ENERGY AUDIT REPORT

Manipal University, Dehmi Kalan, Jaipur,

303007

Conducted by

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DISCLAIMER

This report is based on the information provided by the management of **New Door, Jaipur** & on-site observations on specific dates. We certify that this information and following analysis is correct to the best of our knowledge and ability. The validity of the recommendations is dependent on the accuracy of log books and historical data supplied to us. This report (including any enclosures and attachments) has been prepared for the exclusive use and benefit of the addressee(s) and solely for the purpose for which it is provided. Unless we provide express prior written consent, no part of this report should be reproduced, distributed or communicated to any third party. We do not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report. The recommendations and findings are to be used by client at their own accord and Inventum Power Private Limited or its associates would not be responsible for any material or non-material losses (if any) occurring in any way due to their implementation.

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ACKNOWLEDGEMENT

INVENTUM POWER PVT. LTD. express our sincere thanks to the management of **"New Door"** for giving us the opportunity to conduct energy audit at their Facility and give our findings to them.

INVENTUM POWER PVT. LTD. acknowledges and appreciates the commitment of the management towards conservation of Energy. It needs to be stated here that the **NEW DOOR MANAGEMENT** has been very supportive and cooperative resulting in expeditious completion of the energy audit.

We hereby also express our thanks to all other staff for their support during field study & data collection. We hope that the recommendations/suggestions given in this report will help to reduce the present energy consumption of the Facility with reduced cost & improved productivity.

TEAM MEMBERS FROM ELIN ELECTRONICS UNIT

Mr Shahid Zamal	-Operations Head/Unit In charge
Mr Bharat Bhushan	- AGM
Mr Brij Mohan	-Deputy Manager
Mr Kunal	-Shift Engineer
Mr Hitesh	-Shift Engineer

TEAM MEMBERS FROM INVENTUM POWER PVT. LTD

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Mr. Abhishek Kumar	-	Executive

EXECUTIVE SUMMARY

Energy is one of the major inputs in any industry and is the mainstay of the economic development of the country. Rising Electricity & fuel costs coupled with increased global competition is forcing players to slash the energy costs. Energy Audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating & maintenance practices of the system. It is instrumental in coping with the situation of variation in energy cost availability, reliability of energy supply, decision on appropriate energy mix, decision on using improved energy conservation equipment's, instrumentation's and technology.

The total expenditure in Electrical energy cost is about **9.19 Crore from February 18 to January 19 & total water cost of 80.63 lakhs from Jan-19 to Oct-19 and.** It was aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities.

Energy conservation is a continuous process and there is always scope for further improvements, with this objective the Energy Audit team with the active involvement of **New door** have identified the following Energy Conservation Opportunities (ECO's). Implementation of the ECO's can further help reduce the energy consumption.

Total Saving potential is 7.5% in Electrical and 12.3% in water of the total energy Cost, accordingly we have enumerated the energy savings measures with reference to their payback periods. However, few measures are with larger payback periods but then there are certain initiatives which are necessary from modernization, energy conservation & corporate social responsibility point of view.

To review the reasons for excess energy consumption and Measures undertaken to improve Energy Efficiency, the following table would be helpful.

ENERGY SAVING SUMMARY

S.No	Energy Conservation Projects	Annual Water Saving (KL)	Annual Energy Saving (KVAh)	Annual Monetary Saving in Lakhs	Investment (in lakhs) Rs.	Payback Period in Months	Co2 Emission Reduction in Ton	Page No
1	Avoiding use of transformer-1 during non-peak months		21,818	2.05	1.5	9	17.9	54
2	Maintaining 410-415 V instead of 430 V at Transformer-1		1,40,695	13.23	Nil	Immediate	115.4	55
3	Energy saving achieved by Chiller set point optimisation		13,745	1.29	Nil	Immediate	11.3	57
4	Energy saving by chiller plant optimisation		43,636	4.10	Nil	Immediate	35.8	59
5	Installation of Automation in Unitary AC		7,987.2	0.75	1.2	19	6.5	63
6	Replacement of Old AC by Inverter AC		3,840	0.36	1.2	40	3.1	63
7	Increase Re-use of Grey-Waste Water from laundry	4000		9.76	15.0	18	-	68
8	Energy saving by using fine bubble diffuser		44,460.6	4.26	5.0	14.2	36.5	71
9	Aggregation and optimisation of compressed air usage in STP		3,625.3	0.34	0.5	17.8	3.0	74
10	Installation of Energy efficient fans		2,40,000	22.56	90.0	48	196.8	79
11	Replacement of Inefficient Heat Pumps (Either by new heat pump or through staform hot water system)		49,332.8	5.1	7.8	18.5	40.5	81
12	Cleaning and Maintenance of Heat pumps to improve COP		39,926.3	3.8	6.0	19.2	32.7	83
13	Installation of Solar street light at peripheral roads		24,741.8	2.3	9.5	48.8	20.3	85
Total		**4000**	**6,33,809**	**70**	**138**	**24**	**520**	

1. ENERGY CONSERVATION PRACTISES BY NEW DOOR

We would like to appreciate and admire various good energy practices by New Door engineering team which are as follows:

1. Use of renewable energy like Solar water heater and SPV in the premises.
2. Tighter control of chiller operations avoiding unnecessary use of it.
3. Continuous awareness on energy and water conservation through rear announcement in corridors of each block that can be heard from inside the room.
4. Use of water savings aerator saving at least 2000kl per year.
5. Use of 6/4 toilet flush saving lot of water.
6. Use of regulating chilled water for first and last 15 minutes operation of chiller without using compressors saving lot of energy.
7. Use of LED lights for roads and garden light.
8. Highly proactive maintenance of heat pumps due to which at least 50%of them are working.
9. Use of STP treated water in gardening reducing the requirement of fresh water.
10. Downstream energy metering as a good energy management system.
11. Use of **RAIN WATER STORAGE** system.

2. INTRODUCTION

2.1 OBJECTIVE OF ENERGY AUDIT:

Energy audit is the key to a systematic approach for decision-making in the area of energy management and gives a positive orientation to the energy resource cost reduction. The primary objective of the energy audit is to determine ways to reduce energy consumption to lower operating costs.

The Energy audit is conducted with the following Objectives:

- ❖ Detailed studies of the intended energy consuming equipment including historical and present energy performance trends
- ❖ Quantification of Energy Losses, and Energy Saving Potential
- ❖ Presentations of Energy Efficiency Measures with cost benefit analysis
- ❖ Identifying potential areas of electrical energy economy.

This energy audit assumes significance due to the fact that the New door**, total Electricity bill crossed 9.19 Crore from Feb'18 to Jan'19 & total water cost of 80.63 lakhs from Jan-19 to Oct-19** and it was aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities.

2.2 ABOUT NEW DOOR:

The door to the new era is opened by young people. A steady stream of young talent is essential for the development of societies and nations. At Good Host Spaces, we take great pleasure in fostering the youth, with our new door tech forward houses. When they set out to open doors for embracing new opportunities, in new cities, we offer them a dynamic living experience. Making their belief stronger in the magic of new beginnings.

2.3 ABOUT AUDIT TEAM MEMBERS:

We have dedicated and expert team for services. Your first point of contact with Inventum Power care will be with our dedicated customer services team. We are highly skilled, motivated and fully trained to assist you. Our services team includes our expert, highly experienced advisors for power factor correction systems, harmonic filter and others Energy and Power Quality problems who have over 40 years combined experience for the same. Each team member is dedicated to offering a high level of customer care and also strives for excellence to ensure that you receive the perfect service.

2.4 SCOPE OF ENERGY AUDIT WORK:

Electrical Distribution System:

- Study of Reactive Power Management and option for power factor improvement.
- Study of power quality issues like Power Factors, Voltages, Currents, Active Powers, Reactive Powers, Apparent Powers, THD & Harmonics at various load feeders.
- Capacitor bank health check-up
- Exploring the Energy Conservation Options (ENCON) in electrical distribution system to optimize transformer loading & improvement in level metering.
- Exploring the solutions for improving the power quality.

HVAC System

- Review the performance of the refrigeration & air conditioning systems including AHU, Chillers, Cooling tower, Air conditioners, find out Energy Efficiency Ratio, kW/TR, Specific TR loading and Kwh Calculation, available TR in the area through measuring velocity of air flow & temp. & humidity requirement as per existing & the proposed recommendation to suggest energy conservations means to improve the same.
- Collection of Inventory data of Air conditioners / Sample size selection and testing of power consumption and capacity (TR) delivered under the existing weather conditions / Air-conditioned floor area.

Pumps & Motors

- Performance assessment of HVAC pumps via Head/pressure, flow, power and determination of pump/motor loading based on measured parameters.
- Exploring the Energy Conservation Options (ENCON) in water pumping system. All saving & recommendation.

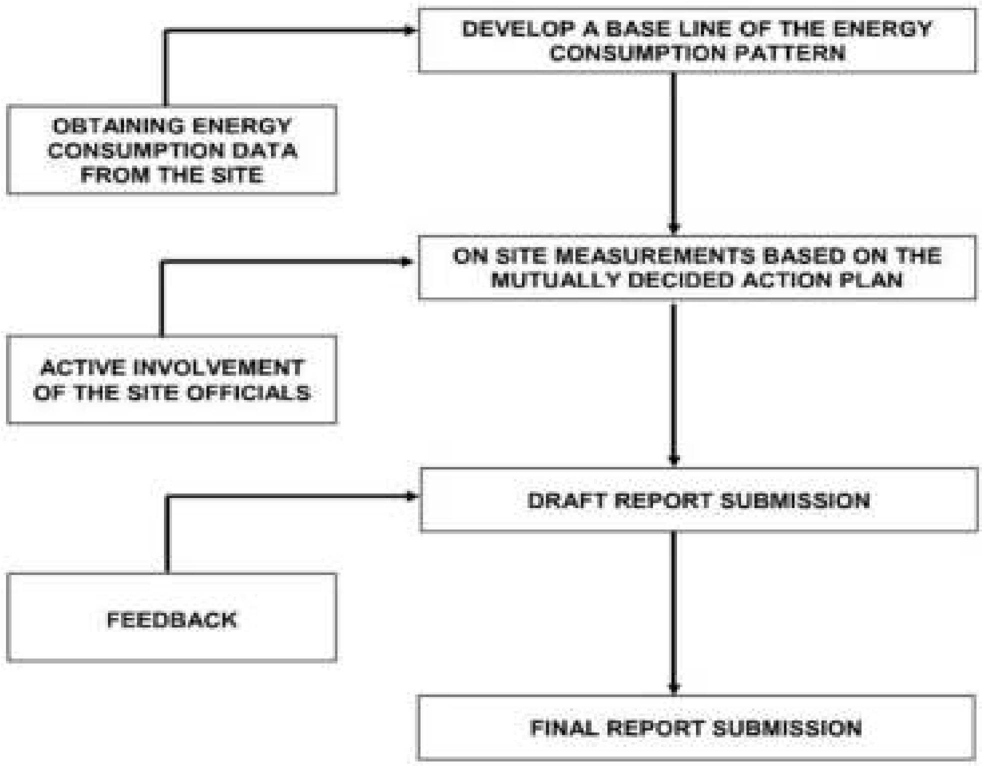
DG Sets:

- Review of the operation and performance of DG set through units generated, diesel consumption
- Specific fuel consumption in terms of KWh/Ltr and suggest for energy conservation opportunity.

2.5 METHODOLOGY OF WORK:

The methodology adopted for this audit was

- A preliminary energy audit has been conducted to establish the energy consumption of the organization by analyzing the available past energy consumption data, identification of the areas requiring more detailed study and measurements.
- Visual inspection and data collection.
- Identification/verification of energy consumption and other parameters by measurements.
- Computation and in-depth analysis of the collected data, including utilization of computerized analysis and other techniques as appropriate were done to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.
- Potential energy saving opportunities
- Flow Chart for Methodology for report preparation



This report is just first step, a mere mile marker towards our destination of achieving energy efficiency and 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.

2.6 LIST OF INSTRUMENTS

- 3 Phase Power Analyzer-Fluke 1736
- BlackBox-G3500
- Power Clamp
- Distance Meter
- Anemometer
- Hygrometer
- Thermal Camera

Figure 1: Energy Audit Instruments

3. GENERAL INFORMATION ABOUT UNIT

3.1 GENERAL DETAILS:

Name & Address of the Unit	New Door, Jaipur
Operational Days	300 Days per annum
Contact Officer	Mr Bharat Bushan
Electricity Connection Details & Consumption	
Connection Type	HT 33000/11000/415 V
Contract demand	4000kW
Average Max. Demand (Feb 18 to Jan'19)	2576
Annual Energy Purchased (Feb 18 to Jan'19)	11,724,600
Annual Energy Purchased Cost (Feb 18 to Jan'19)	9.19 Crore

Table 1: General details of the unit

3.2 ASSUMPTIONS:

For calculation purpose, we have considered following:

Type of Energy Resources	UOM	Value
No. of operating hrs in a day	hours	24
Avg. Electric Rate	Rs. /kVAh	9.4
Avg Water Rate	Rs./KL	246

Table 2: Assumption for calculation

3.3 % SHARE IN ENERGY CONSUMPTION

Percentage Share of Equipment	Energy consumption (KWh)	% Usage
HVAC	3647536	32.3%
Lighting & Fan	4732166	41.9%
STP & WTP	542948	4.8%
Hot water System	1280000	11.3%
Misc. (T&D Losses)	1095923	9.7%

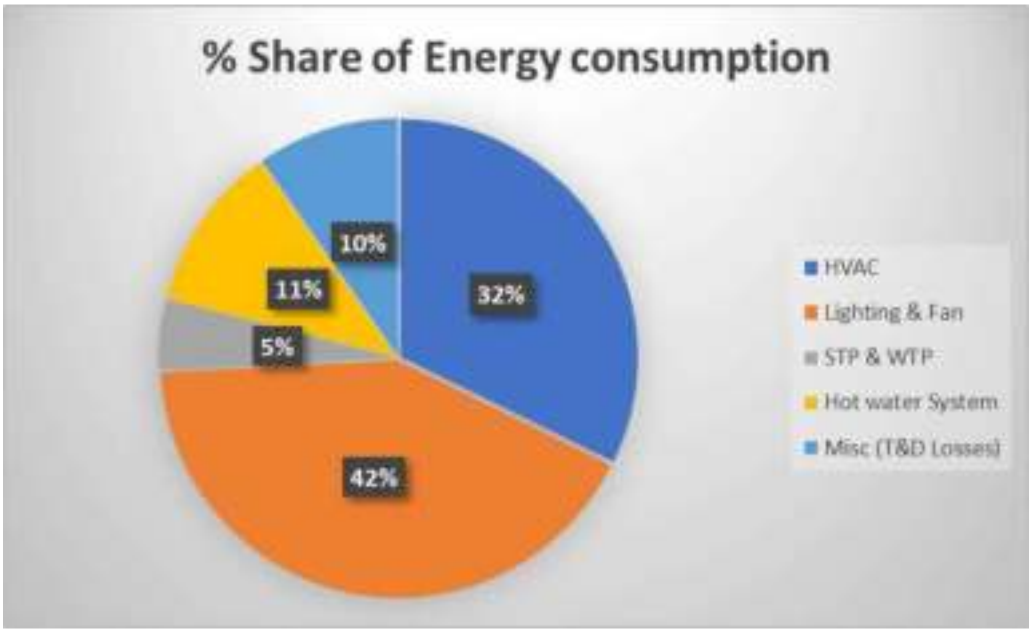


Figure 2: % Share in Energy consumption in different area

4. ELECTRICITY BILL ANALYSIS

4.1 MONTHLY KVAH CONSUMPTION TREND:

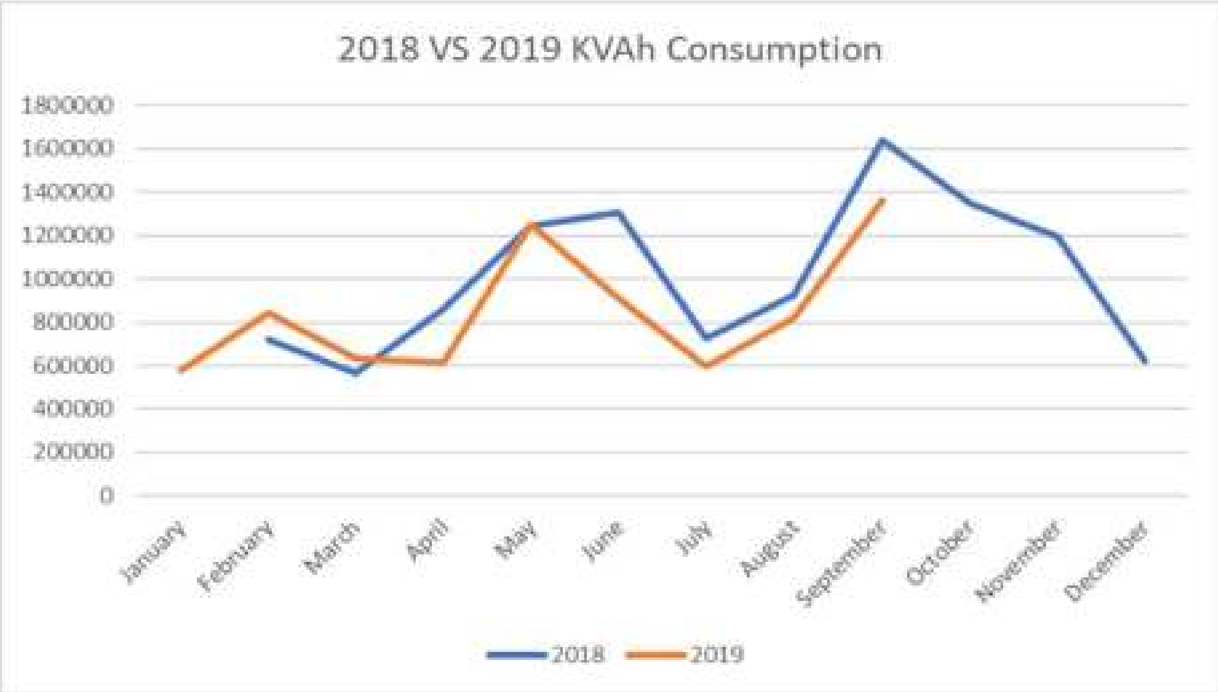


Figure 3: Monthly KVAh Trend

4.2 MONTHLY POWER FACTOR TREND:

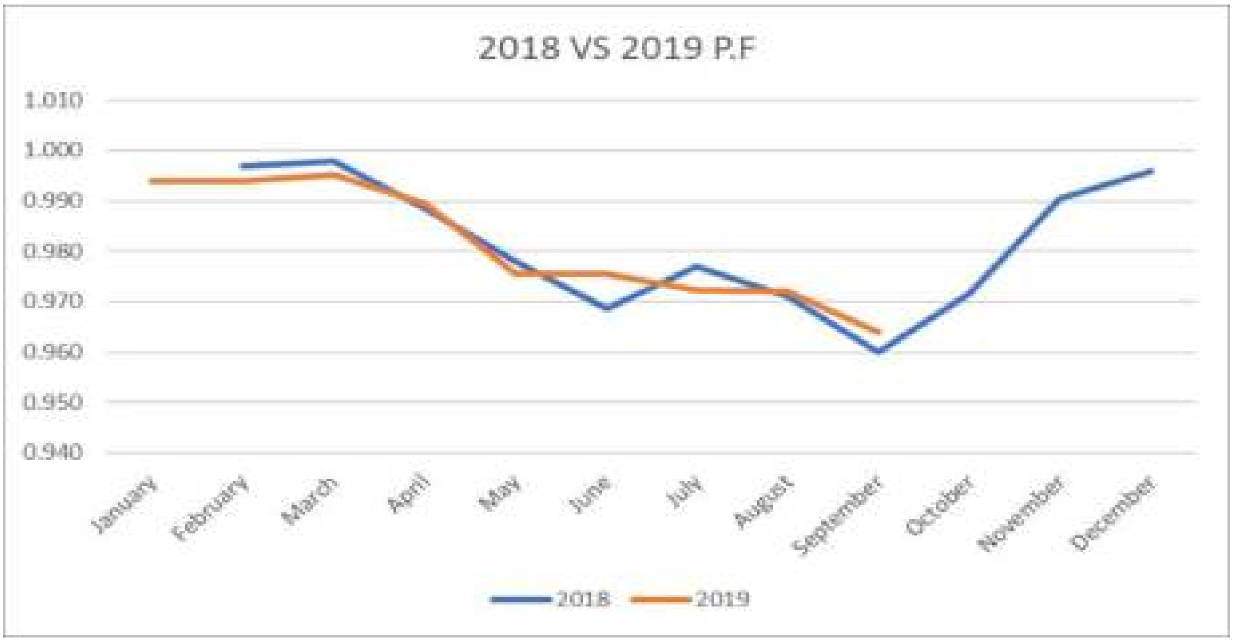


Figure 4: Monthly PF Trend

4.3 MONTHLY C.DEMAND V/S M.DEMAND TREND:

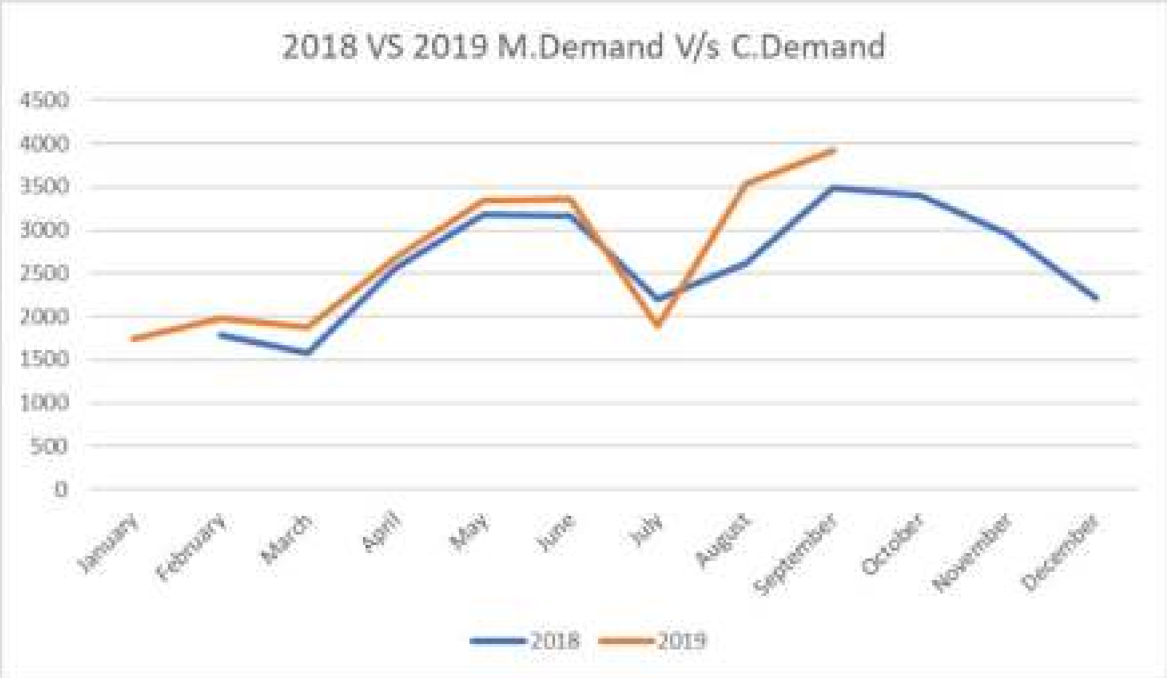


Figure 5: Monthly C. Demand VS M. Demand Trend

Sr no	Month	2018			2019		
		Maximum demand	KVAH	PF	Maximum demand	KVAH	PF
1	January	N. A	N. A	N. A	1746	579309	0.995
2	February	1788	721860	0.998	1980	543936	0.991
3	March	1578	567780	0.999	1872	631659	0.995
4	April	2556	859320	0.988	2670	613617	0.989
5	May	3180	1244040	0.978	3336	1250526	0.975
6	June	3168	1305048	0.969	3360	912564	0.976
7	July	2202	723312	0.978	1896	594477	0.972
8	August	2622	920940	0.971	3528	815805	0.973
9	September	3492	1636191	0.959	3924	1362039	0.964
10	October	3408	1346769	0.971	N. A	N. A	N. A
11	November	2952	1195887	0.991	N. A	N. A	N. A
12	December	2220	624144	0.997	N. A	N. A	N. A

Note: From electricity bill analysis we observed that P.F has decreased to 0.964 in the month of September. This may be due to Low Loading of the transformers.

4. PERFORMANCE ASSESSMENT AND ENERGY SAVING SCOPE

4.1 ELECTRICAL DISTRUBUTION SYSTEM:

4.1.1 POWER QUALITY STUDY OF TRASFORMERS:

At New door, 3 no's of Transformers are installed and the rated of the transformer are 3000 KVA, 2x1000 KVA. Our team connected 3 phase analysers at all 3 transformers and at Solar HT Side and Main HT panel for 24 hours to study their power quality parameters.

Figure 6: Name Plate details Transformers Installed at New Door

4.1.1.1 PQ SUMMARY OF POINTS IN NEW DOOR

1. HT Panel

Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-L)	kVolt	11.17	11.2	11.15	-
2	Average Current	Amp	44.2	43.7	43.3	-
3	Apparent power	kVA	281.15	279.09	285.76	846.01
4	Active power	kW	280.86	278.882	285.61	845.35
5	Reactive power	kVAr	7.67	-1.31	105.36	6.46
6	Power Factor		0.99	0.99	0.99	0.99
7	THD-V	%	0.87	0.94	0.74	-
8	THD-I	%	4.03	4.12	3.73	-

Table 3: PQ Summary of HT Panel

2. Solar Incomer

Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-L)	kVolt	11.23	11.26	11.22	-
2	Average Current	Amp	7.96	7.96	7.72	-
3	Apparent power	kVA	51.38	50.5	51.6	153.06
4	Active power	kW	48.8	48.07	48.75	145.66
5	Reactive power	kVAr	9.09	8.4	7.91	25.4
6	Power Factor		0.95	0.952	0.953	0.95
7	THD-V	%	1.5	1.45	1.41	-
8	THD-I	%	6.23	6.23	5.38	-

Table 4: PQ Summary of Solar Incomer

3. Transformer-I

Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-L)	kVolt	414	415.6	415.3	-
2	Average Current	Amp	301.9	284.4	304.8	-
3	Apparent power	kVA	68.98	70.62	73.5	213.18
4	Active power	kW	68.66	70	73.26	211.98
5	Reactive power	kVAr	-3.61	-7.97	-5.09	-16.63
6	Power Factor		0.995	0.991	0.996	0.994
7	THD-V	%	1.79	1.88	1.67	-
8	THD-I	%	8.82	8.39	6.37	-

Table 5:PQ Summary of Transformer-I

4.Transformer-II

Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-L)	kVolt	415.9	417.5	417.7	-
2	Average Current	Amp	478.8	450.87	443.48	-
3	Apparent power	kVA	110.66	107.59	112.02	330.28
4	Active power	kW	110.52	107.34	111.58	329.44
5	Reactive power	kVAr	-4.34	-6.89	-9.115	-20.36
6	Power Factor		0.999	0.998	0.996	0.997
7	THD-V	%	1.79	1.9	1.79	-
8	THD-I	%	4.86	5.45	3.71	-

Table 6:PQ Summary of Transformer-II

5.Transformer-III

Sr. No	Parameter	Unit	Avg. value R-Phase	Avg. value Y-Phase	Avg. value B-Phase	Total Value
1	Voltage (L-L)	kVolt	426.8	428.4	425	-
2	Average Current	Amp	487	416	431	-
3	Apparent power	kVA	111.2	104.8	111.8	327.9
4	Active power	kW	110.1	104.2	111.4	325.7
5	Reactive power	kVAr	12.95	6.56	3.76	23.52
6	Power Factor		0.99	0.99	0.99	0.99
7	THD-V	%	1.97	1.71	1.82	-
8	THD-I	%	7.03	8.14	5.53	-

Table 7:PQ Summary of Transformer-III

Observations:

HT Panel:

1. Voltage dip of 1KV FROM 11.2 KV to 10.2 KV is observed for 500ms in HT Panel which may be the replica of power quality at transformer-1.
2. Both THD V and THD I are within the range as per IEEE standard. IEEE standard is attached in the Annex. 1.
3. Others parameters of the Transformer are found okay.

Solar HT side:

1. Both THD V and THD I are within the range as per IEEE standard. IEEE standard is attached in the Annex. 1.
2. Ohers parameters of the Transformer are found okay.

Transformer 1:

1. Voltage Dip of 50 V from 415V to 365 is observed for 60 ms in Transformer-1.
2. Both THD V and THD I are within the range as per IEEE standard. IEEE standard is attached in the Annex. 1.
3. The average pf is captured 0.99.

Transformer 2:

1. Both THD V and THD I are within the range as per IEEE standard. IEEE standard is attached in the Annex. 1.

2. The average pf is captured 0.99.

Transformer 3:

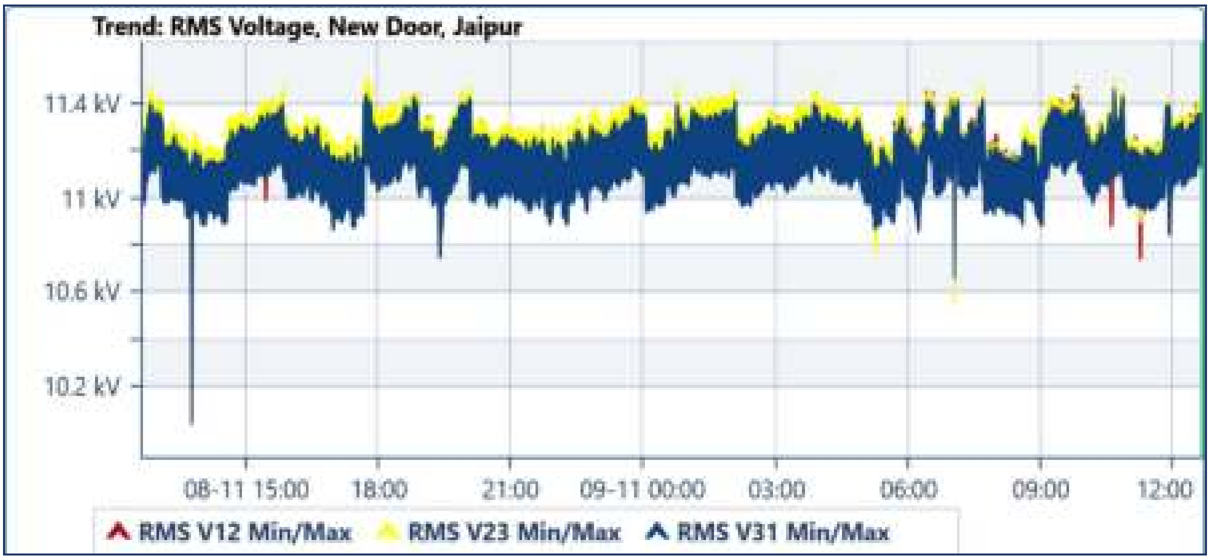
1. Both THD V and THD I are within the range as per IEEE standard. IEEE standard is attached in the Annex. 1.

