ENERGY AUDIT REPORT

JANUARY 2019

SRI SHANMUGHA COLLEGE OF ENGINEERING & TECHNOLOGY

SANKARI, SALEM

Mangla Smart Energy Solutions Private Limited

Specialists in Renewable Energy & Energy Efficiency

Energy Audit Report
Of
M/s Sri Shanmuga College of Engineering &Technology, Sankari, Salem

Prepared by

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EXECUTIVE SUMMARY

An energy audit is an investigation of all facets of a user facility's historical and current energy usage with an objective of identifying and quantifying areas of energy wastage in its activities. The process of energy audit is the key to a systematic approach for decision-making in the area of energy conversation and energy management. The objective of the energy, power quality and thermography audit is primarily to assess the viability to upgrade the energy efficiency measures prior to investing extensive resources with a main focus on electrical and thermal energy. Upon completion of the audit process, the Energy Audit Team has worked out **4 Energy Conservation Action Plans** and the summary of all the **Energy Conservation Proposals (ENCONS)** are presented as follows:-

1. **Projected Annual Energy Savings of 40580 kWh**
2. **With the Annual Financial Saving to be achieved will be Rs. 3.45 Lakhs.**
3. **Total Investments to achieve the above Rs. 6.0 Lakhs.**
4. **With a Simple Pay Back Period of 1.74 Years.**
5. **Hence the Anticipated Total reduction in Annual Fuel Bills = 17.7%**

Audited By **Verified by**

For MANGLA SMART ENERGY SOLUTIONS (P) LTD

Authorised Signatory

Dr. R. Sivakumar

(BEE Certified Energy Manager –EA-6098)

Dr. Vimal Kumar Eswarlal

Mangla Smart Energy Solutions

TABLE OF CONTENTS

Acknowledgement

Mangala Smart Energy Solutions are thankful to the management of M/s Sri Shanmugha educational charitable trust, Sankari, Salem for providing us an opportunity in undertaking this energy audit. We grateful to Mr K.Shanmugam – Chairman, Vice chairman and Dr. Radhakrishnan, Principal for showing keen interest in the study and also thankful to the progressive management of M/s SSECT for their wholehearted support and cooperation t the preparation of Energy audit report, without which the study would not have steered to its successful completion.

We also wish to express our gratitude to the maintenance department officials and other staff members of M/s SSECT for their support and cooperation during the energy audit for retrieving the required information. It is well worthy to mention that the efforts being taken and the enthusiasm shown by all the staffs towards energy conservation and sustainable growth was really admirable. We found all the personnel keen to implement the possible energy conservation aspects. Our special thanks to Mr. Anandakrishna – Quality head for allowing us to perform the audit in the institution campus.

Dr.Vimal Kumar Eswarlal
MD – Mangla Smart Energy Solutions
Tirupur

LIST OF SYMBOLS AND ABBREVIATIONS

List of Abbreviations		List of Abbreviations	
AC	Alternating Current	EE	Energy Efficiency
AC Unit	Air Conditioning Unit	FTL	Fluorescent Tube Light
APFC	Automatic Power Factor Controller	PV	Photovoltaic
BE/NE	Body Earth/Neutral Earth	RD	Recorded Demand
BEE	Bureau of Energy Efficiency	RMS	Root Mean Square
BLDC	Brush Less Direct Current	SS	Servo Stabilizer
CEA	Central Electricity Authority	TDS	Total Dissolved Solids
CT	Current Transformer	TR	Tonnage of Refrigeration
DG	Diesel Generator	UPS	Uninterrupted Power Supply

Units and Measures		Units and Measures	
A	Ampere	MCB	Miniature Circuit Breaker
^{0}F	Degree Fahrenheit	MTBF	Mean Time Between Failure
HP	Horse Power	MV/LV	Medium/Low Voltage
kV	kilo Volt	PD	Permitted Demand
kVA	kilo Volt Ampere	PH	Power House
kVAr	kVA-Reactive	SLD	Single Line Diagram
HT	High Tension	PF	Power Factor
IR	Infra-Red	kW	kilo Watt
PPM	Parts Per Million	kWh	kilo Watt Hour
LED	Light Emitting Diode	Lux	Lumens per Sq. m
LT	Low Tension	THD	Total Harmonic Distortion

List of Figures and Tables

Recommendations

1. ***Replace the existing fluorescent tube lights and fans with energy efficient one***
2. ***Replace the failed motors with International efficiency (IE_3) motors.***
3. ***30kW Solar plant for Engineering building block***
4. ***Install a STP plant and reduce the water consumption by 50% from the existing consumption***
5. ***Solar water heater system can installed in the hostel buildings***
6. ***Solar lightings for the street lightings***
7. ***Retrofit the energy saver in the Air conditioners***
8. ***Implement the waste to energy concept by installing a $2m^3$ Biogas plant for recycling the food wastage. 20% LPG consumption can reduce***
9. ***Desktop computers screen saver timing may be reduced to 5mins from 10mins***
10. ***Rubber mats to be provided in front of electrical panels (Recommended size is 6mm thickness)***
11. ***Periodic preventive maintenance to carried out in the electrical panels***
12. ***Energy meters to be provided in the major energy consumption areas.***
13. ***Encourage the students for doing the energy efficiency projects like street light automation, automation in pumping systems and IoT based energy monitoring systems***
14. ***Motivate the students for doing Solar based projects***
15. ***Train the students in energy management systems***

Energy Savings Proposal Summary

Summary of Energy savings:

Sl.No	Area	kWh savings per year	Cost savings in INR	Investment cost in INR	Payback period
1	Energy Efficient LED lamps – 18W	21600	1.84 Lakhs	2.6 Lakhs	1.4 Years
2	Energy Efficient BLDC Fans – 30W	16740	1.42 Lakhs	3.4 Lakhs	2.4 Years
3	Power factor improvement	2240	0.19 Lakhs	Nil	Immediate
4	Canteen service surrender	0	0.27 Lakhs	Nil	Immediate
	Total	**40580**	**3.45 Lakhs**	**6.0 Lakhs**	**1.74 Years**

5	**30kW Solar Plant**	**45000**	**3.82 Lakhs**	**15 Lakhs**	**4 Years**

Brief Introduction of the audit process:

Name of the Institution	M/s Sri Shanmugha College of Engineering & Technology
No. of years in operation	18
Institution address	Pullipalayam, Morur Post, Sankari Taluk Salem – 637 304
Type of Industry	Educational Institution
Hours of operation per day	10
No. of days of operation per year	300
Energy used	Electricity, Diesel and LPG

A detailed energy audit was carried out in the MV Panels, SSBs, Lighting, Fans, Air Conditioners, UPS and Water pumping systems with the use of the energy auditing instruments. Specific energy consumption was estimated based on the data collection of energy consumption vs students and staff strength. Total students and staff strength is 650 and 100 respectively. The institution baseline was arrived using the historical data of the institution. The total energy consumption for the period January 2019 to December 2019 was **19.72 toe (0.2294 million kWh electricity, 1.086kL HSD and 1908kgs of LPG)** which is equivalent to **15.25 lakhs rupees.** The total CO_2 emission during this period is estimated to be **206.30 tonnes**. Electricity and HSD were considered for **oil** equivalent and **CO_2** emission estimation.

Average per capita energy consumption per person in the campus is 305.79 kWh/annum and the oil equivalent is 0.275mtoe/annum. (Total strength = 750 persons)

- **Students = 650 persons**
- **Staffs = 70 persons**
- **Housekeeping = 30 persons**
- **Total = 750 persons**

Standard calculation of oil equivalent & CO_2 emission:

Type of Fuel	Calorific value in GJ	kg CO_2
EB Units (1 kWh)	3.6	0.85
Diesel	44.9 GJ/ton	2.653
LPG	0.05 GJ/kg	3.01

(***1 mtoe = 41.9 GJ = 11630 kWh), (1 tCO_2 = 1180 kWh)***

Carbon foot print of the institution:

Type of Fuel	Annual consumption	mtoe equivalent	CO_2 equivalent
EB Units	149332 kWh	12.84	126.932
Solar Energy Generation	80104 kWh	6.89	67.88
Diesel	1086 ltrs	2.142	6.172
LPG	1908 kgs	2.26	5.692
Total		**24.122**	**206.30**

The main source of the energy consumption in the institute is from state electricity board (TANGEDCO) and it's cater the energy required by the various facilities like Academic building blocks, Air Conditioners, Lighting, Computer UPS, Lab equipment's, and Water pumping systems. High speed diesel (HSD) is used in DG set as back-up power source in case of EB mains power failure.

Solar plant installed capacity in the institution is 100 kWh. Average energy generated from the solar plant is around ***11390 kWh/month***. Around **65.1%** of the total electricity consumption was generated with solar energy and **34.9 %** from wind energy adjustment.

Overall efficiency of the solar generation system is nearly **91.8%**. (0.881 lakhs kWh generated against 0.96 lakhs kWh).

The average energy consumption from the EB mains is around ***750 to 800 kWh/day***.

