RAJASTHAN ENERGY & CONSULTANCY SERVICES (RECON, UDAIPUR)

CERTIFICATE

This is to certify that Energy Audit at Sangam University – NH-79, Bhilwara Chittor By-Pass, Bhilwara, Rajasthan 311001 was conducted on 28th - 30th July 2021.

The Management is highly conscious about its Energy Efficiency Levels and they have initiated several measures to reduce energy consumption. The Energy Efficient lighting system and the regular performance monitoring and maintenance of various installed equipment represent that the staff is well aware of Energy Efficiency Measures & Methods. University has installed 195 kW Solar Power Plant for Captive power Consumption.

Audit Officer	Date	Certificate No.
CEA Kirtesh Bagarecha	25th August 2021	RECON/EA/2021/018

July, 2021

ENERGY AUDIT REPORT

Prepared for:

SANGAM UNIVERSITY™

where Aspiration meets Opportunity

SANGAM UNIVERSITY

NH-79, Bhilwara Chittor By-Pass,
Bhilwara, Rajasthan, India

Submitted By:

RECON

RAJASTHAN ENERGY & CONSULTANCY SERVICES

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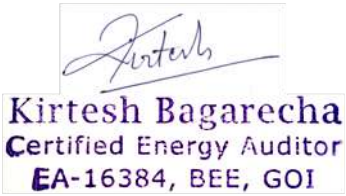


ACKNOWLEDGEMENT

The Energy Audit for the Sangam University, Bhilwara has been carried out by M/s Rajasthan Energy & Consultancy Services, Udaipur (RECON).

The team RECON is thankful to Sangam University, Bhilwara management for their professionalism and co-operation provided during the audit process.

We also thank all officials for supporting us during field study & report preparation.

1. EXECUTIVE SUMMARY

Energy Audit was carried at Sangam University, Bhilwara by M/s Rajasthan Energy & Consultancy Services during July 2021.

The Management is highly conscious about its Energy Efficiency Levels and they have initiated several measures to reduce energy consumption.

We appreciate the support and co-operation of staff during the study and their positive attitude towards Energy Audit. The Energy Efficient lighting system and the regular performance monitoring and maintenance of various installed equipment represent that the staff is well aware of Energy Efficiency Measures & Methods. However, energy conservation is a continuous process and there is always scope for further improvements.

1.1 Energy Conservation Measures Recommendations

The Auditors have identified 7 nos. of Energy Conservation Measures (ECM's) within the building, based on the measurement taken & data collected during the field study. Identified Energy Conservation Measures are presented in tabulated format:

Table 1: Energy Conservation Measures

S.N.	Energy Saving Area	Saving Potential, kWh p.a	Saving Potential, Rs. Lakh p.a.	Investment, Rs. Lakh	Payback Period, Month
I. SHORT TERM AREAS					
1	Estimated Saving by Reduction in Contract Demand	-	1.94	Nil	Immediate
2	Energy Saving by replacement of Tubelight with LED Tube lights	68310	4.99	1.04	2
	Sub Total (I)	68310	6.93	1.04	2
II. MEDIUM TERM AREAS					
3	Improvement of P.F. By installing Additional Capacitor Bank	-	0.47	0.40	10
	Sub Total (II)	0	0.47	0.40	10
III. LONG TERM AREAS					
4	Energy Saving by Replacement of Sodium Vapor with LED Bulb	25423	1.86	1.83	12
5	Energy Saving by Installing of Occupancy Sensors in Toilet	2851	0.21	0.27	16
6	Estimated Saving by installing float valve in all Tanks	3300	0.24	0.35	17
7	Replacement of old ACs with 5 Star Rated Acs	11568	0.84	2.35	33
	Sub Total (III)	43142	3.15	4.80	18
	Grand Total	111452	10.55	6.24	7

2. INTRODUCTION

2.1 Objectives

To undertake an energy audit of electrical utilities to identify areas for energy saving, both without and with investment. To prioritize distinct areas identified for energy savings depending upon saving potential, skills and time frame for execution, investment cost, payback period, etc.

2.2 Scope of Work

To correlate monthly data of production with electricity, diesel, LPG and water consumption, for 12 months of normal operation for overall complex and individual sections.

- **Review of Electricity Bills, Contract Demand & Power Factor**

1. Review of last one-year electricity bill to study monthly power factor, maximum demand, working hours, load factor, etc. for the reference period along with monthly electricity consumption and establish the scope for MD control through possible optimization of load factor and detailed load management study.
2. To recommend a specific rationalization/optimization program based on measurement of DB power factors, existing capacitor system and its maintenance, automatic/manual controls required etc.

- **Electrical System Network**

1. To study monthly transformer loading with existing & future connected load to recommend a specific rationalization/optimization plan for transformer capacity.
2. Harmonic distortion analysis on transformer input/output will be done.
3. To study electrical energy metering, monitoring and control system existing at the university and to recommend a suitable system for future monitoring.

- **Motors**

1. To undertake a detailed motor load study on all motors equal to and above 5 KW size with the help of a clamp on multi-meter to identify instantaneous motor parameters like kW, KVA, P.F., A, V, frequency etc. and establish their variations over a load cycle (for variable load drives, if any).

2. This study will help establish/recommend motor specific rationalization plan including star conversion, downsizing, use of motor energy savers and high efficiency drives etc.

3. Based on the above to evaluate the possibility of replacing major motors with energy efficient motors.

4. To provide cost benefit analysis for the replacement policy.

5. To study compressed air system in the university, in terms of compressor type, make, capacity, loading, motor type / size / loading etc. and to undertake output efficiency test for the operating compressors. This will identify opportunities for compressed air generation optimization and energy savings undertake compressed air leakages tests & recommend the locations of air leakage.

- **Illumination System**

1. Study of the Illumination system

2. Lux level in various areas, area lighting etc.

3. To recommend a specific plan for rationalization of lighting load through the possible use of north light and switching off use of energy efficient lighting equipment like tri-phosphor fluorescent tube light etc.

- **Pumps**

1. Pump performance calculation from flow, pressure and power consumption, Based on the above to evaluate the possibility of replacing old pumps with energy efficient.

2. To provide cost benefit analysis for the replacement policy.

- **Chiller Plant**

1. Analysis of various parameters like Tonnage delivered.

2. Measurement of Specific Energy Consumption i.e KW / TR of refrigeration.

3. Suggestion of Various Energy Efficient Measures to improve its performance.

- **Package Air Conditioners**

1. Study Packaging Air Conditioners.

2. Draw inference to the energy consumption & performance.

- **Window / Split Air Conditioners**

Random survey of ACs to understand the profile of installed equipment & recommendations thereof.

- **DG sets**

1. Study the operation of DG set to evaluate the power cost of Power Generation.
2. Specific Energy Generation.

2.3 Methodology

The methodology adopted for achieving the desired objectives viz. Assessment of the Current operational status and Energy savings included the following:

- Discussions with the concerned officials of the unit for identification of major areas of focus and other related systems.
- A team of professionals visited the Sangam University and had discussions with the concerned officials/supervisors to collect data/information on the Load Distribution and Energy Consumption pattern. The data were analyzed to evaluate the specific power consumption and also to arrive at a baseline energy consumption pattern. Measurements and monitoring with the help of appropriate instruments including continuous and/or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.
- Computation and in-depth analysis of the collected data, including analysis and other techniques as appropriate, was done and to evolve suitable energy conservation plan/s for improvements/reduction in Specific Energy Consumption.
- Instruments were used by Energy Audit Team are given in annexure-1.

3. BACKDROP ON ENERGY SCENE

3.1 Energy Scene

Primary energy sources utilized at Sangam University, Bhilwara is Electricity & HSD. This source is consumed for Air Conditioning, pumps, and motors & lighting and heating. The total annual energy bill is in the range of 228249 kWh and 3520 Ltr. of Diesel. The segregation of energy cost is shown in the pie chart below:

Figure 1: Segregation of Energy Cost

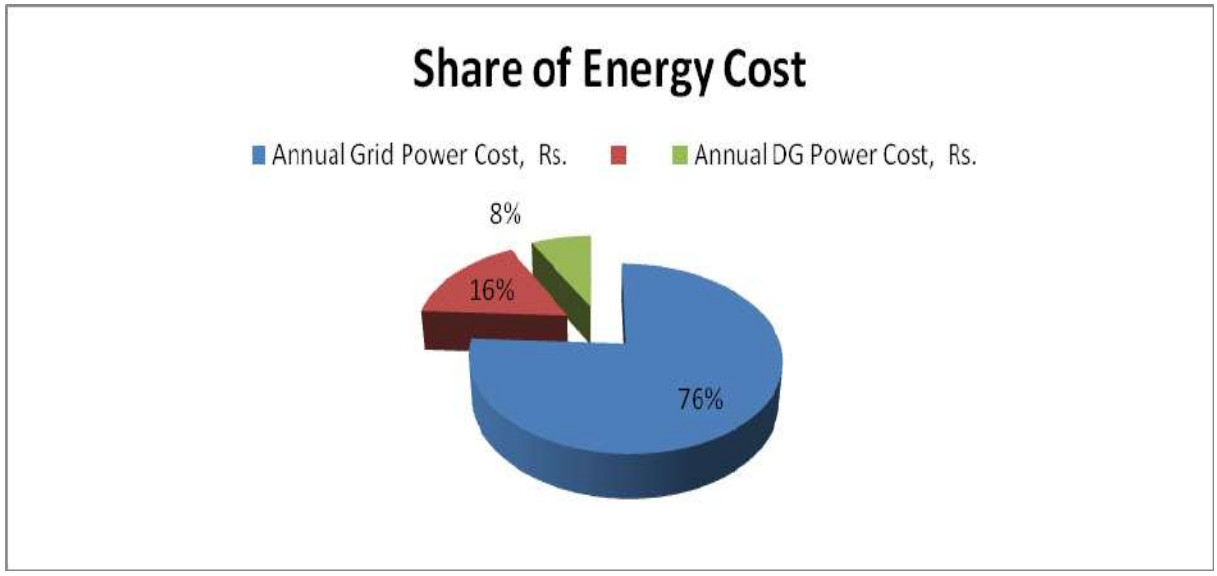
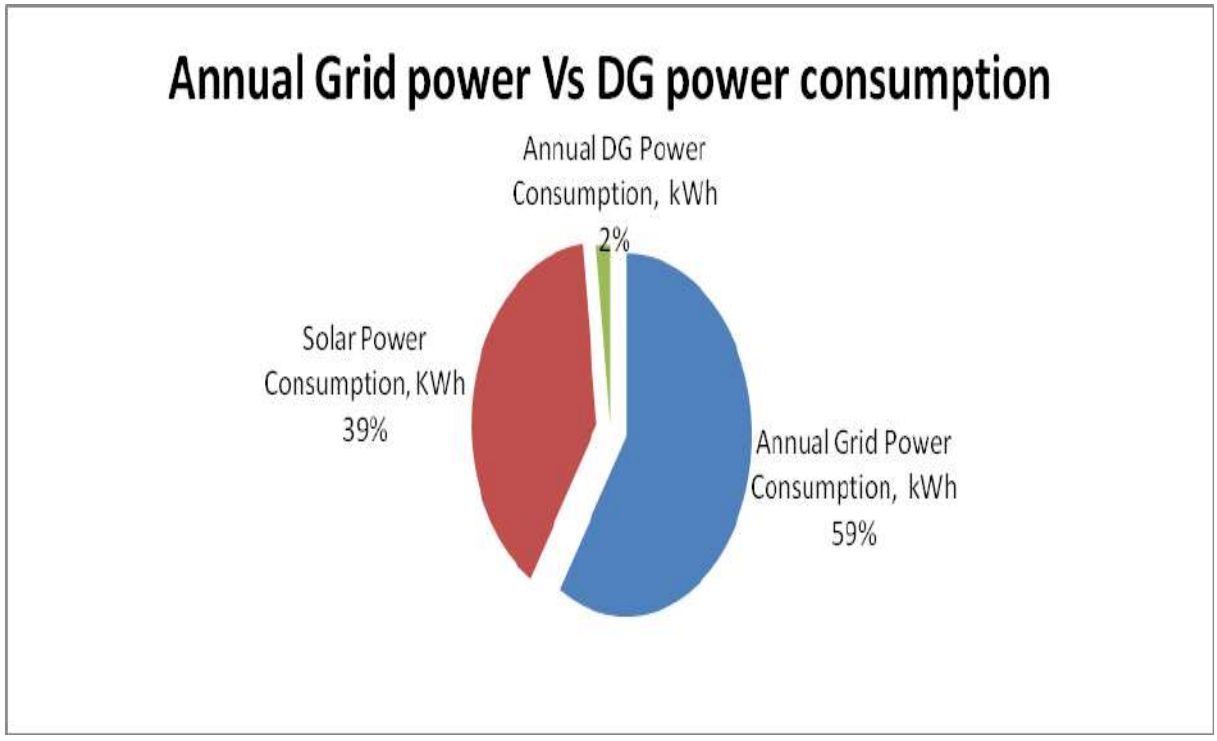


Figure 2: Segregation of Energy Consumption



3.2 Energy: Sources & Utilization

Electricity

- Grid Power is received from AVVNL at 11 kV with a contract demand 240 kVA. The electrical power is stepped down from 11 kV to 433 V via One Distribution Transformer Viz. 1*300 kVA.
- The Demand Charges are Rs. 270/Kva.
- University has installed 195 kW Solar Power Plant for Captive power Consumption.
- University has also installed 500 kVA DG set for Emergency Power Use during power failure.
- The table produced below indicates, maximum registered demand, average power factor, average load factor and average unit consumption for the reference period.

