Energy Audit Report

K. R. Mangalam University

Sohna Road, Gurugram,
Haryana 122103

Audit Date – 04 and 05 March, 2019

Audit Conducted by:

M/S Samarth Consultants
212, Bhera Enclave, Paschim Vihar,
New Delhi, Delhi, 110087.

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Authorized Signatory

SAMARTH™
CONSULTANTS

CERTIFICATE OF EXCELLENCE

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

COMPLETED THE **ENERGY** AUDIT PROGRAM

CONDUCTED ON **04-05 MARCH 2019**

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Samarth Suri
Authorized Signatory

CERTIFICATE NO. **SMPL/2019/C-0013** DATE OF ISSUE **15-03-2019** AUTHORISED SIGNATORY

CONDUCTED BY

SAMARTH™
CONSULTANTS

www.samarthconsultants.com
212, Bhera Enclave, Paschim Vihar,
New Delhi - 110087

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

Acknowledgement

Samarth Consultants 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 Consultants 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.

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Authorised Signatory

Table of Contents

List of tables

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Authorized Signatory

List of Figures

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Authorized Signatory

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

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 Consultants**
Duration	03-04-2019 to 04-04-2019
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	R. Vaidyanathan B. E. (Electrical) Accredited Energy Auditor (B.E.E.) Atul Suri B.E (Electrical), MBA (Operation Research) Energy Auditor (B.E.E.) Seema Suri B.E (Electrical), Energy Auditor (B.E.E.) Sunil Yadav Dip. (Electrical).

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Authorized Signatory

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 Period				
1	It is recommended to reduce contract demand to 1200 KVA from 2000 KVA as maximum demand is not more than 1200 KVA. In one month only MDI was 1192	-	12.8	Nil	0
2	Improvement in Power Factor by installation of Capacitor Bank	47312	4.75	1.0	1
	Total	**47312**	**17.55**	**1.0**	**1 month**

2. Approach and Methodology

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.

Methodology

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

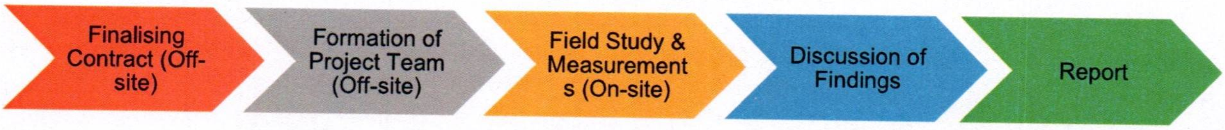

Figure 1. Methodology

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

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

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.

K.R. 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

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.

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Authorized Signatory

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	10.04
Diesel	INR/Liter.	69.49

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 Feb 18 to Jan 19 was

Total KWH: 16,02,248

Electricity Charges: Rs. 1,60,91,179/-

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 Feb 18 to Jan 19 was

Total Diesel in Ltr. 12,664

Cost of Diesel @ Rs. 69.49/Ltr.= Rs. 880021.36/-

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 Generated by University: 14,61,288 KWH
- Total Solar Generated Electricity Exported by University: 38,472 KWH
- Total Solar Generated Electricity Used by University: 14,22,816 KWH
- Rebate on Solar Usage from the DHBNV: 1,35,612

Table 3. **Total Cost of Energy Consumed by University in Year Feb. 2018-Jan. 19**

Electricity (INR)	Diesel (INR)	Total Cost of Energy	% of electricity	% of Diesel
16091179	880021.4	16971200	94.81	5.19

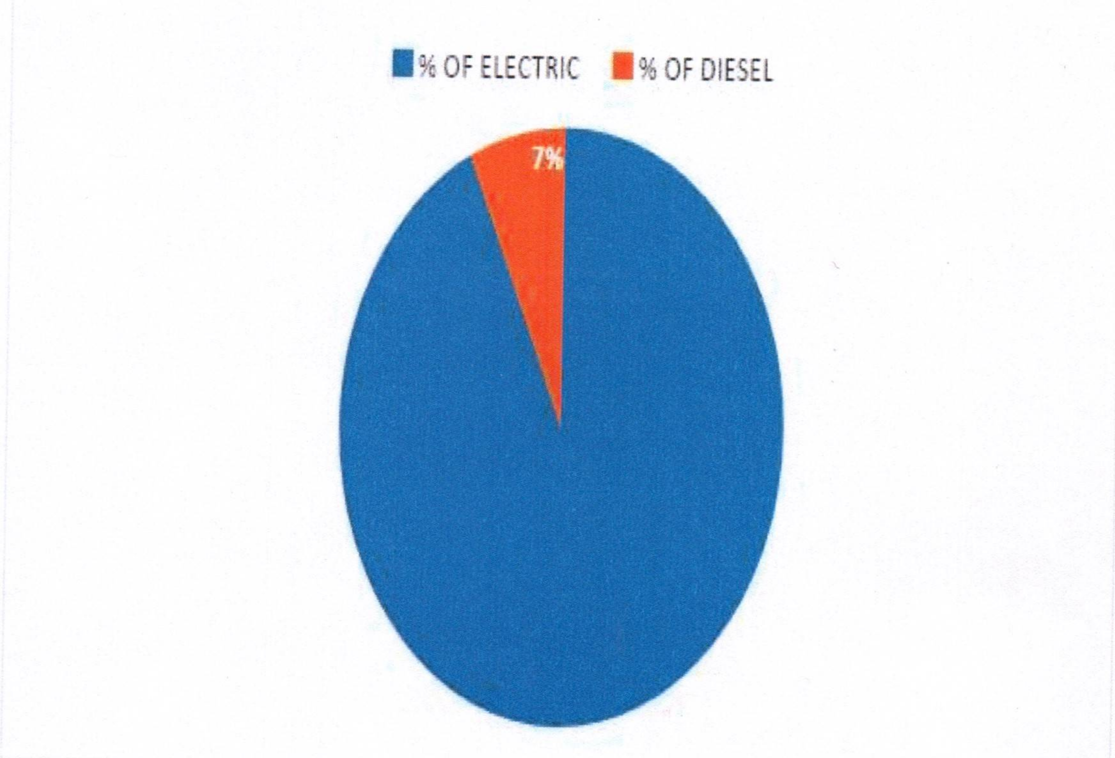

Figure 2. Share of Energy Consumption (Graph)

