ENERGY AUDIT REPORT

OF

Institute of Home Economics

University of Delhi

F-4, Hauz Khas Enclave, Hauz Khas, New Delhi, Delhi 110016

PREPARED BY

URS VERIFICATION PRIVATE LIMITED

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JULY, 2022

ACKNOWLEDGEMENT

URS Verification Private Limited expresses their gratitude for the work awarded of conducting Energy Audit of Institute of Home Economics, New Delhi. The energy audit was conducted from **04/07/2022 to 05/07/2022** with the active involvement of the Senior Management and concerned staff of IHE.

We acknowledge with gratitude the wholehearted support & unstinted co-operation given by-

Dr. Geeta Trilok Kumar, Director, IHE

Dr. Pratima Singh, Convenor, Environment and Community outreach Committee & Programme officer NSS-IHE

Ms. Nitika Nagpal, Member, Environment and Community outreach Committee, Co-Convenor Environment NAAC visit committee

Dr. Rachna Kapila, Co-Convenor, Environment and Community outreach Committee

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Dr. Mamta Singhal, Member, IQAC Committee

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Dr. Sonal Jain, Member, Environment and Community outreach Committee

Dr. Bhupinder Kaur, Member, Environment and Community outreach Committee

The team members of URS Verification Pvt. Ltd. sincerely thank the management and support staff members of IHE, who have rendered their all-possible co-operation and assistance during the entire period of assignment.

For URS Verification Pvt. Ltd

Ashok Kumar (AGM – Energy & Sustainability)

CERTIFICATE

We certify the following

- The data collection has been carried out diligently and truthfully.
- All data measuring devices used by the auditor are in good working condition, have been calibrated and have valid certificate from the authorized approved agencies and tampering of such devices has not occurred.
- All reasonable professional skill, care and diligence had been taken in preparing the energy audit report and the contents thereof are a true representation of the facts.

Ashok

URS Verification (P) Ltd.

Signature

Name: Ashok Kumar
Designation: AGM – Energy & Sustainability

ABBREVIATIONS

A	Ampere
AC	Alternating Current
Avg.	Average
AVR	Automated Voltage Regulator
CFL	Compact Fluorescent Lamp
CFM	Cubic Feet Minute
DG	Diesel Generator
FTL	Florescent Tube Light
GT	Generator Transformer
DTL	Double Tube Light
KL	Kilo Liter
KV	Kilo Volt
kVA	Kilo Volt Ampere
kW	Kilo Watts
kWh	Kilo Watt Hour
LED	Light Emitting Diode
Lit	Liters
M or m	Meter
Max.	Maximum
Min.	Minimum
MT	Metric Ton
MW	Mega Watt
PNG	Piped Natural Gas
No.	Number
PF	Power Factor
PL	PL is holder Type of CFL Tube
TR	Ton of Refrigerant
V	Voltage
CFM	Cubic Feet per Minute

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EXECUTIVE SUMMARY

This report is an attempt of URS to provide an overview on existing energy consumption at Institute of Home Economics, New Delhi. This report also highlights the major energy saving opportunities available in the premises. A set of recommendations which will assist the management of IHE in improving energy efficiency has also been highlighted in this report conducted on 04/07/2022 to 05/07/2022. The brief description is shown below:

<table>
<tr><th colspan="2">Project Title:</th><th colspan="2">URS Project Report Number:</th></tr>
<tr><td colspan="2">Energy Audit in Institute of Home Economics, New Delhi</td><td colspan="2">CCMS141869</td></tr>
<tr><td colspan="4">Client:</td></tr>
<tr><td colspan="4">Institute of Home Economics, New Delhi</td></tr>
<tr><td colspan="4">Contact Persons:</td></tr>
<tr><td colspan="4">Dr. Geeta Trilok Kumar, Director, IHE
Dr. Pratima Singh, Convenor, Environment and Community outreach Committee & Programme officer NSS-IHE
Ms. Nitika Nagpal- Member, Environment and Community outreach Committee, Co-Convenor Environment NAAC visit committee</td></tr>
<tr><td colspan="2">Date of Audit</td><td colspan="2">Source of Electricity</td></tr>
<tr><td colspan="2">04/07/2022 to 05/07/2022</td><td colspan="2">BSES Rajdhani Power Limited, New Delhi</td></tr>
<tr><td colspan="2">Date of this Report:</td><td colspan="2">Date of Approval:</td></tr>
<tr><td colspan="2">08/07/2022</td><td colspan="2">08/07/2022</td></tr>
<tr><td>Work carried out by:
(Team Composition)</td><td colspan="2">Mr. Rohit Dutt Paliwal- Team Lead
Mr. Mohd. Javed – Engineer</td><td>No Distribution without permission from the client or responsible organization unit</td></tr>
<tr><td rowspan="2">Final Report Verified:
(Scheme Manager)</td><td colspan="2">Insert Signature Ashok URS Verification (P) Ltd URS</td><td rowspan="2">Unrestricted Distribution</td></tr>
<tr><td>Name: Ashok Kumar</td><td>Date: 08/07/2022</td></tr>
</table>

HIGHLIGHTS OF THE ENERGY AUDIT

- IHE receives electricity supply from BSES Rajdhani Power Limited, New Delhi and from open access with 11 KV as the input voltage that comes under Non Domestic/above 3KVA (supply upto 11kv) Category. The Contract Demand is 295 kVA. It is observed from electricity bills of last year that the average power factor is 0.83. Existing power factor can be improved from 0.83 to 0.99 by installing 80 KVAR APFC panel. Therefore, the annual energy saving will be 2275 KVAh which result in annual monetary saving of INR 2.32 Lakh and payback period will be 5 months.

- The performance assessment of All AC's has been done and all AC's shows satisfactory performance. Detailed analysis is given its relevant chapter.

- The performance assessment of all motor and pumps which were running during the audit has been done and found satisfactory.

- Replacement of conventional tube light with LED tube light will give **4103 Kwh** annual energy saving, **INR 0.35 lakh** monetary saving and payback period will be around **18 months.**

- IHE is running awareness campaign on regular interval for energy conservation like seminar and competition of poster making on energy conservation, use of solar energy etc. IHE also implemented various measures for energy saving in institution building which involve installation of Solar Street light, use of start rated appliances and adopted regular maintenance activity to avoid any energy loss.

- IHE has been shifted around 20% lights to LED, using sunlight during day time as far as possible and also in process to use motion sensitive light at strategic location.

• An In house survey by faculty and students on energy conservation has been conducted from June 2020 to July 2021. This proactive approach shows IHE keen interest to save energy and aware faculty & students about energy conservation.

Based on the Energy Audit, following areas are identified for reducing energy consumption. Also, the investment required and payback period are detailed in below table:

Table 1: Summary of Energy Conservation Measures (ENCONs)

S. No.	Energy Conservation Measures	Annual Energy Saving		Investment	Monetary	Simple Payback Period (Months)
		Natural Gas	Electricity	(Rs.INR)	Savings	
		SCM	(kVAh)		(Rs.INR/year)	
Low Investment						
1	Installing APFC Panel for Power Factor Correction		27297	88000	232024.2	5
Medium Investment						
2	Replacing Conventional Choke Tubelight with LED Tubelight		4103	51800	34871.76	18
High Investment						
3	NA	NA	NA	NA	NA	NA
	Total		**31400**	**139800**	**266895.96**	

CHAPTER: 1
INTRODUCTION

1.1 THE PROJECT

The Institute of Home Economics (IHE) is a premier institution of the University of Delhi, imparting holistic value-based education to women students. It was established in 1961 by Dr. (Mrs) Surjit Malhan. The college offers undergraduate courses, viz.,B.Sc. Home Science (Hons. and Pass), B.Sc. (Hons) Microbiology, B.Sc. (Hons) Biochemistry, B.El.Ed, B.Sc. (Hons) Food Technology and BA (Hons) Journalism. IHE also offers post - graduate courses viz., M.Sc. in Fabric and Apparel Sciences and M.Sc. in Food and Nutrition, PG Diploma in Dietetics and Public Health Nutrition and PG Diploma in Health and Social Gerontology. A number of students have been enrolled for Ph.D under faculty members for doctoral research. Of the many achievements of college, the most important ones during the last few years include NAAC ‘A’ certification, FIST Grant (2016-2021) from DST and Star College Scheme grant from Department of Biotechnology.

During the year 2020-2021, college undertook various green practices and sustainability initiatives. Organic Composting and Vermicomposting with the use of Aerobins was taken up. To revive and recreate Institute of Home Economics, University of Delhi herbal garden, approximately 16 varieties of medicinal and herbal plant saplings were planted in college campus. Solar lights were put up in the campus of the college as part of ‘go green’ initiative. The IHE has taken many initiatives to redefine its environment culture and develop new ways of making the campus eco-friendly. The faculty, staff, and students worked together to develop a sustainable campus and spread the idea of eco-friendly culture to the nearby community as well. These include activities such as tree plantation in the campus during the rainy season, segregating and recycling of waste material, vertical gardening activities, and vermicomposting pits that have been developed using garden waste. The activity of organic compost formation from wet waste of the canteen has also been started in collaboration with Indian Pollution Control Association under the project SORT (Segregation of Organic Waste for Recycling and Treatment). The Institute also conducts programs such as 'Say No to Plastics' and encourages 'paperless' communication at all levels.

Energy Audit of Institute building situated at F-4, Hauz Khas Enclave, Hauz Khas, New Delhi, Delhi 110016 was conducted by URS Verification where audit team covered all the utilities available in institution building.

The main source of energy is electricity. Institute also using natural gas for practical purpose in laboratories.

1.2 SCOPE OF WORK

URS Verification Pvt. Ltd. was entrusted with the work for conducting Energy Audit in Institute of Home Economics, New Delhi. The audit team has carried out the performance assessment and reviewed operational philosophy of the various Motors, Pumps, AC, Lighting, loading profile of Transformers and Bill Analysis for Electricity.

1.3 METHODOLOGY

The following step by step methodology and approach were adopted to carry out the specified energy audit for Institute of Home Economics, New Delhi. URS team visited the plant on 04/07/2022 for the field measurement and conducting the audit. The team had a meeting/ discussion with senior officials and concerned department heads. The broad methodology adopted for the Energy Audit in Institute of Home Economics, New Delhi is furnished below:

• Pre-Audit Meeting (opening meeting) with management, senior officials of all concerned departments.

• Measurements of electrical/thermal parameters, wherever possible, using portable instruments were carried out.

• Review of documents/ records and operational philosophy (All the relevant maintenance documentation, test records, OEM (Original Equipment Manufacturer) service manuals of electrical installations).

• Submission of Energy Audit Draft Report.

• Review meeting with client on Draft Report.

• Submission of Final Energy Audit Report to Client.