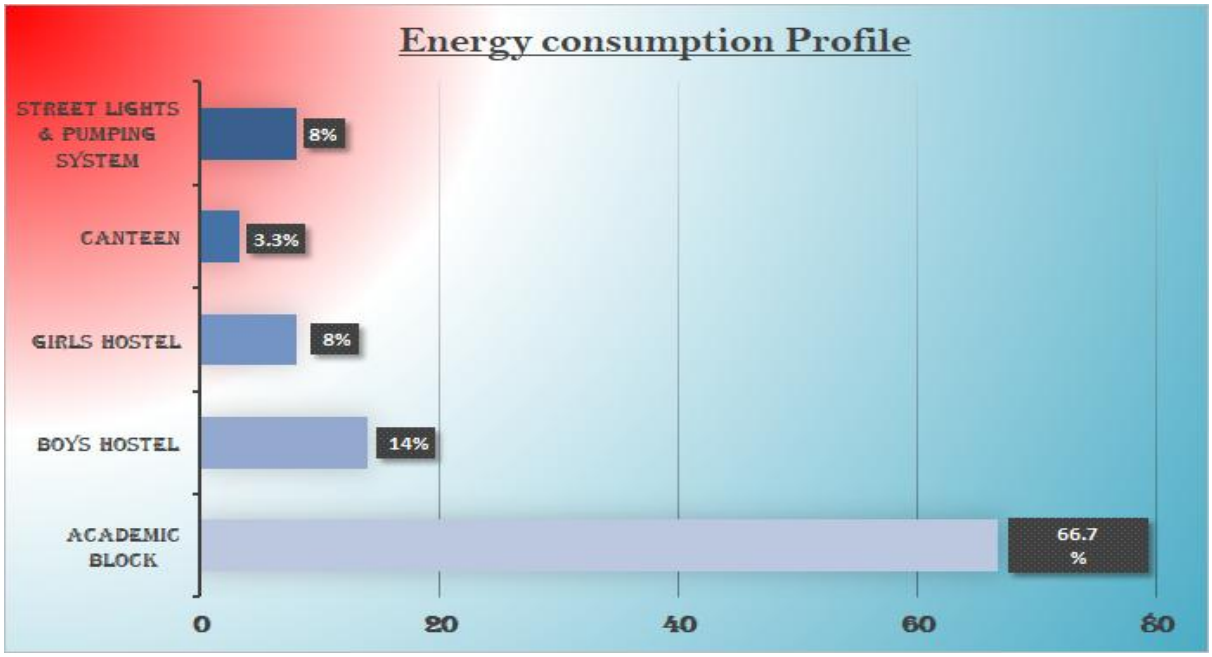


Figure 1: Energy Consumption trend

Average energy consumption per month:

Type of Fuel	Value
EB Units in kWh	12444
Solar energy generated in kWh	6675
LPG consumption in kgs	159
Diesel consumption in ltrs	194

Energy consumption in Canteen & Hostel services is around 0.327 lakhs kWh (21.9%) from the total energy consumption of 1.493 lakhs kWh

Renewable energy generated from the institution per annum is around 0.88 lakhs kWh (59.0%) from the total energy consumption of 1.49 lakhs kWh.

Equivalent to reduction of oil equivalent of 7.58mtoe and 74.66 tCO_2 emission.

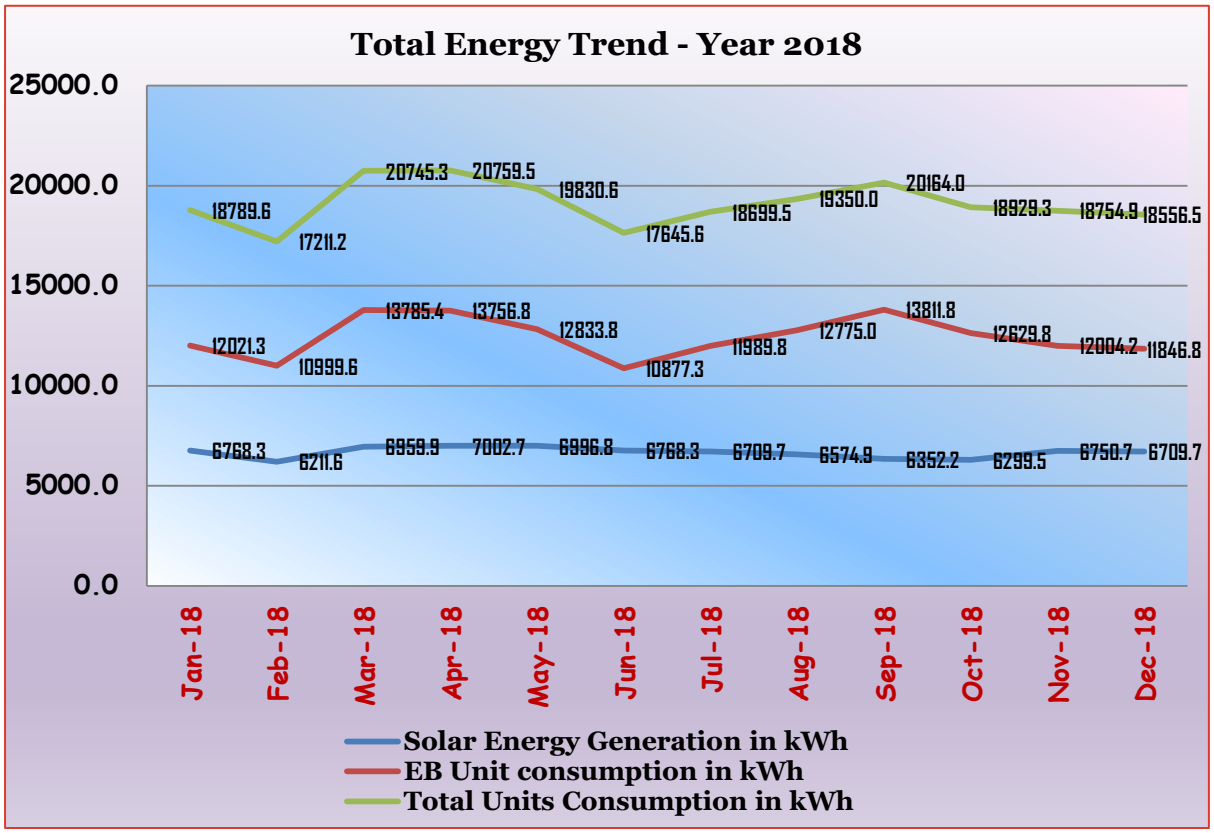


Figure 2: Source Wise Energy Consumption

Energy consumption from the EB grid is nearly 41% during the period Jan18 to Dec 18.

Nearly 59% of the energy consumption in the campus was adjusted with green energy (Solar energy) and the carbon foot print is well maintained.

1.0 Energy consumption

1.1 EB Power consumption and EB Power cost

The energy consumption and energy cost data for the period Jan 2018 to Dec 2018 was collected from the EB bills for the data analysis. The average unit consumption per month is around **19120kWh** and the power cost is around **Rs8.6/kWh**.

The total energy consumption of the unit during Jan 2018 to Dec 2018 was **19.72 toe (0.2294 million kWh electricity, 1.086kL HSD and 1908kgs of LPG)** which is equivalent to **15.25 lakhs rupees.**

Figure 1.1 refers the energy cost profile of the institution.

