DETAILED ENERGY AUDIT REPORT

ASHOKA CENTER FOR BUSINESS AND COMPUTER STUDIES

CHANDSHI NASHIK

November - 2021

Conducted By

PPS Energy Solutions Pvt. Ltd.

Engineering Consultants

Plot No-18, Girish Housing Society

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Energy Auditor Class - A

MEDA/ECNCR-05/2018-19/EA-05

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 Ashoka Center For Business And Computer Studies, Chandshi, Nashik 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 Ashoka Center For Business And Computer Studies, Chandshi, Nashik for entrusting PPS Energy Solutions Pvt. Ltd.

For PPS Energy Solutions Pvt. Ltd.

Dr.Ravi G. Deshmukh
Energy Auditor Class - A
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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
Mrs. Prajakta Joshi	Data tabulation and analysis, report preparation	Graduate Electrical Engineer with 3 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. 3,41,172**/- per Annum
2. Average monthly units consumed are **1173 kWh** equivalent to **Rs. 28,431**/-
3. Average electricity charges works out to be **Rs. 29**/-

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	AC	Optimize the temperature setting to 23-25 degree celsius	0.00	141.12	0.13	0.04	0.00
2	Tube Lights	Replacement of conventional lights with suitable LEDs	1.50	1947.60	1.66	0.56	2.65
3	Fans	Replacement of existing fans with energy efficient Super fans	2.75	3237.71	2.75	0.94	2.93
Total			**4.25**	**5326.43**	**4.53**	**1.54**	**2.75**

Note: Estimated savings may base on operating conditions

During the Energy Audit, Total Estimated Investment of Rs 4.25 Lacs/- yields Total Estimated Savings of Rs. 1.54 lacs/- with an overall payback period of 2.75 Year.

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 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	-4	0	0	-4
1	0	2	2	-3
2	0	2	3	-1
3	0	2	5	0
4	0	2	6	2
5	0	2	8	3
6	0	2	9	5
7	0	2	11	7
8	0	2	12	8
9	0	2	14	10
10	0	2	15	11
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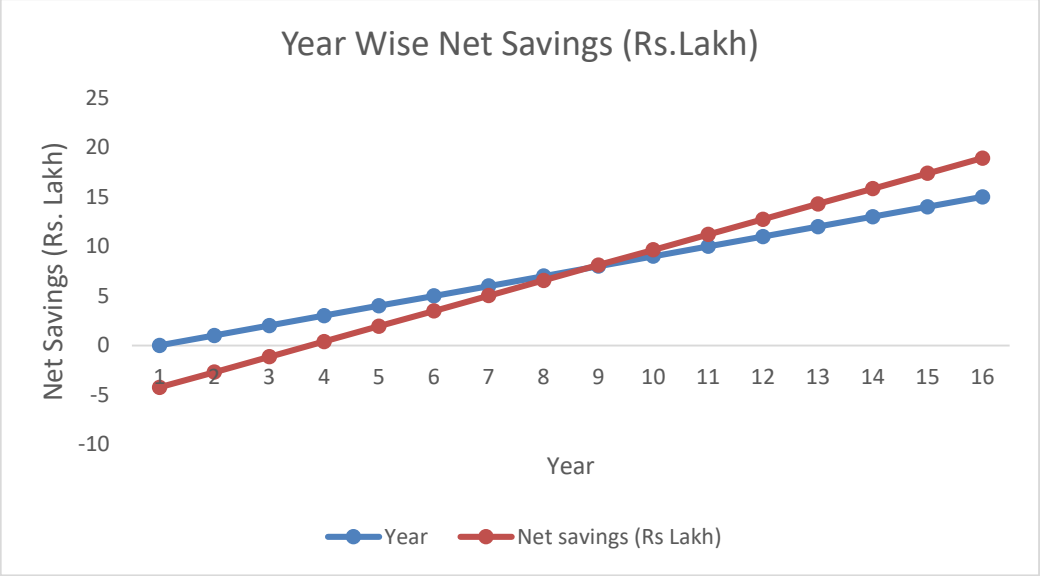
12	0	2	19	14
13	0	2	20	16
14	0	2	22	17
15	0	2	23	19



Net Savings (Rs.Lakh Vs Year)

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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 are energy inefficient.
3. Most of the places the tube light installed are energy inefficient.
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 Single meter according to 89 LT-VII B I Tariff. There is DG Set of 125 KW for emergency purpose and 2 UPS of 30 KW.

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) Air Conditioning

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

Table 1 Name of Area

Sr. No.	Name of the Area
1	1st Floor
2	2nd Floor

4.1. Electricity Bill Analysis

Consumer Details of Meter No. 055-XG454582

Consumer Details

Table 2 Consumer Details

Parameter	Details
Consumer No.	49420004272
Consumer Name	The Chief Promoter Ashoka education Foun
Address	Chandshi Sr. no. 62/162/263 Chandshi Nashik
Pin Code	422101
Sanction load (KW)	80
Tariff	89 LT-VII B I