The Detailed Energy Audit covers the following areas:

(i) Study of Electricity Bills, Contract Demand & Power Factor & Loading Pattern.
(ii) Power Distribution Study
(iii) Electrical Systems Study
(iv) Power Quality Analysis
(v) Motor Loading Study
(vi) Air Conditioning Study
(vii) Pump Systems
(viii) Study of Lighting System
(ix) Projects for Implementing the Energy Saving Measures

Building Cover-Up Area:

Table: Building cover-up area

Area	Square Meter
Block A and Block B	2750

Existing Connected Loads:

The electrical energy consumption is mainly in AC's, Lighting and Fan. The inventory list of the same is listed below:

Table 2: Details of connected load

Load Type	UOM	Block A	Block B	Total Connected Load
AC's	KW	56.10	12.30	68.40
Fan	KW	24.25	10.22	34.47
Light	KW	14.42	4.24	18.66
Miscellaneous	KW	17.50	11.00	28.50
Total		**112.27**	**37.76**	**150**

Sr. No	Category	Load in kW	Load Distribution
1	AC's	68.40	45.59
2	Fan	34.47	22.97
3	Light	18.66	12.44
4	Miscellaneous	28.50	19.00
	Total	**150.0**	**100**

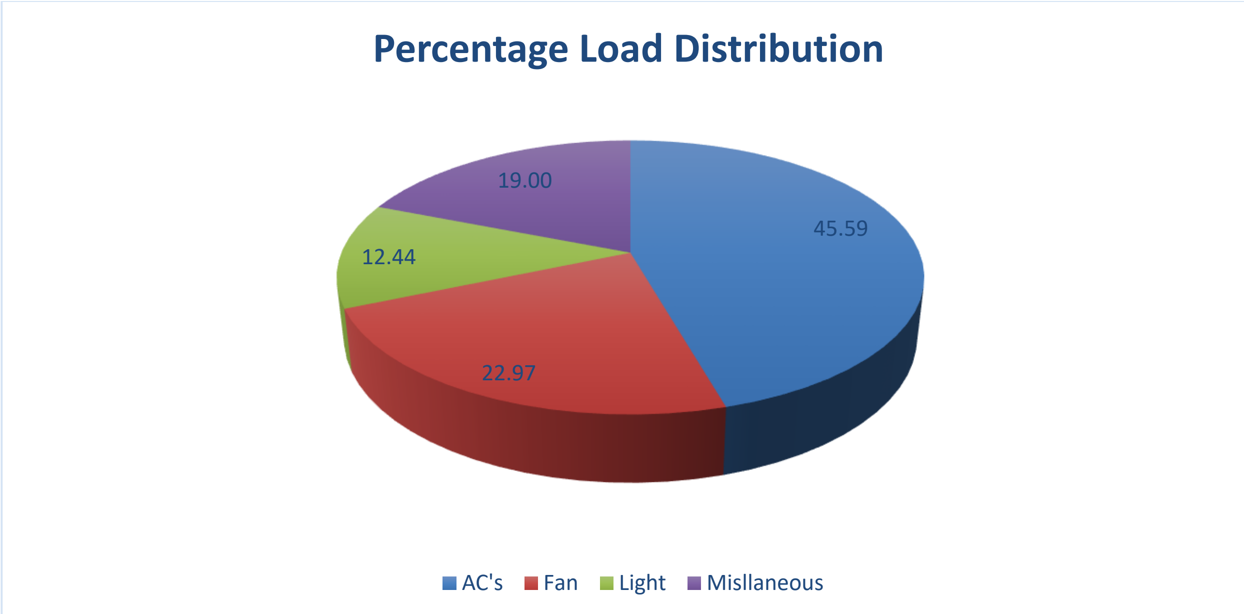

Figure 1: Percentage Distribution of Load

Technical Resources:

The following major instruments were commissioned for the field study:

Table 3: Instruments commissioned for the audit

Sr. No.	Instrument Name	Make	Nos.
1	Three Phase Power Analyzer	ALM 31 KRYKARD	2
2	Single Phase Power Analyzer	ALM 10	1
3	Digital Power Clamp Meter	TESTO	1
4	Ultrasonic Flowmeter	TUF - 2000H	1
5	Pressure Gauge	BAUMER	1
6	IR gun	METRAVI MT-16 and FLUKE	1
7	Rubber Gloves		2
8	Lux Meter	PRECISE LX 804	1
9	Digital Distance Meter	FLUKE	1

Performance Evaluation Of Major Utilities and Process Equipment

- Electricity Bills Analysis & Supply and Distribution System
- Energy Utilization Index
- HVAC System
- Pump System
- Motor System
- Lighting System

CHAPTER: 2
ELECTRICITY BILLS ANALYSIS

2.1 ONE YEAR ELECTRICITY BILLS

Electricity is purchased from BSES Rajdhani Power Limited, from open access with 11 KV as the input voltage that comes under HT supply type (supply upto 11kv) Category. The Contract Demand is 295 kVA.

Table 4: Analysis of one year Electricity Bills

Month & Year	Contract Demand (KVA)	Maximum Demand (KVA)	MD Charges Rs/KVA	Energy Charges Rs/Kwh	Total Energy Consumption		PF	Fixed Charges (Rs)	Energy Charges (Rs)	Current Gross Amount (Rs)	Bill Amount Payable	Average Electricity Cost (Rs/Kwh)
					KWh	KVAh						
2021-NOV	295	66	250	8.5	11406.00	14160.00	0.81	76763.44	116382.00	260867.66	256793.48	22.87
2021-DEC	295	30	250	8.5	8286.00	10722.00	0.77	70736.56	87473.50	213743.13	210680.94	25.80
2022-JAN	295	42	250	8.5	10272.00	12366.00	0.83	70736.56	102720.00	234254.77	234254.77	22.81
2022-FEB	295	54	250	8.5	11478.00	13686.00	0.84	80547.24	112157.50	260050.55	256124.25	22.66
2022-MAR	295	48	250	8.5	12402.00	14778.00	0.84	83605.99	121278.00	276600.21	272354.63	22.30
2022-APR	295	72	250	8.5	16230.00	18738.00	0.87	83605.99	162300.00	332932.22	332932.22	20.51
Average	**295.00**	**52.00**			**11679.00**	**14075.00**	**0.83**	**77665.96**	**117051.83**	**263074.76**	**260523.38**	**22.82**

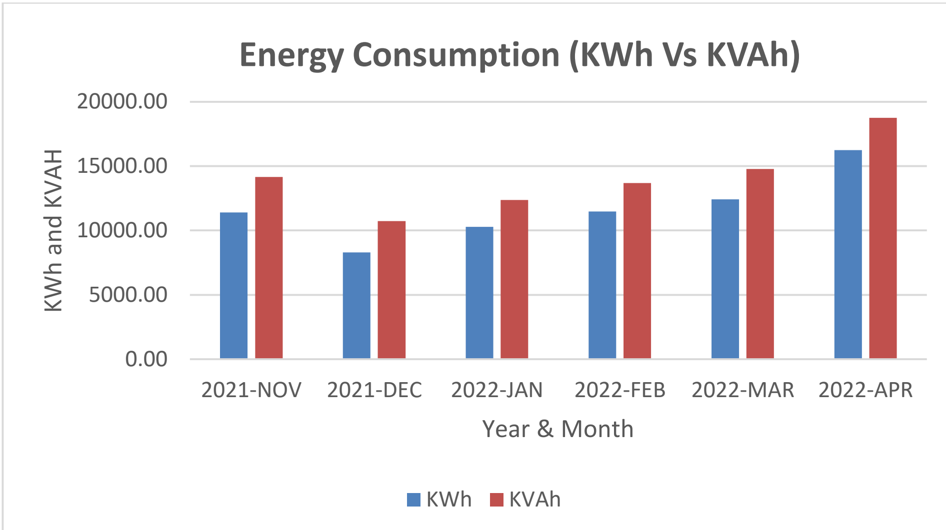

Figure 2: Monthly Energy Consumption KWh & KVAh

It can be seen from the above figure that the maximum energy consumption for the building is in April 2022 and the minimum on December 2021.

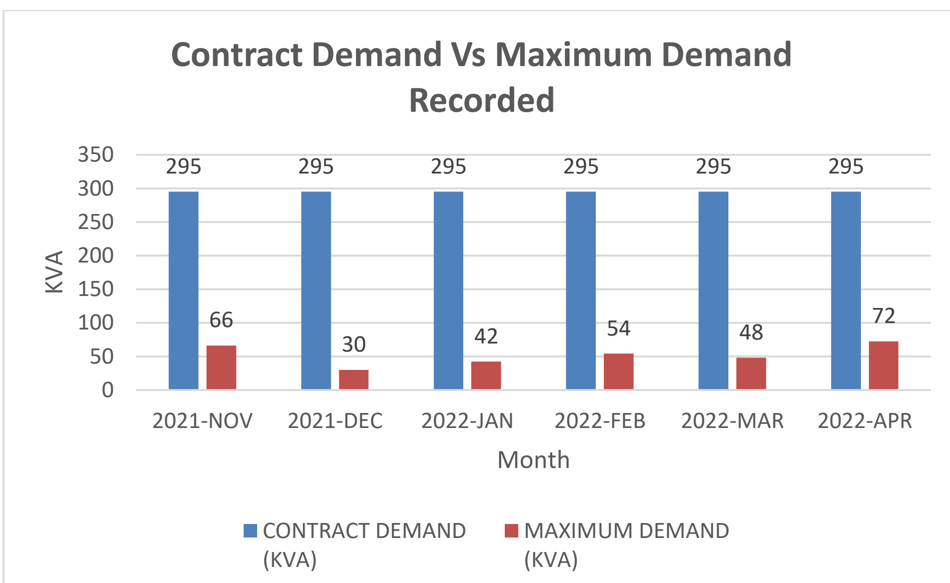

Figure 3: Contract Demand vs. Maximum Demand

From the above figure it is observed that although the Contract Demand is 295 kVA but the highest Maximum Demand was 72 kVA on December 2021 for the FY year 2021-22.

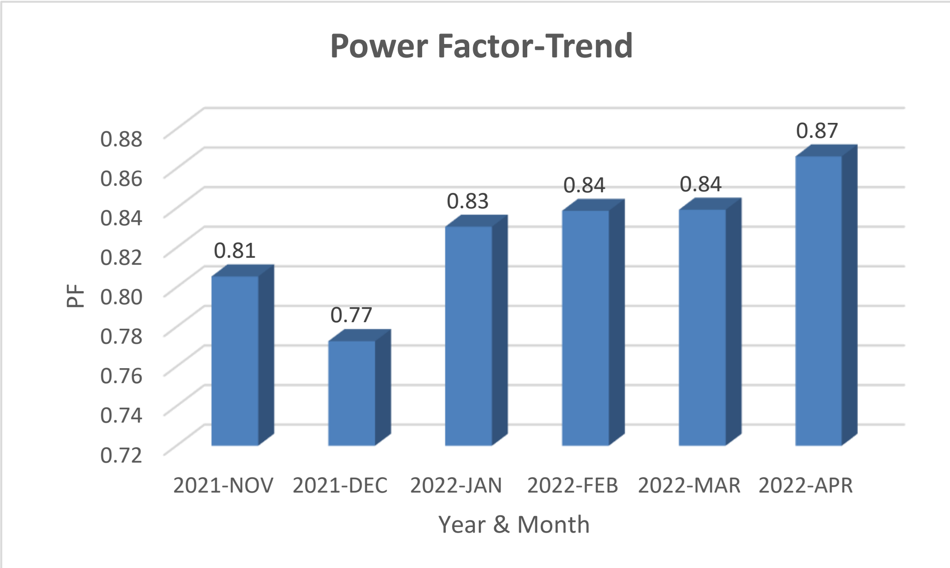

Figure 4: Power Factor

From the above figure it is observed that power factor is varying from 0.77 to 0.87.

2.2 RECOMMENDATIONS

- ***Improving Existing Power Factor:*** Savings in Power Factor improvement can be achieved by installing 80 KVAR APFC which will improve PF from 0.83 to 0.99.