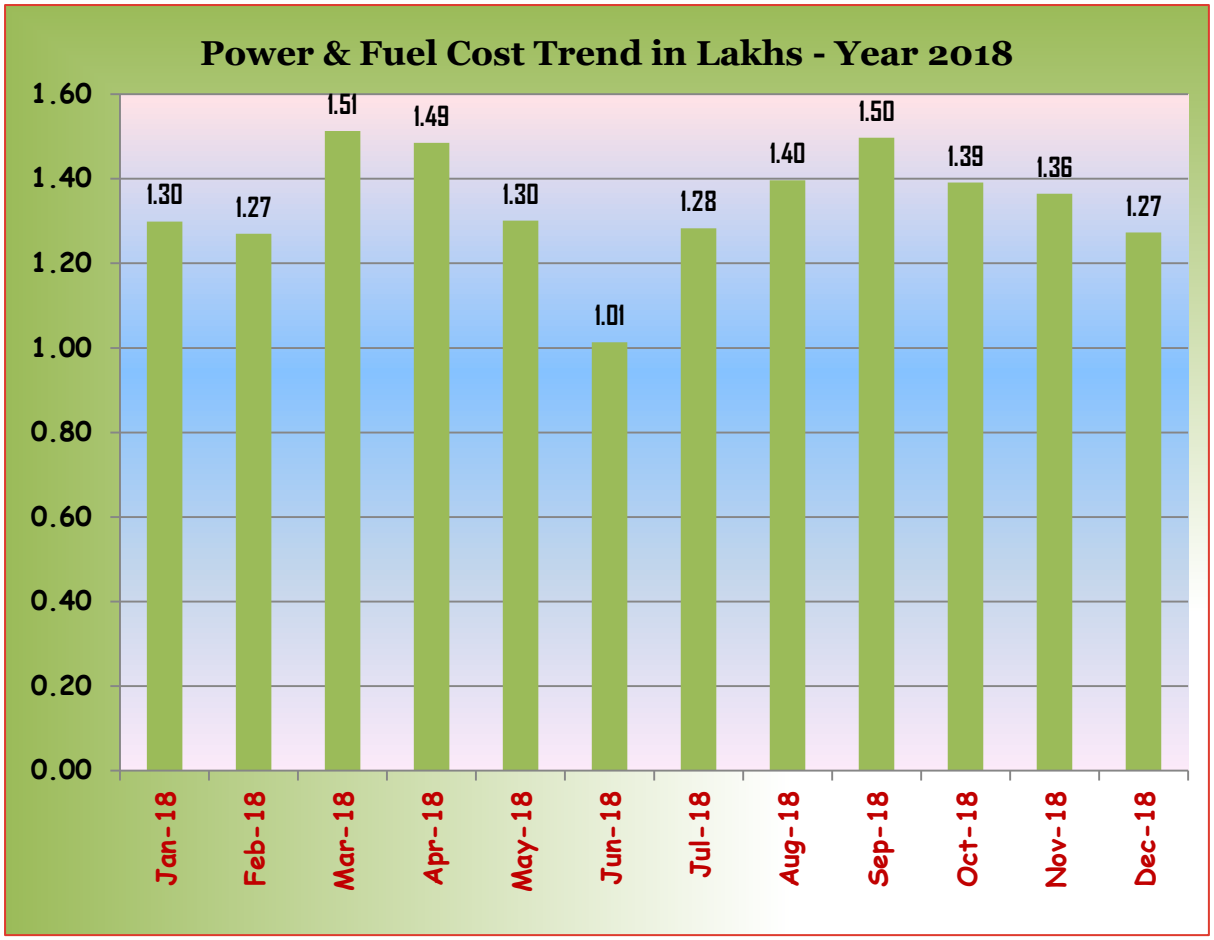


Figure 1.1: Energy cost profile

1.2 Energy consumption trend

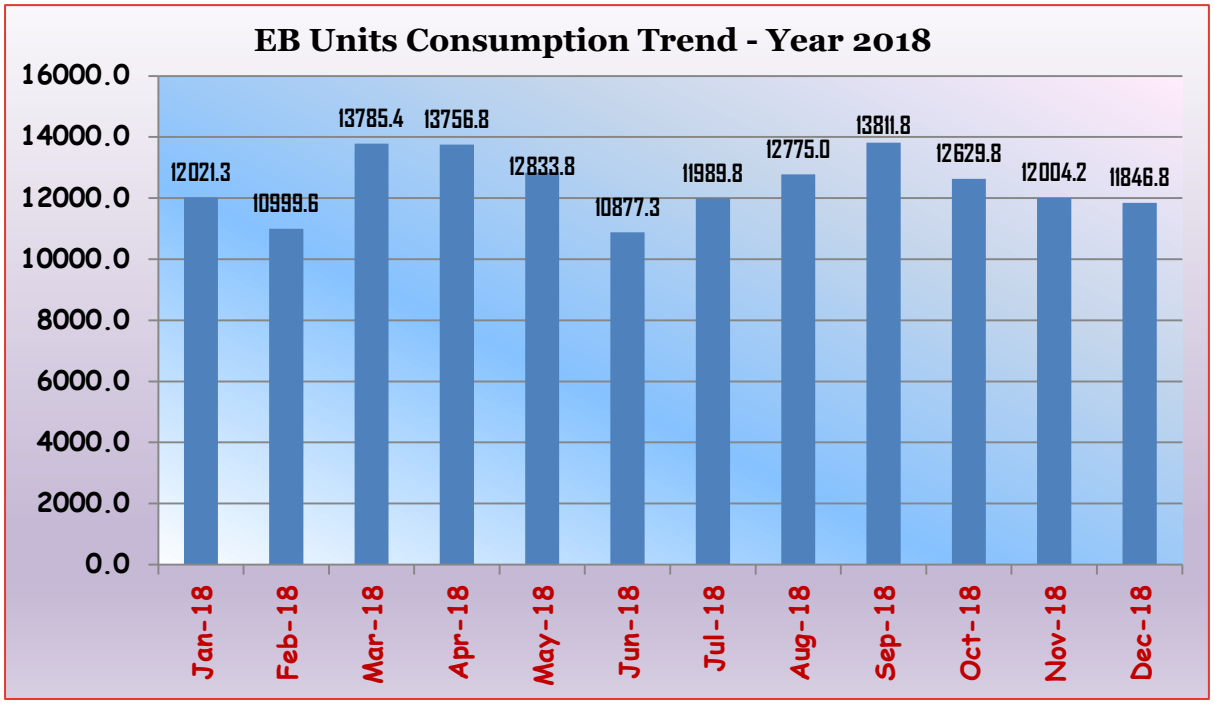


Figure 1.2: EB Units Consumption Trend

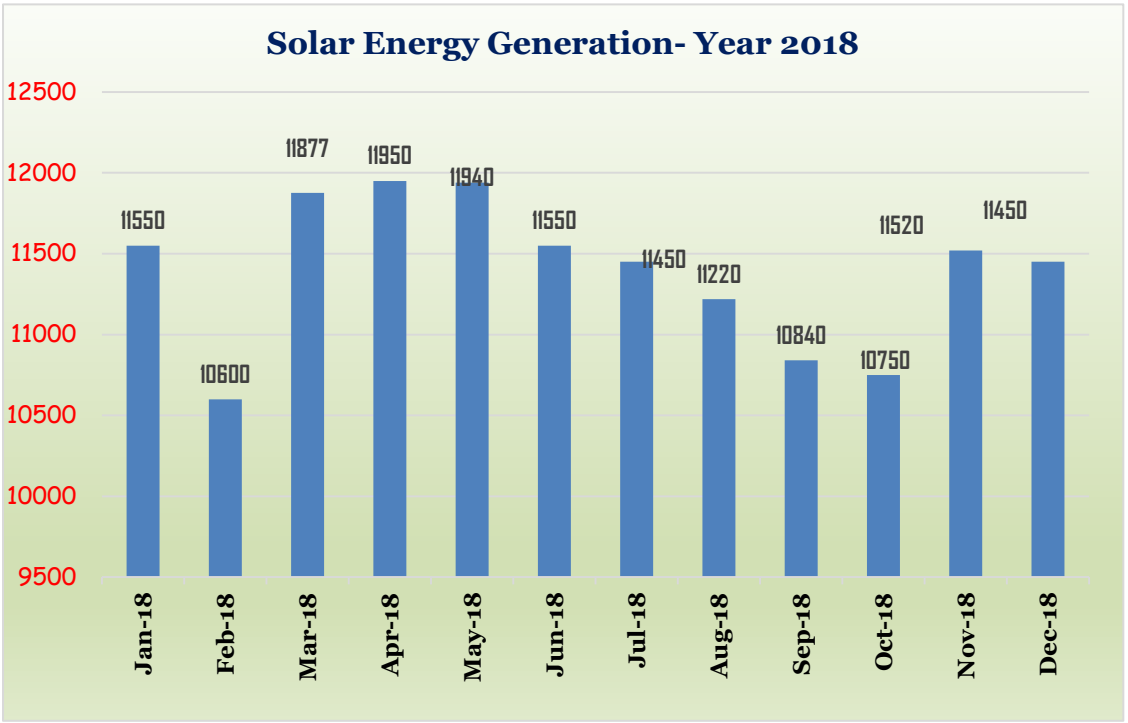


Figure 1.3: Renewable Energy Generation

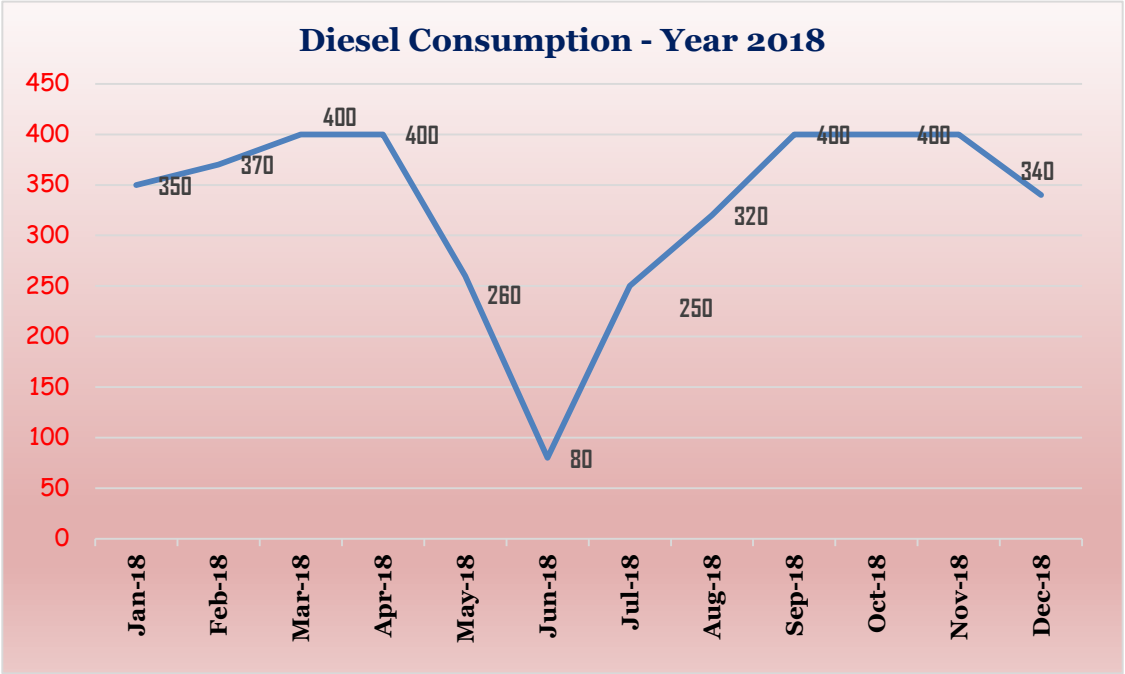


Figure 1.4: Diesel Consumption

Average energy generation from Solar system is around **6675kWh/month**. The generated energy has been utilised in the campus and the balance units were consumed from EB grid.

Two DG sets were installed to cater the power requirement during power failure situations. The average diesel consumption by the DG sets is around **194 ltrs/month**. DG set's log book is not maintained properly and hence the unit generation is not able to calculate.

Based on the energy analysis, average generation by the DG sets is around **460 units/month**.

2.0 Electrical system analysis

2.1 Facility description

2.1.1 General

The main source of electricity for the foundry division is from two separate LT/CT supply lines at 415V supply.

- Service 1 Engineering building
- Service 2 Boys hostel
- Service 3 Canteen
- Service 4 Farm house for Agricultural Engineering

Service 4 is used for farm house and it is dedicatedly used for the department of Agricultural engineering. Few laboratory equipment's were installed in the service for the students from Agricultural engineering. Students are conducting laboratory experiments as per the curriculum prescribed by Anna University, Chennai.