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

ELECTRICITY	DIESEL	IN TJ		TOTAL	% OF ELECTRICITY	% OF DIESEL
1602248	12664	5.768093	0.433	6.201093	93.01736	6.98264

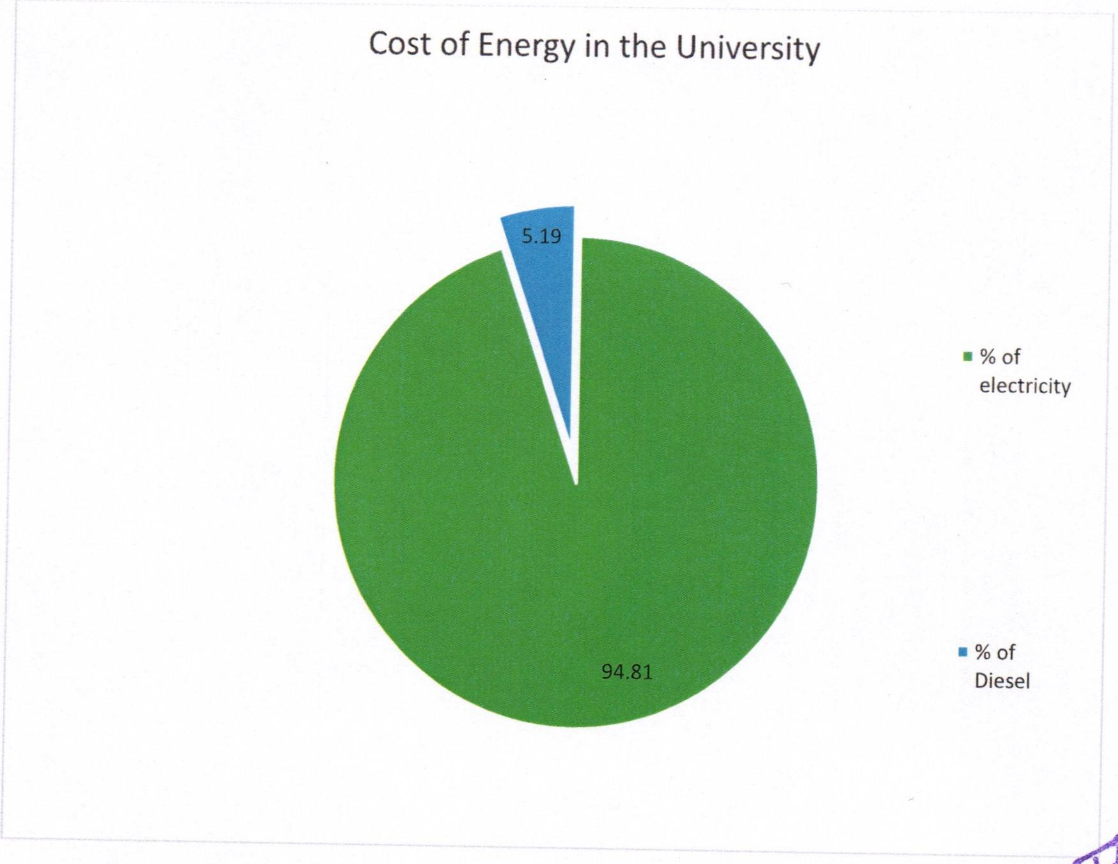

Figure 3. Share of Energy Cost (Graph)

4.2 Analysis of Electricity Bills: Feb. 2018- Jan.19

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	Export Solar Generated	Net Billed Units	Average P.F.	MDI	Sur-charge	Fixed Charge (Rs)	Rebate	Sundry Charges/ Arrears	Energy Charge (Rs.)	Panel Demand charge (Rs.)/ Fuel Surcharge Adjustment	Electricity Duty (Rs.)	Total Bill, Rs.
Feb-18	2000	45920	46000	0	0	46000	1.00	420	9712	320000	0	0	310500	16990	4592	652082
Mar-18	2000	107360	108020	0	0	108020	0.99	1190	16333	320000	0	0	729135	39723	10736	1099594
Apr-18	2000	123414	128960	126448	292	128668	0.96	1130	26919	320000	135612	0	1529064	81178.74	21940.2	1816571
May-18	2000	262080	274680	269960	140	274540	0.95	1086	34051	320000	0	0	1853145	96932.6	26198	2296276
Jun-18	2000	170200	177880	175040	120	177760	0.96	986	23860	320000	0	34051	1199880	62944.4	17012	1633887
Jul-18	2000	151300	159420	156740	140	159280	0.95	950	21700	320000	0	0	1075140	55958.8	15124	1466223
Aug-	2000	26268	27556	27108	160	275	0.95	10	341	320	0	0	185	97191.	26268	2302