Table 5: Calculation of Savings from Energy Reduction

Particular	UOM	Value
Present Operating Power Factor		0.83
Non Corrected Load (Avg. Monthly)	KVA	150
Actual Load (Avg. Monthly)	KW	124.5
Desired Power Factor		0.99
Proposed Capacitor Bank	KVAR -- KW*(Tan(Cos-1 (ø1))-Tan(cos-1(ø2)))	80

Particular	UOM	Value
Energy Consumption (Average/Month)	KVAh	14075
Actual Energy Consumption (Average/Month)	KWh	11682
Energy Consumption at Desired PF (@0.99) (Average/Month)	KVAh	11800
Energy Saving	KVAh	2275
Annual Energy Saving	KVAh	27297
Annual Moneatry Saving in Energy	Rs/Year	232024.2
Total Monetary Saving	Rs/Year	232024.24
Investment	Rs	88000
Payback (Months)	Months	5

CHAPTER: 3
LOAD PROFILE OF TRANSFORMERS AND POWER QUALITY ANALYSIS

3.1 TRANSFORMERS

At present 500 kVA, 11 kV/ 433V transformer is installed to cater LT power of the electrical system. IHE has two building block which are having separate distribution panel in each block.

Audit team installed power analyser on main incomer panel and recorded transformer loading which loading pattern is shown below

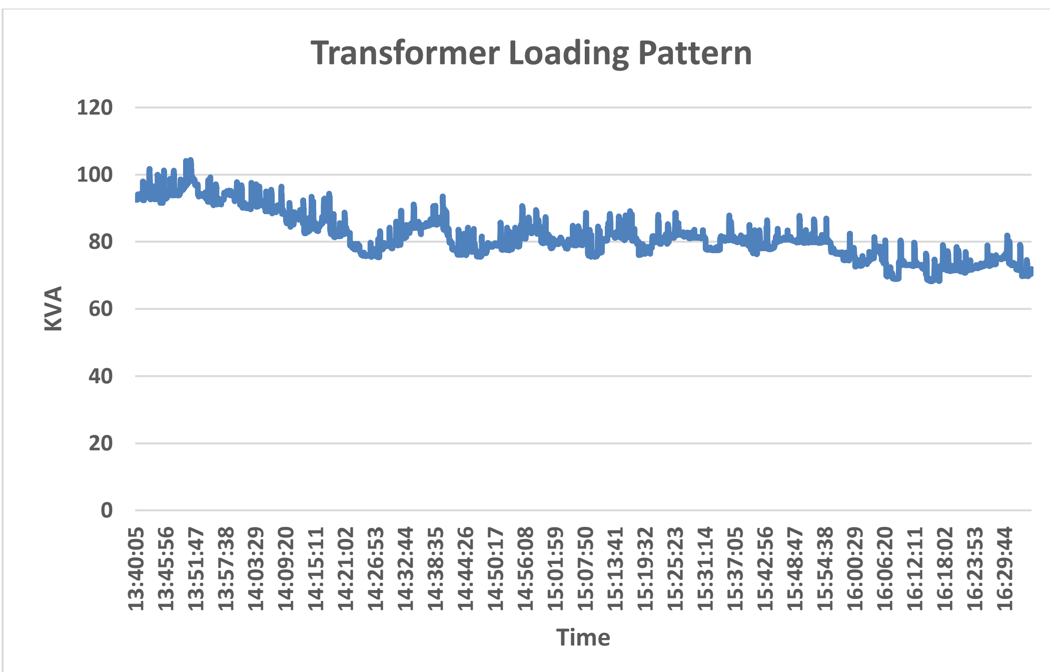

Figure 5: Loading Pattern of Transformer

From Data analysis it is observed that presently above transformer is loaded up to 21% and in good working condition. Average running load on transformer is 81 kVA and Maximum running load on transformer is 104 kVA.

3.2 BLOCK A LOAD PROFILE ANALYSIS

Block A has 3 floors, the connected load in Block A are AC, Fan, Light and other laboratories instruments. Major and continuous running load is of AC, fan and light.
Audit team recorded loading pattern of Block A which are shown in below graphs.

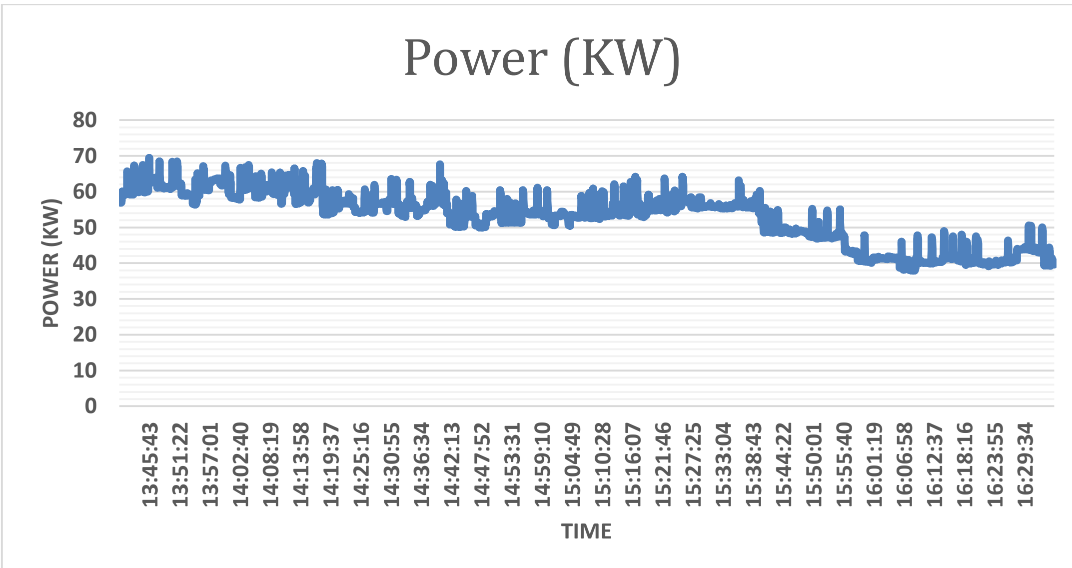

Figure 6: Power profile of Block A

The figure above shows the Power profile of the Block A building during the audit period and it was observed that the maximum load during the audit was 69 KW.

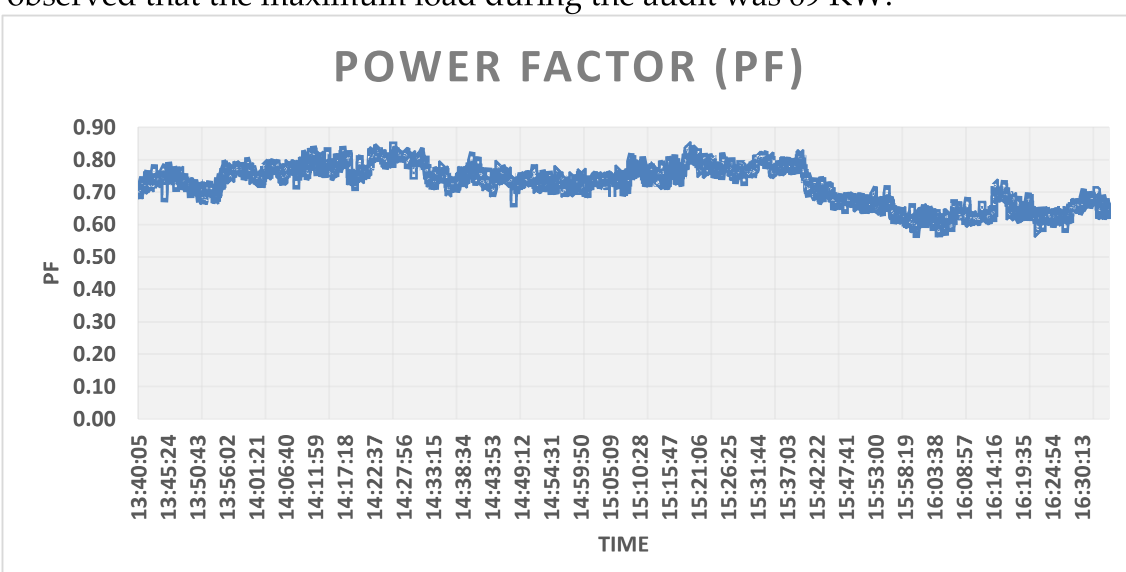

Figure 7: Power Factor profile of Block A

The figure above shows the power factor profile of the Block A building during the audit period and it was observed that the maximum PF during the audit was 0.87 and minimum was 0.57.

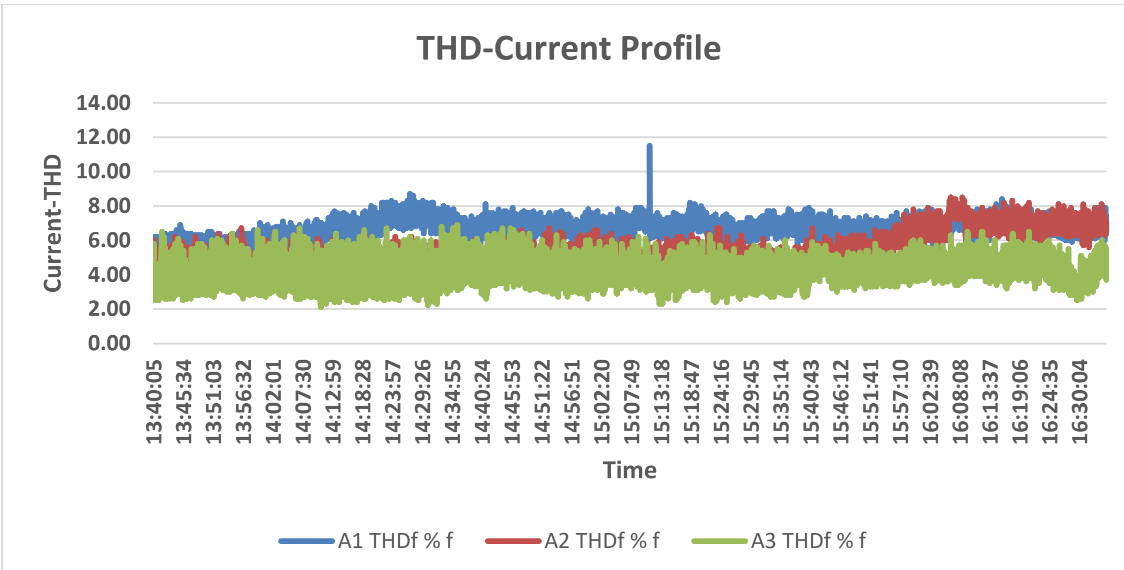

Figure 8: Total Harmonic Distortion (Current) profile of Block A

The figure above shows the profile of Total Harmonic Distortion (Current) of the building during the audit period and it was observed that the current THD during the audit was ranging from 3.93% to 7.30% which under the limit of 15%.