Table 2: Electrical Operating Parameters – As per Electricity Bills

Sr.No.	Billing Month	Contract Demand, KVA	Billing Demand, kVA	Grid Power, kWh	Recorded Max. Demand, kVA	Excess Max Demand from Billable Demand, kVA	P.F.	Total Bill, Rs	Grid Power Cost, Rs. / kWh
1	Apr-20	240	180.0	32400	64.8	115.20	0.916	401040	12.4
2	May-20	240	180.0	19143	73.5	106.50	0.953	290088.3	15.2
3	Jun-20	240	180.0	20277	47.7	132.30	0.946	300945.3	14.8
4	Jul-20	240	180.0	21168	93	87.00	0.95	247420.9	11.7
5	Aug-20	240	180.0	5995	65.1	114.90	0.90	217655.8	36.3
6	Sep-20	240	180.0	6303	76.2	103.80	0.96	235027.7	37.3
7	Oct-20	240	180.0	16920	82.8	97.20	0.98	204592.5	12.1
8	Nov-20	240	180.0	14241	75.6	104.40	0.98	188220.6	13.2
9	Dec-20	240	180.0	20250	89.1	90.90	0.97	250438.5	12.4
10	Jan-21	240	180.0	22254	93.9	86.10	0.97	255999.3	11.5
11	Feb-21	240	180.0	21707	86.7	93.30	0.96	251509.2	11.6
12	Mar-21	240	180.0	27591	106.2	133.80	0.96	311890.1	11.3
Sum/Avg.		240	180.0	228249	79.55	105.45	0.953	3154828	13.82

Figure 3: Monthly Grid Power Consumption Variation

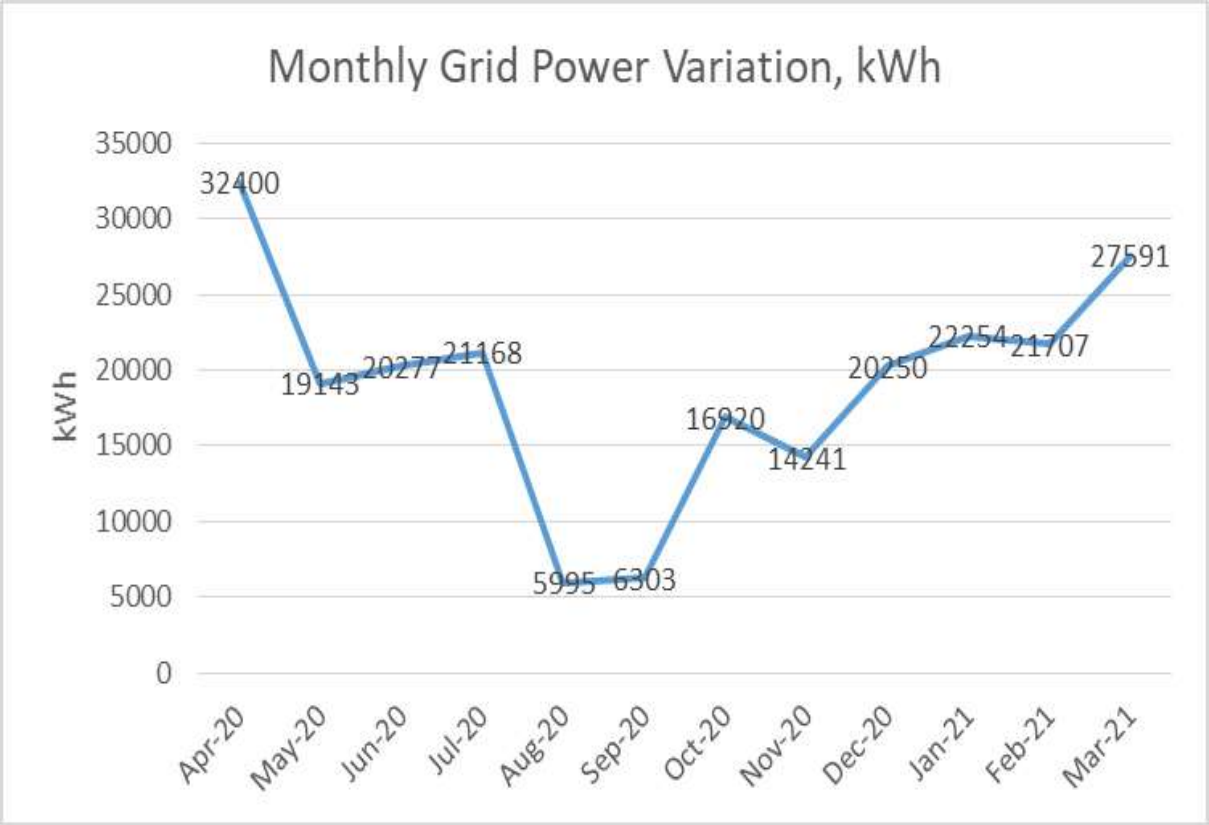
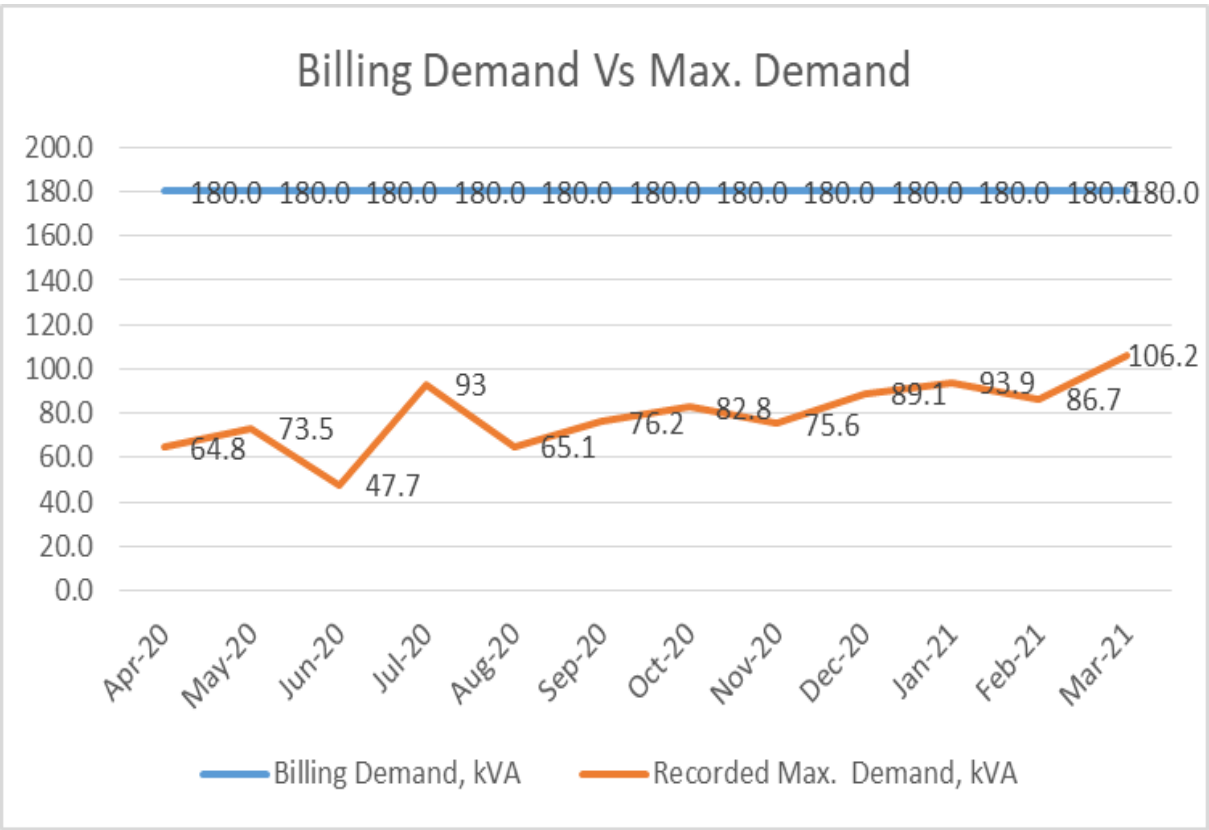


Figure 4: Monthly Billing Demand Variation



The actual maximum demand registered is 106 kVA in March 2021 & Avg maximum demand is 79.5 KVA during the last 12 months.