Consumption Details

Table 3 Billing Data

Month	KWH	KVAH	RKVAH (Lag)	Recorded MD	Billed MD	Demand Rate(Rs/KVA)	Billed PF	Unit rate (Rs/kWh)	Demand Charges (Rs)	Energy Charges (Rs)	PF Penal/Incentive (Rs)	Total Current Bill (Rs)
Nov-20	610	3213	1738	17	32	362	0.830	12.95	11584	4782	717	22512
Dec-20	1302	3418	1864	17	32	362	0.830	15.76	11584	10208	933	29385
Jan-21	1581	3446	1929	15	32	362	0.820	16.71	11584	12395	1145	32230
Feb-21	633	3309	1863	11	32	362	0.820	12.30	11584	4963	817	22906
Mar-21	571	3066	1722	25	32	362	0.820	12.83	11584	4477	788	22086
Apr-21	639	3093	1740	26	32	373	0.820	13.27	11936	4786	824	23090
May-21	657	3282	1898	24	32	373	0.810	12.33	11936	4921	924	23411
Jun-21	571	3445	1952	25	32	373	0.810	11.46	11936	4277	881	22371
Jul-21	924	4026	2258	27	32	373	0.820	11.72	11936	6921	943	26467
Aug-21	2887	4684	2646	26	32	373	0.820	17.94	11936	21624	1683	47461
Sep-21	2373	3842	1939	21	32	373	0.860	20.66	11936	17774	802	40053
Oct-21	1325	3436	1797	5	32	373	0.840	16.25	11936	9924	814	29199
Avg	**1173**	**3522**	**1946**	**20**	**32**	**368**	**0.825**	**14.51**	**11789**	**8921**	**939**	**28431**
Max	**2887**	**4684**	**2646**	**27**	**32**	**373**	**0.860**	**20.66**	**11936**	**21624**	**1683**	**47461**
Min	**571**	**3066**	**1722**	**5**	**32**	**362**	**0.810**	**11.46**	**11584**	**4277**	**717**	**22086**
Sum	**14073**	**42260**	**23346**						**141472**	**107051**	**11273**	**341172**

Month	"A" Zone Units	"A" Zone Demand	"B" Zone Units	"B" Zone Demand	"C" Zone Units	"C" Zone Demand	"D" Zone Units	"D" Zone Demand
Nov-20	0	6	0	17	0	12	610	13
Dec-20	689	6	0	17	0	16	613	8
Jan-21	983	6	0	15	0	13	598	6
Feb-21	0	0	0	11	0	0	633	0
Mar-21	0	13	0	25	0	16	571	13
Apr-21	0	13	0	26	0	13	639	13
May-21	0	9	0	24	0	9	657	15
Jun-21	0	9	0	25	0	23	571	13
Jul-21	0	11	105	27	253	24	566	11
Aug-21	786	8	1038	22	435	26	628	9
Sep-21	1145	8	418	21	242	18	568	11
Oct-21	725	0	0	5	0	0	600	0
Avg	**361**	**7**	**130**	**20**	**78**	**14**	**605**	**9**
Max	**1145**	**13**	**1038**	**27**	**435**	**26**	**657**	**15**
Min	**0**	**0**	**0**	**5**	**0**	**0**	**566**	**0**
Sum	**4328**		**1561**		**930**		**7254**	