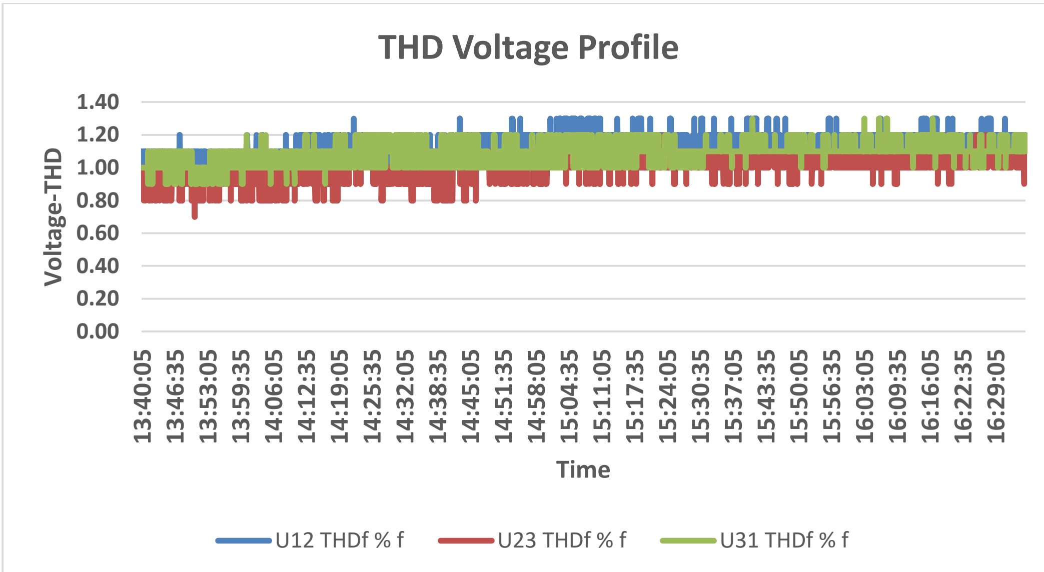

Figure 9: Total Harmonic Distortion (Voltage) profile of Block A

The figure above shows the profile of Total Harmonic Distortion (voltage) of the building during the audit period and it was observed that maximum voltage THD during the audit was ranging from 0.87% to 1.23% which is under the limit of 3%

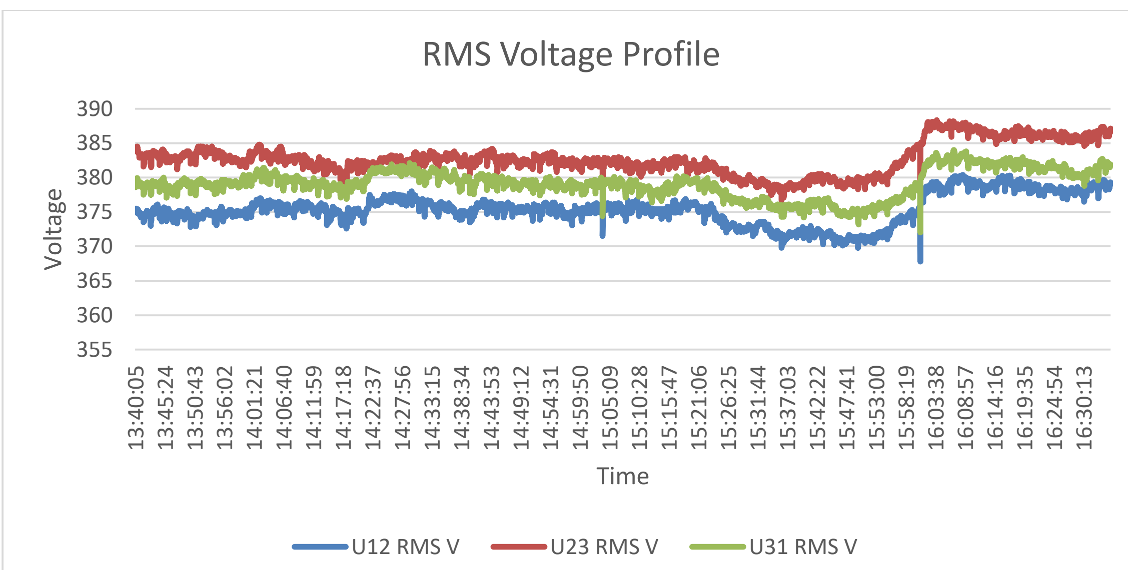

Figure 10: RMS Voltage Profile of Block A

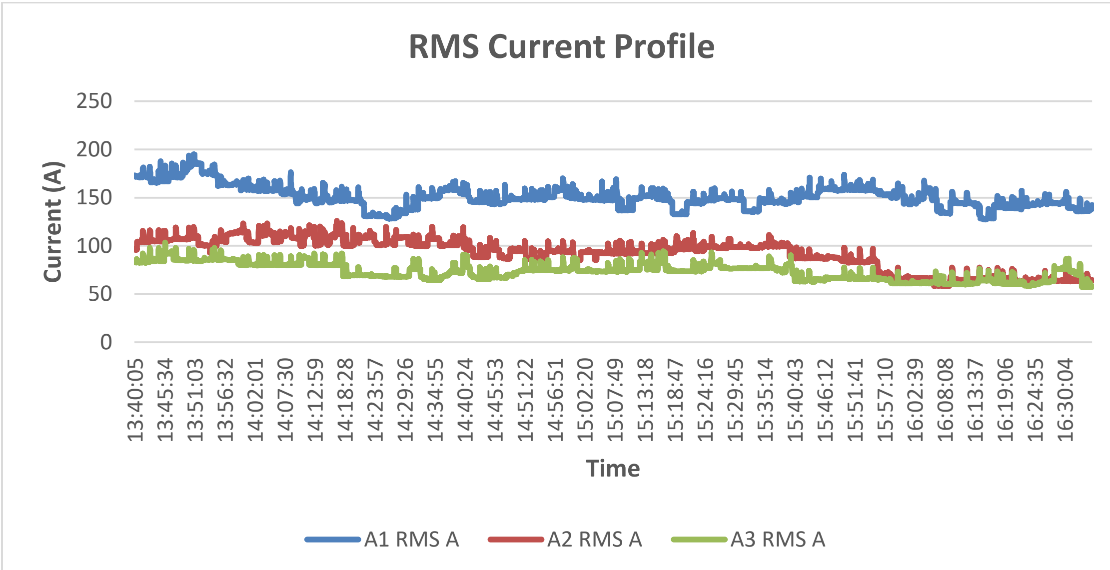

Figure 11: RMS Current Profile of Block A

The figure above shows the profile of voltage variations during the audit period and it was observed that, the voltage varies in the range **372 V to 384 V**. Also the profile of current variations during the audit period was observed in the range **84.20 A to 136.77 A.**

3.2 BLOCK B LOAD PROFILE ANALYSIS

Block B has 4 floors, the connected load in Block A are AC, Fan, Light and other laboratories instruments. Major and continuous running load is of AC, fan and light.

Audit team recorded loading pattern of Block A which are shown in below graphs.

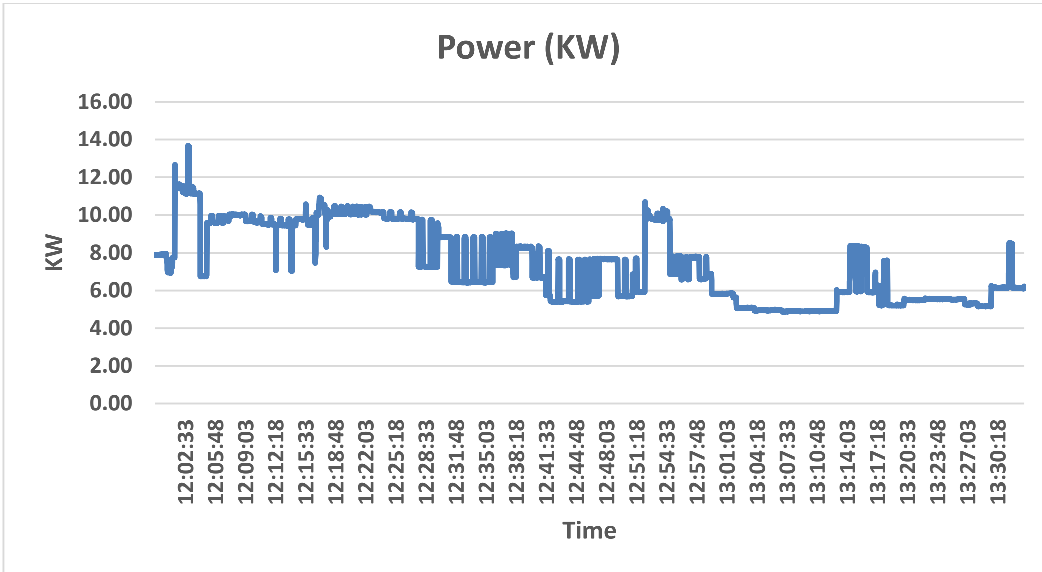

Figure 12: Power profile of Block B

The figure above shows the Power profile of the Block B building during the audit period and it was observed that the maximum load during the audit was 13.68 KW.

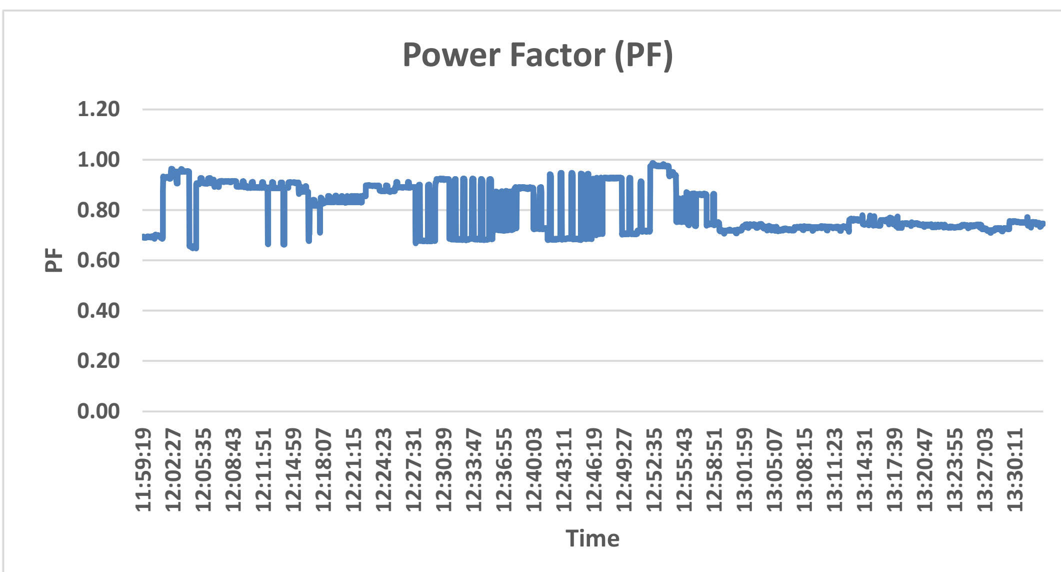

Figure 13: Power Factor profile of Block B

The figure above shows the power factor profile of the Block B building during the audit period and it was observed that the maximum PF during the audit was 0.99 and minimum was 0.65.