Figure 5: Monthly Power Factor Variation

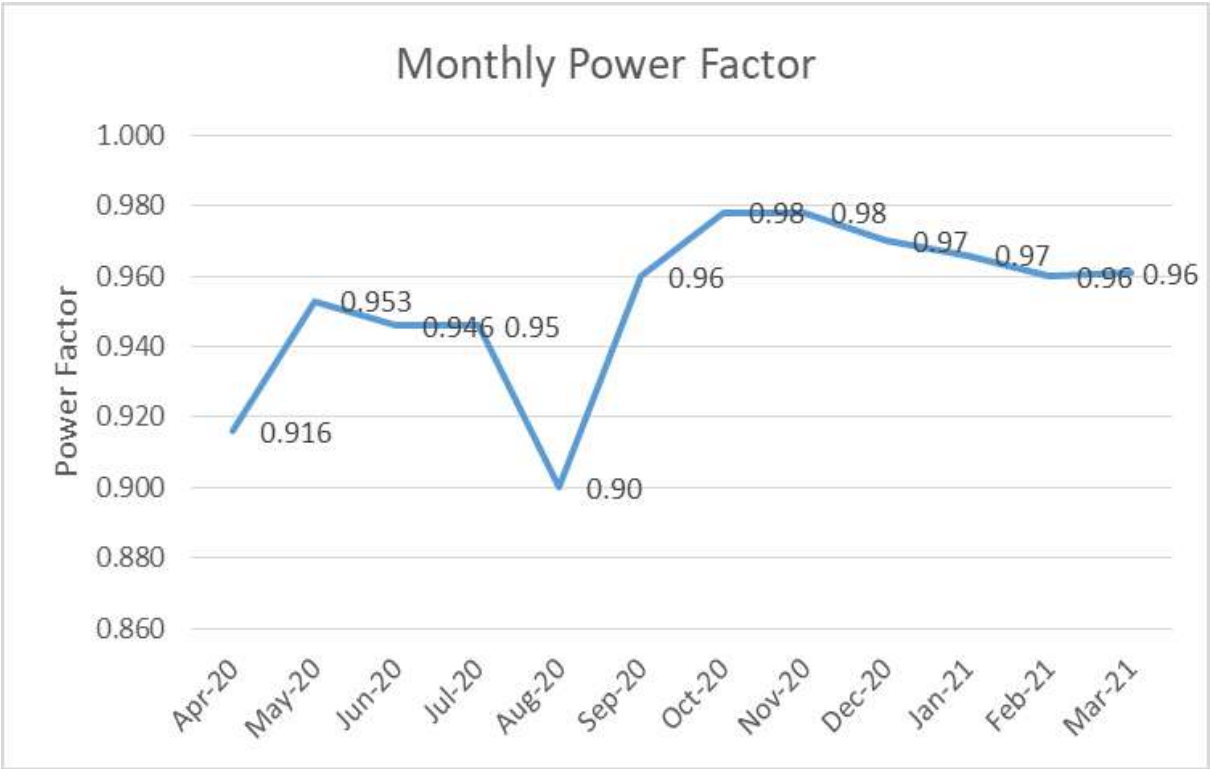
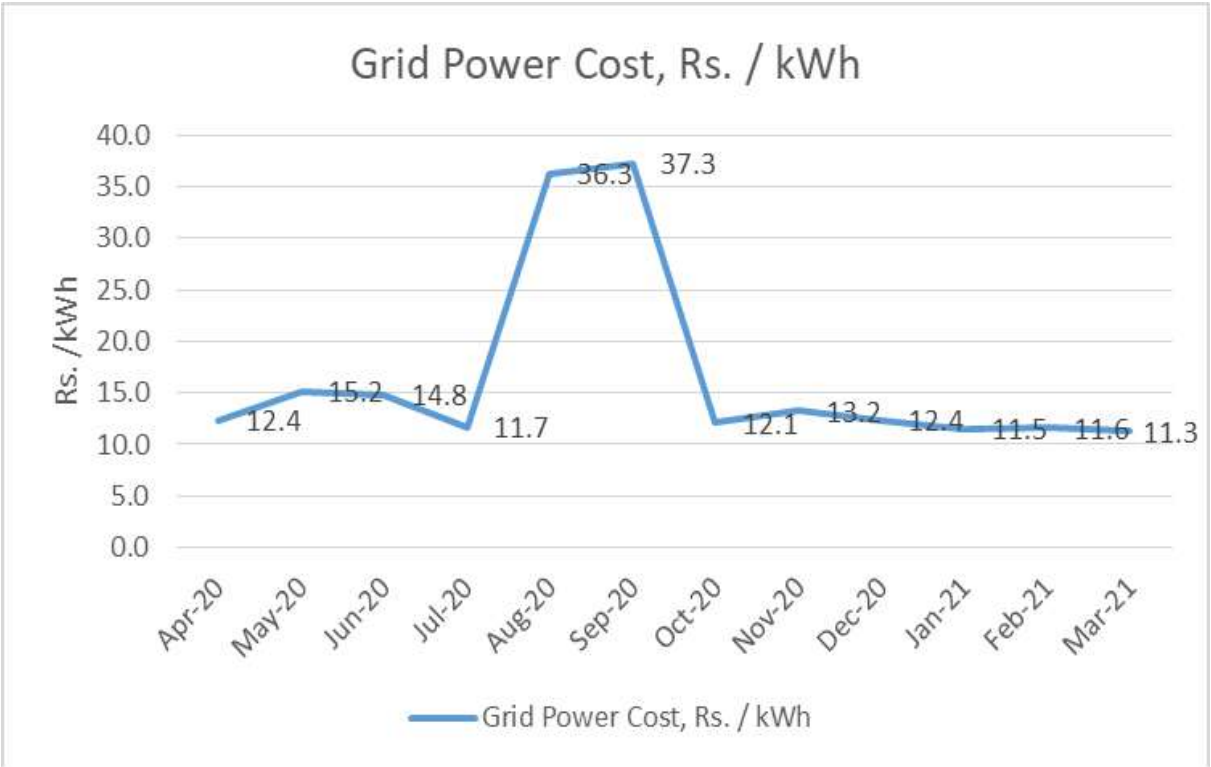


Figure 6: Monthly Power Cost



University has installed 195 kW Solar Power plant in Net Metering scheme as a source of renewable energy. Solar Power Generation and consumption details are tabulated below.

Table 3: Solar Power Details

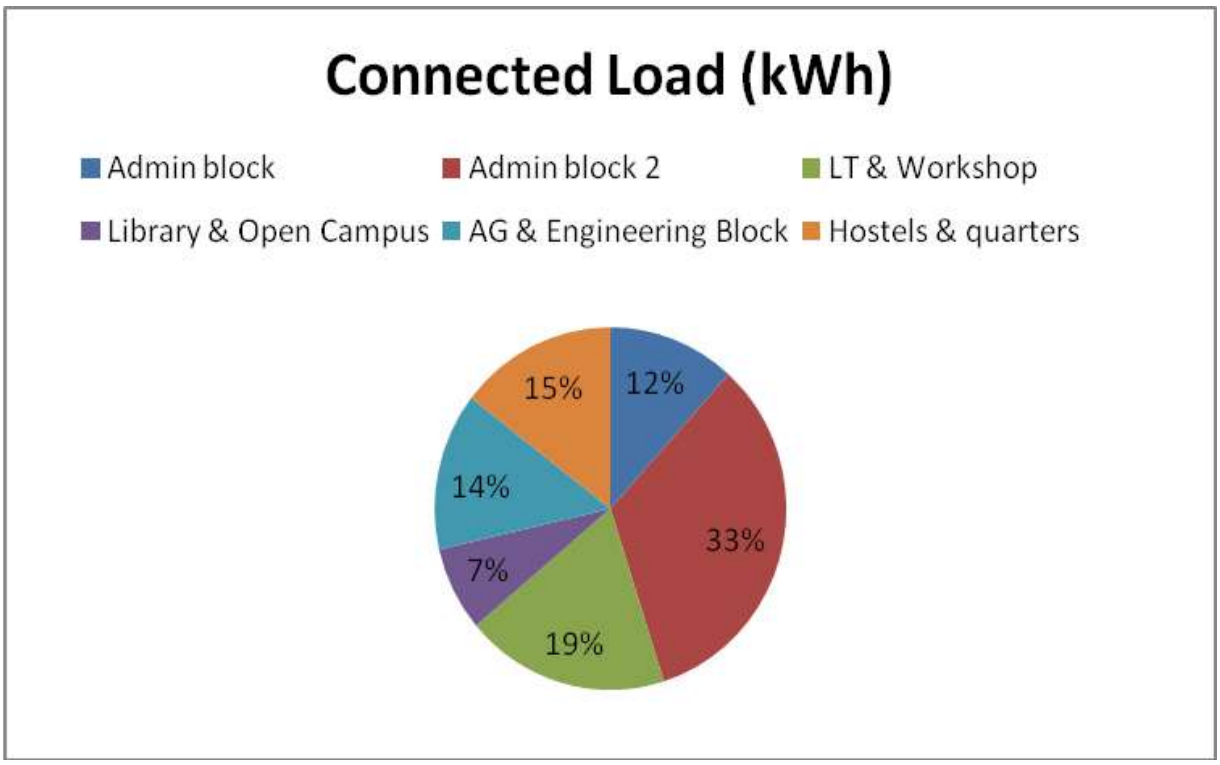
Sr. No.	Month	Solar Power Generation, kWh	Solar Power Export, kWh	Solar Power Self Consumption, kWh
1	Apr-20	29022	9237	19785
2	May-20	32258	29229	3029
3	Jun-20	31299	16374	14925
4	Jul-20	25649	7806	17843
5	Aug-20	24771	8130	16641
6	Sep-20	19123	7329	11794
7	Oct-20	24874	11496	13378
8	Nov-20	27552	15201	12351
9	Dec-20	22389	14058	8331
10	Jan-21	23123	13059	10064
11	Feb-21	23216	11553	11663
12	Mar-21	25342	12492	12850
Sum/Avg.		**308618**	**155964**	**152654**

University is consuming 152654 kWh from solar generation and 155964 KWh exporting to the grid. The major electrical loads are Air Conditioner, Fan, Motors, Pumps and Lighting. The total connected load of the entity is around 500 kW.

Table 4: Connected Load Details

Area	Connected Load (kWh)
Admin block	58.78
Admin block 2	166.37
LT & Workshop	93.98
Library & Open Campus	37.58
AG & Engineering Block	70.08
Hostels & quarters	72.81

Figure 7: Total Load Distribution



3.3 Energy Performance Index

Energy Performance Index is a measuring tool to evaluate the performance of the building in terms of the total energy consumption and the total built-up area.

Energy Performance index (EPI), kWh/annum/m² = (EB Energy + DG Energy), kWh/annum / Total Build-up Area m²

Table 5: Energy Performance Index (EPI)

Total Bld. Area	Total annual Grid Consumption kWh	Total annual DG Generation in kWh	EPI, kWh/annual/m^2
40303.93	228249	7040	5.8

Table 6: Benchmarks for Star Rated University

EPI(Kwh/sqm/year)	Star Label
75-65	1 Star
65-55	2 Star
55-45	3 Star
45-35	4 Star
Below 35	5 Star

Note- above Benchmarks are applicable for less than 50% conditioned space. ***EPI of Sangam University is very good because of the 195 kW Solar Power Plant installed at the university.***

3.4 Energy Metering, Monitoring & Control System – Existing Status

Energy meters are installed on HT, LT sides and Each building Input, Energy Monitoring of the Sangam University is very good.

The power factor maintained most of the time is around 0.95 and the university needs to maintain a unity power factor to avail of the incentives by AVVNL.

3.5 Energy Conservation: Level of Awareness

The level of awareness for energy conservation is satisfactory. Staff members are interested in taking initiatives for efficient energy use.

4. ENERGY EFFICIENCY ELECTRICAL & THERMAL UTILITIES

4.1 Introduction

The study of Sangam University operations, data collection, observations, field trials and analysis of various areas as per the scope of work was undertaken, keeping in view the energy scene at Sangam University, Bhilwara focus areas elaborated in the previous chapter and to identify energy conservation opportunities in the same. The basis for this is the orientation visit, discussions with the Sangam University personnel and the agreed plan for data collection and field trials. All these trials were undertaken at normal operating conditions.

4.2 Review of Electricity Bill, Contracts Demand and Power Factor

- Sangam University has sanctioned a **Contract Demand of 240 kVA**.
- The average kWh demand at the Sangam University based on data collection for the period (April-2020 to Mar-2021) is 19020 kWh/Month.
- The average monthly load at the university is around 26 kW.
- The monthly power consumption data for the last 12 months provides an overall unit purchase cost of Rs. 13.82/unit.
- The average monthly demand registered is 48 KVA.
- The average monthly power factor for the analysis period is 0.95
- The average load factor as per demand registered is around 33.58 %.

4.3 Study of Electrical System Network

Study of Transformers Performance

The transformer is a device, which always remains in the circuit. The loading on transformers varies with the operation of Sangam University. Estimation of transformer efficiency and load/no-load losses are difficult in a continuously running System. Transformer efficiencies nevertheless are in close range of 99% and above. To evaluate the transformer's loading pattern, power factor variation, voltage variation & other power quality analysis; we recorded the parameters at each transformer at 15 minute intervals. Brief detail of transformer has been given in below table:

Table 7: Technical Specification of Transformer

S.No.	Rated Specifications	Tr-1
1	KVA	300
2	Voltage (HV/LV) V	11000/433
3	Current Amp (HV/LV)	26.25/666
4	Make	Shree Electricals
5	Type of Cooling	ONAN
6	Frequency	50

Table 8: Performance Analysis of Transformer

S.No.	Specifications	Units
1	Transformer Rating in kVA	300
2	Rated NL Loss (kW)	0.64
3	Avg.Load in KVA (12 AM to 12 AM)	51.0
4	% Loading	17.0
5	Full Load Losses of Transformer (kW)	4.45
6	Total Losses of Transformer(kW)	0.77
7	Operating Power Factor	0.96
8	Total Loss (kVA)	0.80
9	Transformer Efficiency, %	98.49

Study of Load, Power Factor & Voltage at Transformers

- The measurements undertaken at the transformer include data logging for power, voltage, P.F., current, KVAr, Thd levels, etc. Presently the harmonic distortions are well within prescribed limits.
- The voltage variation at the 440 V transformer was recorded. As noted from the readings, the average load at the transformer is about 52.2 kVA. The study is undertaken to understand voltage and load variation. The voltage at the transformer varies between 388.5 V to 431.5 V with a few occasional further dips due to power cut. The average Voltage at mains is 420 V.
- Wide Voltage fluctuation is a common phenomena all over the country. Generally, voltage is very low during daytime and high during night hours. Therefore, univercity 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 the high voltage which is more dangerous.