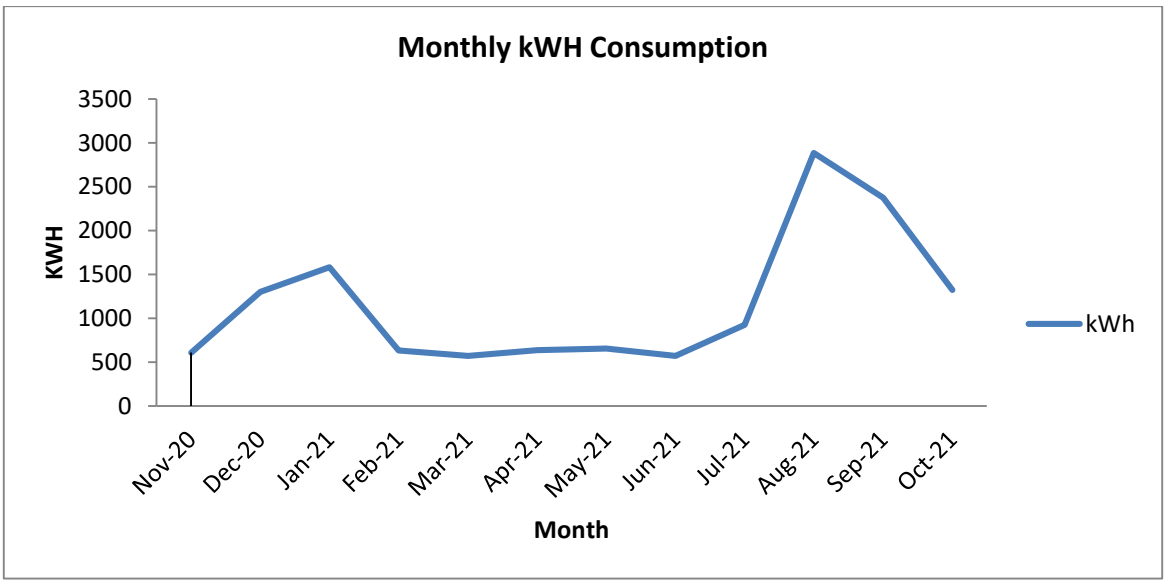

Figure 1 Monthly kWh Consumption

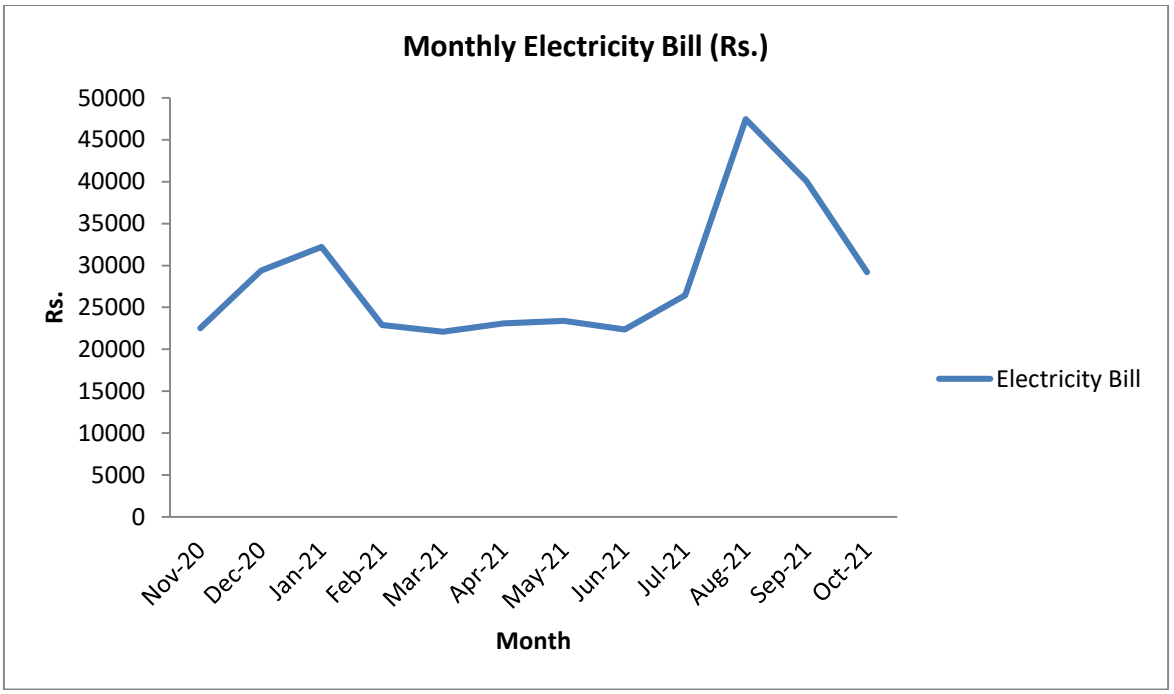

Figure 2 Monthly Electricity Bill

Comments:

1. Average monthly units consumed is 1173 kWh equivalent to Rs. 28,431/-
2. Average electricity charges works out to be Rs. 29/-

