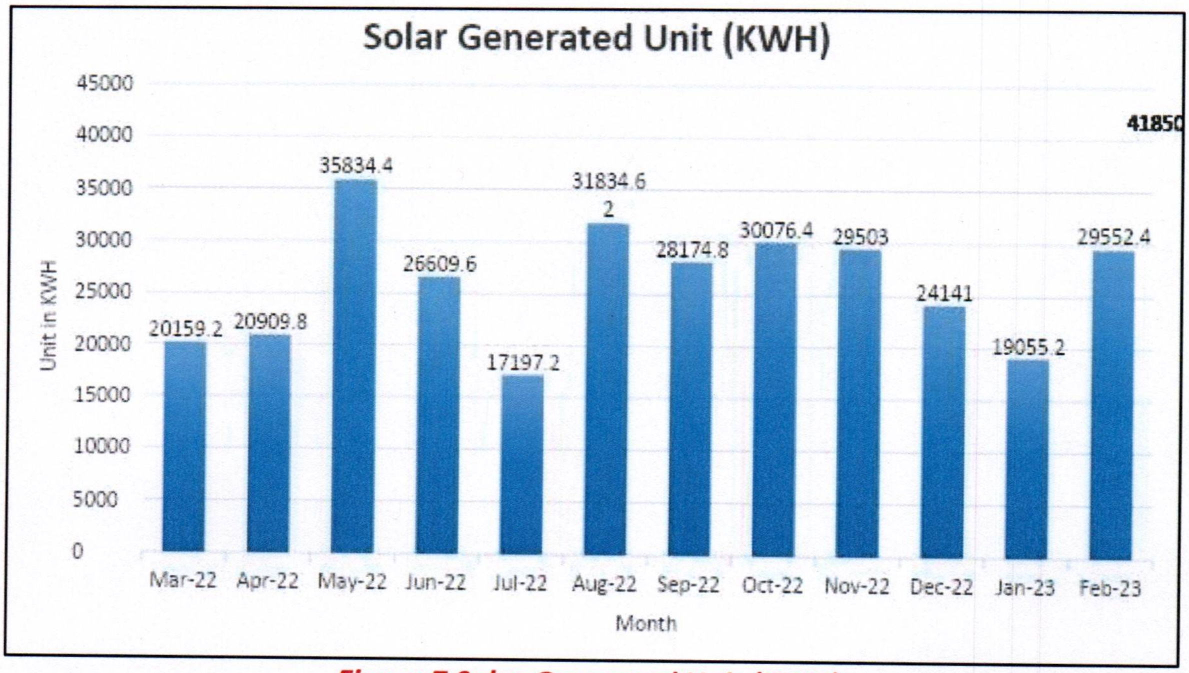

Figure 7 Solar Generated Unit (KWH)

Table 7 Average Sunshine data of Gurugram

Month	Temperature	Average Sunshine (Hours)
January	13.5	8.3
February	17	9.4
March	22.8	10.6
April	29.4	11.5
May	33.1	12.1
June	33.4	11.8
July	30.2	9.6
August	29	9.1
September	28.2	9.4
October	25.8	10.1
November	20.8	9.6
December	15.5	8.9

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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.

4.4.1 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

4.4.2 Transformer Load Survey (TR 2000 kVA)

During the site visit, 24-hour log of Transformer (2000 kVA) (3th April 2023 to 4th April 2023) 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.

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"	410
	Phase "Y"	417
	Phase "B"	420
Current (Amps)	Phase "R"	1256
	Phase "Y"	1198
	Phase "B"	1305
	Neutral	12
Load (KW)	Phase "R"	273.83
	Phase "Y"	271.70

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Main Incomer LT Side		Transformer (2000 kVA)
Particulars	Phase	Average Measured Values
	Phase "B"	294.62
	Total	**840.16**
Apparent Power (KVA)	Phase "R"	297.32
	Phase "Y"	288.43
	Phase "B"	316.45
	Total	**902.21**
Power Factor (P.F.)	Phase "R"	**0.921**
	Phase "Y"	**0.942**
	Phase "B"	**0.931**
Voltage THD %	Phase "R"	4.1
	Phase "Y"	5.2
	Phase "B"	2.1
Current THD %	Phase "R"	**12.1**
	Phase "Y"	**10.9**
	Phase "B"	**13.8**

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	0.927	1002.21	902.21	50.11	45.15

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4.4.3 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 420V**, 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 **0.927,** 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.

