DETAILED ENERGY AUDIT REPORT

Ashoka Education Foundation

Ashoka Universal school
P. No. 4, No. 8/1/13, Ashoka Marg,
Kalptaru Nagar, Vadala, Nashik – 422011.

January, 2022

Conducted By

PPS Energy Solutions Pvt. Ltd.

Plot No-18, Girish Housing Society
Warje, Pune – 411058, Maharashtra, India

PPS ENERGY SOLUTIONS PVT. LTD. PPS

Dr. Ravi G. Deshmukh
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 Education Foundation, Vadala, 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 Education Foundation, Vadala, Nashik for entrusting PPS Energy Solutions Pvt. Ltd.

For PPS Energy Solutions Pvt. Ltd.

CONTENTS

List of Figure

List of Table

List of Picture

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. 834428**/- per Annum
2. Average monthly industrial units consumed are **2011 kVAh** equivalent to **Rs. 18662.08**/-
3. Average electricity charges work out to be **Rs. 9.28**/-

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:

ECM No.	Equipment Name	ECM Details	Investment (Rs. in Lakh)	Savings (kWh/year)	Carbon credit (Tons of Co2)	Saving (Rs.in Lakh /Year)	Payback (Years)
1	Tube Lights	Replacement of conventional lights with suitable LEDs	0.63	2138.40	1.82	0.20	3.18
2	Fans	Replacement of existing fans with energy efficient fans	5.81	907.20	0.77	0.08	69.02
3	AC	Replacement of three-star ACs with 5 star ACs.	2.88	528.39	0.47	0.05	58.76

ECM No.	Equipment Name	ECM Details	Investment (Rs. in Lakh)	Savings (kWh/year)	Carbon credit (Tons of Co2)	Saving (Rs.in Lakh /Year)	Payback (Years)
4	AC	Optimize the temperature setting to 23-25 degree Celsius	0.00	278.96	0.25	0.03	0.00
5	APFC	Optimize the Power Factor	0.44	0.00	0.00	0.07	0.49
Total			**9.76**	**3852.95**	**3.31**	**0.43**	**22.59**

Note: Estimated savings may base on operating conditions

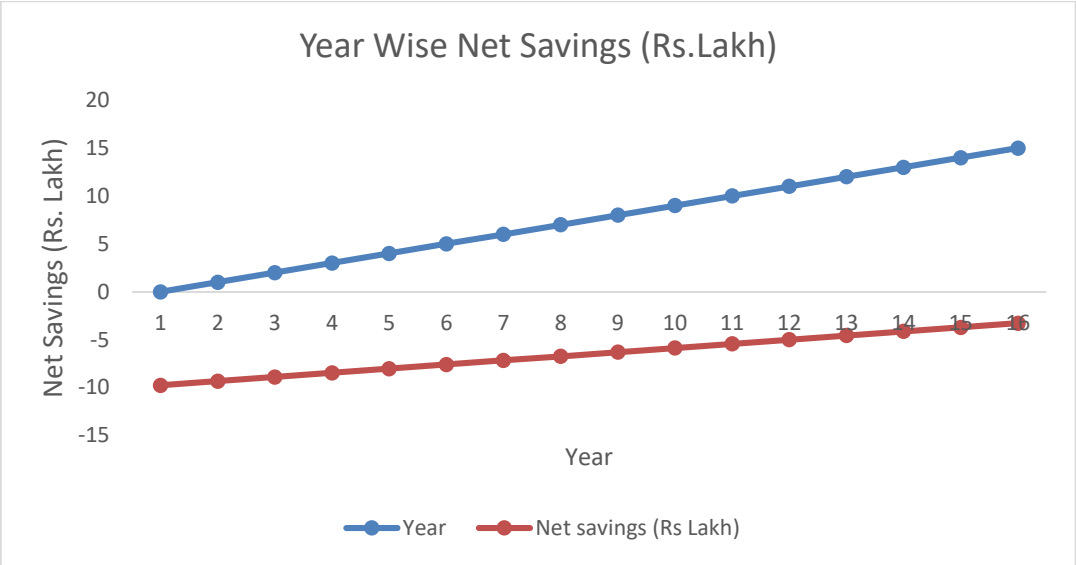
During the Energy Audit, total estimated investment of Rs 9,76,000/- yields total estimated savings of Rs. 43,000/- which 5 % of the total energy cost of Rs. 834428/- with an overall payback period of 22.59 years.

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 Lakh)	Saving (Rs.in Lakh /Year)	Cum Savings (Rs Lakh)	Net savings (Rs Lakh)
0	-10	0	0	-10
1	0	0	0	-9
2	0	0	1	-9
3	0	0	1	-8
4	0	0	2	-8
5	0	0	2	-8
6	0	0	3	-7
7	0	0	3	-7
8	0	0	3	-6
9	0	0	4	-6
10	0	0	4	-5
11	0	0	5	-5

12	0	0	5	-5
13	0	0	6	-4
14	0	0	6	-4
15	0	0	6	-3



Net Savings (Rs. Lakh Vs Year)

Dr. Ravi G. Deshmukh
Energy Auditor Class - A
MEDA/ECNCR-05/2018-19/EA-05

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 efficient.
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.

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 055-XD448282 meter according to146 HT-VIII 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) Air conditioner
2) Ceiling fans
3) Pumps & different motor
4) Lighting Load

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	Air conditioner
2	Ceiling fans

4.1. Electricity Bill Analysis

Consumer Details of Meter No. 049019021050

Consumer Details

Table 2 Consumer Details

Parameter	Details
Consumer No.	**049019021050**
Consumer Name	M/s Ashoka Education Foundation
Address	P. No. 4, No.8/1/13, Ashoka Marg, Kalptaru Nahar, Vadala, Nashik
Pin Code	422011
Connected load (KW)	400
60% of con. Demand (KVA)	84.0
Sanctioned Load (KW)	400
Sanct. Demand (KVA)	140
Tariff	146 HT-VIII B
Bu/ Circle No	595