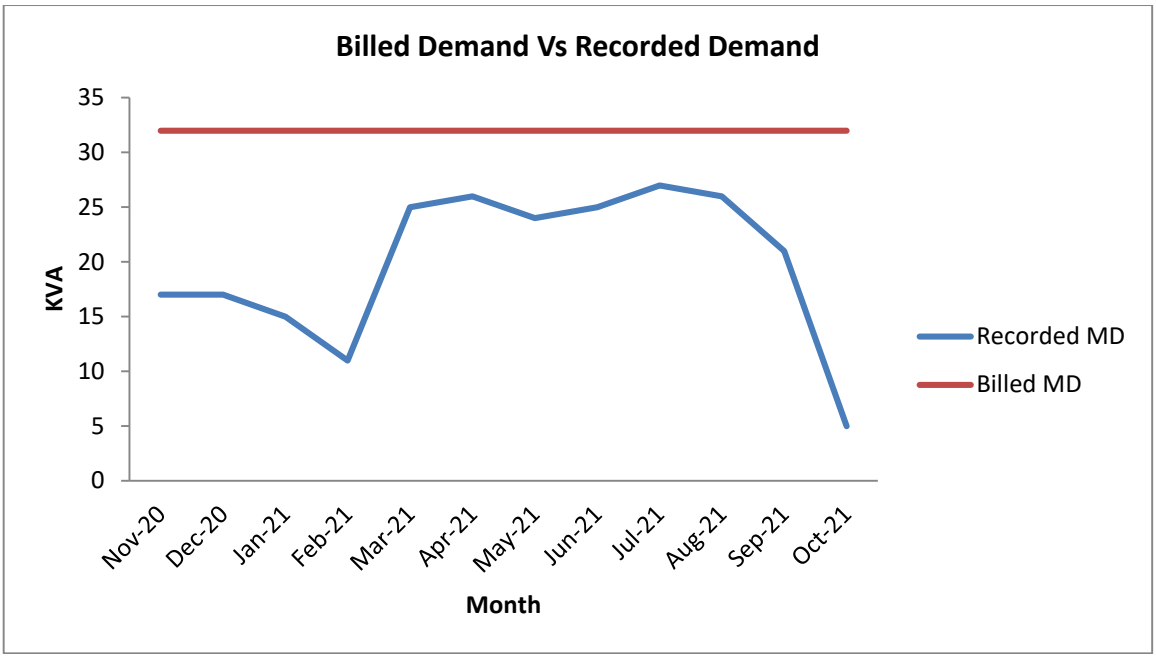

Figure 3 Billed Demand vs Recorded Demand

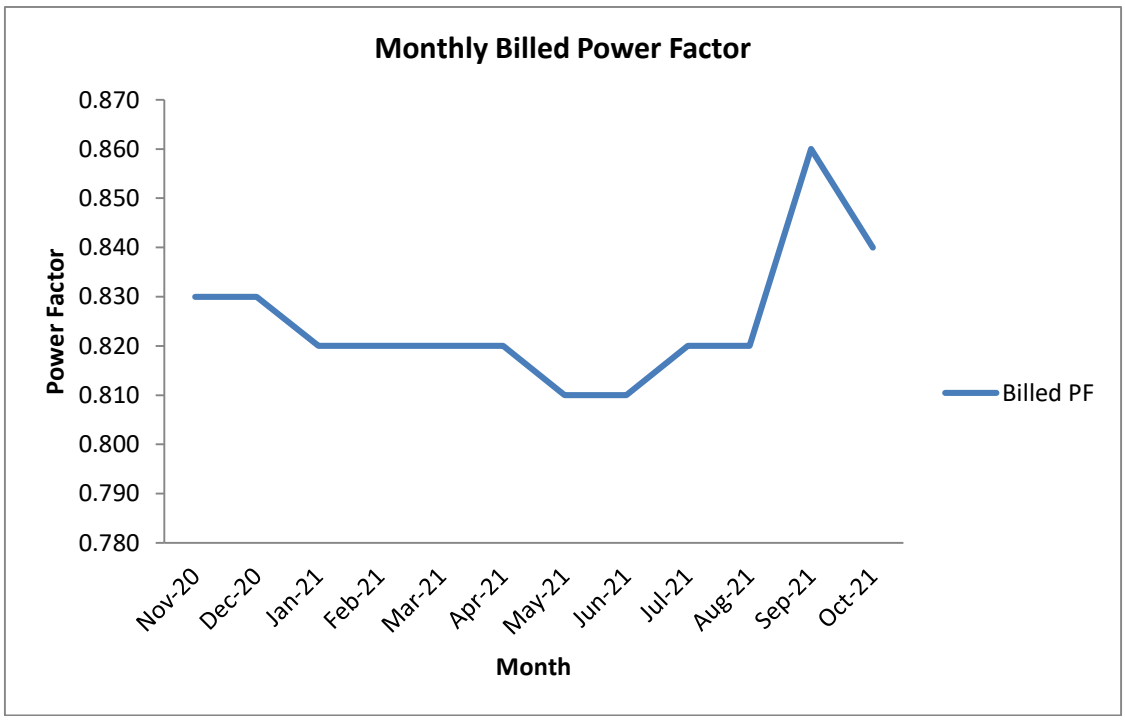

Figure 4 Billed PF

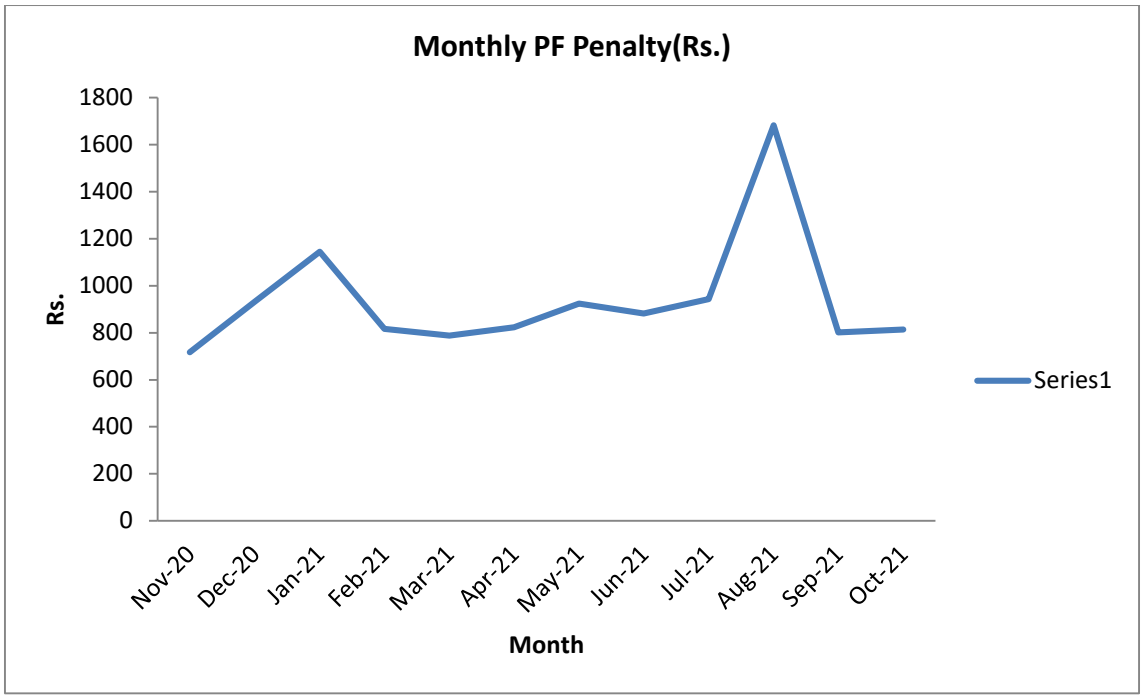

Figure 5 PF Penalty

4.2. Connected Load Quantity of Buildings

Table 4 Connected Load of Facility

Fixtures	Wattage	GROUND FLOOR	1ST FLOOR	2ND FLOOR	3RD FLOOR	TOTAL QTY	TOTAL kW
Ceiling Fan	75	66	97	90	30	283	21.23
Wall Fan	55	0	1	1	1	3	0.17
Pedestral Fan	55	2	1	1	1	5	0.28
Exhaust Fan	40	16	16	16	16	64	2.56
Tube Light	28	80	15	28	12	135	3.78
Tube Light	36	45	72	80	0	197	7.09
LED Light	18	0	3	12	0	15	0.27
CFL	11	32	32	30	32	126	1.39
CFL	36	0	0	0	102	102	3.67
Refrigerator	750	2	0	0	0	2	1.50
Water Cooler	500	1	1	1	2	5	2.50
Computer	250	0	217	0	0	217	54.25
Printer	220	3	6	4	1	14	3.08
Projector	150	0	38	0	0	38	5.70
Xerox	500	0	1	1	0	2	1.00
Air Conditioner (CS) (1.5 Ton) (2*)	1950	1	1	0	0	2	3.90
Duct AC	3000	0	2	0	0	2	6.00
Duct AC	1500	0	1	0	0	1	1.50
Water Pump(Submercible)	3730	1	0	0	0	1	3.73
TOTAL	**9174**	**249**	**504**	**264**	**197**	**1214**	**124**