- Current harmonics are a little higher side. Presently there is no need to take any measure.

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 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%.

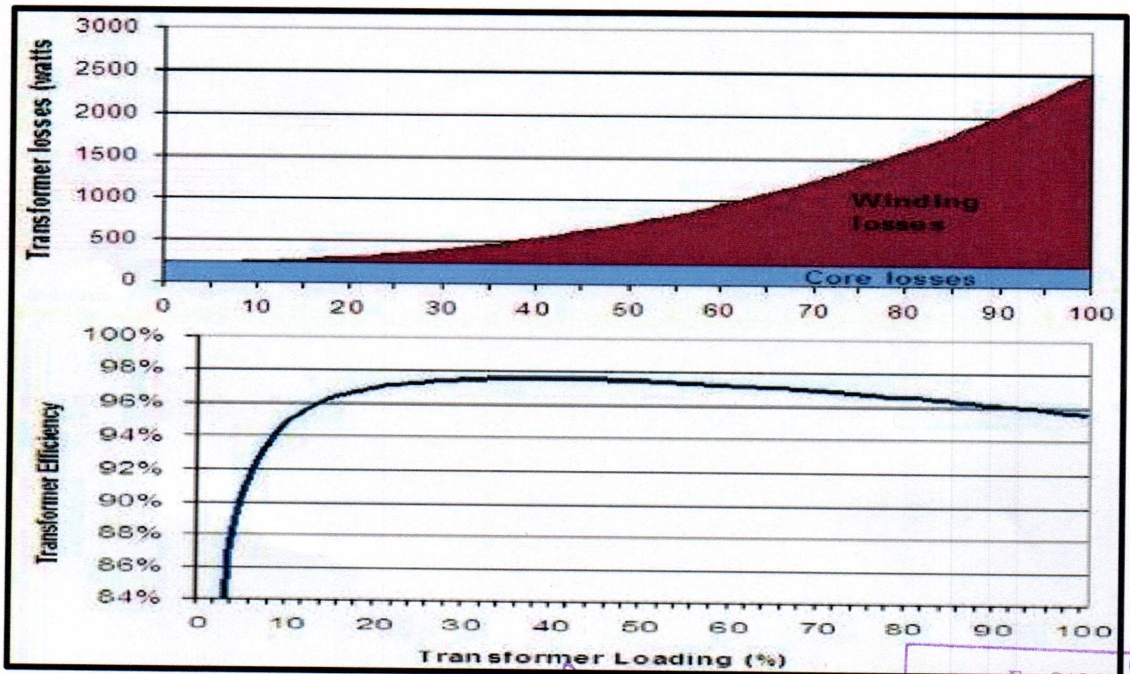

Figure 8 Transformer loading Vs Efficiency

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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.

Note: Total loss = No load loss at 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.

Transformer load is 51% noted during power quality analysis. There is no possibility of overloading. Though Maximum demand is not given in the electricity bill of Last 12 Months. It has been observed from the bills of the last 5 years that the maximum loading observed in one month is 1200 KVA. It is advisable to reduce contract demand and save on fixed charges.

University is paying fixed charges approximately Rs 165/ KVA since the installation of the meter whereas maximum load is less than 1000 KVA in most of the months.

University can save approximately Rs. 1,32,000/- per month and Rs 15,00,000/- yearly without any investment.

5. Total Energy Consumption Analysis

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	19.33
LIGHTING	11.23	8.6	9.73	11.04	40.6	9.11
FAN	32.4	30.4	32.8	40.2	135.	30.48

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LIFT AND FIRE SYSTEM	0	0	144	0	144	32.32
COMPUTER & LAPTOP	10	13	16	0	39	8.75
Total	72.03	71.4	223.93	78.14	445.5	100.00
%age	16.17	16.03	50.26	17.54		