Table 2.1.1a: Technical specifications of EB Services

Parameters	LT/CT -1	LT/CT-2	LT/CT-3	LT/CT-4
Service Number	04170006513	04170005846	04170006520	04170006554
Sanctioned Load	111.0 kW	15.6 kW	30 kW	14.65 kW
Tariff	LM 2B2	LM 2B2	LM 51	LM 51
Unit cost	Rs 7.5/kWh	Rs 7.5/kWh	Rs 8.05/kWh	Rs 8.05/kWh
Fixed cost	Rs 60/kW	Rs 120/kW	Rs 140/kW	Rs 140/kW
Freqiency	Monthly	Bi monthly	Bi monthly	Bi monthly

The unit was installed with one 125 kVA and one 62.5 kVA Diesel Generator to cater the necessary power requirements to the entire campus during power failure. All the DG sets are provided with acoustic enclosure.

To maintain the power factor near to unity, the campus has provided two no's of automatic power factor controller (APFC) for the main service and canteen service. 58.5 kVAr APFC is installed in the main service and 25kVAr is installed in the canteen service.

2.1.2 Electricity consumption data

The contracted load from TANGEDCO LT/CT lines are mentioned in the above table 2.1.1a. Average cost of electricity from electricity board is around **Rs8.46/kWh**. The detail of electricity consumption is given in the table 2.1.2. Figure 2.1 refers the bill amount paid to electricity board.

Sl.No	Month	Engg College Share				
		EB Unit consumption in kWh	Solar Energy Generation in kWh	Total Units Consumption in kWh	EB Cost in Rs	Cost per unit
1	Jan-18	12021.3	6768.3	18789.6	102596.3	8.53
2	Feb-18	10999.6	6211.6	17211.2	94281.5	8.57
3	Mar-18	13785.4	6959.9	20745.3	116246.0	8.43
4	Apr-18	13756.8	7002.7	20759.5	115810.6	8.42
5	May-18	12833.8	6996.8	19830.6	108558.8	8.46
6	Jun-18	10877.3	6768.3	17645.6	92443.3	8.50
7	Jul-18	11989.8	6709.7	18699.5	101258.5	8.45
8	Aug-18	12775.0	6574.9	19350.0	107668.7	8.43
9	Sep-18	13811.8	6352.2	20164.0	115810.6	8.38
10	Oct-18	12629.8	6299.5	18929.3	106368.4	8.42
11	Nov-18	12004.2	6750.7	18754.9	101424.9	8.45
12	Dec-18	11846.8	6709.7	18556.5	100357.2	8.47
Average		12444	6675	19120	105235	8.46

Table 2.1.2: Month wise electricity consumption details

From the above table information, monthly energy consumption is high in the months March, April & September. Energy consumption is low in the month of February & June.

- **Energy consumption is high may be due to summer (Air conditioner loads)**
- **Low energy consumption may due to vacation**