- Most electrical equipments are designed for 230 volts (single-phase) or 415 volts (3-phase) and operate with optimum efficiency at its rated voltage.

Figure 8: Frequency Variation of Main 300 kVA Transformer

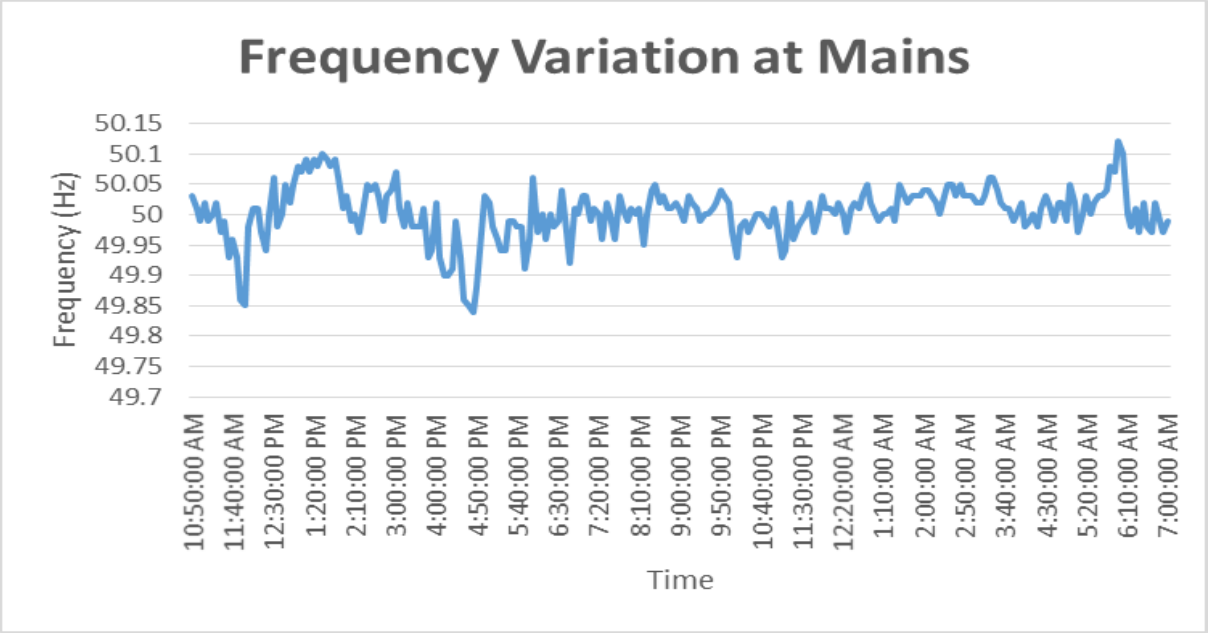


Figure 9: Voltage Variation of Main 300 kVA Transformer

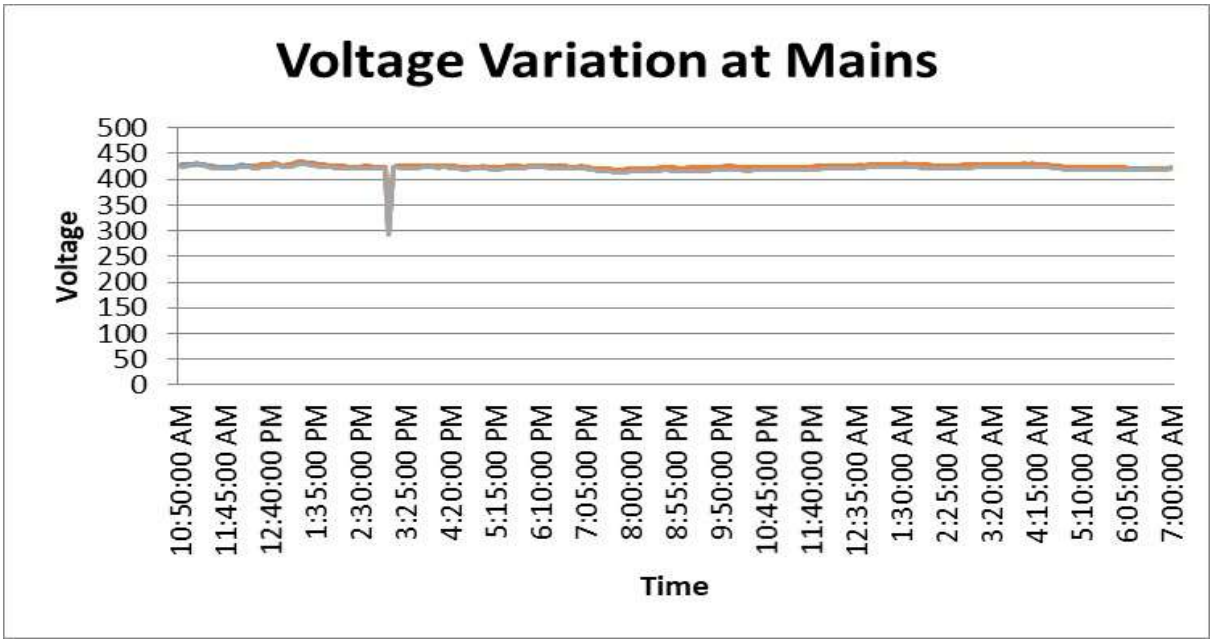


Figure 10: Load Variation of Main 300 kVA Transformer

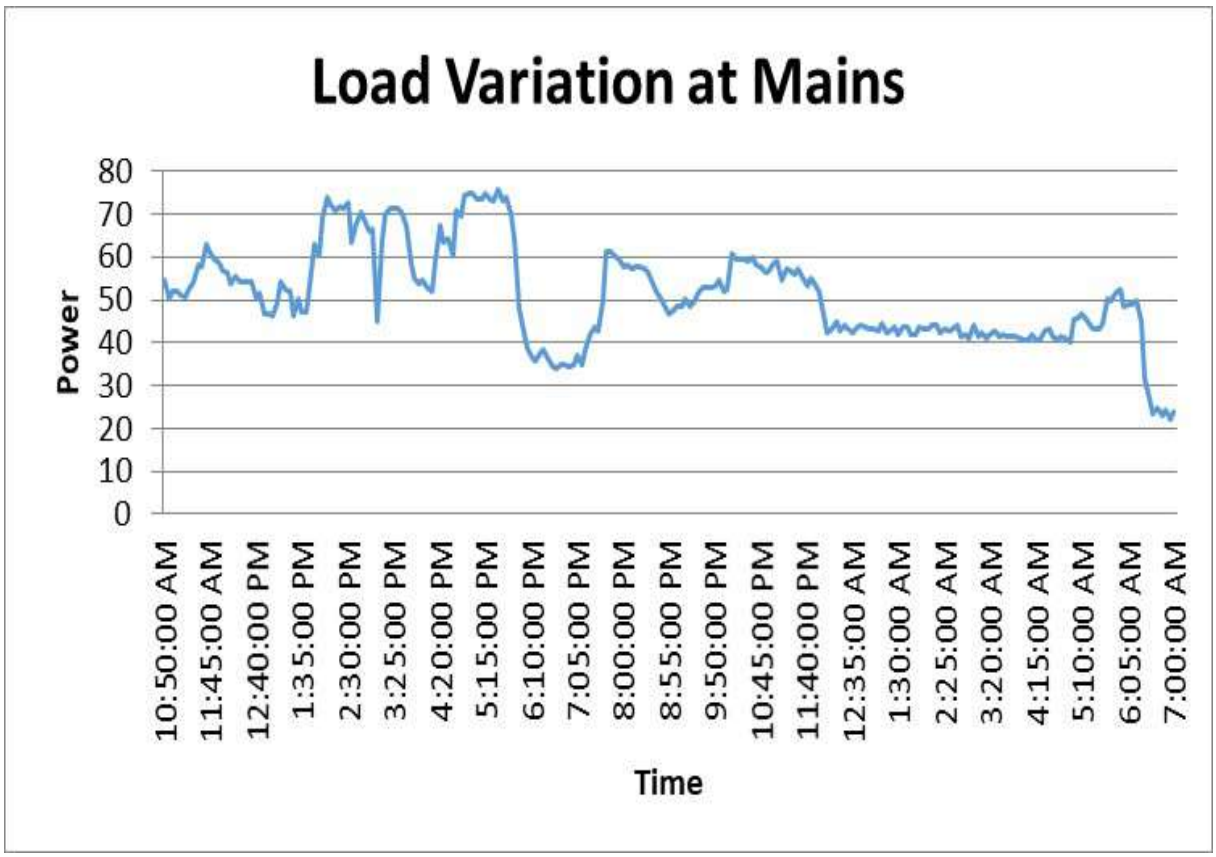
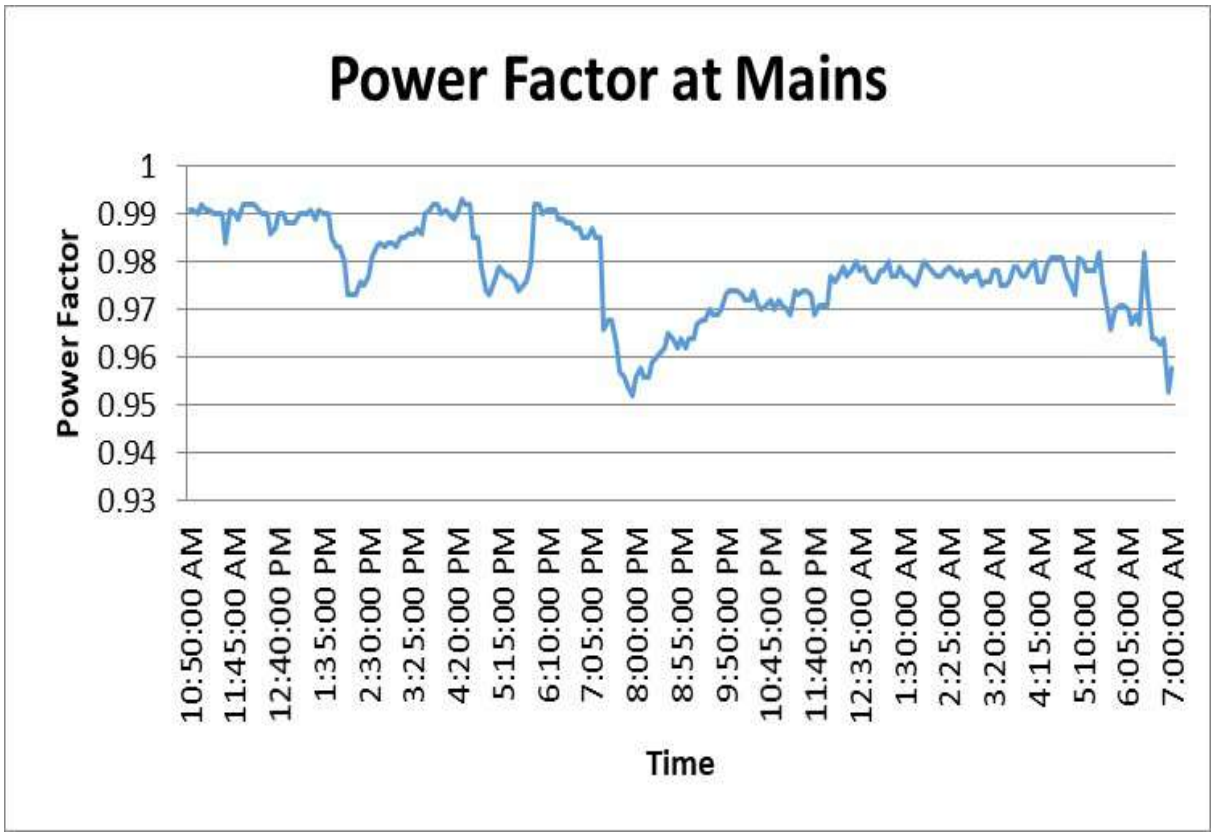


Figure 11: Power Factor Variation of Main 300 kVA Transformer



Recommendation: Estimated Savings by Reduction of Contract Demand

During Energy Audit, the Audit team observed that University having a contract demand of 240 kVA and also installed 195 kW Solar Power Plant and Unversity major load comes during day time as AC and Equipment loads and for day load solar plant is sufficient to meet the daily day time demand.