2. The average pf is captured 0.99.

4.1.1.2 GRAPHICAL TRENDS OF PQ OF TRANSFORMERS:

1. HT Panel

Trend of RMS Voltage, New Door, Jaipur



Parameter	Min	Max	Average
RMS V12 (Auto)	10.041 kV	11.503 kV	11.179 kV
RMS V23 (Auto)	10.114 kV	11.512 kV	11.204 kV
RMS V31 (Auto)	10.042 kV	11.469 kV	11.153 kV

Trend of RMS Current, New Door, Jaipur

Parameter	Min	Max	Average
RMS I1 (Auto)	12.769 A	168.111 A	44.215 A
RMS I2 (Auto)	13.698 A	114.511 A	43.722 A
RMS I3 (Auto)	13.236 A	144.844 A	43.303 A

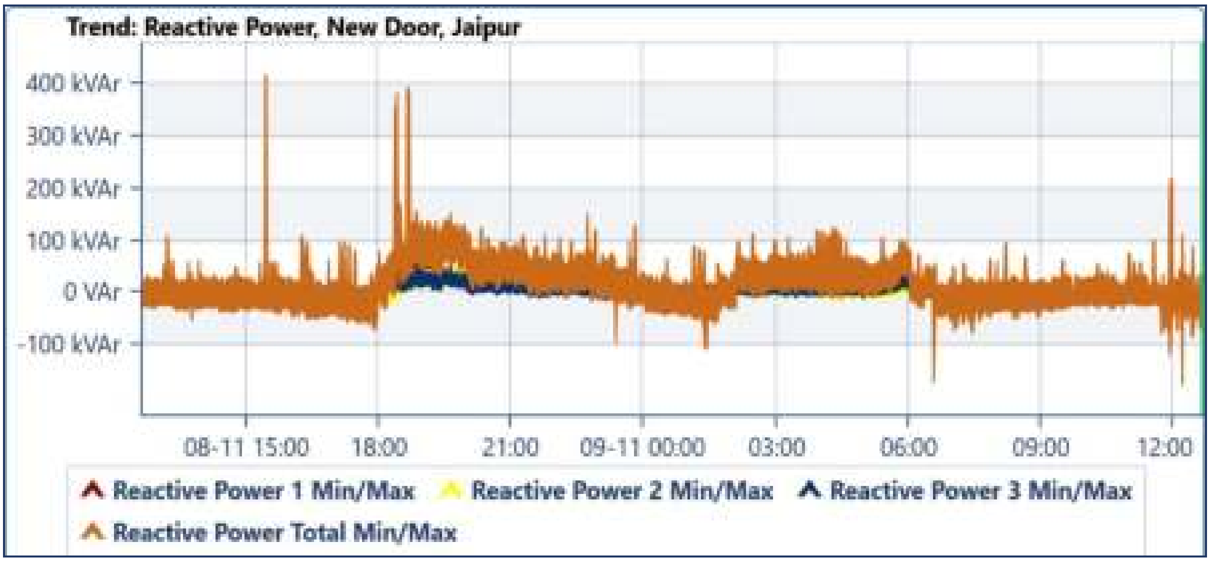
Trend of Apparent Power, New Door, Jaipur

Parameter	Min	Max	Average
Apparent Power 1 (Auto)	82.404 kVA	552.595 kVA	281.149 kVA
Apparent Power 2 (Auto)	83.2 kVA	545.624 kVA	279.099 kVA
Apparent Power 3 (Auto)	83.387 kVA	690.589 kVA	285.767 kVA
Apparent Power Total (Auto)	260.604 kVA	1.71 MVA	846.016 kVA

Trend of Active Power, New Door, Jaipur

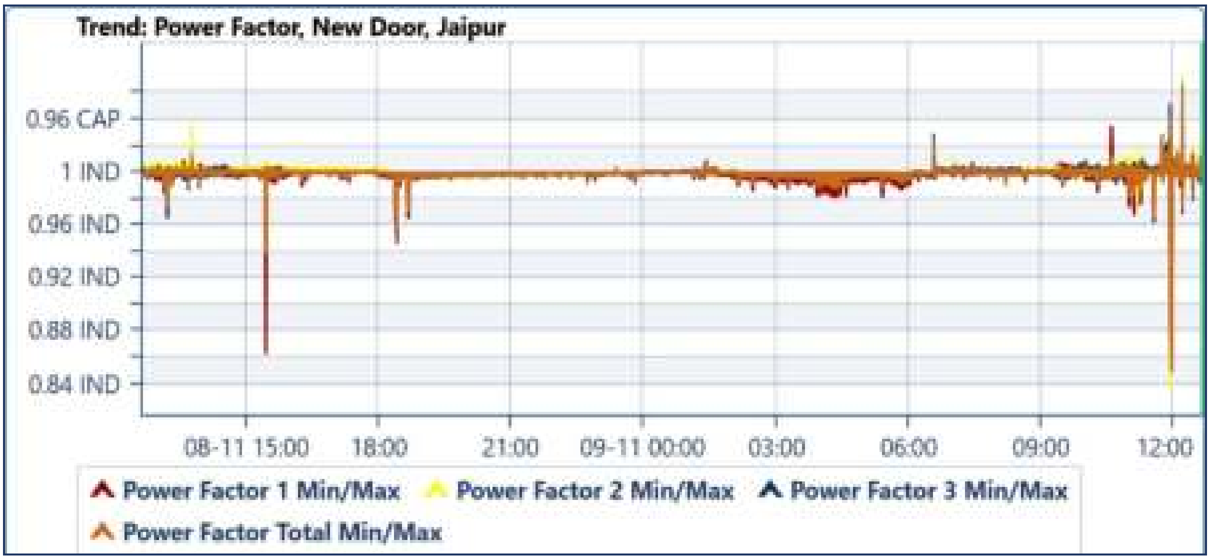
Parameter	Min	Max	Average
Active Power 1 (Auto)	79.517 kW	550.985 kW	280.862 kW
Active Power 2 (Auto)	82.875 kW	543.748 kW	278.882 kW
Active Power 3 (Auto)	83.333 kW	683.588 kW	285.61 kW
Active Power Total (Auto)	260.411 kW	1.65 MW	845.354 kW

Trend of Reactive Power, New Door, Jaipur



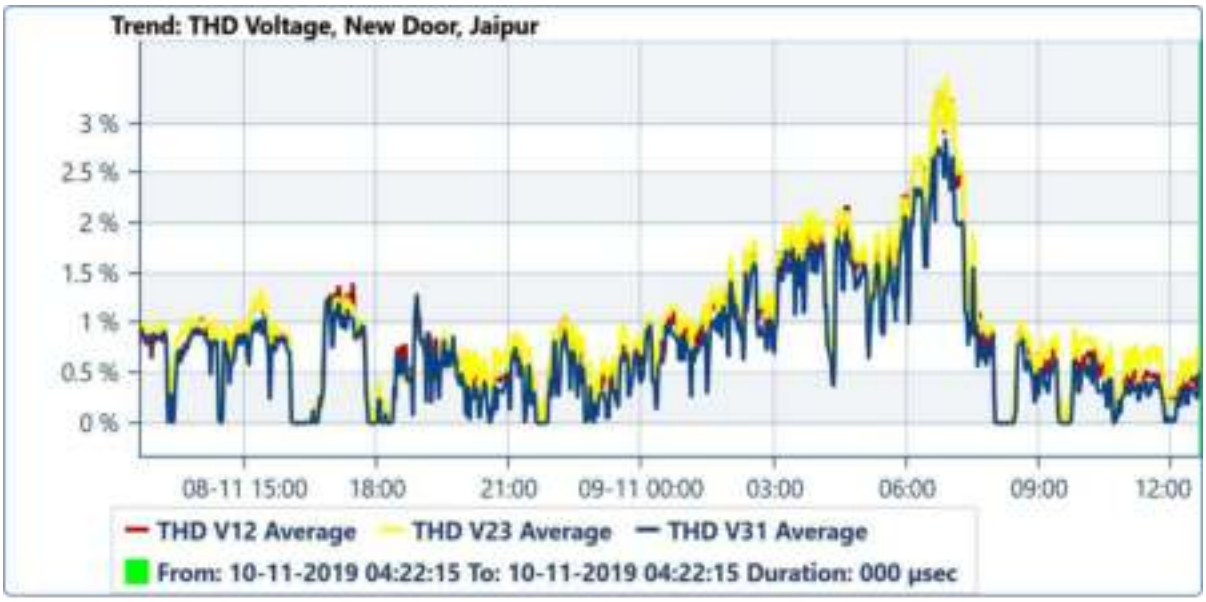
Parameter	Min	Max	Average
Reactive Power 1 (Auto)	-56.23 kVAr	258.03 kVAr	7.676 kVAr
Reactive Power 2 (Auto)	-61.589 kVAr	129.255 kVAr	-1.317 kVAr
Reactive Power 3 (Auto)	-65.942 kVAr	135.357 kVAr	105.369 VAr
Reactive Power Total (Auto)	-177.15 kVAr	419.167 kVAr	6.464 kVAr

Trend of Power Factor, New Door, Jaipur



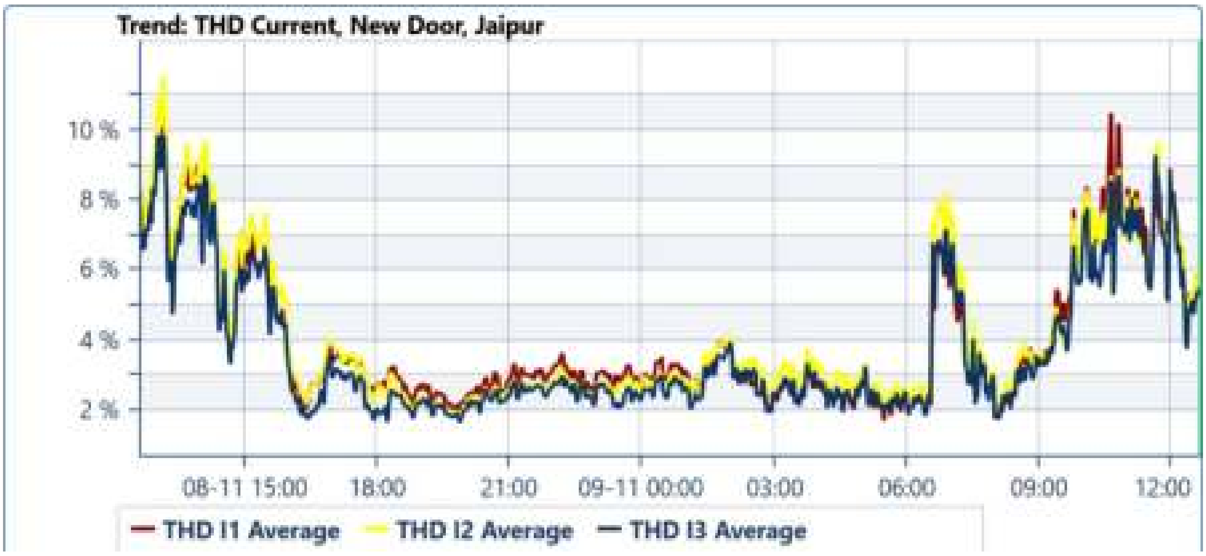
Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.937 CAP	0.858 IND	0.999 IND
Power Factor 2 (Auto)	0.926 CAP	0.839 IND	0.999 CAP
Power Factor 3 (Auto)	0.934 CAP	0.85 IND	0.999 IND
Power Factor Total (Auto)	0.932 CAP	0.849 IND	0.999 IND

Trend of THD Voltage, New Door, Jaipur



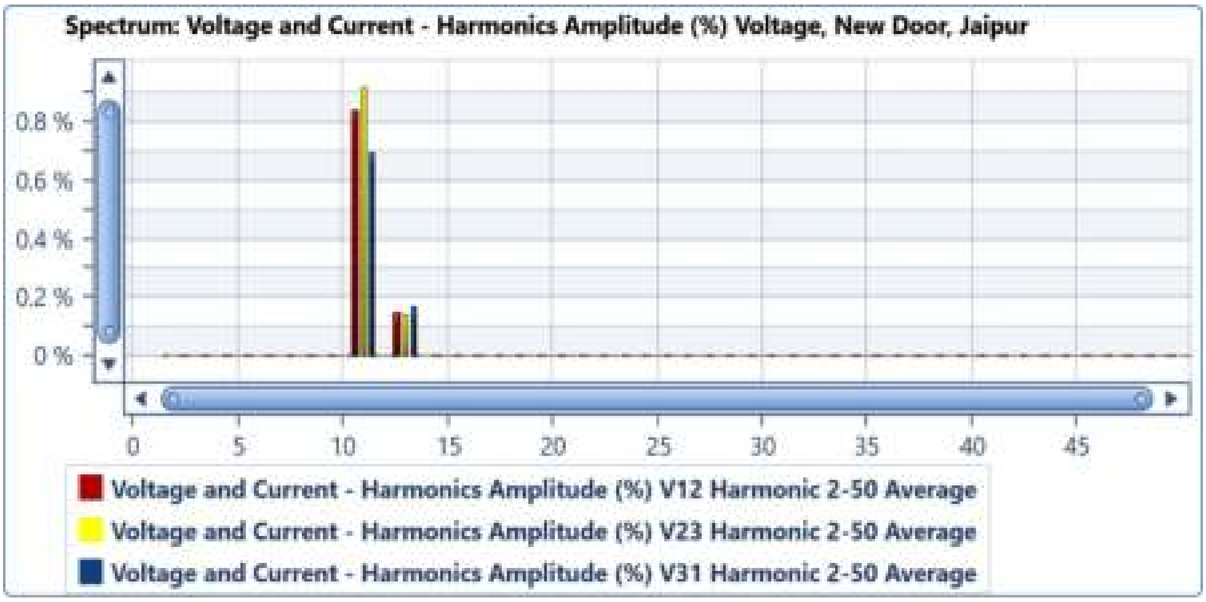
Parameter	Min	Max	Average
THD V12 (Auto)	0 %	4.93 %	0.87 %
THD V23 (Auto)	0 %	4.05 %	0.94 %
THD V31 (Auto)	0 %	4.05 %	0.74 %

Trend of THD Current, New Door, Jaipur

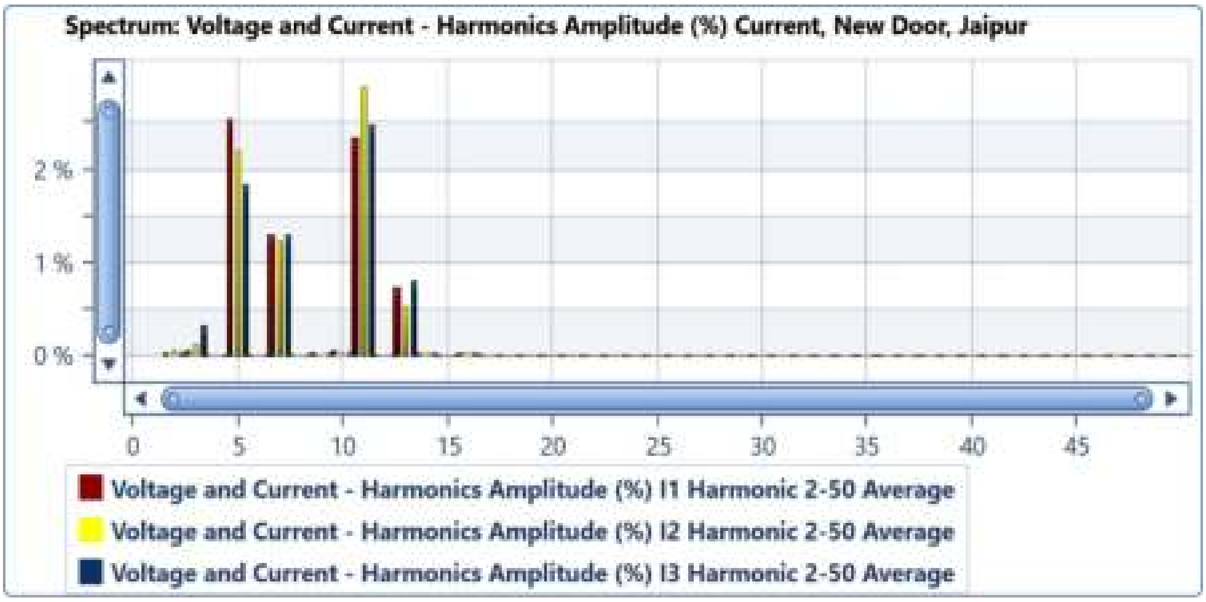


Parameter	Min	Max	Average
THD I1 (Auto)	1.06 %	33.55 %	4.03 %
THD I2 (Auto)	1.05 %	45.63 %	4.12 %
THD I3 (Auto)	0.94 %	50.77 %	3.73 %

Harmonics Amplitude (%) Voltage, New Door, Jaipur

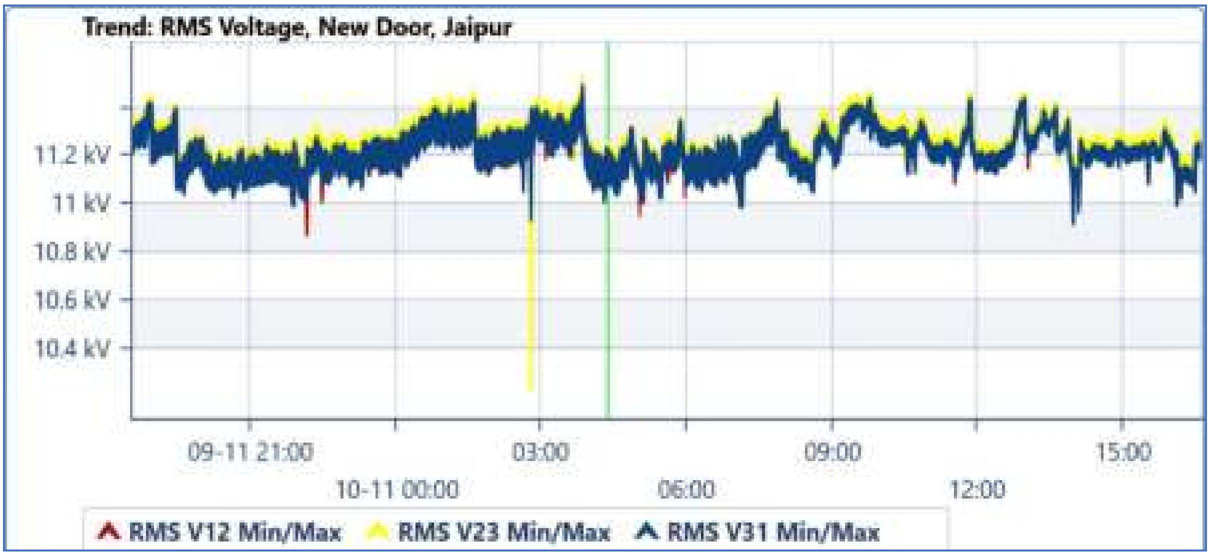


Harmonics Amplitude (%) Current, New Door, Jaipur



2. Solar HT Side

Trend of RMS Voltage, New Door, Jaipur



Parameter	Min	Max	Average
RMS V12 (Auto)	10.866 kV	11.506 kV	11.237 kV
RMS V23 (Auto)	10.23 kV	11.538 kV	11.269 kV
RMS V31 (Auto)	10.914 kV	11.498 kV	11.223 kV

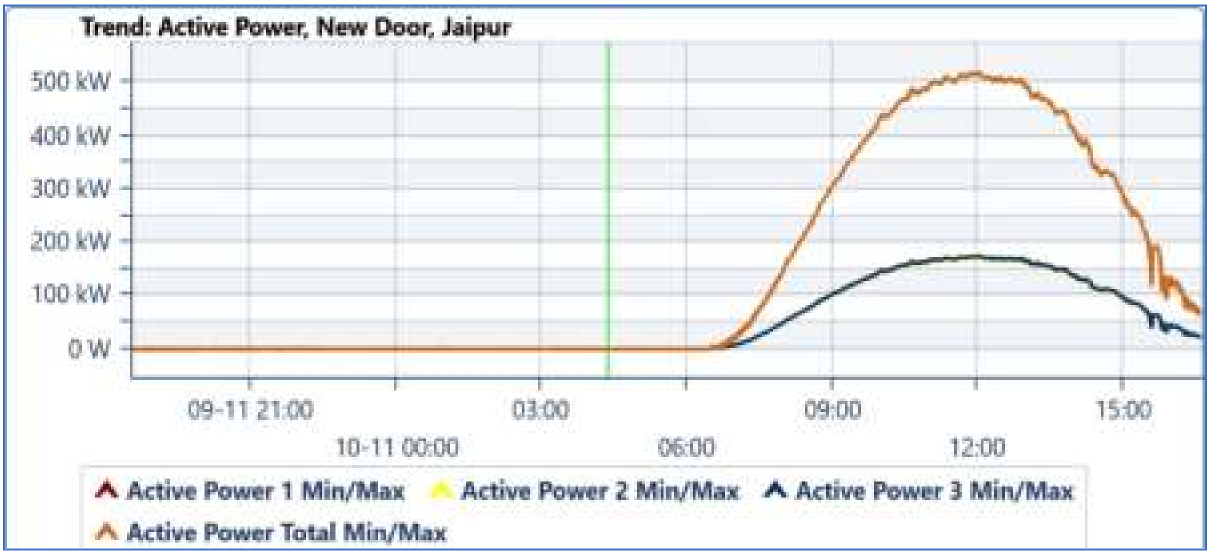
Trend of RMS Current, New Door, Jaipur

Parameter	Min	Max	Average
RMS I1 (Auto)	0.218 A	27.242 A	7.969 A
RMS I2 (Auto)	0.21 A	27.149 A	7.967 A
RMS I3 (Auto)	0.207 A	26.328 A	7.726 A

Trend of Apparent Power, New Door, Jaipur

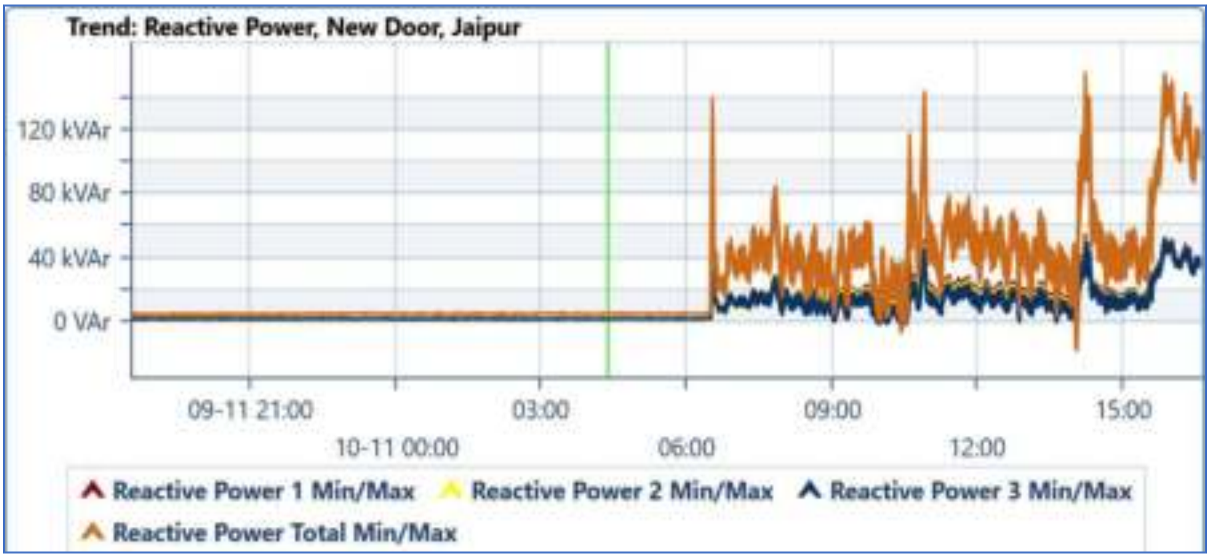
Parameter	Min	Max	Average
Apparent Power 1 (Auto)	404.128 VA	176.639 kVA	51.383 kVA
Apparent Power 2 (Auto)	183.809 VA	173.348 kVA	50.511 kVA
Apparent Power 3 (Auto)	658.045 VA	175.588 kVA	51.166 kVA
Apparent Power Total (Auto)	3.664 kVA	522.36 kVA	153.06 kVA

Trend of Active Power, New Door, Jaipur



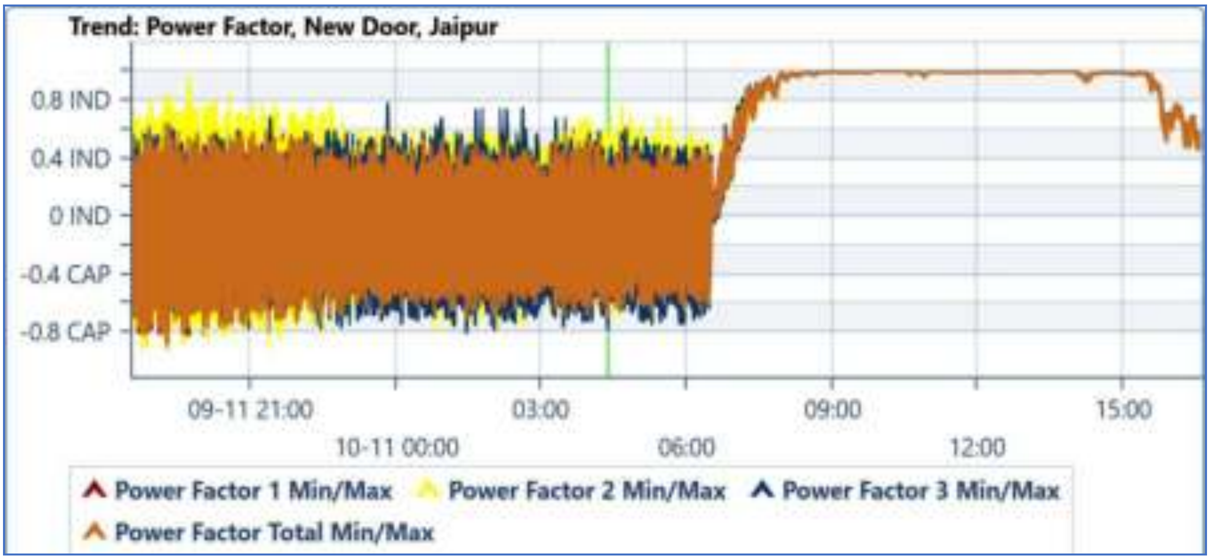
Parameter	Min	Max	Average
Active Power 1 (Auto)	-1.876 kW	175.623 kW	48.838 kW
Active Power 2 (Auto)	-1.564 kW	172.886 kW	48.076 kW
Active Power 3 (Auto)	-1.324 kW	175.054 kW	48.753 kW
Active Power Total (Auto)	-3.899 kW	520.123 kW	145.667 kW

Trend of Reactive Power, New Door, Jaipur



Parameter	Min	Max	Average
Reactive Power 1 (Auto)	-4.687 kVAr	54.795 kVAr	9.096 kVAr
Reactive Power 2 (Auto)	-6.473 kVAr	51.955 kVAr	8.476 kVAr
Reactive Power 3 (Auto)	-8.497 kVAr	51.93 kVAr	7.919 kVAr
Reactive Power Total (Auto)	-18.717 kVAr	157.276 kVAr	25.49 kVAr

Trend of Power Factor, New Door, Jaipur

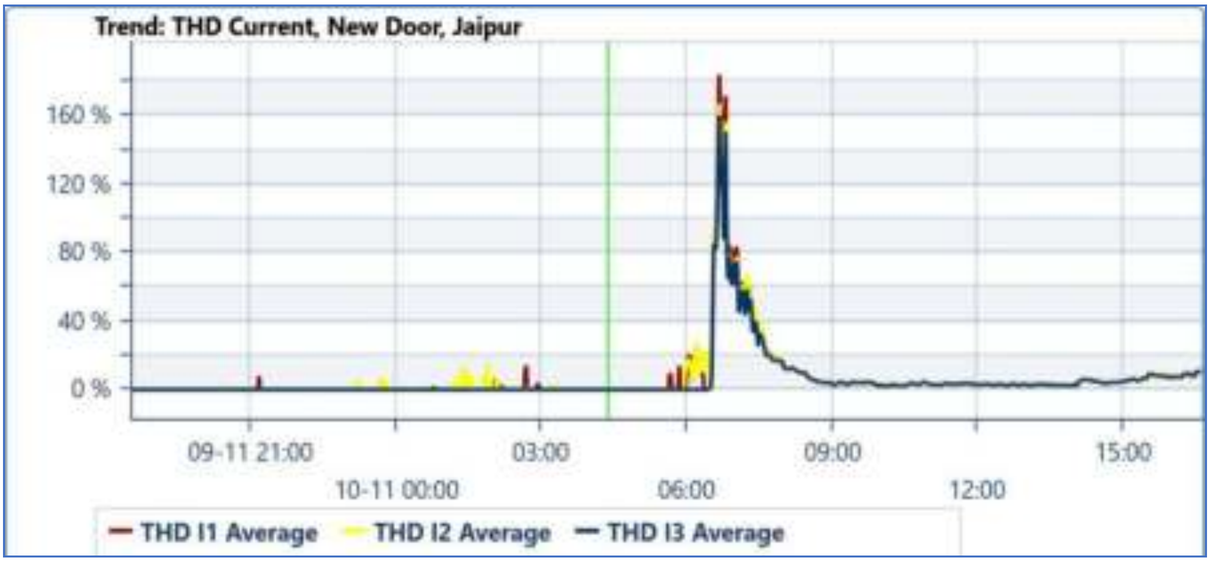


Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.999 CAP	-0.911 CAP	0.95 IND
Power Factor 2 (Auto)	0.999 CAP	-0.924 CAP	0.952 IND
Power Factor 3 (Auto)	0.998 CAP	-0.852 CAP	0.953 IND
Power Factor Total (Auto)	0.999 CAP	-0.89 CAP	0.952 IND

Trend of THD Voltage, New Door, Jaipur

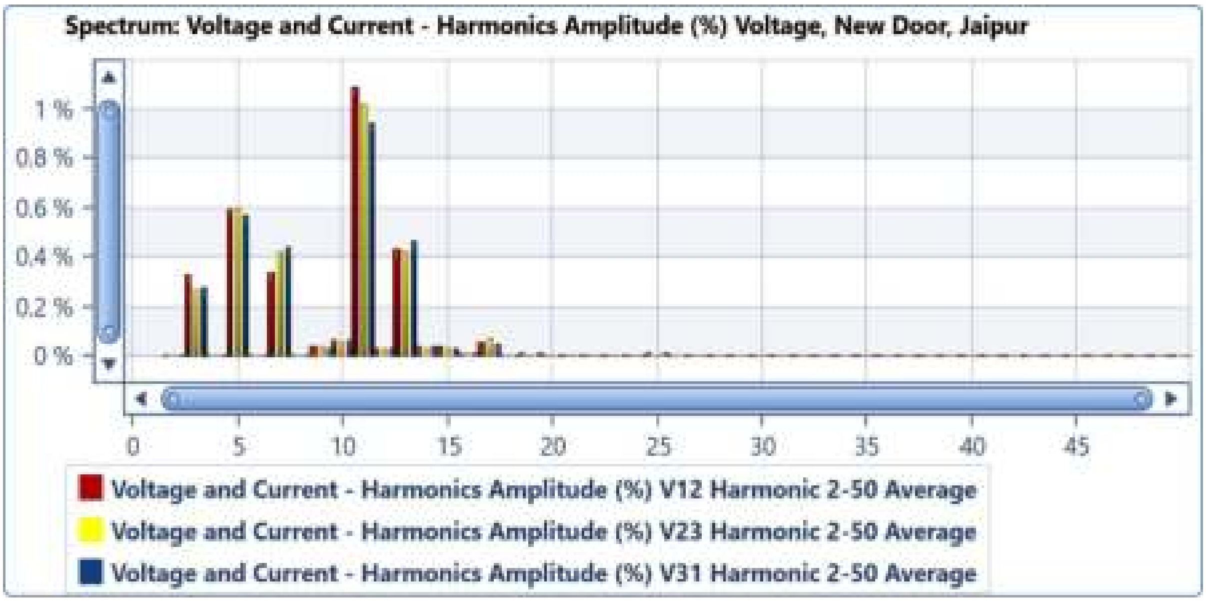
Parameter	Min	Max	Average
THD V12 (Auto)	0.39 %	3.78 %	1.5 %
THD V23 (Auto)	0.51 %	5.15 %	1.45 %
THD V31 (Auto)	0.4 %	3.6 %	1.41 %

Trend of THD Current, New Door, Jaipur

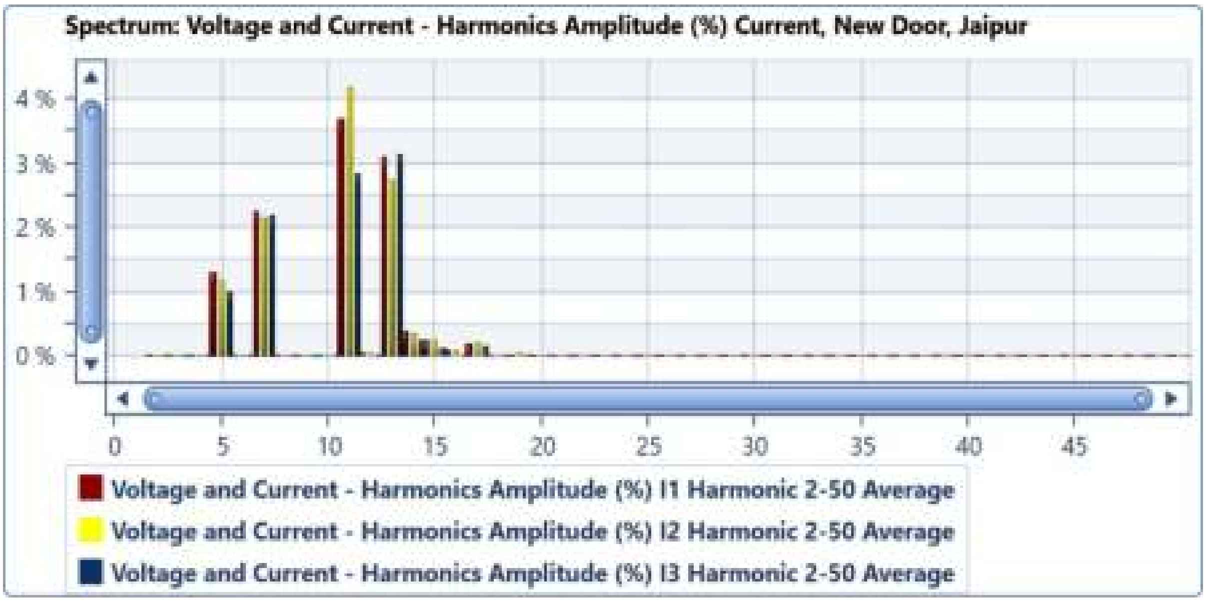


Parameter	Min	Max	Average
THD I1 (Auto)	0 %	263.45 %	6.23 %
THD I2 (Auto)	0 %	243.91 %	6.23 %
THD I3 (Auto)	0 %	233.39 %	5.38 %