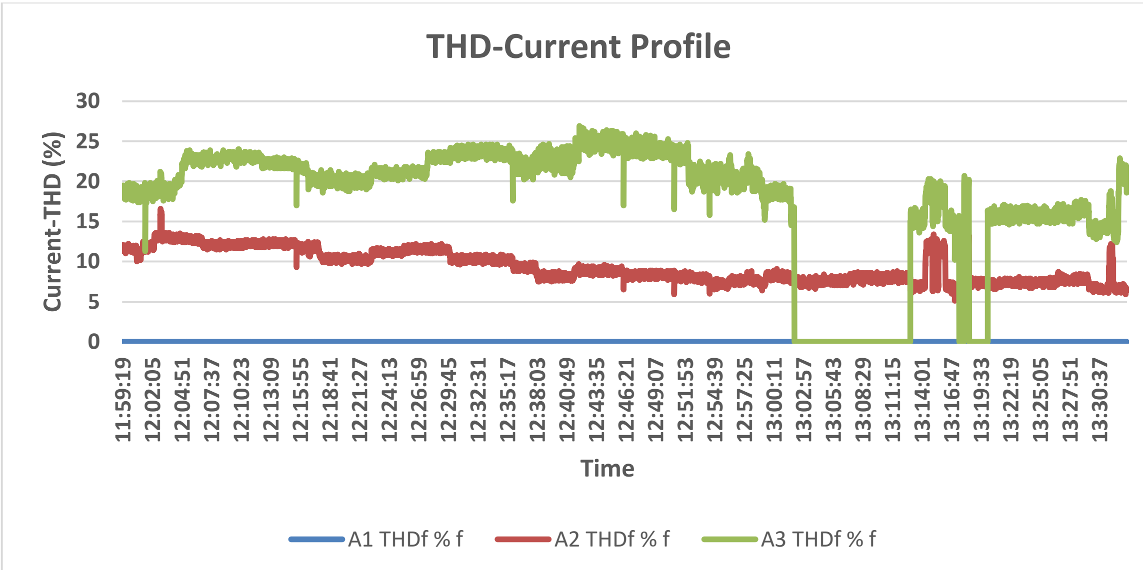

Figure 14: Total Harmonic Distortion (Current) profile of Transformer

The figure above shows the profile of Total Harmonic Distortion (Current) of the building during the audit period and it was observed that the average current THD during the audit was ranging from 3.30% to 12.47% which under the limit of 15%.

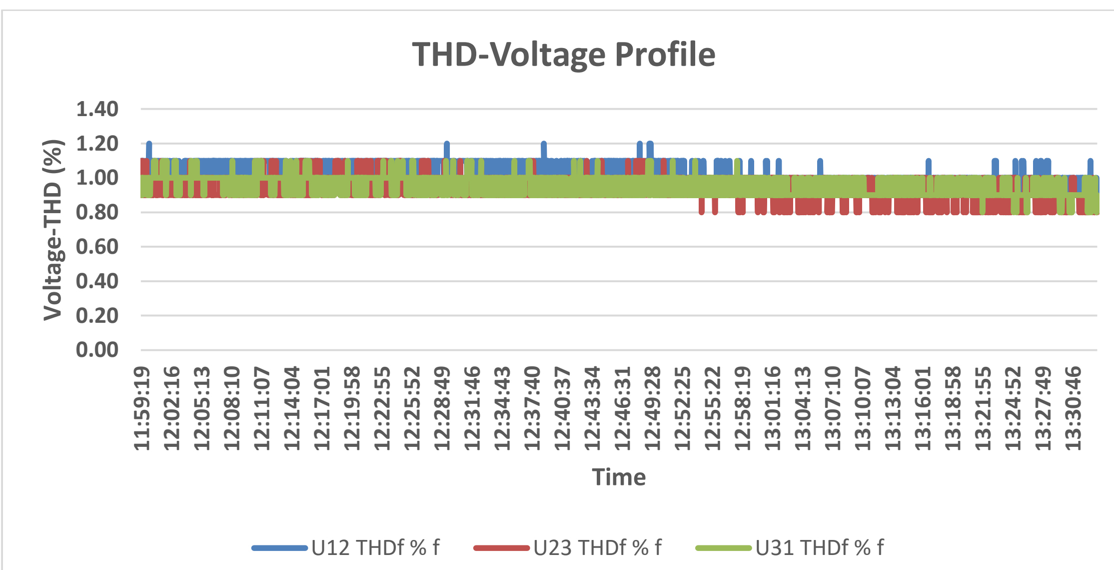

Figure 15: Total Harmonic Distortion (Voltage) profile of Block B

The figure above shows the profile of Total Harmonic Distortion (voltage) of the building during the audit period and it was observed that average voltage THD during the audit was ranging from 0.83% to 1.10% which is under the limit of 3%.

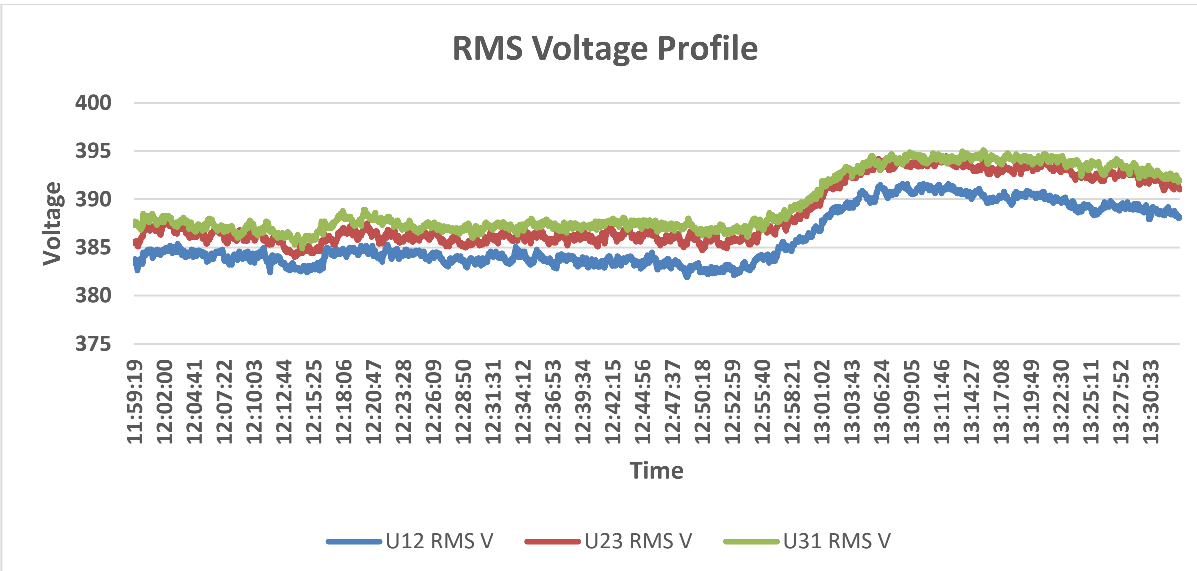

Figure 16: RMS Voltage Profile of Block B

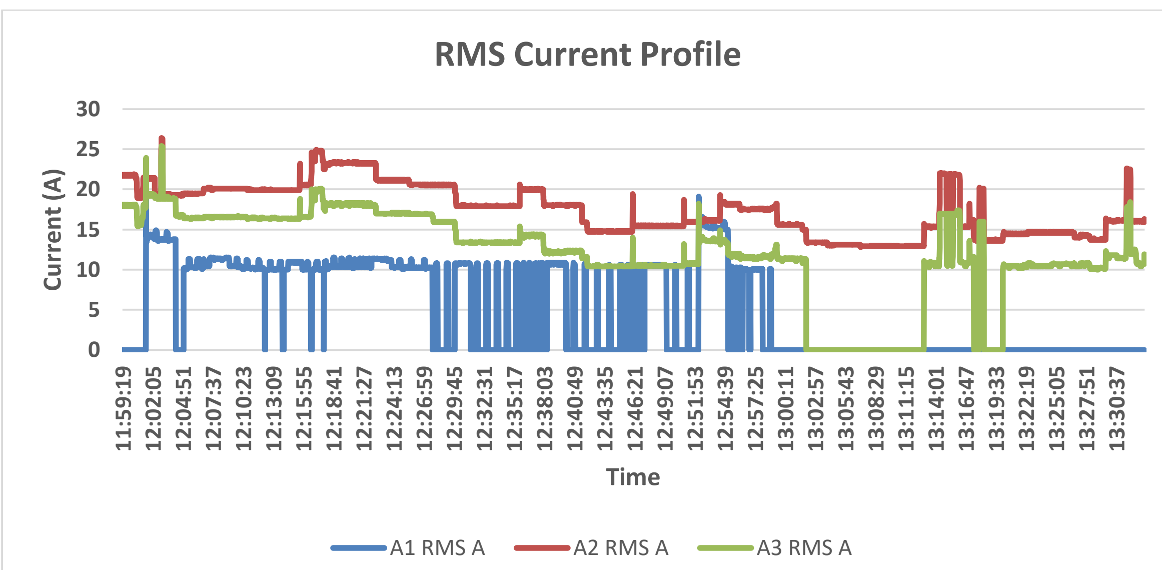

Figure 17: RMS Current Profile of Block B

The figure above shows the profile of voltage variations during the audit period and it was observed that, the voltage varies in the range **384 V to 393 V**. Also the profile of current variations during the audit period was observed in the range **4.27 A to 21.83 A.**

Maximum Voltage Distortion for SEB/Utility as per IEEE Standard 519:

Bus Voltage at PCC	Individual Voltage Distortion(%)	Total Voltage Distortion THD (V) (%)
69 kV and below	**3.0**	**5.0**
69.001 kV through 161 kV	1.5	2.5
161 kV and above	1.0	1.5
Note: High voltage systems can have up to 2.0% THD where the cause is an HVDC terminalthat will attenuate by the time it is tapped for a user.		

To assess the presence of current harmonic disturbing the power quality of electrical network, we have to calculate the short circuit ratio I_{sc}/I_L, through following formula where I_{SC} is the max short circuit current at the point of coupling "PCC". I_L is the max fundamental frequency load current at PCC. TDD is the Total Demand Distortion (=THD normalized by I_L).

$$I_{SC} \text{ at the secondary of transformer} = \frac{\text{Rated Capacity of Transformer}}{\text{Impedance of Transformer}}$$

Limits of Voltage & Current Harmonics as Per IEEE-519-1993:

For PCC Voltages 69kV & below						
Maximum Harmonic Current Distortion in % of I_L						
Individual Harmonic Order (Odd Harmonics)						
I_{SC}/I_{load}	**<11**	**11≤h<17**	**17≤h<23**	**23≤h<35**	**35≤h**	**TDD**

<20*	4	2	1.5	0.6	0.3	5
20 < 50	7	3.5	2.5	1	0.5	8
50 < 100	10	4.5	4	1.5	0.7	12
100 < 1000	12	5.5	5	2	1	15
> 1000	15	7	6	2.5	1.4	20

Even harmonics are limited to 25% of the odd harmonics limits above.

Current distortions that result in a direct current offset, e.g., half wave converters are not allowed.

*** All power generation equipment is limited to these values of current distortion, regardless ofactual I_{sc}/I_L.**

Where,
I_{sc} = Maximum short circuit current at Pcc. And I_L = Maximum Demand Load Current (fundamentalfrequency component) at PCC; TDD = Total Demand Distortion

The table is for 6 pulse rectifiers. For 12-pulse, 18-pulse, etc. increase characteristic harmonicsby: the value of the square root of q/6, where q = 12, 18, etc. Thus for 12-pulse, increase by 1.414.

CHAPTER: 4 PUMPING SYSTEM

4.1 PUMPING SYSTEM

Pumping Systems account for nearly 20% of the world's electrical energy demand. Furthermore, they range between 25-50% of the energy usage in certain industrial plant operations. The use of pumping systems is widespread. They provide domestic, commercial, and agricultural services. In addition, they provide municipal water and wastewater services, and industrial services for food processing, chemical, petrochemical, pharmaceutical, and mechanical industries.