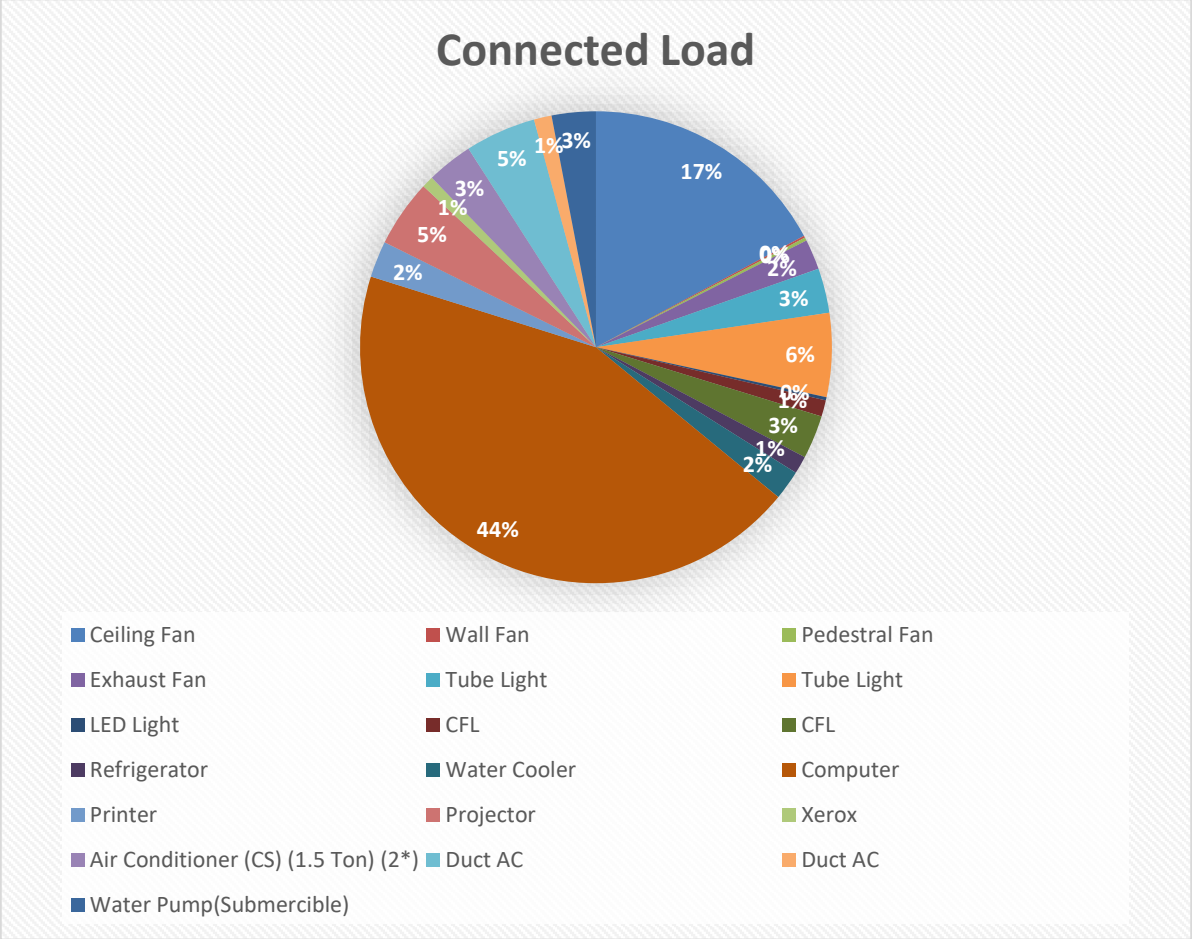

Figure 6 Distribution of Connected Load

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 graphs shows the loading pattern, Voltage, Current PF variation.

Parameter		R-Phase	Y-Phase	B-Phase	Total/Neutral
Voltage (V)	Avg	409.19	415.49	408.08	
	Max	416.30	421.20	414.40	
	Min	375.70	379.90	373.70	
Current (A)	Avg	24.73	22.74	19.99	7.41
	Max	39.87	43.40	43.86	13.28
	Min	17.43	16.19	15.96	3.50
Active Power (W)	Avg	2842.62	2467.63	1177.31	6487.56
	Max	4342.00	4761.00	3368.00	12299.00
	Min	-6717.00	-8089.00	-8546.00	-23352.00
Power Factor	Avg	0.49	0.46	0.27	0.42
	Max	0.71	0.79	0.68	0.72
	Min	-0.74	-0.81	-0.85	-0.80
V % THD	Avg	4.93	4.64	4.70	
	Max	6.07	5.67	5.70	
	Min	4.27	3.96	4.10	
I % THD	Avg	78.01	91.95	113.62	58.54
	Max	137.97	190.19	198.49	139.95
	Min	45.68	39.14	38.12	29.63

Comments:

1) Average, Maximum and Minimum variations for all the Phases is not within the limit of +/- 6% i.e.,373 V to 421 V
2) The voltage unbalance between the Phases is Present.
3) The current unbalance between the Phases is Present.
4) Total Harmonic Distortion for voltage is more than 5% whereas Total Harmonic Distortion for Current is more than 15%.

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

Voltage Variation:

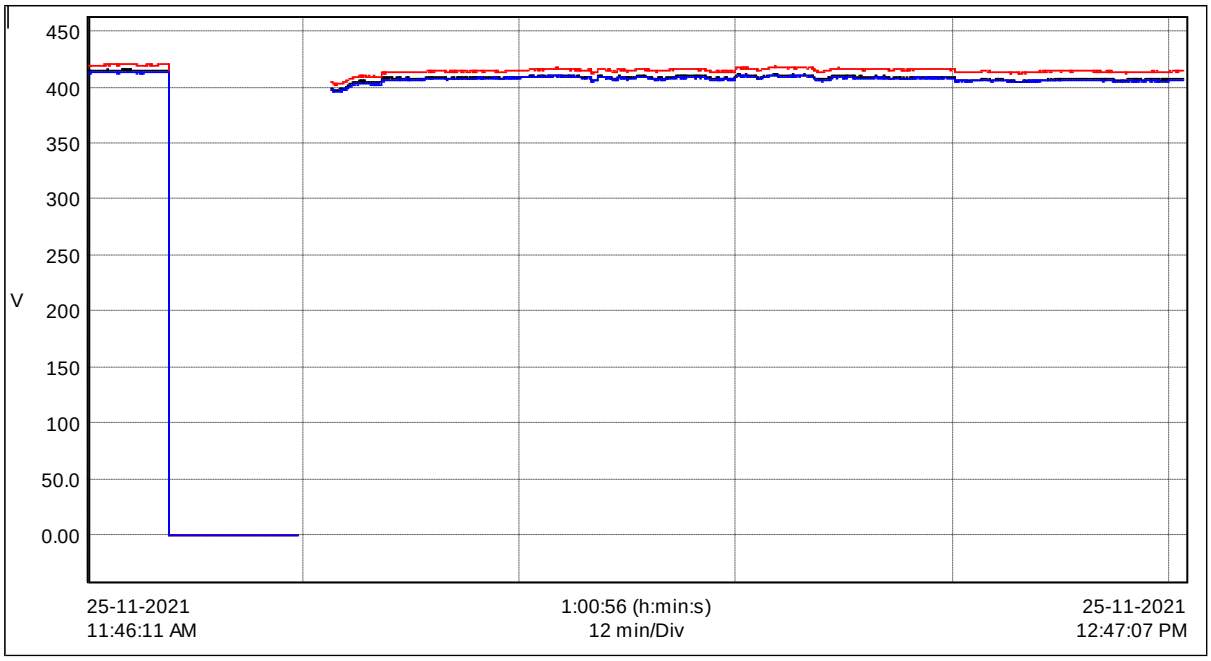

Figure 6 Voltage vs Time Period

Current Variation:

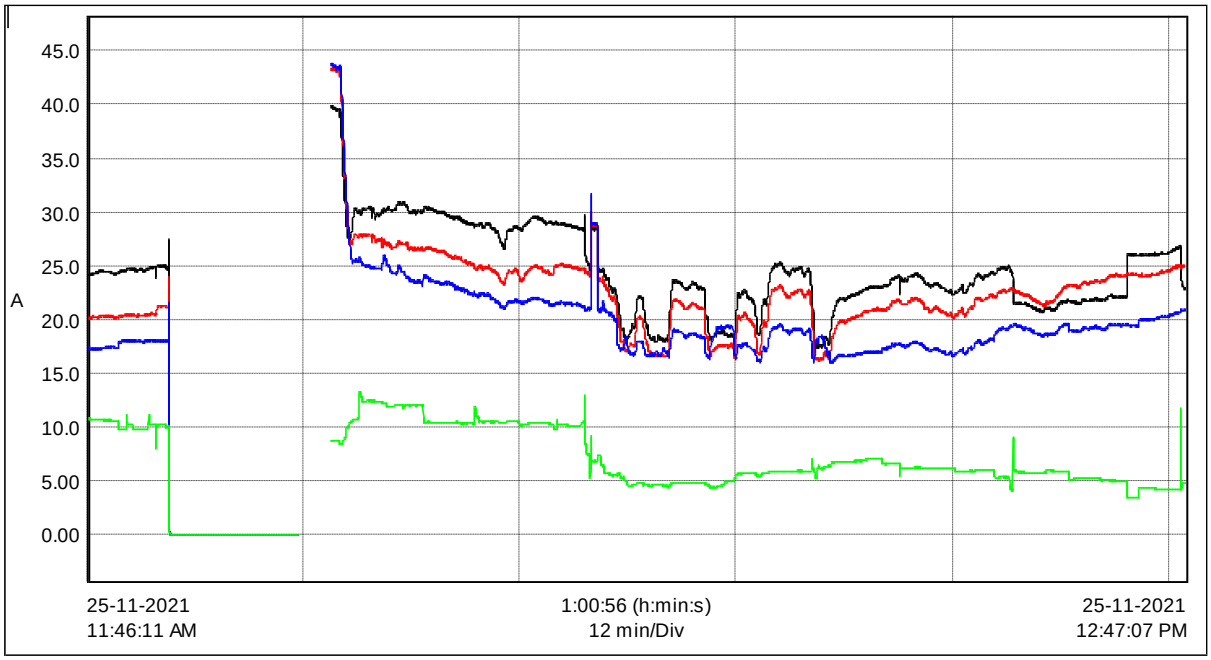

Figure 7 Current vs Time Period

Power Variation:

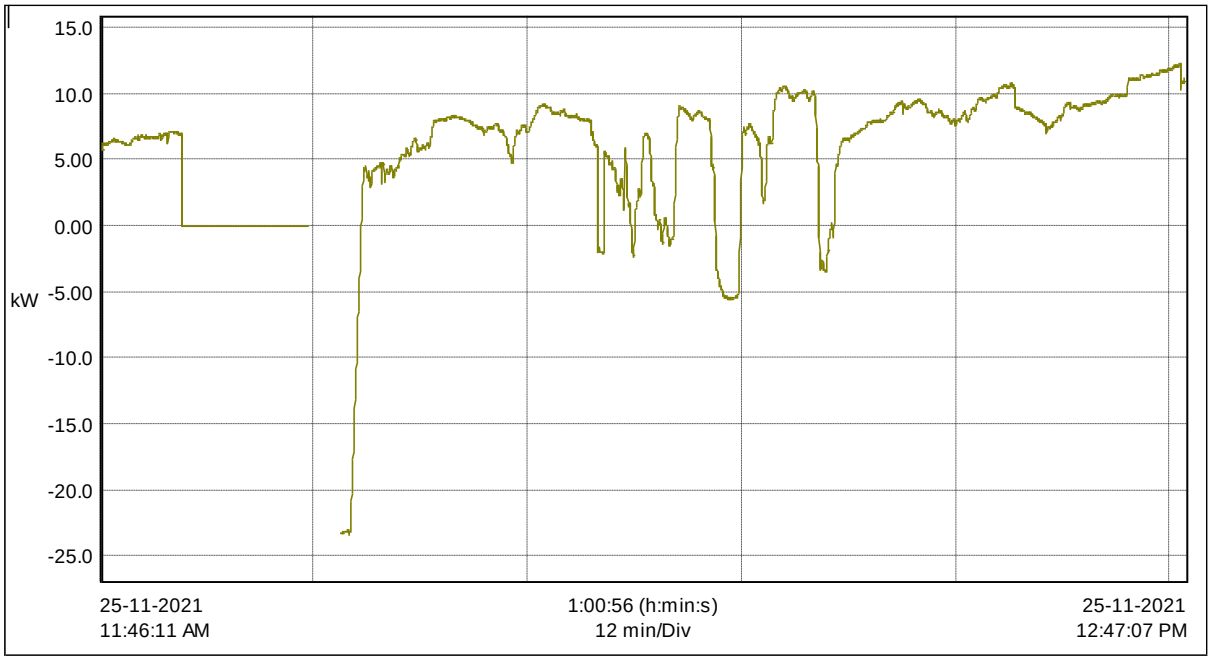

Figure 8 Power vs Time Period

Power Factor Variation:

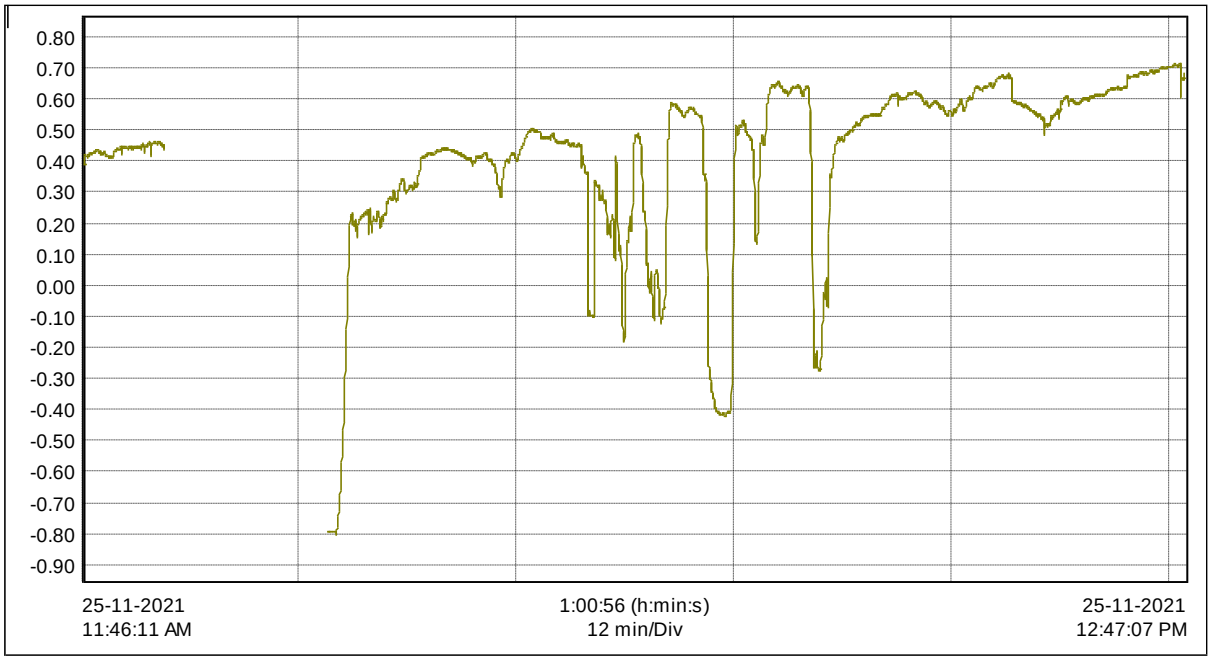

Figure 9 Power Factor vs Time Period

Voltage Total Harmonic Distortion Variation:

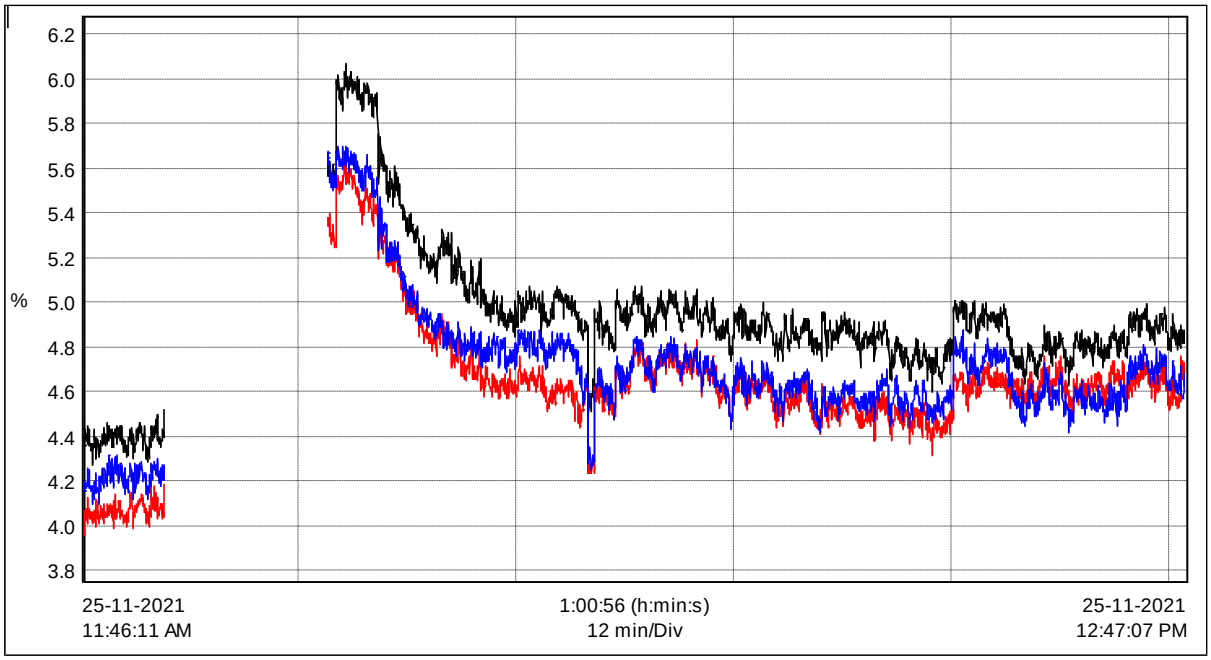

Figure 10 Voltage THD % vs Time Period

CurrentTotal Harmonic Distortion Variation:

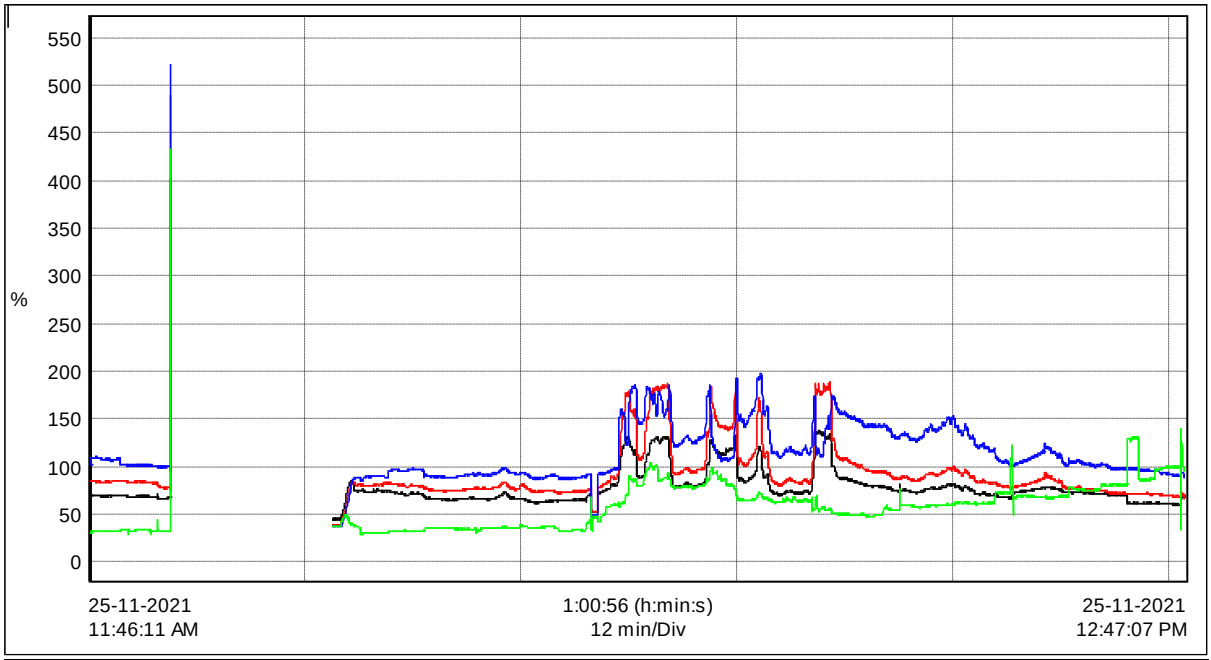

Figure 11 Current THD % vs Time Period

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 suitable LEDs	1.50	1947.60	1.66	0.56	2.65

Observations:

Facility has installed Tube lights of 28 watt and 36 watt, CFL of 36 watt and 11 watt in their premises

Recommendations:

During energy audit, it is observed that facility has installed Tube lights of 28 watt and 36 watt, CFL of 36 watt and 11 watt 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 2 hours. LED tube of 18 watt and 20 watt, LED lamp of 7 watt and 18 watt 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 lamps	KW	7.48
Power consumption of suitable LED light	KW	4.23
Average power saving after replacement with LED light	KW	3.25
Replacement of conventional lights (TL,CFL) of 28,36,11 W with suitable LEDs	Nos	234
Average working hour per day	Hrs	2
No. of working days in a year	Days	300
Cost Benefit Calculation		
Annual Energy Saving potential	kWh	1948
Electricity tariff	Rs/unit	29
Annual Cost Saving	Rs. Lakh	0.56
Total investment cost	Rs. Lakh	1.50
Annual Saving	Rs. Lakh	0.56
Simple Payback Period	Years	2.65

Type of Exisitng Fitting	Wattage	Qty	Proposed LED W	Price - Rs/Unit	Dismanteling Cost	Total Cost	Existing KW	Proposed KW	Saved kW	Investment Rs Lakh
Tube Light	28	68	18	570	13	39644	1.90	1.22	0.68	0.40
Tube Light	36	99	20	878	13	88209	3.56	1.98	1.58	0.88
CFL	11	16	7	134	13	2352	0.18	0.11	0.06	0.02
CFL	36	51	18	369	13	19482	1.84	0.92	0.92	0.19
TOTAL	**111**	**234**	**63**	**1951**	**52**	**149687**	**7.48**	**4.23**	**3.25**	**1.50**

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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 kWh	Carbon credit (Tons of CO_2)		
2	Replacement of existing fans with energy efficient Super fans	2.75	3237.71	2.75	0.94	2.93

Observations:

During energy audit, it is observed that facility has old 75 watts 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 75 watts 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	4633
Wattage of Energy Efficient Super Fan	Watt	35
Energy consumption after replacing with Energy Efficient Super Fan	kWh/year	7
Operating hrs/day	Hrs/day	2
No. of working days in a year	Days	290
Diversity factor	%	70%
Annual Saving	kWh/year	3238
Unit rate	Rs/kWh	29
Annual Saving	Rs. In Lacs	0.94

Fan category	Nos	Estimated Running kW
Ceiling Fan 75 W	142	10.65
Total	**142**	**10.65**

ECM 3.: Optimization of Set Temperature of ACs

Sr. No.	Energy efficiency improvement measures	Investment Rs. In Lacs	Estimated Saving		Savings Rs. In Lacs	Payback Year
			Electricity kWh	Carbon credit (Tons of Co2)		
3	Optimize the temperature setting to 23-25 degree celsius	0.00	141.12	0.13	0.04	0.00

Observations:

Facility has installed split AC (2*), Cassette AC, Duct AC in their premises

Recommendations:

During assessment, it is observed that Type of AC, Qty and Ton of ACs set point was 21^0 C. Hence, it is recommended to increase set temperature setting to 21^0 C as well as improve maintenance of AC 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 (℃)	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	4704
Estimated Saving	%	3%
Operating Hrs per day	hrs/day	2
Operating days per year	Days/year	300
Estimated Saving	kWh/year	141
Unit Rate	Rs/kWh	29
Annual Saving	Rs Lakh/year	0.0409

Sr No	Type	Ton	Qty	Annual Consumption
1	Air Conditioner (split) (1.5 Ton) (2*)	1.5	2	588
2	Duct AC	2	2	784
3	Duct AC	1	1	196
Total				**1568**

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℃~1050 ℃
Contact	-50℃~1370 ℃
IR Temp. Resolution	0.1℃
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

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Energy Auditor Class - A
MEDA/ECNCR-05/2018-19/EA-05