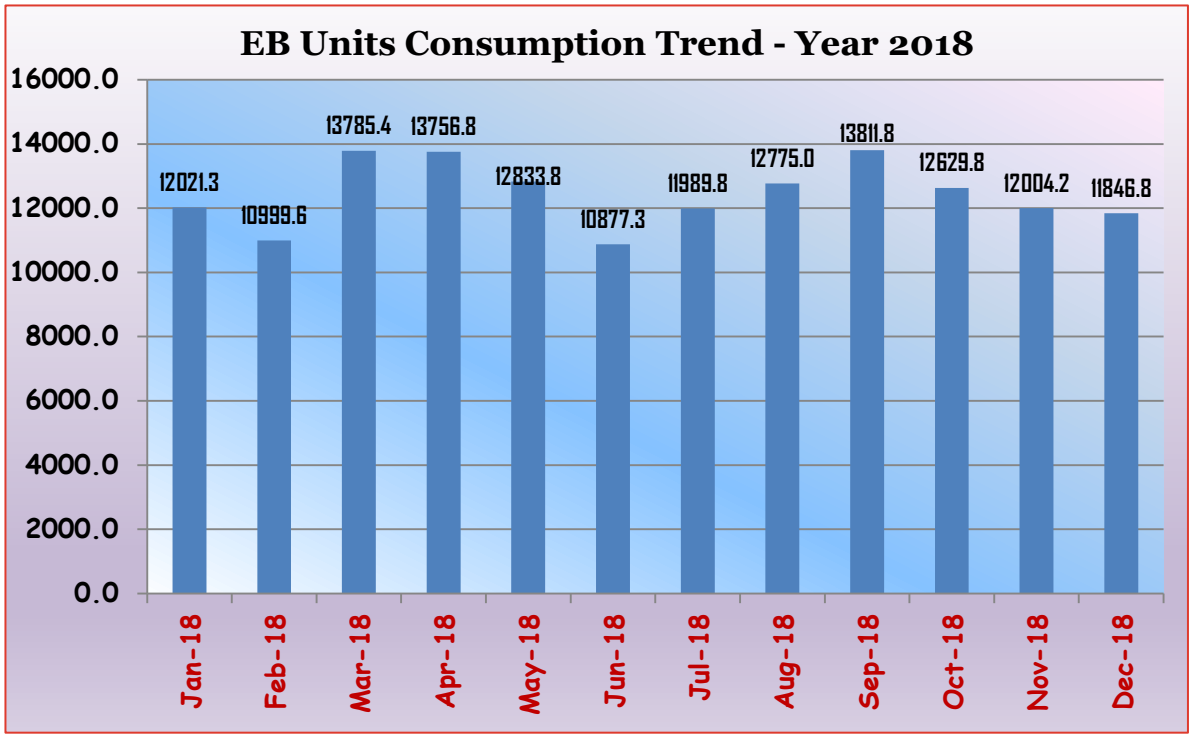


Figure 2.1: EB unit's consumption

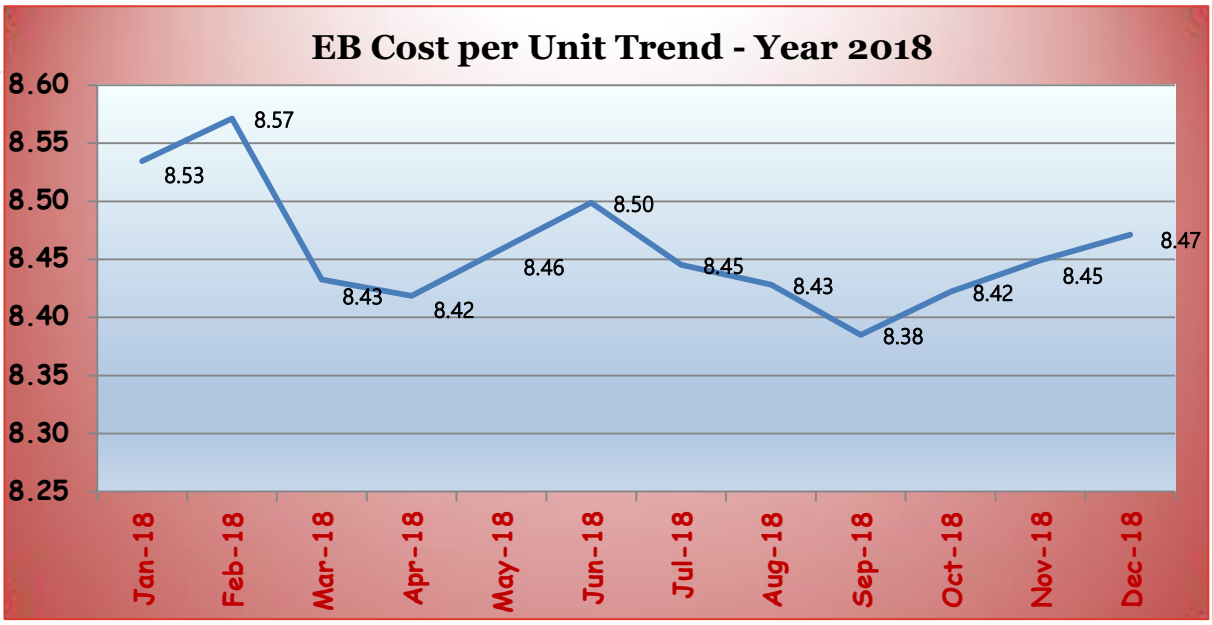


Figure 2.2: EB units cost trend

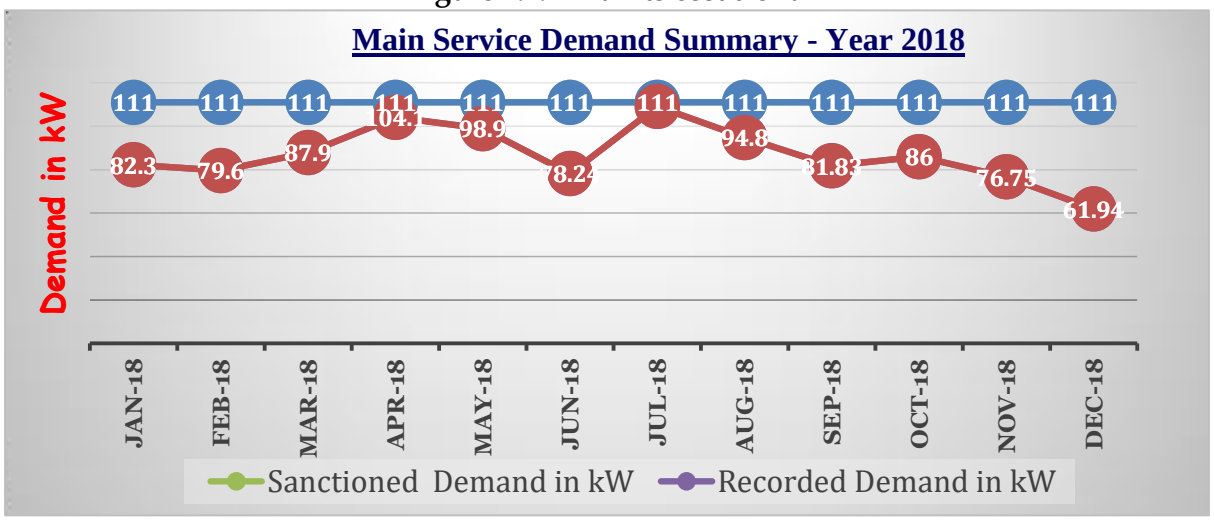


Figure 2.3: Main Service Demand Summary

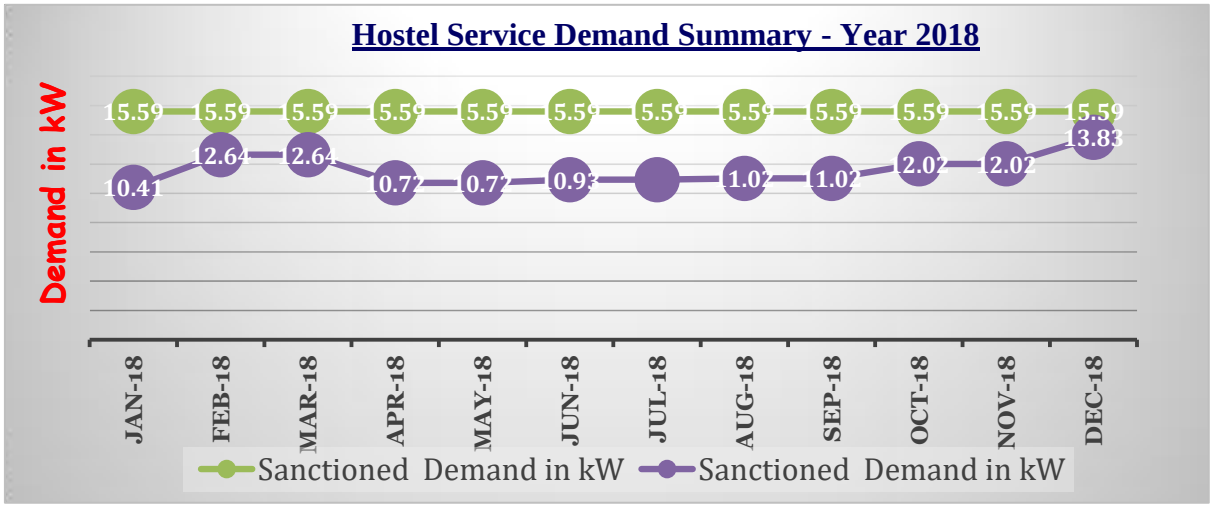


Figure 2.4: Hostel Service Demand Summary

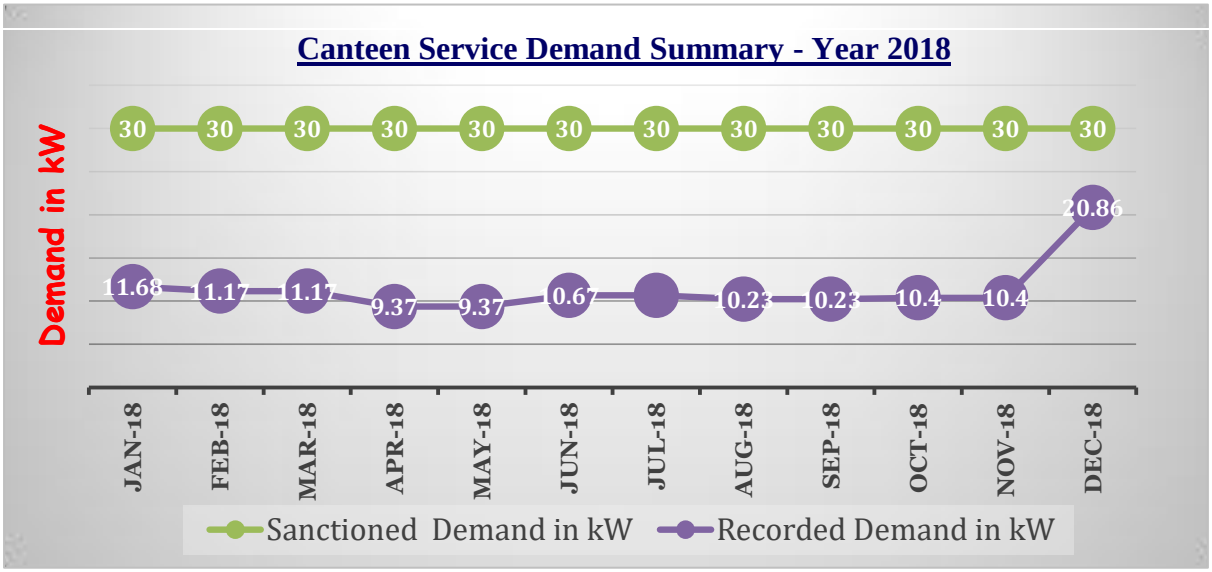


Figure 2.5: Canteen Service Demand Summary

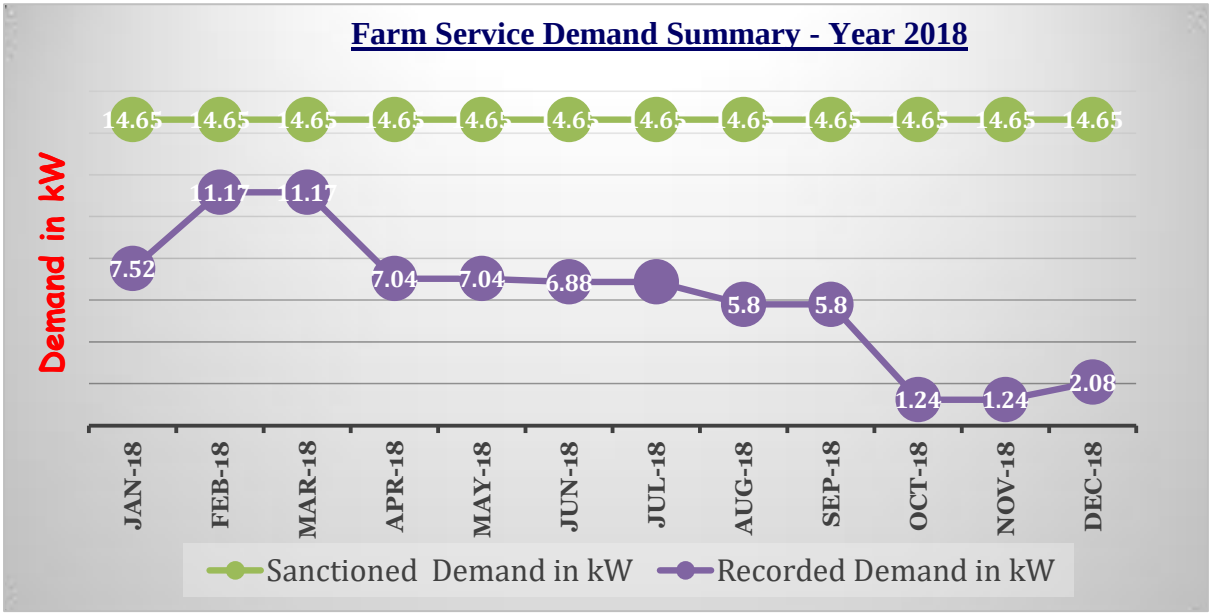


Figure 2.6: Farm Service Demand Summary

As observed from above figures 2.3 to 2.6

Parameters	Main	Hostel	Canteen	Farm
Max demand reached in kW	109.17	13.83	20.86	11.17
Min demand reached in kW	61.94	10.41	9.4	1.14
Average demand in kW	84.10	11.58	11.35	6.16

On analysis, the demand side management was well maintained and there is no penalty charges paid for excess recorded demand during this period.

Suggestions:

- Canteen service may be surrendered to EB and the power can be feed from main service.
- Canteen service is under commercial line and cost per unit is Rs.8.05.
- Fixed cost is also high (Rs.140/kWh) when compared to other service.
- Expected cost savings per annum is around **Rs.27000/.**

2.2 Observation and analysis

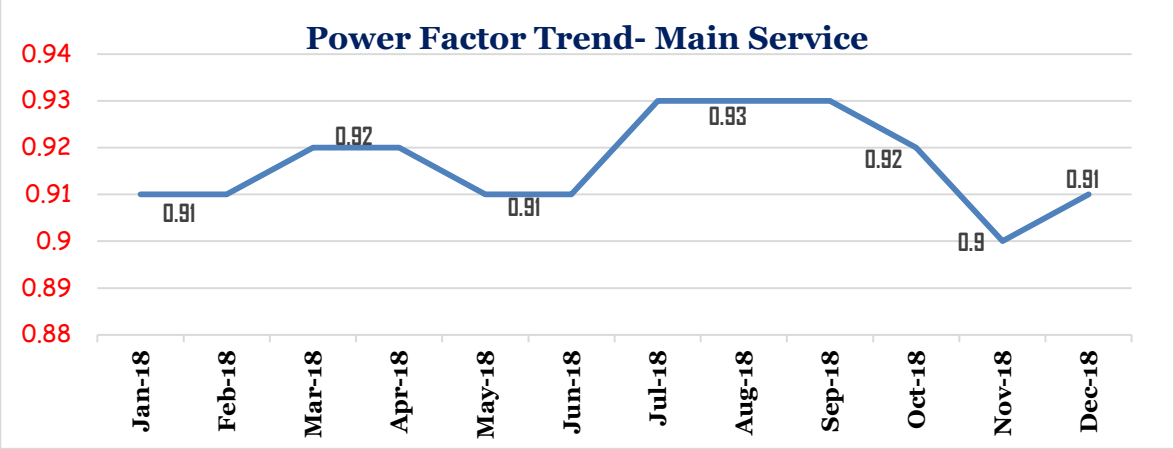
2.2.1 Electrical power measurement

Electrical power data logging was carried out on the main power incomer at MV panel using three-phase power quality analyser extensively. All electrical parameters have been recorded for identification and analysis of energy consumption and other key electrical parameters of the institution. Some necessary data has been taken from the plant maintenance department logbook for historical pattern better analysis.