Harmonics Amplitude (%) Voltage, New Door, Jaipur

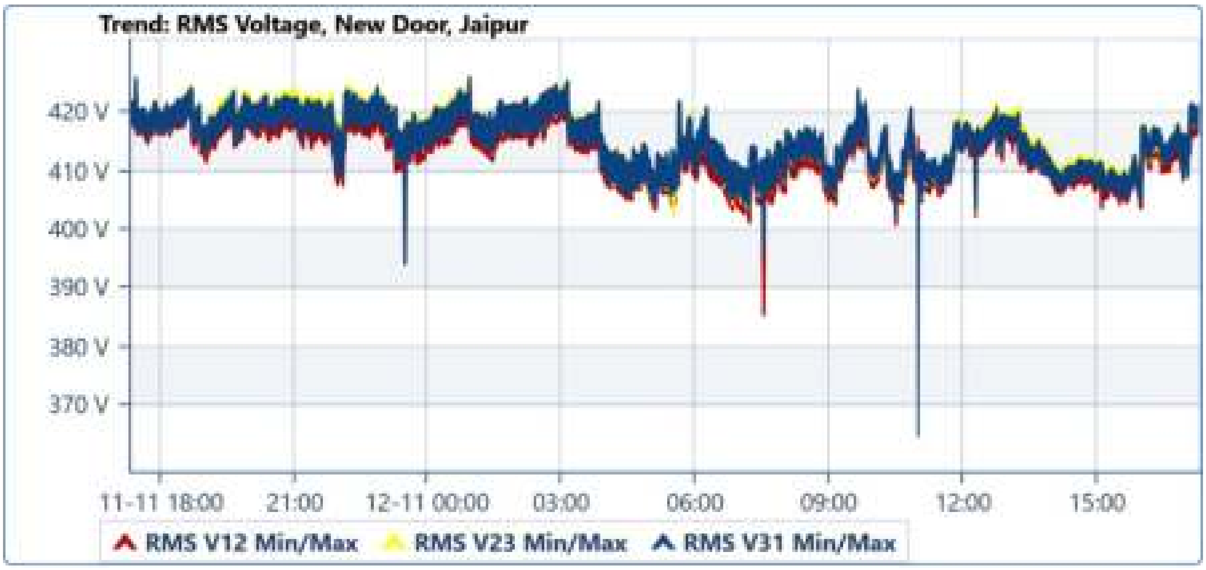


Harmonics Amplitude (%) Current, New Door, Jaipur



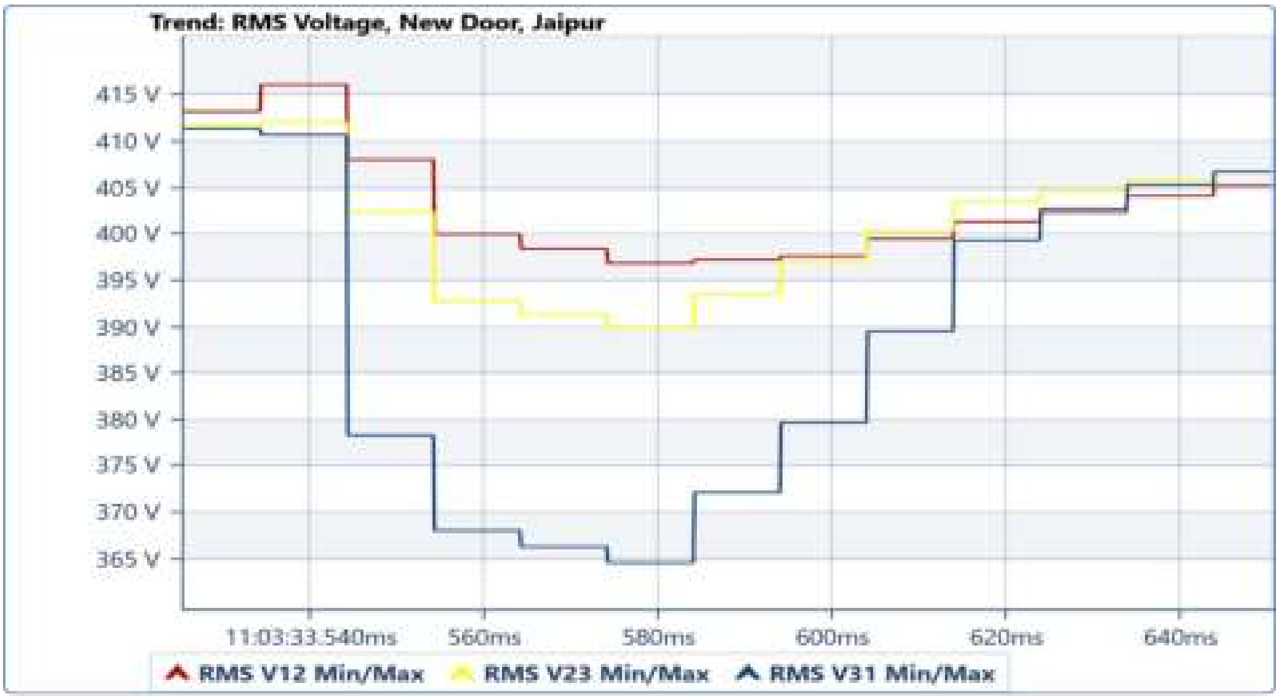
3.Transformer-1

Trend of RMS Voltage, New Door, Jaipur

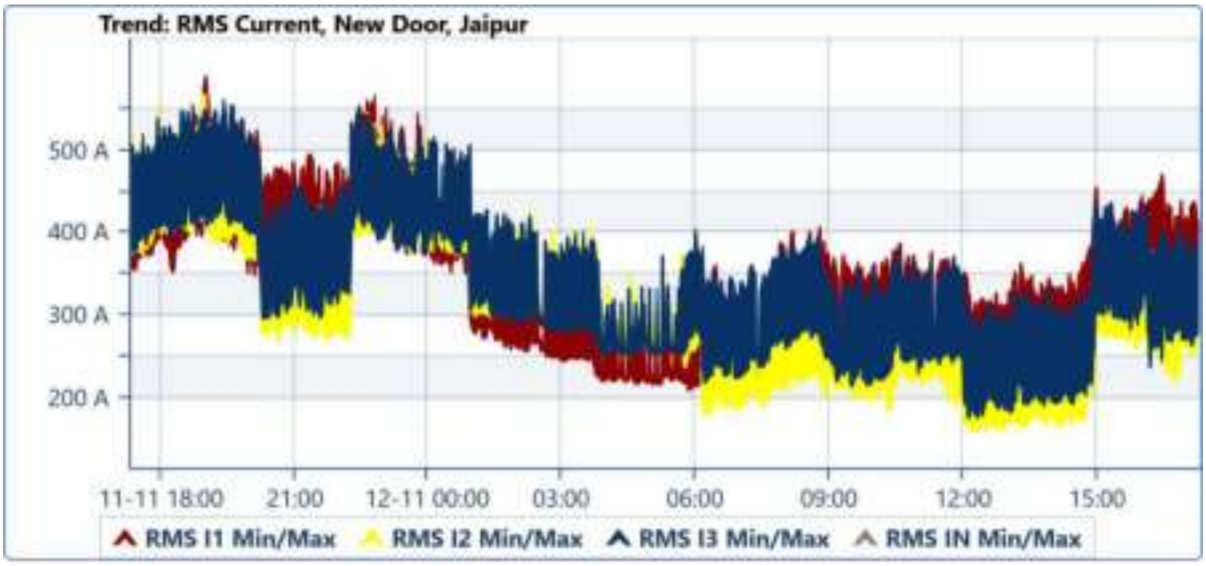


Parameter	Min	Max	Average
RMS V12 (Auto)	385.346 V	425.526 V	414.061 V
RMS V23 (Auto)	389.995 V	426.251 V	415.637 V
RMS V31 (Auto)	364.643 V	426.215 V	415.304 V

Voltage drops

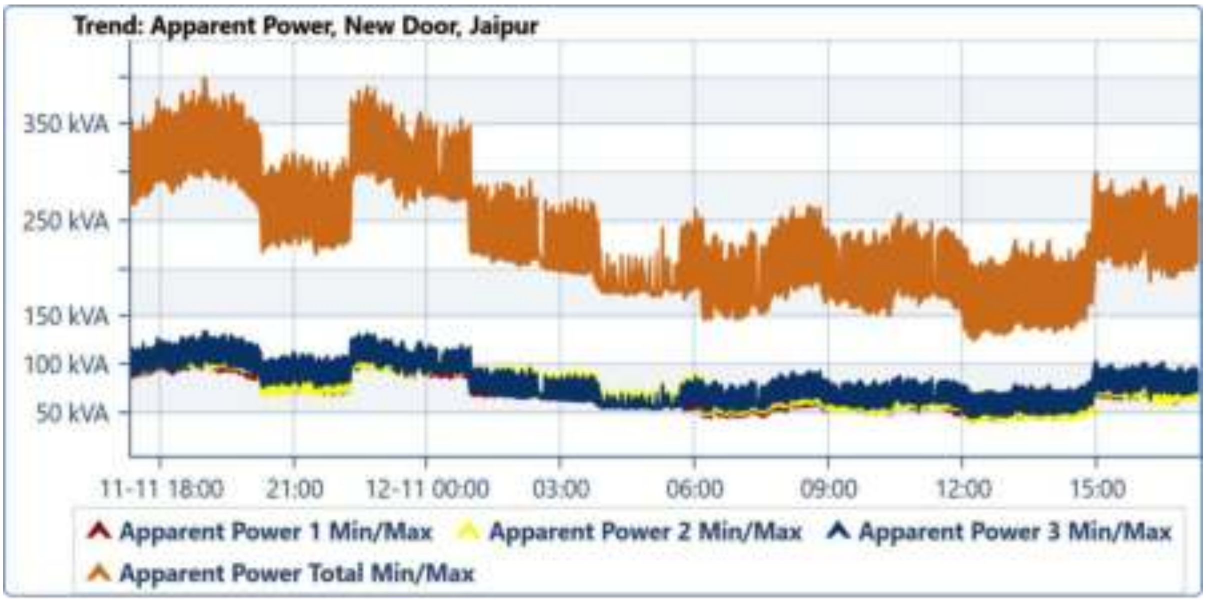


Trend of RMS Current, New Door, Jaipur



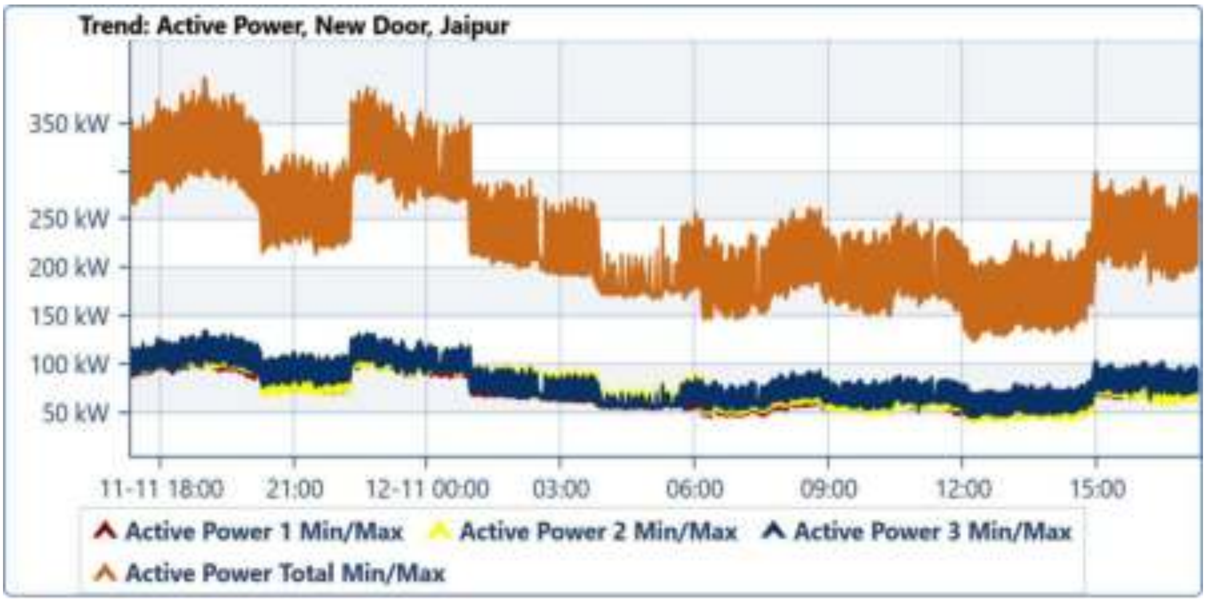
Parameter	Min	Max	Average
RMS I1 (Auto)	188.461 A	590.27 A	301.949 A
RMS I2 (Auto)	156.118 A	568.343 A	284.825 A
RMS I3 (Auto)	174.881 A	562.127 A	304.84 A

Trend of Apparent Power, New Door, Jaipur



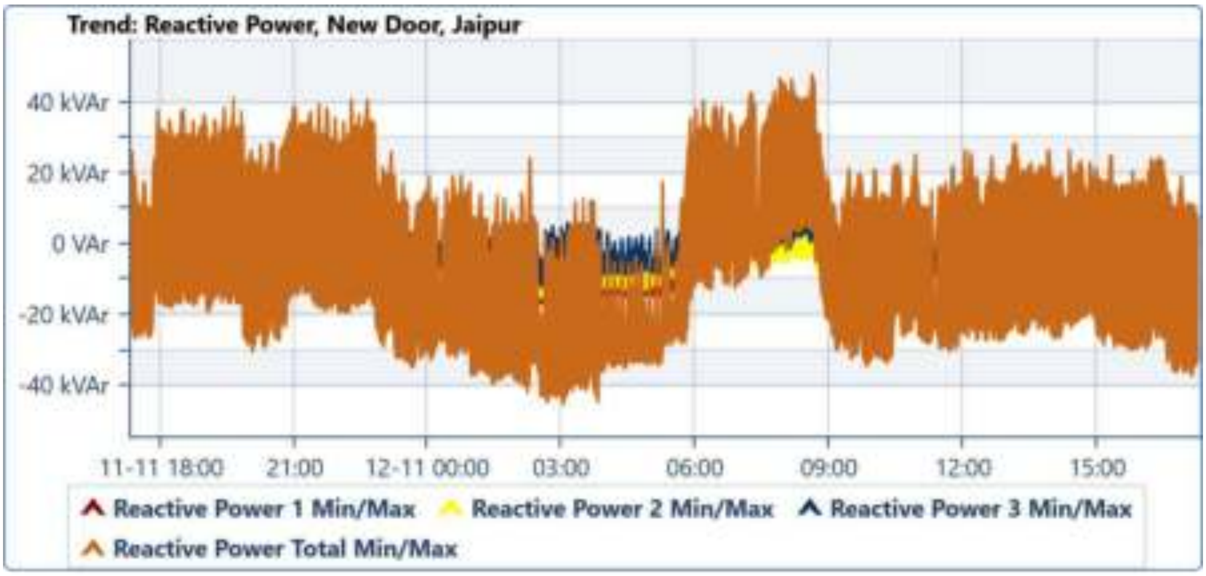
Parameter	Min	Max	Average
Apparent Power 1 (Auto)	39.785 kVA	134.729 kVA	68.986 kVA
Apparent Power 2 (Auto)	39.744 kVA	130.134 kVA	70.624 kVA
Apparent Power 3 (Auto)	43.961 kVA	136.28 kVA	73.57 kVA
Apparent Power Total (Auto)	123.49 kVA	400.312 kVA	213.181 kVA

Trend of Active Power, New Door, Jaipur



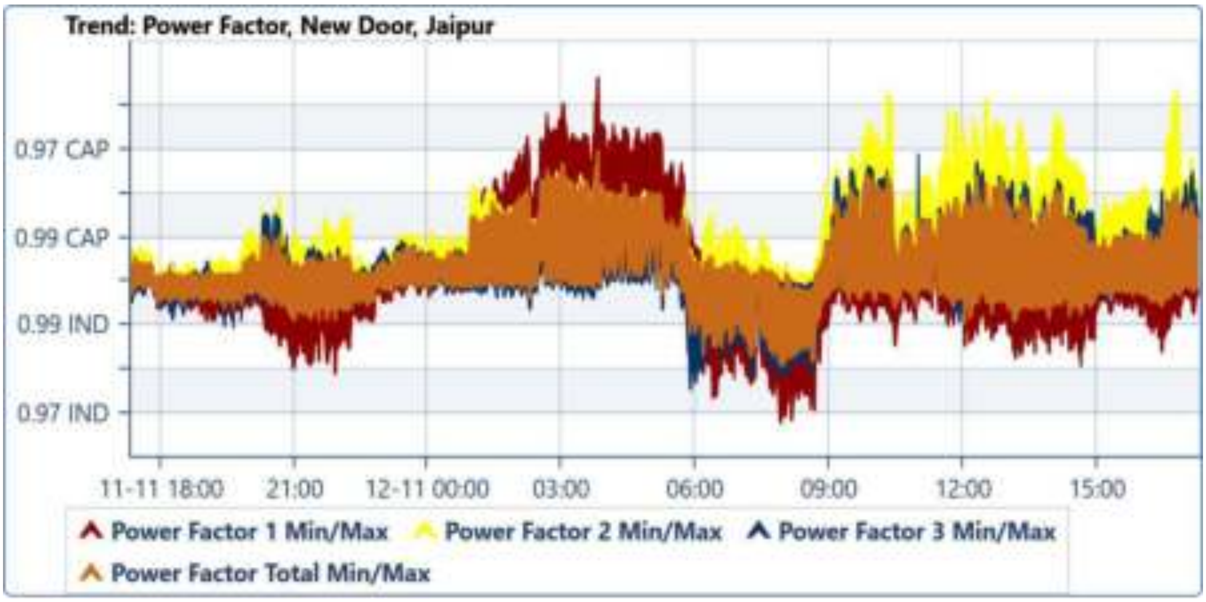
Parameter	Min	Max	Average
Active Power 1 (Auto)	39.578 kW	134.025 kW	68.66 kW
Active Power 2 (Auto)	38.851 kW	129.953 kW	70.063 kW
Active Power 3 (Auto)	43.632 kW	135.977 kW	73.261 kW
Active Power Total (Auto)	122.475 kW	399.07 kW	211.984 kW

Trend of Reactive Power, New Door, Jaipur



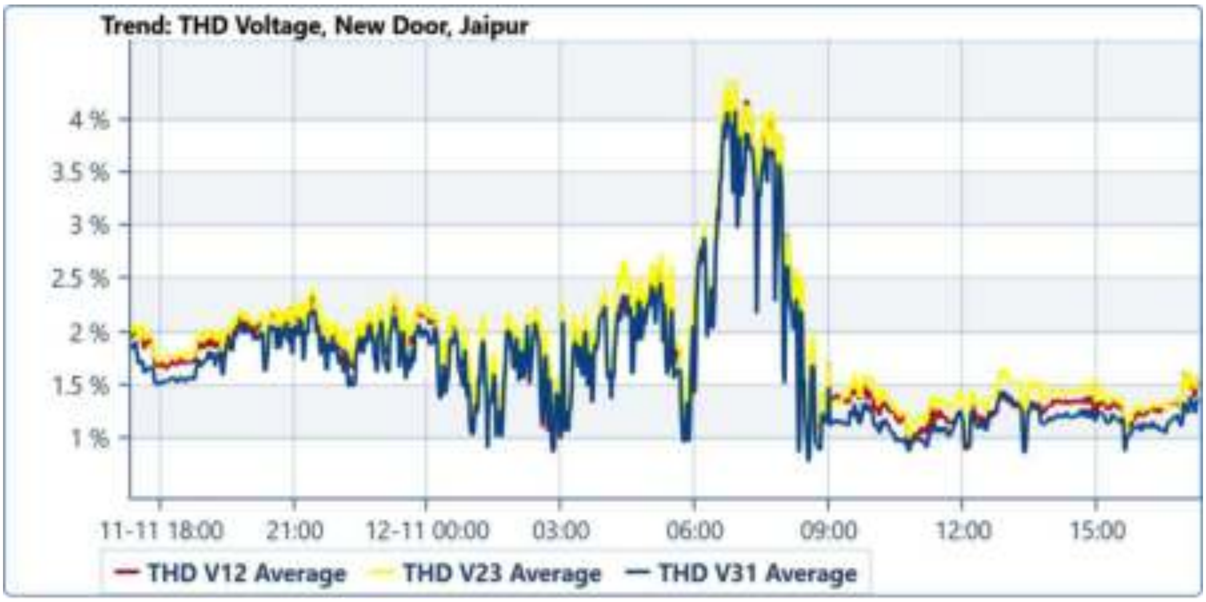
Parameter	Min	Max	Average
Reactive Power 1 (Auto)	-18.376 kVAr	20.56 kVAr	-3.612 kVAr
Reactive Power 2 (Auto)	-18.008 kVAr	11.886 kVAr	-7.978 kVAr
Reactive Power 3 (Auto)	-16.408 kVAr	18.612 kVAr	-5.049 kVAr
Reactive Power Total (Auto)	-45.345 kVAr	48.061 kVAr	-16.638 kVAr

Trend of Power Factor, New Door, Jaipur



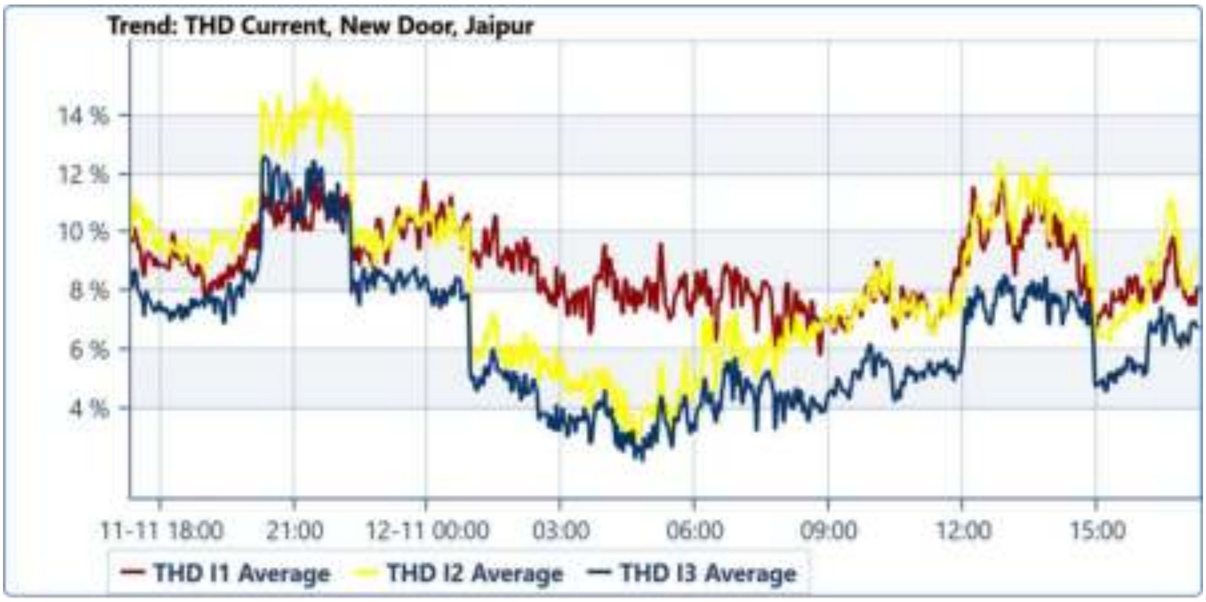
Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.953 CAP	0.968 IND	0.995 CAP
Power Factor 2 (Auto)	0.956 CAP	0.99 IND	0.992 CAP
Power Factor 3 (Auto)	0.971 CAP	0.975 IND	0.996 CAP
Power Factor Total (Auto)	0.97 CAP	0.98 IND	0.994 CAP

Trend of THD Voltage, New Door, Jaipur



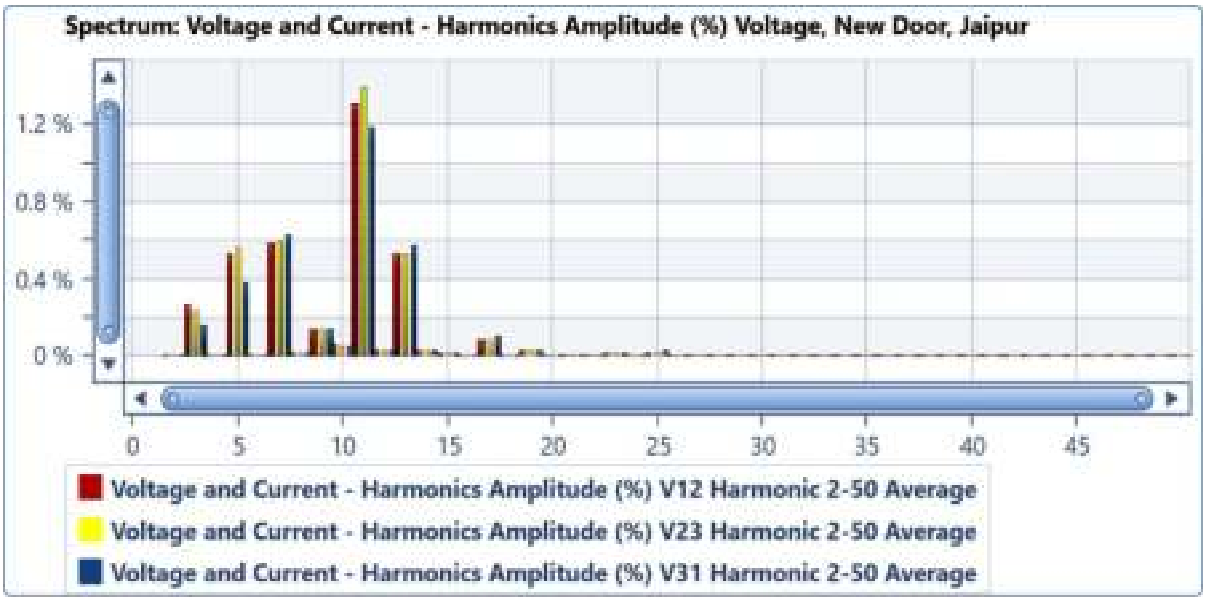
Parameter	Min	Max	Average
THD V12 (Auto)	0.37 %	6.13 %	1.79 %
THD V23 (Auto)	0.43 %	6.19 %	1.88 %
THD V31 (Auto)	0.35 %	5.74 %	1.67 %

Trend of THD Current, New Door, Jaipur

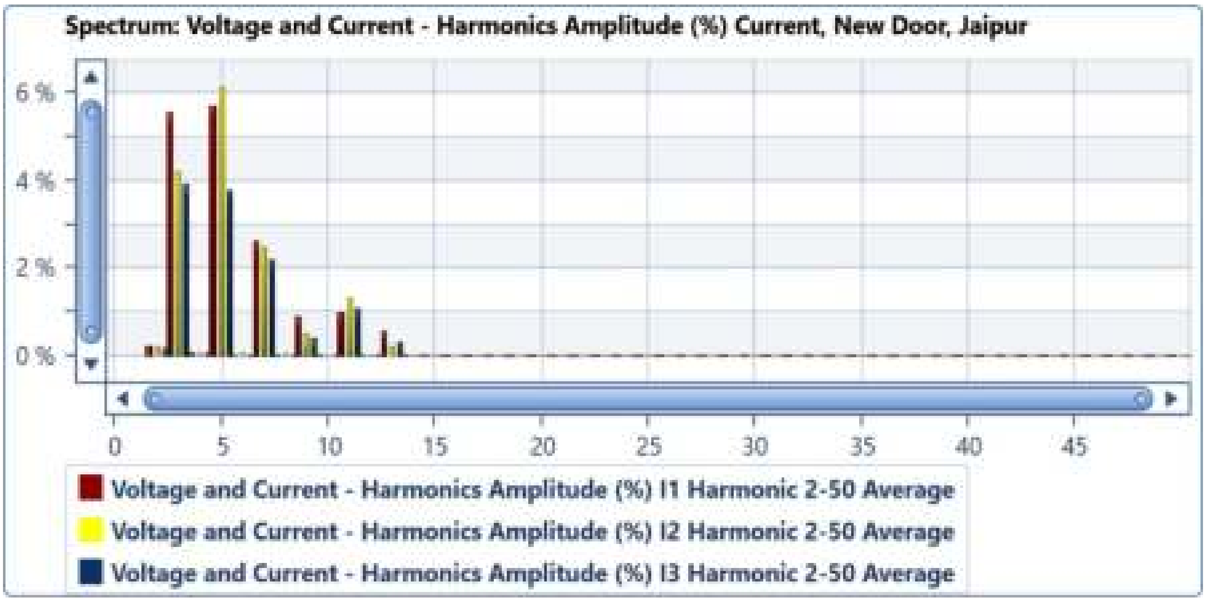


Parameter	Min	Max	Average
THD I1 (Auto)	3.54 %	22.75 %	8.82 %
THD I2 (Auto)	2.13 %	25.53 %	8.39 %
THD I3 (Auto)	1.71 %	20.95 %	6.37 %

Harmonics Amplitude (%) Voltage, New Door, Jaipur

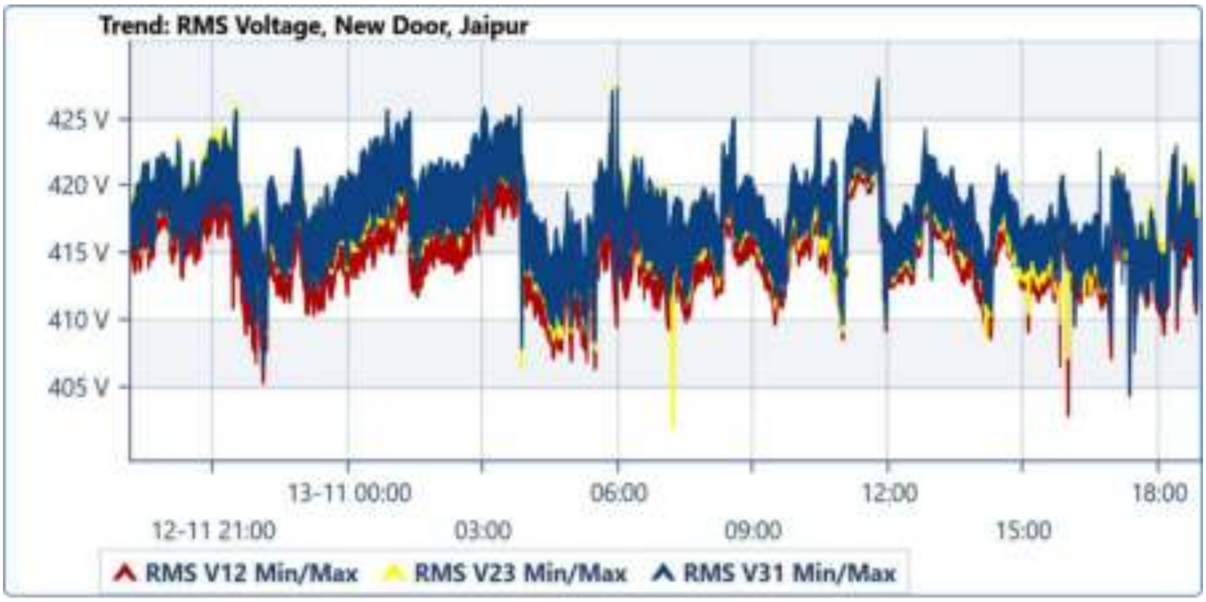


Harmonics Amplitude (%) Current, New Door, Jaipur



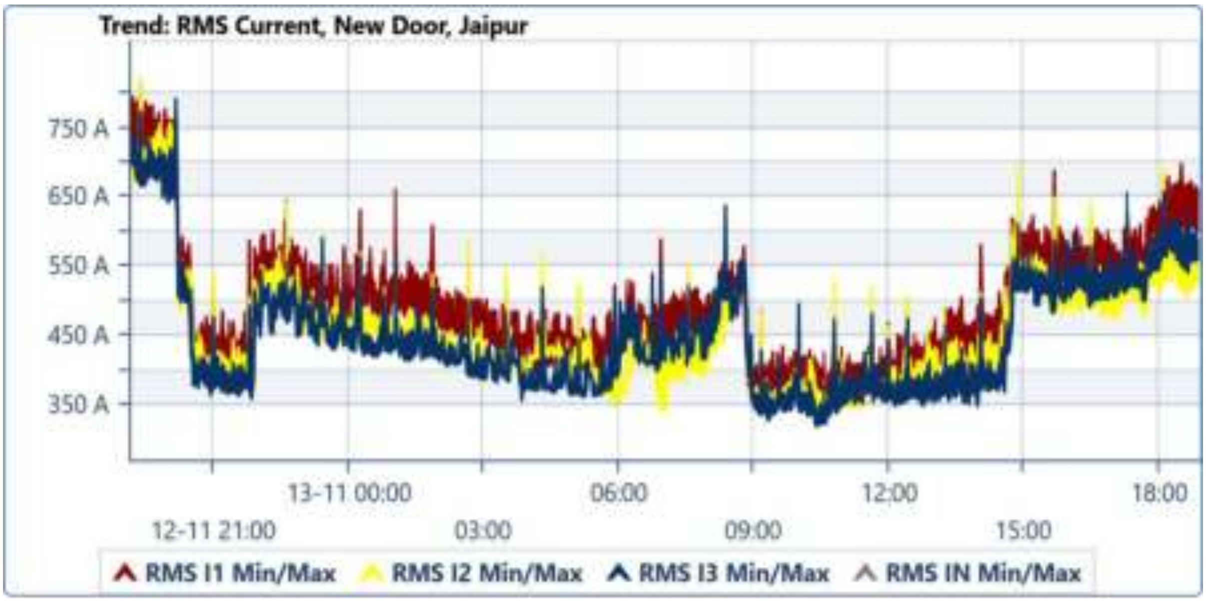
4.Transformer -2

Trend of RMS Voltage, New Door, Jaipur



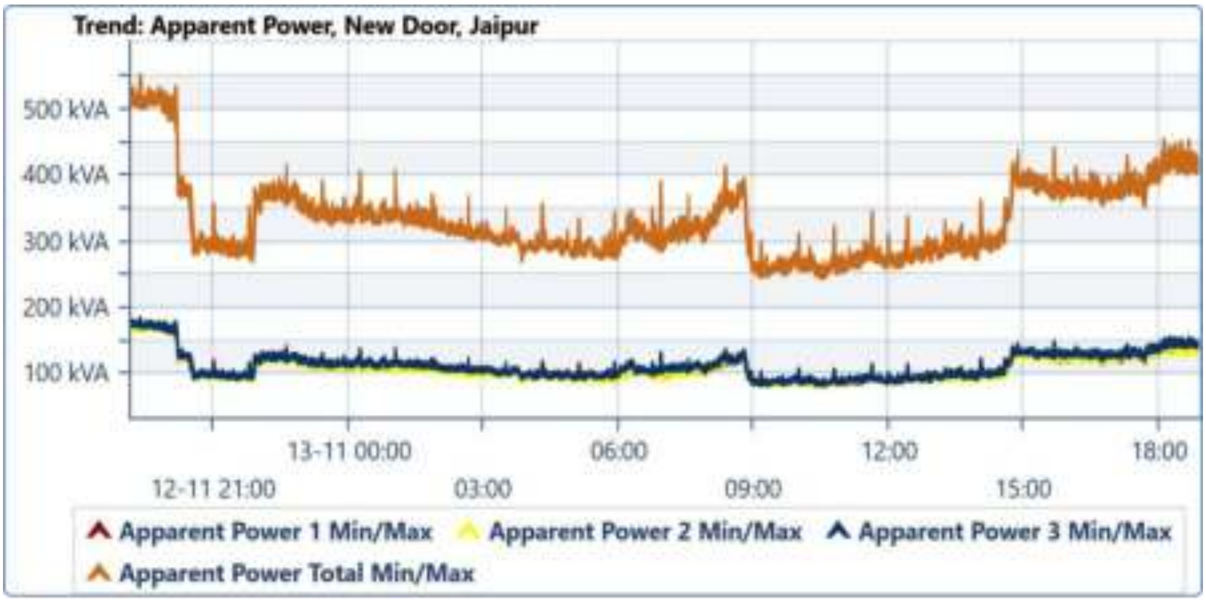
Parameter	Min	Max	Average
RMS V12 (Auto)	402.816 V	427.318 V	415.989 V
RMS V23 (Auto)	402.026 V	428.078 V	417.508 V
RMS V31 (Auto)	404.283 V	428.166 V	417.719 V

