PPS Energy Solutions

PPS Energy Solutions Pvt. Ltd.
Regd. Off: B-403, Bharti Vihar, S.No-78, Bharti Vidyapith Campus, Katraj, Pune – 411046 Ph: +91-20-2523 2858, 6400 0643

Date: 18th April 2020

CERTIFICATE

TO WHOMSOEVER IT MAY CONCERN

This is to certify that, we M/s. **PPS Energy Solutions Pvt. Ltd.** has successfully completed **Energy Audit at Shri R.L.T. College of Science, Akola** and submitted report.

For PPS Energy Solutions Pvt. Ltd, Pune

Dr. Ravi. G. Deshmukh
Director

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Regd. Off: B-403, Bharti Vihar, S.No-78, Bharti Vidyapith Campus, Katraj, Pune – 411046 Ph:+91-20-2523 2858, 6400 0643

Date: 16th April 2021

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Regd. Off: B-403, Bharti Vihar, S.No-78, Bharti Vidyapith Campus, Katraj, Pune – 411046 Ph:+91-20-2523 2858, 6400 0643

Date: 10th April 2022

CERTIFICATE

TO WHOMSOEVER IT MAY CONCERN

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For PPS Energy Solutions Pvt. Ltd, Pune

Dr. Ravi. G. Deshmukh
Director

DETAILED ENERGY AUDIT REPORT

SHRI R.L.T. COLLEGE OF SCIENCE, AKOLA

Sitabai Art College Road
Akola

10th April 2022

Conducted By

PPS Energy Solutions Pvt. Ltd.
Plot No-18, Girish Housing Society
Warje, Pune – 411058, Maharashtra, India.

For PPS Energy Solutions Pvt. Ltd.

Dr. Ravi G. Deshmukh
Energy Auditor Class - A
MEDA/ECN/2021-22/EA-01

MAHARASHTRA ENERGY DEVELOPMENT AGENCY

Maharashtra Energy Development Agency
(Government of Maharashtra Institution)
Aundh Road, Opposite Spicer College Road, Near Commissionerate of Animal Husbandary,
Aundh, Pune, Maharashtra 411067
Ph No: 020-35000450
Email: eee@mahaurja.com, Web: www.mahaurja.com

ECN/2021-22/CR-28/3412 — 06th July, 2021

CERTIFICATE OF REGISTRATION
FOR CLASS 'A'

We hereby certify that, the firm having following particulars is registered with ***MAHARASHTRA ENERGY DEVELOPMENT AGENCY (MEDA)*** under given category as "Energy Planner & Energy Auditor" in Maharashtra for Energy Conservation Programme of MEDA.

Name and Address of the firm	:	M/s PPS Energy Solutions Pvt. Ltd. B-403, Bharat Vihar, S.No-78, Bharti Vidyapith, Campus, Katraj, Pune-411043.
Registration Category	:	*Empanelled Consultant for Energy Conservation Programme for Class 'A'*
Registration Number	:	***MEDA/ECN/2021-22/Class A/EA-11***

- Energy Conservation Programme intends to identify areas where wasteful use of energy occurs and to evaluate the scope for Energy Conservation and take concrete steps to achieve the evaluated energy savings.
- MEDA reserves the right to visit at any time without giving prior information to verify quarterly activities performed by the firm and canceling the registration, if the information is found incorrect.
- This empanelment is valid till **05th July, 2023** from the date of registration, to carry out energy audits under the Energy Conservation Programme
- The Director General, MEDA reserves the right to cancel the registration at any time without assigning any reasons thereof.

General Manager (EC)

PREFACE

Energy Audit is a key parameter of systematic approach for decision-making in the area of energy management. It attempts to determine how and where energy is used and to identify methods for energy savings. There is now a universal recognition of the fact that new technologies and much greater use of some that already exists provide the most hopeful prospects for the future. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options.

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

Present energy audit is a mare mile marker towards destination of achieving safe, healthy and energy efficient unit. We would like to emphasize that an energy audit is a continuous process. We have compiled a list of possible actions to conserve and efficiently utilize our scarce resources and identified their savings potential. The next step would be to prioritize their implementation. Implementation of recommended measures can help consumes to achieve significant reduction in their energy consumption levels.

WHY ENERGY AUDIT?

An energy audit determines the amount of energy consumption affiliated with a facility and the potential savings associated with that energy consumption. Additionally, an energy audit is designed to understand the specific conditions that are impacting the performance and comfort in your facility to maximize the overall impact of energy-focused building improvements.

An energy audit is a systematic review of the energy consuming installations in a facility to ensure that energy is being used sensibly and efficiently. An energy audit usually commences with the collection and analysis of all information that may affect the energy consumption of the facility, then follows with reviewing and analyzing the condition and performance of various installations and facility management, with an aim at identifying areas of inefficiency and suggesting means for improvement.

Through implementation of the suggested improvement measures, facility owners can get the immediate benefit for paying less energy bills. On the other hand, lowering of energy consumption in facility will lead to the chain effect that the power supply companies will burn less fossil fuel for electricity generation and relatively less pollutants and greenhouse gases will be introduced into the atmosphere, thus contributing to conserve the environment and to enhance sustainable development.

ACKNOWLEDGEMENT

We express our sincere gratitude to the authorities of R.L.T. College of Science, Akola for entrusting and offering the opportunity. It is our immense pleasure to present the detailed energy audit report.

We acknowledge the positive support from management in undertaking the task of Detailed Energy Audit of all electrical system, thermal systems, utilities and other area and for continuous help and support before and during the Detailed Energy Audit.

We are also thankful to all field staff and agencies working with whom we interacted during the field studies for their wholehearted support in undertaking measurements and eagerness to assess the system / equipment performance and saving potential. We admire the help of all concerned staff for their active participation in completing official documentations.

We express our sincere gratitude to the authorities of R.L.T. College of Science, Akola for entrusting PPS Energy Solutions Pvt. Ltd.

For PPS Energy Solutions Pvt. Ltd.

Dr. Ravi G. Deshmukh
Energy Auditor Class - A
MEDA/ECN/2021-22/EA-01

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About PPSES

M/s. PPS Energy Solutions Pvt. Ltd (PPSES) is an ambitious company, established by enterprising engineering professionals in the year 2009. The company offers services pertaining to Energy and Engineering to clients across the globe. Our team is based in Pune, a city known for its Software and Engineering talent in India. We are a rapidly growing company with a team of about 100 people which includes highly trained and experienced Techno-Managers, Analysts, and Engineers & Detailers.

We are presently working in India (Maharashtra, Assam, Madhya Pradesh, Gujarat, Andhra Pradesh, Delhi, Orissa, Chhattisgarh, Bihar, Andhra Pradesh, Telangana and Jharkhand) and Abroad (Bahrain, Stanford)

- We serve in majorly four areas,
  - Energy Audit, Management and System Evaluations
  - Power Distribution System Design, Evaluations and Monitoring
  - MEP Design and Project management
  - Research and Training

PPSES Team Members

Name	Role	Academics and Expertise
Dr. Ravi Deshmukh	ECM verification, Report verification and presentation	Accredited Energy Auditor, PhD, M tech, MBA (Power), Graduate E&TC Engineer with over 18 years of experience in Energy Management, Management of Power System, street light projects, Power Exchange Operations, Power Trading and Analysis, Electrical Automation. Has worked as Expert in Iron & Steel sector and Energy
Mr .Nilesh Saraf	Co-ordination with officers, project status review.	Expert in Energy sector with 16 years of experience in Energy efficiency assessment, Industrial engineering sector & Renewable Energy.
Mr. Vinayak Apte	Energy Audit Expert	Graduate Electrical Engineer with more than 10 years of experience in various sectors. He handled Energy Audits, Energy Conservation and Energy Efficiency projects in Industries, Commercial and Residential Buildings, Pump House
Mr. Vedmurthy Swamy	Field study, data tabulation and analysis, report preparation	Graduate Mechanical Engineer with 5 years of experience in project management, energy efficiency assessment

1. EXECUTIVE SUMMARY

Detailed Energy Audit was undertaken in order to evaluate energy performance and identify potential energy conservation measures. Detailed Energy Audit was undertaken in three steps, i.e. document review of data and information initially provided by facility, site visit and preparation of this report.

Energy Audit team conducted the site visit. The site visit includes interaction with staff, electricians of facility, the collection/review of further data and a field inspection of the facility and equipment.

The salient observations and recommendations are given below.

1. The Total Cost of Energy is around **Rs. 3,25,534**/- per Annum
2. Average monthly units consumed are **3,707 kWh** equivalent to **Rs. 27,128**/-
3. Average electricity charges works out to be **Rs. 7.5**/-

This brief report has therefore sought to provide a high-level overview of the status of energy efficiency at facility, combined with an illustration of areas where further, previously unidentified savings opportunities may exist.

Our survey has identified further potential opportunities, ranging from "no & low cost" measures, through to those that will require significant capital expenditure.

Note: Investment figures mentioned in are only indicative, further detailed study is recommended.

Summary of Recommended Energy Conservation Measures:

Sr.No.	Equipment Name	ECM Details	Investment (Rs. In Lacs)	Savings (kWh/year)	Carbon credit (Tons of Co2)	Saving (Rs.In Lacs /Year)	Payback (Years)
1	Tube Lights	Replacement of conventional lights with suitable LEDs	5.11	3686.40	3.13	0.28	16.51
2	Fans	Replacement of existing fans with energy efficient Super fans	7.43	9550.80	8.12	0.72	10.37

Sr.No.	Equipment Name	ECM Details	Investment (Rs. In Lacs)	Savings (kWh/year)	Carbon credit (Tons of Co2)	Saving (Rs.In Lacs /Year)	Payback (Years)
3	AC	Optimize the temperature setting to 23-25 degree celsius	0.00	15.88	0.01	0.00	0.00
4	Pump	Replacement of Existing Pumpsets with Energy Efficient Pumpsets	0.42	104.44	0.09	0.01	53.48
5	Refrigerator	Optimize the temperature setting of Refrigerators	0.00	4698.00	4.20	0.35	0.00
6	APFC	Optimize the Power Factor	0.34	0.00	0.00	0.12	0.24
7	Other Appliances	Replacement of old appliances (like fridge, air cooler, water cooler etc) with 5 star rating	2.11	2713.50	2.43	0.20	10.35
8	Main Incomer	Optimization of Neutral Current	0.00	157.68	0.14	0.01	0.00
Total			**15.41**	**20926.70**	**18.13**	**1.69**	**9.14**

Note: Estimated savings may base on operating conditions

During the Energy Audit, Total Estimated Investment of Rs. 15,41,000/- yields Total Estimated Savings of Rs. 1,69,000/- which 52 % of the Total Energy Cost of Rs. 3,25,534/- with an overall payback period of 9.14 Years.

Other Recommendations:

A. Regular cleaning and maintenance of equipment's is important to reduce energy losses.
B. Use of star rated equipment's is also strongly recommended specially in case of Fans and Air conditioning.
C. Cleaning of ceiling fan and exhaust fan blades will reduce the drag on the fan and intern will reduce energy loss.
D. Awareness amongst energy users is very essential step to reduce wastage of electricity

E. Energy conservation awareness programs can be conducted once a year. Increasing energy awareness of energy users motivates them to work as a team can lead to reductions in energy consumption and save the money.