2.2.2 Power factor management

Power house has been installed the 58.5kVAr and 25kVAr APFC for the power factor correction system at main MV panel. Power factor trend was analysed for the past 12months electricity bills.

Figure 2.7: Main service Power factor trend



Average power factor maintained in the service is 0.92, even this service was connected with 58.5kVAr APFC. During the audit process, we checked all the capacitors provided in the banks and found it is working and satisfactory. Current measurement has been taken and the individual capacitors are working in manual mode.

Suggested to service and calibrate the controller for achieving the power factor to unity. Hence the distribution losses has been reduced. Expected distribution loss reduction is around 15% from the present system by improving the power factor closer to unity.

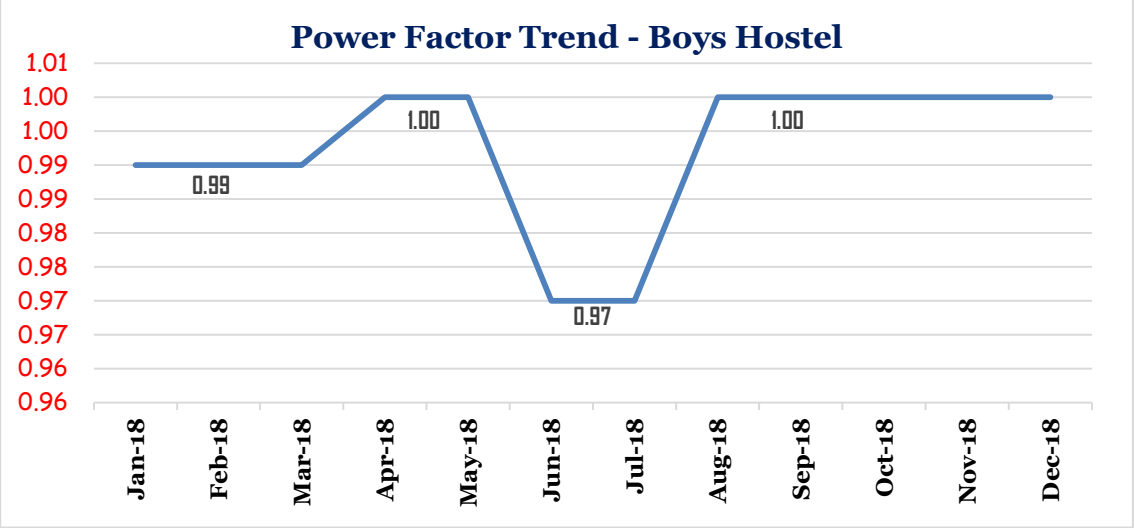


Figure 2.8: Hostel service Power factor trend

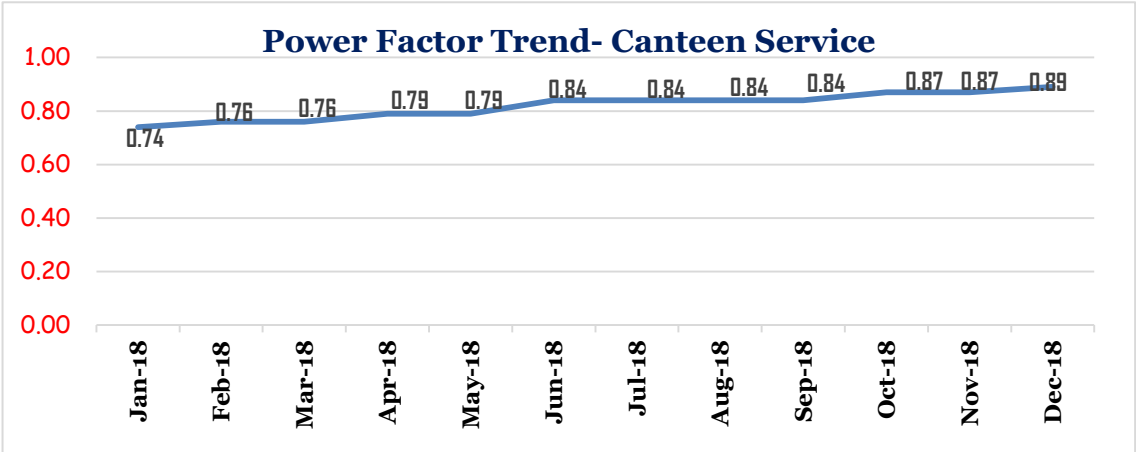


Figure 2.9: Canteen service Power factor trend

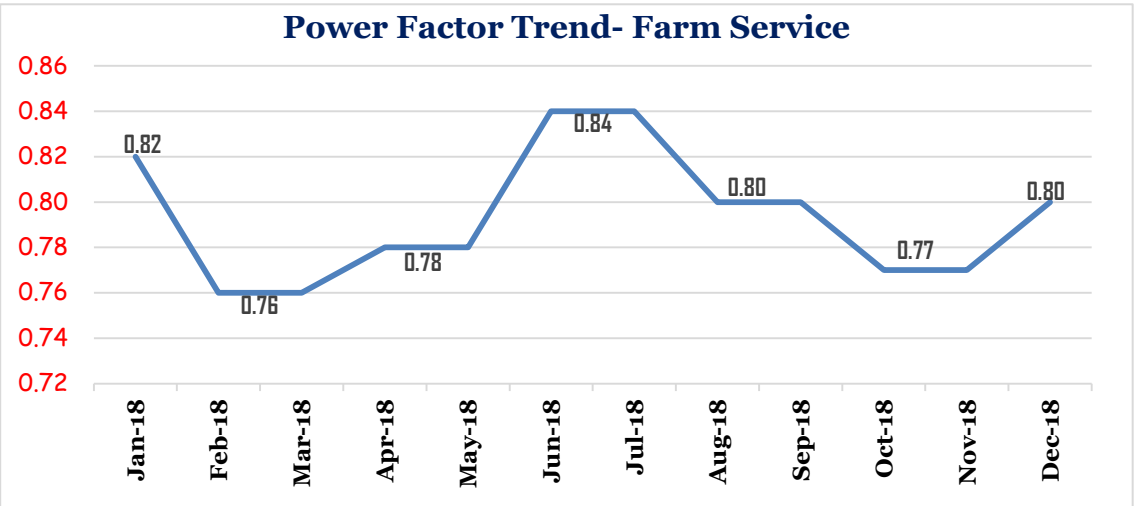


Figure 2.10: Farm service Power factor trend

Average power factor maintained in the service is 0.82, even this service was connected with 25kVAr APFC. During the audit process, we checked all the capacitors provided in the banks and found it is working and satisfactory. Current measurement has been taken and the individual capacitors are working in manual mode.

Suggested to surrender the service and power can be feed from main service line.

Suggestions:

- Canteen service may be surrendered and utilize the 25kVAR APFC panel for Farm service or boys hostel service.
- Periodic checking of the capacitors by measuring the current to be followed and documented.
- Power factor value to be monitored daily basis in all the services to avoid penalty
- Scope for improvement the power factor in the main services and possible of reducing the distribution losses by 15%.
- Expected energy savings due to reducing the above losses is around **4480kWh/annum.**

3.0 Energy Analysis in Distribution System

3.1 MV Panel

The main MV panel is installed in the main power house. All the electrical loads connected in the campus is distributed thru MV panel. Each building is having separate electrical distribution system. Buildings lighting and fan loads are connected through MLSB panel which is installed in the power house.

3.1.1 Observation and analysis

2 hours study:

MV panel was studied for 2 hours. Average energy consumption during this period is around ***6.9 kWh.*** Nearly 65 kWh units were generated from Solar panel.