Trend of RMS Current, New Door, Jaipur



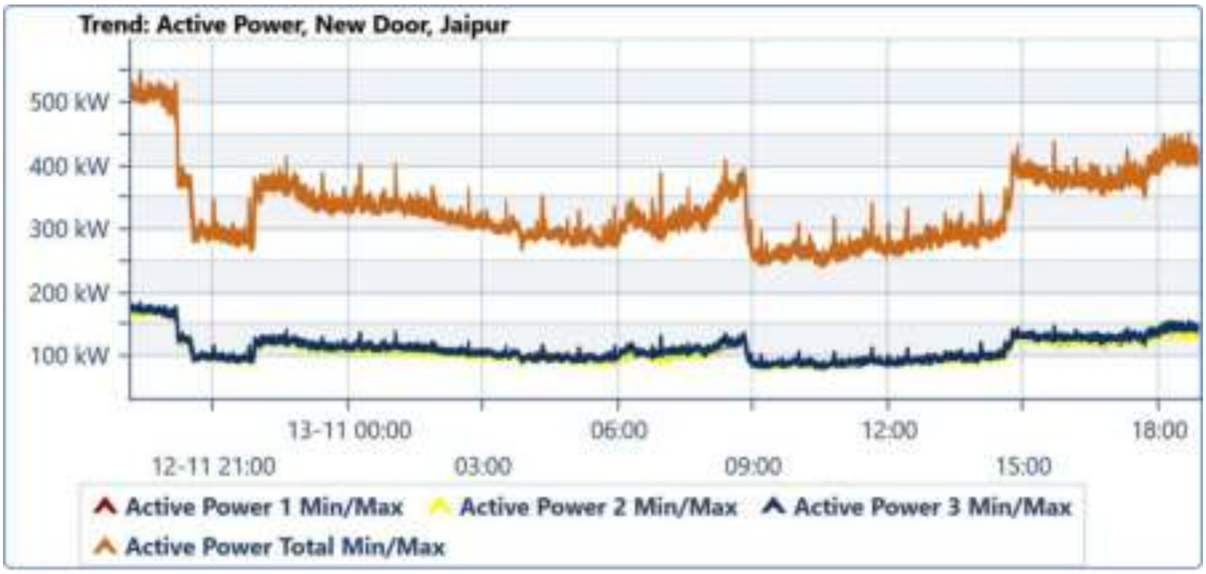
Parameter	Min	Max	Average
RMS I1 (Auto)	346.521 A	821.51 A	478.857 A
RMS I2 (Auto)	338.023 A	822.86 A	450.879 A
RMS I3 (Auto)	318.946 A	793.016 A	443.488 A

Trend of Apparent Power, New Door, Jaipur



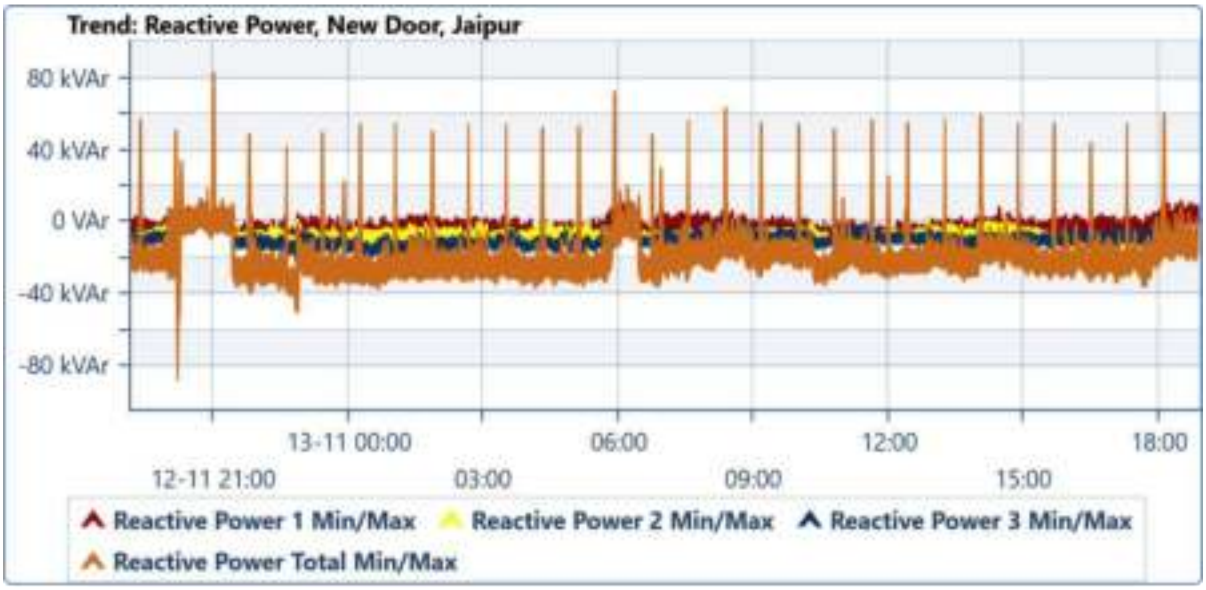
Parameter	Min	Max	Average
Apparent Power 1 (Auto)	80.665 kVA	185.737 kVA	110.666 kVA
Apparent Power 2 (Auto)	78.618 kVA	182.983 kVA	107.597 kVA
Apparent Power 3 (Auto)	81.288 kVA	187.394 kVA	112.023 kVA
Apparent Power Total (Auto)	243.523 kVA	553.942 kVA	330.286 kVA

Trend of Active Power, New Door, Jaipur



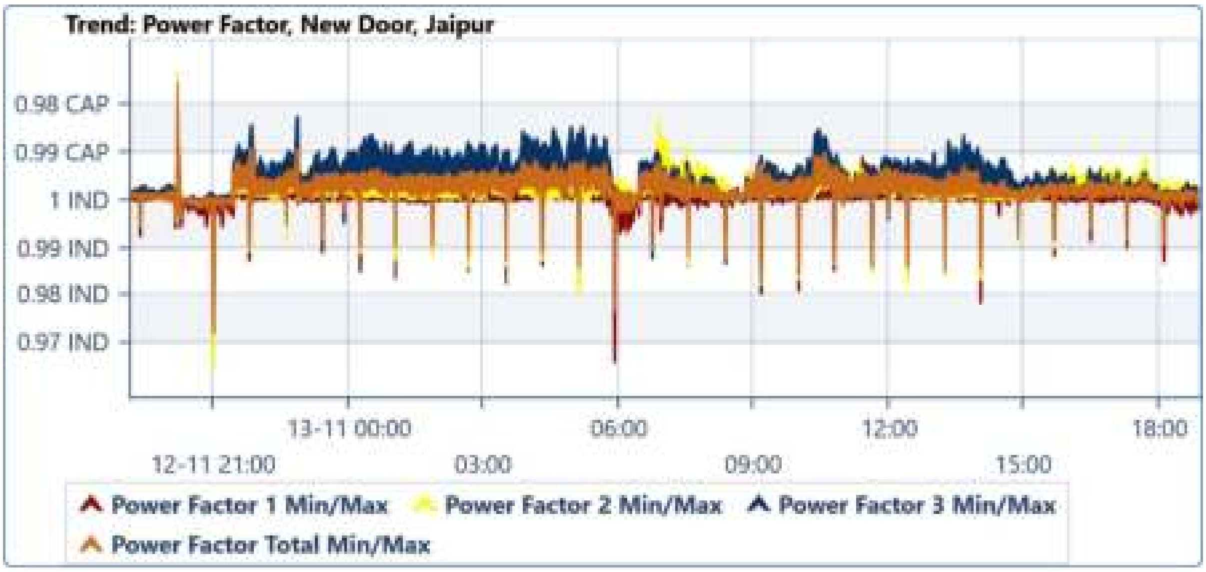
Parameter	Min	Max	Average
Active Power 1 (Auto)	80.366 kW	184.527 kW	110.525 kW
Active Power 2 (Auto)	78.103 kW	182.764 kW	107.34 kW
Active Power 3 (Auto)	80.512 kW	186.892 kW	111.582 kW
Active Power Total (Auto)	241.652 kW	551.505 kW	329.447 kW

Trend of Reactive Power, New Door, Jaipur



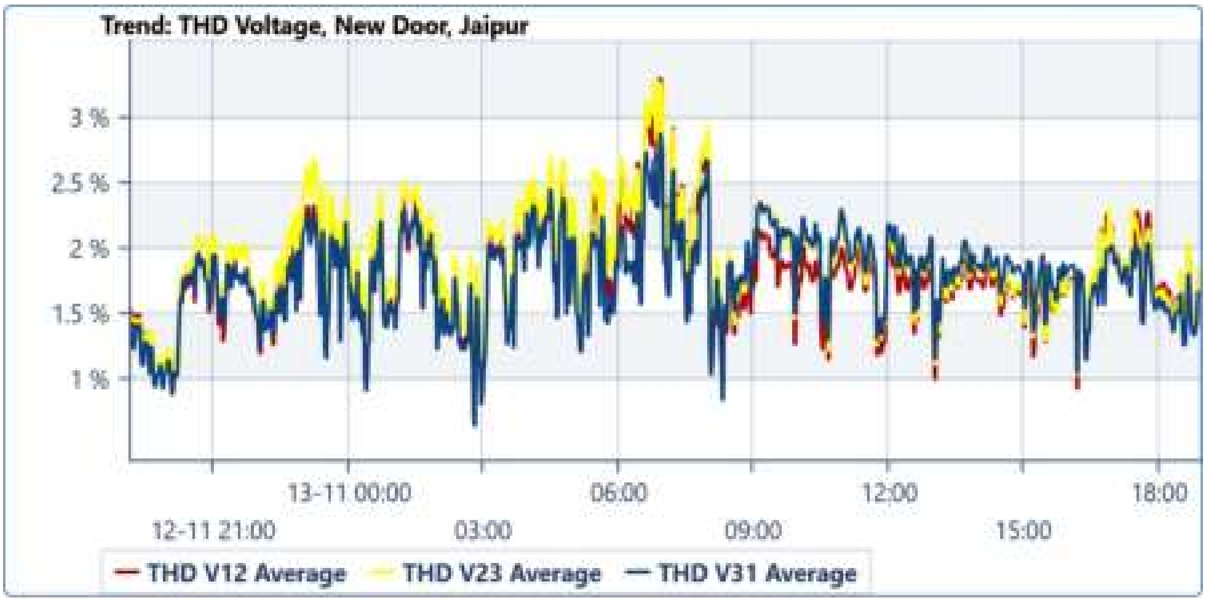
Parameter	Min	Max	Average
Reactive Power 1 (Auto)	-28.443 kVAr	29.745 kVAr	-4.348 kVAr
Reactive Power 2 (Auto)	-30.906 kVAr	31.102 kVAr	-6.896 kVAr
Reactive Power 3 (Auto)	-28.93 kVAr	23.922 kVAr	-9.115 kVAr
Reactive Power Total (Auto)	-88.279 kVAr	83.615 kVAr	-20.36 kVAr

Trend of Power Factor, New Door, Jaipur



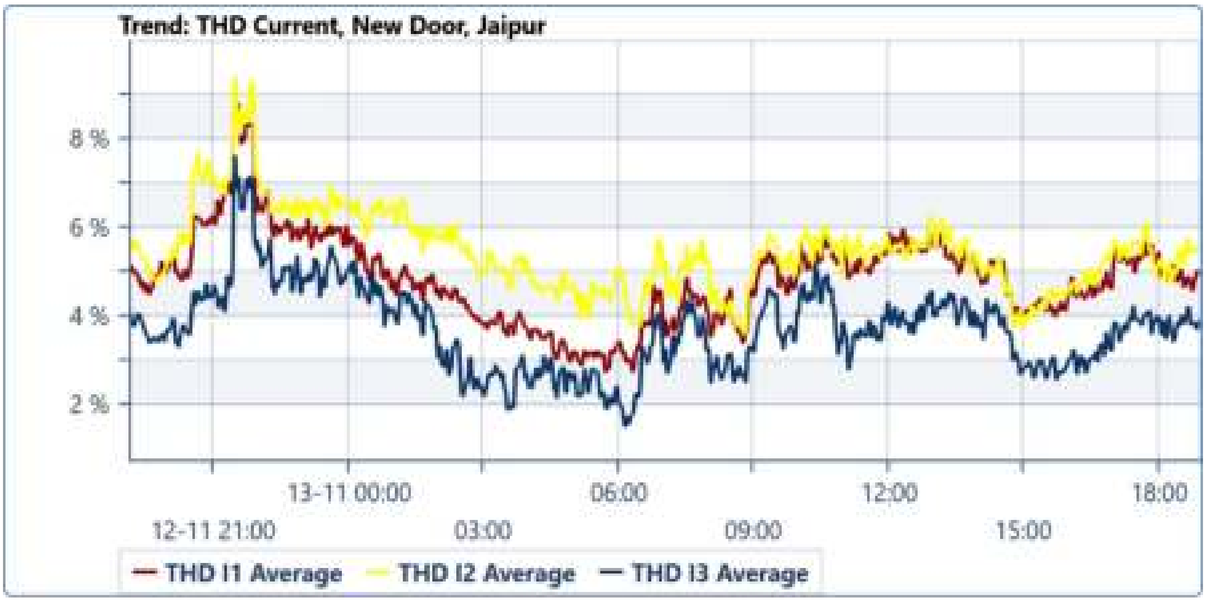
Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.976 CAP	0.966 IND	0.999 CAP
Power Factor 2 (Auto)	0.973 CAP	0.965 IND	0.998 CAP
Power Factor 3 (Auto)	0.976 CAP	0.979 IND	0.996 CAP
Power Factor Total (Auto)	0.975 CAP	0.972 IND	0.997 CAP

Trend of THD Voltage, New Door, Jaipur



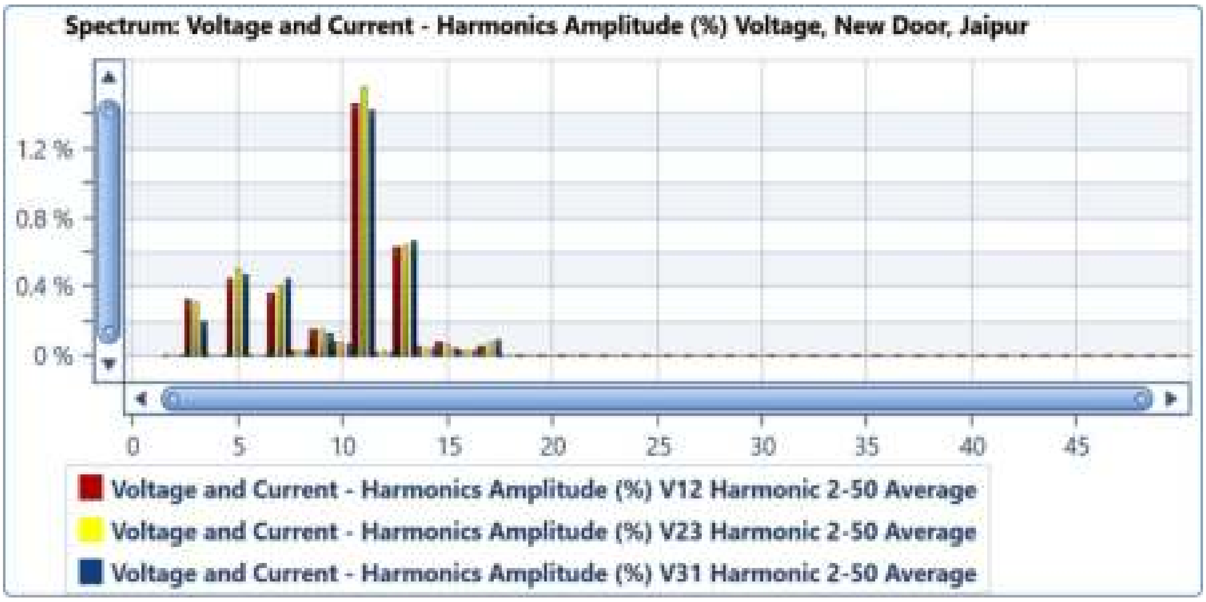
Parameter	Min	Max	Average
THD V12 (Auto)	0.45 %	4 %	1.79 %
THD V23 (Auto)	0.48 %	3.9 %	1.9 %
THD V31 (Auto)	0.39 %	3.74 %	1.79 %

Trend of THD Current, New Door, Jaipur

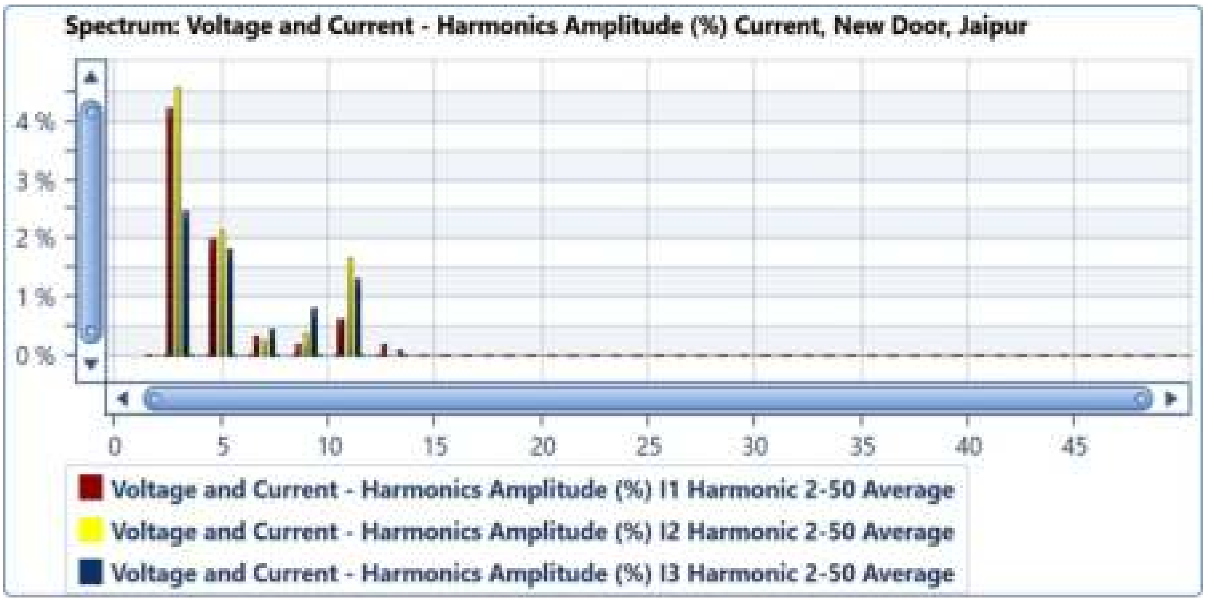


Parameter	Min	Max	Average
THD I1 (Auto)	1.88 %	15.14 %	4.86 %
THD I2 (Auto)	3.33 %	22.05 %	5.45 %
THD I3 (Auto)	1.22 %	17.51 %	3.71 %

Harmonics Amplitude (%) Voltage, New Door, Jaipur

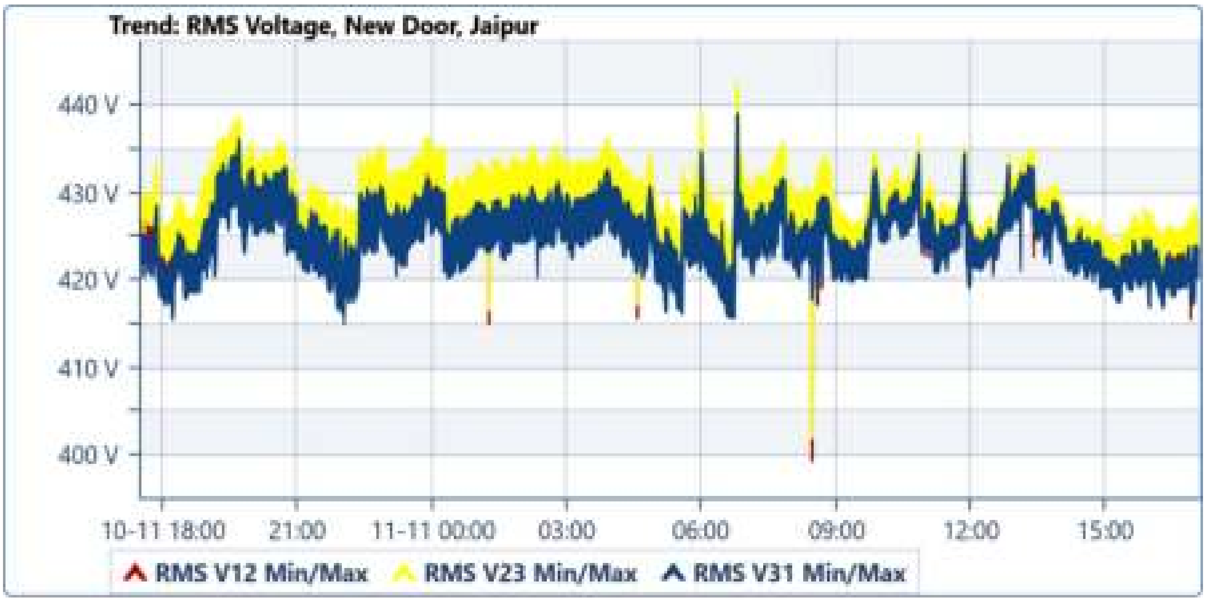


Harmonics Amplitude (%) Current, New Door, Jaipur



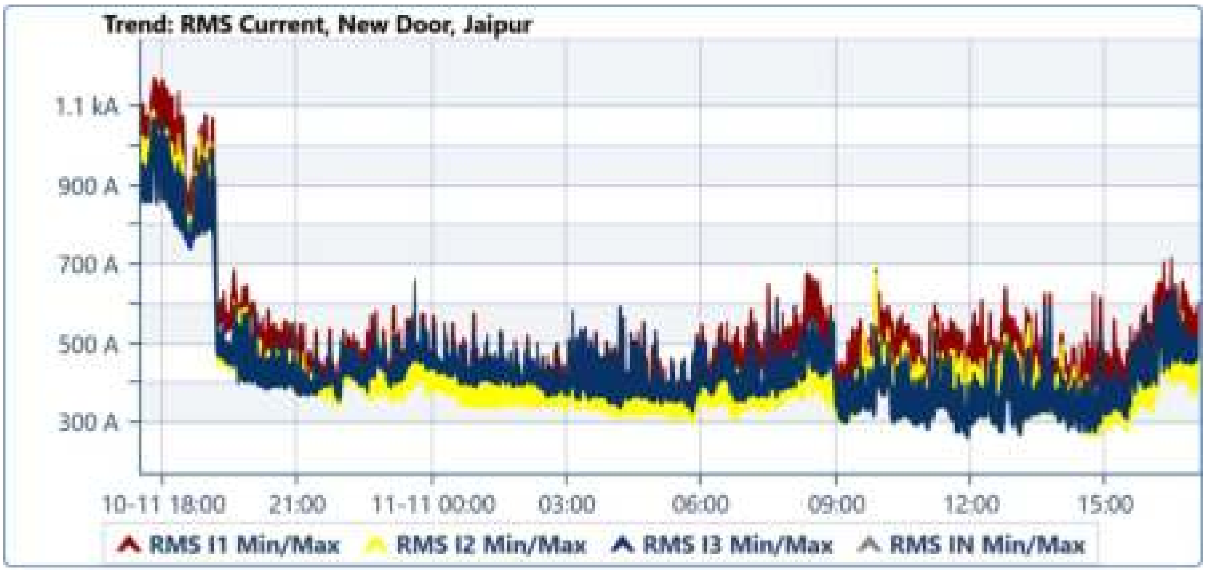
5.Transformer-3

Trend of RMS Voltage, New Door, Jaipur



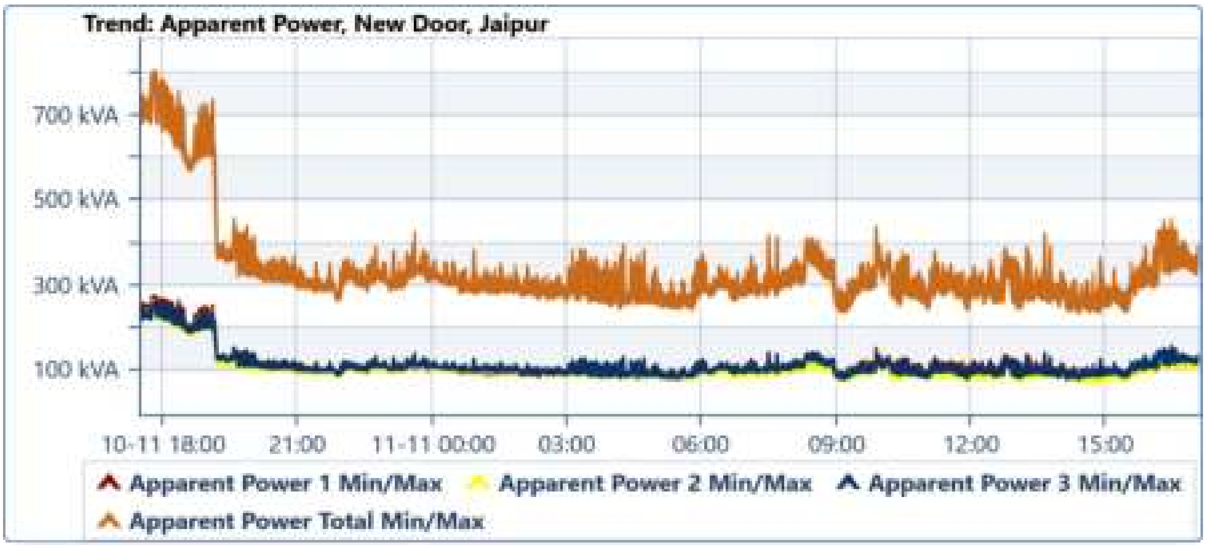
Parameter	Min	Max	Average
RMS V12 (Auto)	399.365 V	440.606 V	426.848 V
RMS V23 (Auto)	401.962 V	442.848 V	428.492 V
RMS V31 (Auto)	414.875 V	439.071 V	425.034 V

Trend of RMS Current, New Door, Jaipur



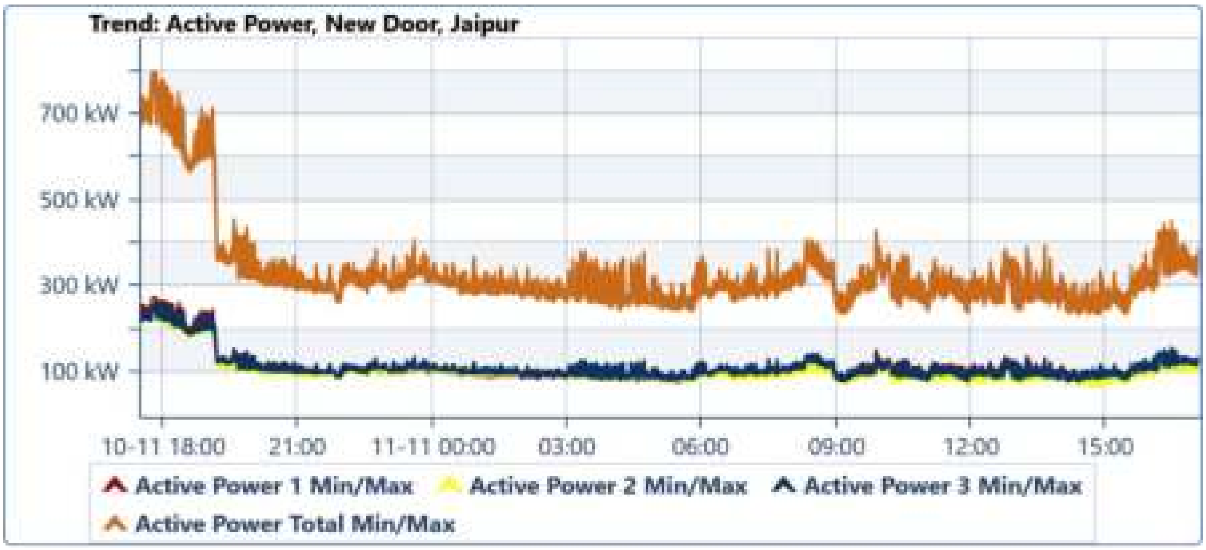
Parameter	Min	Max	Average
RMS I1 (Auto)	338.165 A	1.175 kA	487.346 A
RMS I2 (Auto)	263.54 A	1.091 kA	416.257 A
RMS I3 (Auto)	261.156 A	1.072 kA	431.589 A

Trend of Apparent Power, New Door, Jaipur



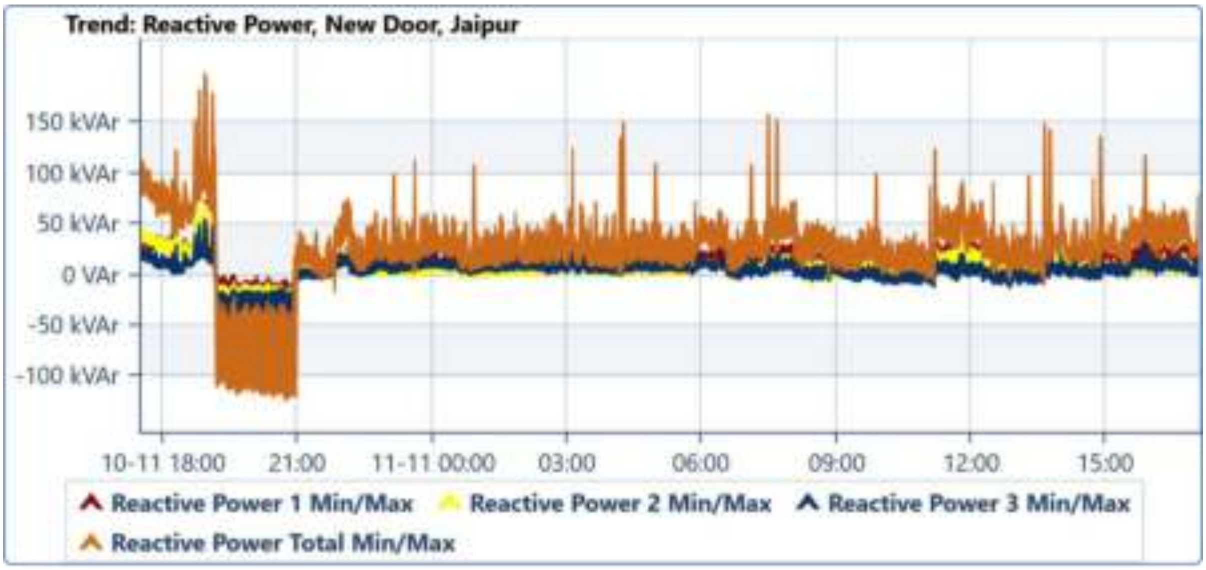
Parameter	Min	Max	Average
Apparent Power 1 (Auto)	77.216 kVA	277.929 kVA	111.262 kVA
Apparent Power 2 (Auto)	66.589 kVA	268.175 kVA	104.826 kVA
Apparent Power 3 (Auto)	77.139 kVA	265.29 kVA	111.872 kVA
Apparent Power Total (Auto)	233.658 kVA	806.447 kVA	327.96 kVA