Year	Investment (Rs. In Lacs)	Saving (Rs.In Lacs /Year)	Cum Savings(Rs Lakh)	Net savings (Rs Lakh)
0	-15	0	0	-15
1	0	2	2	-14
2	0	2	3	-12
3	0	2	5	-10
4	0	2	7	-9
5	0	2	8	-7
6	0	2	10	-5
7	0	2	12	-4
8	0	2	13	-2
9	0	2	15	0
10	0	2	17	1
11	0	2	19	3
12	0	2	20	5
13	0	2	22	7
14	0	2	24	8
15	0	2	25	10

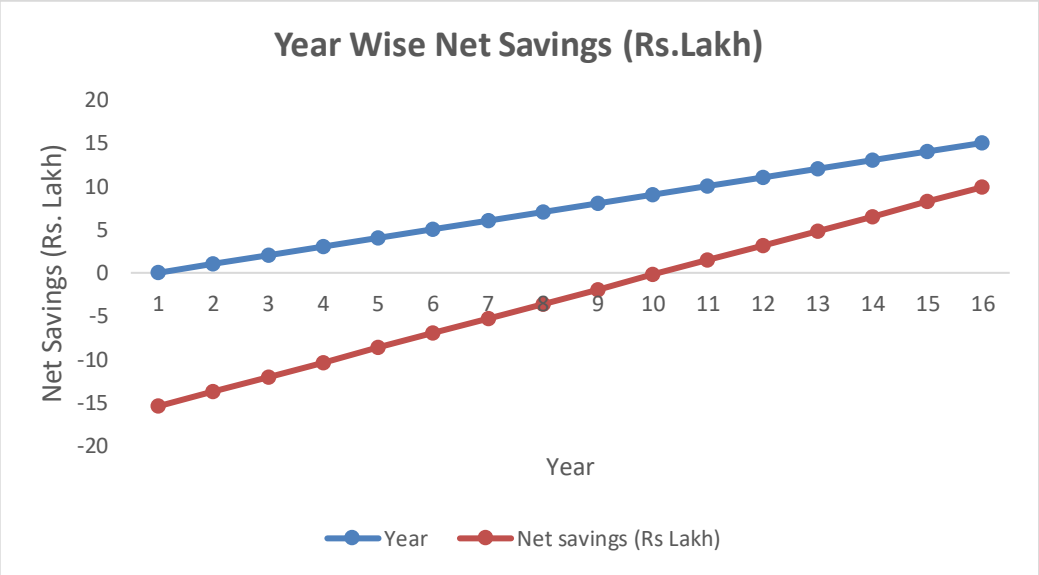

Figure 1 Net Savings (Rs. Lakhs) Vs Year

For PPS Energy Solutions Pvt. Ltd.

Dr. Ravi G. Deshmukh
Energy Auditor Class - A
MEDA/ECN/2021-22/EA-01

2. GENERAL AUDIT REVIEW

Facility can implement faster payback energy conservation measures (ECMs) which have already been considered and for which the ECMs are fully developed.

Other General Points:

1. Energy conservation awareness programs can be conducted once a year. Increasing energy awareness of staff, students and motivating them to work as a team can lead to reductions in energy consumption and save the money. Savings estimates range in the order of 5 to 10%. When implemented effectively these savings can be realized quickly and cost effectively.
2. Most of the fans are of older design and not energy inefficient.
3. Most of the places the tube light installed are energy efficient and fittings are in healthy condition.
4. Natural day light is efficiently used in corridor and few classrooms and labs areas.

It is believed that with the current approach and organization of energy management, energy can be reduced in a systematic, cost effective manner. We hope that this report will help facility to implement these changes and provide direction to the Energy Management Team.

3. ABOUT ENERGY AUDIT

Objective

The overall objective of the assignment is to quantify energy saving in existing system and achieve reduction in energy consumption pattern.

Hence, the detail objectives are as under,

1. To calculate the energy consumption
2. To evaluate the performance of the equipment
3. To find out the energy saving opportunities
4. To quantify the total energy savings
5. To find out the ways to achieve energy efficiency

3.1. Scope of Work

Following is the scope of work envisaged for this assignment,

Data Collection

To collect the details of various electrical and mechanical system and their ratings, the available drawings and details shall be studied. Detail load list shall be prepared and checked.

A, B, C Analysis

With the details available from load list, analysis shall be carried out depending on the present usage trends. All the power consuming equipment's shall be classified in three categories depending on their ratings, condition and operating time. The area for larger potentials for savings shall be identified.

Field Study

The detail field study on site shall include the following as well as all other measures required for energy audit study,

a. Lay out the system and study of Electrical distribution
b. Study of area wise power distribution and Measurement of power consumption
c. Study of instrumentation provided
d. Measurement of motor currents, voltages, power etc. parameters by energy analyzer and measurement of water flow, pressures etc. parameters of pumps simultaneously and

other measurements as needed to characterize the system and required for calculating efficiency at various combinations

e. Study of air conditioner operations and system requirements

f. Analysis of readings obtained from field with the standard consumption.

3.2. Approach and Methodology

1. Understanding the Scope of Work and Resource Planning

2. Identification of Key Personnel for the assignment/ project

3. Structured Organization Matrix

4. Steps in preparing and implementing energy audit assignment
   a) Discussions with key facility personnel
   b) Site visits and conducting "walk-through audit".
   c) Preliminary Data Collection through questionnaire before audit team's site visit
   d) Steps for conducting the detailed audit
      - Plan the activities of site data collection in coordination with the facility in-charge.
      - Study the existing operations involving energy consumption
      - Collect and collate the energy consumption data with respect to electricity consumption
      - Conduct performance tests to assess the efficiency of the system equipment/ electricity distribution, lighting, and identify energy losses.
      - Discuss with facility personnel about identified energy losses.

5. List proposed efficiency measures
   - Develop a set of potential efficiency improvement proposals
   - Baseline parameters
   - Data presentation
   - System mapping
   - List of potential Energy Savings proposals with cost benefit analysis.
   - Review of current operation & maintenance practices

6. Preparation of the Draft Energy Audit Report

7. Preparation and submission of final Energy Audit Report after discussion with concerned persons

4. ENERGY DETAILS

Maharashtra State Electricity Distribution Company Limited (MSEDCL) provides the electricity supply for facility. Billing is carried out with the help of Two meter according to 073/LT VII (B) Tariff.

Detailed Energy Audit was conducted for the load connected to the mains supply used.

Mainly energy is used on this facility for the following purposes:

1) Lighting Load
2) Ceiling Fans
3) Refrigerator
4) Exhaust Fans
5) Water Pump
6) Oven

Based on above it is clear that followings equipments have highest potential for energy savings

Table 1 Name of Equipment

Sr. No.	Name of the Equipment
1	Lighting Load
2	Ceiling Fan
3	Water Pump
4	Refrigerator
5	Other Appliances

4.1. Electricity Bill Analysis

4.1.1. Details of Consumer No.: 310070527919

Consumer Details

Table 2 Consumer Details

Parameter	Details
Consumer No.	**310070527919**
Consumer Name	THE PRINCIPAL R T COLLEGE OF SCIENCE
Address	SITABAI ART COLLEGE ROAD AKOLA
Pin Code	444001
Date of Connection	01-01-1980
Sanctioned load (KW)	2.00
Tariff	073/LT VII(B)
Bu/ Circle No	4592

Consumption Details

Table 3 Billing Data

Month	kWH	Commercial Unit rate (Rs/kWh)	Demand Charges (Rs)	Wheeling Charges (Rs)	Other charges	Energy Charges (Rs)	Total Current Bill (Rs)	Total Unit Rate (INR)
Aug-21	503	4.68	373	694.14	814.22	2354.04	4235.4	8.42
Sep-21	2552	4.68	373	3521.76	3811.91	11943.36	19650.0	7.70
Oct-21	1585	4.68	373	2187.30	2397.18	7417.80	12375.3	7.81
Nov-21	1453	4.68	373	2005.14	2204.07	6800.04	11382.3	7.83
Dec-21	6767	4.68	373	9338.46	9978.45	31669.56	51359.5	7.59
Jan-22	2214	4.68	373	3055.32	3317.42	10361.52	17107.3	7.73
Feb-22	1226	4.68	373	1691.88	1871.99	5737.68	9674.6	7.89
Mar-22	2313	4.68	373	3191.94	3462.25	10824.84	17852.0	7.72
Apr-22	1918	4.57	376	2589.30	3216.27	8765.26	14947.1	7.79
May-22	3469	4.57	760	4683.15	-9335.98	15853.33	11960.8	3.45
Jun-22	1927	4.57	384	2601.45	3192.94	8806.39	14984.8	7.78
Jul-22	8331	4.57	768	11246.85	6192.32	38072.67	56279.8	6.76
Avg	**2855**	**4.64**	**439**	**3901**		**13217**	**20151**	**7.06**
Max	**8331**	**4.68**	**768**	**11247**		**38073**	**56280**	**6.76**
Min	**503**	**4.57**	**373**	**694**		**2354**	**4235**	**8.42**
Sum	**34258**		**5273**	**46807**		**158606**	**241809**	

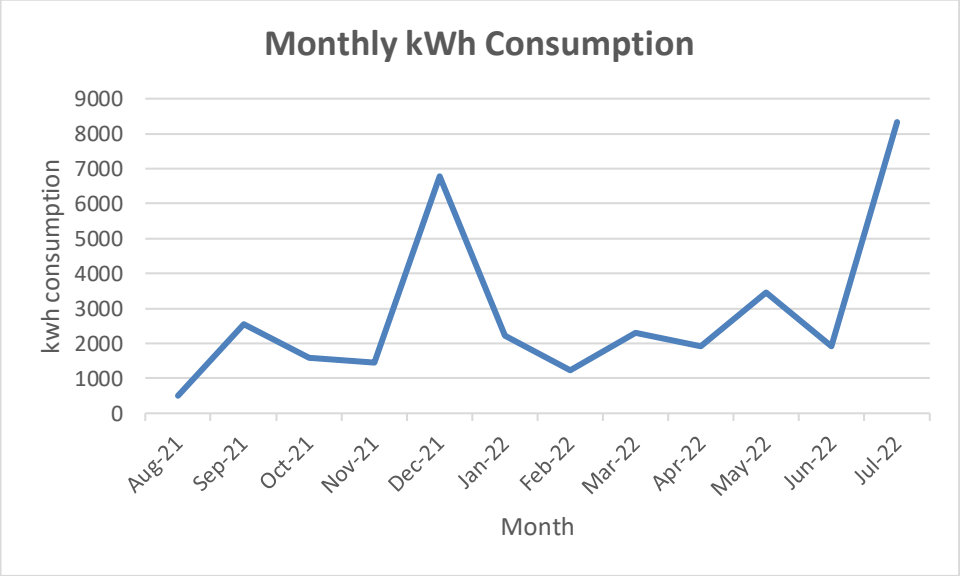

Figure 2 Monthly kWh Consumption

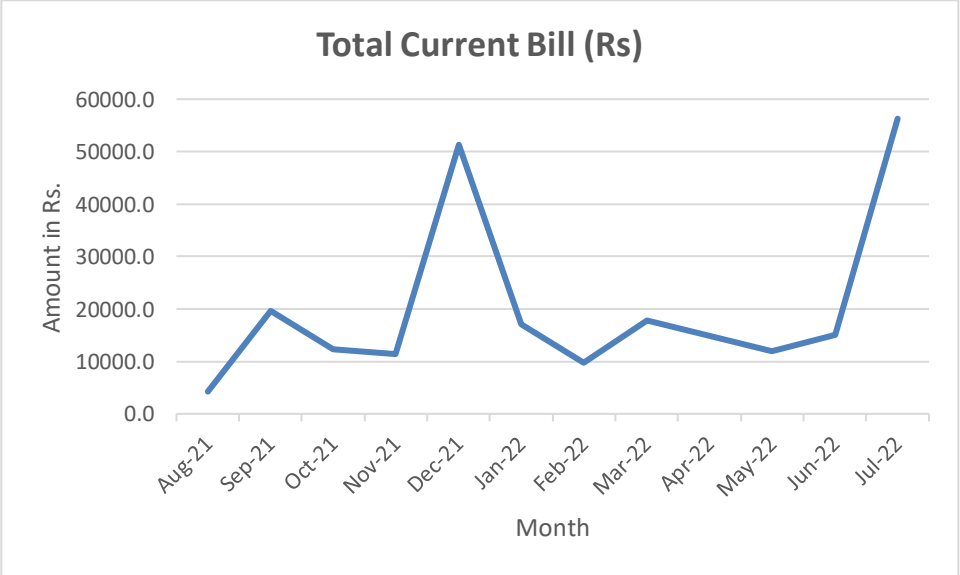

Figure 3 Monthly Electricity Bill

Comments:

1. Average monthly units consumed is **2,855 kWh** equivalent to **Rs. 20,151/-**
2. Average electricity charges works out to be **Rs. 7.06/-**

4.1.2. Details of Consumer No.: 310070527935

Consumer Details

Table 4 Consumer Details

Parameter	Details
Consumer No.	**310070527935**
Consumer Name	THE PRINCIPAL R L T COLLEGE
Address	CHOUDHRI HOSPITAL ROAD AKOLA
Pin Code	444001
Date of Connection	1/19/1972
Sanctioned load (KW)	12.00
Tariff	73 LT-VII B I
Bu/ Circle No	4592

Consumption Details

Table 5 Billing Data

Month	kWH	Commercial Unit rate (Rs/kWh)	Demand Charges (Rs)	Wheeling Charges (Rs)	Other charges	Energy Charges (Rs)	Total Current Bill (Rs)	Total Unit Rate (INR)
Jul-21	933	4.68	373	1287.54	1443.31	4366.44	7470.3	8.01
Aug-21	785	4.68	373	1083.30	1226.78	3673.80	6356.9	8.10
Sep-21	712	4.68	373	982.56	1119.98	3332.16	5807.7	8.16
Oct-21	733	4.68	373	1011.54	1150.71	3430.44	5965.7	8.14
Nov-21	497	4.68	373	685.86	805.64	2325.96	4190.5	8.43
Dec-21	633	4.68	373	873.54	1004.41	2962.44	5213.4	8.24
Jan-22	402	4.68	373	554.76	666.44	1881.36	3475.6	8.65
Feb-22	591	4.68	373	815.58	942.97	2765.88	4897.4	8.29
Mar-22	986	4.68	373	1360.68	1699.80	4614.48	8048.0	8.16
Apr-22	1349	4.57	384	1821.15	2259.41	6164.93	10629.5	7.88
May-22	1342	4.57	384	1811.70	2248.11	6132.94	10576.8	7.88
Jun-22	1259	4.57	384	1699.65	3256.58	5753.63	11093.9	8.81
Avg	**852**	**4.65**	**376**	**1166**		**3950**	**6977**	**8.19**
Max	**1349**	**4.68**	**384**	**1821**		**6165**	**11094**	**8.22**
Min	**402**	**4.57**	**373**	**555**		**1881**	**3476**	**8.65**
Sum	**10222**		**4509**	**13988**		**47404**	**83725**	

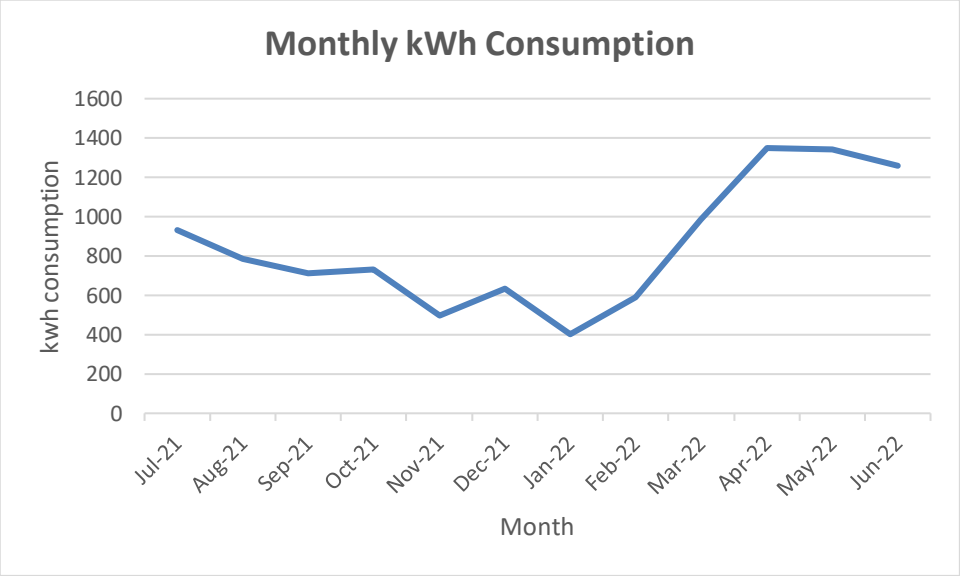

Figure 4 Monthly kWh Consumption

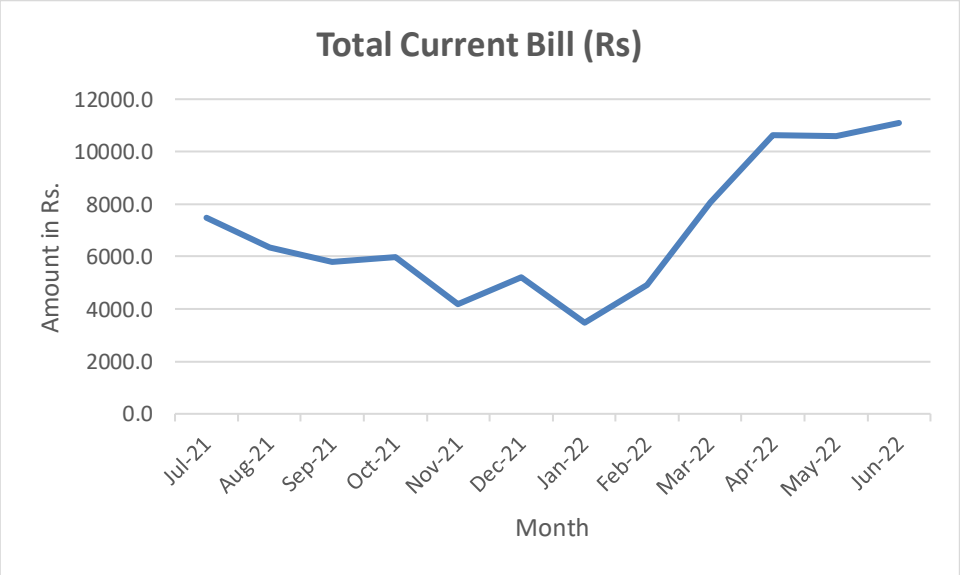

Figure 5 Monthly Electricity Bill

Comments:

1. Average monthly units consumed is **852 kWh** equivalent to **Rs. 6,977/-**
2. Average electricity charges works out to be **Rs. 8.19/-**

4.2. Connected Load Quantity of Buildings

Table 6 Connected Load of Facility

Fixtures	Watt age	Wing-D			Wing-C			Wing-B			Wing-A		Total Qty	Total Connected Load in KW
		Ground Floor	First Floor	Second Floor	Ground Floor	First Floor	Second Floor	Ground Floor	First Floor	Second Floor	Ground Floor	First Floor		
Ceiling Fan	75	36	21	50	28	35	34	22	8	24		4	262	19.65
Ceiling Fan	100	4	14	5	5		12	9	23				72	7.20
LED Tube Light	18	36	71	60	8	37		7	17	37	18	5	296	5.33
LED Light POP	18	19	1					66					86	1.55
CFL Tube Light	28	1	1	9	36	6	47	4	3				107	3.00
Computer	200	8	3	2	2	11	1		4				31	6.20
Printer	150	6	5		2	2	1	1	2				19	2.85
Laser Printer (Small)	120	1							3				4	0.48
LED Screen	55	1											1	0.06
Xerox Machine	350	1											1	0.35
Street Light LED	50	14					4					1	19	0.95
Amplifier	300	3									1		4	1.20
Projector	150	3	2	1				1	2	2			11	1.65
Exhaust Fan	35	1		2									3	0.11
Monitor	100		22										22	2.20
CPU	100		1										1	0.10
Tube Light	40		5	2	1				14				22	0.88
Table Fan	55		1										1	0.06

Fixtures	Watt age	Wing-D			Wing-C			Wing-B			Wing-A		Total Qty	Total Connected Load in KW
		Ground Floor	First Floor	Second Floor	Ground Floor	First Floor	Second Floor	Ground Floor	First Floor	Second Floor	Ground Floor	First Floor		
CFL Bulb	15		16		2				3			3	24	0.36
LED Bulb	15		12										12	0.18
Micro-Oven	2000		2										2	4.00
Refrigerator (5*)	750		1						1				2	1.50
Laptop	100		1						2				3	0.30
Wall Fan	55		1										1	0.06
Refrigerator	700			1									1	0.70
Hot air Oven	2000												0	0.00
Hot air Oven	2500												0	0.00
Auto Clave Machine	250			1									1	0.25
Refrigerator	700			1									1	0.70
Deep Refrigerator	700			1	1				1				3	2.10
Lab Equipments	100			7	2				2				11	1.10
Tube Light	36			4				5	8				17	0.61
Motor	1490	1											1	1.49
Sub. Pump	746	2											2	1.49
Exhaust Fan	55				4								4	0.22
LED Light POP	15				30								30	0.45
Hot air Oven	1450				3								3	4.35
Oven	800				1								1	0.80
Refrigerator	800				2				1				3	2.40
LED Light	15				4								4	0.06

Fixtures	Watt age	Wing-D			Wing-C			Wing-B			Wing-A		Total Qty	Total Connected Load in KW
		Ground Floor	First Floor	Second Floor	Ground Floor	First Floor	Second Floor	Ground Floor	First Floor	Second Floor	Ground Floor	First Floor		
POP														
Exhaust Fan	65				11								11	0.72
Wall Fan	35				2								2	0.07
Small R.O. Cooler	800				1	1							2	1.60
Air Cooler	1500				1								1	1.50
Street Light LED	30				8		3						11	0.33
Exhaust Fan	45							5					5	0.23
Halogen Light	200										6		6	1.20
Sound System	350										1		1	0.35
Oven	1300								3				3	3.90
Total													**1130**	**86.81**