18		0	0	0		400		80	42	000			8950	6		410
Sep-18	2000	205120	214940	210620	740	214200	0.95	1100	27624	320000	0	0	1445850	75716.8	20464	1862031
Oct-18	2000	146400	151860	148860	1180	150680	0.96	1040	20865	320000	0	0	1017090	53916	14572	1405578
Nov-18	2000	37880	38120	37720	11220	26900	0.99	352	7697	320000	0	0	181575	11551	3122	516248
Dec-18	2000	32520	32560	32360	13140	19420	1.00	120	6899	320000	0	0	131085	8865	2396	462346
Jan-19	2000	32600	32720	32460	11340	21380	1.00	148	8633	320000	0	102452	144315	8791.2	2376	577934
Sum/ Avg.		**1577474**	**1640720**	**1461288**	**38472**	**1602248**	**0.96**	**1190**								**16091179**

For SAMARTH MANAGEMENT PRIVATE LIMITED
Authorized Signatory

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

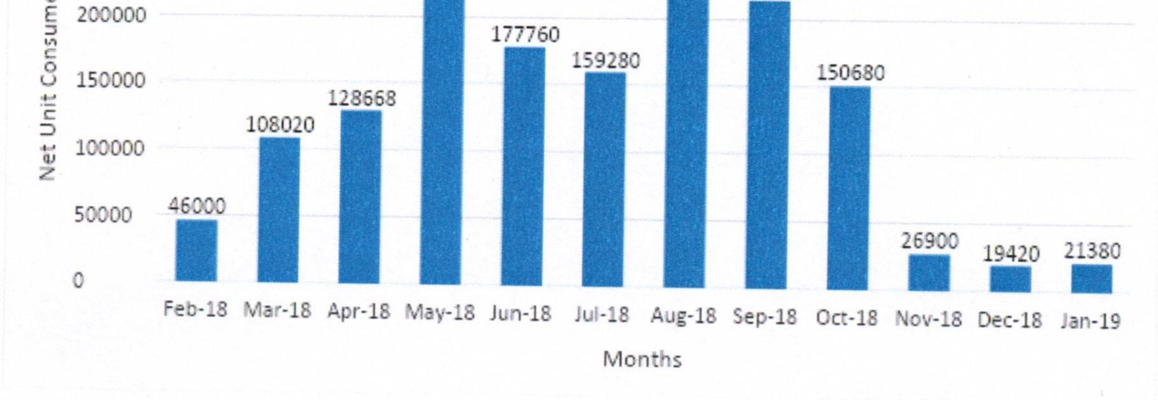

Figure 4. Electrical Energy Consumption

- It can be seen from figure 1, that electricity consumption in the month of May 18' is the highest.