Trend of Active Power, New Door, Jaipur



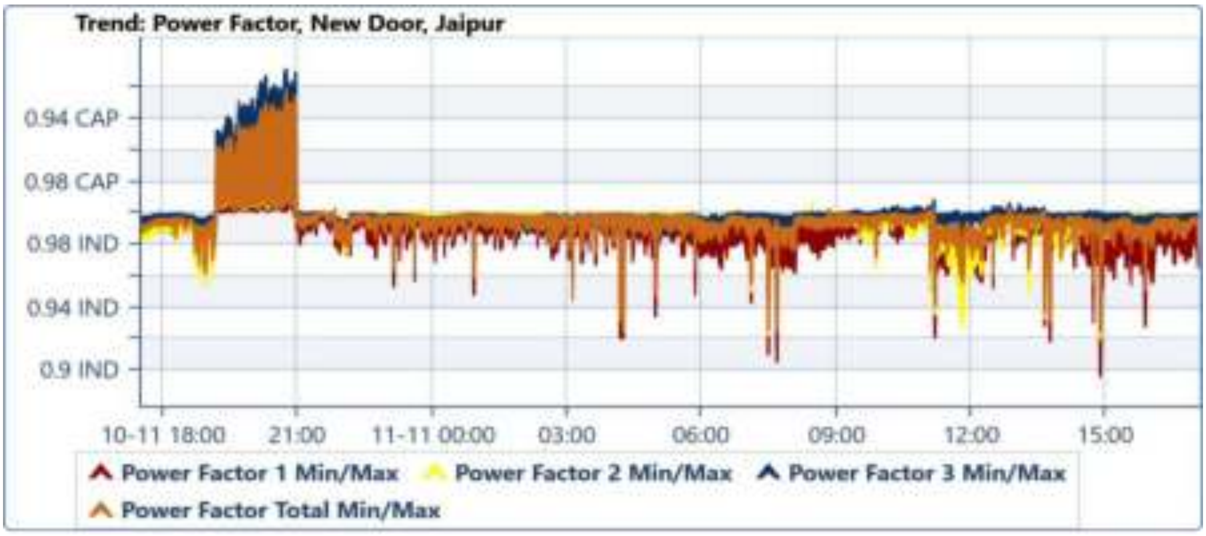
Parameter	Min	Max	Average
Active Power 1 (Auto)	76.883 kW	275.868 kW	110.123 kW
Active Power 2 (Auto)	66.367 kW	266.388 kW	104.233 kW
Active Power 3 (Auto)	77.134 kW	264.388 kW	111.404 kW
Active Power Total (Auto)	232.357 kW	801.417 kW	325.76 kW

Trend of Reactive Power, New Door, Jaipur



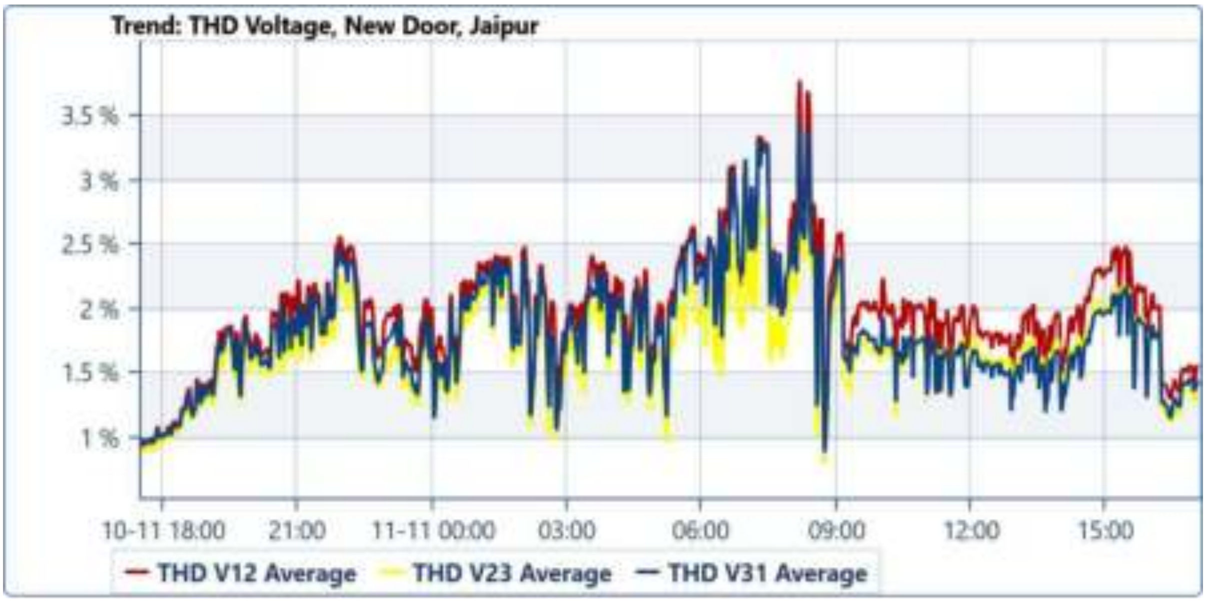
Parameter	Min	Max	Average
Reactive Power 1 (Auto)	-38.082 kVAr	73.427 kVAr	12.935 kVAr
Reactive Power 2 (Auto)	-41.998 kVAr	70.697 kVAr	6.56 kVAr
Reactive Power 3 (Auto)	-46.865 kVAr	55.146 kVAr	3.761 kVAr
Reactive Power Total (Auto)	-123.934 kVAr	199.27 kVAr	23.256 kVAr

Trend of Power Factor, New Door, Jaipur



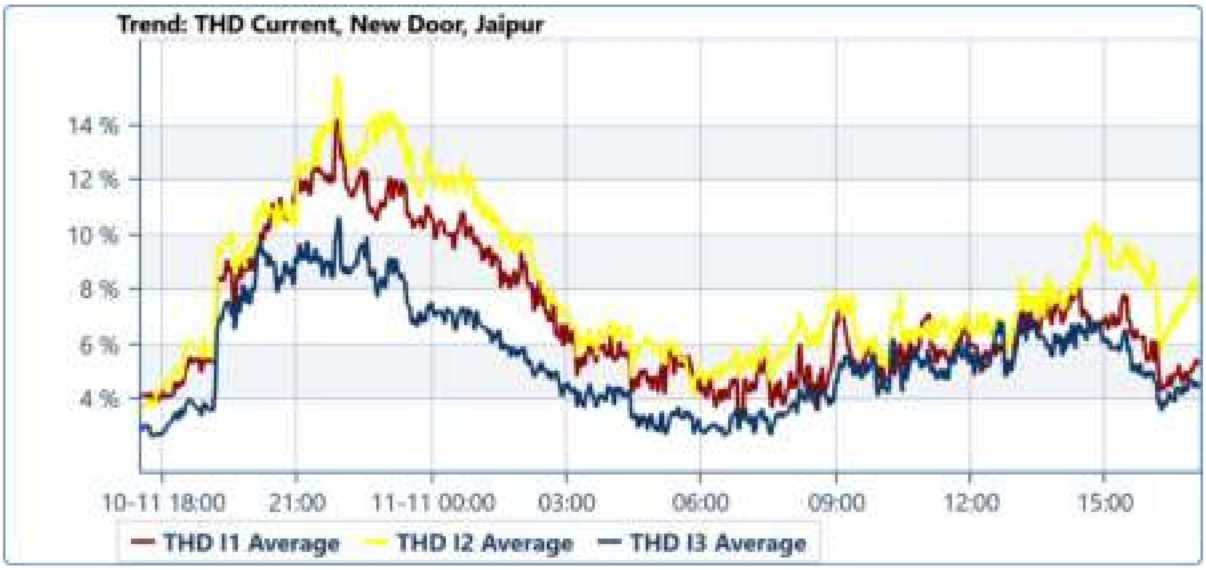
Parameter	Min	Max	Average
Power Factor 1 (Auto)	0.933 CAP	0.896 IND	0.99 IND
Power Factor 2 (Auto)	0.91 CAP	0.92 IND	0.994 IND
Power Factor 3 (Auto)	0.908 CAP	0.93 IND	0.996 IND
Power Factor Total (Auto)	0.921 CAP	0.924 IND	0.993 IND

Trend of THD Voltage, New Door, Jaipur



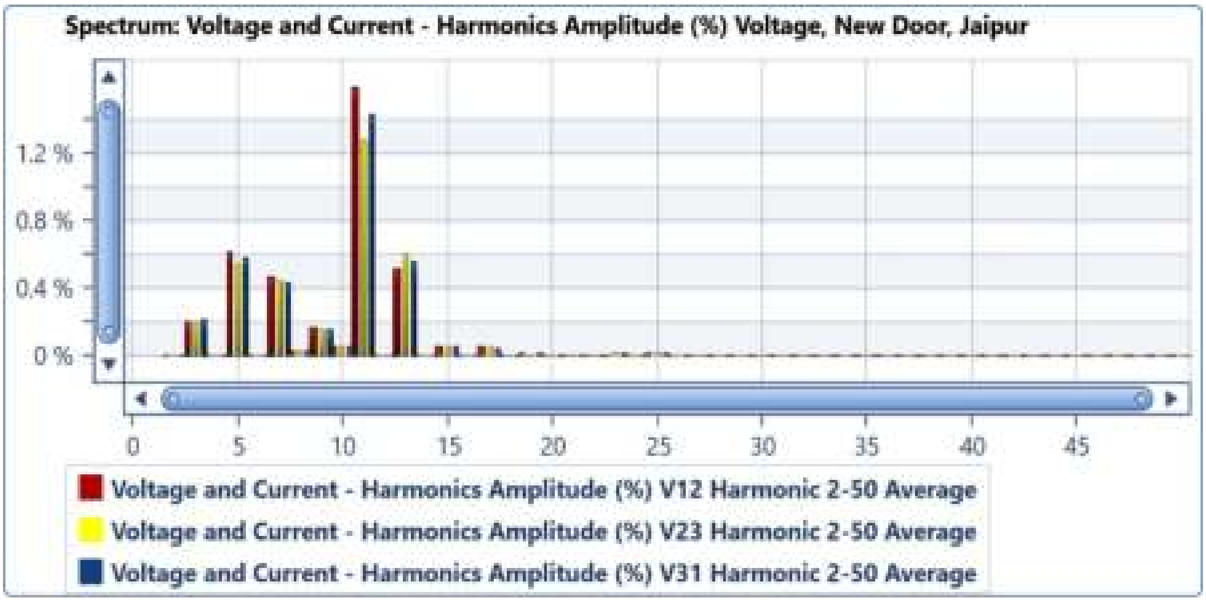
Parameter	Min	Max	Average
THD V12 (Auto)	0.58 %	4.37 %	1.97 %
THD V23 (Auto)	0.35 %	4.62 %	1.71 %
THD V31 (Auto)	0.33 %	5.53 %	1.82 %

Trend of THD Current, New Door, Jaipur

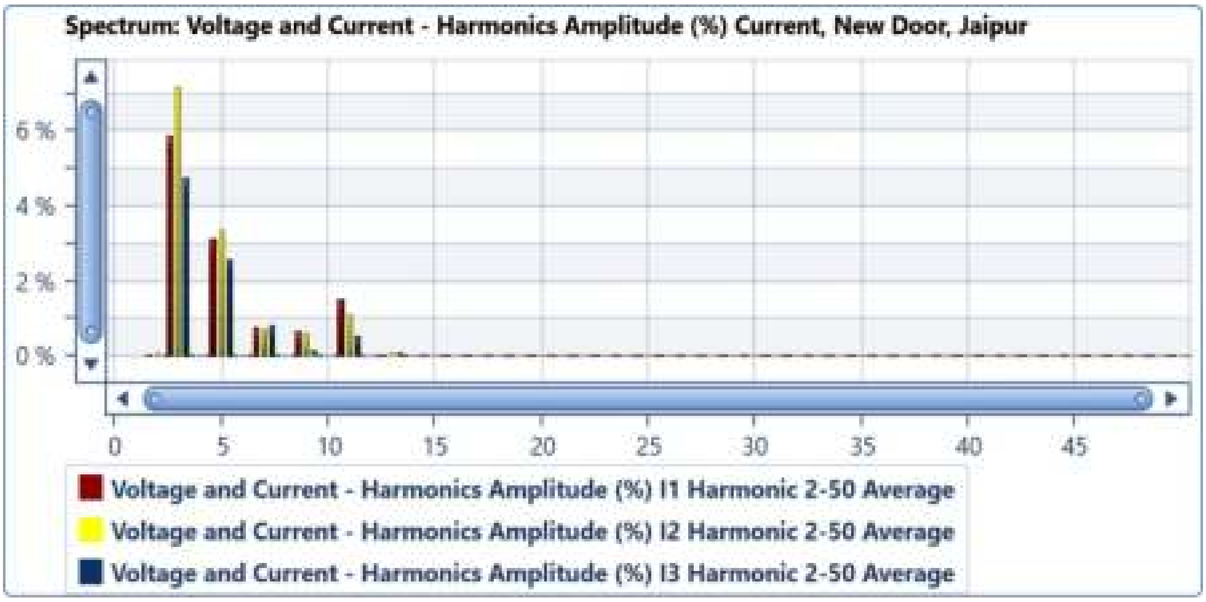


Parameter	Min	Max	Average
THD I1 (Auto)	2.91 %	18.34 %	7.03 %
THD I2 (Auto)	2.99 %	29.04 %	8.14 %
THD I3 (Auto)	2.01 %	30.24 %	5.53 %

Harmonics Amplitude (%) Voltage, New Door, Jaipur



Harmonics Amplitude (%) Current, New Door, Jaipur



4.1.2 APFC HEALTH CHECK-UP:

There are 3 APFC panels in New door for reactive power management.360 KVAr panel with reactor is installed at Transformer-3(3000 KVA), 360KVAr panel with reactor on Transformer-2(1000 KVA) and 240 KVAr panel with reactor is installed at Transformer-1(1000 KVA). Our team conducted health check-up of these panel and the data are given below-

1. **APFC Panel -3 of 360 KVAr with reactor on Transformer-3(3000 KVA)**

S.NO	CAPACITOR BANK	CAPACITOR RATING	MCB RATING	CONTACTOR RATING	CURRENT			REMARKS
					R	Y	B	
1	1	25	C160, ABB	ACB UA30-30-10RA	28	28.6	29	OKAY
		25			30	31	31	OKAY
		10			13	12.6	12	OKAY
2	2	25	C160, ABB	ACB UA30-30-10RA	32	32.1	32	OKAY
		25			32	32.2	32	OKAY
		10			12	12.1	11	OKAY
3	3	25	C160, ABB	ACB UA30-30-10RA	33	32.2	32	OKAY
		25			34	34.1	32	OKAY
		10				12.2	12	OKAY
4	4	25	C160, ABB	ACB UA30-30-10RA	34	33.7	32	OKAY
		25			35	34.3	32	OKAY
		10			11	11.3	12	OKAY
5	5	15	C80, ABB	ACB UA30-30-10RA	20	19.2	18	OKAY
		15			18	18.2	20	OKAY
6	6	15	C80, ABB	ACB UA30-30-10RA	19	18.2	20	OKAY
		15			20	19.2	19	OKAY
7	7	15	C80, ABB	ACB UA30-30-10RA	21	20.9	20	OKAY
		15			20	20.2	20	OKAY
8	8	15	C80, ABB	ACB UA30-30-10RA	21	21.1	18	OKAY
		15			20	20.3	20	OKAY

Table 8: APFC Summary of Panel-3

2. **APFC Panel -2 of 360 KVAr with reactor on Transformer-2(1000 KVA)**

S.NO	CAPACITOR BANK	CAPACITOR RATING	MCB RATING	CONTACTOR RATING	CURRENT			REMARKS
					R	Y	B	
1	1	15	C80 ABB	ACB UA 30-30-10R	20	18	20	OKAY
		15			20	18	20	OKAY
2	2	25	C160 ABB	ACB UA 30-30-10R	32	32	32	OKAY
		25			32	32	32	OKAY
		10			12	12.8	13	OKAY

3	3	15	C80 ABB	ACB UA 30-30-10R	20	18	20	OKAY
		15			18	20	18	OKAY
4	4	25	C160 ABB	ACB UA 30-30-10R	32	31	32	OKAY
		25			31	32	31	OKAY
		10			12	12	12	OKAY
5	5	25	C160 ABB	ACB UA 30-30-10R	32	33	32	OKAY
		25			31	32	31	OKAY
		10			12	12	12	OKAY
6	6	25	C160 ABB	ACB UA 30-30-10R				MCB Faulty
		25						
		10						
7	7	15	C80 ABB	ACB UA 30-30-10R	20	18	20	OKAY
		15			20	18	20	OKAY
8	8	15	C80 ABB	ACB UA 30-30-10R	18	20	20	OKAY
		15			20	18	20	OKAY

Table 9: APFC Summary of Panel-2

3. APFC Panel -1 of 240 KVAr with reactor on Transformer-1(1000 KVA)

S.NO	CAPACITOR BANK	CAPACITOR RATING	MCB RATING	CONTACTOR RATING	CURRENT			REMARKS
					R	Y	B	
1	1	15	C80 ABB	ACB UA 30-30-10R	20	18	20	OKAY
		15			18	20	18	OKAY
2	2	25	C160 ABB	ACB UA 30-30-10R	32	32	32	OKAY
		25			32	32	32	OKAY
		10			12	12.8	13	OKAY
3	3	15	C80 ABB	ACB UA 30-30-10R	20	18	20	OKAY
		15			18	20	18	OKAY
4	4	25	C160 ABB	ACB UA 30-30-10R				MCB Faulty
		25						
		10						
5	5	25	C160 ABB	ACB UA 30-30-10R				MCB Faulty
		25						
		10						

Table 10: APFC Summary of Panel-1

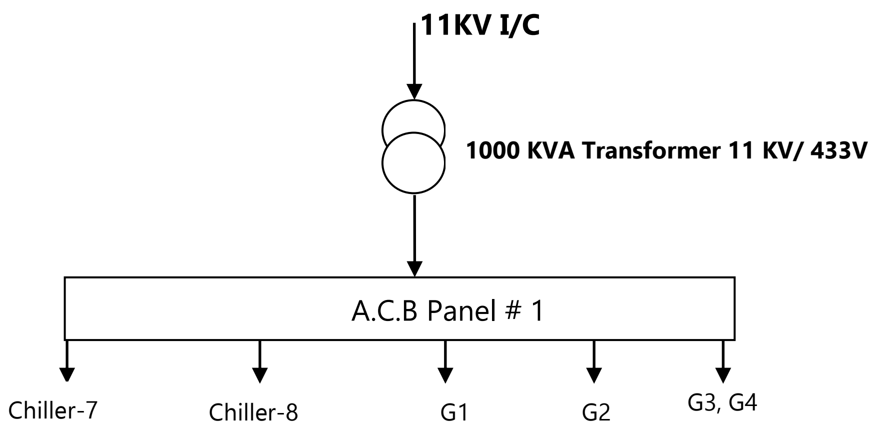
Observation: Some of the MCB are faulty that should be replaced as soon as possible

4.1.3 Saving analysis on Distribution Transformer:

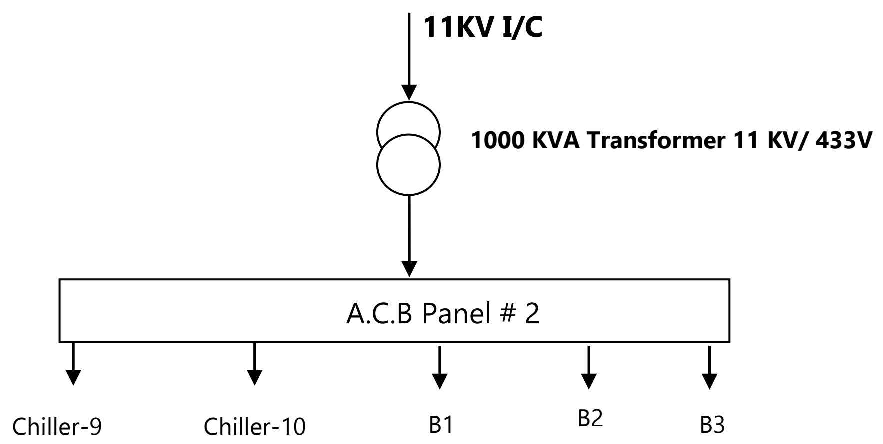
Optimizing capacity utilisation of Transformers to reduce transformer losses: -

1) The incoming supply from grid is coming at 11 KV level, which is stepped down to 433 V level to be supplied at New Door. There are three power transformers: 3000 KVA, 1000 KVA &1000 KVA which are stepping down the potential TO 430/415 volt in 3-phase/ 4-wire circuit. The single line diagram for individual transformer is shown below:

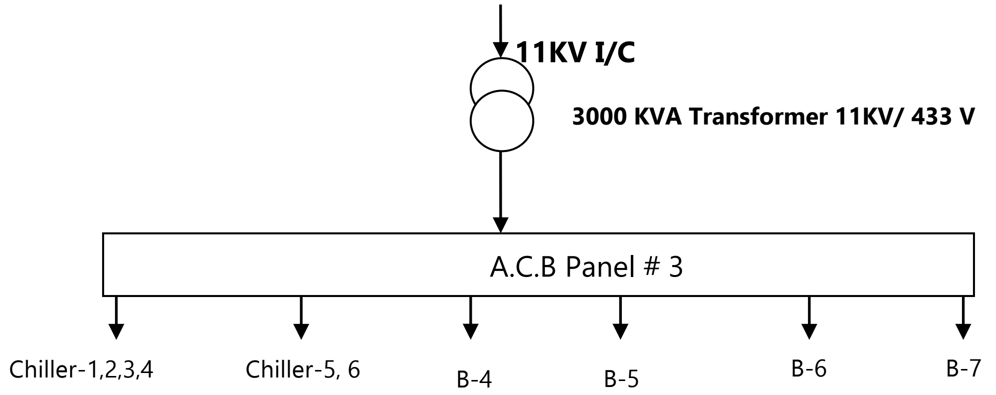
2) Single line diagram for Loads attached with 1000 KVA Transformer (TR#1)



3) Single line diagram for Loads attached with 1000 KVA Transformer (Tr#2)



4) Single line diagram for Loads attached with 3000 KVA Transformer (Tr#3)

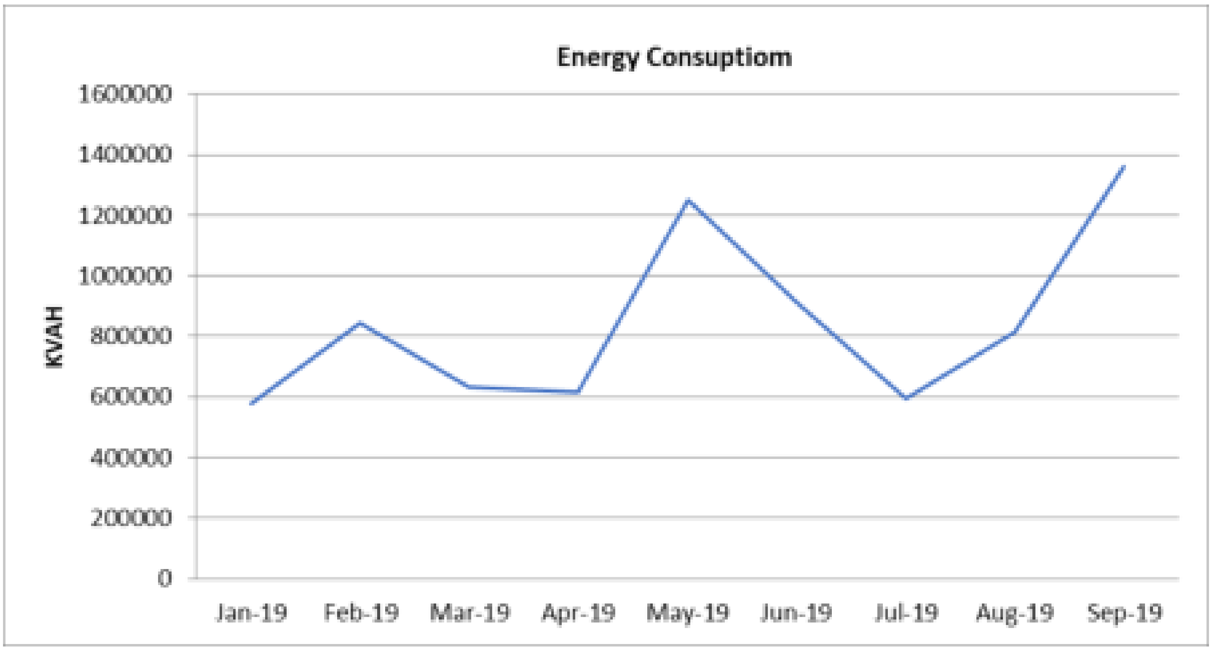


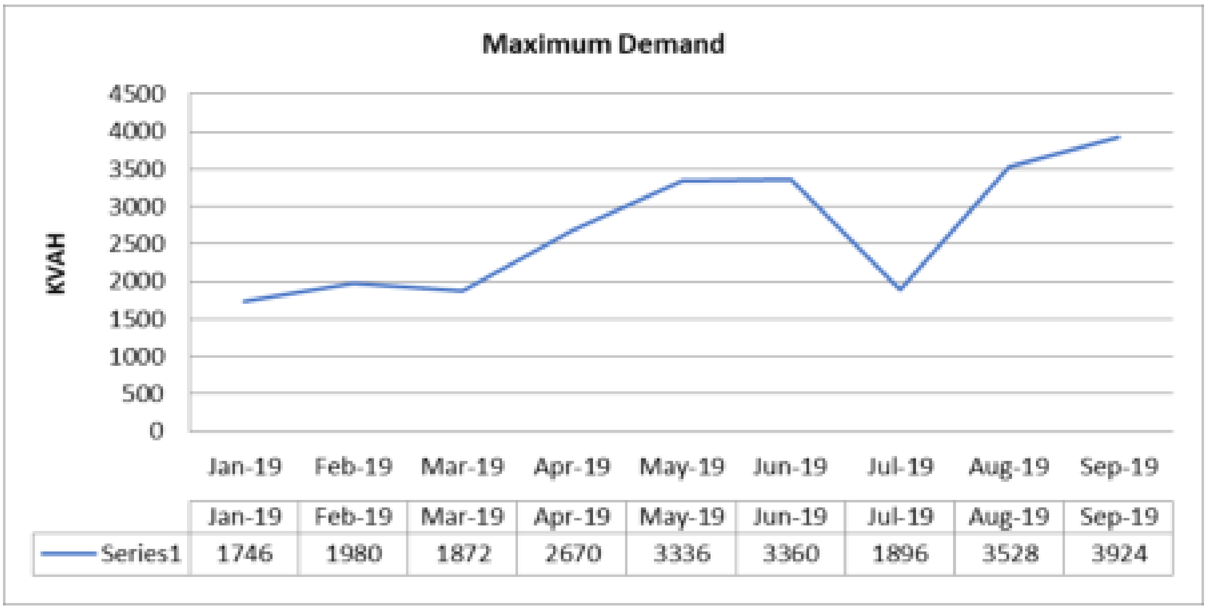
5) Load Details of Transformers: -

S. No	Location	Rating (KVA)	Max. Load KVA	Avg. Load KW	% Loading in KVA	Avg. Load KVA	Avg. Load KW	%Loading in KVA
1	11-kV Main Incomer	5000	1710	1650	34.2	846.01	845.35	16.92
2	Transformer-1	1000	400.31	399.07	40.03	213.18	211.98	21.32
3	Transformer-2	1000	553.94	551.5	55.39	330.28	329.44	33.03
4	Transformer-3	3000	806.44	801.41	26.88	327.96	325.76	10.93

Table 11: Transformer Information

6) Details of Energy Consumed by New Door Hospital during the period Feb-19 to Sept-19: -





7) Analysis of available data: -

i) The figure indicates that on average loading, the transformer-3(3000KVA) is running on 11% loading. The total load connected on transformer-3 is 1800KW (approx.). The loading on transformer-3 is 50% in case of maximum. Load on condition.

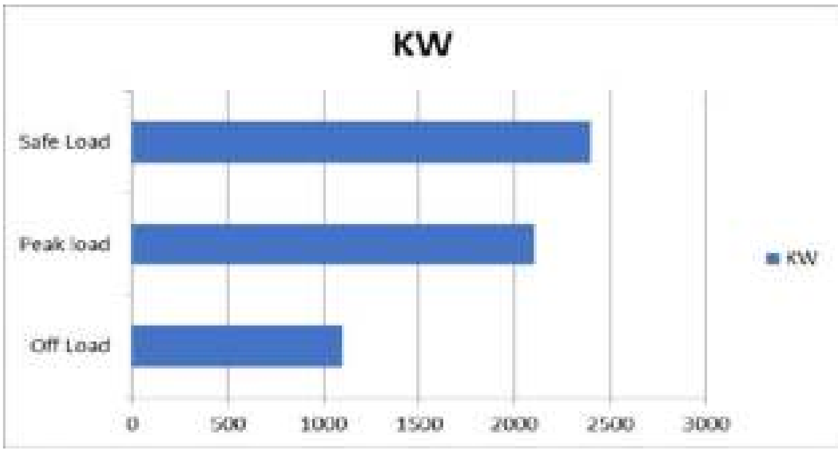
ii)) Transformer-1 is running on 21% average loading. The total connected load on transformer-1 is 600 KW (approx.).

Total Connected Load on Transformer-1

Total Load, including Chiller & Block (G1, G2, G3, G4) – 600 KW (approx.)

Total Load, excluding Block – 300 KW.

3) If we shift the block load (G1, G2, G3, G4) on Transformer-3, it will be total load 2100 kW on transformer-3 which will be 70% loading in case of total connected load is on condition. Another option is to shift the load from transformer -1 to transformer -2 through bus coupler.



1) As per analysis of electricity bill, the maximum demand is in August & September which is due to chiller load. By discarding transformer-1 for remaining month & running chiller load accordingly on rest of transformers. The energy saving analysis is given below: -

S. No	Particulars	UOM	Value
1	Transformer Rating	KVA	1000
2	Min % saving of no-load losses	%	0.3%
3	Unit Loss	KVA	3
4	Operating Hours	Hours	24
5	Operational Days	Days	300
6	Annual Energy saving	KVAh	21818
7	Unit Cost	Rs.	9.4
8	Annual Monetary saving (in Lakhs)	Rs.	2.051
9	Investment (in Lakhs)	Rs.	1.5
10	Payback	Rs.	9

Table 12: Energy saving analysis on Transformer

Note: Load shifting can either be done by shifting the cables or by using Bus coupler.

Standard Philosophy:

1. Shifting of load will be during non-peak seasons.
2. Turn off transformer-1 and operate transformer-2 and 3 during non-peak seasons' July to September.
3. Do not put chiller load on Transformer- 1 or 2 until load on transformer 3 crosses 2200 Kw.
4. After the visit it has been observed that it can be achieved through shifting of cables to the panel which already has provision of some of the loads on 3 MVA transformer

to operate on DG also. Since there is no investment required, therefore there is no need of proposal.

2) As per analysis of power quality, the running voltage at transformer-3(3000KVA) is 430 Volt so by reducing voltage level to 410-415 volts the energy saving that can be achieved is given below-

S. No	Particulars	UOM	Value
1	Annual Energy consumption from transformer 3	KVAH	70,34,760
2	Running Voltage	Volt	430
3	Reduction in Volt	Volt	15-20
4	Saving by voltage reduction annually	%	2
5	Annual Energy saving	KVAh	1,40,695
6	Unit Rate	Rs.	9.4
7	Annual Monetary Saving (in Lakhs)	Rs.	13.23
8	Investment	Rs.	Nil
9	Payback		Immediate

Table 13: Energy saving analysis on Transformer

4.2 HVAC SYSTEM:

4.2.1 CHILLERS:

MUJ Hostel has installed ten chillers (10) of Carrier Make in the premises and have operating max 5 to 6 chillers at a time during peak season (July, Aug, Sep) to cater the cooling load of almost 3000 rooms say at occupancy rate of 70% (average). There are 6 chillers (135 TR each) which can operate in both cooling and heating mode and 4 chillers (270 TR each) which can operate in cooling mode. Performance assessment has been conducted and the results are as mentioned below.