During the last year, the university's highest demand was 100 kVA. So it is suggested to reduce contract demand to 180 kVA if possible. Its cost-saving benefithas been tabulated below:

Table 9: Estimated Savings by Reduction of Contract Demand

Sr. No	Particulars	Value
1	Present Contract Demand, kVA	240
2	Present Avg Max Demand, kVA	80
3	Proposed Contract Demand in kVA	180
4	Proposed Reduction in Contract Demand, kVA	60
5	Reduction in Billing Demand	45
6	Present Demand Charges, Rs/kVA	270
7	Annual Saving in Lakh	1.46
8	Investment	Nil
9	Payback Period	Immediate

By implementing this, University can save **Rs. 1.46 Lacs per annum** without any investment.

Recommendation: Estimated Savings by Installing Additional Capacitor

One APFC Panel has been installed at Sangam University. We have measured the performance of all capacitors of the APFC panel with their rated capacity. It is noticed that some of the capacitors are derated by more than 25% of their rated capacity. It is recommended to replace capacitors where derating is more than 25%.

Table 10: Performance of Existing Capacitor Bank

S.NO	kVA	Rated Current	R	Y	B	Average	% Derating	Remark
1	10	13.3	0.1	0.11	0.26	0.16	98.82	Need to replace
2	10	13.3	7.51	13.22	7.45	9.39	29.37	Need to replace
3	5	6.65	6.28	6.29	6.41	6.33	4.86	OK

4	5	6.65	6.24	6.32	6.21	6.26	5.91	OK
5	5	6.65	5.56	0	5.53	3.70	44.41	Need to replace
6	2	2.66	2.4	2.49	2.54	2.48	6.89	OK
7	1	1.33	1.29	1.16	1.18	1.21	9.02	OK
8	5	6.65	6.27	6.26	6.33	6.29	5.46	OK
9	10	13.3	NOT WORKING				100.00	Need to replace
10	10	13.3	7.22	7.21	7.32	7.25	45.49	Need to replace
11	20	26.6	25.2	25.5	25.4	25.37	4.64	OK
12	20	26.6	25.1	25.5	25.4	25.33	4.76	OK

For improvement in the power factor from 0.97 to 0.99, with an avg. operational load, 20 kVAr additional capacitor banks are required including replacement of derated capacitors in existing APFC panel.

Improvement in the power factor would reduce the maximum demand in kVA and saving in the bill as given in the table produced below:

Table 11: Estimated Savings by Installing Additional Capacitor

Sr.No.	Billing Month	Grid Power, kWh	Grid Power, kWh	P.F.	Total Bill, Rs	Power Cost, Rs./kWh	Average Load KW	Capacitor Bank Required in kVA	Saving in Bill After P.F improved to .99 in Rs.
1	Apr-20	32400	35371	0.92	401040	11.3	45	19	11116
2	May-20	19143	20087	0.95	290088	14.4	26	8	3983
3	Jun-20	20277	21434	0.95	300945	14.0	28	9	4737
4	Jul-20	21168	22376	0.95	247421	11.1	28	9	4945
5	Aug-20	5995	6661	0.90	217656	32.7	8	4	2407
6	Sep-20	6303	6566	0.96	235028	35.8	9	3	1150
7	Oct-20	16920	17301	0.98	204593	11.8	23	3	1482
8	Nov-20	14241	14561	0.98	188221	12.9	20	3	1248
9	Dec-20	20250	20876	0.97	250439	12.0	27	7	2957
10	Jan-21	22254	23037	0.97	255999	11.1	30	8	3899
11	Feb-21	21707	22611	0.96	251509	11.1	32	10	3962
12	Mar-21	27591	28711	0.96	311890	10.9	37	11	4935
13	Overall Reduction in Bill, Rs								46819
14	Overall Requirement of Capacitor Bank								20
15	Investment, Rs								40000
16	Payback Period in Months								10

- The capacitor banks should be maintained in a clean and cold condition to improve performance. The present PCC room is marginally warmer. It is suggested that a draft fan may be installed in the PCC room that will provide apparent comfort and lower the room temperature by displacing warm air.
- The operating conditions directly affect the life of the capacitor. The ambient temperature has the largest effect on life. The life of a capacitor doubles by every 10 °C decreases in temperature.
- By Maintaining P.F. Unity Sangam University can save around Rs. 46819 Per annum with an investment of Rs. 40000 and the Payback period for the same is around 10 months.

4.4 Study of Power Quality

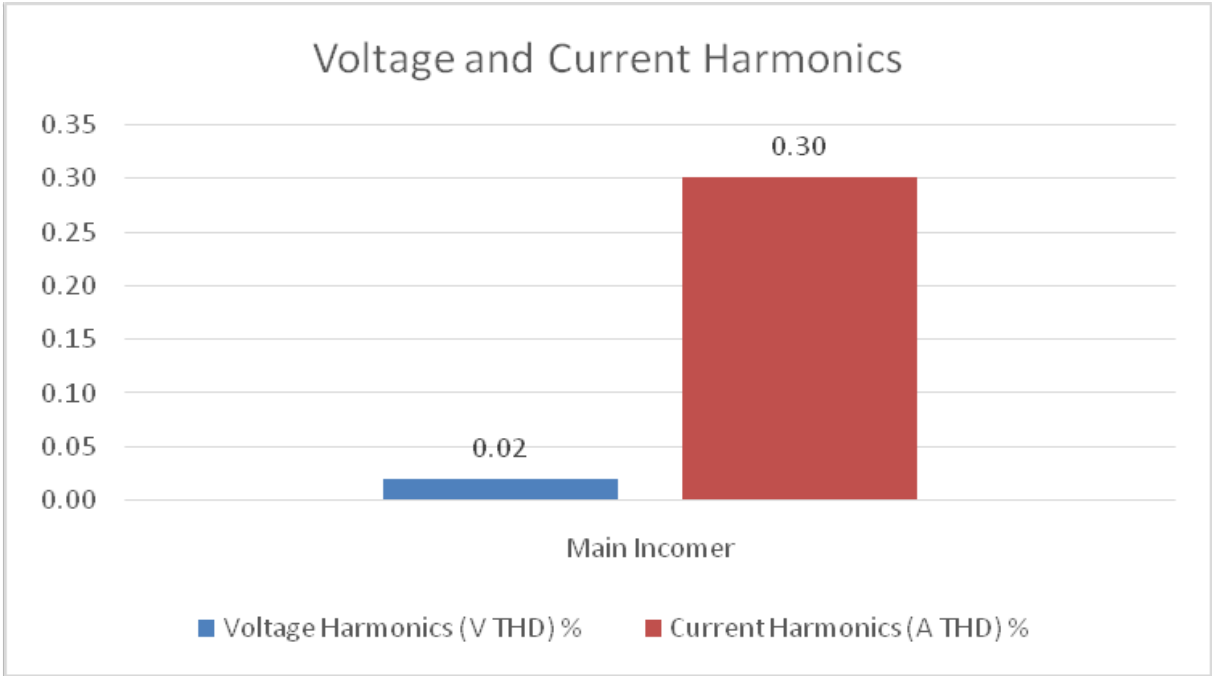
Study of Harmonics

- Equipment based on frequency conversion techniques generates harmonics. With the increasing use of such equipment, harmonics related problems have been enhanced which are leading to heating of cables, bus bars and transformers, overloading of the electrical distribution system, frequent tripping of switchgears, frequent failure of costly mother boards and capacitors of equipment, etc.
- The harmonic currents generated by different types of loads travel back to the source. While traveling back to the source, they generate harmonic voltages, following simple Ohm's law. Harmonic voltages, which appear on the system bus, are harmful to other equipment connected to the same bus, In general, sensitive electronic equipment connected to the bus, will be affected.

System Problem	Common Causes	Possible Effects	Solutions
Harmonics (non-sinusoidal voltages and /or current wave forms)	Office – Electronics, UPSs, variable frequency drives, high intensity discharge lighting and electronic and core coil ballasts.	Over-heating of neutral conductors, motors .transformers, switchgear. Voltage drop, low power factors, reduced capacity.	Take care with equipment selection and isolate sensitive electronics from noisy circuits.

The Harmonics level on 11 kV mains was recorded at Sangam University and the results are as follows:

Figure 12: Voltage & Current Harmonics

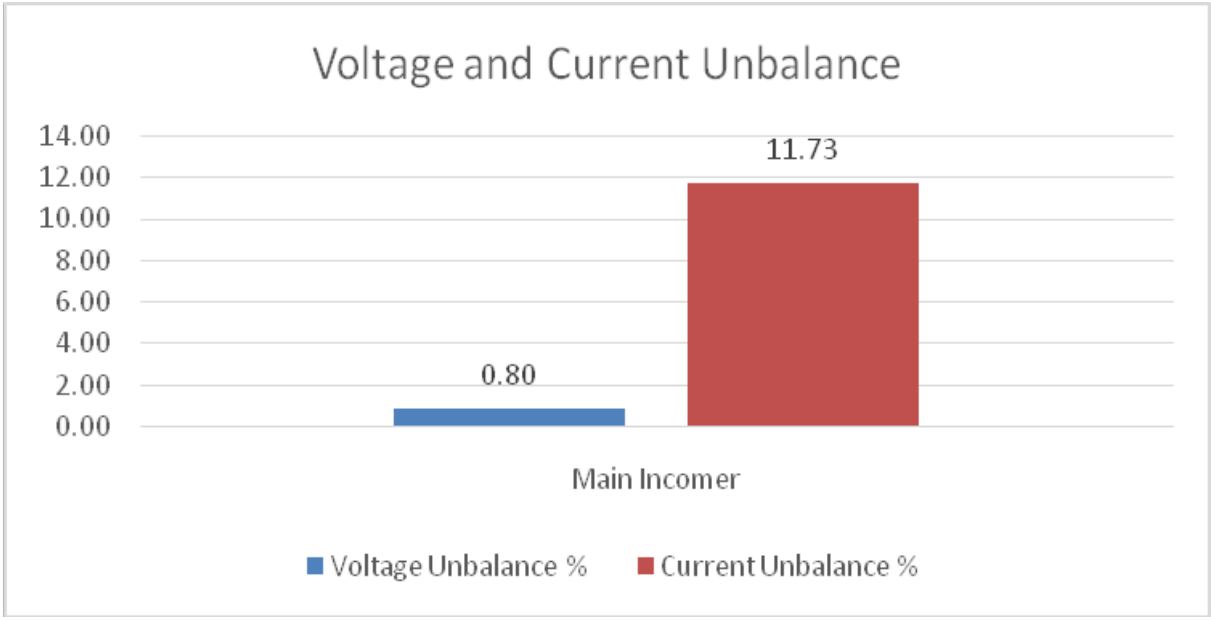


Voltage and Current Harmonics levels are within the specified limits.

Study of Voltage/Current Unbalance in the System

System Problem	Common Causes	Possible Effects	Solutions
Voltage imbalances among three phases.	Improper transformer tap setting, single – phase loads not balanced among phases, poor connections, bad conductors, transformer grounds or faults	Motor vibration premature motor failure A 5 % imbalance causes a 40 % increase in motor losses.	Balance loads among phases.

Figure 13: % Voltage & Current Unbalance



Practically the single phase lighting/power load cannot be balanced to such an extent that the load is shared equally among the three phases, thus no specific modification has been suggested in this case.

Table 12: Summary of Power Quality Analysis

Location	Voltage Harmonics (V_{THD}) %	Current Harmonics (A_{THD}) %	Voltage Un. (V_{UN}) %	Current Un. (A_{UN}) %
Main Incomer	0.02	0.30	0.80	11.73

4.5 Study of D.G. Set

The Sangam University has 1 no of 500 kVA DG set for emergency or power failure. This is due to erratic grid supply and frequent un-scheduled load shedding. Diesel is used as fuel in DG set. The DG set are operated in open cycle mode i.e. there is no heat recovery from exhaust or jacket hot water system due to very less running hours. We have also collected the diesel consumption & generation of electricity (2 kWh per Ltr Calculated) from DG set from the historical record.