Consumption Details

Table 3 Billing Data

Month	KWH	KVAH	RKVAH (Lag)	RKVAH (Lead)	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)
Jan-21	1613	1911	1680	538	1737	64	411	0.960	9.48	31647	15926.40	0	61265.71
Feb-21	1621	1911	1669	1208	402	73	411	0.971	9.48	31647	15822.12	0	61118.82
Mar-21	1646	1911	1690	1512	47	64	411	0.974	9.48	31647	16021.20	0	61406.91
Apr-21	1615	1911	1663	1451	26	40	432	0.971	9.21	36288	15316.23	0	66088.92
May-21	1719	1911	1758	1253	56	33	432	0.978	9.21	36288	16191.18	0	67358.23
Jun-21	1540	1911	1581	1559	51	47	432	0.974	9.21	36288	14561.01	0	68196.79
Jul-21	1604	1911	1649	2135	51	66	432	0.973	9.21	36288	15187.29	0	65902.68
Aug-21	2324	1911	2396	2271	89	66	432	0.970	9.21	36288	22067.16	0	75095.52
Sep-21	3296	1911	3448	2102	926	66	432	0.956	9.21	36288	31756.08	0	88352.75
Oct-21	2097	1911	2602	1191	5312	61	432	0.806	9.21	36288	23964.42	0	78531.08
Nov-21	1948	1911	2031	1877	446	64	432	0.959	9.21	36288	18705.51	0	70992.51
Dec-21	1914	1911	1965	1788	232	65	432	0.974	9.21	36288	18097.50	0	70117.97
Avg	**1911**		**2011**	**1574**	**781**	**59**	**427**	**0.956**	9.48	**35128**	**18635**	**0**	**69536**
Max	**3296**		**3448**	**2271**	**5312**	**73**	**432**	**0.978**	9.48	**36288**	**31756**	**0**	**88353**
Min	**1540**		**1581**	**538**	**26**	**33**	**411**	**0.806**	9.48	**31647**	**14561**	**0**	**61119**
Sum	**22937**		**24132**	**18885**	**9375**					**421533**	**223616**	**0**	**834428**

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
Jan-21	0	20	0	65	0	58	1680	24
Feb-21	0	26	0	74	0	47	1669	28
Mar-21	0	19	0	64	0	28	1690	25
Apr-21	0	22	0	40	0	20	1663	24
May-21	0	32	0	33	0	24	1758	32
Jun-21	0	34	0	47	0	37	1581	27
Jul-21	0	29	0	66	0	56	1649	30
Aug-21	0	30	524	66	198	55	1674	30

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
Sep-21	0	32	988	67	599	60	1860	33
Oct-21	0	33	0	61	0	53	2602	34
Nov-21	0	25	0	64	0	45	2031	30
Dec-21	0	23	0	65	0	57	1965	32
Avg	**0**	**27**	**126**	**59**	**66**	**45**	**1819**	**29**
Max	**0**	**34**	**988**	**74**	**599**	**60**	**2602**	**34**
Min	**0**	**19**	**0**	**33**	**0**	**20**	**1581**	**24**
Sum	**0**		**1512**		**797**		**21822**	

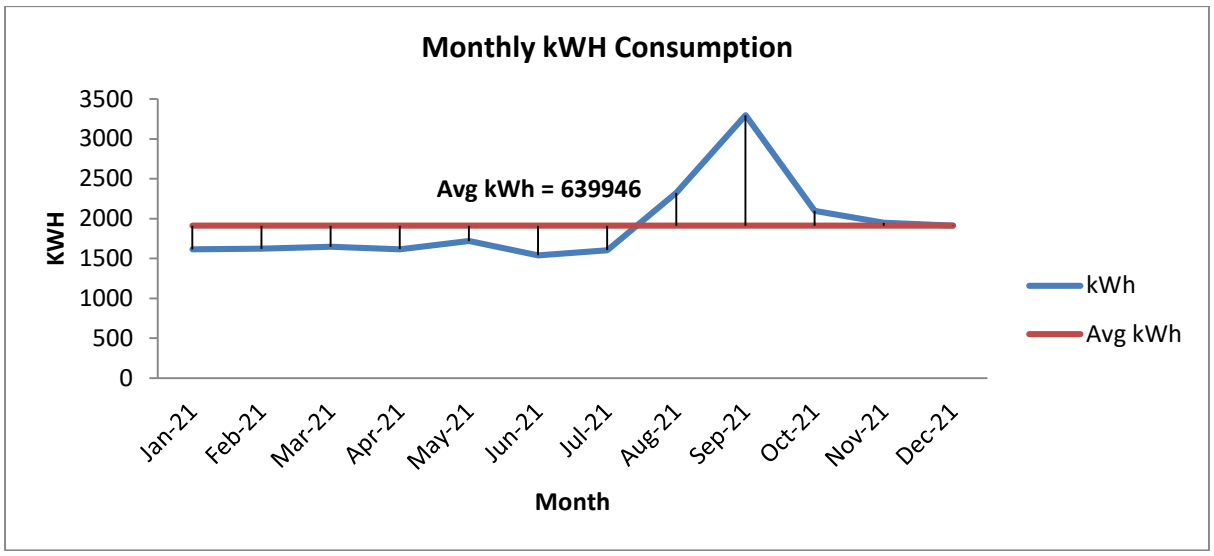


Figure 1 Monthly kWh Consumption

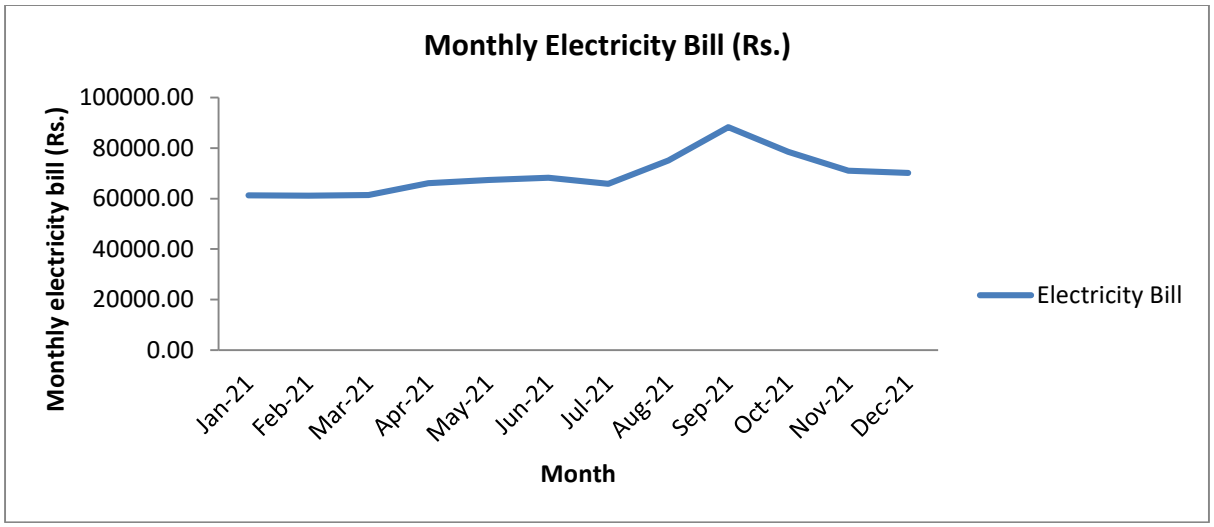


Figure 2 Monthly Electricity Bill

Comments:

1. Average monthly units consumed is 2011 kVAh equivalent to Rs. 18662.08/-

2. Average electricity charges work out to be Rs. 9.28/-

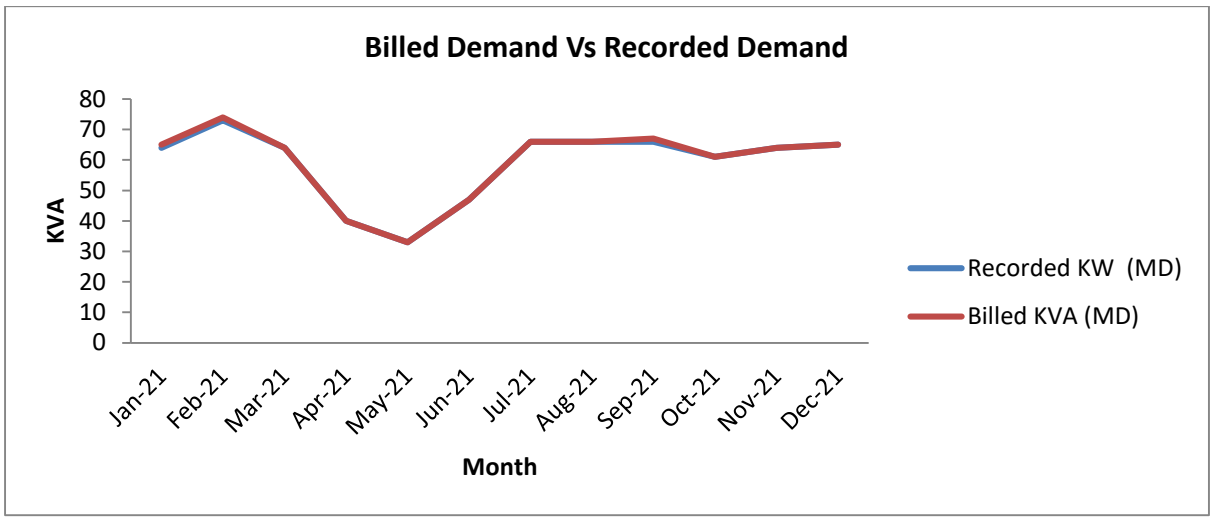


Figure 3 Billed Demand vs Recorded Demand

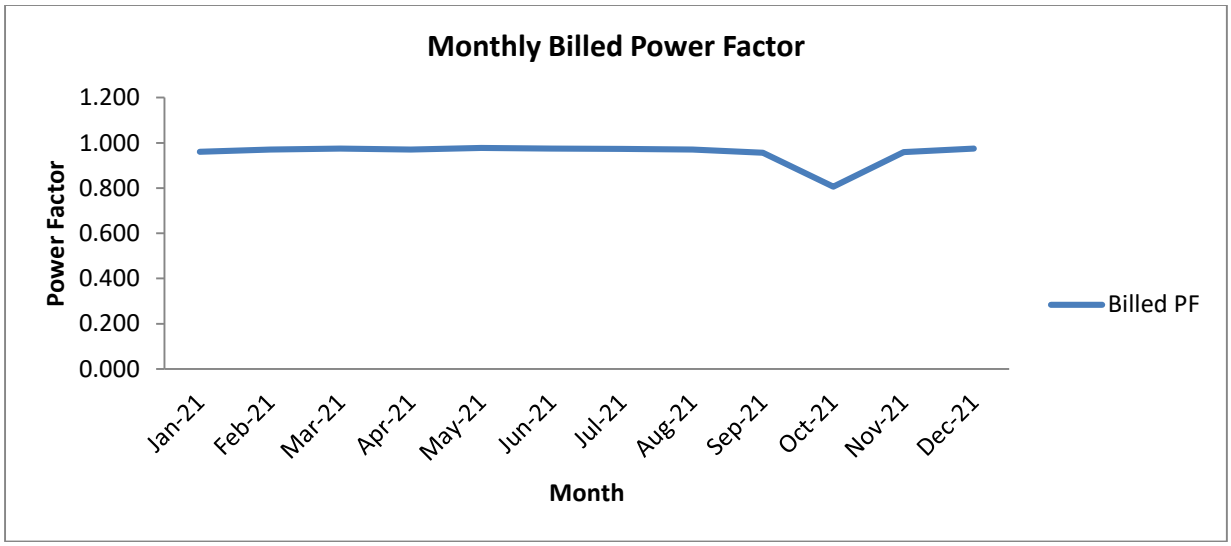


Figure 4 Billed PF

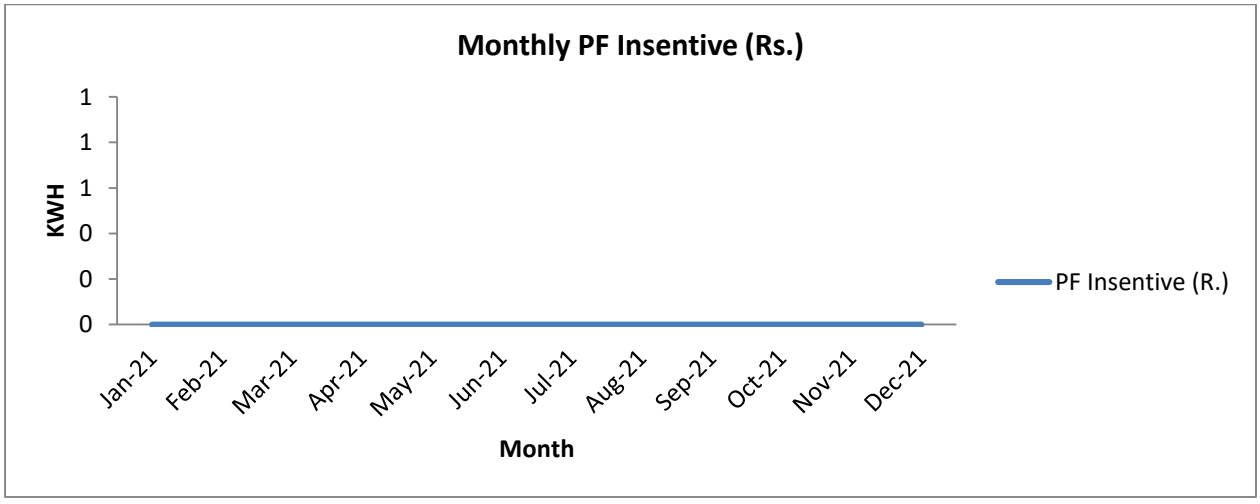


Figure 5 PF Incentive

4.2. Connected Load Quantity of Buildings

Table 4 Connected Load of Facility

Fixtures	Wattage	Total number of fixtures	Total KW
Ceiling fan	70	674	47.18
Exhaust Fan	70	35	2.45
LED round	15	150	2.25
LED round	20	920	18.4
Tube-light	36	165	5.94
Regular Motor (Ground floor tank)	7.5 H.P	2	11.19
Regular Motor (Ground floor tank)	0.5 H.P	1	0.37
Boring & kitchen motor	3 H.P	7	15.67
Hydrant pump (fire)	30 H.P	1	22.38
Hydrant pump (fire)	10 H.P	1	7.46
Hydrant pump (fire)	7.5 H.P	1	5.60
Lift	5.5 H.P	3	12.31
Electric pressure cooker (Bio-green office)	6000	1	6
Electric pressure cooker (Bio-green office)	3000	1	3
LED	250	10	2.5
LED	200	2	0.4
LED	100	2	0.20
AC (3 star split type)	2 Ton	17	65.89
AC (3 star split type)	1.5 Ton	4	9.40
AC (3 star split type)	1 Ton	1	1.09
AC (cassette)	3 Ton	3	13.5
AC (cassette)	4 Ton	8	48
Computer+ projector	20 KVA (4 no.) 7 15 KVA (1 no.)	5	NA
Total			**301.173**