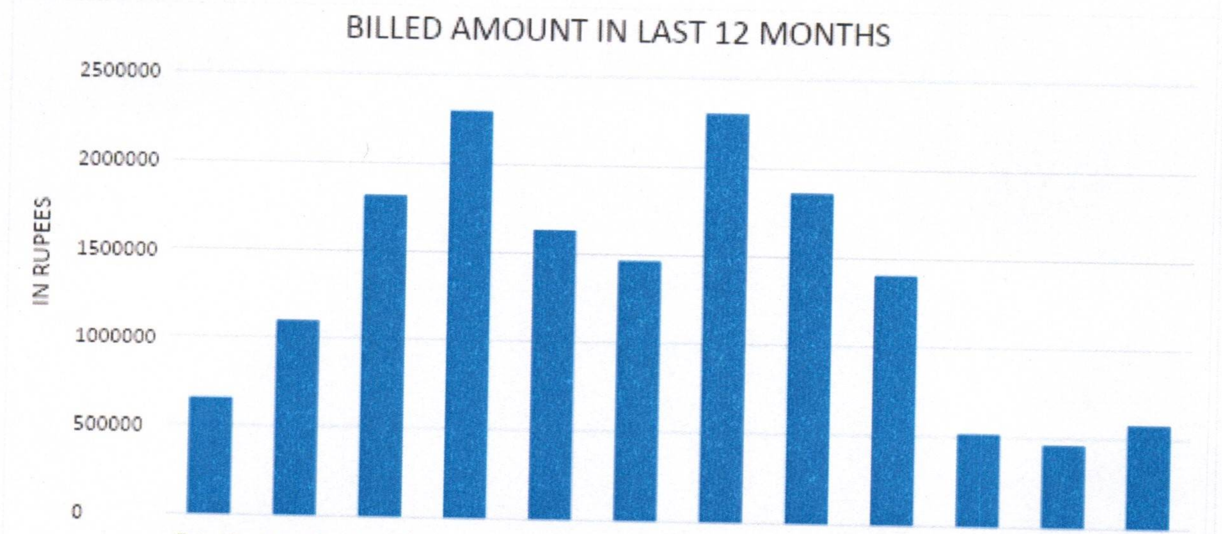

Figure 5. Billed Amount in Feb. 2018- Jan.19

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

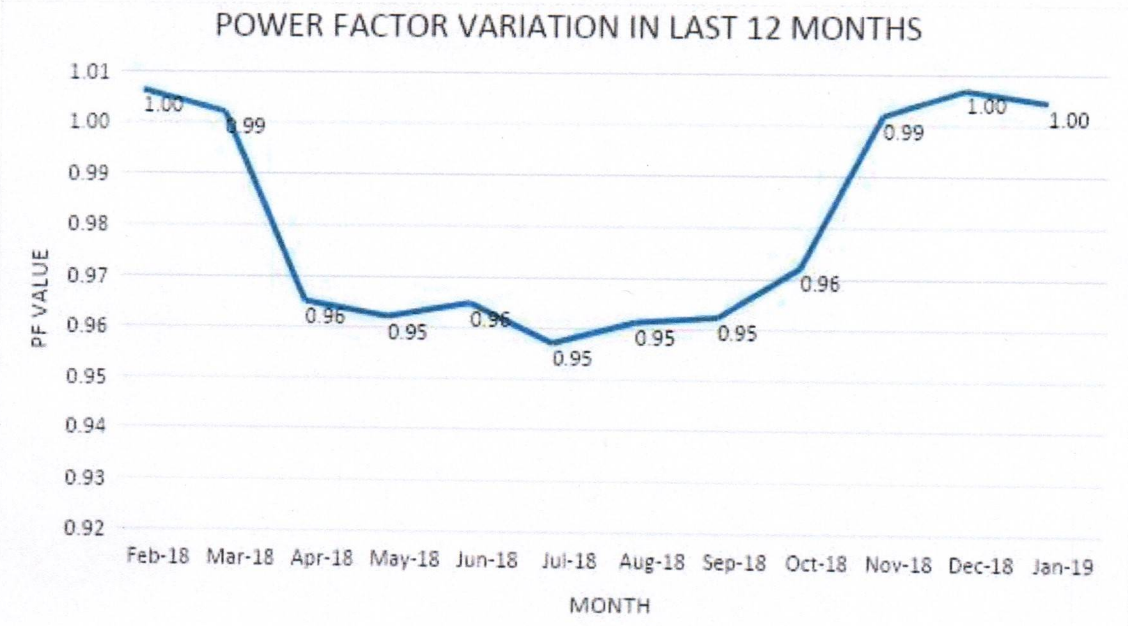

Figure 6. Power Factor Variation

- It can be seen from figure 3, that Recorded Highest Power Factor is 1.00 on Dec 18 and Lowest is 0.95 in July 2018. Average Power Factor in the last 12 months is 0.96.
- 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 meeting specifications.
- **By installing the Automatic Power Factor controller (APFC) University can save approximately 4.75 Lakhs rs. With an investment of Rs 1.0 Lakh.**

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				

Table 6. **Month-wise Solar Generated Units**

Sr. No.	Billing Month	Solar Generated KWH
1	Feb-18	0
2	Mar-18	0
3	Apr-18	126448
4	May-18	269960
5	Jun-18	175040
6	Jul-18	156740
7	Aug-18	271080
8	Sep-18	210620
9	Oct-18	148860
10	Nov-18	37720
11	Dec-18	32360
12	Jan-19	32460
Sum/Avg.		**1461288**

- In various months from Apr-18 to Oct-18 the recorded solar generated unit exceeds the total capacity of the Solar Plant. Data taken from last 12 months electricity bills from DHBVN.

- Meter needs to be checked by the official personnel.

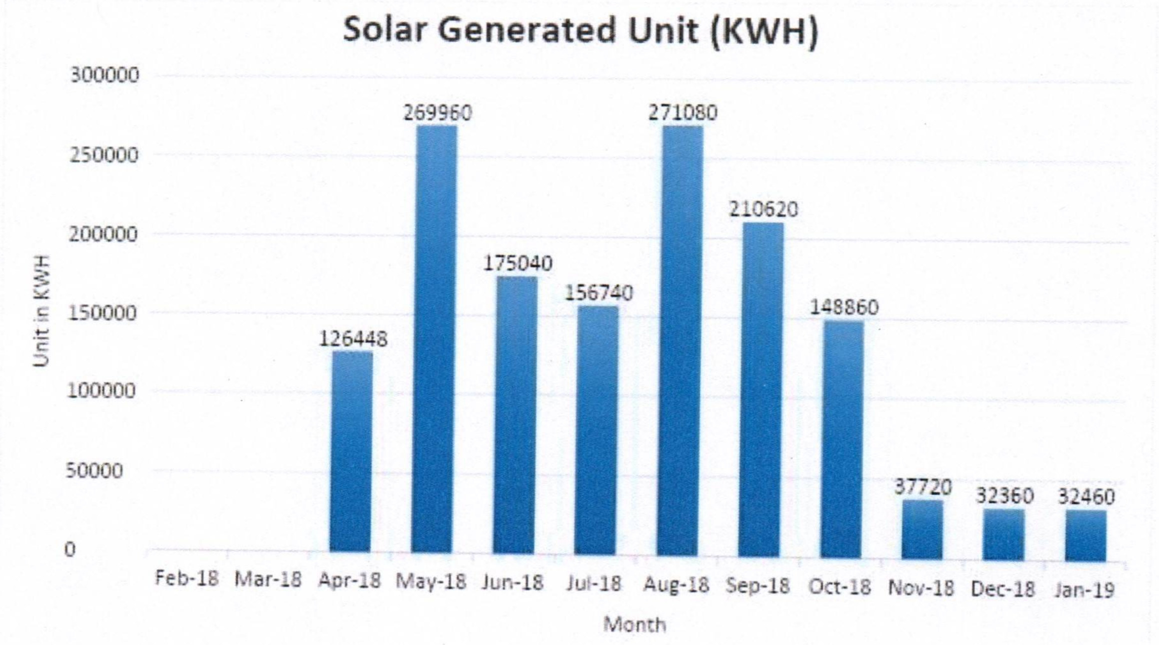

Figure 7. Solar Generated Unit (KWH)

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

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 7. **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, a 24-hour log of Transformer (2000 kVA) (3th March to 4th March 2019) 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 8. **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"	1156
	Phase "Y"	1002
	Phase "B"	986
	Neutral	12
Load (KW)	Phase "R"	264.89
	Phase "Y"	229.18

Main Incomer LT Side		Transformer (2000 kVA)
Particulars	**Phase**	**Average Measured Values**
	Phase "B"	229.54
	Total	**723.61**
Apparent Power (KVA)	Phase "R"	273.65
	Phase "Y"	241.24
	Phase "B"	239.10
	Total	**753.99**
Power Factor (P.F.)	Phase "R"	0.968
	Phase "Y"	0.95
	Phase "B"	0.96
Voltage THD %	Phase "R"	3.1
	Phase "Y"	3.2
	Phase "B"	3.1
Current THD %	Phase "R"	8.1
	Phase "Y"	6.9
	Phase "B"	6.8

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
Authorized Signatory

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 420**, 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 **0.96,** 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 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%.