Particulars	R - Phase	Y - Phase	B - Phase
Voltage – 3 phase	427.2	419.6	423.8
Voltage – 1 phase	253.7	250.6	239.7
Current in amps	31.1	26.4	26.8
Power in kW	**+ 18.12**		
PF maintained	**+ 0.711**		
Q1 kvar	**15.86 (Capacitive)**		
S kVA	**21.79**		

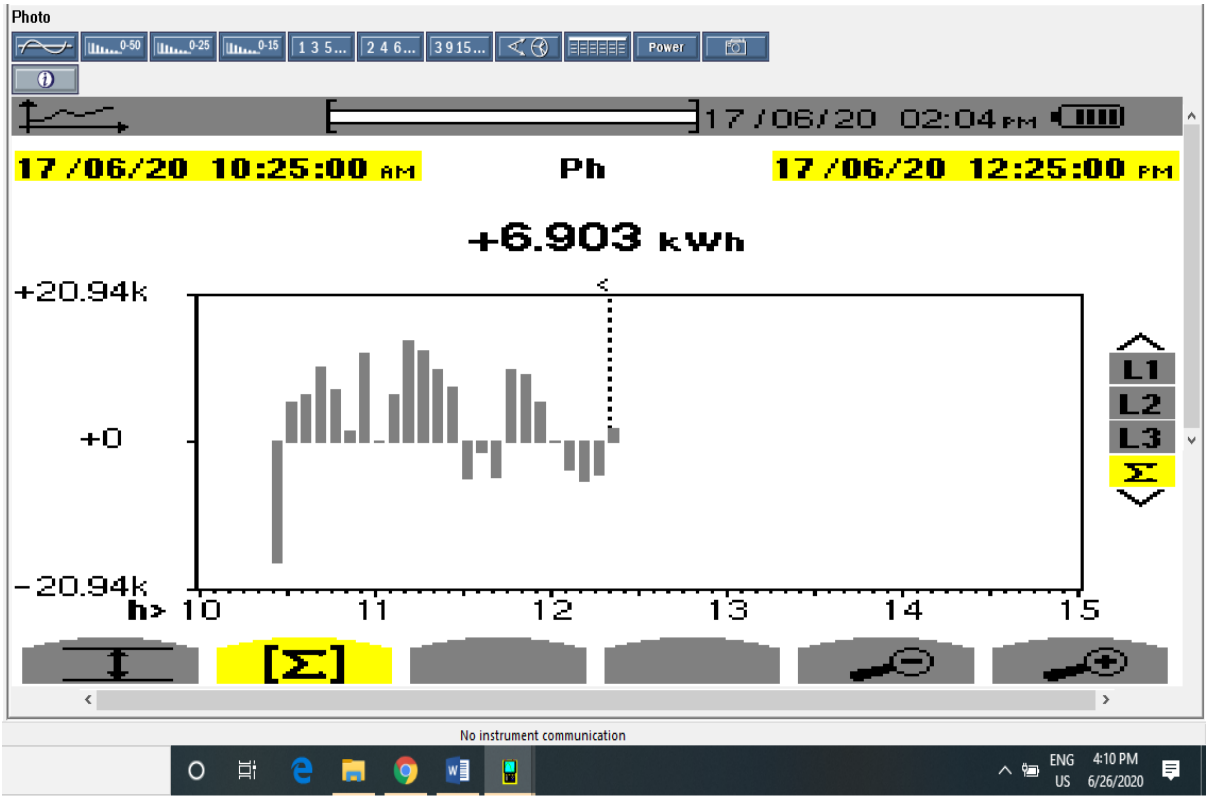


Fig 3.1 – MV panel study

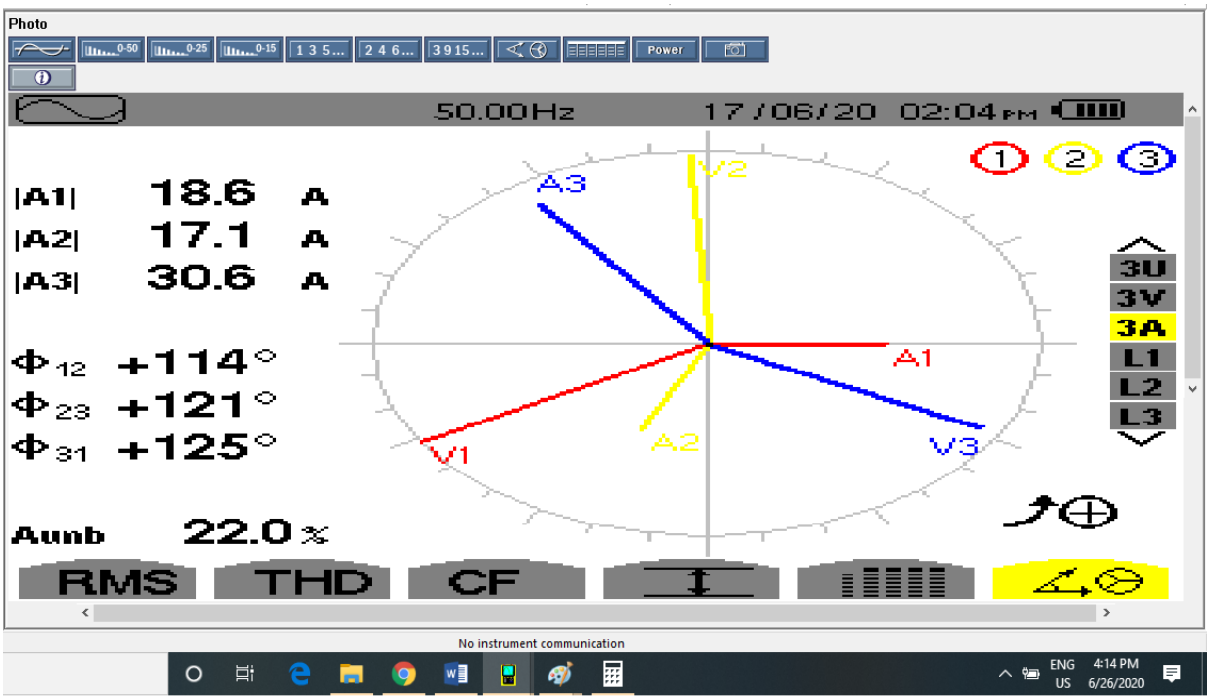


Figure 3.2 – Current consumption by MV panel

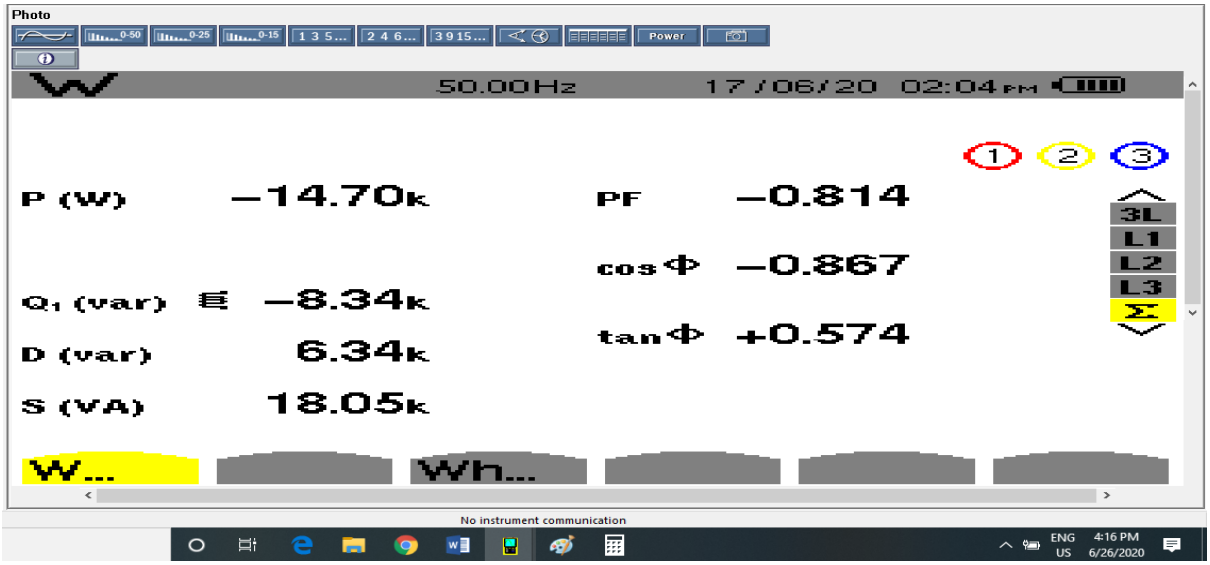


Figure 3.3 – Electrical parameters in MV panel

Observations:

- Neutral current flow found **3A to 4.3 A** respectively.
- Maximum voltage harmonics (V_{THD}) found this period is **2.3 % to 5.0%.**
- Maximum current harmonics (I_{THD}) found this period is **21 % to 65%**.
- Observed that voltage between neutral to earth is **0.4V** and well maintained.**(Standard < 1V, Body earthing value is < 1 ohm and neutral earthing is < 2.5 ohms)**

4.0 Energy Analysis in Lighting & Fans

4.1 Lighting loads details:

Total installed capacity of the lighting load in the campus is around 45.88kW. Nearly 96.8% (46.8 kW) of the present lighting system is installed with Fluorescent light fixtures and 3.2% with LED fixtures. Table 4.1 reveals the types of light fixtures installed and load details.

Table 4.1: Academic building lighting details

S.No	Type	Nos	Total load in kWh
1	Fluorescent Tube lights (40W)	420	21
2	36W CFL lamps	410	14.8
3	40W CFL lamps	16	0.64
4	16W CFL lamps	70	1.12
5	85W CFL lamps	13	1.1
6	LED lamps	18	0.32
Total			**39.0**

Average energy consumption in the lighting is around 156kWh/day.

Table 4.2: Street lights details

S.No	Type	Nos	Burning hrs	Total load in kWh	Energy consumed in kWh
1	20W LED lamp Posts	57	10	1.14	11.4
2	36W LED lamp Posts	08	10	0.288	2.88
3	24W LED lamp Posts	05	10	0.12	1.2
4	85W CFL lamps	01	10	0.085	0.85
5	400W Focus lamp	05	05	2.00	10.00
6	300W Focus lamp	01	05	0.33	1.50
Total		**77**		**3.96**	**27.8**

Average energy consumption in the lighting is around **28.0kWh/day.**

Lighting Illumination Study:

Lighting level has been studied with Lux meter and the readings are noted down. All the values are noted in lumens.