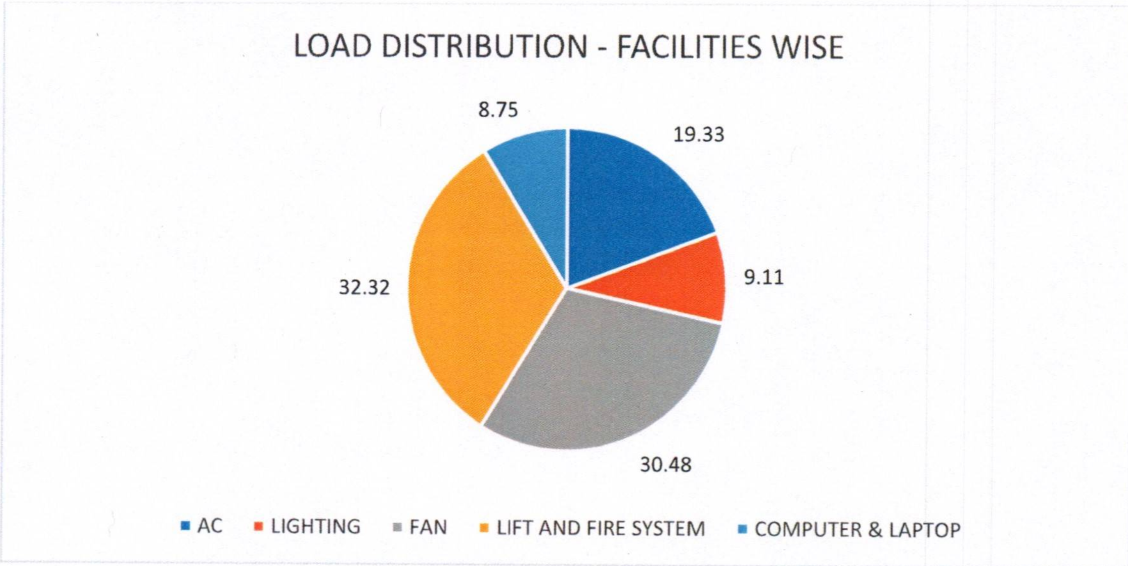

Figure 9 Load Distribution – Facilities-wise

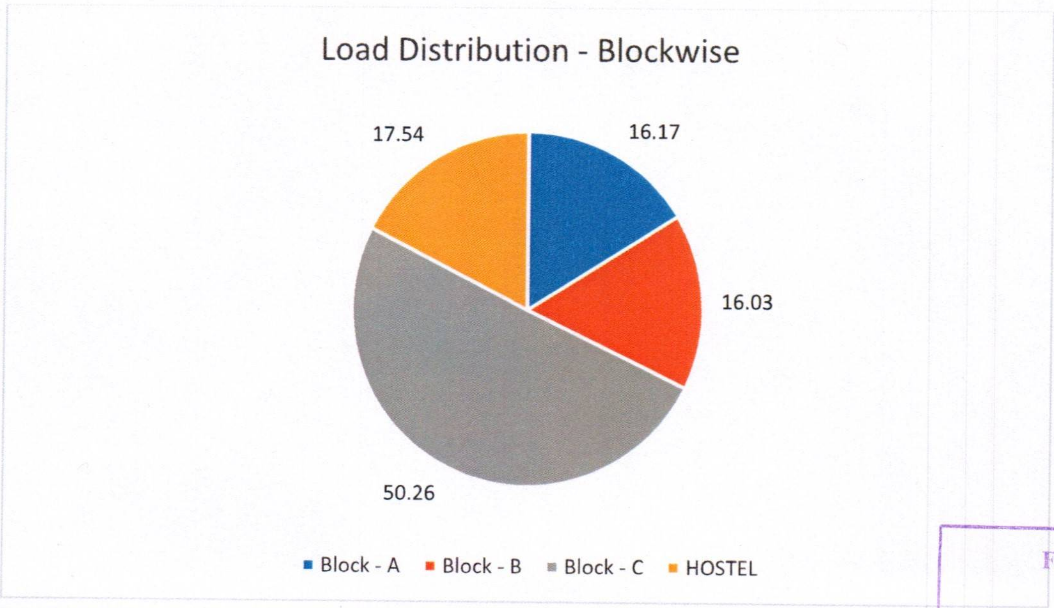

Figure 10 Load Distribution – Block-wise

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- **Observation:** Block C consumption is approx. 50% of the total consumption. Monitoring of Energy consumption of Block C shall be monitored to identify Energy Guzzlers and prepare an action plan to reduce the consumption.