Table 13: SEGR Evaluations DG Set

Sr.No.	Billing Month	DG (2 kWh per Ltr Average)	HSD Consumption, Ltr	SEG, kWh/L
		Total kWh		
1	Apr-20	400	200	2.00
2	May-20	670	335	2.00
3	Jun-20	694.02	347.01	2.00
4	Jul-20	940.02	470.01	2.00
5	Aug-20	460.04	230.02	2.00
6	Sep-20	640	320	2.00
7	Oct-20	534	267	2.00
8	Nov-20	748	374	2.00
9	Dec-20	795	397.5	2.00
10	Jan-21	489.18	244.59	2.00
11	Feb-21	670	335	2.00
12	Mar-21	0	0	0.00
Avg/Sum		**7040**	**3520**	**2.00**

During Energy Audit, Audit team tried to check the performance of DG set, Performance of DG set has been tabulated below.

Table 14: Performance Sheet of DG

S.No.	Particulars	Value
	Rated Specifications	**DG**
1	kVA	500
2	Make	SUDHIR
Operating Parameter		
1	Time at Start	2:38 PM
2	Time at Stop	3:08 PM
3	Initial kWh	0
4	Final kWh	22.5
5	Total kWh generated	22.5
6	Total diesel consumption during trial, Ltr	12
7	Avg. Annual Diesel Consumption, Ltr	3520
8	Avg Annual Power Generation, kWh	7040
9	Avg. Annual Diesel Cost, @ Rs. 90 /Ltr.	316811.7
10	Cost of DG Power Generation, Rs./kWh	45.00
11	Calorific Value of Diesel (kCal/kg)	11840
12	Diesel Density (kg/m^3)	0.83
13	Specific Fuel Consumption (SFC), Ltr/kWh	0.53
14	Specific Energy Generation Ratio (SEGR), kWh/Ltr	1.88
15	DG % loading	9.18
16	DG System Efficiency by Direct method	16.51
17	Remark	Need Improvement

Present Status: The present SEGR of the all DG set is 1.88 kWh/Ltr should be in the range 3.8 to 4.1. DG SEGR is coming less due to less loading of DG set.

4.6 Study of Motors & Pumps

Study of Motor Loading

- A detailed motor load study was undertaken on all continuously operating motors, with help of clamp-on energy meter to measure instantaneous parameters including ampere, power factor, KVA and kW.
- Motors are used inherently for driving various types of equipment in an industrial establishment.
- Also, it is to be noted that in normal running motor capacity may not match with the one existing on record/nameplate. This is because the existing motors are likely to be rewound a couple of times and as such they never come near to the nameplate capacity. It is therefore advisable to keep a **motor history card**, which will include rewinding frequency and record of no-load, current after every rewinding. It is also recommended to discard the motor in continuous duty of operation after 3 rewindings with energy efficient motors because with each rewinding efficiency of motor capacity goes down by approx. 2 %.
- It is therefore very important to evaluate the existing condition of the motor accurately and thereafter go in for any proposal depending upon the application and loading.
- University has mainly motor driven pumps and power consumption of Pump coupled motors are shown below.

Table 15: Study of Motor Loading Section Wise

Sr. No.	Motor Name	Actual Measurement			
		Voltage	Current	Active Power	Power Factor
		Volt (V)	Ampere (A)	Kilo Watt (kW)	
1	RO Plant Supply Pump	401.00	1.5	0.8	0.80
2	RO Plant High Pressure Pump	407.0	9.7	5.2	0.76
3	Water Supply Pump	404.0	2.4	1.6	0.96
4	Softener Plant Pump	399.0	5.4	3.2	0.87
5	Samsan Boring Pump	398.0	11.3	6.9	0.89
6	Boring Behind Library	412.0	15.5	9.8	0.89
7	Boring Behind Canteen	404.0	6.0	3.8	0.91
8	Boring (Udiya)	397	4.81	2.5	0.75

Study of Pumps

While the field trial, RECON team tried to take pump performance by measurement of various parameters of pumps with a connected load of more than 5 HP to evaluate the pump efficiency.

Table 16: Comparison of Various Pump Performances

Sr. No.	Particulars	Unit	RO Plant Supply Pump	High Pressure Pump	Softener Plant Pump	Samsan Pump	Boring Behind Library	Water Supply Motor	Boring Behind Canteen	Boring (Udiya)
1	Connected Motor	kW	1.1	3.7	0.75			2.2	5	
2	Measured Operating Flow	m^3/hr	6	6	26.6	8.2	8	3	7.8	3.34
3	Fluid density	Kgs/m^3	1000	1000	1000	1000	1000	1000	1000	1000
4	Discharge Head	mts.	15	120	25	137	106	30	45.72	76
5	Suction Head	mts.	3	10	-1.0	0	0	1.5	0	0
6	Operating Head	mts.	12	110	26	137	106	28.5	45.72	76
7	Hydraulic Power	KW	0.20	1.80	1.88	3.06	2.31	0.23	0.97	0.69
8	Rated Motor Efficiency	%	90	90	90	90	90	90	90	90.00
9	Measured Pump Input Power	KW	0.80	5.21	3.22	6.9	8.30	1.5	3.82	2.48
10	Corrected Pump Input power	KW	0.72	4.69	2.90	6.21	7.47	1.35	3.44	2.23
11	Pump Efficiency	%	27	38	65	49	31	17	28	31
12	Overall Efficiency	%	25	35	59	44	28	16	25	28

Pump Performance of all major pumps is low but replacement is not suggested due to low running hours.

Recommendation – Estimated Saving by installing float valve in all Tanks

During the energy audit, it was observed that some tanks' float valve was not working properly or not installed due to this, water wastage is happening via the overflow. So it is suggested to install a flat valve in all tanks and in one tank install float switch so that pump can automatically off after filling all tanks. At Present time, gards check the water overflow and call the operator for swiching of Pump which is wastage of time, Water and Power.

By implementing this plant can save approx 10% of Pump Power both drinking water and Black water. University can save 10 kW per day and 3300 kW per year and 24090 Rs. Per year with an investment of approx Rs. 35000 for installation of Float valve and float sensors.

4.7 Performance of Air Conditioner Units

University has installed 42 ACs, Energy Audit team has taken the performance of all these 42 AC's and Performance data has been tabulated below:

Table 17: Performance of ACs

Sl. No	Description	Unit	Split AC	Window AC	Window AC	Window AC	Split AC	Split AC	Split AC
	Rated Capacity	TR	1.5	1.5	1.5	1.5	1.5	1.5	2
1	Return Air Size	m2	0.07	0.04	0.04	0.04	0.09	0.09	0.07
2	Make	NA	Voltas	Voltas	Voltas	Voltas	Voltas	Voltas	Bluestar
3	Location	NA	R-1	R-2	R-08	R-109	R-102	Chairperson	R-104
	Power Consumption								
1	Current	A	4.68	5.92	4.81	5.78	5.1	5.56	8.4
2	Power	kW	1.12	1.30	1.04	1.40	1.20	1.27	2.10

3	Pf		0.98	0.96	0.95	0.95	0.98	0.98	0.98
	Supply Air Parameter								
1	Air velocity	m/s	3.30	3.62	2.98	4.36	4.48	4.57	6.32
2	DBT	oC	20.98	17.43	20.66	18.43	15.41	21.35	22.01
3	WBT	oC	18.31	15.38	18.35	17.02	14.31	19.8	20.59
4	Enthalpy of air (H_{in})	KJ/Kg	51.88	43.02	51.93	47.83	40.04	57.12	59.4
	Return Air Parameter								
1	Mass flow of Air	kg/h	837.44	489.12	402.00	589.09	1419.84	1448.64	1586.95
2	DBT	oC	27.5	30.0	31.36	26.8	22.2	26.2	28.8
3	WBT	oC	23.41	26.09	27.04	25.71	18.59	23.35	24.61
4	Enthalpy of air (H_{out})	KJ/Kg	69.86	78.8	85.24	79.41	52.77	69.47	74.65
5	Heat load	TR	1.19	1.38	1.06	1.47	1.43	1.41	1.91
6	Specific Power Consumption	KW/TR	0.94	0.94	0.98	0.95	0.84	0.90	1.10
7	Energy Efficiency Ratio, EER		3.73	3.74	3.58	3.69	4.18	3.91	3.20
8	Performance		Good	Good	Satisfactory	Satisfactory	Good	Good	Satisfactory

Performance Assessment of AC's									
Sl. No	Description	Unit	Split AC	Window	Window	Window	Window	Window	Window
	Rated Capacity	TR	2	1.5	1	2	2	2	2
1	Return Air Size	m2	0.07	0.04	0.03	0.04	0.04	0.04	0.04
2	Make	NA	Voltas	Voltas	Voltas	Voltas	Voltas	Voltas	Voltas
3	Location	NA	R-104	R-104	R-128	R-14	R-14	R-14	System Room
	Power Consumption								

1	Current	A	8.96	6.13	3.42	10.1	9.97	10.9	11
2	Power	kW	1.90	1.35	0.77	2.20	2.06	2.25	2.40
3	Pf		0.97	0.96	0.96	0.98	0.98	0.98	0.98
	Supply Air Parameter								
1	Air velocity	m/s	6.50	12.12	9.14	7.77	7.96	10.13	4.97
2	DBT	oC	21.67	23.47	29.4	19.51	15.63	17.84	5.49
3	WBT	oC	20.12	22.61	25.75	17.63	14.21	17.02	4.1
4	Enthalpy of air (H_{in})	KJ/Kg	57.75	66.75	79.48	49.66	39.8	47.88	16.86
	Return Air Parameter								
1	Mass flow of Air	kg/h	1632.15	1636.50	883.94	1208.39	1118.09	1400.48	687.05
2	DBT	oC	27.1	26.8	29.1	26.9	21.8	24.79	23.8
3	WBT	oC	24.18	23.38	26.03	23.18	21.02	21.5	17.49
4	Enthalpy of air (H_{out})	KJ/Kg	72.91	69.72	80.68	68.97	60.96	62.7	49.3
5	Heat load	TR	1.95	0.38	0.08	1.84	1.87	1.64	1.76
6	Specific Power Consumption	KW/TR	0.97	3.52	9.19	1.19	1.10	1.37	1.36
7	Energy Efficiency Ratio, EER		3.62	1.00	0.38	2.95	3.19	2.56	2.58
8	Performance		Good	Need To Replace Immediately	Need To Replace Immediately	Satisfactory	Satisfactory	Satisfactory	Satisfactory

Performance Assessment of AC's									
Sl. No	Description	Unit	Split AC	Split AC	Split AC	Window	Window	Split AC	Split AC
	Rated Capacity	TR	2	2	2		2	2	2
1	Return Air Size	m2	0.10	0.10	0.11		0.04	0.11	0.11
2	Make	NA	Voltas	Voltas	Godraj	National	Voltas	Godraj	Godraj

3	Location	NA	Server Room	Server Room	Old Research Lab	R-120	R-120	PG Lab	R-201 (DMW Lab)
	Power Consumption								
1	Current	A	11.7	11.2	7.7		12.4	8.47	11.1
2	Power	kW	2.30	2.20	1.50		2.50	1.79	2.30
3	Pf		0.98	0.98	0.97		0.98	0.97	0.97
	Supply Air Parameter								
1	Air velocity	m/s	9.27	9.53	5.17		8.62	6.17	6.46
2	DBT	oC	17.12	18.16	20.31		19.13	19.9	20.3
3	WBT	oC	15.67	17.21	19.02		17.51	18.61	19.31
4	Enthalpy of air (H_{in})	KJ/Kg	45.343	48.44	54.09		49.27	52.76	55.02
	Return Air Parameter					Not Working			
1	Mass flow of Air	kg/h	3203.71	3292.63	2025.12		1318.58	2416.62	2528.44
2	DBT	oC	22.3	21.6	24.0		26.4	26.5	24.8
3	WBT	oC	18.4	17.29	22.41		22.9	21.65	22.1
4	Enthalpy of air (H_{out})	KJ/Kg	52.14	48.68	65.89		67.63	63	64.73
5	Heat load	TR	1.72	0.06	1.89		1.91	1.95	1.94
6	Specific Power Consumption	KW/TR	1.34	35.24	0.79		1.31	0.92	1.19
7	Energy Efficiency Ratio, EER		2.63	0.10	4.42		2.69	3.84	2.96
8	Performance		Satisfactory	Need To Replace Immediately	Satisfactory		Satisfactory	Good	Satisfactory