Pumps have two main purposes:

- Transfer of liquid from one place to another place (e.g., water from an underground aquifer into a water storage tank)
- Circulate liquid around a system (e.g., cooling water or lubricants through machines and equipment)

Since the pump is a dynamic device, it is convenient to consider the pressure in terms of head i.e., meters of liquid column. The pump generates the same head of liquid whatever the density of the liquid being pumped. The actual contours of the hydraulic passages of the impeller and the casing are extremely important in order to attain the highest efficiency possible. The standard convention for centrifugal pump is to draw the pump performance curves showing Flow on the Horizontal Axis and Head generated on the Vertical Axis. Efficiency, Power & NPSH required are conventionally shown on the vertical axis, plotted against Flow, as illustrated in the figure below

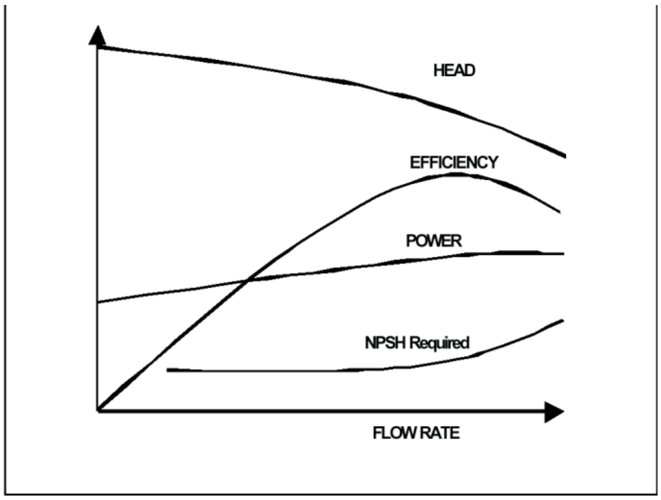

Figure 18: Pump Performance Curve

Given the significant amount of electricity attributed to pumping systems, even small improvements in pumping efficiency could yield very significant savings of electricity. The pump is among the most inefficient of the components that comprise a pumping system, including the motor, transmission drive, piping and valves.

Hydraulic power, pump shaft power and electrical input power:

$$\text{Hydraulic Power (Ph)} = \frac{Q \text{ X } (h_d - h_s) \text{ X } \rho \text{ X } g}{1000}$$

Where, Q: Flow Rate (in m^3/hr.)

h_d: Discharge Head (in metres)

h_s: Suction Head (in metres)

ϱ: Density of the Fluid (in kg/m^3)

g: Acceleration due to gravity (m/s^2)

$$\text{Pump Shaft Power } (P_s) = \frac{\text{Hydraulic Power } (P_h)}{\text{Pump Efficiency}}$$

Electrical Input Power = Pump Shaft Power (Ps) X Motor Efficiency (η)

IHE has installed two bore wells for ground water extraction of capacity 3HP each and one supply water transfer pump of 3 HP capacity. Audit team has been conducted the performance assessment of pumps which are shown in below table.

Table 6: Performance Assessment of Source Water Pump

Sr. No.	Description	Unit	Supply Water Transfer Pump	Submersible Pump
1	Input Power of Pump	kW	1.12	0.83
2	Motor Efficiency	%	89	89
3	Shaft Power	kW	0.99	0.74
4	Total Head	m	60.00	45.00
5	Density of Fluid	kg/m^3	1000	1000
6	Water Flow	m^3/hr.	3.9	4.4
7	Hydraulic Power	kW	0.64	0.54
Pump Calculated Efficiency		%	**64.17%**	**72.81%**

4.2 OBSERVATIONS AND RECOMMENDATIONS

- Performance Assessment of Supply Water Transfer Pump and Submersible pump has been done and its performance found satisfactory.

CHAPTER: 5 AC's PERFORMANCE

In IHE 32 numbers of AC units are installed on different floor with various capacity and type. Rated capacity of each AC unit along with its location are given in below tables.

Table 7: Installed AC's in Building

S.N	AREA	TYPE	NOS.	RATED TR	Watt	TOTAL WATTAGE
1	Block-A Ground Floor	Window Ac	6	1.50	1758.5	10551
		SPLIT AC	3	2.00	2269.0	6807
			3	1.50	1701.8	5105
2	Block-A First Floor	Window Ac	3	1.50	1758.5	5276
			1	2.00	2344.7	2345
3	Block-A Second Floor	Window Ac	3	1.50	1758.5	5276
			1	1.00	1172.3	1172
		SPLIT AC	2	1.50	1701.8	3404
			1	2.00	2269.0	2269
4	Block-A Third Floor	Window Ac	1	1.50	1758.5	1759
		SPLIT AC	2	2.00	2269.0	4538

S.N	AREA	TYPE	NOS.		Watt	TOTAL WATTAGE
1	Block-A Basement Floor	Window Ac	-	-		
		SPLIT AC	3	2	2269.0	6807.1
2	Block-A Ground Floor	Window Ac	-	-		
		SPLIT AC	1	2	2269.0	2269.0
3	Block-A First Floor	Window Ac	-	-		
		SPLIT AC	1	2	2269.0	2269.0
4	Block-A Secondfloor	Window Ac	-	-		
		SPLIT AC	1	2	2269.0	2269.0
5	Block-A Third Floor	Window Ac	-	-		
		SPLIT AC	-	-		

Performance Assessment of some AC units has been conducted during the audit which results are listed in below table.

Table 8: AC's Performance Assessment

Sr. No.	Location	Nos	Rating	Electrical load				Flow	Area Section	Suction		Discharge		Performance	
										DBT	RH	DBT	RH		
				Voltage	PF	Ampere	KW	m/s	m2	°C	%	°C	%	TR	KW/TR
1	Block-B Room No-1003	**Split**	2	221	0.81	5	0.90	2.9	0.066	16	78	10	66	0.81	1.10
2	Block-B Room No-1105	**Split**	2	220	0.82	4.5	0.81	2.75	0.041	19	78	14.2	58	0.52	1.57
3	Block-B Room No-1204	**Split**	2	220	0.76	4.7	0.79	3	0.041	20	89	17.6	57	0.57	1.37
4	Block-A Admin Room	**Split**	1.5	219	0.80	4.3	0.75	3.2	0.035	17.9	83	14.5	65	0.41	1.85
5	Account Room	**Window**	1.5	217	0.79	4.9	0.84	2.8	0.045	22	80	16	68	0.69	1.22
6	Library	**Split**	2	217	0.85	5.1	0.94	3.8	0.045	18.2	79	15.2	55	0.66	1.43
7	Computer Lab-318	**Split**	2	221	0.88	5.6	1.09	3.4	0.041	23.6	81	21.6	59	0.58	1.88
8	Server Room	**Split**	1.5	222	0.84	5.8	1.08	3.9	0.041	22.8	84	21.6	60	0.59	1.82
9	Director Room	**Split**	1.5	220	0.81	4.9	1.51	4.2	0.046	22.1	79	19.4	52	0.92	1.64

Management has adopted AMC for AC's and regular service of AC support in good performance. So AC performance found satisfactory during audit.

CHAPTER 6 LIGHTING PERFORMANCE

6.1 ENERGY SAVING IN LIGHTING

IHE has already replaced conventional tube light of 40 W capacity with LED tube light of 18 W capacity in some of the area of institution building. Few areas where conventional tube lights installed are identified by audit team and recommended for their replacement with LED tube light.

LED tubelight has several advantage over conventional choke tubelight like:

1) Low Energy Consumption & higher Cost Saving
2) Low Heat Production
3) Higher Life Span of around 20000 Hrs.
4) LED tubelight maintain their brightness levels throughout their lifespan.

Table 9: Cost Benefit Analysis

Sr. No	Particulars	UOM	Values
1	Energy consumption of Conventional Choke Tube Light	KW	0.04
2	Energy Consumption of LED Tube Light	KW	0.02
3	Operating Hours/day	hrs	6
4	Annual Operating Period	days	200
5	Quantity of Luminary	nos	259
6	% of Light Operating at any instant	%	0.6
7	Annual Energy Saving	kWh	4,103
8	Unit Cost of Electricity	Rs./kWh	8.50
9	Annual Monetary Saving	Rs in lakhs	0.35
10	Total Investment	Rs. in lakhs	0.52
11	Payback period	Months	18

6.2 LUX LEVELS OF VARIOUS LIGHTING AREAS

The lux levels at various locations were measured with a lux meter which is detailed below:

Table 10: Lux Details Block A

SN.NO.	AREA/LOCATION	MIN	MAX	AVG.	Remark
Block - A /Ground Floor					
1	Director room	221	225	223	Within Limit
2	Kitchen Area	105	109	107	Within Limit
3	SPA Room	102	110	106	Within Limit
4	Administration	198.5	206	202.25	Within Limit
5	Common Room	194	199	196.5	Within Limit
6	Canten				Within Limit
7	Account	175	184	179.5	Within Limit
8	Room No.-13 (IQAC/NAAC)	201	220	210.5	Within Limit
9	Room No.-9	114	118	116	Within Limit
10	Room No.-11	145	150	147.5	Within Limit
11	Room No.-10	165	161	163	Within Limit
12	Room No.-11A	167	175	171	Within Limit
13	Room No.-8A	125	132	128.5	Within Limit
14	Room No.-8	156	166	161	Within Limit
15	Room No.-8B	161	167	164	Within Limit
16	Room No.-5	157	167	162	Within Limit
17	Room No.-6	166	169	167.5	Within Limit
Block - A /First Floor					
18	Room No.101	165	170	167.5	Within Limit
19	Room No.102 (Medical Room)	213	252	232.5	Within Limit
20	Room No.103	265	284	274.5	Within Limit
21	Room No.103 A	214	225	219.5	Within Limit
22	Room No.104	243	256	249.5	Within Limit

SN.NO.	AREA/LOCATION	MIN	MAX	AVG.	Remark
23	Room No.105	274	298	286	Within Limit
24	Room No.106	199	216	207.5	Within Limit
25	Room No.107	161	165	163	Within Limit
26	Room No.108	175	167	171	Within Limit
27	Room No.109	132	125	128.5	Within Limit
28	Room No.110	166	156	161	Within Limit
29	Room No.111	167	161	164	Within Limit
30	Room No.112	167	157	162	Within Limit
31	Room No.114	169	166	167.5	Within Limit
32	Room No.115	245	266	255.5	Within Limit
33	Room No.116	224	248	236	Within Limit
34	Room No.117	246	278	262	Within Limit
35	Phatocop	226	265	245.5	Within Limit
36	Room No.119 (Staff Room)	285	299	292	Within Limit
37	Room No.120	265	287	276	Within Limit
Block - A / Second Floor					
38	Room No.201	265	289	277	Within Limit
39	Room No.202	298	305	301.5	Within Limit
40	Room No.203	266	301	283.5	Within Limit
41	Room No.204	265	288	276.5	Within Limit
42	Room No.205	267	278	272.5	Within Limit
43	Room No.206	285	297	291	Within Limit
44	Room No.207	249	268	258.5	Within Limit
45	Room No.209	167	161	164	Within Limit
46	Room No.210	206	209	207.5	Within Limit
47	Room No.211	169	166	167.5	Within Limit
48	Room No.211 A	245	266	255.5	Within Limit
49	Room No.212	224	248	236	Within Limit
50	Room No.213	246	278	262	Within Limit
51	Room No.214	249	255	252	Within Limit