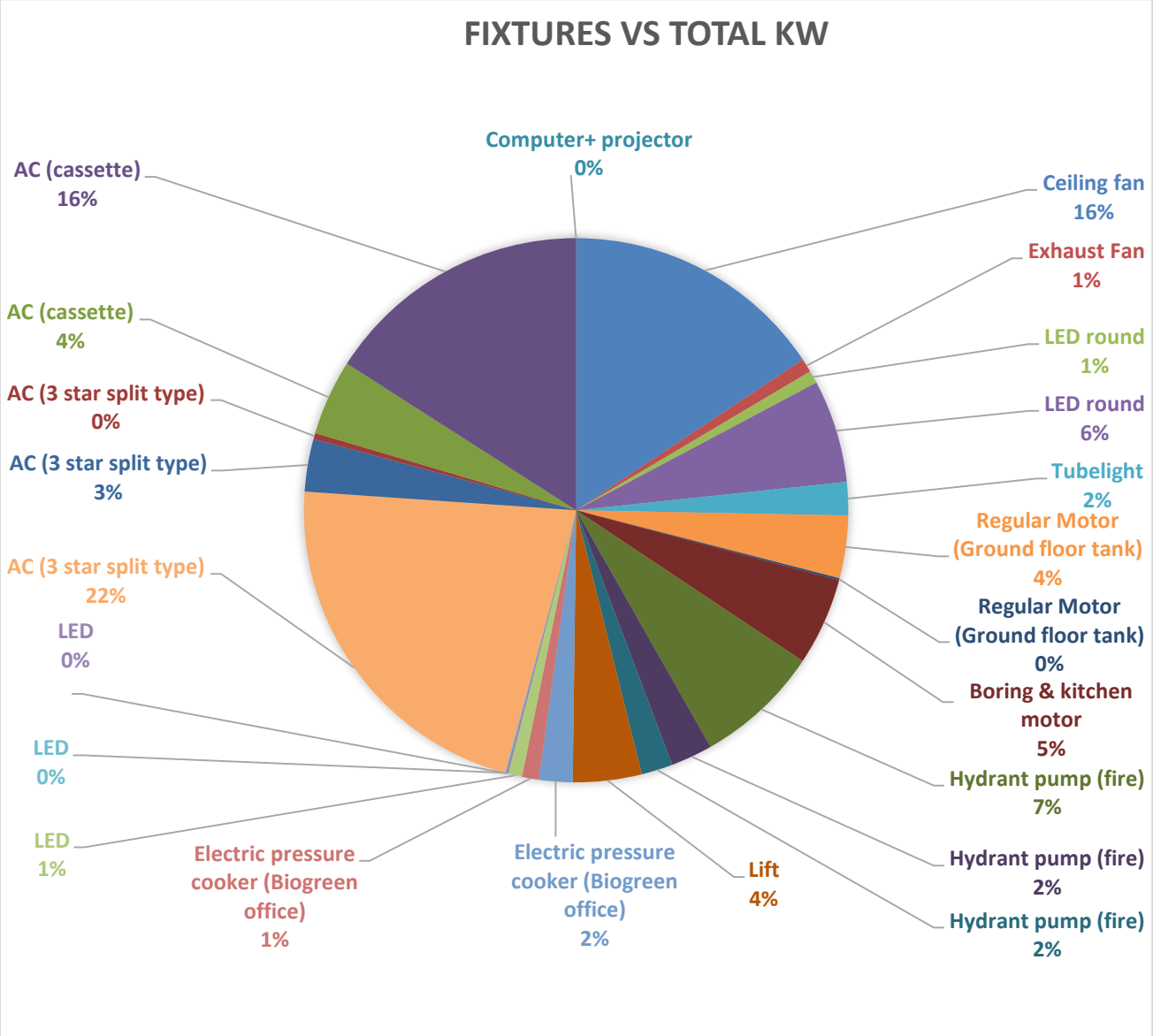


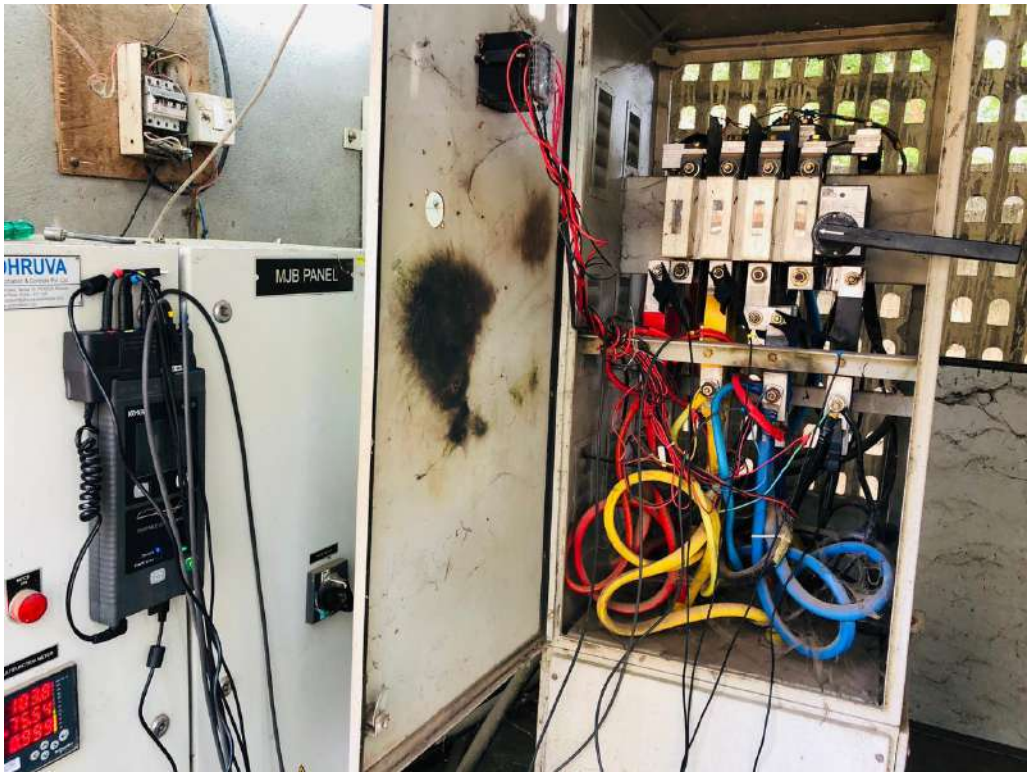
Figure 6 Distribution of Connected Load

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	420.1	414.5	417.2	34.0
	Max	423	417.3	420.1	47.3097
	Min	0	0	0	0
Current (A)	Avg	43.3	33.6	10.2	1.4
	Max	58.3943	43.5784	18.9864	1.387
	Min	0	0	0	1.365
Active Power (W)	Avg	5313.8	8515.8	5156.9	18986.5
	Max	9377	12683	7989	29538
	Min	0	0	0	0
Power Factor	Avg	0.6	0.8	0.6	0.7
	Max	0.818	0.897	0.768	0.825
	Min	0.433	0.779	0.574	0.641
V % THD	Avg	3.7	3.8	3.8	
	Max	3.86	4.02	4.06	
	Min	3.37	3.51	3.47	
I % THD	Avg	112.9	70.5	79.2	45.6
	Max	167.82	79.21	95.06	307.11
	Min	70.03	50.06	60.71	11.11