5.1. 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				

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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	0.9	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				

5.2. 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 analyse 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

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
Power	KW	25	25	25	25	25

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Water Pumps - Secondary						
Description	UOM	Pump 1	Pump 2	Pump 3	Pump 4	Pump 5
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 (η 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 (η Motor=91%)	%	59%	67%	63%	70%	70%

- **Pump performance found satisfactory.**

5.3. Lighting system

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

Replacement of energy consuming lights with energy saving LED bulbs in the University lowers CO2 emission; energy consumption, decreases maintenance costs as well as less wear and tear on heating and cooling systems. LED lighting is an excellent & easy way to go green & save environment.

Table 16 DETAILS OF LEDs FITMENT

A Block		
Location	**Capacity In Watt**	**Total**
Canteen	20 Watt	26
Library	15 Watt	36
Ground Floor (Admission area)	20 Watt	25
Wash room	18 Watt	26
Moot court	15 Watt	52
Class Rooms	20 Watt	186
Corridor 1st Floor	20 Watt	24
B Block		
Class Rooms	20 Watt	111
C Block		
Basement	24 Watt	92
Basement	14 Watt	24
Basement	36 Watt	36
Class Rooms/Corrridor	20 Watt	509
Wash room	24 Watt	44
Hostel		
Boys Gym	40 Watt	19
Ground Floor corridor	24 Watt	31
1st Floor corridor	24 Watt	29
3rd Floor Washrooms & Toilets	08 Watt	112
3rd Floor Study Light	9 Watt	54
3r Floor Washbasin	5 Watt	54
4th Floor Washrooms & Toilets	08 Watt	112

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4th Floor Study Light	9 Watt	54
4th Floor Washbasin	5 Watt	54
Girls Mess	20 Watt	35
Boys Mess	20 Watt	26
3rd Floor inside Room (surface Light)	20 Watt	28
3rd Floor Inside Room (Tube Light)	20 Watt	54
3rd Floor Corridor	20 Watt	60
4th Floor inside Room (surface Light)	20 Watt	28
4th Floor Inside Room (Tube Light)	20 Watt	54
4th Floor Corridor	20 Watt	60
Outer Area		
A Block Terrace	400 Watt	8
B Block Terrace	400 Watt	1
C Block Terrace	400 Watt	1
Hostel Terrace	200 Watt	8
Sports Club	250 Watt	36
DG Room Terrace	200 Watt	2
		2111

Table 17 LED Consumption in the University

Blocks	LED Consumption (KWH)	%age
A - Block	7.01	12.93
B - Block	2.22	4.10
C - Block	15.08	27.82
Hostel	16.90	31.18
Outer Area	13.00	23.98
Total Consumption (KWH)	54.21	

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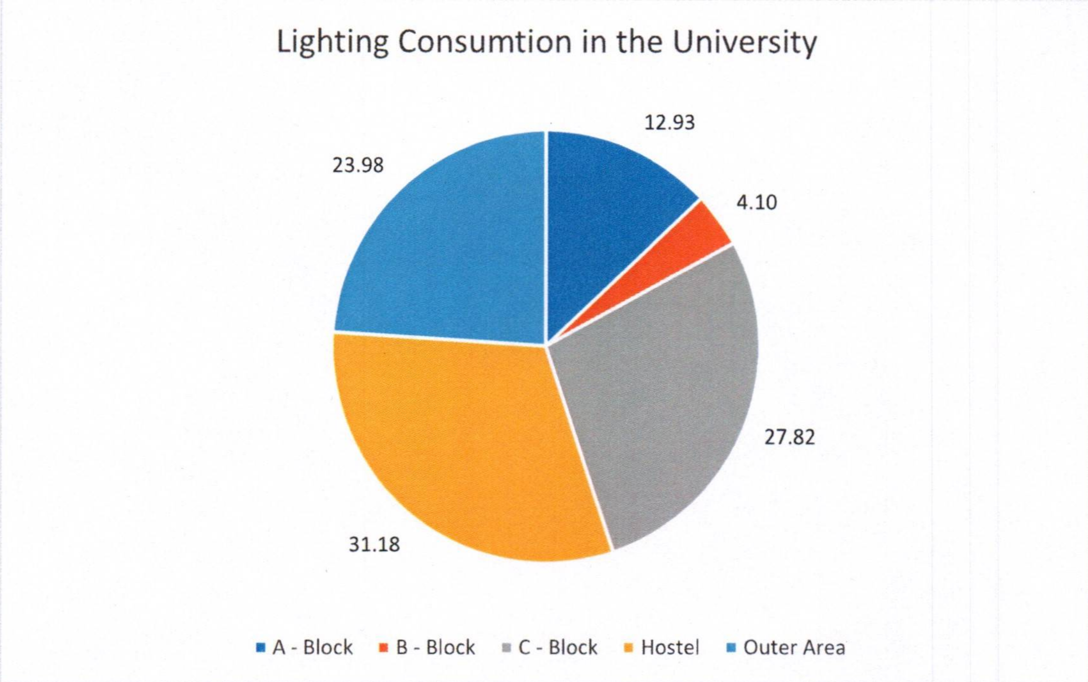