Performance Assessment of AC's									
Sl. No	**Description**	**Unit**	**Split AC**	**Split AC**	**Split AC**	**Split AC**	**Split AC**	**Window**	**Window**

	Rated Capacity	TR	2	2	2	2	2	2	1.5
1	Return Air Size	m2	0.11	0.11	0.11	0.07	0.11	0.04	0.04
2	Make	NA	Godraj	Godraj	Godraj	Vedicon	Voltas	Voltas	Voltas
3	Location	NA	R-201 (DMW Lab)	R-201 (ERP Lab)	R-201 (ERP Lab)	R-217	R-217	R-138	R-24
	Power Consumption								
1	Current	A	11.3	10.7	10.3	11.8	10.5	11.1	5.54
2	Power	kW	2.11	2.37	2.16	2.49	2.30	2.30	1.18
3	Pf		0.95	0.96	0.95	0.95	0.96	0.97	0.94
	Supply Air Parameter								
1	Air velocity	m/s	5.90	4.02	3.28	5.93	4.46	17.25	10.95
2	DBT	oC	19.29	19.87	14.32	17.7	22.7	19.4	24.31
3	WBT	oC	18.4	18.67	13.11	16.3	21.5	17.7	23.4
4	Enthalpy of air (H_{in})	KJ/Kg	51.16	52.96	36.89	45.68	62.6	49.88	69.82
	Return Air Parameter								
1	Mass flow of Air	kg/h	2309.85	1573.12	1284.83	1537.92	1815.93	2384.64	1513.73
2	DBT	oC	23.2	26.8	21.1	26.9	26.9	26.1	28.7
3	WBT	oC	21.11	23.07	17.52	23.43	22.47	23.25	25.79
4	Enthalpy of air (H_{out})	KJ/Kg	61.17	68.54	49.41	61.18	65.49	59.22	79.67
5	Heat load	TR	1.83	1.94	1.27	1.88	0.41	1.76	1.18
6	Specific Power Consumption	KW/TR	1.16	1.22	1.70	1.32	5.55	1.31	1.00
7	Energy Efficiency Ratio, EER		3.04	2.87	2.07	2.66	0.63	2.69	3.51
8	Performance		Satisfactory	Satisfactory	Satisfactory	Satisfactory	Need To Replace Immediately	Satisfactory	Good

Performance Assessment of AC's									
Sl. No	Description	Unit	Window	Window	Window	Window	Split AC	Split AC	Window
	Rated Capacity	TR	1.5	1.5	1.5	1.5	1.5	1.5	1.5
1	Return Air Size	m2	0.04	0.04	0.03	0.04	0.06	0.06	0.03
2	Make	NA	Voltas	Voltas	Hitachi	Voltas	Voltas	Voltas	Voltas
3	Location	NA	R-22	IUPC cell	R-17	R-60	LT102	LT102	LT-209
	Power Consumption								
1	Current	A	7.22	6.35	6.44	8.95	4.5	5.27	4.3
2	Power	kW	1.56	1.39	1.43	1.93	1.09	1.22	1.70
3	Pf		0.97	0.98	0.98	0.96	0.99	0.99	0.99
	Supply Air Parameter								
1	Air velocity	m/s	10.32	6.00	6.84	8.76	7.39	5.95	6.44
2	DBT	oC	22.4	19.64	18.5	13.96	17.3	18.45	16.77
3	WBT	oC	22.1	18.48	17.94	12.6	16.2	17.6	15.43
4	Enthalpy of air (H_{in})	KJ/Kg	61.16	52.4	47.64	35.61	45.44	49.6	43.18
	Return Air Parameter								
1	Mass flow of Air	kg/h	1426.18	829.44	690.70	1211.49	1532.87	1232.85	681.22
2	DBT	oC	28.1	24.5	27.0	21.10	22.04	27.01	25.42
3	WBT	oC	25.19	18.88	24.08	18.1	20.0	22.1	23.7
4	Enthalpy of air (H_{out})	KJ/Kg	77.06	53.7	72.49	51.08	57.36	64.68	70.89
	Heat load	TR	1.79	0.09	1.36	1.48	1.44	1.47	1.49
	Specific Power Consumption	KW/TR	0.87	16.32	1.05	1.30	0.76	0.83	1.14
	Energy Efficiency Ratio, EER		4.04	0.22	3.33	2.70	4.66	4.23	3.08
	Performance		Good	Need To Replace Immediately	Satisfactory	Satisfactory	Good	Good	Satisfactory

Performance Assessment of AC's									
Sl. No	Description	Unit	Split AC	Split AC	Window	Window	Window	Window	Window
	Rated Capacity	TR	1.5	1.5	1.5	1.5	1.5	1.5	1.5
1	Return Air Size	m2	0.09	0.09	0.04	0.04	0.04	0.04	0.04
2	Make	NA	Voltas	Voltas	Voltas	Voltas	Voltas	Voltas	Voltas
3	Location	NA	LT101	LT101	Admission Block	Admission Block	Admission Block	R-41	R-209
	Power Consumption								
1	Current	A	4.7	4.3	6.1	6.5	6.6	5.94	8.68
2	Power	kW	1.03	1.01	1.29	1.40	1.70	1.10	1.80
3	Pf		0.95	0.94	0.95	0.97	0.97	0.81	0.99
	Supply Air Parameter								
1	Air velocity	m/s	6.37	6.17	7.58	7.30	7.90	11.59	6.48
2	DBT	oC	20.32	24.1	22	15.36	18.27	21.8	15.01
3	WBT	oC	18.85	21.4	20.4	14.87	17.5	19.8	13.95
4	Enthalpy of air (H_{in})	KJ/Kg	53.34	62.18	58.7	41.63	49.3	55.29	50
	Return Air Parameter								
1	Mass flow of Air	kg/h	2120.03	2051.28	1179.36	985.64	1228.61	1735.55	951.78
2	DBT	oC	24.02	25.51	27.62	23.95	24.13	25.02	26.03
3	WBT	oC	21.3	23.6	24.1	20.7	21.7	22.4	23.3
4	Enthalpy of air (H_{out})	KJ/Kg	61.8	70.5	72.66	59.8	63.47	65.85	69.227
	Heat load	TR	1.42	1.35	1.30	1.41	1.38	1.45	1.45
	Specific Power Consumption	KW/TR	0.73	0.75	0.99	0.99	1.24	0.76	1.25
	Energy Efficiency Ratio, EER		4.84	4.69	3.54	3.55	2.84	4.63	2.82
	Performance		Good	Good	Satisfactory	Satisfactory	Satisfactory	Good	Satisfactory

Recommendation: Replacement of old AC's with 5 Star Rated AC's

During the audit team has observed that some of the Acs are giving very low EER (cooling Vs Power Consumption). So we suggest replacing some Ac with BEE 5 star rated ACs with immediate effect, list and saving calculation has been tabulated below.

Table 18: Replacement of AC

Sr.No.	Particulars	R-104	R-128	Server Room	R-217	IUPC cell
1	Present Avg EER of AC	1.00	0.38	0.10	0.63	0.22
2	Proposed minimum EER with three star AC	2.70	2.70	2.70	2.70	2.70
3	Energy Saving, kW	1.7	2.3	2.6	2.1	2.5
4	Annual operating Hours	960	960	8640	960	960
5	Annual Energy Saved, kWh	1632	2225	22466	1984	2385
6	Cost Of Power, Rs/kWh	9.00	9.00	9.00	9.00	9.00
7	Total Annual Saving, in Lakh	14688	20022	202194	17852	21466
8	Price of 5 Star AC	40000	55000	70000	85000	100000
9	Simple Payback Period, Months	33	33	4	57	56

4.8 Study of Illumination Systems

- Sangam University has total lighting load of about 36 kW, which is nearly 7% of the overall electrical demand. Lighting loads are supplied power from single phase supply and there is no separate lighting feeder at the main power control centre (PMCC).
- Sangam University has mostly 36 W T-8 Lamps, LED & CFLs. The distribution of these lamps as per the location is mentioned above. The Sangam University's total Lighting Fixtures Installed is listed below:

Table 19: Installed Load of Lighting Fixtures

Sr. No.	Type	Wattage, W	Total Qty.	Installed Load, KW
1	C.F.L.	11	89	0.98
2	LED	18	226	4.07
3	LED	100	3	0.30
4	Sodium	250	24	6.00

Sr. No.	Type	Wattage, W	Total Qty.	Installed Load, KW
5	Sodium	400	6	2.40
6	Sodium Vapour	100	9	0.90
7	Tube light	36	557	20.05
8	Tube light	48	18	0.86
Total			932	35.56

Table 20: Measurement of Lux Level

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
1	Room 001	C.F.L.	11	8	147	88
2	Room 002	LED	18	3	132	54
3	Room 008	LED	18	2	157	36
4	Room 109	Tube light	36	2	103	72
5	Room 102	C.F.L.	11	4	132	44
6	Conference room / chair person	C.F.L.	11	3	203	33
7	Conference room	LED	18	12	175	216
8	Room 128	Tube light	36	2	188	72
9	Room 14 Server Room	Tube light	36	1	98	36
10	Room 14 Advance computer lab	Tube light	36	8	65	288
11	Room 119	Tube light	36	4	104	144
12	Room 120 EC M.tech	Tube light	36	8	126	288
13	Room 119 M.tech 2	LED	18	4	106	72
14	Room 201 DMW Lab	Tube light	36	9	147	324
15	Room 201 ERP Lab	LED	18	12	153	216
16	Room 201 Registration DMW&ERP	Tube light	36	12	159	432
		LED	18	8		144
17	Room 217 Language lab	LED	18	7	98	126
		Tube light	36	5		180
18	Room 138 Associate Prof/Computer Science	LED	18	2	202	36
19	Room 024	LED	18	1	112	18

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
		Tube light	36	1		36
20	Room 022	LED	18	2	157	36
21	IUPC Cell	Tube light	36	2	54	72
22	Room 017	LED	18	1	84	18
23	Room060	LED	18	4	130	72
24	Room LT102	C.F.L.	11	18	111	198
		Tube light	36	4		144
25	Room LT101	C.F.L.	11	18	40	198
		LED	18	1		18
26	Room LT 103	C.F.L.	11	18	64	198
		Tube light	36	1		36
27	Room LT 209	Tube light	36	4	74	144
28	Room LT 201	Tube light	36	5	188	180
29	Admission Block	LED	18	29	153	522
30	Library				271	0
31	EE Library	LED	18	1	66	18
		Tube light	36	5		
32	Central Library	C.F.L.	11	8	71	88
33	Reading Room	LED	18	5	74	90
34	Applied Science Section	LED	18	6	77	108
35	Computer Sc. IT & M.tech Section	LED	18	6	62	108
36	Mechanical Engg.	LED	18	4	113	72
37	Room 041	LED	18	1	62	18
		Tube light	36	1		36
38	Room 209	Tube light	36	4	136	144
39	Reception	LED	18	6	242	108
		C.F.L.	11	12		132
40	Room 04	LED	18	6	154	108
		Tube light	36	2		72

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
41	Room 007	Tube light	36	3	87	108
42	Room 011	LED	18	4	121	72
43	Room 012	LED	18	1	87	18
44	Room 009	LED	18	1	61	18
45	Chemistry lab 017	Tube light	36	2	85	72
		LED	18	3		54
46	Room 018	LED	18	1	96	18
47	Room 020	LED	18	1	104	18
48	Room 025	Tube light	36	1	120	36
		LED	18	2		36
49	Room 010	Tube light	36	3	100	108
		LED	18	7		126
50	Room 030	Tube light	36	1	99	36
		LED	18	1		18
51	Room 031	Tube light	36	5	131	180
		LED	18	5		90
52	Room 028	Tube light	36	1	87	36
		LED	18	4		72
53	Room 034	Tube light	36	2	87	72
		LED	18	4		72
54	Room 135	Tube light	36	4	167	144
		LED	18	4		72
55	Room 134	Tube light	36	4	189	144
		LED	18	4		72
56	Room 133	Tube light	36	1	84	36
		LED	18	1		18
57	Room 130	Tube light	36	1	99	36
		LED	18	1		18
58	Room 129	LED	18	1	47	18