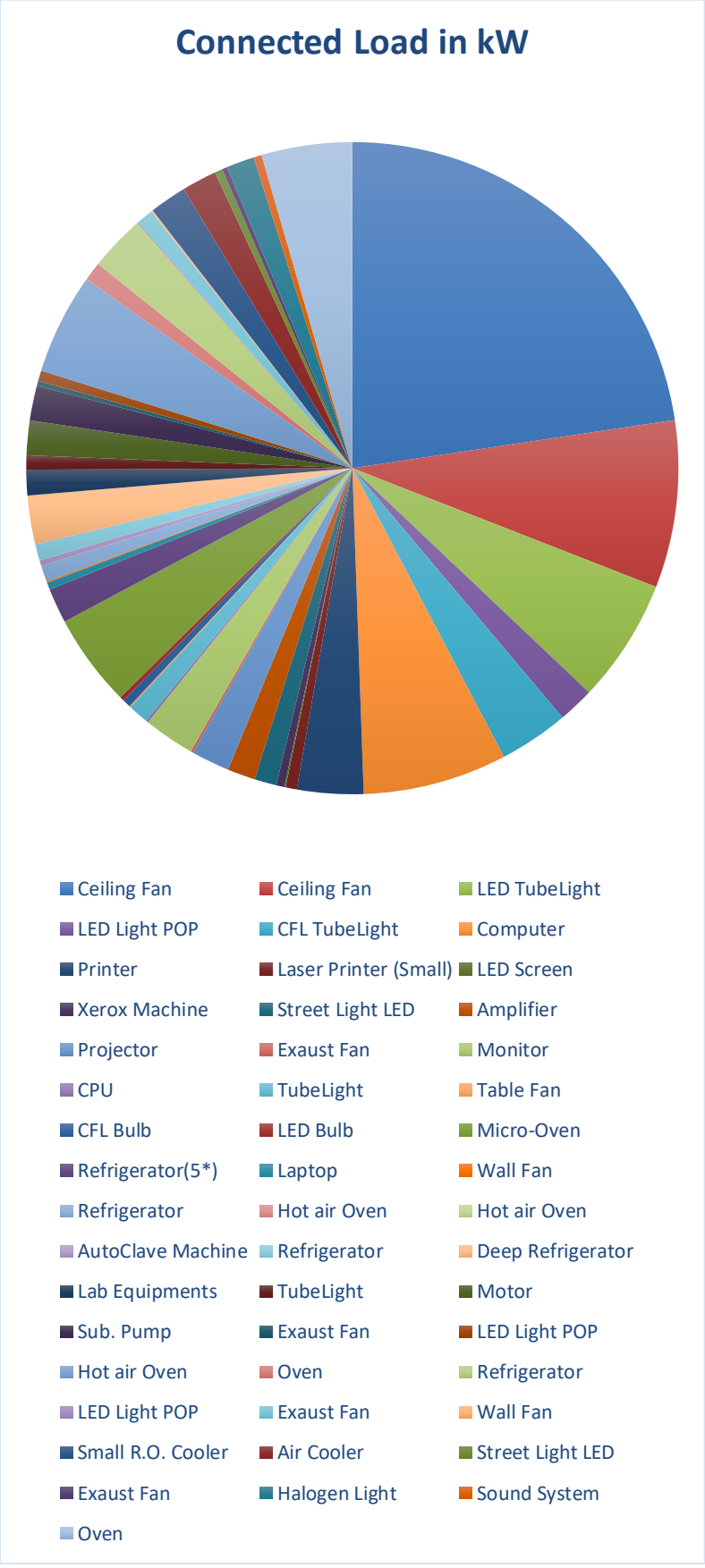

Figure 6 Distribution of Connected Load

5. ACTUAL MEASUREMENTS

5.1. Study of Loading Pattern for Facility:

The Three-phase portable power analyzer was installed at incoming panel and data is recorded. Following data shows the loading pattern, Voltage, Current PF variation.

Figure 7 Main Incomer

Table 7 Study of Loading Pattern of Facility

Parameter		R-Phase	Y-Phase	B-Phase	Total/Neutral
Voltage (V)	Avg	422.24	422.79	417.71	
	Max	424.00	424.50	419.80	
	Min	419.80	420.30	414.90	
Current (A)	Avg	8.96	12.89	4.29	8.40
	Max	13.74	18.20	13.34	12.28
	Min	6.92	11.07	3.41	4.17
Active Power (W)	Avg	1259.78	1522.34	710.46	3492.59
	Max	2017.00	2692.00	2019.00	4902.00
	Min	918.00	1244.00	612.00	3033.00
Power Factor	Avg	0.59	0.48	0.68	0.55
	Max	0.68	0.61	0.79	0.61
	Min	0.51	0.44	0.53	0.51
V % THD	Avg	2.04	2.00	2.15	
	Max	2.28	2.26	2.38	
	Min	1.78	1.79	1.90	
I % THD	Avg	14.74	24.95	12.71	39.93
	Max	18.86	42.45	17.84	-
	Min	8.77	17.39	4.42	25.36

Comments:

1) Average, Maximum and Minimum variations for all the Phases is within the limit of +/- 6% i.e.,413 V to 467 V
2) The voltage unbalance between the Phases is Absent.
3) The current unbalance between the Phases is Present.
4) Total Harmonic Distortion for voltage is within the limits of 5% whereas Total Harmonic Distortion for Current is more than 15%.

Recommendation:

1) To minimize the Neutral current, it is recommended to balance the load equally among the three phases.

2) It is recommended to install suitable size of Active Harmonic Filter to suppress Current Total Harmonic Distortion.

Voltage Variation:

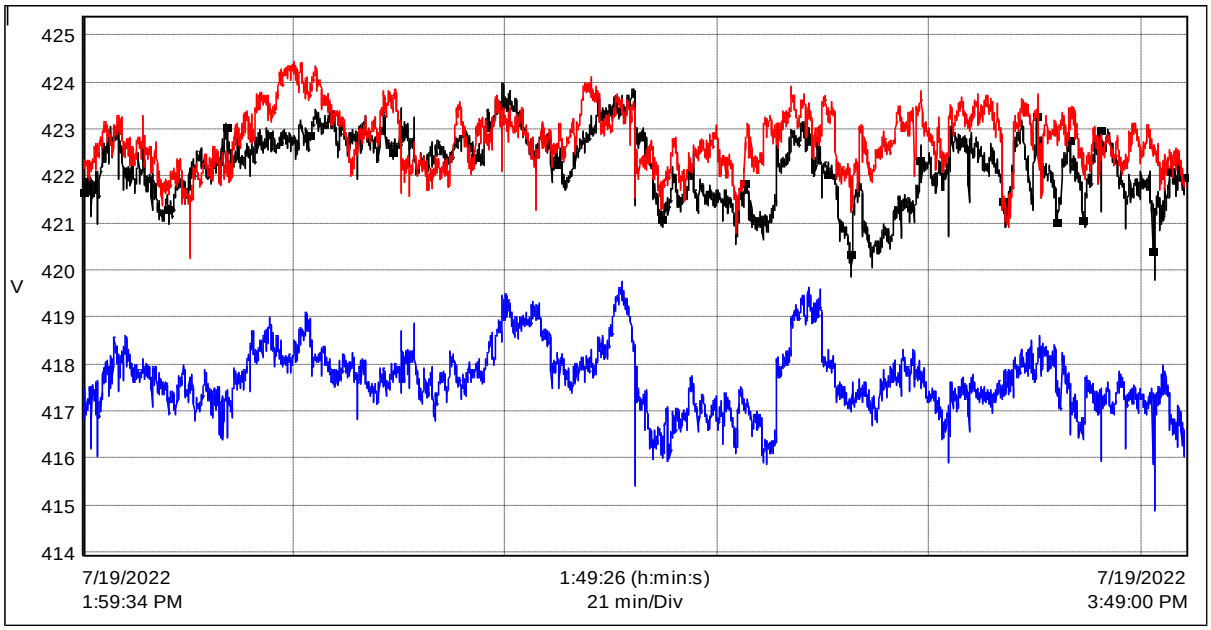

Figure 8 Voltage vs Time Period

Current Variation:

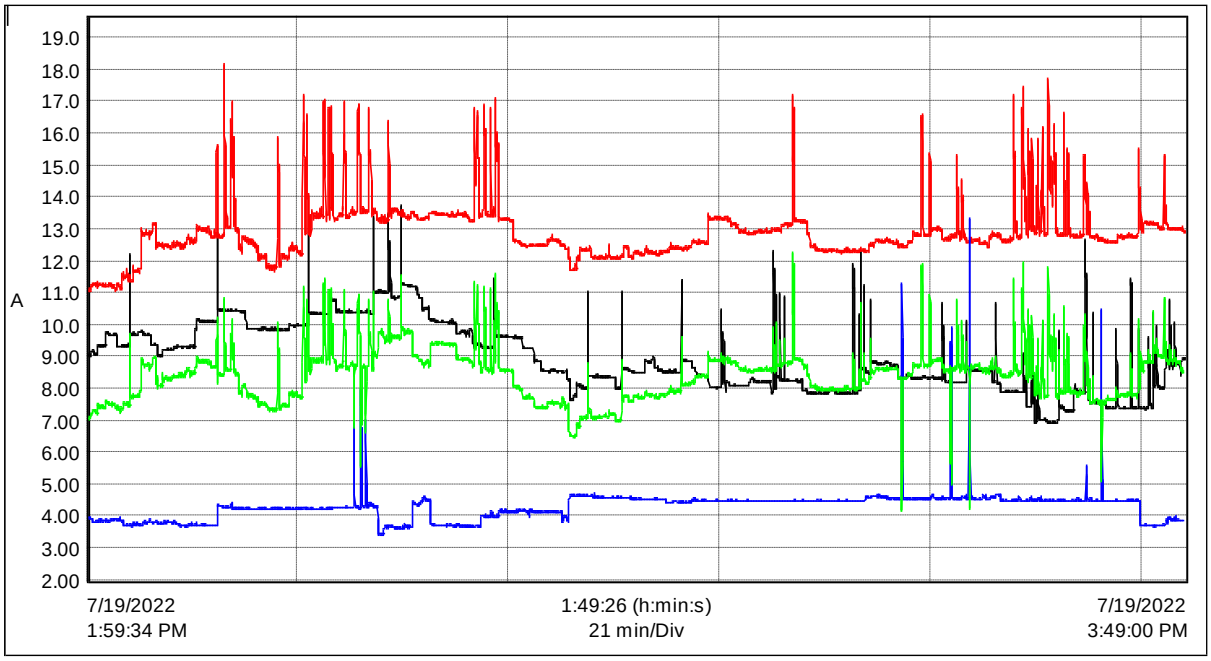

Figure 9 Current vs Time Period

Power Variation:

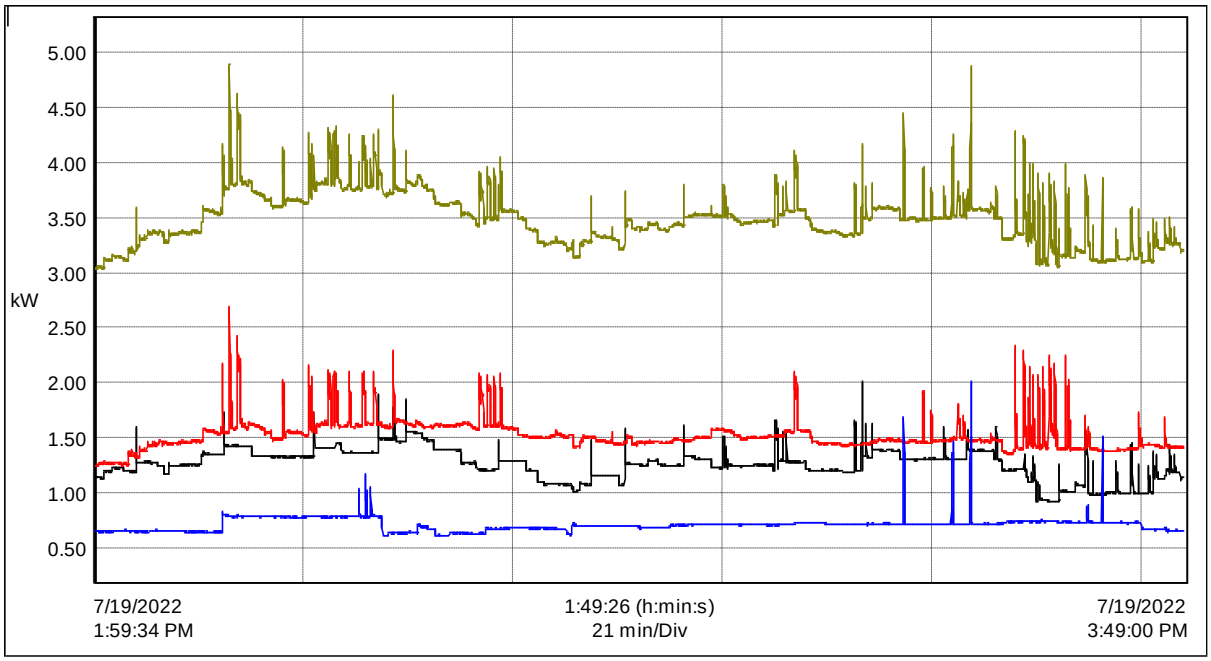

Figure 10 Power vs Time Period

Power Factor Variation:

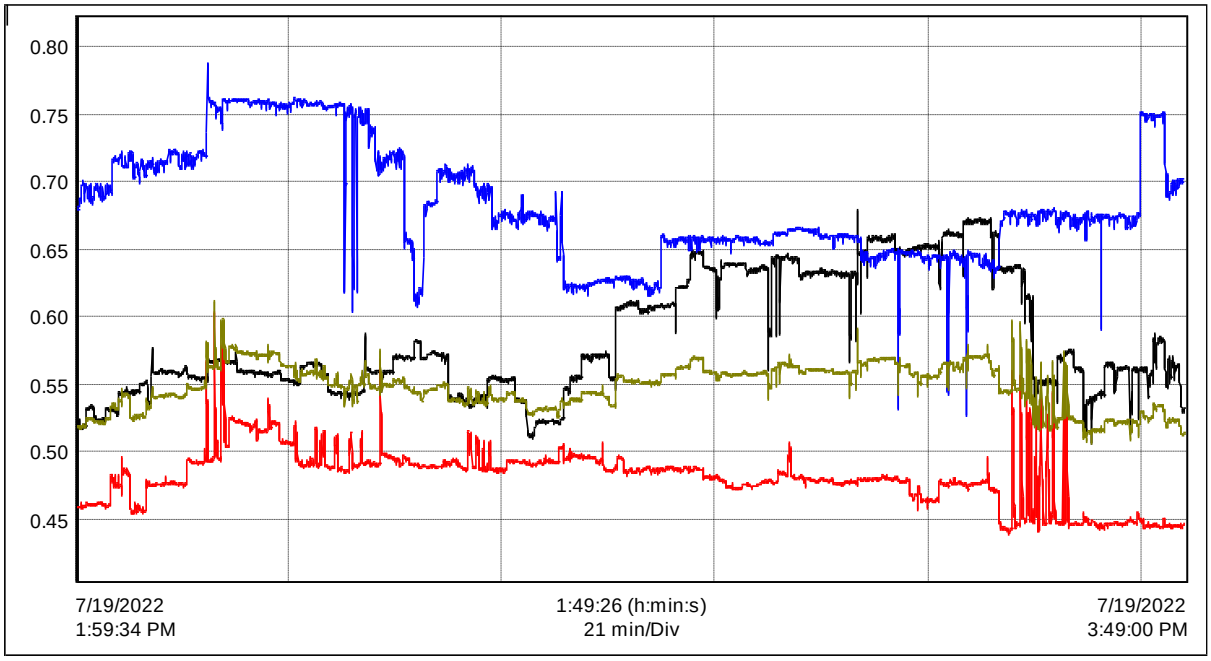

Figure 11 Power Factor vs Time Period

Voltage Total Harmonic Distortion Variation:

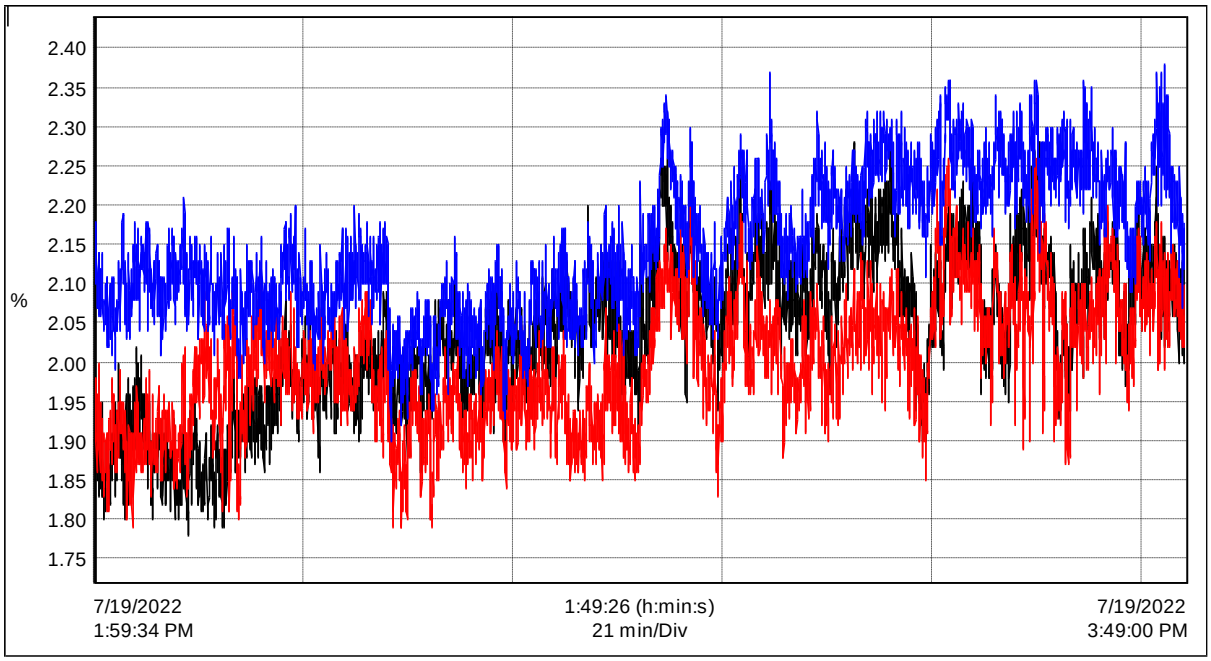

Figure 12 Voltage THD % vs Time Period

CurrentTotal Harmonic Distortion Variation:

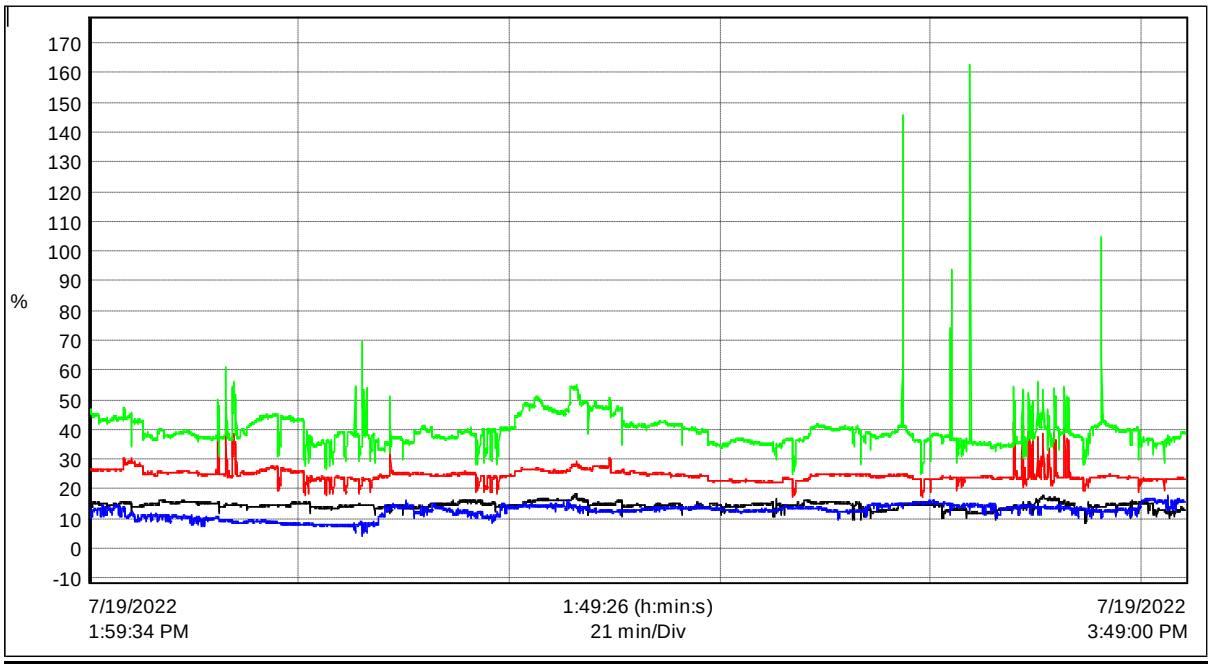

Figure 13 Current THD % vs Time Period

5.2. Study of Lighting Intensity for Facility:

It is observed that, in the entire campus on an average same lux level of 40-50.The team measured Lux level for one room on sample basis.

Table 8 Study of Lighting Intensity of Facility

ROOM 4	
Location	**LUX**
Point 1	30
Point 2	35
Point 3	55
Point 4	55
Point 5	30
Average	**41**

Recommendation:

1) It is recommended to install lighting fixtures given in ECMs, so that lux level can be maintained as per standard.

6. ENERGY CONSERVATION MEASURES

ECM 1: Replacement of Tube Lights with More Efficient Lights

ECM No.	Energy Efficiency Improvement Measures	Investment Rs. In Lakh	Estimated saving		Estimated Savings Rs. In Lacs	Estimated Payback Years
			Electricity	Carbon credit		
			kWh	(Tons of CO_2)		
1	Replacement of Conventional Lights with More Efficient Lights	5.11	3686.40	3.13	0.28	16.51

Figure 14 Lighting Fixture

Observations:

Facility has installed Tube Light of 28W, 36 W and 40 W, CFL of 15 W and Halogen Light of 200 W in their premises

Recommendations:

During energy audit, it is observed that facility has installed Tube Light of 28W, 36 W and 40 W, CFL of 15 W and Halogen Light of 200 W at some of the places in the facility Also energy team at facility has already replaced some of the CFLs with LEDs. The operating hours for these lightings are around 6 hours. Tube Light of 28W, 36 W and 40 W, CFL of 15 W and Halogen Light of 200 W with equivalent LED fixture thereby achieving significant reduction in energy consumption. The LEDs could be replaced in such a manner that it has

same fixture so there will not be retrofitting cost attached to the replacement. The replacement could be done in a phased manner. LED lights have better efficacy as well as better lifetime than conventional lights

Energy Saving Calculations:

Particular	Unit	Value
Energy Saving Calculation		
Power consumption of TL,CFL and Halogen lamps	KW	6.05
Power consumption of suitable LED	KW	4.00
Average power saving after replacement with LED lights	KW	2.05
Replacement of conventional lights with suitable LEDs	Nos	176
Average working hour per day	hrs	6
No. of working days in a year	Days	300
Cost Benefit Calculation		
Annual Energy Saving potential	kWh	3686
Electricity tariff	Rs/unit	7.5
Annual Cost Saving	Rs. Lakh	0.28
Total investment cost	Rs. Lakh	4.56
Annual Saving	Rs. Lakh	0.28
Simple Payback Period	Years	16.5