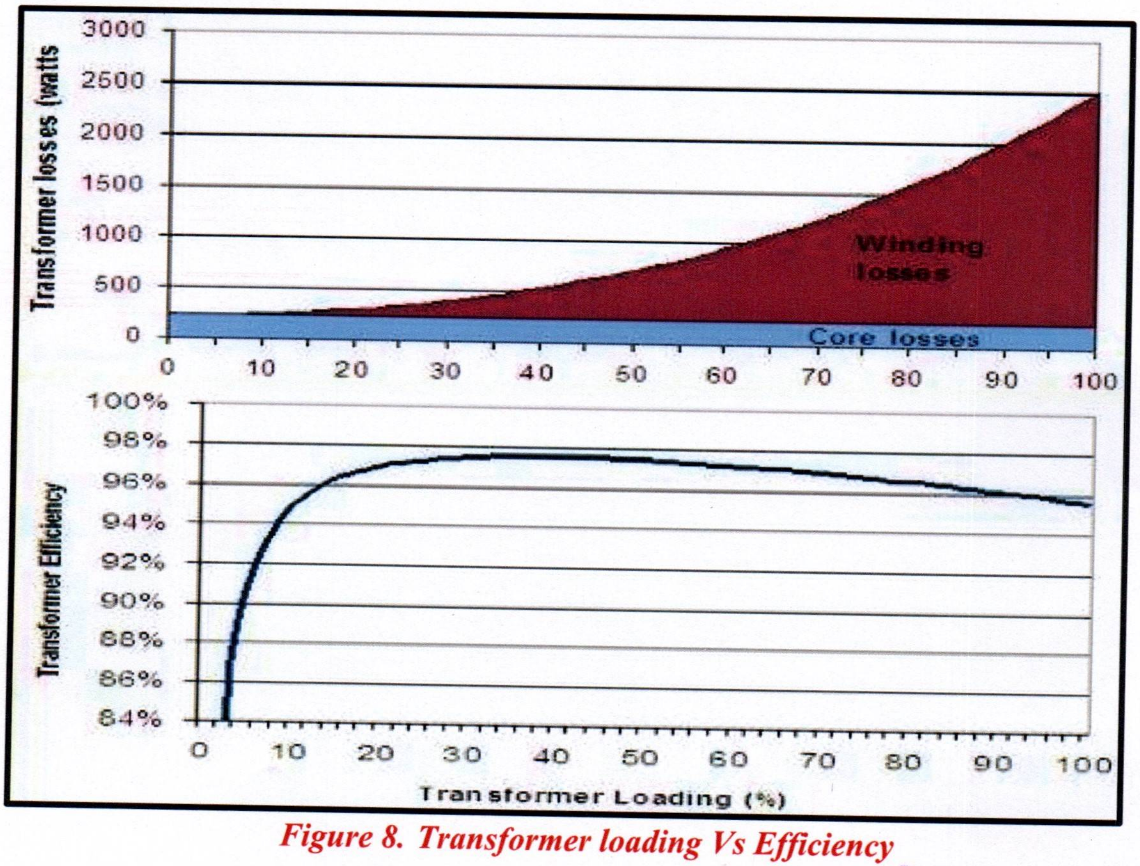

Figure 8. Transformer loading Vs Efficiency

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 transformers are obtained from standards to calculate the transformer losses as follows.

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 9. **Transformer loading**

Description	Transformer Capacity	Power factor	Maximum Apparent power	Average Apparent Power	Max Loading	Average Loading
	kVA	PF	kVA	kVA	%	%
TR1	2000	0.97	854	753.99	42.7	37.69

6. Electrical Load Distribution

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 10. **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	35	37.2	39.1	18.2	129.5	26.34
LIGHTING	11.23	8.6	9.73	11.04	40.6	8.26
FAN	49.1	49.6	48	10.8	157.5	32.04
LIFT AND FIRE SYSTEM	0	0	144	0	144	29.29
COMPUTER & LAPTOP	6	6	8	0	20	4.07
Total	101.33	101.4	248.83	40.04	491.6	100.00
%age	20.61	20.63	50.62	8.14		

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE [illegible]
Authorized Signatory