SN.NO.	AREA/LOCATION	MIN	MAX	AVG.	Remark
52	Room No.215	201	265	233	Within Limit
53	Room No.216	198	204	201	Within Limit
54	Room No.217 (Server room)	187	209	198	Within Limit
55	Room No.218	221	265	243	Within Limit
56	Room No.221	222	233	227.5	Within Limit
Block - A / Third Floor					
57	Room No.301	267	288	277.5	Within Limit
58	Room No.302	249	277	263	Within Limit
59	Room No.303	169	176	172.5	Within Limit
60	Room No.304	245	266	255.5	Within Limit
61	Room No.306	224	248	236	Within Limit
62	Room No.307	246	278	262	Within Limit
63	Room No.308	213	226	219.5	Within Limit
64	Room No.309	265	298	281.5	Within Limit
65	Room No.310	214	265	239.5	Within Limit
66	Room No.312	243	278	260.5	Within Limit
67	Room No.315	274	295	284.5	Within Limit
68	Room No.316	199	206	202.5	Within Limit
69	Room No.317	161	201	181	Within Limit
70	Room No.318 (Computer lab)	175	199	187	Within Limit
71	Room No.319	285	296	290.5	Within Limit
72	Room No.321 (Computer lab)	282	287.3	284.65	Within Limit
73	Room No.322 (Computer lab)	245	278	261.5	Within Limit
74	Server Room	248	265	256.5	Within Limit
75	Library	301	306	303.5	Within Limit

Table 11: Lux Details Block B

SN.NO.	AREA/LOCATION	MIN	MAX	AVG.	Remark
Block - B /Basement					
1	Pannel Room	167	198	182.5	Within Limit
2	Fitness center	205	211	208	Within Limit
3	Physical Edu(Basement	245	265	255	Within Limit
Block - B /Ground Floor					
4	1001	206	224	215	Within Limit
5	1002	289	306	297.5	Within Limit
6	1003 (Confereaance room)	289	309	299	Within Limit
7	1004	226	269	247.5	Within Limit
8	1005	264	298	281	Within Limit
9	1006	287	294	290.5	Within Limit
Block - B / first Floor					
10	1101	175	184	179.5	Within Limit
11	1102	201	220	210.5	Within Limit
12	1103	114	118	116	Within Limit
13	1104	145	150	147.5	Within Limit
14	1105	165	161	163	Within Limit
15	1106	167	175	171	Within Limit
Block - B / Second Floor					
17	1201	265	288	276.5	Within Limit
18	1202	267	278	272.5	Within Limit
19	1203	285	297	291	Within Limit
20	1204	249	268	258.5	Within Limit
21	1205	167	161	164	Within Limit
22	1206	206	209	207.5	Within Limit
Block - B / Third Floor					
23	1301	265	284	274.5	Within Limit
24	1302	214	225	219.5	Within Limit
25	1303	243	256	249.5	Within Limit
26	1304	274	298	286	Within Limit

SN.NO.	AREA/LOCATION	MIN	MAX	AVG.	Remark
27	1305	199	216	207.5	Within Limit
28	1306	161	165	163	Within Limit

The below table may be referred to decide the minimum LUX level to be maintained at different areas in the office which includes office, production floor and street lighting.

BIS standard (IS 3646-1 (1992): Code of practice for interior illumination)

Activity	LUX
Passage	50-100-150
General Office	300-500-750
Substation	100-150-200

6.3 OBSERVATIONS AND RECOMMENDATIONS

- LED Solar Street lights were already incorporated.
- Few areas where conventional tube lights installed are identified by audit team and recommended for their replacement with LED tube light.

CHAPTER: 7 ENERGY SAVING PERFORMANCE SHEET

Encon 1: Power Factor Correction

Background:

IHE receives electricity supply from BSES Rajdhani Power Limited, New Delhi and from open access with 11 KV as the input voltage that comes under Non Domestic/above 3KVA (supply upto 11kv) Category. The Contract Demand is 295 kVA. It is observed from electricity bills of last year that the average power factor is 0.83.

Recommendation:

Existing power factor can be improved from 0.83 to 0.99 by installing 80 KVAR APFC panel. Therefore, the annual energy saving will be 2275 KVAh which result in annual monetary saving of INR 2.32 Lakh and payback period will be 5 months.

Table 12: Cost Benefit Analysis of Power Factor Correction

Particular	UOM	Value
Present Operating Power Factor		0.83
Non Corrected Load (Avg. Monthly)	KVA	150
Actual Load (Avg. Monthly)	KW	124.5
Desired Power Factor		0.99
Proposed Capacitor Bank	KVAR -- KW*(Tan(Cos-1 (ø1))-Tan(cos-1(ø2)))	80
Energy Consumption (Average/Month)	KVAh	14075
Actual Energy Consumption (Average/Month)	KWh	11682
Energy Consumption at Desired PF (@0.99) (Average/Month)	KVAh	11800
Energy Saving	KVAh	2275
Annual Energy Saving	KVAh	27297
Annual Monetary Saving in Energy	Rs/Year	232024.2
Total Monetary Saving	Rs/Year	232024.24
Investment	Rs	88000
Payback (Months)	Months	5

Encon 2: Energy Saving by Installation of Solar Power Plant of 120 kWp

Background:

The Institute has roof top space where solar PV panels can be installed. It is therefore, recommended to use the roof top of building for this purpose of installation of solar PV plant.

Recommendation:

The indicative analysis has been done on the basis of area available.

Table 13 : Cost Benefit Analysis of Installing Solar Panel

Sr. No	Parameters	UOM	Value
1	Available Area Rooftop	m2	2750
2	Considered Area	m2	1375
3	Size of Solar System	kWp	120
4	Approx. Annual Generation from Solar Power Plant	kWh/year	192000
5	Current Avg. Tariff Electrical Unit Cost from DISCOM	Rs./kWh	8.5
6	Avg. Annual Energy Consumption @ 14075 kWh Monthly	kWh	168900
7	Units Generated Annually (in kWh)	kWh/year	189216
8	Kcals Savings	Kcals	162725760
9	Monetary Savings	Lakh/year	16.08
10	Investment @40,991 rs per KW	lakh	49.19
11	Payback Period	months	37

For example, to generate 10,000 watts from a 12% efficient system, we need a 100 sq MTR of roof area. Solar home lighting systems approved under NSM (National Solar Mission) are required to have a certain level of efficiency. The CFL based solar systems are required to have module efficiency of 14% and above and a LED based solar system is required to have module efficiency of 12% and above.

The units or kWh output of a solar panel will depend on the panel efficiency and availability of sunlight in a location. The factor that defines this output is called CUF (or Capacity Utility Factor). For India, it is typically taken as 19% and the calculation of units goes as:

Units Generated Annually (in kWh) = System Size in Kw * CUF * 365 * 24.

So typically, a 1 kW capacity solar system will generate 1600-1700 kWh of electricity per year. This can provide electricity for 25 years.

Around 120 kw of solar PV based power plant can be installed in the areas as recommended above which cost capital @ 0.41 lac /kw will be required. Thus, the total cost will be around 49.19 lacs. The annual Power generation will be 189216 kWh. The total cost of such power @Rs 8.5 /kWh, INR 16.08 lakh. Accordingly, the payback period is around 3 Years.

This way recommendation if opted will result in reduction in electricity cost of the establishment.

Encon 2: Replacing Conventional Choke Tubelight with LED Tubelight

LED tubelight has several advantage over conventional choke tubelight like:

5) Low Energy Consumption & higher Cost Saving
6) Low Heat Production
7) Higher Life Span of around 20000 Hrs.
8) LED tubelight maintain their brightness levels throughout their lifespan.

IHE has already replaced conventional tube light of 40 W capacity with LED tube light of 18 W capacity in some of the area of institution building. Few areas where conventional tube lights installed are identified by audit team and recommended for their replacement with LED tube light. A cost benefit analysis is given below-

Table 14 : Cost Benefit Analysis of Replacement of Choke Tubelight with LED Tube

Sr. No	Particulars	UOM	Values
1	Energy consumption of Conventional Choke Tube Light	KW	0.04
2	Energy Consumption of LED Tube Light	KW	0.02
3	Operating Hours/day	hrs	6

Sr. No	Particulars	UOM	Values
4	Annual Operating Period	days	200
5	Quantity of Luminary	nos	259
6	% of Light Operating at any instant	%	0.6
7	Annual Energy Saving	kWh	4,103
8	Unit Cost of Electricity	Rs./kWh	8.50
9	Annual Monetary Saving	Rs in lakhs	0.35
10	Total Investment	Rs. in lakhs	0.52
11	Payback period	Months	18

Replacement of conventional tube light with LED tube light will give **4103 Kwh** annual energy saving, **INR 0.35 lakh** monetary saving and payback period will be around **18 months.**

CHAPTER: 8 GENERAL TIPS FOR ENERGY CONSERVATION IN DIFFERENT SYSTEMS

8.1 ELECTRICITY

- Schedule your operations to maintain a high load factor.
- Minimize maximum demand by tripping loads through a demand controller.
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

8.2 MOTORS

- Properly size to the load for optimum efficiency (High efficiency motors offer 4 - 5% higherefficiency than standard motors).
- Check alignment.
- Provide proper ventilation (For every 10°C increase in motor operating temperature overrecommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply (An unbalanced voltage can reduce 3 - 5% in motorinput power).
- Demand efficiency restoration after motor rewinding.

8.3 PUMPS

- Operate pumping near best efficiency point.

- Modify pumping to minimize throttling.
- Adept to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump inthe problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

8.4 DG SETS

- Optimize loading.
- Use waste heat to generate steam/hot water /power an absorption chiller or preheat processor utility feeds.
- Use jacket and head cooling water for process needs.
- Clean air filters regularly.
- Insulate exhaust pipes to reduce DG set room temperatures.
- Use cheaper heavy fuel oil for capacities more than 1MW.

8.5 HVAC (Heating / Ventilation / Air Conditioning)

- Tune up the HVAC control system.
- Consider installing a building automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.
- Balance the system to minimize flows and reduce blower/fan/pump power requirements.

- Eliminate or reduce reheat whenever possible.
- Use appropriate HVAC thermostat setback.
- Use morning pre-cooling in summer and pre-heating in winter (i.e. -- before electrical peak hours).
- Use building thermal lag to minimize HVAC equipment operating time.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.
- Reduce HVAC system operating hours (e.g. -- night, weekend).
- Optimize ventilation.
- Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).
- Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
- Use evaporative cooling in dry climates.
- Reduce humidification or dehumidification during unoccupied periods.
- Use atomization rather than steam for humidification where possible.
- Clean HVAC unit coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.
- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air-conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in high-bay areas.
- Relocate air diffusers to optimum heights in areas with high ceilings.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.

- Use professionally-designed industrial ventilation hoods for dust and vapor control.
- Use local infrared heat for personnel rather than heating the entire area.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
- Purchase only high-efficiency models for HVAC window units.
- Put HVAC window units on timer control.
- Don't oversize cooling units. (Oversized units will "short cycle" which results in poor humidity control.)
- Install multi-fueling capability and run with the cheapest fuel available at the time.
- Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
- Minimize HVAC fan speeds.
- Consider desiccant drying of outside air to reduce cooling requirements in humid climates.
- Consider ground source heat pumps.
- Seal leaky HVAC ductwork.
- Seal all leaks around coils.
- Repair loose or damaged flexible connections (including those under air handling units).
- Eliminate simultaneous heating and cooling during seasonal transition periods.
- Zone HVAC air and water systems to minimize energy use.
- Inspect, clean, lubricate, and adjust damper blades and linkages.
- Establish an HVAC efficiency-maintenance program. Start with an energy audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

8.6 MISCELLANEOUS

- Meter any unmetered utilities. Know what normal efficient use is. Track down causes ofdeviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like AC and cooling water.
- Renegotiate utilities contracts to reflect current loads and variations.

- Consider buying utilities from neighbors, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease willcontinue for several more years.