Type of Exisitng Fitting	Wattage	Qty	Proposed LED W	CSR NO	Price - Rs/ Unit	Dismantling cost	TOTAL COST	Existing KW	Proposed KW	Saved kW	Investment Rs Lakh	GST 12%	Total Investment
Tube Light	28	107	20	2-1-23	926	15	1.13	3.00	2.14	0.86	1.13		
Tube Light	36	17	20	2-1-23	926	15	0.30	0.61	0.34	0.27	0.30		
Tube Light	40	22	20	2-1-23	926	15	0.34	0.88	0.44	0.44	0.34		
CFL Bulb	15	24	20	2-1-23	140	15	0.05	0.36	0.48	-0.12	0.05		
Halogen Light	200	6	100	2-7-2.	13051	15	2.74	1.20	0.60	0.60	2.74		
TOTAL	**319.00**	**176.00**	**180.00**		**15969.00**	**75.00**	**4.56**	**6.05**	**4.00**	**2.05**	**4.56**	**0.55**	**5.11**

Investment Details

CSR no	Description	Material	Labour	Total	Dismantling cost	Quantity	Total Cost
2-1-23	Supplying & erecting LED 20W tube light fitting (4 feet) with aluminium housing, heat sink, integrated HF electronic driver complete.	881	45	926	15	107	112972
2-1-23	Supplying & erecting LED 20W tube light fitting (4 feet) with aluminium housing, heat sink, integrated HF electronic driver complete.	881	45	926	15	17	29632
2-1-23	Supplying & erecting LED 20W tube light fitting (4 feet) with aluminium housing, heat sink, integrated HF electronic driver complete.	881	45	926	15	22	34262
2-1-23	Supplying & erecting LED 20W tube light fitting (4 feet) with	135	5	140	15	24	5460

CSR no	Description	Material	Labour	Total	Dismantling cost	Quantity	Total Cost
	aluminium housing, heat sink, integrated HF electronic driver complete.						
2-7-2.	Supplying and erecting highbay LED fitting IP 65 with lamp 110W-120W, PF >0.95 duly connected complete with accessories as per specification no. FG-ODF/LED	12858	193	13051	15	6	274071
	Total						**4.56**
	12% GST on total Investment cost						**0.55**
	Total cost						**5.11**

ECM 2: Replacement of Old Fan with Energy Efficient Super Fan

ECM No.	Energy Efficiency Improvement Measures	Investment Rs. In Lakh	Estimated saving		Estimated Savings Rs. In Lacs	Estimated Payback Years
			Electricity	Carbon credit		
			kWh	(Tons of CO_2)		
2	Replacement of Existing Fans with Energy Efficient Fans	7.43	9550.80	8.12	0.67	11.11

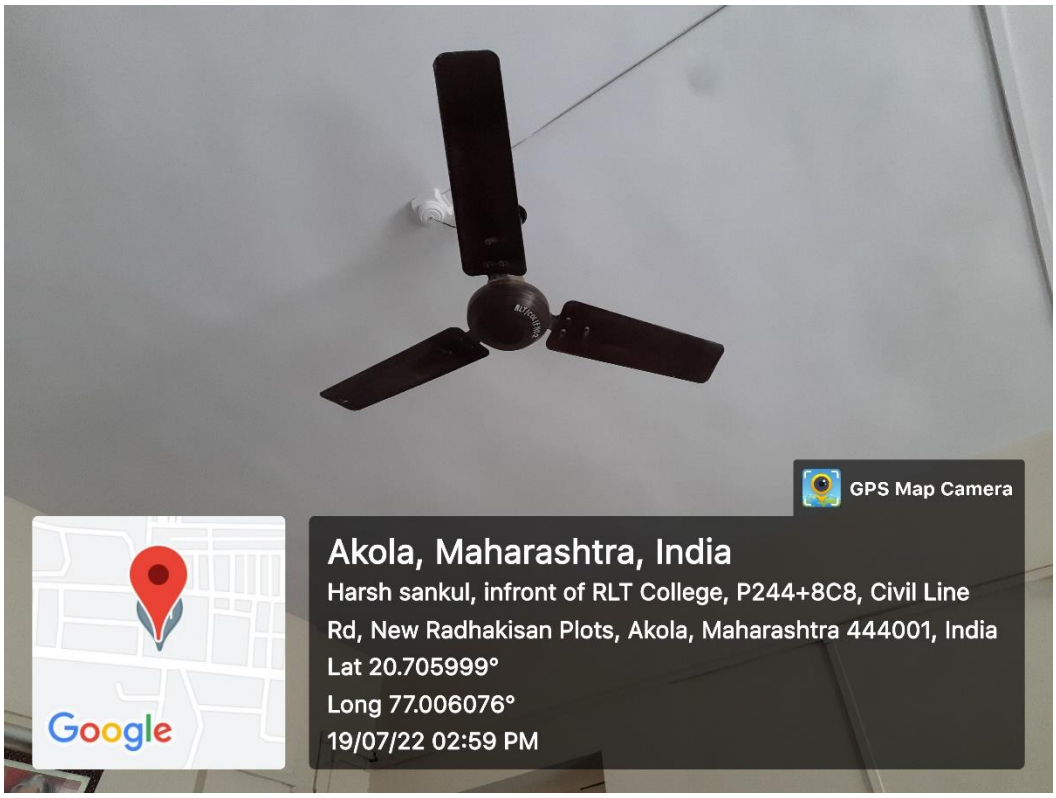

Figure 15 Ceiling Fans

Observations:

During energy audit, it is observed that facility has old 100 W and 75 W fan and its energy consumption is on higher side.

Recommendations:

During energy audit it is observed that facility has installed non star rated fan of 100 W and 75 W so we recommend to replace energy consuming fan with energy efficient super fan

Energy Saving Calculations:

Particular	Unit	value
Existing energy consumption of Fan	kWh/year	24165
Wattage of Energy Efficient Super Fan	Watt	35
Energy consumption after replacing with Energy Efficient Super Fan	kWh/year	10521
Operating hrs/day	Hrs/day	3
No. of working days in a year	Days	300
Diversity factor	%	70%
Annual Saving	kWh/year	9551
Unit rate	Rs/kWh	7
Annual Saving	Rs. In Lacs	0.67

AC category	Nos	Estimated Running kW
Ceiling Fan 100W	72	7.20
Ceiling Fan 75 W	262	19.65
Total	**334**	**26.85**

Investment Details

CSR No	Description	Material	Labour	Total	Quantity	Total Cost
2-14-4	Dismantling the existing ceiling fan /exhaust fan / cabin fan / bracket fan complete with accessories, G.I. down rod, frame etc. and making the site clear.	0	37	37	334	12358
2-12-21.	Supplying and erecting five star rated energy saving Ceiling fan 230 V A.C. 50 cycles 1200 mm complete erected in position as per specification no. FG-FN/CF	1858	91	1949	334	650966
	Total					**6.63**
	12% GST on total Investment cost					**0.80**
	Total cost					**7.43**

ECM 3: Optimization of Set Temperature of ACs

ECM No.	Energy efficiency improvement measures	Investment Rs. In Lakh	Estimated saving		Estimated Savings Rs. In Lacs	Estimated Payback Years
			Electricity	Carbon credit		
			kWh	(Tons of CO_2)		
3	Optimization of Set Temperature of ACs	0.00	15.88	0.01	0.00	0.00

Observations:

Facility has installed Split AC of 1 Ton 5 star in their premises

Recommendations:

During assessment, it is observed that Split AC! of 1 Ton 5 star set point was 22^0 C. Hence, it is recommended to increase set temperature setting to 23^0 C as well as improve maintenance of AC frequency.

It is known that, a 1℃ raise in evaporator temperature can help to save almost 3% on power consumption (this also can be verified from BEE guideline: Chapter 4. HVAC and Refrigeration System).

The TR capacity of the same refrigeration will also increase with increase in the evaporator temperature, as given in table below:

Effect of variation in Evaporator Temperature on Compressor Power Consumption			
Evaporator Temperature (℃)	Refrigeration Capacity* (tons)	Specific Power Consumption	Increase in kW/ton (%)
5	67.58	0.81	-
0	56.07	0.94	16
-5	45.98	1.08	33
-10	37.2	1.25	54
-20	23.12	1.67	106

** Condenser temperature 40°C*

Energy Saving Calculations:

Particular	Unit	Value
Estimated Annual Consumption of ACs	kWh/hr	529
Estimated Saving	%	3%
Operating Hrs per day	hrs/day	3
Operating days per year	Days/year	90
Estimated Saving	kWh/year	16
Unit Rate	Rs/kWh	7.5
Annual Saving	Rs Lakh/year	0.00

Sr No	Type	Ton	Qty	Annual Consumption
1	Air Conditioner (Split) (2 Ton) (5*)	2	1	705.6
Total				**705.6**

ECM 4: Optimization of Set Temperature of Refrigerators

ECM NO.	Energy Efficiency Improvement Measures	Investment Rs. In Lakh	Estimated Saving		Estimated Savings Rs. In Lacs	Estimated Payback Years
			Electricity	Carbon Credit		
			kWh	(Tons of CO_2)		
4	Optimize the temperature setting of Refrigerators	0.00	4698.00	4.20	0.35	0.00

Observations:

Facility has Refrigerators of wattages ranging from 700 to 800 W and Deep Freezer of 700 W in their premises

Recommendations:

During assessment, it is observed that Refrigerators of wattages ranging from 700 to 800 W set point was 4^0 C and Deep Freezer of 700 W set point was -6^0 C. Hence, it is recommended to increase set temperature setting by 1^0 C as well as improve maintenance of refrigerator frequency.

It is known that, a 1°C raise in evaporator temperature can help to save almost 3% on power consumption (this also can be verified from BEE guideline: Chapter 4. HVAC and Refrigeration System).

The TR capacity of the same refrigeration will also increase with increase in the evaporator temperature, as given in table below:

Effect of variation in Evaporator Temperature on Compressor Power Consumption			
Evaporator Temperature (°C)	Refrigeration Capacity* (tons)	Specific Power Consumption	Increase in kW/ton (%)
5	67.58	0.81	-
0	56.07	0.94	16
-5	45.98	1.08	33
-10	37.2	1.25	54
-20	23.12	1.67	106

** Condenser temperature 40°C*

Energy Saving Calculations:

Sr No	Name of Equipment	Wattage	Qty	Present Set Temp deg C	Reccomended Set Temp deg C	Differnce of Temperature	Per Deg C Temperature Saving	Running Load (kW)	Avg. Running Hours/ Day	Avg. Operating Days/Year	Present Energy Consumption (kWh/Year	Percentage Saving (%)	Estimated Annual Energy Saving (kWh/Year)	Unit Rate (Rs./kWh)	Toatl Annual Saving (Rs.Lacs /Year)
1	Refrigerator (5*)	750	2	5	5	0	3	0.45	3	300	405.00	0	0.00	7.50	0.00
2	Refrigerator	700	1	4	5	1	3	0.42	3	300	378.00	3	1134.00	7.50	0.09
3	Refrigerator	700	1	4	5	1	3	0.42	3	300	378.00	3	1134.00	7.50	0.09
4	Deep Refrigerator	700	3	-6	-5	1	3	0.42	3	300	378.00	3	1134.00	7.50	0.09
5	Refrigerator	800	3	4	5	1	3	0.48	3	300	432.00	3	1296.00	7.50	0.10
	Total		**10**					**2.190**	**3**	**300**	**1971.00**		**4698.00**		**0.35**

ECM 5: Replacement of Existing Pumps with Energy Efficient Pumps

ECM No.	Energy efficiency improvement measures	Investment Rs. In Lakh	Estimated saving Electricity kWh	Carbon credit (Tons of CO2)	Estimated Savings Rs. In Lacs	Estimated Payback Years
5	Replacement of Existing Pumps with Energy Efficient Pumps	0.42	104.44	0.09	0.01	53.48

Observations:

During Energy Audit, it is observed that facility has 1 No of old Bore well pump and 1 No of old submersible Water pump to fulfil the water requirement

Recommendations:

We recommend to replace the existing pumps with energy efficient pumps to get the energy saving.