Table 4.3: Lighting Level Measurement:

Location	Lights ON Condition	Lights OFF Condition	Recommended level
Principal Room	200 - 406	70 - 170	250
IT Remote Centre	215 - 300	55 - 65	250

Mechanical Machine Shop	245 - 420	150 - 300	200
Location	Lights ON Condition	Lights OFF Condition	Recommended level
Second Floor – Agri Engg Class room	290 - 495	105 - 385	250
Second Floor – Civil Class room 209	250 - 545	135 - 230	250
Second Floor – Class room 207	150 - 375	100 - 190	250
Second Floor – Class room 203	185 - 390	135 - 160	250
Electronics Circuits Lab	330 - 610	80 - 185	300
Electrical Machines Lab	130 - 190	75 - 110	300
Thermal Engineering Lab	175 - 350	100 -320	300
Third Floor – Staff room	270 – 415	145 – 285	250
Third Floor – Class room	320 – 540	150 – 185	250
Canteen	470 - 1570	320 - 800	300
Girls Hostel – Ground Floor	185 - 210	75 - 95	150
Girls Hostel – Ground Floor	145 - 200	40 - 70	150
Girls Hostel – First Floor	230 - 350	120 - 150	150
Boys Hostel – Ground Floor	110 - 190	55 - 75	150
Boys Hostel – First Floor	280 - 310	170 - 210	150

Observations:

- Daylighting utilisation is excellent in the entire campus. Most of the day timing lighting is not required in the class rooms and laboratories.
- Lighting level was maintained in optimum level
- Lightings level in the class rooms are above 300 lumens
- Lighting level in the lab area is around 250 lumens
- Electrical machines lab lighting is low compared with others
- Girls hostel ground floor lighting level is low
- Canteen lighting level is very high and it need not lighting during day time
- Most of the street lights are installed with energy efficient LED lamps

Recommendations:

- Lighting loads are connected through 80 kVA servo stabilizer and the operating voltage is around 200 volts. It gives around **10% energy savings**
- Nearly 860 no's of conventional Fluorescent lamp (36 W) and CFL fittings is installed in the entire campus and it leads 85% of the total energy consumption in the lighting. It can be replaced with energy efficient LED lamps in phaser manner.
- Energy saving potential is around 50% in the existing FL to LED lamps conversion. Expected energy savings per annum is around **21600 kWh** and the investment cost is around **2.60 lakhs**. Pay back is around **1.4 years**.
- Timer can be installed for street light control.

4.2Fan loads details:

Total installed capacity of the Fans load in the campus is around 38kW. Table 4.5 to 4.6 reveals the types of light fixtures installed and load details.

Table 4.4: Fan details

S.No	Block	Total Fans	Total load in kWh
1	Engineering & Main Block	370	27.75
2	Boys Hostel	66	4.95
3	Girls Hostel	58	4.35
4	Canteen	12	0.90
5	Entrance	2	0.15
Total		**508**	**38.0**

Fan performance study:

Fan air flow measurements has been studied with Anemometer and the readings are noted down. All the values are noted in meter per seconds (m/s).

Table 4.6: Air flow measurement:

Location	Air Flow in m/s
Principal Room	1.8 to 3.1
IT Remote Centre	1.5 to 2.0
Mechanical Machine Shop	1.0 to 2.5
Second Floor – Agri Engg Class room	1.5 to 2.7
Second Floor – Civil Class room 209	0.8 to 1.9
Second Floor – Class room 207	1.2 to 2.4
Second Floor – Class room 203	1.4 to 2.1
Electronics Circuits Lab	1.5 to 3.0
Electrical Machines Lab	1.5 to 3.0
Thermal Engineering Lab	0.5 to 2.0
Third Floor – Staff room	1.5 to 2.5
Third Floor – Class room	1.6 to 2.8
Canteen	1.0 to 2.8
Girls Hostel – Ground Floor	1.5 to 2.0
Girls Hostel – Ground Floor	0.5 to 1.5
Girls Hostel – First Floor	0.6 to 1.7
Boys Hostel – Ground Floor	0.6 to 1.5
Boys Hostel – First Floor	0.9 to 1.8

Observations:

- Total fans installed in the campus is around 510 no's and the wattage range is around 70W/fan
- Air flow level was maintained in optimum level
- Conventional fans air flow is below average level

Recommendations:

- BLDC fans may be installed in the hostel building blocks
- BLDC fans air flow is better and above average level (48 to 120 CMM)
- Energy saving potential is around 55% by conversion with BLDC fans. Expected energy savings per annum is around **16740 kWh** and the investment cost is around **3.4 lakhs**. Pay back is around **2.4 years**.

5.0 Energy Analysis in UPS

Two no's of each 20 kVA uninterrupted power supply was installed in the campus to feed the input voltage supply for the desktop computers of the academic building blocks.

Parameters	UPS – K Block	UPS – Y Block
Rating (kVA)	20	20
Make	Numeric UPS	Numeric UPS
Input Voltage (V)	415 AC, 3 phase, 50Hz	415 AC, 3 phase, 50Hz
Output Voltage (V)	220 AC, 1 phase, 50 Hz	220 AC, 1 phase, 50 Hz

5.1 Ground Floor UPS – 20 kVA:

UPS was studied for 0.5 hours. Average energy consumption during this period is around ***5.27 kWh.***

Particulars	R - Phase	Y - Phase	B - Phase
Voltage – 3 phase	425	414	417
Voltage – 1 phase	218		
Current in amps	5.0	5.3	5.7
Power in kW	**5.58**		
PF maintained	**0.92**		
S kVA	**6.83**		

5.2 First Floor UPS – 20 kVA:

UPS was studied for 0.5 hours. Average energy consumption during this period is around ***6.3 kWh.***

Particulars	R - Phase	Y - Phase	B - Phase
Voltage – 3 phase	422	415	418
Voltage – 1 phase	221		
Current in amps	6.2	6.1	5.9
Power in kW	**6.68**		
PF maintained	**0.91**		
S kVA	**7.78**		

Observations:

- Neutral current flow is around 1.3 amps
- Cable trenches needs to be closed
- Proper clearance to be provided for Battery rack and SSB panel
- Observed that voltage between neutral to earth is **0.3V to 0.45V**.

(Standard < 1V, Body earthing value is < 1 ohm and neutral earthing is < 2.5 ohms)

6.0 Energy Analysis in Pumping Systems

The installed capacity of the Reverse Osmosis plant (RO) is 1.5kL per hour. Inlet water is came from the raw water pump and the untreated water is used for toilet flushing system and gardening purpose.

Pumps Installed:

Pump application	Motor Rated HP	No of Pumps installed	Operating hours	Control
RO plant Feed water	5.5	1	4	Manual
Unique pump	1.6	1	4	Manual
Pressure booster pump	1.5	1	4	Manual
Raw water pump	5.0	1	6 to 8	Manual
Submersible pump for hostel building	5.0	1	4 to 6	Manual

Recommendations:

- Most of the motors installed in the campus is lesser efficiency. It can be replaced ith IE_3 motor when it fails.
- Sewage treated plant can be installed in the campus. Recycled water can be used for gardening purpose and toilet flushing systems. Energy Efficient Motors:

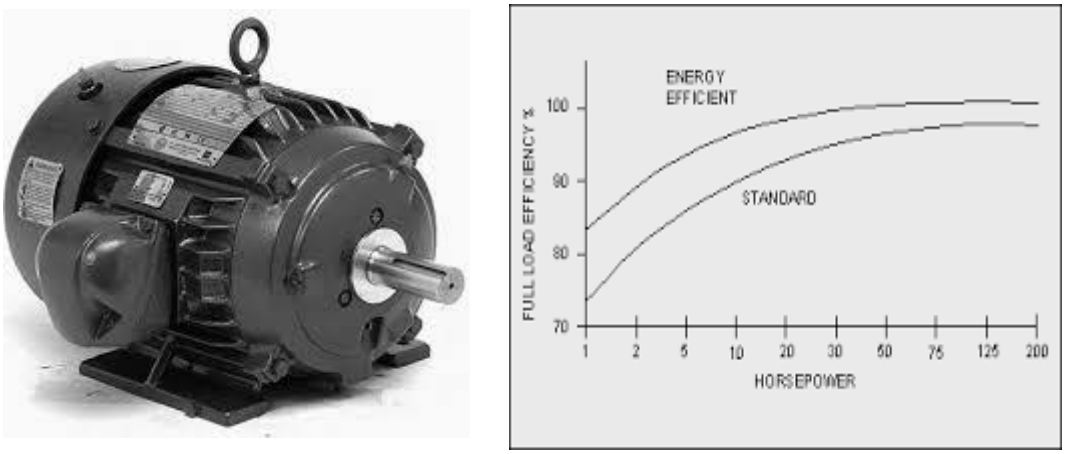


Figure 6.1: Energy Efficient Motor

Table 1 – Example of changing of efficiency, speed and torque demand with energy efficiency class of three 11 kW, 50 Hz motors in the same application

	eff	n	T	Pout	Pin
	%	min-1	Nm	kW	kW
IE1	87.6	1464	75.4	11,559	13,195
IE2	89.8	1474	76.4	11,792	13,131
IE3	91.4	1480	77.1	11,948	13,073
IE4	92.6	1500	79.2	12.433	13,426

Energy efficient motors use less electricity, run cooler, and often last longer than NEMA (National Electrical Manufacturers Association) B motors of the same size.

Energy efficient electric motors utilize improved motor design and high quality materials to reduce motor losses, therefore improving motor efficiency.

List of Equipment's used for Audit Process:

The audit team uses the following testing/measuring equipment's to conduct the audit process. This equipment's provides accurate readings and are recently calibrated.

S. No.	Name of the Equipment	Model/Range
1.	Three Phase Power Quality Analyser	Chavin Arnoux CA8336
2.	Single Phase Power Quality Analyser	Chavin Arnoux ALM - 10
3.	Digital Clamp Meter (True RMS)	Fluke – 317
4.	Digital True RMS Multimeter	Fluke-115 & 15B
5.	Digital Lux meter	Testo
6.	Digital Anemometer	Testo
7.	Thermo Hygrometer	Testo
8.	Other general electrical/mechanical measuring instruments	