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

Voltage Variation:

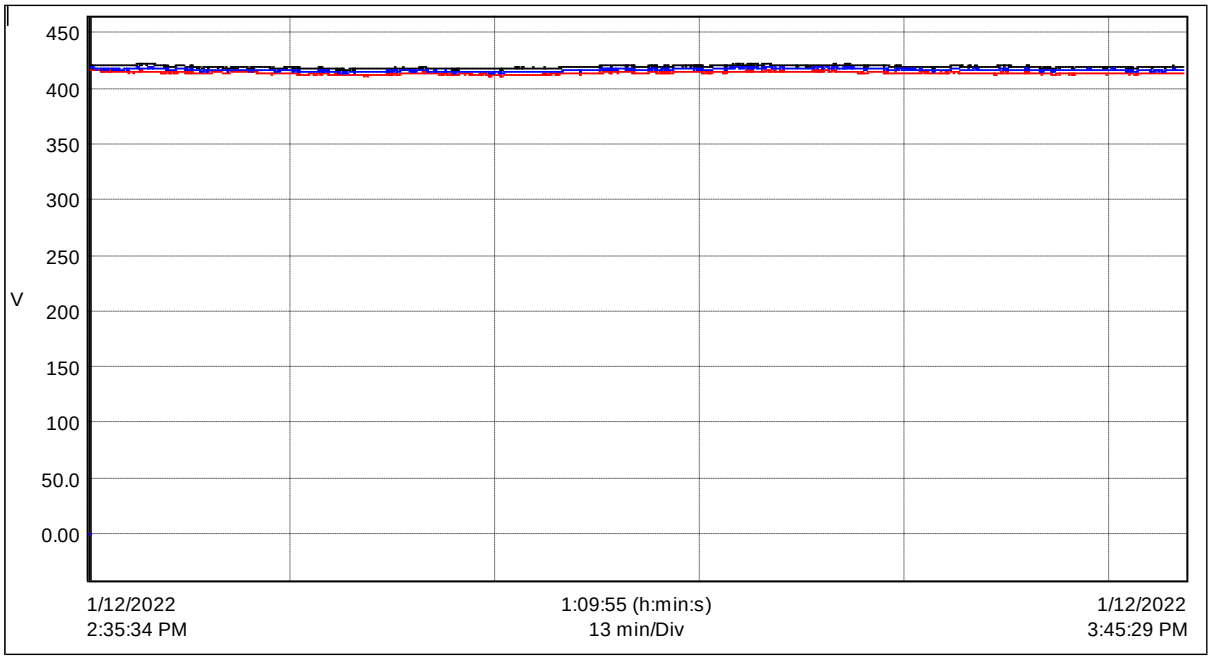


Figure 6 Voltage vs Time Period

Current Variation:

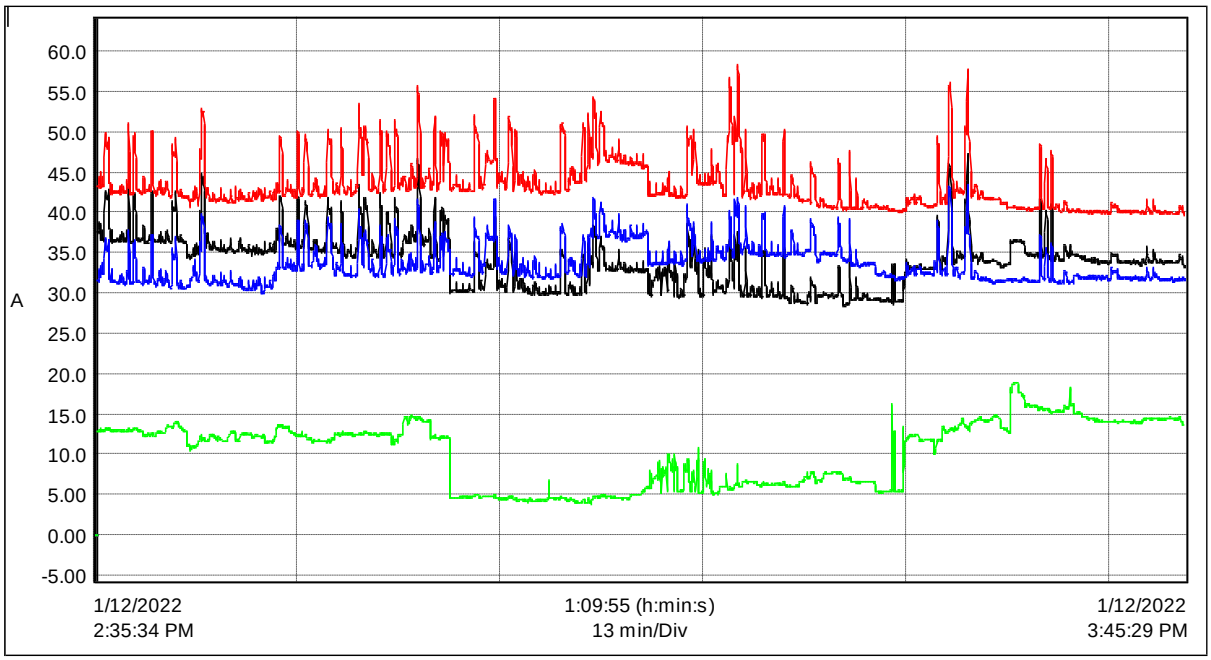


Figure 7 Current vs Time Period

Power Variation:

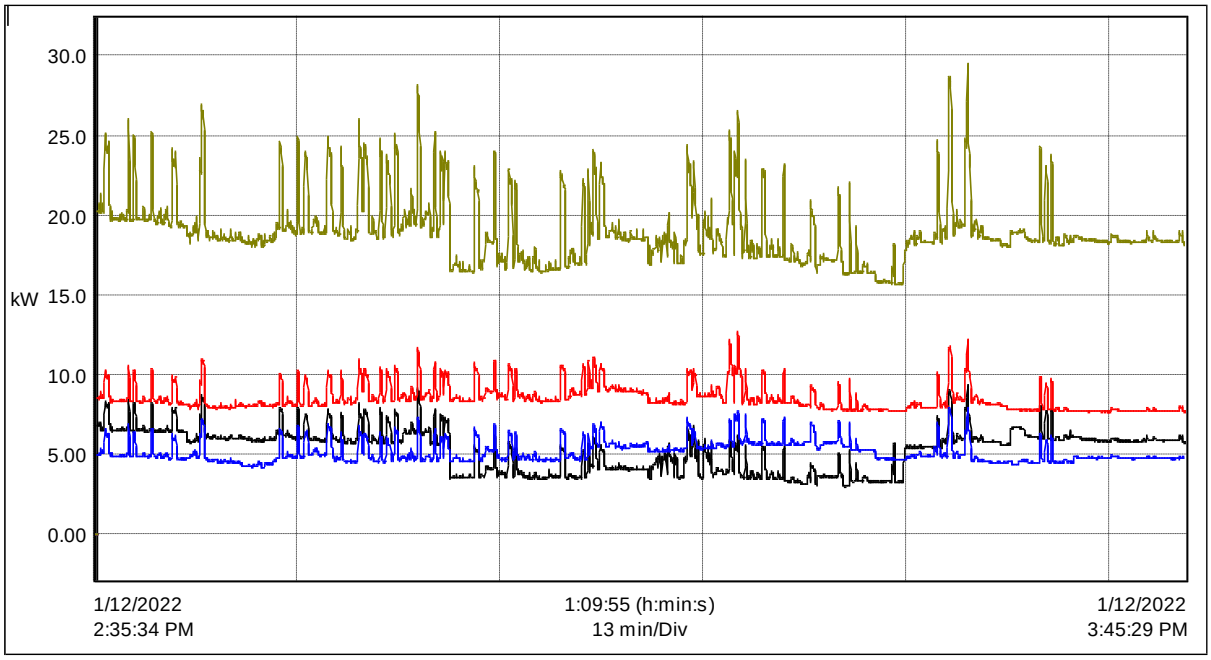


Figure 8 Power vs Time Period

Power Factor Variation:

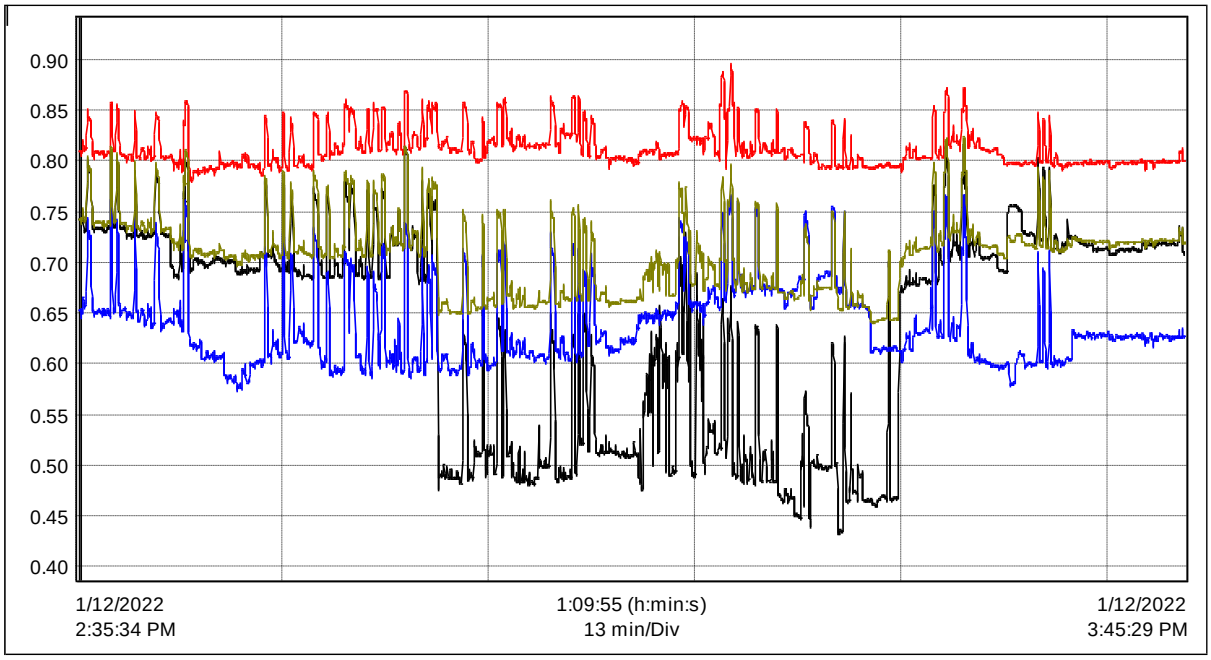


Figure 9 Power Factor vs Time Period

Voltage Total Harmonic Distortion Variation:

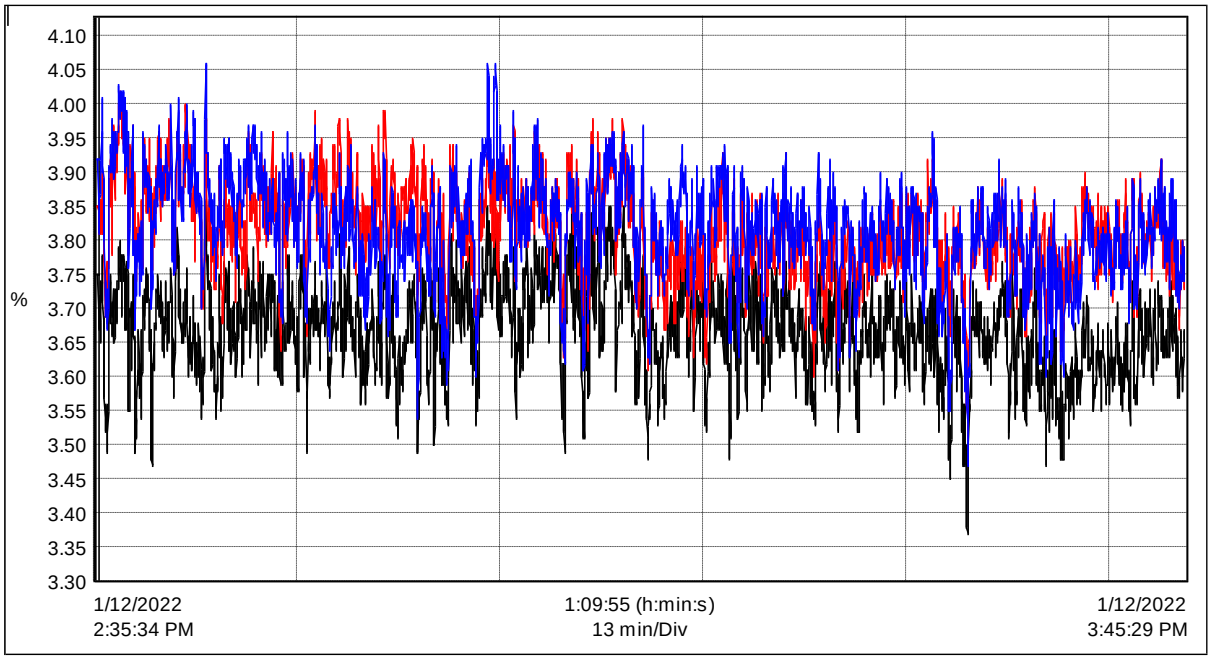


Figure 10 Voltage THD % vs Time Period

CurrentTotal Harmonic Distortion Variation:

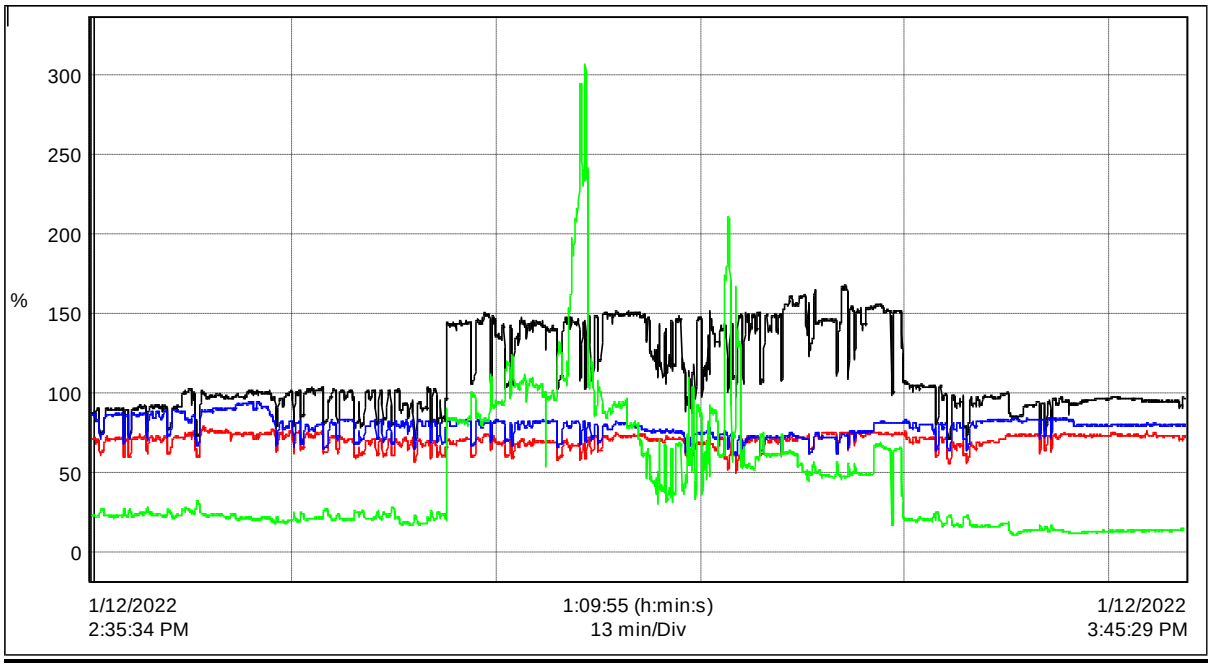


Figure 11 Current THD % vs Time Period

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 Lakh	Estimated Payback Years
			Electricity kWh	Carbon credit (Tons of CO_2)		
1	Replacement of Conventional lights with suitable LED	0.63	2138.40	1.82	0.20	3.18

Observations:

Facility has installed different type of light fittings with different wattage in their premises which is tabulated below.

Fixtures	Wattage	Total number of fixtures
LED round	15	150
LED round	20	920
LED	250	10
LED	200	2
LED	100	2
Tube-light	36	165

Recommendations:

During energy audit, it is observed that facility has installed type of fixture and wattage at some of the places in the facility Also energy team at facility has already replaced some of the lights

with LEDs. An average operating hour for these lightings are around three hours. Type of fixture and wattage 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 (here all tube-lights are considered for replacement with investment of Rs.63,000/-). 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 tube-lights	KW	5.94
Power consumption of suitable LED light	KW	2.97
Average power saving after replacement with LED light	KW	2.97
Replacement of conventional lights with suitable LEDs	Nos	165
Average working hour per day	Hrs	4
No. of working days in a year	Days	180
Cost Benefit Calculation		
Annual Energy Saving potential	kWh	2138
Electricity tariff	Rs/unit	9.28
Annual Cost Saving	Rs. Lakh	0.20
Total investment cost	Rs. Lakh	0.63
Annual saving	Rs. Lakh	0.20
Simple Payback Period	Years	3.18

Type of Existing Fitting	Watt	Qty	Proposed LED W	Total Cost	Existing KW	Proposed KW	Saved kW	Investment Rs in Lakhs
Tube-light	36	165	18	63030	5.94	2.97	2.97	0.63
TOTAL	**36**	**165**	**18**	**63030**	**5.94**	**2.97**	**2.97**	**0.63**

Sr. No	Item	C.S.R No.	Rate	Unit
1	18W led light	2-10-13.	369	Each
2	Dismantling of fluorescent fittings	2-14-1.	13	Each

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 Lakh	Estimated Payback Years
			Electricity kWh	Carbon credit (Tons of CO_2)		
2	Replacement of existing fans with energy efficient fans	5.81	907.20	0.77	0.08	69.02

Observations:

During energy audit, it is observed that facility has old 70 watts ceiling as well as exhaust fans and its energy consumption is on higher side.

Category	Nos	Estimated Running kW
Ceiling fan 70W	674	47.18
Exhaust fan 70 W	35	2.45
Total	**709**	**49.63**

Recommendations:

During energy audit it is observed that facility has installed non star rated fan of 70 watts so we recommend to replace energy consuming fan with energy efficient super fan with phased manner. For calculation purpose only 300 ceiling fans (out of 674 ceiling fans) are replaced with investment of Rs. 5,81,000/-.

Energy Saving Calculations:

Particular	Unit	value
Existing energy consumption of Fan	kWh/year	4536
Wattage of Energy Efficient Super Fan	Watt	35
Energy consumption after replacing with Energy Efficient Super Fan	kWh/year	2268
Operating hrs/day	Hrs/day	3
No. of working days in a year	Days	180
Diversity factor	%	40%
Annual Saving	kWh/year	907
Unit rate	Rs/kWh	9.28
Annual Saving	Rs. In Lakh	0.08

ECM 3: Replacement of three-star AC with 5 star AC.

ECM No.	Energy Efficiency Improvement Measures	Investment Rs. in Lakh	Estimated Saving			
			Electricity kWh	Carbon Credit (Tons of CO_2)	Estimated Savings Rs. in Lakh	Estimated Payback Years
3	Replacement of three-star ACs with 5 star AC	2.88	528.39	0.47	0.05	58.76

Observations:

Facility has installed different type of three-star ACs in their premises which are tabulated below.