Figure 11 Lighting Consumption in the University

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 is different from 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

Table 18 Details of measured lux in University

S.NO.	LOCATION NAME	MIN LUX	MAX LUX	Recommendation
1	Ground Floor – A-Block	121	126	100-200
2	Basement – C-Block	103	115	100-200
3	DG Room - Terrace	150	170	100-200
4	Classrooms – C-block	310	450	300
5	Lecture rooms (including Demonstration areas)	310	450	300

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S.NO.	LOCATION NAME	MIN LUX	MAX LUX	Recommendation
6	Reading rooms	250	450	300-500
7	Laboratories	530	670	500-750
8	Corridors	150	170	150
9	Libraries	210	295	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

Solar Daylight tubes use the solar light to illuminate the interior of the building using the mirrors to reflect the light as per convenience. The lights do not use any electricity for their functioning. The estimated saving calculations are given below:

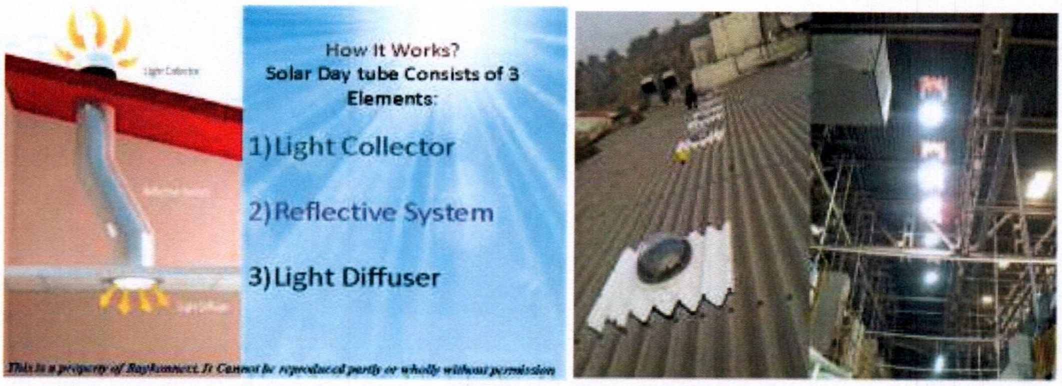

Figure 12 Solar Daylight tubes

Table 19 Saving Calculation for Daylight Tubes

Parameter	Unit of Measurement	Existing	Proposed
Lighting Type	-	LED Lamps	Solar Light Pipes
No of Fans	Nos	60	18
Power Consumption	Watts	18	0
Hours of Operation per year	Hours	2400	2400
Energy Consumed Annually	kWh/lamp	43.2	0
Saving in Energy	kWh/Fan		43.2
For 60 lamps	kWh		2592

Saving in Rs	Rs in Lakhs		0.23328
Investment for 20 Light Pipes	Rs in Lakhs		3.78
Payback	Years		16.2

5.4. Computers and other power devices

University is using approximately 1100 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 1100 computers per day = 110 KWH= 2200 KWH per month
Considering 250 days of working power consumption = 250 X 110 = 27500 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 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.