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
59	Room 127	Tube light	36	3	93	108
		LED	18	3		54
60	Room 126	LED	18	1	89	18
61	Room 110	LED	18	1	102	18
62	Room 113	LED	18	1	86	18
63	Room 115	Tube light	36	11	101	396
64	Room 123	Tube light	36	1	117	36
		LED	18	1		18
65	Room 121	LED	18	1	127	18
66	Room 112	LED	18	1	132	18
67	Room 221	Tube light	36	1	108	36
		LED	18	5		90
68	Room 212	LED	18	1	161	18
69	Room 214	LED	18	1	48	18
70	Room 27	LED	18	2	Locked	36
71	Room 29	LED	18	2	Locked	36
72	Room 46	LED	18	1	Locked	18
73	Room 35	LED	18	1	Locked	18
74	Room 36	Tube light	36	1	Locked	36
75	Room 38	Tube light	36	1	Locked	36
76	Agriculture block Room 02	LED	18	1	70	18
77	Agriculture block Room 09	LED	18	1	93	18
78	Agriculture block Room 11	LED	18	2	112	36
79	Agriculture block Room 10	LED	18	4	175	72
80	Agriculture block Room 03	LED	18	5	127	90
81	Agriculture block Room 04	Tube light	36	6	53	216
82	Agriculture block Room 08	LED	18	4	111	72
		Tube light	36	3		108
83	Agriculture block Room 105	Tube light	36	16	114	576

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
84	Agriculture block Room 101	Tube light	36	4	86	144
85	Agriculture block Room 106	Tube light	36	2	58	72
86	Agriculture block Room 102	Tube light	36	12	92	432
87	Agriculture block Room 104	Tube light	36	5	67	180
88	Agriculture block Room 103	Tube light	36	6	66	216
89	Agriculture block Room 203	Tube light	36	8	155	288
90	Agriculture block Room 207	Tube light	36	5	87	180
91	Agriculture block Room 204	Tube light	36	2	36	72
92	Agriculture block Room 205	Tube light	36	2	62	72
93	Agriculture block Room 206	Tube light	36	3	61	108
94	Agriculture block Room 201	Tube light	36	4	89	144
95	Agriculture block Room 211	Tube light	36	1	80	36
96	Agriculture block Room 210	Tube light	36	1	100	36
97	Agriculture block Room 208	Tube light	36	1	72	36
98	Agriculture block Room 209	Tube light	36	4	151	144
99	Agriculture block Room 144	Tube light	36	12	135	432
100	Agriculture block Room 135	Tube light	36	9	99	324
101	Agriculture block Room 145	Tube light	36	14	84	504
102	Agriculture block Room 136	Tube light	36	14	94	504
103	Agriculture block Room 148	Tube light	36	15	117	540
104	Agriculture block Room 137	Tube light	36	16	82	576
105	Agriculture block Room 138	Tube light	36	8	174	288
106	Agriculture block Room 149	Tube light	36	4	161	144
107	Agriculture block Room 230	Tube light	36	12	112	432
108	Agriculture block Room 229	Tube light	36	10	90	360
109	Agriculture block Room 240	Tube light	36	12	145	432
110	Agriculture block Room 241	Tube light	36	14	77	504
111	Agriculture block Room 244	Tube light	36	15	79	540
112	Agriculture block Room 232	Tube light	36	1	104	36

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
113	Agriculture block Room 245	Tube light	36	4	83	144
114	Agriculture block Room 231	Tube light	36	16	98	576
115	Agriculture block Room 067	Tube light	36	24	74	864
116	Agriculture block Room 065	Tube light	36	16	63	576
117	Agriculture block Room 066	Tube light	36	4	126	144
118	Agriculture block Room 068	Tube light	36	12	91	432
119	Legal Studies Room LT105	Tube light	36	2	189	72
120	Legal Studies Room LT106	Tube light	36	7	107	252
121	Legal Studies Room LT107	Tube light	36	7	Locked	252
122	Legal Studies Room LT109	Tube light	36	7	67	252
123	Legal Studies Room LT110	Tube light	36	12	123	432
124	Legal Studies Room LT111	Tube light	36	6	91	216
125	Legal Studies Room LT112	Tube light	36	6	53	216
126	Legal Studies Room LT211	Tube light	36	4	82	144
127	Legal Studies Room LT212	Tube light	36	1	86	36
128	Legal Studies Room LT215	Tube light	36	6	106	216
129	Legal Studies Room LT213	Tube light	36	6	222	216
130	Legal Studies Room LT208	Tube light	36	6	148	216
131	Legal Studies Room LT206	Tube light	36	2	308	72
132	Legal Studies Room LT207	Tube light	36	5	207	180
133	Legal Studies Room LT203	Tube light	36	4	90	144
134	Legal Studies Room LT204	Tube light	36	12	129	432
135	Legal Studies Room LT202	Tube light	36	4	111	144
136	Legal Studies Room LT210	Tube light	36	4	85	144
137	Legal Studies Room LT216	Tube light	36	6	170	216
138	Legal Studies Room LT217	Tube light	36	1	96	36
139	Fire And Safety	Tube light	36	6	Locked	216
140	Front of University Main gate	Sodium	400	1	39	400
		Sodium	250	9		2250

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
141	college main circle	Sodium	250	8	47	2000
142	work shop	LED	100	1	33	100
143	Ro plant	Sodium	400	1	48	400
144	main gate	Sodium	250	1	33	250
145	Basket Ground	Sodium	400	4	0	1600
146	college mess	Sodium	250	4	40	1000
147	Hostel	Sodium	250	2	25	500
		LED	100	1		100
148	Security Colony	LED	100	1	32	100
149	Colony Road	Sodium	100	9	25	900
150	Common toilet 6	Tube light	48	1	104	48
151	Common toilet 5	Tube light	48	1	185	48
152	Common toilet 15	Tube light	48	1	60	48
153	Common toilet 14	Tube light	48	1	70	48
154	Common toilet 19	Tube light	48	1	512	48
155	Common toilet 117	Tube light	48	1	118	48
156	Common toilet 116	Tube light	48	1	11	48
157	Common toilet 108	Tube light	48	1	94	48
158	Common toilet 107	Tube light	48	1	88	48
159	Common toilet 131	Tube light	48	1	128	48
160	Common toilet 132	Tube light	48	1	117	48
161	Common toilet 218	Tube light	48	1	104	48
162	Common toilet 219	Tube light	48	1	132	48
163	Common toilet 207	Tube light	48	1	126	48
164	Common toilet 206	Tube light	48	1	127	48
165	Common toilet 32	Tube light	48	1	9	48
166	Common toilet 33	Tube light	48	1	111	48
167	Common toilet 37	Tube light	48	1	396	48
168	PG 147	LED	18	1	254	18

Sr. No.	Location or Area	Luminary			Lux Level	Connected wattage (W)
		Type	Watt	SL	Avg.	
169	PG 146	LED	18	1	195	18
170	PG 248	LED	18	1	221	18
171	PG 242	LED	18	1	111	18
172	PG 64	LED	18	1	140	18
173	PG 63	LED	18	1	103	18
174	Agriculture G-FLOOR HE	LED	18	1	104	18
175	Agriculture G-FLOOR SHE	LED	18	1	9	18
176	Agriculture 1ST-FLOOR HE	LED	18	1	10	18
177	Agriculture 1ST-FLOOR SHE	LED	18	1	65	18
178	Agriculture 2ST-FLOOR HE	LED	18	1	56	18
179	Agriculture 2ST-FLOOR SHE	LED	18	1	88	18
180	LT GST-FLOOR HE	LED	18	1	98	18
181	LT GST-FLOOR SHE	LED	18	1	109	18
182	LT 1ST-FLOOR HE	LED	18	2	122	36
183	LT 1ST-FLOOR SHE	LED	18	3	71	54

Recommendation: Replacement of Tube lights with LED Lamps

During the Energy Audit, lighting survey is carried out throughout the Sangam University. Many places in the Sangam University T8 Tube lights are observed. In the University lighting, fluorescent tubelights has been installed and we propose the same to be replaced by LED lamps. It will provide same illumination with approx half power consumption.

Table 21: Replacement of Tube light with LED lamps

Sr.No.	Particulars	Tubelight 48 Watt
1	Present Power Consumption, Watt	48.00
2	Proposed Power consumption of LED light, Watt	18.00
3	Energy Saving, Watt	30.0
4	Annual operating Hours (330*12)	3960
5	Total Number of Tube lights	575

6	Annual Energy Saved, kWh	68310
7	Cost Of Power, Rs/kWh	7.30
8	Total Annual Saving, in Rs. Lakh	4.99
9	Cost per LED light Rs/Light	180
10	Estimated investment in Rs. Lakh	1.035
11	Simple Payback Period, Months	2

By implementing this University can save **68310 kWh and around Rs. 5 Lakh** per annum with an investment of Rs. 1.03 Lakh.

Recommendation: Replacement of Street and Focus Lights with LED Lamps

During Energy Audit, the Audit team observed that University is using conventional street lights, so it is suggested to replace them with LED street lights. By LED street light lighting, the load will reduce more than 50%. Energy Saving calculation has been tabulated below.

Table 22: Replacement of Street Light with LED Light

Sr.No.	Particulars	S.V. 100	S.V. 250	S.V. 400
1	Present Power Consumption, Watt	100.00	250	400.00
2	Proposed Power consumption of LED light, Watt	40.00	80.00	100.00
3	Energy Saving, Watt	60.0	170.0	300.0
4	Annual operating Hours (330*12)	3960	3960	3960
5	Total Number of S.V. Lamps	9	24	6
6	Annual Energy Saved, kWh	2138	16157	7128
7	Cost Of Power, Rs/kWh	7.30	7.30	7.30
8	Total Annual Saving, in Rs. Lakh	0.16	1.18	0.52
9	Cost per LED light Rs/Light	2000	5000	7500
10	Estimated investment in Rs. Lakh	0.18	1.20	0.45
11	Simple Payback Period, Months	14	12	10

By implementing this University can save **25423 kWh and around 1.86 Lakh per annum** with an investment of Rs. 1.82 Lakh.

Recommendation: Energy Saving by installing occupancy sensor's to the Exhaust fan and Light combined in Toilets

During the energy audit, the audit team observed that the exhaust fan and tube light continuously running all the time in Toilets and hence exhaust fan of 32 watts and tube light of 48 watts consuming power throughout 12 hrs. So it is recommended to install occupancy sensors in each common washroom. Energy Saving calculation has been tabulated below.

Table 23: Energy Saving by installing occupancy sensor's

Sr.No.	Particulars	Value
1	Present Power Consumption of Tube light, Watt	864.00
2	Present Power Consumption of Exhaust Fan, Watt	576.00
3	Annual operating Hours (330*12)	3960
4	Total Number of Occupancy Sensor	18
5	Annual Energy Saved considering half time occupancy, kWh	2851
6	Cost of Power, Rs/kWh	7.30
7	Cost of Sensor each	1500.00
8	Total Annual Saving, in Rs. Lakh	0.21
9	Estimated investment in Rs. Lakh	0.27
10	Simple Payback Period, Months	16

By implementing this University can save **2851 kWh and around Rs. 0.21 Lakh** per annum with an investment of Rs. 0.27 Lakh.

Annexure-1

List of Instruments used in Energy Audit:

- Lux Meter – Lutron
- Hygrometer & Anemometer– HTC
- IR Gun – HTC
- 3 Phase Power Analyzer Krykard ALM 36 with CT PT
- Signal phase Power Analyzer Nanovip with CT PT
- Signal phase Power Analyzer Testo-770-3 with PT
- Digital Anemometer – MECO
- Digital Thermometer Mextech
- Ultrasonic Flow Meter with Transducers