S. No	Particulars	UOM	Values									
1	Chiller		5	6	7	8	9	10	1	2	3	4
2	Make		Carrier									
3	Rated Capacity	TR	135	135	135	135	135	135	275	275	275	275
4	Operating Hours		1000	1000	1000	1000	1000	1000	700	700	700	700
5	Actual Chiller Current	Amp	227	222	225	218	236	233	470	481	410	418
6	Set Point	°C	7	7	7	7	7	7	7	7	7	7
7	Ambient temp	°C	28.7	28.5	28.8	28.8	28.8	28.8	26.1	24.6	24.6	24.3
8	Control Point	°C	6.7	6.7	6.7	6.7	7	7	6.7	6.7	6.7	6.7
9	Cooler entering fluid	°C	23.8	21.2	21	21.3	22	21.9	25.6	23.8	23.2	23
10	Cooler leaving fluid		14.5	14.1	13.4	13.4	13.5	13.6	11.7	13.4	12.9	11.6
11	Delta T	°C	9.3	7.1	7.6	7.9	8.5	8.3	13.9	10.4	10.3	11.4
12	Chiller Tonnage	TR	115	87	94	97	105	102	342	256	254	281
13	Power Consumed	kW	135	132	133	129	141	140	287	292	235	242
14	SPC	kw/ton	1.18	1.51	1.42	1.33	1.35	1.37	0.84	1.14	0.93	0.86
15	COP		2.98	2.33	2.48	2.65	2.61	2.57	4.20	3.09	3.79	4.08
16	Range of Good Performance COP	kw/ton	0.80 to 1.3									
17	Remark		Good	OK	OK	OK	OK	OK	Good	Good	Good	Good

Table 14: Details of Chiller

In descending order Chiller 1,4,3,2,5 are found to be efficient chiller as their COP is near or more than 3. Overall performance of Chillers is found satisfactory though it can be further improved with the help of advanced control systems which may require high capex and will not be feasible owing to a smaller number of operating hours for each chiller. It is to note that Chillers mostly run at evening to dawn, i.e., 14 hrs (max) and we would like to appreciate the way it is being monitored to control the energy consumption. However, in controlling one has to take caution against too much start/stop of Compressors which will reduce its life.

AUXILIARIES OF CHILLER

FANS

Each chiller is fitted with Fans of 1.5 kW & there are 10 nos in 135 TR chiller unit and 16 nos in 270 TR chiller unit.

Energy Saving in Chillers:

1) Reduce entering water temperature or increase chilled water supply temperature or increase set point temperature

On some building systems, operators can reduce the chilled water set point to overcome air handler deficiencies such as dirty coils. Beware of this practice, which may stop the symptoms but won't cure the problem. It makes the chiller work harder for the same net cooling effect.

For each 1 °C increase in set point temperature can save almost 5% of chiller energy consumption. As Good host is maintaining chilled water temperature around 10 to 11 °C, there are instances in the log when the chilled water temp goes below 9.5 °C. Therefore, there is a strong possibility that these events can occur for at least 10% of the time even after manual control of chiller for start/stop. Hence, consider 10% of saving achievable from potential saving:

S. No	Particulars	UOM	Value
1	Existing Setpoint	°C	6.7
2	Proposed Set Point	°C	10
3	Energy Saving Potential	%	5%
4	Existing SPC of Chiller	kW/TR	1.17
5	Improvement in SPC by 5%	kW/TR	0.06
6	Average Running TR per hour	TR	540
7	Total Energy Saving per hour	kW	32.4
8	Annual Operating hours	hrs	4200
9	Annual Energy saving	kVAh	137454
10	Duration of energy saving potential in a year	%	10
11	Potential energy saving	kVAh	13745.4
12	Unit Cost of Electricity	Rs.	9.4
13	Annual Monetary saving	Rs.	1,29,207
12	Investment	Rs.	Nil
13	Achievable Energy Savings	months	Immediate

Table 15: Energy saving analysis on Chiller

Note:

1) If Cooling capacity is under rated due to low CD then it needs to be increased and not to operate the chiller on inefficient parameters.

2) We have noted down of some logs where it has shown Set point as 6.7 deg C in past too. Please see the attach.

3) Through the same logs and as per your earlier comments also, you told that temp does not reach below 10-11 deg C on any instance. We have seen it through logs also. Accordingly, we had reduced the saving.
4)The logs that are randomly picked by us and not selectively. This saving point is valid based on all above.

2) Free cooling or Chiller free cooling

Use of PLC and Sensor before starting chiller to maintain chiller water supply at required temperature with the help of fans only from all chillers. It involves removing the unwanted heat from the cooling system without the use or with minimal use of the compressors. This isn't possible in all locations it can only be used when the outdoor air temperature is below the chilled water set point temperature.
Using a free cooling allows the chillers compressor to be turned off, however the pumps and fans will still run and will likely run at high speeds so some of the savings from the compressor being off are offset here.
Using a free cooling cycle could reduce the chillers annual energy consumption by 20-50% again this really depends on the local ambient conditions and setpoint temperature.

Alternatively, air cooled condensers can be fitted into the system to use just ambient air to remove as much heat as possible before reaching the chiller.

Implementation: This saving cannot be achieved as communicated to IPPL by Good Host because the operational starting time of the chiller would be in between 4-5 PM for most of the days of the year. Due to it this suggestion is infeasible. However, we suggest to separate the starter of fan and compressor i.e. the fan and compressor should start independently.

3) Chiller plant optimization

With reference to operational logs maintained by Good host the existing SPC for the set of operating chillers is found to be approximately 1.17. Running combination of most efficient chiller in this condition only will give SPC approximately 0.94. However, for conservative estimate we consider SPC as 1. The chiller, cooling towers and pumps all have different efficiency curves especially at part load conditions. A plant sequencer can be used to ensure that the most efficient combination of plant items is used to match the current cooling load. The sequencer can be either just for the chillers or more advanced ones will include all the associated large plant items.
If you opt for the combined plant sequencer then it's possible to reduce the entire systems energy consumption by around 20% sometimes higher but this depends on how bad the controls strategy previously was and how efficient your plant items run at part load. Therefore, running most efficient chiller (1,2,3,4,5) for most of the time will reduce the energy consumption.

S.No.	Particulars	UOM	Value
1	Annual Energy Consumption	kWh	1345181
2	Existing SPC of Chiller	kW/TR	1.16
3	Proposed SPC of Chiller	kW/TR	1.00
4	Improvement in SPC	kW/TR	0.16
5	Average Running TR per hour from other chillers	TR	270
6	Total Energy Saving per hour	kW	43.2
7	Annual Operating hours	hrs	1000
8	Annual Energy saving	kVAh	43636.3
9	Unit Cost of Electricity	Rs.	9.4
10	Annual Monetary Saving	Rs.	4.1
11	Investment	Rs.	Nil
12	Payback	months	Immediate

Table 16: Energy saving analysis on Chiller

Implementation: Good Host must operate set of chillers with best efficiencies referring to Table 14: Details of chiller on page no 55 for most of the days in the year. Though we understand that Good Host also practises this philosophy up to some extent however we still emphasise that this operational strategy should be kept on record and the record should be displayed near the operating panel. This suggestion will save energy in long term.

Note: We have observed through the logs that even you operate with best combination of chillers then the SPC is till high for which this suggestion has been made. Since you operate mostly 2-3 chillers at time sometimes operate 4-5 chillers in peak season. Therefore, it can achieve by enumerate putting 2-3 chillers on both Mains and DG also with necessary changes. And rest of the chillers will remain as they are. We are saying that just select and run the best chillers only in combination.

4.2.2 CHILLED WATER PUMPS:

8 Chilled water pumps are present for circulation of water. 4 Chilled water pumps are operated to match the requirement of the plant and 4 are on standby. We measured the electrical and the flow of these pumps to determine their efficiency and the details are given below-

Figure 7:Chilled water pumps

Sr.no	Particulars	UOM	CWP-1	CWP-2	CWP-3	CWP-4	CWP-5	CWP-6	CWP-7	CWP-8
1	Make		Armstrong							
2	Rated Power	kW	37	37	37	37	37	37	37	37
3	Rated P.F		0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
4	Rated Head	m	51	51	51	51	51	51	51	51
5	Rated Flow	m^3/h	148	148	148	148	148	148	148	148
6	Rated Motor Efficiency	%	92.5%	92.5%	92.5%	92.5%	92.5%	92.5%	92.5%	92.5%
7	Measured Head	m	42	42	44	42	42	42	42	44
8	Velocity	m/s	0.931	0.921	0.942	0.941	0.926	0.943	0.929	0.961
9	Pipe Size	mm	870	870	870	870	870	870	870	870
10	Calculated flow	m^3/h	201.9	199.7	204.3	204.0	200.8	204.5	201.4	208.4
11	Measured Flow	m^3/h	183.9	183.5	186.1	185.6	184.5	184.2	183.3	183.8
12	Measured Motor Loading	%	26%	27%	26%	26%	24%	25%	25%	26%
13	VFD	Hz	35	35	35	35	35	35	35	35
14	Measure Hydraulic Power	kW	6.01	6.00	7.10	6.07	6.03	6.02	5.99	7.01
15	Measured Power	kW	12.8	13.1	13	13	12.0	12.2	12.3	12.6
16	Pumping	%	47.0%	45.8%	54.6%	46.7%	50.5%	49.3%	48.6%	55.7%

	Efficiency									
17	Motor Efficiency@30% loading	%	75%	75%	75%	75%	75%	75%	75%	75%
18	Pump Efficiency	%	62.6%	61.1%	72.8%	62.2%	67.3%	65.7%	64.8%	74.2%
19	Remarks		Efficient System							

Table 17: Details of Chilled Water Pumps

Remark: Overall Pumping system efficiency is found good.

4.2.4 UNITARY AC SYSTEM:

New door uses mainly uses Spilt AC for human cooling in areas such as Facility block, Common area and guest rooms. Our team measured different parameters to calculate the efficiency of the split AC's on 20% sample basis. Below given is our findings:

Sr.no	Location	Make	Capacity (TR)	Measured TR	Kilowatt	Kw/TR	Remark
1	B2 Common area	Carrier	1	0.74	0.72	0.97	Efficient
2	Reception	Carrier	1.5	1.01	1.14	1.13	Efficient
3	G1 Common Area	Carrier	1.5	1.35	1.13	0.83	Efficient
4	Login	Vestar	1.5	0.84	1.16	1.37	Inefficient
5	Login	Carrier	1.5	0.99	1.17	1.18	Efficient
6	Medical Centre	Toshiba	2	1.44	1.60	1.12	Efficient
7	Medical Centre	Toshiba	2	1.31	1.57	1.19	Efficient
8	Medical Centre	Toshiba	2	1.50	1.67	1.11	Efficient
9	B1 Guest Room	Carrier	1	0.73	0.70	0.96	Efficient
10	B1 Guest Room (506)	Carrier	1	0.61	0.61	0.99	Efficient
11	B1 Guest Room (505)	Carrier	1	0.55	0.69	1.25	Efficient
12	B1 Guest Room (511)	Carrier	1	0.88	0.79	0.90	Efficient
13	B1 Guest Room (510)	Carrier	1	0.65	0.67	1.04	Efficient
14	Girls Common Area	Carrier	1	0.71	0.68	0.95	Efficient
15	Chief warden office	Carrier	1	0.89	0.77	0.87	Efficient
16	G1 Guest Room (502)	Carrier	1	1.11	0.69	0.62	Efficient
17	G1 Guest Room (505)	Carrier	1	1.15	1.29	1.12	Efficient
18	G1 Guest Room (504)	Carrier	1	0.85	0.74	0.87	Efficient
19	G1 Guest Room (507)	Carrier	1	0.46	0.63	1.38	Inefficient
20	Mr Bharat Bushan Room	Carrier	1.5	1.04	1.16	1.12	Efficient
21	Office area	Carrier	1.5	1.06	1.12	1.05	Efficient
22	Conference area	Carrier	1.5	1.30	1.18	0.91	Efficient
23	Mr Ranjay Verma	Carrier	1	0.89	0.66	0.74	Efficient
24	Recreational Room	Toshiba	6	4.12	4	0.97	Efficient

Table 18: Details of AC

The average EER of the window ac is 2.36 which is low compared to 3-star Ac's EER 3.50 in the market. For energy saving is AC we suggest:

1. Maintain the set point between $24^{O}C$ to $27^{O}C$.
2. Prevent Air Leakage from the envelops.
3. Replace Non star rating ac with new energy efficient inverter ac. The payback period will be 2 to 3 years depending on the operating hours of the AC's.

1) **Install automation system in AC's to control the compressor off/on cycle by Automation. The energy saving analysis is captured below table:**

Sr.no	Parameters	UOM	Value
1	Average kW/TR	kW/TR	1.3
2	Energy saving Potential	%	20
3	No of units	No	16
4	Operating hours	Hours	8
5	Annual operation days	Days	240
6	Annual Energy saving	KVAh	7987.2
7	Unit rate	Rs/unit	9.4
8	Annual Monetary Saving	Rs	0.7508
9	Investment	Rs	1.2
10	Payback period	Months	19.2

Table 19: Energy Saving Analysis of AC

2) We suggest to replace Inefficient AC by 5-star Inverter AC. Given below is the analysis table

Sr.no	Parameters	UOM	Value
1	Energy consumption per hour by old AC	kWh	1.4
2	Energy consumption per hour by new Inverter AC	kWh	0.9
3	Diff. in energy consumption	kWh	0.5
4	Operating Hours	Hours	8
5	Annual operation days	Days	240
6	No of units to be replaced	No	4
7	Annual energy saving	KVAh	3840
8	Unit Rate	Rs.	9.4
9	Annual monetary saving	Rs.	0.36096
10	Investment	Rs	1.2
11	Payback	Months	40

Table 20: Energy Saving Analysis of AC

4.2.5 AIR HANDLING UNIT (AHU):

Total 2 nos of Air handling units are present in the facility. The performance assessment of the AHU's are illustrated below table:

Sr.no	Location	Rated CFM	Rated kW	Measured kW	Measured CFM	Remark
1	Gym-Outside	12500	5.5	3.4	12688.2643	Satisfactory
2	Gym-Inside	12500	5.5	2.3	10886.6226	Satisfactory

Table 21: Performance assessment of AHU's

1) Energy saving achieved by installation of ZERAX and EC^{+} System

In HVAC System, EC^{+} Concept facilities design of topmost efficient AHU's and boost energy efficiency of the existing systems. The concept prescribes components for optimum system design of high efficiency fans, high efficiency IE4 motors and high efficiency Danfoss VFD's. The combined system has the potential to deliver efficiencies in the range of 80 - 85%, which is 15% – 25% points better than the closest alternative solutions such as direct-driven centrifugal plug fans with EC motors. The payback period of the system will come 3 to 4 years.

4.2.6 COLD STORAGE/ROOMS:

Sr.no	Location	DB	RH	Return grill	Supply grill	RH	Area of indoor unit			TR	SP	KW	kW/TR	Reqd TR
							2 Fan	3 Fan	Room Volume					
							(in m^2)	(in m^2)	(in m^3)					
1	Cold Room-I	11.6	89	11.6	14	90	0.42	0.525	30.64	5.7	11	8.1	1.41	5.2
2	Cold Room-II	12	81	11	15	85		0.525	19.58	5.4	11	7.1	1.31	4.9
3	Cold room-III	5	70	6.5	8	81	0.42		20.39	3.1	7	4	1.3	2.7
4	Deep Cold room	-3.5	50	-5	-3	85		0.525	13.01	3	-13	3.5	1.14	2.6

Table 22: Performance assessment of cold room unit

Overall Performance of the Cold room indoor unit are found to be satisfactory.

4.3 Water Survey

WATER BILL ANALYSIS

Months	Purchased (in KL)	Amount (in Rs)	Rs. /KL
Jan-19	3537	871804	246
Feb-19	3378	823980	244
Mar-19	2635	671310	255
Apr-19	3521	897208	255
May-19	2995	711311	237
Jun-19	609	142840	235
Jul-19	648	152080	235
Aug-19	3315	821000	248
Sep-19	3468	871280	251
Oct-19	3003	756975	252
Estd. Annual Expenditure	32531	80,63,745	246

WATER BALANCE DIAGRAM

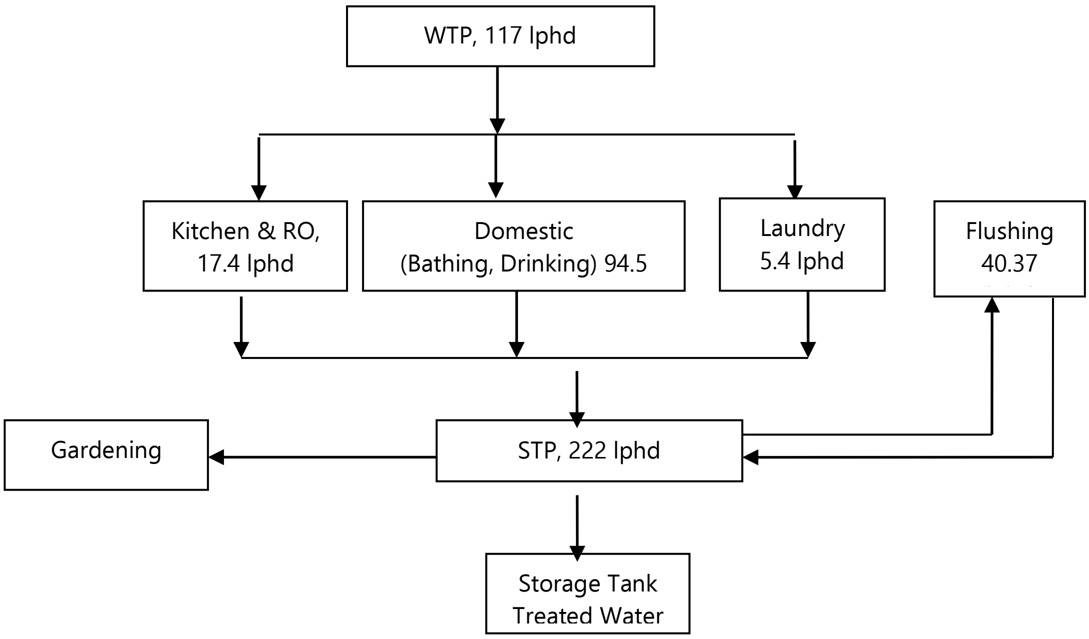


Figure 8:Water Balance Diagram

S.No	Particulars	UOM	Values
1	WTP	lphd	117.3
2	STP	lphd	222.2
3	Domestic	lphd	94.5
4	Laundry	lphd	5.4
5	Kitchen	lphd	13.7
6	Retail Outlets	lphd	3.7
7	Flushing	lphd	40.4

TOTAL WATER CONSUMPTION

S. No	Consumption	UOM	No. of Rooms	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	B1-Zone 1	lphd	147	133	166	145	181	146	34	80	181	175	184	136	109
2	B1-Zone2	lphd	212	170	214	172	222	161	38	68	225	222	232	173	134
3	B1-Zone 4	lphd	116	92	114	98	120	95	24	32	112	116	125	89	70
4	B2-Zone 1	lphd	127	87	109	103	133	82	28	30	153	108	108	84	74
5	B2-Zone2	lphd	205	146	185	170	208	142	28	46	212	183	185	139	107
6	B2-Zone 3	lphd	98	88	92	85	116	80	11	11	124	128	112	89	61
7	B3-Zone A	lphd	118	83	96	61	71	62	48	69	94	107	109	75	76
8	B3-Zone B	lphd	90	47	59	48	50	41	28	29	53	73	66	43	56
9	B4	lphd	241	169	149	121	115	103	60	90	218	242	251	192	173
10	B5	lphd	111	118	125	113	153	166	20	47	201	188	199	151	144
11	B6	lphd	276	195	184	205	210	216	99	105	267	256	279	223	217
12	B7	lphd	364	328	414	350	417	305	94	101	453	376	437	292	226
13	G1 -Zone 3	lphd	167	110	121	110	110	121	55	56	219	146	154	107	114
14	G1-Zone 4	lphd	167	151	165	155	172	151	36	58	199	166	224	162	152
15	G2	lphd	163	153	159	147	184	146	21	24	221	217	229	168	123
16	G3	lphd	171	144	168	144	150	111	18	40	108	150	181	139	117
17	G4	lphd	173	77	25	6	2	85	66	83	174	158	150	121	140
18	Total	lphd		2288	2547	2233	2615	2213	708	967	3214	3011	3226	2384	2093
19	Average Consumption per head , lphd			135	150	131	154	130	42	57	189	177	190	140	123
20	Annual Average Consumption per head, lphd			138.37											

As per CGWA and NBC 2016, the water consumption per head is given as 135 lphd for Hostel Category. Therefore, overall water consumption of Hostel is found satisfactory.

DOMESTIC WATER CONSUMPTION

S. No	Consumption	UOM	No. of Rooms	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	B1-Zone 1	lphd	147	133	166	145	181	146	34	80	181	175	184	136	109
2	B1-Zone2	lphd	212	170	214	172	222	161	38	68	225	222	232	173	134
3	B1-Zone 4	lphd	116	92	114	98	120	95	24	32	112	116	125	89	70
4	B2-Zone 1	lphd	127	87	109	103	133	82	28	30	153	108	108	84	74
5	B2-Zone2	lphd	205	146	185	170	208	142	28	46	212	183	185	139	107
6	B2-Zone 3	lphd	98	88	92	85	116	80	11	11	124	128	112	89	61

7	B3-Zone A	lphd	118	83	96	61	71	62	48	69	94	107	109	75	76
8	B3-Zone B	lphd	90	47	59	48	50	41	28	29	53	73	66	43	56
9	B4	lphd	241	169	149	121	115	103	60	90	218	242	251	192	173
10	B5	lphd	111	118	125	113	153	166	20	47	201	188	199	151	144
11	B6	lphd	276	195	184	205	210	216	99	105	267	256	279	223	217
12	B7	lphd	364	328	414	350	417	305	94	101	453	376	437	292	226
13	G1 -Zone 3	lphd	167	110	121	110	110	121	55	56	219	146	154	107	114
14	G1-Zone 4	lphd	167	151	165	155	172	151	36	58	199	166	224	162	152
15	G2	lphd	163	153	159	147	184	146	21	24	221	217	229	168	123
16	G3	lphd	171	144	168	144	150	111	18	40	108	150	181	139	117
17	G4	lphd	173	77	25	6	2	85	66	83	174	158	150	121	140
18	Total	lphd		2288	2547	2233	2615	2213	708	967	3214	3011	3226	2384	2093
19	Average Consumption per head , lphd			135	150	131	154	130	42	57	189	177	190	140	123
20	Annual Average Consumption per head, lphd			94.5											

FLUSHING WATER CONSUMPTION

S. No	Consumption	UOM	No. of Rooms	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	B1-Zone 1	lphd	147	109	133	111	147	98	32	49	135	132	145	113	89
2	B1-Zone2	lphd	212	122	155	119	163	96	25	36	137	144	151	107	84
3	B1-Zone 4	lphd	116	55	74	56	75	44	4	8	58	67	75	53	43
4	B2-Zone 1	lphd	127	49	73	63	92	51	18	8	78	45	58	36	29
5	B2-Zone2	lphd	205	100	131	116	154	84	4	18	125	100	111	80	57
6	B2-Zone 3	lphd	98	71	75	67	92	50	6	7	74	79	77	64	40
7	B3-Zone A	lphd	118	59	74	44	54	38	20	30	55	79	81	55	51
8	B3-Zone B	lphd	90	36	45	25	23	22	16	17	34	46	47	26	38
9	B4	lphd	241	125	119	97	93	73	35	61	149	183	196	150	130
10	B5	lphd	111	95	100	85	118	100	17	32	123	141	149	118	107
11	B6	lphd	276	136	141	130	144	112	40	39	172	186	205	160	149
12	B7	lphd	364	231	263	240	300	182	67	62	253	221	269	198	154
13	G1 -Zone 3	lphd	167	110	121	110	121	110	61	33	147	146	154	107	110
14	G1-Zone 4	lphd	167	108	123	113	140	94	20	30	137	129	140	106	97
15	G2	lphd	163	107	114	100	135	87	20	18	132	143	157	117	87
16	G3	lphd	171	144	168	144	166	100	20	40	108	150	181	139	113
17	G4	lphd	173	60	21	3	1	43	40	47	106	114	113	88	96
18	Total	lphd		1715	1932	1624	2018	1383	445	534	2021	2104	2307	1717	1476

19	Average Consumption per head lphd	101	114	96	119	81	26	31	119	124	136	101	87
20	Annual Average Consumption per head, lphd	40.37											

Flushing requirement of hostel (45 lphd) is being fulfilled by STP treated water which means the actual consumption of water would be 98 lphd for hostel from outside resources and rain water.

Water Saving Potential

1) Increasing Re-use of grey waste water after separate treatment with UV disinfectant, Chlorination and other technology available and mixing 50% with fresh water into Laundry, Dish washing or Chilled water application will further reduce the fresh water consumption resulting into saving of Rs 9.76 lacs and 4000 KL per year. As the treatment of waste grey water from Block is very tedious it is suggested to treat the grey water of laundry.

2) Flushing water can be reused for same tank if stored for less than 1 hour. In case, there is no reuse of stored waste water in tank, it can be discard flushed toward STP. It will reduce the load on STP and waste water generation.

3) We observed by surveying the area that many water leakages were present. Further water saving can be achieved by arresting water leakages.

Figure 9: Images of water wastage around the facility

4.4 STP

MUJ hostel has 2 no's of STP installed of 350 KLD and 1 MLD capacities to cater the need of treating sewage water generated from buildings.

. The oxygen allows bacteria in a fermentation process to digest the food source (the sewage). These processes break down the waste and reduce it, so that it can settle in clarifiers or get filtered by membranes in a last stage of treatment, before being returned as final effluent into the environment. Originally the method was mechanical and worked well for decades. Atmospheric air or even pure oxygen was injected or mixed with the liquor in the reactor, followed by mechanical stirring. More recently, the air diffusing concept developed, enabling us to distinguish between coarse bubbling systems (with a bubble size of 5-10mm diameter) with typical AOR/SOR (or AOTE/SOTE) of 0.50 and fine bubble diffusing (FBD) systems with 0.33. Fine bubble diffusers are all about satisfying the needs of the wastewater and sewage treatment industry, in order to achieve an efficient mass transfer of oxygen to the water, particularly that with a suspension of active sludge in a biological reactor. The industry evolved to reach the point where we can now speak about ultra-fine bubbles. The main way of evaluating the operational expenses (OPEX) of the technology is by using the aeration efficiency (AE). This figure is a ratio between how many kilos of O2 can be transferred into wastewater by using 1 kWh of electrical energy, at the required desired dissolved oxygen levels (usually 2mg/l). Typically, 80% of the energy consumption of a treatment plant goes to the blower station in the process of air-feeding the aeration reactors. Energy also goes into inefficient mechanical aeration devices, usually installed only for the sake of reduced CAPEX some years ago. Due to better efficiency of oxygen transfer of fine bubble, the requirement of air to be blower is reduced and hence the size of blower which in turn reduces power consumption resulting into energy savings.

They are many types and shapes of fine bubble diffusers. They have evolved according to the market's needs and include:

• Ceramic diffusers. Made of ceramic porous material, with a dome structure. Air is blown to a bottom mounted grid, diffused through the ceramic pores into water. Although they have high resistance to corrosion, they are very prone to clogging.

• Floor covering panels with flexible polyurethane or silicone membranes. Very high efficiency and long life, but heavy in weight and difficult to manipulate and replace.

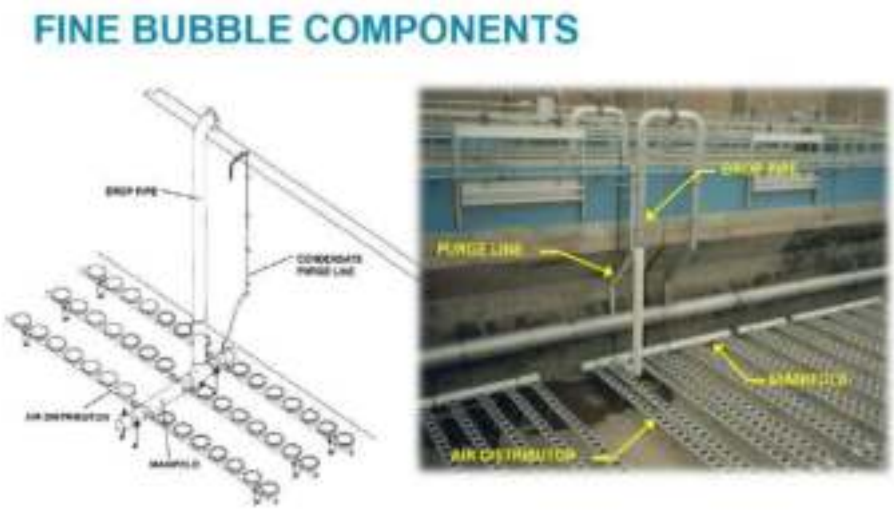
• Flexible EPDM membranes of any shape, from disc to flat surface and tubes. Very low CAPEX, but short membrane life.

• Flexible polyurethane or silicone membranes, on extremely flat stripes, as floor covering. Higher CAPEX, but low OPEX. Long membrane life.

It may be that the approach focused on the diffusers themselves and not on the whole assembly, being the blower station, pipe work, headers, manifolds, diffusers and process automation.

Advantages of Fine Bubble Diffusers

- Highest oxygen transfer efficiency
- Roughly 2% SOTE per foot submergence
- 4 - 7 kg oxygen/kW
- Minimal maintenance, includes hosing off diffusers
- Every 2-3 years
- Membrane life is 8 - 10+ years



S. No.	Parameters	UOM	350 KLD	1 MLD
1	Waste water inflow	m^3/day	350.00	1049.00
2	Total BOD load	mg/l	100	100
3	BOD load in tank	kg/hr	35.0	104.9
4	For 1 kg of BOD removed 1.5 kg of oxygen is required	kg/kg	2	2
5	Density of air		1.17	1.17
6	Oxygen in air		21%	21%
7	Alpha factor		0.65	0.65
8	Beta factor		0.9	0.9
9	Existing Operating kW of the Blower	HP	13	15
10	Therefore, Air required	m^3/day	5411	10426
11	Aeration time	hrs	24	24
12	Therefore, air required	m^3/hr	225	434
13	Air required	CFM	146	281
14	Aeration Tank Depth (including free drop of pipe and distribution pipes, valve's throttle back pressure which you have fitted in the distribution line)	kg/cm^2	0.55	0.55
15	Existing Oxygen transfer efficiency		9%	14%
16	Proposed Oxygen transfer efficiency of fine bubble technology		25%	25%
17	New Operating kW of blower	HP	5	13
18	Potential Energy Savings	kW	6	1

19	Annual Operating hours	hrs	6000	6000
20	Annual Energy Savings	kWh	38400	6061
21	Cost of Electricity	Rs./kVAh	9.4	9.4
22	Annual Monetary Savings	Rs.	368327	58132
23	Investment	Rs.	500000	Nil
24	Payback	months	16	Immediate

Table 23: Energy saving analysis in STP

Note: For 1 MLD STP:

For 1MLD as per discussion with Good host and the comments from OEM, it is noted that the aerator tank already has fine bubble diffuser in it. However, the calculation shows AOTE is low which means either the diffusers are clogged or the aerator blowers are overdesigned as system is not running under full load condition that is 1 MLD which is evident from the log as well where it is reflected for most of the time system is running at part load for most of the days in the year. System runs under full load condition for Peak periods which may be rainy season etc. Therefore, it is recommended to check both of this. In case of blower is overdesigned it is suggested to control the blower through VFD by further reducing frequency. If the diffusers are clogged then we suggest to clean them at once and reduce the frequency as well.

For 350 KLD:

As it is older and there is no information about the diffuser from Good Host as well as OEM, it is suggested to replace the existing diffuser.

ECO STP

Most STPs in use in India today work with aerobic bacteria. This requires the continuous use of air and hence regular power is required to operate the STP. An ecoSTP, on the other hand, works with anaerobic bacteria, which do not require any oxygen or power to function. Hence, it cleans water in a natural and chemical-free manner. The unique ecoSTP technology does not use chemicals or energy to treat the water. Instead, it mimics the processes of the natural world — using a combination of microorganisms, plants and gravel to clean sewage water and return clean water back to mother earth, completing the 'cradle to cradle' sustainable lifecycle.