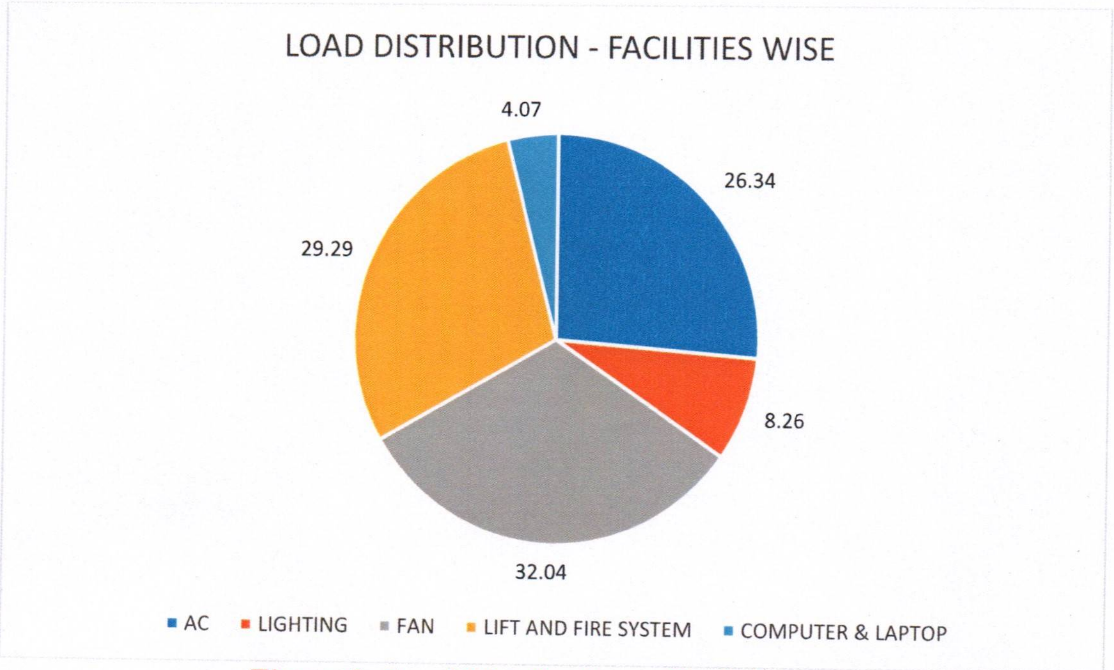

Figure 9. Load Distribution – Facilities-wise

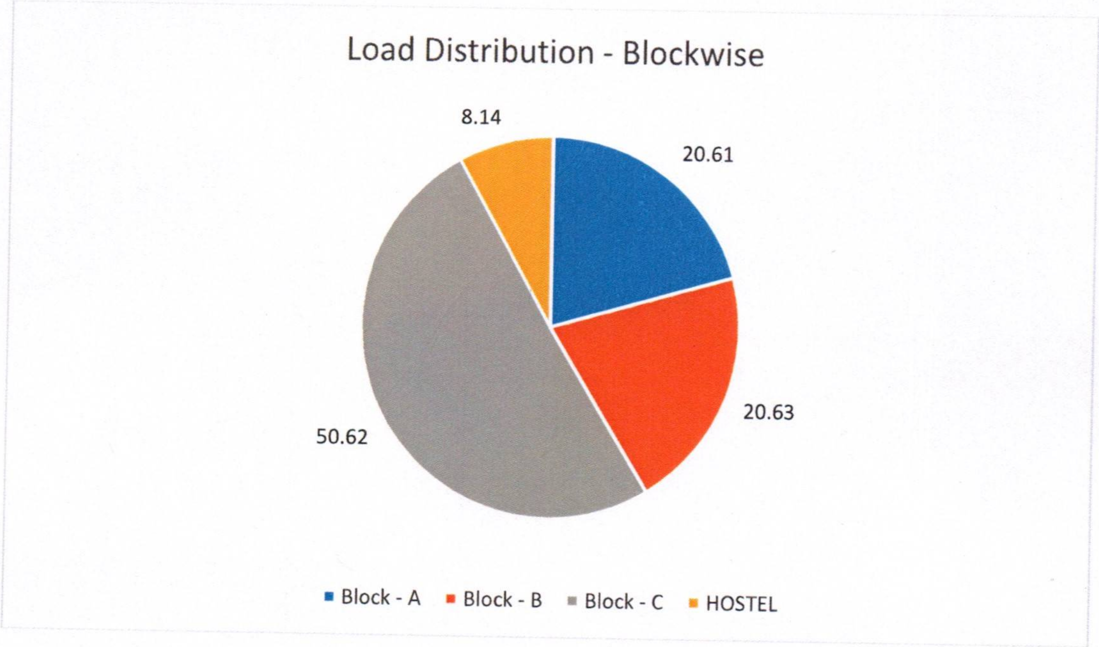

Figure 10. Load Distribution – Block-wise

- **Observation:** Block C consumption is 51% of the total consumption.

For SAMARTH ENVIRO TECH PRIVATE LIMITED
Authorized Signatory

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

7. Air Conditioning and Ventilation

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
3 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 11. **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 12. **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				

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

Table 13. **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

There are 5 Primary pumps of 18KW each and 5 Secondary pumps of 11 kW each Pumps are running as per the air-conditioning load 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

Table 14. **Performance Analysis of water pumps.**

Water Pumps						
Description	**UOM**	**Pump 1**	**Pump 2**	**Pump 3**	**Pump 4**	**Pump 5**
Design						
Make		Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar
Model		K99576751P119030001	K99576751P1119030002	K99576751P1119030010	K99576751P1119030030	K99576751P1119030030
Capacity	m^3/hr	150	150	150	150	150
Head	M	30	30	30	30	30
Power	KW	18	18	18	18	18
Operating Parameter						
Suction head	m	12.5	12.5	12.5	12.5	12.5
Discharge head	m	28	28	28	28	28
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.**

Model		B99576751P119030001	B99576751P1119030002	B99576751P1119030010	B99576751P1119030030	B99576751P1119030030
Capacity	m^3/hr	120	120	120	120	120
Head	M	25	25	25	25	25
Power	KW	11	11	11	11	11
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 area at different places. All conventional lamps are replaced by LED Lamps.