5.5. 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 = 79656 Litres.

5.6. Fans

KRMU has installed many fans for the comfort of the employees and students. The fans are regular fans consuming 70 watts each. The auditors recommend the use of Energy efficient BLDC Fans which consume less power.

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The fans are regular fans consuming 70 watts each. The auditors recommend the use of Energy efficient BLDC Fans which consume less power.

Table 20 Saving Calculation for Ceiling fans

Parameter	Unit of Measurement	Existing	Proposed
Ceiling Fan Type		Induction Motor	Brushless DC Motor
No of Fans	Nos	145	145
Power Consumption	Watts	70	25
Hours of Operation per year	Hours	1600	1600
Energy Consumed Annually	kWh/Fan	112	40
Saving in Energy	kWh/Fan		72
For 145 fans	kWh		10440
Saving in Rs	Rs in Lakhs		0.9396
Investment	Rs in Lakhs		4.35
Payback	Years		4.6

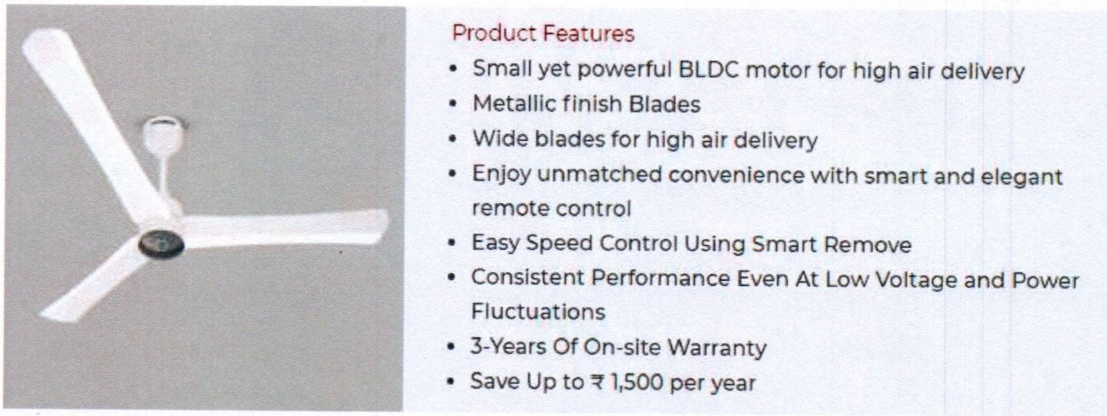

Figure 13 Energy Efficient BLDC Fan

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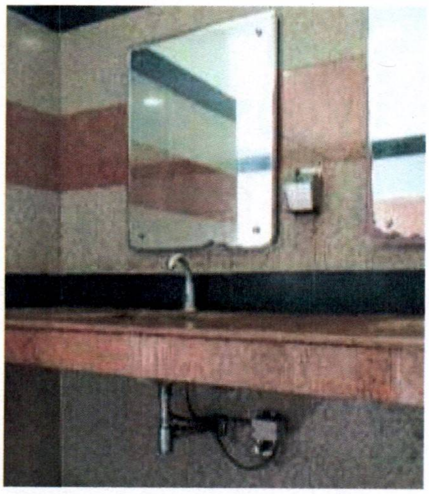
6. Energy Saving Activities in the University

Sensor Based Water Conservation System

Energy efficiency is a key strategy for the sustainable growth of the planet. The University with this objective has sensor-based water conservation system installed in all the washrooms. Further, the optimization of energy resources is ensured with the installation of sensor-based entry gates at every building within the University premises.

There are two circuits: sensor module and controller module. PIR sensor module is used here to detect the Human body movement, whenever there is any body movement the voltage at output pin changes. Basically, it detects the change in Heat, and produce output whenever such detection occurs. In controller module Relay is an electromagnetic switch, which is controlled by small current, and used to switch ON and OFF relatively much larger current. By applying small current we can switch ON the relay which allow much larger current to flow.