Unlike motor-based STP's which are not sustainable, ECOSTP is a completely sustainable solution. The table below highlights few of the key differences:

How are we different?	
MOTOR BASED STP's	ECOSTP
ENERGY INTENSIVE (POWER NEEDED)	ZERO POWER
BACKUP GENSET + DIESEL	NO GENSET + NO DIESEL
MOTORS + BLOWERS + FREQUENT OIL CHANGE	NO MOTORS
24x7 HUMMING NOISE	NO NOISE
EXHAUST FANS - RISK IF IT IS OFF	NO EXHAUST FANS
CHEMICALS (UREA ETC.)	NO CHEMICALS
SAFETY RISK - OPEN TANK	NO RISK - SEALED TANK
SLUDGE REMOVAL - DAILY/WEEKLY	SLUDGE REMOVAL - ONCE IN 2 YEARS
SLUDGE PATHOGEN RISK	NO MANUAL HANDLING - NO RISK
24x7 MAINTENANCE - SKILLED STP OPERATOR	NO OPERATOR REQUIRED
DEDICATED STP SPACE	SPACE CAN BE REUSED
MLSS MONITORING - NEED TO ADD BACTERIA HOURLY!!!	ONE TIME BACTERIA ADDITION
STP LIFE - 3-5 YEARS (KEEP BUYING SPARES)	ONCE DONE - FOR GENERATIONS
STRONG ODOUR	SEALED - NO ODOUR
STP CAN BE ACCIDENTALLY SWITCHED OFF	CANNOT SWITCH OFF
30% MINIMUM LOAD TO OPERATE	ONLY 1 TOILET TO OPERATE
CRISIS MANAGEMENT (YOUR TIME)	PEACE OF MIND

Product Description (Cow's Stomach Engineering)

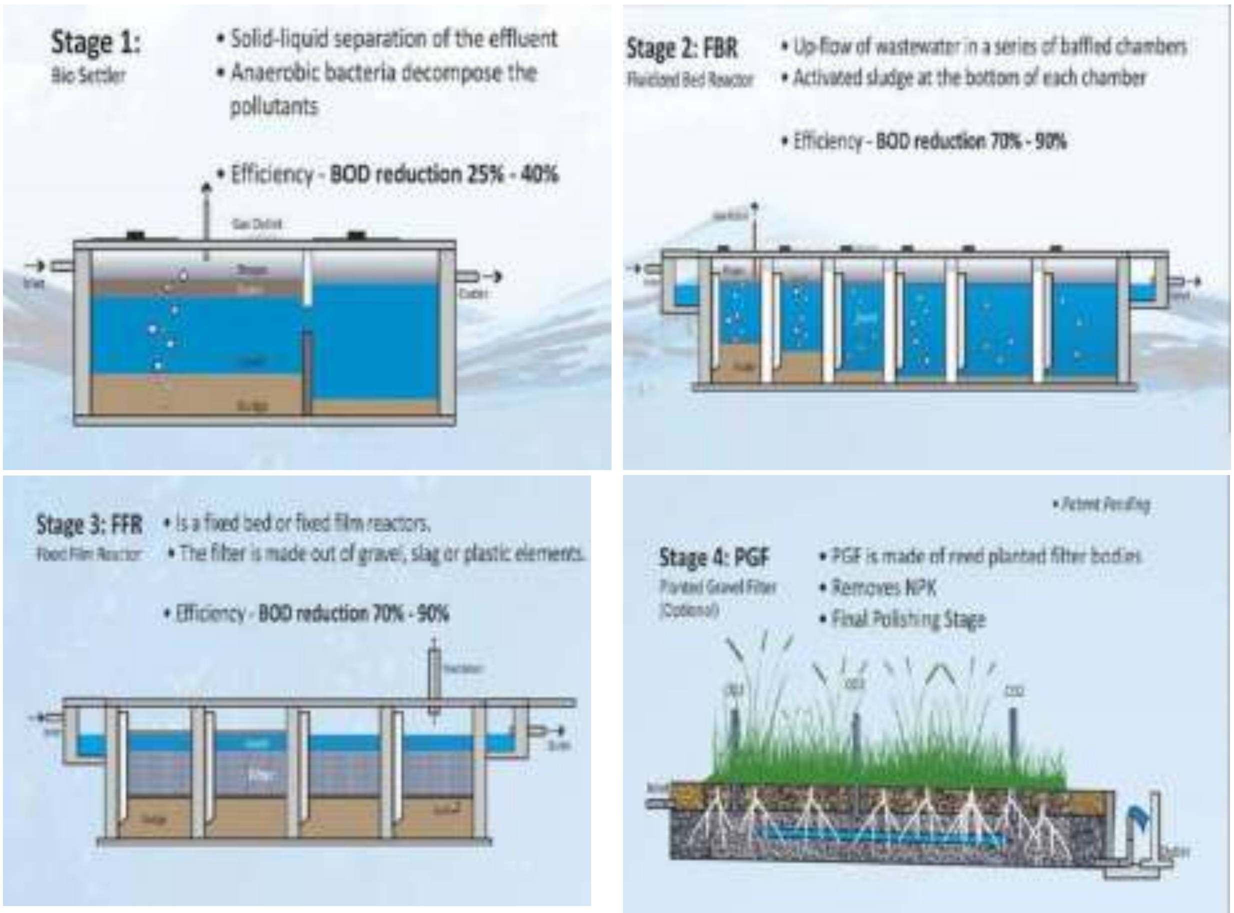


Figure 10:EcoSTP Working

Replacing 350 KLD STP with EcoSTP of 250 KLD

Sr. No.	Parameters	UOM	Value
1	Average Electrical Load of STP plant 350 KLD	kWh/day	480
2	Annual Operating Days	days	360
3	Annual Energy Consumption	kWH	172800
4	Cost of Electricity	Rs./kVAh	10
5	Additional Energy Consumption by Pump	kWh	30240
6	Annual Monetary Savings	Rs.	1425600
7	Investment	Rs.	10000000
8	Payback	months	84.2

Table 24: Energy saving analysis in STP

Implementation: As this suggestion is economically infeasible and requires high effort, we recommend this when there will be a need for new installation.

Optimization of Compressors in STP

FAD test conducted for reciprocating compressors installed in both STP & the results are as given below.

Sr. No	Particulars	UOM	Compressor No 1, 1 MLD	Compressor No 2, 350 KLD
1	Rated FAD	CFM	14.5	6.8
2	Rated KW	KW	4.2	2.6
3	Motor Efficiency	%	90%	85%
4	Make		ELGI	ELGI
5	Initial Pressure	Kg/cm^2	5	5
6	Final pressure after filling	Kg/cm^2	12	10
7	Atmospheric Pressure	Kg/cm^2	1	1
8	Storage Volume	m^3	0.22	0.16
9	Time Taken to build initial pressure to Final Pressure	min	4.8	6.50
10	Compressor output	m^3/min	0.3	0.1
11	Measured KW	kW	4.5	2.3
12	Compressor output	CFM	11	4.3
13	Rated SPC	kW/CFM	**0.319**	**0.433**
14	Measured SPC	kW/CFM	**0.397**	**0.529**
15	Remark		OK	NOT OK

Table 25: Compressor analysis in STP

Performance of small reciprocating compressor of 350 KLD is found not OK. But there is no feasibility in replacing them as their operating hours is very less. However, using following strategy will reduce its energy consumption.

1) Combining the Air distribution for both the STP and fulfilling the pneumatic demands of plants through operating 1 MLD compressor only.
2) Reducing Compressed Air from 12 kg/cm^2 to 10 kg/cm^2 will save energy.

S. No	Particulars	UOM	Values
1	Air Demand by 1 MLD plant in a day	CFM	109
2	Air Demand by 350 KLD plant in a day	CFM	26
3	Power Consumed in a day by 1 MLD	KWh	43.2
4	Power Consumed in a day by 350 KLD	KWh	13.8
5	Total Power Consumed in a day	KWh	57.0
6	Total Power Consumed in a day after combining air distribution	KWh	54
7	Daily Energy Savings	KWh	3.4
8	Annual Energy Savings (I)	KWh	1252
9	Annual Energy Saving due to Reduction in Pressure from 12 to 10 kg (II)	KWh	2337
10	Annual Energy Savings (I+II)	KVAh	3625.3
11	Annual Monetary Saving	Rs	33735
12	Investment	Rs	50000
13	Payback	months	18

Table 26: Energy saving analysis in STP

S. No	Detail	Rated Parameters					Measured Parameters				
		KW	Efficiency	Capacity (m³/hr)	Pressure (kg/cm²)	Blower Efficiency	PF	KW	Flow, m3/hr	Efficiency	Freq
1	STP Blower-1 1 MLD	22	91.6	866	0.5	54%	0.84	11	271	34%	35
2	STP Blower-2 1 MLD	22	91.6	866	0.5	54%	Standby				
3	STP Blower-3 1 MLD	11	89.8	351	0.55	48%	0.78	10.2	324	48%	
4	STP Blower-4 1 MLD	11	89.8	351	0.55	48%	Standby				
5	STP Blower-5 1 MLD	11	89.8	276	0.45	31%	Standby				
6	STP Blower- 6 1 MLD	11	89.8	276	0.45	31%	0.81	9.6	277	35%	
7	STP Blower-7 350 KLD	11	89.8	862	0.55	Incorrect Config	0.85	9.9	324	49%	
8	STP Blower-8 350 KLD	11	89.8	862	0.55	Incorrect Config	Standby				
9	STP Blower-9 350 KLD	7.5	88.5	278	0.5	50%	0.82	6.3	184	40%	10.5

10	STP Blower-10 350 KLD	7.5	88.5	862	0.5	Incorrect Config	0.82	5.4	153	38%	

Table 27: Details of blowers in STP

Overall performance of blowers is found satisfactory. Though incorrect practices have been identified as for high capacity of blowers are coupled with low motor rating than required

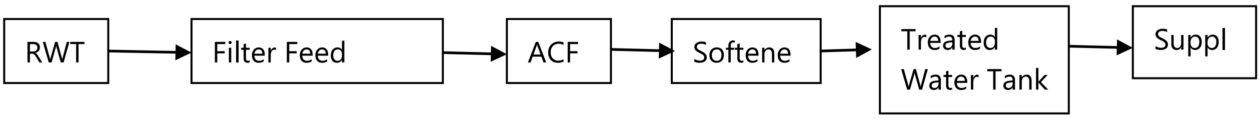
We observed that the belt used in the blowers were loose that decrease the efficiency of the blower. These belts can be replaced by Synchronous belt.

4.5 WTP

Water treatment plant is nothing but the softener plant. There are various WTPs in the premises, however, mainly three are in use which are as follows:

1) WTP B-1
2) WTP G-1
3) WTP B-7

While first two are running continuously, WTP B-7 runs for sometimes. However, all WTP are running at 40-50 % of installed capacity as the valve is throttled to 40-50% before filter feed pump. The average production or yield of the WTP is around 530 m^3/day.



S. No.	Detail	Rated Parameters				Measured Parameters				
		KW	Amp	Efficiency	P. F	Amp	PF	KW	m3/hr	Efficiency
1	WTP B-1 Sump pump	11	21	89.4	0.91	11	0.89	7.1	40	57%
2	WTP B1 Filter feed pump	5.5	11	87	0.88	7.5	0.75	4.1	20	50%
3	WTP G1 Sump pump	5.5	11	87	0.88	7.5	0.75	4.1	26	65%
4	WTP G1 Filter feed pump	4				7.5	0.87	4.7	26	56%

Table 28: Details of WTP Pumps

Overall Performance of pumps is found satisfactory.

4.6 BLOCK PROFILE

MUJ hostel has blocks from B1 to B7 for boys and G1 to G4 for girls. B1 and G1 blocks along with Food court are the biggest consumer of electricity as they also have higher number of rooms in these blocks.

Block	Zone	No. of rooms	Block	Zone	No. of rooms
B1	1	147	G1	1	74
B1	2	212	G1	2	129
B1	3		G1	4	131
B1	4	116	G2	1	163
B2	1	127	G3	1	81
B2	2	205	G3	2	90
B2	3	98	G4	-	173
B3	1	118			
B3	2	90			
B4	1	109			
B4	2	132			
B5	1	75			
B5	2	111			
B6	1	171			
B6	2	66			
B6	3	39			
B7	2	232			
B7	3	132			

Table 29: Block Details

4.6.1 ELECTRICAL PROFILE

Sr. no	Location	Voltage	Current			Unbalance	P. F	KW	Average units per hour
			R	Y	B				
1	G-1	404	137	167	118	19%	0.93	103	110.0
2	G-2	407	70.2	58.2	68.6	11%	0.99	46.85	36.8
3	G-3	404	38.4	25.4	20.1	37%	0.65	14.34	31.6
4	G-4	409	79	86	63	17%	0.95	42.76	34.4
5	B-1	410	273	285	243	9%	0.98	148	162.2
6	B-2	409	161	142	159	8%	0.98	109	76.9
7	B-3	408	76	30	74	50%	0.90	41	48.0
8	B-4	428	67	38	191	94%	0.82	40.13	51.7
9	B-5	425	53	47	75	29%	0.91	70.88	37.2
10	B-6	423	119	81	85	25%	0.97	70.88	62.4
11	B-7	426	115	90	96	15%	0.97	71.86	69.0
12	Food Court	425	94	56	65	31%	0.92	48.08	165.3
13	Facility Block	421	7.59	7.62	7.51	1%	0.65	5.6	39.8

Figure 11:Electrical Profile of Blocks

There are 2 lifts in each block. We measured the load of Lift that is given below:

Sr.no	Parameters	Value
1	Voltage	410
2	Current	8.2
3	P. F	0.87
4	Active power	5.18

It is suggested to restrict one lift from stopping at Floor -1 as it can save some energy. We have said for 1 lift out of 2 rather than both lifts and it can be used during all the times in fact large commercial building used to practice each lift for alternate floors. For Ex: Lift 1 for odd number floor & Lift 2 for even no. floors. During vacation, leaving, entering time it can restore back onto fully functional at all floors.

Note: In fact, we have seen lot of students use stairs for Floor 1 and Floor2 in regular time.

4.6.2 COOLING LOAD PROFILE

Each room is facilitated with 400 CFM and 1 TR Fan Coil Unit (FCU) through which chilled water over air is passes in heat exchanger and provide the required cooling effect for it.

Sr. no	Block	Zone	No. of rooms	Flow (m^3/h)	TR per room	Reqd. TR for 100 sq. ft. room
1	B1	1	147	25.0	0.91	1-1.5
2	B1	2	212	45.0	1.13	1-1.5
3	B1	3				1-1.5
4	B1	4	116	25.5	1.17	1-1.5
5	B2	1	127	7.8	0.33	1-1.5
6	B2	2	205	34.7	0.90	1-1.5
7	B2	3	98	21.8	1.18	1-1.5
8	B3	1	118	26.0	1.18	1-1.5
9	B3	2	90	21.0	1.25	1-1.5

10	B4	1	109	47.8	2.34	1-1.5
11	B4	2	132	29.6	1.20	1-1.5
12	B5	1	75	15.7	1.11	1-1.5
13	B5	2	111	29.1	1.40	1-1.5
14	B6	1	171	29.6	0.92	1-1.5
15	B6	2	66	40.4	3.27	1-1.5
16	B6	3	39	31.6	4.32	1-1.5
17	B7	2	232	23.5	0.54	1-1.5
18	B7	3	132	26.7	1.08	1-1.5
19	G1	1	74	17.9	1.29	1-1.5
20	G1	2	129	28.4	1.18	1-1.5
21	G1	4	131	22.3	0.91	1-1.5
22	G2	1	163	38.7	1.27	1-1.5
23	G3	1	81	51.0	3.36	1-1.5
24	G3	2	90	24.0	1.42	1-1.5
25	G4	-	173	72.0	2.22	1-1.5

Table 30: Cooling Profile of Blocks

Observations

1) For 100 sqft room area, the required cooling load varies from 1 (ground floor) to 1.5 (top floor). Almost all of blocks fulfil the criteria except blocks B2 and B7 where the cooling delivered is less than 1 which may generate less comfort in these blocks.
2) Similarly, few zones of blocks B4, B6, G3 & G4 receive higher cooling than requirement.
3) It is suggested to have same pipe sizes of all risers for all blocks so that flow uniformity could be maintained.
4) Also, few blocks which are near to chillers and have a smaller number of rooms and therefore rooms could be throttled to avoid high flow of chilled water in it and therefore can avoid excessive cooling there.
5) Check for the scaling, corrosion, rusting in pipes and change the faulty ones with PVC pipes that can sustain pressure of Chilled water.
6) B1, G1 blocks have high energy consumption as compared to other blocks due to retail outlets in them.
7) There is a saving potential with the replacement of existing 50 W Havells fan with BLDC fans of 28 W:

Sr.no	Parameters	UOM	Value
1	Wattage of each fan	W	50
2	Wattage of energy efficient fan	W	28
3	Wattage saved	kW	0.022
4	Operating hours	Hours	15
5	Total no of fans to be replaced	No	3000
6	Annual operation days	Days	240
7	Annual Energy saving	KVAh	240000
8	Unit rate	Rs/unit	9.4
9	Annual Monetary Saving (in lakhs)	Rs	22.56

10	Investment (in lakhs)	Rs	90
11	Payback period	Months	47.9

Table 31: Energy Saving Analysis of Fans

4.7 Heat Pumps & HEATER:

Total 33 heat pumps are installed in all the blocks of MUJ hostel to cater the needs of hot water generation but only 18 approx. are in working and rest of them are either not working or blocked due to scaling in coils of heat exchanger.

Block No.	Building No.	No. of Rooms	Heat Pump		Measured Parameters								
						Ambient							
			No	Heating Capacity, kW	Flow (m/s)	DBT, T°C	RH, %	DBT, T°C	RH, %	Power, kW	P. F	Heating Capacity, kW	COP
B1	Zone-1	147	1	40	blocked								
	Zone-2&3	212	2	20, 35	not working								
	Zone-4	116	1	35	blocked								
B2	Zone-1	127	2	20*2	9.83	31.3	36	27	43.2	7.6	0.92	12.3	1.61
	Zone-2	205	1	40	blocked								
	Zone-3	98	1	35	working								
B3	Zone-1	118	1	35	blocked								
	Zone-2	90	1	20	working								
G1	Zone-1	74	1	35	9.16	30.2	37.3	25.4	47.1	10.0	0.87	20.2	2.02
	Zone-2	51	1	35	working								
	Zone-3	78	1	40	blocked								
	Zone-4	131	1	20	9.83	29	40	20	65.3	6.0	0.85	20.8	3.46
G2	Zone-1	163	1	40	blocked								
B4	Zone-1	109	2	35*2	blocked								
	Zone-2	132	1	35	9.85	28.3	44.1	21.9	60.6	13.0	0.85	29.4	2.67
B5	Zone-1	75	1	40	blocked								
	Zone-2	111	1	40	blocked								
B6	Zone-1	171	2	35*2	10.25	26	46	20.2	63.7	10.0	0.91	24.3	2.21
	Zone-2	66	1	35	blocked								
	Zone-3	39	1	35	blocked								
G3	Zone-1	81	1	40	blocked								
	Zone-2	90	1	40	working								
G4	Zone-1	83	1	40	9.48	27.4	43.5	20.6	64.3	14.0	0.88	25.4	2.17
	Zone-2	90	1	40	working								
FC	N Zone		1	35	not working								
	S Zone		1	35	9.70	31.5	36.6	28.8	42.2	10.0	0.85	10.9	1.40
B7	Zone-2	232	2	30	7.50	27.5	42.8	19.4	65	8.3	0.68	27.2	3.48
	Zone-3	102	1	30	10.60	27.5	42.8	19.5	72	11.6	0.77	27.6	3.53

Table 32: Analysis of Heat Pumps

Almost 50% Sample is selected to measure the performance of the Heat Pumps. Therefore, savings have been calculated from faulty machines from sample and then double the energy saving potential from it.

1) Replacement of Inefficient heat pumps (Either by new heat pump or through staform hot water system)

Option -1: Inefficient heat pumps can be replaced by new heat pumps for which the analysis is given below:

Sr. No.	Particulars	UOM	Values
1	Existing COP		Less than 2
2	Proposed COP		3
3	Energy Saving	kW	19.8
4	Annual operating hrs	hrs	2000
5	Annual Energy Saving	kWh	39527
6	Unit Rate	Rs/kWh	9.4
7	Annual Monetary Saving	Rs	371552
8	Investment	Rs	600000
9	Payback	months	19

Table 33: Energy saving analysis Heat pumps

Option 2: Inefficient heat pumps can be replaced by Stafor heat carrier. Below given are the comparison between Stafor heat carrier and heat pumps and saving analysis of the same:

Figure 12: Images of Stafor Carrier

Sr. No.	Stafor Heat Carrier	Heat Pump
1	Stafor Boiler gives COP up to 204% on any temperature. It doesn't affect by ambient temperature. It can work easily in -40℃ and has ability to 24x7 days continues operation. Can give maximum temperature continues in	Heat Pump claims COP up to 400% @ ambient temperature 25-30℃. At ambient temp. 10℃ or less its COP will be max. up to 200% and can't reach the targeted temperature it goes Max. 45-48℃. It doesn't comfort in 24x7 days working it

	minimum ambient temperature without any shut down.	blinks over heating errors and during less temperature its evaporator coils gets freeze and system shuts down immediate.
2	Temperature can be raised up to 90-95 C.	Temperature can be raised up to 55-60℃.
3	There is no regular maintenance require for Ion boiler that's why the recurring cost is nominal.	Regular maintenance requires and gets higher when operation time is more. Parts are not easily available.
4	System doesn't shut down due to any types of water because it always comes with PHE and that can be service easily by any plumber.	Most of the heat pump comes with inbuilt coil System that get affected due to hard water and only technical person can handle the problem and takes much time to resolve the problem. PHE base can be service easily.
5	The heat carrier liquid life is although 12 years but after about 8 years it should be refill again on minimum cost for better performance. Whole system has a lifespan about 20-25 years.	Heat Pump life span is about 8-10 years in Ideal position and due to hard water, it gets less.
6	Stafor Boiler load can be decided manually according to requirement of temperature. It saves the Energy consumption.	Heat pump works on a fix load according to factory setting we cannot change manually.
7	For Cold Region the efficiency of Ion Boiler will be same for the temperature up to -40℃.	NA
8	Automatic shutdown of the boiler at a "loss" of any incoming electrical phases and voltage up (250V) and down (180V). Fully automated switch on of the system when power is restored. This keeps the boiler in economy mode.	NA
9	Eco Friendly, Noise Pollution- No Air Pollution-No	Noise Pollution- Yes Air Pollution- No
10	Space Require-Less	Space Require -Big

Table 34: Comparison between Stafor heat carrier and heat pumps

Sr.no	Particulars	UOM	Values
1	Existing COP of Heat Pump		< 2
2	Proposed COP of Stafor Boiler		2
3	Electric Load for back up as Heat Pump gets faulty or locked due to low ambient temp	kWh	540.8
4	Electric load for Heat Pump for less COP	kW	172.7
5	Electric Load for Stafor Heat Carrier system	kWh	469.3
6	Annual operating days	days	200
7	Annual Energy Saving	kVAh	49332.8
8	Unit Rate	Rs/KVAh	9.4
9	Annual Maintenance Cost of Heat pump	Rs.	45000

10	Annual Monetary Saving (in Lakhs)	Rs	5.08
11	Investment (in Lakhs)	Rs	7.8
12	Payback	months	18.5

Table 35: Energy saving analysis Heat pumps

Conclusion: By comparing both the options we suggest to implement Option-2 as operational cost is reduced as heat pumps get choked due to low (less than 10 °C) ambient temperature and the saving potential is higher in stafor heat pump.

2) Cleaning and Maintenance of Heat Pumps to restore the COP

Sr. No.	Particulars	UOM	Values
1	Existing COP		Less than 2
2	Proposed COP		3
3	Energy Saving	kW	19.8
4	Annual operating hrs	hrs	2000
5	Annual Energy Saving	kWh	39527
6	Unit Rate	Rs/kWh	9.4
7	Annual Monetary Saving	Rs	371552
8	Investment	Rs	600000
9	Payback	months	19

Table 36: Energy saving analysis Heat pumps

Heaters:

We Measured the electrical parameter of the heaters on sample basis. Our findings are given below:

Sr.no	Location	Power	P.F	Remark
1	G1 Zone-3	5.69	0.99	Satisfactory
2	G1 Zone-2	5.92	0.99	Satisfactory
3	G1 Zone-1	5.69	0.99	Satisfactory
4	G1 Zone-4	5.70	0.99	Satisfactory
5	G3 Zone-1	5.80	0.99	Satisfactory
6	B2 zone-1	6.15	0.99	Satisfactory

Table 37: Analysis of Heater

The performance of the heaters are found to be satisfactory. Our Suggestion will be to not run the heaters for a long period of time.

4.8 DG PERFORMANCE ASSESSMENT:

There are 6 DG of 500 KVA each in New door for Backup power generation. We measured the fuel level and energy generation of DG 1 & 6 to determine their performance. Data are provided below:

Figure 13: DG Performance Test

Sr.no	DG No	Start Time	Stop Time	Duration	KWh Consumption	Diesel Consumed	KW/ltr
1	1	15:28	15:48	20	72.129	25.2	2.862
2	6	16	16:20	20	75.61	25.2	3.0

Table 38: DG Performance assessment

Observation: During the measurement as no proper method was available for accurate measurement of Fuel oil and less duration of the study, 20-25% addition can be assumed **in the study which makes the performance of the DG's satisfactory.**

As the operation time of the DG's is less which makes the replacement of DG's **highly infeasible.**

4.9 LIGHTING STUDY:

We measured the Lux level with our instrument in different areas. Below given are our findings:

Sr.no	Location	Standard Lux	Measured Lux	Remark
1	Corridor	50-100	61	Satisfactory
2	Staircase	50-100	57	Satisfactory
3	Rooms	150-200	178	Satisfactory
4	Bathroom	150-200	198	Satisfactory
5	Peripheral Roads	50-100	51	Satisfactory
6	Public Places	100-150	113	Satisfactory
7	Offices	150-200	169	Satisfactory

Table 39: Lux Level in different areas

As per IES recommended Lighting level with combination of lighting.

We observed that the lights used for the peripheral roads are of 90-Watt and 60-Watt LED that use grid power. We recommend using solar power street light with battery for the peripheral roads and replacing 90-Watt bulbs with 60-Watt bulbs. Below given is our analysis

Sr.no	Parameters	UOM	60-Watt
1	Wattage of streetlight	W	60
2	Wattage saved by installing solar and converting 90-watt Bulb to 60 watts	kW	0.09
3	Operating hours	Hours	12
4	Total no of lights to be replaced	No	63
5	Annual operation days	Days	360
6	Annual Energy saving	KVAh	24741.8
7	Unit rate	Rs/unit	9.4
8	Annual Monetary Saving	Rs	2.33
9	Investment	Rs	9.45
10	Payback period	Months	48.8

4.10 MAJOR RETAIL OUTLETS:

Electrical safety Inspection:

• **Location- Login** • **Observation: DB Cover is not grounded.** • **Risk/violation: NEC 2011** • **Action Required: DB Cover Grounding should be done.**	
• **Location-Login** • **Observation: Fire extinguisher is past its Refilling date.** • **Risk/violation: NEC 2011** • **Action Required: Refilling should be done within the given time period.**	

• **Location- Login** • **Observation: Temporary connection is made.** • **Risk/violation: NEC 2011** • **Action Required: Remove temporary connection and fix a permanent fixture.**	
• **Location- 360** • **Observation: Lugs are not used for connections.** • **Cable dressing is improper.** • **Risk/violation: NEC 2011** • **Action Required: Lugs should be used for connections.**	

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- **Location- 360**
- **Observation: Cable trays are not used for cable laying.**
- **Risk/violation: NEC 2011**
- **Action Required:**
- **Cable trays should be used.**

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- **Location-360**
- **Observation: Exposed wire is observed.**
- **Risk/violation: NEC 2011**
- **Action Required: Wire should be properly insulated.**

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• **Location- 360** • **Observation: Earth strip is not present for LT Panel.** • **Risk/violation: NEC 2011** • **Action Required:** • **Earth strip should be provided.**	
• **Location- Tandoor** • **Observation: Exposed wire is observed.** • **Risk/violation: NBC 2016** • **Action Required: Wire should be properly insulated.**	

• **Location- Tandoor** • **Observation: Jointing of wires is done with temporary connection** • **Risk/violation: Best practise** • **Action Required: Single unjointed wire should be laid from source to load.**	
• **Location- Tandoor** • **Observation: Metal sheets are used as Covers.** • **Risk/violation: NEC 2011** • **Action Required: Replace the metal sheets with plastic coated covers instead.**	

• **Location- Tandoor** • **Observation: Rodent found dead inside DB.** • **Risk/violation: NBC 2016** • **Action Required: The area where small gap is found should all be covered in DB.**	
• **Location- Coffee shop** • **Observation: Earth mat is not used.** • **Risk/violation: NEC 2011** • **Action Required: Earth mat according to IS Code should be used at all panel area.**	

Electrical Load Distribution:

We measured the Electrical Load at each of the retail outlet with our instrument. Below given is our findings:

Sr. no	Location	Voltage	Current			Power factor	kW	THD-V	THD-I	Un balanced	Average
			R	Y	B						
1	Login	413	7.6	3.8	10.1	0.89	2.63	1.9	2.9	47%	7.17
2	360-Meter-1	409	2.2	3.8	5	0.85	1.27	1.4	3.3	40%	3.67
3	360-Meter-2	410	2	2.5	7	0.88	1.38	0.9	2.8	83%	3.83
4	Tandoor	415	0.6	4.4	6.4	0.87	1.37	1.4	3.5	84%	3.80
5	Food Court	411	3.1	2.2	2.1	0.84	0.85	1.7	3.4	26%	2.47
6	Food Court Bakery	411	5.7	18	3.3	0.84	3.11	1.7	3.4	100%	9.00

Table 40: Power quality of Retail Outlet

OBSERVATIONS:

1. Major Observation is that Current imbalance is observed in all the outlets. This is a cause of concern as it may pose a hazard in the near future.
2. Both THD-V and THD-I are within IEEE Standards.

4.11 RENEWABLE ENERGY:

At New Door there are 2 solar power plant installed. One of 50 KWp and the other of 800KWp. 50 KWp plant is used for food court while 800KWp plant is used for captive Generation. We connected our analyser at Solar panel of 11 KV to capture its parameters. Below given is our findings:

Figure 14:KWh Production of solar per hour

S.No	Time	KWh Production
1	06:30-07:30	26.3
2	07:30-08:30	146.1
3	08:30-09:30	299.9
4	09:30-10:30	421.0
5	10:30-11:30	491.5
6	11:30-12:30	511.3
7	12:30-13:30	489.7
8	13:30-14:30	407.4
9	14:30-15:30	288.4
10	15:30-16:30	131.2

Table 41: Solar Production

The total unit generation of the plant is about 3200, which is about 4 unit/KWp. The average capacity utilisation factors the plant is found to be 18% which is satisfactory.

ANNEXURE 1: WATER SURVEY FORM

Building Information

Building Name: Manipal University Hostel, Jaipur
Age of building: > 10 yrs
Type of building: Hostel /Residential
Numbers of permanent occupants: 4500 persons
Where does your water come from? Outside
Number of buildings at facility: 15 Size of buildings (area):
Number of employees per shift: 200 Number of shifts per day: ________
Water pressure at your facility: 2 kg/cm^2

Washrooms

Tank type:

Number: 3000 @ 6/4 litres per flush

Urinals

Sensor flush:

Number _______@____2/3____ litres per flush

Total water consumption per workday from toilet flushes: ________
* Assuming each employee/occupant uses the bathroom 4x per workday

Newer urinals and toilets have the gallons/litres per flush printed on the unit with the name of the manufacturer. Older toilets and urinals do not. If there is no indication on flush volume, note the manufacturer and the age of the toilet or urinal. With this information the manufacturer can provide flush volume information. The volume of the flush can be adjusted on these units. The flush or meter manufacturer can provide the flush volume data or the data may be found in the building maintenance manuals.

Basins/faucets

# of faucets ___3000______ Flow rate _________lpm sensor control
# of faucets _____1000_____ Flow rate _________ lpm sensor control

Showers

Number of showers __3000_____ Showerhead flow rate _______ gpm/ls

Kitchens/Cafeterias/Lunch rooms

Number of staff: 70
Number of kitchen sinks/ faucets: 17 Faucet flow rates: _______ lpm
Number of meals served/day: 9000
Do spray heads have automatic shut off? NA
Do refrigerators provide drinking water? NA
Do kitchens use: garbage disposals composting neither Yes but not working therefore sending to vendor for disposals
Is there a dishwasher? _1______ Average number of loads per week: 35
Are only full loads washed? yes
Are dishes routinely pre-rinsed prior to wash? yes
Is frozen food routinely thawed under running water? yes
Are kitchen floors hosed clean? ____yes____ How often? ___4 times per day_____
Are hoses equipped with high-pressure, water efficient nozzles? ____NA____

Number of Drinking fountains: air cooled __1____
Number of Vending machines/ coffee makes/ water coolers/ etc. connected to the domestic water system: 2
Number of Ice machines: deep freezer air cooled
If automatic regeneration, is it initiated by: time meter sensor

Cleaning/Janitorial

Are janitorial staff aware of office water conservation efforts? yes
Are there areas that janitors mop? Yes Where: rooms and toilets
Are hoses used? No
Are dry-clean (rather than wet-clean) practices and procedures in place? (i.e. sweep instead of hosing, scrape before spraying, etc.) Yes

Landscaping/Irrigation

Does your landscape use mulch? STP treated water
Does your facility have an automatic irrigation system? _Yes, up to some extent but more manual
What does the system irrigate? Plants/greenery
How often? 2-3 At what time of day? day
Is there a rain gauge and/or rain sensor incorporated in your system? No
Is your irrigation water metered? No
Is there a municipal sewer charge rebate on irrigation water? No
Are hoses equipped with fine-spray/high-pressure/water-efficient nozzles? No
Does your facility have any pools or fountains? No

Heating, Ventilating and Air Conditioning (HVAC) Consumption

What type of HVAC system do you have? Air Cooled Chillers
Are drink machines in vending areas? air-cooled
Are cooling towers in use at your facility? No
Are faucets, pipes and plumbing checked regularly for leaks? Yes
Are maintenance staff to respond to and repair leaks? Yes
(Often reducing water pressure by merely 10 or 15 percent can reduce water consumption significantly without interfering in daily consumption activities. Water pressure that is too high can result in leaks.)
Does staff have good general water conservation awareness habits? Yes
Have you ever had a water-balance or leak-check? Yes
(Entails shutting off all known water usage. If the meter records any water usage during this period, you have a leak or undocumented consumption.)
Is there an on-site water treatment facility? Yes
If so, give a brief description of the facility, flow rates, chemical additions, and average cost (per unit volume).
Is there an on-site wastewater treatment facility? Yes, if so, give a brief description of the facility, flow rates, chemical additions, and average cost (per unit volume).
Are toilets equipped with toilet dams or low-flow flapper valves? Yes
Do flush valve (tankless) toilets have water-saving diaphragms? ❑ Yes ❑ No
Are toilets equipped with automatic water-flushing systems? No
Are faucets equipped with aerators? Yes
Are faucets equipped with automatic or metered shutoff mechanisms? No

ANNEXURE 2: ENERGY CONSERVATION TIPS

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.