Load Calculations and Investment Details:

Location	Quantity	Type	HP	kW	csr	Cost	Working Hours/Day	Total Days/Year	Total Load
Water Pump	1	Submersible	1.5	1.12	12-2-51	21043	1	200	1.12
Water Pump	1	Submersible	1	0.75	12-3-6	16361	1	200	0.75
Total	**2**		**2.5**	**1.87**		**37404**	**2**	**400**	**1.87**

Energy Saving Calculations:

Particular	unit	value
Estimated Running load of old motors	Kw	1.87
Avg Operating hrs./day	Hrs	2.00
Avg Operating days/year	Days	400.00
Estimated saving	%	0.07
unit rate	Rs/Kwh	7.5
Estimated Existing Energy consumption kWh	Kwh/year	1492.00
Estimated Proposed Energy consumption Kwh	Kwh/year	1387.56
Annual saving	Kwh/year	104.44
Estimated savings	Rs in Lacs/year	0.01

ECM 6: Optimize the Power Factor

Sl. No.	Energy efficiency improvement measures	Investment Rs. In Lacs	Savings Rs. In Lacs	Payback Year
6	Optimize the Power Factor	0.00	0.00	#DIV/0!

Figure 16 Main Panel

Observations:

Facility is Maining average PF of 0.55

Calculation for KVAR Required based on Desired Unity PF:

Particular	Value	Unit
Total Annual Consumption	44480	kWh/Year
Unit Rate	7.5	Rs./kWh
Total Annual Energy Charges	333600	Rs./year
With Operation of all Capacitor banks, Annual Energy Saving	11676	Rs./year
Annual Energy Saving	0.11676	Rs (Lakhs)/year
Present Billed Power Facor	0.55	
Desired Billed Power Factor	1.00	
Multiplying Factor	1.519	
Total Connected Load	15	kW
Size of required Capacitor Bank	23	kVAR
Rate of Capaitor Bank with APFC	1500	Rs./KVAR
Total Investment	0.34	Rs (Lakhs)/year
Payback Period	0.24	Years

Recommendations:

To get the PF incentive/ get the savings in kWh, it is recommended to install APFC with 25 kVAR capacitor banks and check the operation of each capacitor bamk installed once in a month and maintain the PF to unity.

ECM 7: Replacement of old appliances with 5-star appliances

ECM No.	Energy efficiency improvement measures	Investment Rs. In Lacs	Estimated saving		Estimated Savings Rs. In Lacs	Estimated Payback Years
			Electricity	Carbon credit		
			kWh	(Tons of CO_2)		
6	Replacement of old appliances with 5-star appliances	2.11	2713.50	2.43	0.20	10.35

Figure 17 Water Cooler

Observations:

During energy audit it was observed that few appliances were old. Refigerator, air cooler and water cooler were old and consuming more energy.

Recommendations:

It is recommended to replace old refrigerator, air cooler and water cooler with energy efficient new appliance with 5-star rating. It will reduce 50% of present energy consumption.

Energy Saving Calculations:

Particular	Unit	value
Existing energy consumption of old appliances e.g. fridge, air cooler water cooler etc.	kWh/year	5427
Wattage of Energy Efficient appliances (considered 50% reduction)	Watt	2714
Energy consumption after replacing with Energy Efficient appliances	kWh/year	2714
Operating Hours per day	Hrs/day	3
Operating days per year	Days	300
Diversity factor	%	90%
Annual Saving	kWh/year	2714
Unit rate	Rs/kWh	7.5
Annual Saving	Rs. In Lacs	0.20
Investment	Rs. In Lacs	1.88
Investment with 12% GST	Rs. In Lacs	2.11

Details of Equipment

Particular	Units	Value	CSR No.
Quantity of Fridge	No	3	
Wattage of Fridge	KW	0.80	
Quantity of Air Cooler	No.	1	
Wattage of Air Cooler	KW	1.5	
Quantity of Water Cooler	No.	2	
Wattage of Water Cooler	kW	0.80	
Total Wattage	kW	6.7	
Rate of 5-Star Refrigerator	Rs.	25509	3-3-2.
Rate of 5-Star Water Cooler	Rs.	50086	3-3-5.
Rate of 5-Star Air Cooler	Rs.	11391	3-4-3.
Total Investment	**Rs. In Lakhs**	**1.88**	
Total Investment with 12% GST	**Rs. In Lakhs**	**2.11**	

ECM 8: Optimization of Neutral Current

ECM No.	Energy efficiency improvement measures	Investment Rs. In Lacs	Estimated Saving		Savings Rs. In Lacs	Payback Year
			Electricity kWh	Carbon credit (Tons of Co2)		
8	Optimization of Neutral Current	0.00	157.68	0.14	0.01	0.00

Figure 18 MSEDCL Meter Panel

Observations:

During study with power analyser it was observed that neutral currents were varying between 4 A to 12 A, average neutral current 8 A. This flow of current through neutral can be reduced by balancing loads through each phase at various power distribution centres. It has been assumed that significant reduction in losses can be achieved. However, a tentative estimation was done for balancing of loads and considered average 6 A neutral current can be saved.

Recommendations:

Hence it is recommended to balance three phase loads at MCC/PDB level which can reduce this neutral current up-to targeted level.

Following observations were made by considering neutral resistance as 0.5 ohms and calculations were done for energy savings:

Energy Saving Calculations:

Particular	Unit	Value
Average neutral resistance as assumed/discussed	Ohms	0.5
Estimated reduction of current in neutral	Amp	6
Operating Hours	hr/day	24
Operating Days	Days/annum	365
Average electrical energy tariff	Rs./kWh	7.5
Estimated annal energy saving	kWh/annum	157.68
Estimated annual saving	Rs. In Lacs	1,183
Estimated annual saving	**Rs. In Lacs**	**0.0118**
Estimated Investment Cost	**Rs. In Lacs**	**0.00**
Payback Period	**Years**	**0.00**

7. List of Instruments

POWER ANALYSER

Picture 1 ALM 20 Power Analyzer

ALM 20 Power Analyzer is designed for Measuring power network parameters

TECHNICAL SPECIFICATIONS

Number of channels	3U/3I
Voltage (TRMS AC + DC)	100V to 2000V ph-ph /50V to 1000V ph-N
Voltage ratio	Up to 650 kV
Current (TRMS AC + DC)	5mA to 10,000 Aac / 50 mA to 5,000 Adc (depending on Clamp)
Current ratio	Up to 25 kA
Frequency	42.5 - 69 Hz, 340 - 460Hz
Power values	W, VA, VAr, VAD, PF, DPF, cos ø, tanø
Energy values	Wh, VAh, VArh
Harmonics, THD	on V, U, I & In up to 50th order
Electrical safety	IEC 61010, 1000V CAT III / 600V CAT IV
Protection	IP54

DIGITAL CLAMP METER

Picture 2 MECO 3150 DIGITAL CLAMP METER

Power Clamp meter is a Portable Digital multi-functional measuring instrument. Designed for Measuring selected power network parameters, AC/DC Voltage, AC/DC current, Resistance, Continuity, Diode and Frequency.

TECHNICAL SPECIFICATIONS

DC VOLTAGE (Auto Ranging)	
Ranges	4V, 40V, 400V, 1000V
Overload Protection	1200V DC/800V AC
AC VOLTAGE (Auto Ranging) 40-500Hz	
Range	4V, 40V, 400V, 750V
Overload Protection	1200V DC/800V AC
RESISTANCE (Auto Ranging)	
Range	400Ω, 4KΩ, 40KΩ, 400KΩ, 4MΩ, 40MΩ
Test Current	0.7mA on 400Ω, 0.1mA on 4KΩ
Diode Test	
Measurement Current	1.0 ± 0.6 mA Approx
Open Circuit Voltage	0.4V Approx
Overload Protection	500V DC / AC
Frequency (Auto Ranging)	
Range	10.00Hz, 50.00Hz, 500.0Hz, 5.000kHz,
	50.00kHz, 500.0kHz
Sensitivity	3V
Overvoltage Protection	200V DC or AC peak

DIGITAL CLAMP METER

Picture 3 RISH POWER CLAMP 1000 A/400 A AC-DC

Power Clamp meter is a Portable Digital multi-functional measuring instrument. Designed for Measuring selected power network parameters, AC/DC Voltage, AC/DC current, Resistance, Continuity, Diode and Frequency.

TECHNICAL SPECIFICATIONS

Measuring function	Measuring range
kWh	9.999 kWh
	99.99 kWh
	999.9 kWh
	9999 kWh
Ahr	999.9 Ahr
Phase angle	0.0°….360.0°
Power Factor	-1…0…1
Harmonics (RMS & %)	1…13
	14…49
THD	0…99.9%
Crest Factor	1.0…2.9
	3.0…5.0
Power Clamp 1000A peak	1400 A/ 1400 V
Power Clamp 400A peak	100 A
	560 A/ 1000 V
Power Clamp 1000A INRUSH	999.9 A
Power Clamp 400A INRUSH	99.99 A
	400 A
Resistance	9999 Ohm
Continuity	Below 40 Ohm

THERMAL IMAGER

Picture 4 FLIR TG 167 Thermal imager

FLIR TG 167Thermal imager is designed to easily find unseen hot and cold spots in electrical cabinets or switch boxes, giving you quality image detail on even small connectors and wires.

TECHNICAL SPECIFICATIONS

Accuracy	±1.5% or 1.5°C (2.7°F)
Detector Type	Focal plane array (FPA), uncooled micro bolometer
IR Resolution	80 × 60 pixels
Laser	Dual diverging lasers indicate the temperature measurement area, activated by pulling the trigger
Memory Type	Micro SD card
Object Temperature Range	-25°C to 380°C (-13°F to 716°F)
Thermal Sensitivity/NETD	<150 mK
Display	2.0 in TFT LCD

INFRARED THERMOMETER

Picture 5 HTC IRX 64 Infrared thermometer

HTC IRX 64 infrared thermometer is useful instrument to measure the surface temperature. Infrared thermometers are ideal for taking temperatures need to be tested from a distance. They provide accurate temperatures without ever having to touch the object you're measuring (and even if your subject is in motion).

TECHNICAL SPECIFICATIONS

Specification	Range
IR	-50°C~1050 °C
Contact	-50°C~1370 °C
IR Temp. Resolution	0.1°C
Basic Accuracy	+/- 1.5% of reading
Emissivity	Adjustable 0.10 ~ 1.0
Optical resolution	30 : 1

LUX METER

Picture 6 Nishant NE 1010 Lux meter

Nishant NE 1010 Lux meter is used to measure the lux levels.