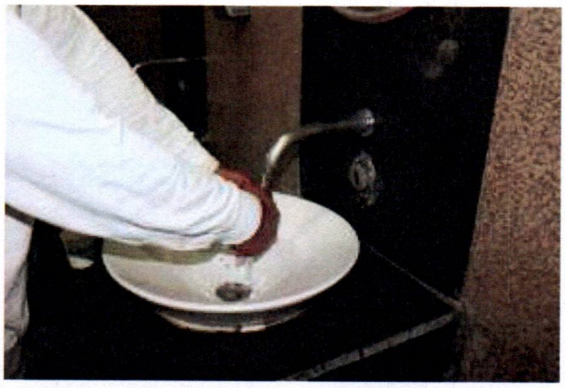


Figure 14 Sensor based Tap in the Washrooms

Automatic Doors with Motion Detecting Sensors

Nowadays, most automatic doors operate with motion-detecting sensors. The majority of motion detectors use either microwave pulses or passive infrared (PIR) sensors to detect movement. Microwave beam motion detectors send out pulses of microwaves that measure the reflections of moving objects. In contrast, passive infrared sensors measure temperature changes to detect body heat. Sensors with microwave technology are usually more expensive than infrared sensors because they can cover a larger area. However, they are also at risk of electrical interference.

Figure 15 Automatic Doors

Biogas Plant

KR Mangalam University committed to sustainable and eco-friendly practices, has undertaken a significant initiative to install a biogas plant on its campus. Biogas technology is a sustainable solution that not only helps in waste management but also contributes to energy conservation. This installation is a part of the university's broader effort to reduce its carbon footprint and promote renewable energy sources.

The installation of a biogas plant at KRMU is a significant step towards a greener and more sustainable future. It not only contributes to energy savings but also exemplifies the university's commitment to environmental stewardship. This project will serve as a model for other educational institutions and organizations seeking to implement similar sustainable initiatives.

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Figure 16 Bio Gas Plant

Solar Energy

The University consists of solar power generating system of 310 KW on the roof top of the academic building A, B & C as well as on the hostel building. Additional benefit comes in the form of rebate in property tax under 'Green Building' norms and uninterrupted energy is available for use during daytime all around the year. Apart from this, solar power generating system is provided in the hostels for power generation and hot water requirement.

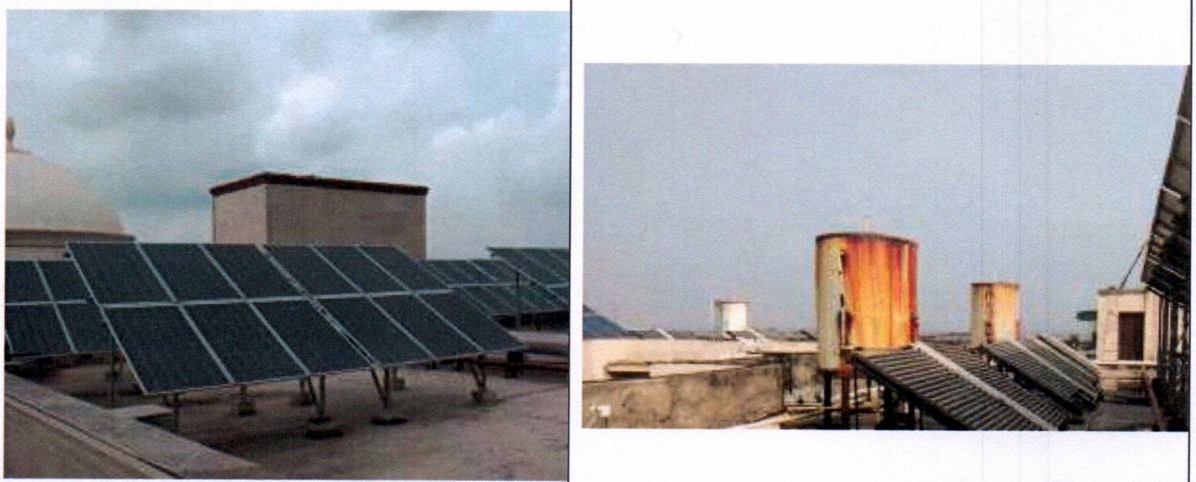

Figure 17 Photograph of Solar facilities

7. General Tips for Energy Conservation in Different Utilities

Figure 18 Awareness Posters

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