Table 15. **LED Consumption in the University**

Blocks	**LED Consumption (Kwh)**	**%age**
A - Block	5.06	12.12
B - Block	1.79	4.29
C - Block	11.89	28.48
Hostel	12.97	31.07
Outer Area	10.04	24.05
Total Consumption (KWH)	41.75	

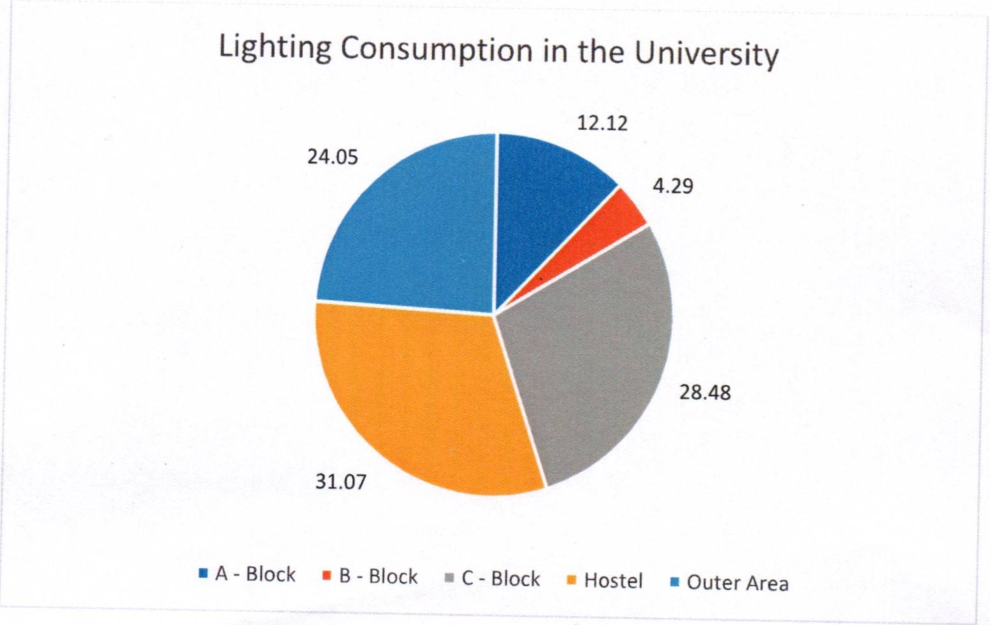

Figure 11. Lighting Consumption in the University

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, ([illegible])

Observation:

- University has opted for the latest LED technology for lighting.
- Maximum consumption of light is in the hostel block.
- It is recommended to install occupancy sensors ex. restroom, offices, lobby, staircases, panel room etc.
- Lux level is found satisfactory in many palaces but at some places, it is different from standard. It can be maintained as per the University requirement.
- Students' awareness for energy consumption shall be increased through training programmes.

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 16. **Details of measured lux in the 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	280	350	200-300
4	Classrooms – C-block	310	450	300
5	Lecture rooms (including Demonstration areas)	310	450	300
6	Reading rooms	250	450	300-500
7	Laboratories	650	700	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

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

For SAMARTH MANAGEMENT
PRIVATE LIMITED
Authorized Signatory

10. 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 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.

11. 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 = 12,664 Litres.

Observations:

- Logbooks for DG were not maintained in a prescribed format by the University. It is recommended to maintain a prescribed monthly format of logbook for DG sets. This will help them to evaluate the specific power generation i:e kWH/ltr of DG sets on a periodic basis.

Sample Log Sheet for DG performance monitoring is shown in below table:

Table 17. **Sample Log Sheet for DG Performance Monitoring**

Date	Time Start	Time Stop	Running Hours	Power Generated (Kwh)	Fuel Tank			Specific Power Consumption
					Initial Dip (mm)	Final Dip (mm)	Diesel Consumed (Ltr)	(Kwh/ ltr)

12. General Tips for Energy Conservation in Different Utilities

Electricity

- Schedule your operations to maintain a high load factor.
- Minimize maximum demand by tripping loads through a demand controller.
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

Motors

- Properly size to the load for optimum efficiency.
- (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Check alignment.
- Provide proper ventilation.
- For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved.
- Check for under-voltage and overvoltage conditions.
- Balance the three-phase power supply.
- An Imbalanced voltage can reduce 3 - 5% in motor input power.
- Demand efficiency restoration after motor rewinding.

Drives

- Use variable-speed drives for large variable loads.
- Use high-efficiency gear sets.
- Use precision alignment.
- Check belt tension regularly.
- Eliminate variable-pitch pulleys.
- Use flat belts as alternatives to v-belts.
- Use synthetic lubricants for large gearboxes.
- Eliminate eddy current couplings.
- Shut them off when not needed.

Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.

- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed.

Blowers

- Use smooth, well-rounded air inlet ducts or cones for air intakes.
- Minimize blower inlet and outlet obstructions.
- Clean screens and filters regularly.
- Minimize blower speed.
- Use low-slip or no-slip belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable blower loads.
- Use energy-efficient motors for continuous or near-continuous operation.
- Eliminate ductwork leaks.
- Turn blowers off when they are not needed.

Pumps

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.

- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

Chillers

- Increase the chilled water temperature set point if possible.
- Use the lowest temperature condenser water available that the chiller can handle.
- Reducing condensing temperature by 5.5°C, results in a 20 - 25% decrease in compressor power consumption.
- Increase the evaporator temperature
- 5.5°C increase in evaporator temperature reduces compressor power consumption by 20 - 25%.
- Clean heat exchangers when fouled.
- 1 mm scale build-up on condenser tubes can increase energy consumption by 40%.
- Optimize condenser water flow rate and refrigerated water flow rate.
- Use water-cooled rather than air-cooled chiller condensers.
- Use energy-efficient motors for continuous or near-continuous operation.
- Specify appropriate fouling factors for condensers.
- Do not overcharge oil.
- Install a control system to coordinate multiple chillers.
- Study part-load characteristics and cycling costs to determine the most-efficient mode for operating multiple chillers.
- Run the chillers with the lowest operating costs to serve base load.
- Avoid oversizing -- match the connected load.
- Isolate off-line chillers and cooling towers.
- Establish a chiller efficiency-maintenance program. Start with an energy audit and follow-up, then make a chiller efficiency-maintenance program a part of your continuous energy management program.