Motors:

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

Pumps:

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt 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 in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Repair seals and packing to minimize water waste.

HVAC (Heating / Ventilation / Air Conditioning):

- Tune up the Air Conditioning control system.
- Use appropriate AC thermostat setback.
- 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 AC 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 AC systems on continuous loads (e.g. -- computer rooms).
- Use evaporative cooling in dry climates.
- Clean AC unit coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check AC 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.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
- Purchase only high-efficiency models for AC units.
- Put AC window units on timer control.
- Don't oversize cooling units. (Oversized units will "short cycle" which results in poor humidity control.)
- Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
- Minimize AC fan speeds.
- Eliminate simultaneous heating and cooling during seasonal transition periods.
- Establish an AC 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.

Lighting:

- Replace existing T8, CFL by LED.
- Reduce excessive illumination levels to standard levels using switching, de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapour lighting, etc. Efficiency (lumen/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapour, incandescent.

- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider day lighting, skylights, etc.
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.

DG sets:

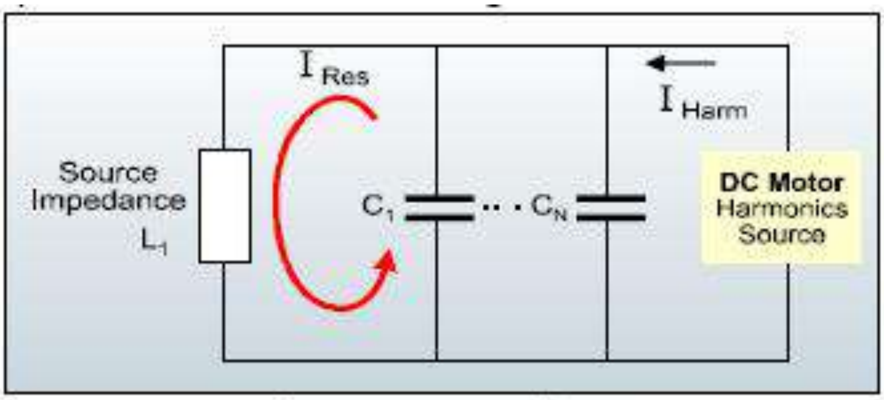
- Optimize loading
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

Buildings:

- Seal exterior cracks/openings/gaps with caulk, gasketting, weather stripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

ANNEXURE 3: GENERAL INFORMATION ABOUT HARMONICS AND ITS STANDARDS HARMONIC RESONACE

Capacitors do not generate harmonics but application of the same in any network with adequate protection magnifies the existing harmonic content. Then there can be a problem of parallel resonance which takes place between Reactive impedance of capacitor bank and impedance of other network devices like Transformers, Cables etc. The Problem of resonance as explained below in the diagram.

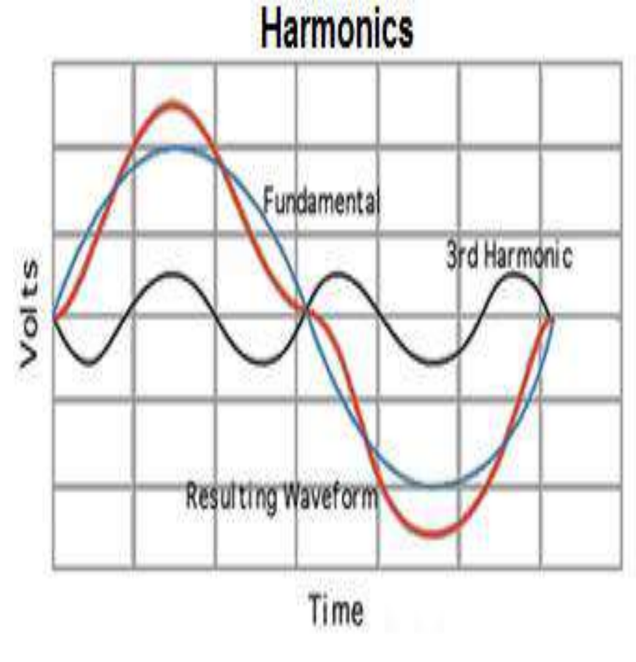


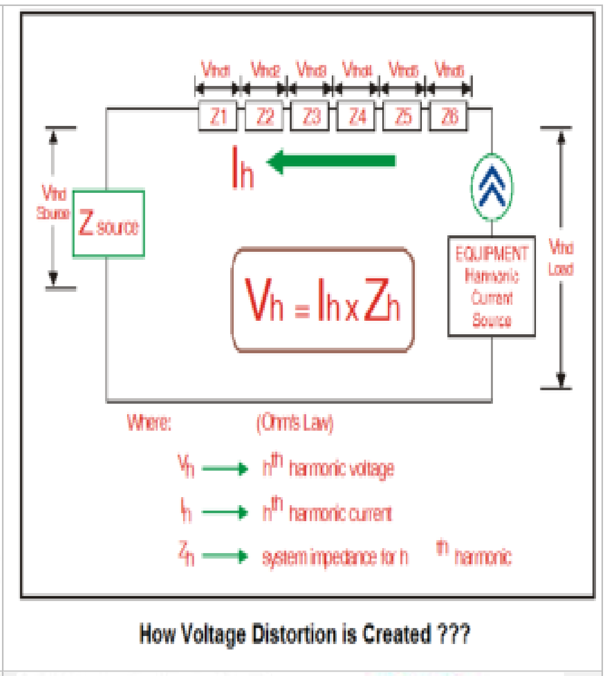
Resonance conditions

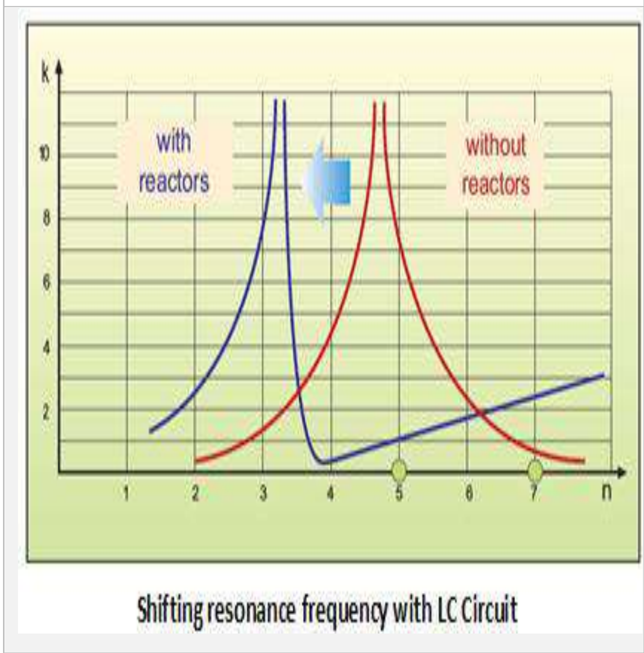
The harmonic and resonance can create negative influence on capacitor bank and other network devices. This can cause pre-mature failure / de-rating / busting of capacitor bank and other failure in the network devices like electronic cards / parts, overheating of switchgear /cables/transformers etc.

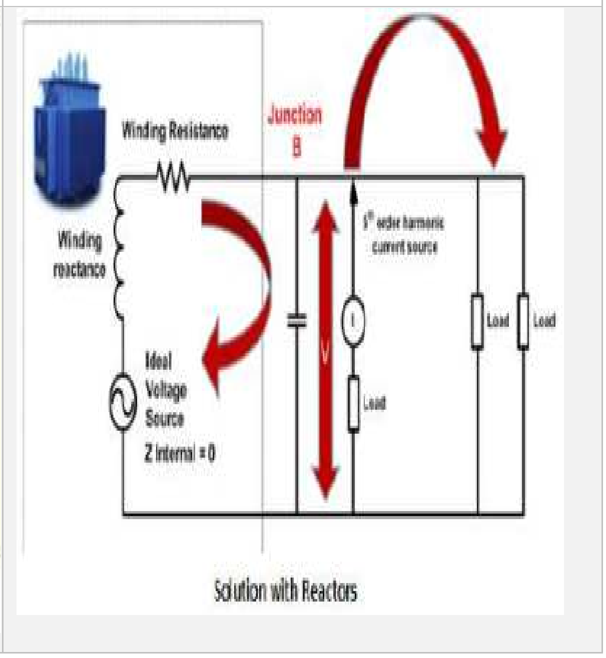
Some other problems because of high harmonic distortions can be as follows:

1. Malfunctioning and failure in electronic equipment
2. Overheating and failure in transformers and cables
3. Overload and failure in capacitor banks, contactors & switchgears in APFC System
4. Low efficiency of transformers and cables
5. Tripping of protections without apparent reason
6. Overload and failure in motors
7. Interferences in communication network









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 terminal that will attenuate by the time it is tapped for a user.		

Table 42: IEEE THD V Standard

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-519-2014:

For PCC Voltages 69kV & below						
Maximum Harmonic Current Distortion in % of I_L						
Individual Harmonic Order (Odd Harmonics)						
I_{sc}/I_{load}	**<11**	**$11 \le h < 17$**	**$17 \le h < 23$**	**$23 \le h < 35$**	**$35 \le h$**	**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 of actual Isc/I_L.**						
Where, I_{sc} = Maximum short circuit current at Pcc. And I_L = Maximum Demand Load Current (fundamental frequency component) at PCC; TDD = Total Demand Distortion. The table is for 6 pulse rectifiers. For 12-pulse, 18-pulse, etc. increase characteristic harmonics by: the value of the square root of q/6, where q = 12, 18, etc. Thus for 12-pulse, increase by 1.414.						

Table 43: IEEE THD I Standard

ANNEXURE 4: THERMOGRAPHY

We have scanned the Electrical Installations of your facility with an Infrared Camera of Fluke Make and it is one of the best imager available in the world for electrical & industrial applications.

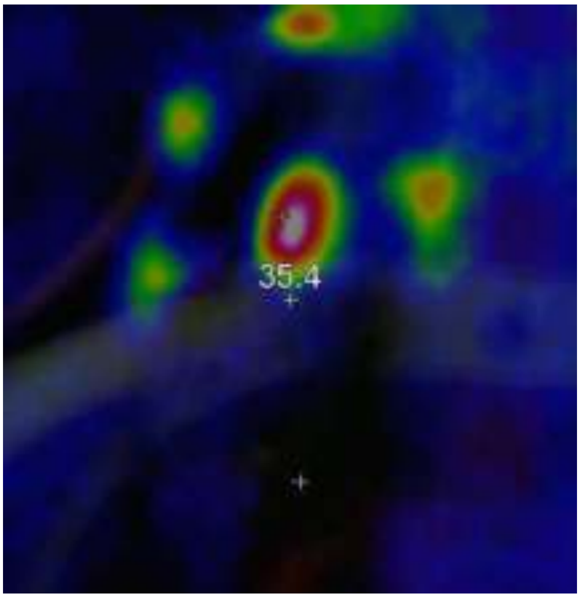
During the scanning process, in all 26 anomalies were identified and ambient temperature is taken 26^{O}C. As per the severity priority rating considered in the report, categorization of the anomalies and their repair priorities are as under-

Anomaly Summary:

Sr. No	Location	Measured Temperature (^{O}C)	Remark
1	STP MLD Panel-1 main incomer	35.4	No Need to repair
2	STP MLD Panel-1 350 KLD	76.4	Repair Immediately
3	STP MLD Panel-1 30HP Blower MCCB STP	29.6	No Need to repair
4	STP 360 KLD incomer	28.2	No Need to repair
5	LT Room MV Panel-3 Busbar	27.4	No Need to repair
6	LT Room ACCP Panel-1 incomer	30.4	No Need to repair
7	LT Room ACCP Panel-2 incomer	27.9	No Need to repair
8	LT Room main MV Panel EB-2 incomer	27.8	No Need to repair
9	LT Room main MV Panel EB-1 incomer	26	No Need to repair
10	LT Room main ACCP Panel-3 incomer	27	No Need to repair
11	Chiller Room New Panel-1 incomer	26	No Need to repair
12	Chiller Room New Panel-2 incomer	24.7	No Need to repair
13	Chiller Room MCC Panel-2 incomer	25.2	No Need to repair
14	Chiller Room MCC Panel-1 incomer	32.8	No Need to repair
15	Chiller Room MCC Panel-3 incomer	32.4	No Need to repair
16	Transformer-2	31	No Need to repair
17	G Block Ground Floor Elect. Room Power DB	30.5	No Need to repair
18	G Block Ground Floor Elect. Room incomer	32.5	No Need to repair
19	G Block Ground Floor Elect. Room MCCB	30.1	No Need to repair
20	MDB Panel block G-4	29.2	No Need to repair
21	G-2 Ground Floor Elect. Room outside Power DB	28.6	No Need to repair
22	G-1 Common Area 1st floor 360 shop	28.8	No Need to repair
23	G-1 Common Area 1st floor 360 shop Power DB	30.7	No Need to repair
24	G-1 360 Elect. Panel incomer	31.9	No Need to repair
25	G-1 Common Area Ground floor tandoor Power DB	32.8	No Need to repair
26	G-1 Common Area Ground floor tandoor Power DB	55.1	Repair as soon as possible

Table 44: Thermography Table

1. **STP MLD Panel-1 1main incomer**



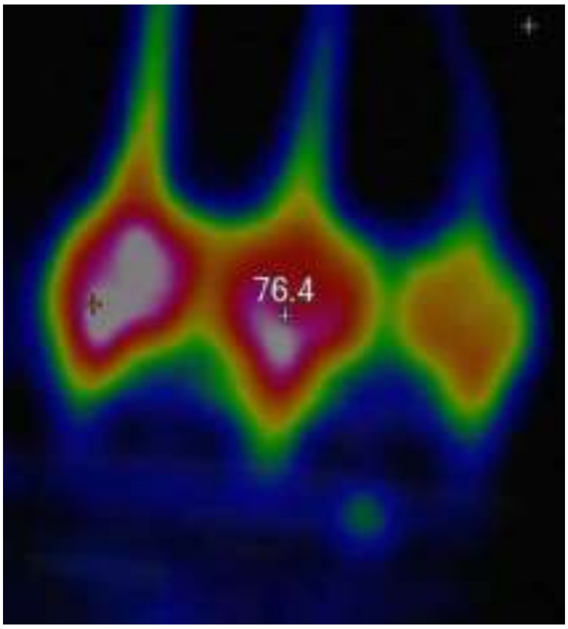
Infrared Image

Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	35.4°C

2. **STP MLD Panel-1 350 KLD**



Infrared Image

Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	76.4°C

3.STP MLD Panel-1 30HP Blower MCCB STP

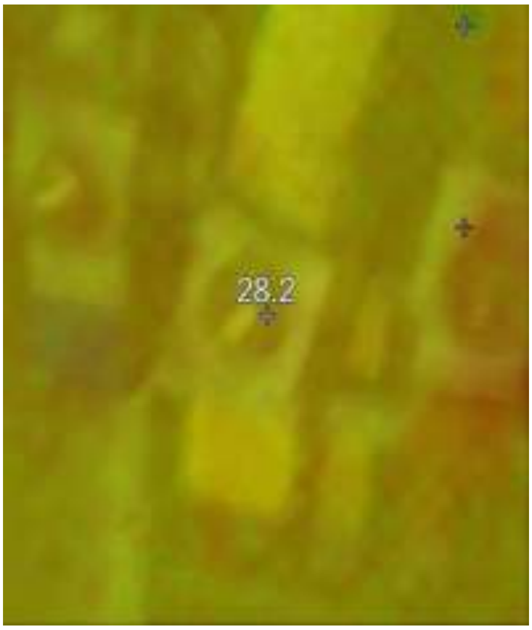
Infrared Image

Visible Light Image

Image Info

Centerpoint	29.6°C
Emissivity	0.95

4. STP 360 KLD incomer



Infrared Image

Visible Light Image

Image Info

Centerpoint	28.2°C
Emissivity	0.95

5.LT Room MV Panel-3 Busbar

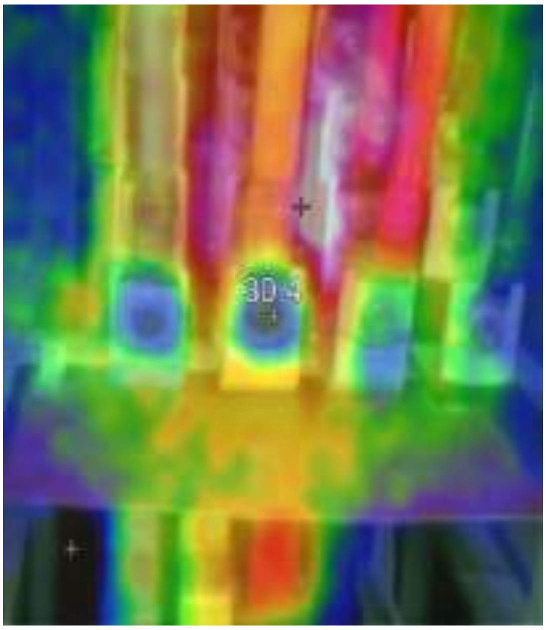
Infrared Image

Visible Light Image

Image Info

Centerpoint	27.4°C
Emissivity	0.95

6. LT Room ACCP Panel-1 incomer



Infrared Image

Visible Light Image

Image Info

Centerpoint	30.4°C
Emissivity	0.95

7. LT Room ACCP Panel-2 incomer


Infrared Image


Visible Light Image

Image Info

Centerpoint	27.9°C
Emissivity	0.95

8. LT Room main MV Panel EB-2 incomer

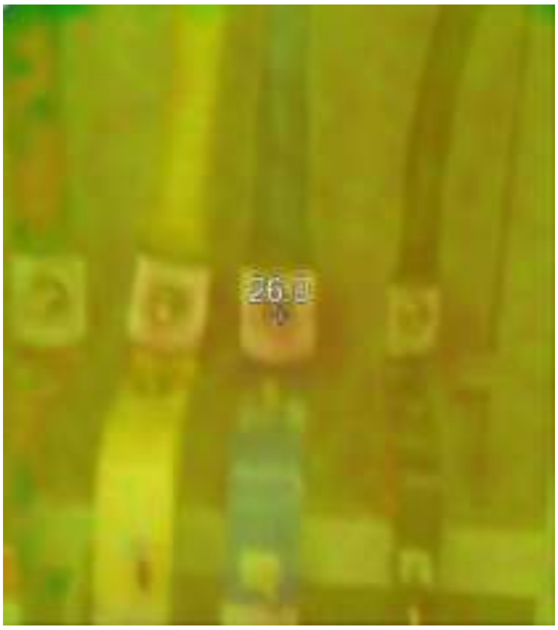

Infrared Image


Visible Light Image

Image Info

Centerpoint	27.8°C
Emissivity	0.95

9. LT Room main MV Panel EB-1 incomer



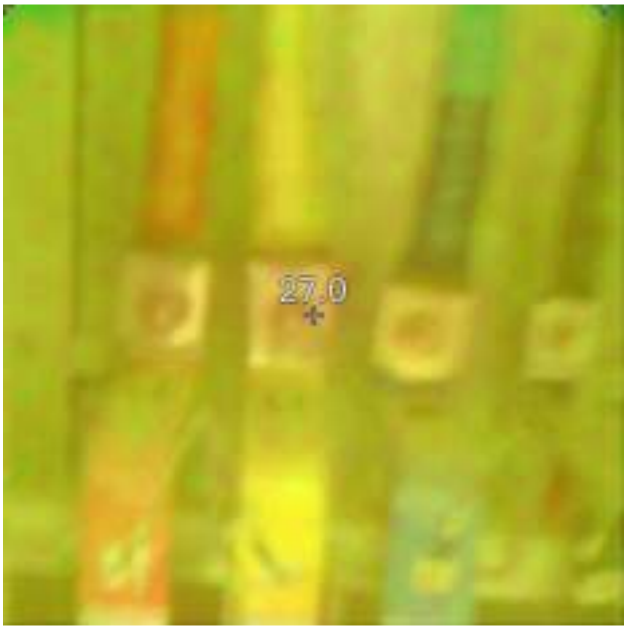
Infrared Image

Visible Light Image

Image Info

Centerpoint	26.0°C
Emissivity	0.95

10. LT Room main ACCP Panel-3 incomer



Infrared Image

Visible Light Image

Image Info

Centerpoint	27.0°C
Emissivity	0.95

11. Chiller Room New Panel-1 incomer

Infrared Image

Visible Light Image

Image Info

Centerpoint	26.0°C
Emissivity	0.95

12. Chiller Room New Panel-2 incomer

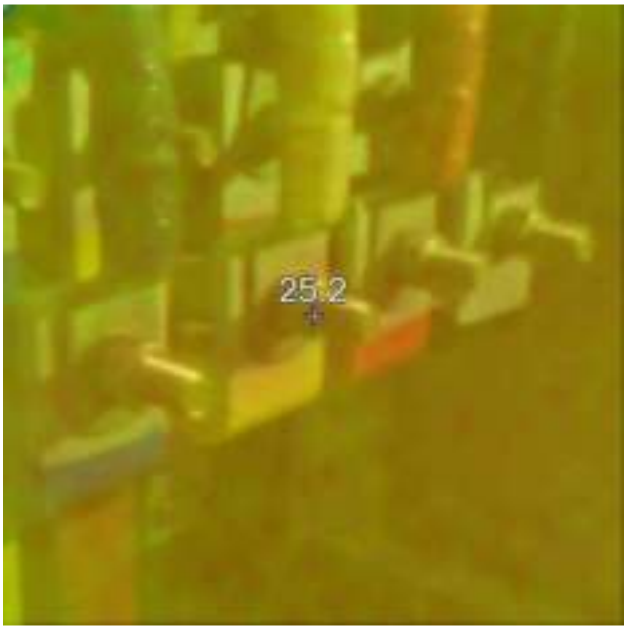
Infrared Image

Visible Light Image

Image Info

Centerpoint	24.7°C
Emissivity	0.95

13. Chiller Room MCC Panel-2 incomer



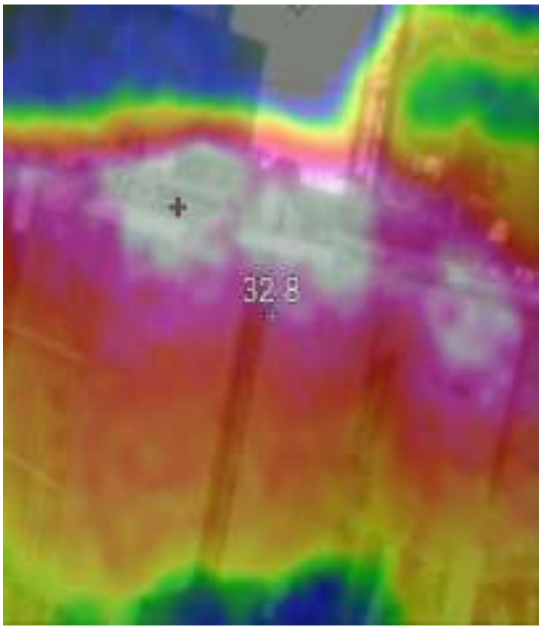
Infrared Image

Visible Light Image

Image Info

Centerpoint	25.2°C
Emissivity	0.95

14. Chiller Room MCC Panel-1 incomer



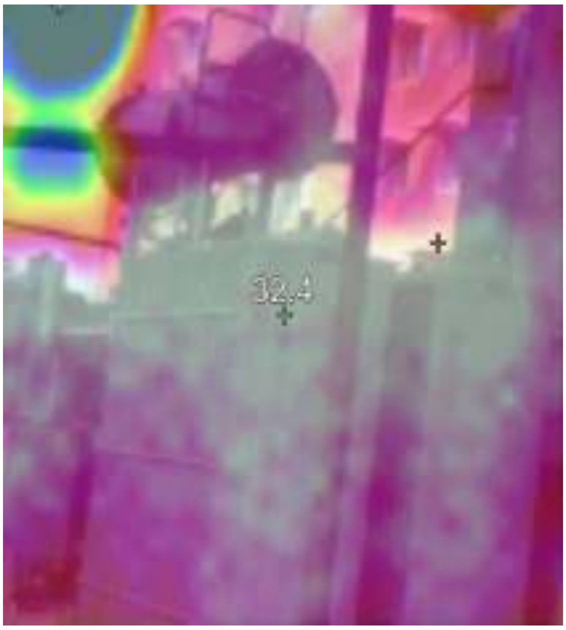
Infrared Image

Visible Light Image

Image Info

Centerpoint	32.8°C
Emissivity	0.95

15. Chiller Room MCC Panel-3 incomer



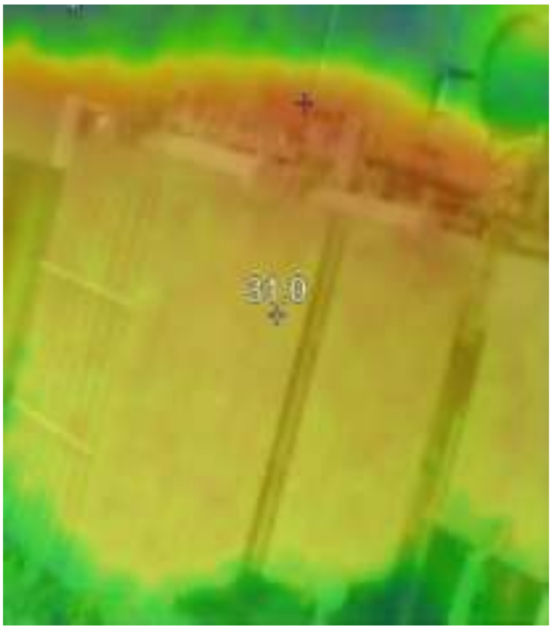
Infrared Image

Visible Light Image

Image Info

Centerpoint	32.4°C
Emissivity	0.95

16. Transformer-2



Infrared Image

Visible Light Image

Image Info

Centerpoint	31.0°C
Emissivity	0.95

17. Transformer-3

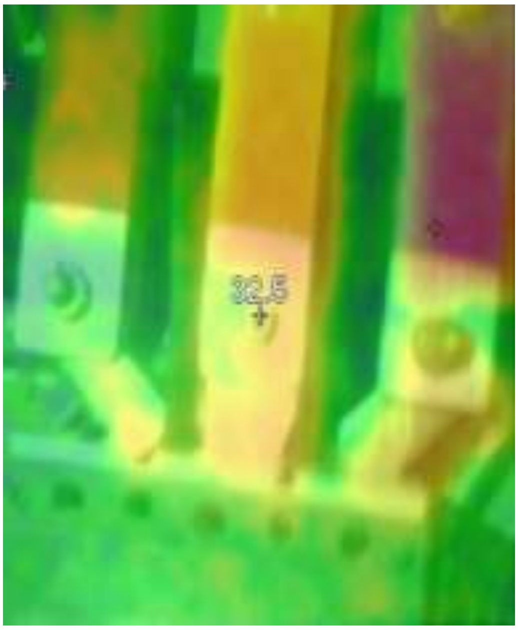
Infrared Image

Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	30.5°C

18. Transformer-1



Infrared Image

Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	32.5°C

19. G Block Ground Floor Elect. Room Power DB

Infrared Image


Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	30.1°C

20. MDB Panel block G-4

Infrared Image


Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	29.2°C

21. G-2 Ground Floor Elect. Room outside incomer

Infrared Image


Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	28.6°C

22. G-1 Common Area 1st floor 360 shop

Infrared Image


Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	28.8°C

23. G-1 Common Area 1st floor 360 shop Power DB

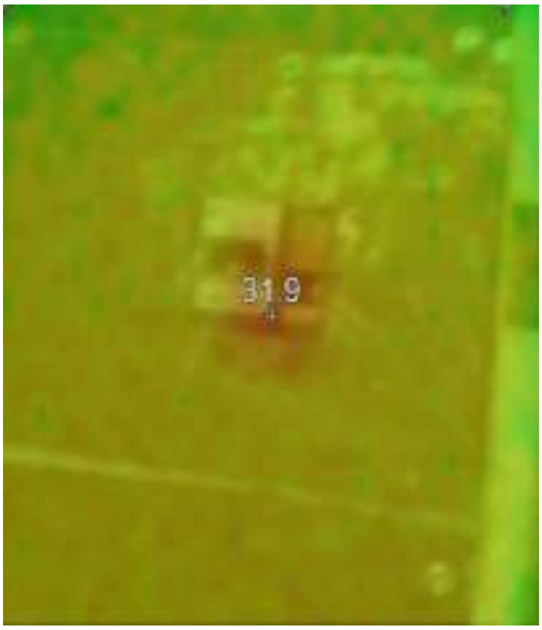
Infrared Image

Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	30.7°C

24. G-1 360 Elect. Panel incomer



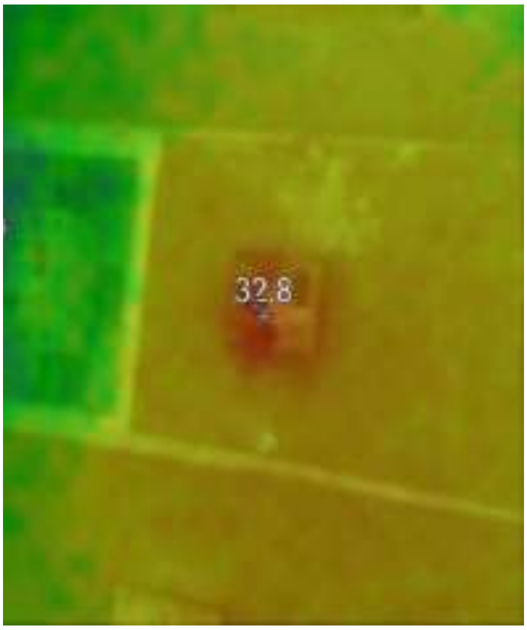
Infrared Image

Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	31.9°C

25. G-1 Common Area Ground floor tandoor Power DB



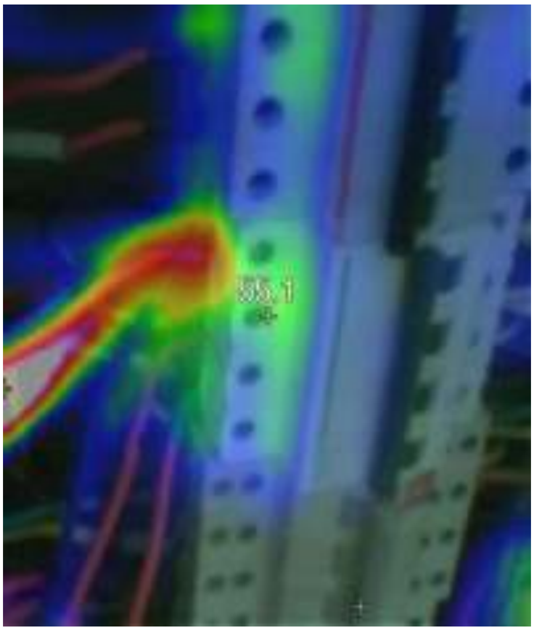
Infrared Image

Visible Light Image

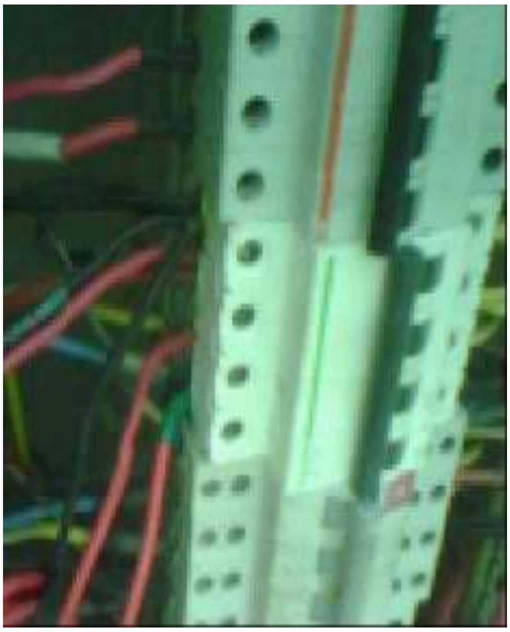
Image Info

Emissivity	0.95
Centerpoint	32.8°C

26. G-1 Common Area Ground floor tandoor Power DB



Infrared Image



Visible Light Image

Image Info

Emissivity	0.95
Centerpoint	55.1°C

THANK YOU

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