AC type	Ton	Quantity
AC (3 star split type)	2 Ton	17
AC (3 star split type)	1.5 Ton	4
AC (3 star split type)	1 Ton	1
AC (cassette)	3 Ton	3
AC (cassette)	4 Ton	8

Recommendations:

It is recommended to install 5 star ACs.

Energy Saving Calculations:

Particular	Unit	Value
Quantity of 1 Ton AC with 3-star	Nos	1
Wattage of 1 Ton AC with 3-star	Watt	1092
Quantity of 1.5 Ton AC with 3-star	Nos	4
Wattage of 1.5 Ton AC with 3-star	Watt	1566
Quantity of 2 Ton AC with 3-star	Nos	17
Wattage of 2-ton AC with 3-star	Watt	1938
Total load of 1 Ton AC with 3-star	kW	1.092

Total load of 1.5 Ton AC with 3-star	kW	6.264
Total load of 2 Ton AC with 3-star	kW	32.946
Total load of all 3-star installed AC	kW	40.302
Wattage of 1 Ton 5-star AC	Watt	984
Wattage of 1.5 Ton 5-star AC	Watt	1490
Wattage of 2 Ton 5-star AC	Watt	1732
Total load of 1 Ton 5 Star AC	kW	0.984
Total load of 1.5 Ton 5 Star AC	kW	5.96
Total load of 2 Ton 5 -star AC	kW	29.444
Total load of all 5-star AC	kW	36.388
Load reduction after replacement	kW	3.914
Diversity Factor	%	50%
Operating Hrs per day	hrs./day	3
Operating days per year	Days/year	90
Estimated energy Saving	**kWh/year**	**528**
Unit Rate	Rs/kWh	9.28
Annual Saving	**Rs Lakh/year**	**0.05**

Replacement old ACs with 5 star rated ACs could be done in phase manner, for calculation purpose only 2 ACs of 2 ton capacity (out of 17), 2 ACs of 1.5 ton capacity (out of 4) and 1 AC of 1 ton capacity have been considered.

Investment Details

Particular	Value	Unit	CSR No
Quantity of 1 Ton Split AC	1	Nos.	
Quantity of 1.5 Ton Split AC	2	Nos.	
Quantity of 2 Ton Split AC	2	Nos.	
Rate of 1 Ton 5 star Split AC	38824	Rs.	3-2-10.
Rate of 1.5 Ton 5 star Split AC	51676	Rs.	3-2-9.
Rate of 2 Ton 5 star Split AC	62944	Rs.	3-2-7.
Dismantling Cost for Split AC	743	Rs.	3-12-3.
Total Investment for 1 Ton Split AC	39567	Rs.	
Total Investment for 1.5 Ton Split AC	104838	Rs.	
Total Investment for 2 Ton Split AC	127374	Rs.	
Total Investment for All AC	**288125**	**Rs.**	

	Model	Star Rating	W
Split AC	1.0 Ton	5 Star	984
	1.5 Ton		1490
	2 Ton		1732
	0.8 Ton	3 Star	812
	1.0 Ton		1092
	1.5 Ton		1566

	2.0 Ton		1938
	1.0 Ton	2 Star	1154
	1.5 Ton		1709
	2.0 Ton		2210
	1.0 Ton	No star	1600
	1.5 Ton		2500
	2.0 Ton		3000
Window AC	1.0 Ton	3 Star	1157
	1.5 Ton		1676
	2.0 Ton		2266
	1.0 Ton	2 Star	1250
	1.5 Ton		1745
	2.0 Ton		2396
	1.0 Ton	No star	1600
	1.5 Ton		2500
	2.0 Ton		3280

ECM4: Optimization of Set Temperature of ACs

ECM No.	Energy efficiency improvement measures	Investment Rs. In Lakh	Estimated saving Electricity kWh	Carbon credit (Tons of CO_2)	Estimated Savings Rs. In Lacs	Estimated Payback Years
4	Optimize the temperature setting to 23-25 degree Celsius	0.00	278.96	0.25	0.03	0.00

Observations:

Facility has installed different ACs with different capacity in their premises.

AC type	Ton	Quantity
AC (3 star split type)	2 Ton	17
AC (3 star split type)	1.5 Ton	4
AC (3 star split type)	1 Ton	1
AC (cassette)	3 Ton	3
AC (cassette)	4 Ton	8

Recommendations:

During assessment, it was observed that set point of ACs was 20-22^0 C. Hence, it is recommended to increase set temperature setting to 23-24 ^{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	9299
Estimated Saving	%	3%
Operating Hrs per day	hrs/day	3
Operating days per year	Days/year	90
Estimated Saving	kWh/year	279
Unit Rate	Rs/kWh	9.28
Annual Saving	Rs Lakh/year	0.0259

Sr No	Type	Ton	Qty	Annual Consumption
1	Air Conditioner (Split) (1 Ton) (3*)	1	1	151.2
2	Air Conditioner (Split) (1.5 Ton) (3*)	1.5	4	907.2
3	Air Conditioner (Split) (2 Ton) (3*)	2	17	5140.8
4	Air Conditioner (Cassette) (3 Ton) (3*)	3	3	680.4
5	Air Conditioner (cassette) (4 Ton) (3*)	4	8	2419.2
Total				**9298.8**

ECM 5: Optimize the Power Factor

ECM No.	Energy efficiency improvement measures	Investment Rs. In Lakh	Savings Rs. In Lakh	Payback Year
5	Optimize the Power Factor	0.44	0.07	0.49

Observations:

Facility is Maining PF around = 0.956

Recommendations:

To get the PF incentive, it is recommended to check the operation of each capacitor bank installed once in a month and maintain the PF to unity.

Calculation for KVAR Required based on Desired Unity PF:

Particular	Value	Unit
Total Annual Consumption	22937	kWh/Year
Unit Rate	9.28	Rs./kWh
Total Annual Energy Charges	212855.36	Rs./year
With Operation of all Capacitor banks, Annual Energy Saving	7449.94	Rs./year
Annual Energy Saving	0.07	Rs (Lakhs)/year
Present Billed Power Factor	0.956	
Desired Billed Power Factor	1	
Multiplying Factor	0.363	
Total Connected Load	300	kW
Size of required Capacitor Bank	108.9	kVAR
Rate of Capacitor Bank	400	Rs./KVAR
Total Investment	43560	Rs.
Payback	0.49	Years

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

PPS ENERGY SOLUTIONS PVT. LTD.

Dr. Ravi G. Deshmukh
Energy Auditor Class - A
MEDA/ECNCR-05/2018-19/EA-05

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: 31st January 2022

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 Ashoka Education Foundation, Nashik** and submitted report**.**

For PPS Energy Solutions Pvt. Ltd, Pune

Dr. Ravi. G. Deshmukh
Director