HVAC (Heating / Ventilation / Air Conditioning)

- Tune up the HVAC control system.
- Consider installing a Plant automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.
- Balance the system to minimize flows and reduce blower/fan/pump power requirements.
- Eliminate or reduce reheat whenever possible.
- Use appropriate HVAC thermostat setback.
- Use Plant thermal lag to minimize HVAC equipment operating time.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.
- Reduce HVAC system operating hours (e.g. -- night, weekend).
- Optimize ventilation.
- Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).
- Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
- Use evaporative cooling in dry climates.
- Clean HVAC unit coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.

- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in high-bay areas.
- Relocate air diffusers to optimum heights in areas with high ceilings.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.
- Use professionally-designed industrial ventilation hoods for dust and vapor control.
- Use local infrared heat for personnel rather than heating the entire area.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).

Lighting

- Reduce excessive illumination levels to standard levels using switching, de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapor lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapor, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic
- Change exit signs from incandescent to LED.

DG sets

- Optimize loading.

- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs.
- Clean air filters regularly.
- Insulate exhaust pipes to reduce DG set room temperatures.
- Use cheaper heavy fuel oil for capacities more than 1MW.

Plants

- Seal exterior cracks/openings/gaps with caulk, gasketing, weather stripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the Plant.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize Plant stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

Water & Wastewater

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Eliminate once-through cooling with water.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blowdown to minimize it.
- Provide proper tools for wash down -- especially self-closing nozzles.
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.
- Use the lowest possible hot water temperature.
- Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.
- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Use freeze protection valves rather than manual bleeding of lines.

Miscellaneous

- Meter any unmetered utilities. Know what is normal efficient use. Track down causes of deviations.

- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high-pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

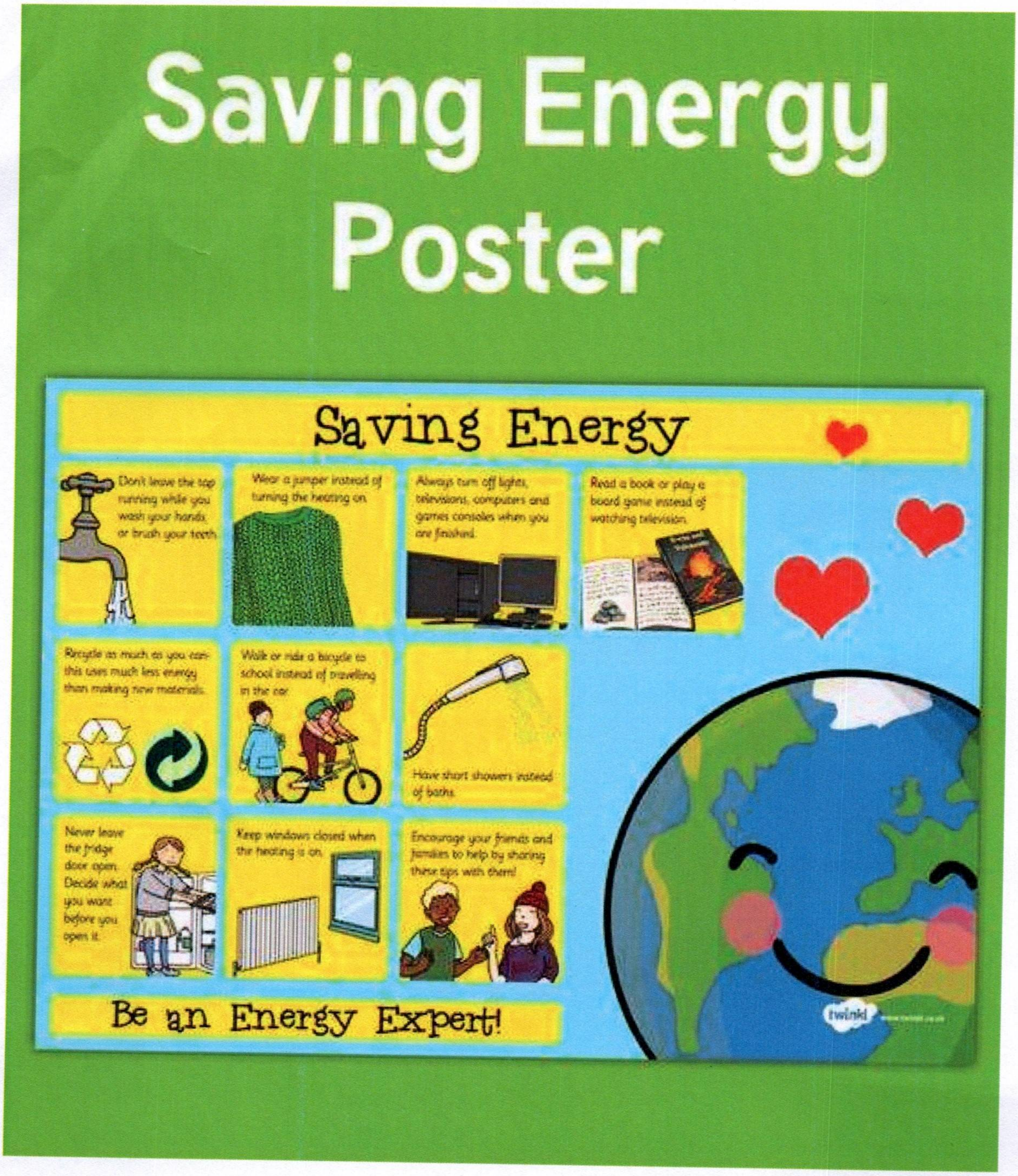

Figure 12. Awareness Posters