CHAPTER: 9- ANNEXURES

1. **Site Photographs**

Figure 19: Site Photograph 1 – Energy Recording at Main Incomer

Figure 20: Site Photograph – Awareness Regarding Energy Efficiency

Figure 21: Site Photograph – Solar Street Light

Figure 22: Site Photograph – Awareness Activity

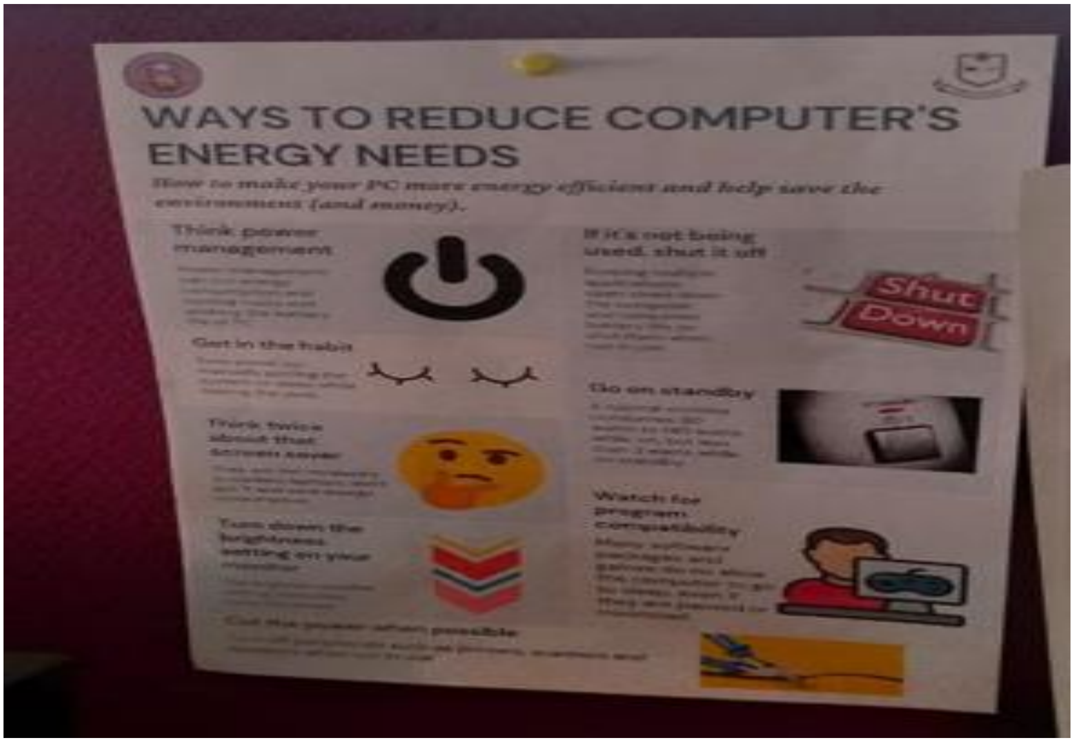

Figure 23: Site Photograph – Awareness Activity

2. A Survey on Energy Management Practices by Institute

ENERGY MANAGEMENT PRACTICES

INSTITUTE OF HOME ECONOMICS

(June 2020 – July 2021)

Compiled by:

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Environment and Community Outreach Committee

Institute of Home Economics

University of Delhi

Energy Consumption: A Survey Report

Introduction

Energy consumption and economic growth are closely interlinked. India's energy policy focus on increasing energy generation and to reduce energy poverty. In contemporary times the drift has been on developing alternative sources of energy and working towards self-sustainability. In 2017, India attained 63% energy self-sufficiency. The good practice and endeavours of energy generation and reducing energy poverty may further be instilled in behaviour and functioning through HEI. To navigate and understand the consumption, attitudes and readiness for energy saving opportunities, a survey was conducted in the college. The survey elicited 550 responses. The participants were students, faculty and non-teaching staff.

The survey aimed to understand the existing fuel consumption patterns among staff and students. It also was an attempt to increase the awareness regarding the usage of green fuel.

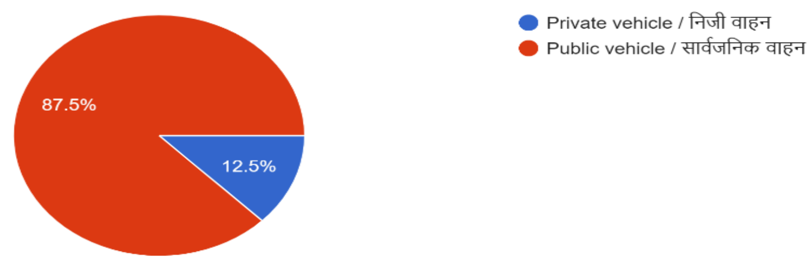
Method

The questionnaire used as the survey instrument consisted of 13 questions items translated both in English and Hindi including questions on background information as well as fuel consumption pattern. A sample of the questionnaire was generated and shared using the link https://forms.gle/L66EstWcEq7PGhrd6. Further the questionnaire was circulated among teaching and non-teaching staff as well as students through the WhatsApp groups. Responses were generated on excel format, frequency tabulation and percentages were auto generated using excel software. Students and faculty both were involved in constructing tools, result analysis and discussion.

Results and Discussions

The survey generated a total of 550 responses. It was found that out of total 82.7% (n = 454) were from students, 10.9% (n = 60) were teachers and 6.4% (n = 35) were non-teaching staff. A gender distribution represented 529 (96.2%) were women and 21 (3.8%) men respondents. Further, the age wise pattern in the survey participation highlighted majority respondents to be in age of 18-25 years, 2.9 % were between 25-35 years, 8.2 % were in 35-50 years and 6 % were above 50 years.

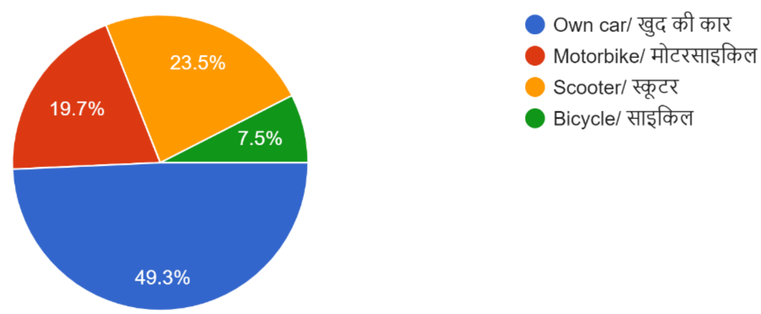
Table 1. Mode of Transport Used



Majority of respondents i.e. 87.5% (n=477) utilized pubic transport for commuting to college in comparison to 12.5% (n= 68) who used private vehicles. Recommendations of working group on Urban Transport (2006) and Ministry of New and Renewable Energy, Government of India have deliberated the changing landscape of cities in favour of planning, practices and support.

Further the use public transport as mode of commuting highlighted commuting by metro (80.3%) followed by bus (13.1%), autorickshaw (3.4%), cab (1.7%), train (0.9%).

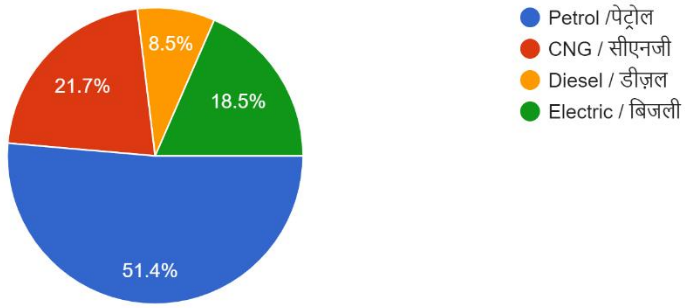
Table 2. Fuel patterns of Private Vehicle Commuters



213 respondents preferred and used private vehicles like cars (49.3%; n= 105), two wheelers (23.5%; n=50) and motorbikes (19.7%; n= 42) while bicycles (7.5%; n=16). The college environment committee has taken a note of it and would work towards channelising renewable fuel sources further.

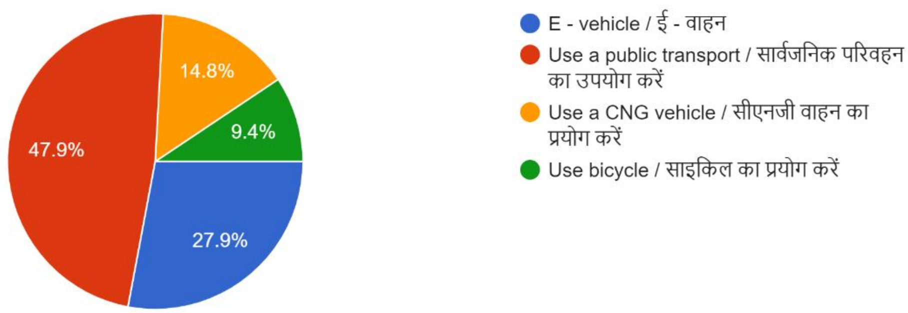
Another finding elaborated on preference towards carpooling. Only 30% (138) respondents reported use carpooling. This may require further attention.

Table 3: Nature of Fuel Consumption at IHE



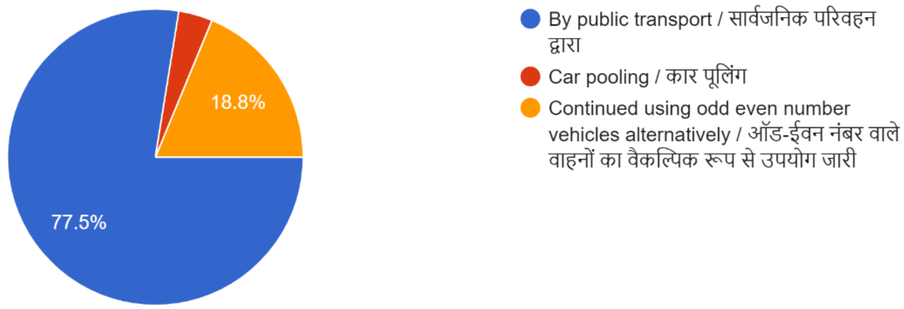
The college data revealed that almost half of the respondents were conscious fuel consumers working towards renewable and green energy alternatives as the fuel sources. Almost 40.2% staff and students in the college used CNG and electric energy as their vehicle fuel source used were reported as CNG (21.7%), electric (18.5%). The least preferred fuel was diesel which was reported to be used by 8.5% of respondents. Almost all that is 510 respondents (96.1%) of the college consented in favor of green and sustainable energy to be used as an energy alternative source.

Table 4. Preferred Commuting Pattern



Most respondents opted for utilizing public transport (47.9%; n=240) as their preferred option. Other opted for switching over to e-vehicles (27.9%, n= 140), use of CNG vehicle (14.8%, n=74) and use of bicycle (9.4%; n=47).

Table 4. Tackling the AQI crisis in Delhi



The college responded to Delhi's very poor Air Quality Index (AQI), by mostly switching over to public mode of transport (75 %). More than 75% (n= 397) while some (18.8%) continued to use odd and even number vehicles alternatively and only 3.7% reported to initiate carpooling.

Conclusions

- IHE is an energy and fuel conscious college. Most prefer and use public transport to commute to the college.
- The switch over to green energy fuel-based vehicles was a preferred choice for most private vehicle commuters in the college.
- Better community-based programmes and vehicle link apps may facilitate carpooling in the college.
- The college is geared towards renewable energy plan and switch over and is actively working to be fully energy efficient.