TECHNICAL SPECIFICATIONS

Measuring range	0 Lux ☐200, 000 Lux/0 Fc☐185, 806 Fc
Accuracy	± 3% rdg ± 0.5% f.s.(<10,000 Lux)
	± 4% rdg ± 10% f.s.(>10,000 Lux)
Digital Updates	2 times/s
Photometric sensor	Silicon diode
Battery life	18 hours (continuous operation)
Operating temperature and humidity	0°C ☐40°C, 10% RH ☐90% RH
Storage temperature and humidity	-20°C ☐50°C, 10% RH ☐90% RH
Power	9V battery
Unit Size	52.5 x 52.5 x 166 mm
Auto power off	After 5 minutes

8. ANNEXURE (SOLAR)

1) Introduction

The solar energy has a great potential as future source of energy. With its availability in large quantity almost in every corner of the country, solar power has the distinctive advantage of generating power at local and decentralized levels and being one of the prime factors for empowering people at grassroots level. The solar mission, which is part of the National Action Plan on Climate change has been set up to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar energy competitive with fossil-based energy options. The solar photovoltaic device systems for power generation had been deployed in the various parts in the country for electrification where the grid connectivity is either not feasible or not cost effective as also some times in conjunction with diesel based generating stations in isolated places, communication transmitters at remote locations. With the downward trend in the cost of solar energy and appreciation for the need for development of solar power, solar power projects have recently been implemented. A significant part of the large potential of solar energy in the country could be developed by promoting solar photovoltaic power systems of varying sizes as per the need and affordability coupled with ensuring adequate return on investment.

2) Benefits of Solar Energy

a. Power from the sun is clean, silent, limitless and free.

b. Photovoltaic process releases no CO2, SO2, or NO2 gases which are normally associated with burning finite fossil fuel reserves and don't contribute to global warming.

c. Photovoltaic are now a proven technology which is inherently safe as opposed to other fossil fuel based electricity generating technologies.

d. Solar power shall augment the needs of peak power needs.

e. provides a potential revenue source in a diverse energy portfolio

f. Assists in meeting renewable portfolio standards goals.

This proposal is prepared for design, engineering, procurement / manufacture and installation of solar power generating system. The grid-tie solar photovoltaic power generation system is mainly composed of PV array, String Inverter, and PV mounting structure.

It also consists of supporting devices like AC / DC switchgears, Lighting Arrestor, Earth Electrodes, AC / DC cables. As there is no any battery, it’s maintenance cost is negligible and initial investment per KW is very low.

3) Objective

- Provide reliable, clean, regulated, un-interrupted power on demand to the pre-identified critical loads
- System to provide low life cycle cost and maximize savings to the beneficiaries.
- To save diesel in institutions and other commercial establishments including industry facing huge power cuts especially during daytime.

4) Design Assumptions

General

a. The Solar Radiation Data's are based on standard books & simulation software as NASA and Metronome. The Mean Hourly Radiation Data is considered.

b. The module rating considered is tentative. The exact module sizing and rating will depend on the availability of cell grade and site suitability.

c. Solar Panels are roof/ground mounted in one location. Environmentally protected, closed, ventilated, inverter room at minimum distance from PV modules.

d. Application: Self consumption, captive grid or NET metering.

e. Emergency Backup: Generator or any other source in absence of Grid.

5) System Description:

Solar Power Plant comprises of the main equipment and components listed below:

1. Solar PV Modules
2. String Inverter with MPPT
3. Module mounting system
4. Monitoring system
5. Cables & connectors

Each of the sub systems has been described for the functionality and operation modes. The physical construction of the system follows a modular approach, which is field-tested and is regularly used for delivery of power systems.

5.1 Solar PV Module (Electrical Features)

The PV modules convert the light reaching them into DC power. The amount of power they produce is roughly proportional to the intensity and the angle of the light reaching them. They are therefore required to be positioned to take maximum advantage of available sunlight within sitting constraints.

5.2 Solar PV Module (Mechanical Features)

Solar Module design will conform to following Mechanical requirements:

- Toughened,
- low iron content,
- High transmissivity from glass.
- Anodized Aluminum Frame.
- Ethyl Vinyl Acetate (EVA) encapsulating.
- Tedlar/Polyester trilaminate back surface.
- ABS plastic terminal box for the module output termination with gasket to prevent water & moisture.
- Resistant to water, abrasion hail impact, humidity & other environment of actors for the worst situation at site.

5.3 Module Mounting Structure

The structure shall be designed to allow easy replacement of any module and shall be in line with site requirement. Structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. There shall be no requirement of welding or complex machinery at site. The array structure shall have tilt arrangement to adjust the plane of the solar array for optimum tilt.

5.4 Junction Box

The junction boxes shall be dust, vermin and waterproof and made of FRP/ABS Plastic with IP65 protection. The terminals shall be connected to copper bus bar arrangement of proper sizes. The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable marking shall be provided on the bus bar for easy identification and cable ferrules shall be fitted at the cable termination points for identification

5.5 String Inverter

The STRING INVERTER is A combination of Solar Charger (MPPT), Inverter and synchronization unit for two different AC supplies, all housed in a single unit. Maximum power point tracker (MPPT) shall be integrated into it to maximize energy drawn from the solar array. The Inverter converts the DC available from the array into an AC output. The output of the inverter is filtered to reduce the harmonics to an acceptable level (less than 5%). MPPT shall be microprocessor/micro controller based to minimize power losses and maximize energy utilization. The efficiency of MPPT shall not be less than 90% and shall be designed to meet the solar PV Array capacity.

5.6 AC /DC Cables

We use DC & AC cables of Lap, Apar, Polycab, Havels, Finolex or equivalent make to ensure minimum losses in transmission.

In order to complete the energy study that leads to the construction of a photovoltaic installation, hourly series of global horizontal irradiation values for a complete year are used, which resume the irradiation and other meteorological parameters behavior over a long term. We use PV. SYST. Software to workout optimum power production at site with minimum loses.

5.7 Grounding and Lighting Protection

- A protective earth (PE) connection ensures that all exposed conductive surfaces are at the same electrical potential as the surface of the Earth, to avoid the risk of electrical shock. It ensures that in the case of an insulation fault (a "short circuit"), a very high current flows, which will trigger an over current protection device as fuses and circuit breakers that disconnects the power supply.
- A functional earth connection serves a purpose other than providing protection against electrical shock. In contrast to a protective earth connection, a functional earth connection may carry a current during the normal operation of a device.
- Lightning protection is a very specialized form of grounding used in an attempt to divert the huge currents from lightning strikes. A ground conductor on a lightning arrester system is used to dissipate the strike into the earth.
- Lightning ground conductors must carry heavy currents for a short period of time. To limit inductance and the resulting voltage due to the fast pulse nature of lightning currents, lightning ground conductors may be wide flat strips of metal, usually run as directly as possible to electrodes in contact with the earth.
- In proposal, the entire system is fully provided with the required lighting and grounding protection.

6) Solar PV Locations

Area Considered for Solar Power Installation

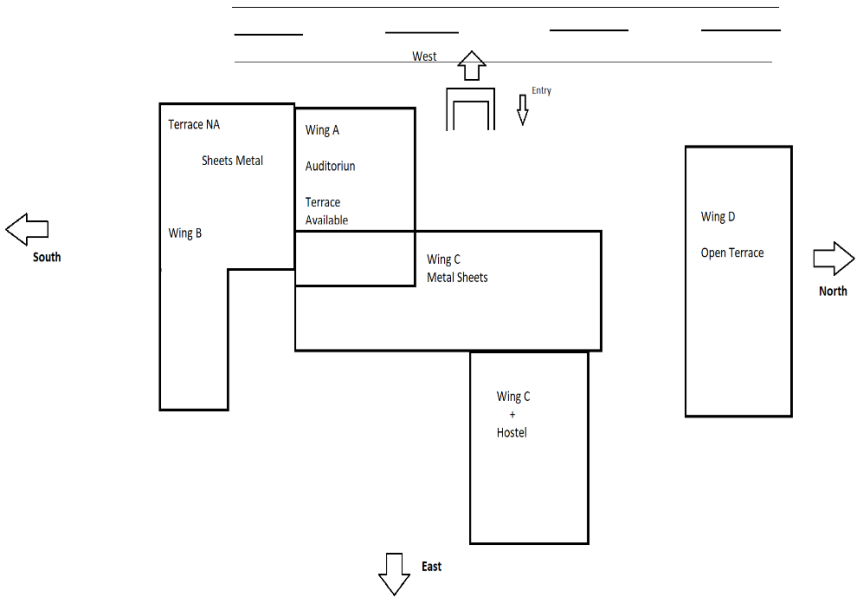

Figure 19 Solar Area

Details of Facility:

Total Unit Consumption / year of facility is 44480 kWh (Ref. 12 months Electricity Bills)

Sr. No.	Area	Length (ft.)	Width (ft.)	Area (Sq. ft.)	Plant Installed (kW)
1	Wing D	200	80	16000	200
2	Wing A	80	60	4800	60
3	Wing C	100	80	8000	100
Total				**28800**	**360**

Total Available Area = **28,800 Sq. Ft.** & As per available shadow free Area maximum **360 KW** Plant can be installed at facility as per details mentioned in above table.

7) Capacity Evaluation

Calculation for Required Solar Capacity plant to fulfill In-house Requirement

Calculation to Fulfill Building Total Load Requirement			
Sr. No.	**Details**	**Value**	**Unit**
1	Total electrical consumption per year	44480	KWh
2	Units generated per day per KWp	4.5	KWh/KWp/day
3	Units generated per Year per KWp (330 days / Year)	1485	KWh/KWp/Year
4	Solar KW capacity For 44480 KWh consumption / year	30	KWp

As per electrical consumption (Building Load), capacity of Solar Power Plant required is 30 KWp. As per shadow free space available on college building maximum 360 KWp plant can be installed which is more than the actual requirement of full Electrical Load. As per MSEDCL bill total Sanctioned load is 2 kW + 12 kW = 14 kW.

It is suggested to install Solar Plant of Capacity 30 KWp, by increasing sanctioned load of 12 kW to 30 kW, which can be installed & it covers all required load.

The SPV power plant with proposed capacity of 30 KWp would be connected to the main electrical distribution panel. The system would meet full load requirement of the connected load during the day. Advance control mechanism in the Power Conditioning Unit will ensure that the maximum power generated by PV modules will be utilized first and the balance requirement of power will be met by either grid or DG set

The 30 KWp SPV Power Plant is estimated to afford annual energy feed of 44480 KWh/year (After considering all losses) considering efficiency of the solar module as 15.16%, Power Conditioning Unit (PCU) efficiency as 98.3% and losses in the DC and AC system as 3%.

8) Budgetary Estimation of the Project

Details	Value	Unit
Shadow free space required for approx. 1 KWp Solar Plant	80	Sq.Ft
Shadow free space available at Facility		Sq.Ft.
Solar Plant capacity to be Installed at Facility	0.00	KWp
Solar Plant Requirement as per actual consumption	30	KWp
Installation Cost Per KW for 1 KWp Solar Plant	0.57	Rs. In Lakh
Gross Estimated System cost (For 30 KWp Grid Connected Solar Plant)	17	Rs. In Lakh
Unit generated per day per kWp	4.5	KWh
Electricity generation per day for 30 KWp Grid Connected Solar Plant	135	KWh/day
Electricity generation per year for 30 KWp Grid Connected Solar Plant (330 days/year)	44480	KWh/year
Average Electricity Unit Cost	7.5	Rs./KWh
Electricity cost saved per year	3.34	Rs. In Lakh
Simple Payback Period	5.12	Years

For PPS Energy Solutions Pvt. Ltd.

Dr. Ravi G. Deshmukh
Energy Auditor Class - A
MEDA/ECN/2021-22/EA-01