Sep 2023

Energy Audit Report
Kashi Institute of Pharmacy, Varanasi

Conducted BY: -

M/s GANGES CONSULTANCY

KANPUR-U.P

Confidentiality

This document is confidential and the content of this report shall be used only Kashi Institute of Pharmacy, Varanasi (UP) for the purpose of implementation of the recommendations and bringing energy saving awareness among the employees.

GANGES CONSULTANCY

Kanpur

Certificate

This part shall indicate certification by ACCREDITED ENERGY AUDITOR (AEA) Stating that —

- The Energy Audit has been carried at Kashi Institute of Pharmacy, Varanasi U.P. in September - 2023
- The site data collection has been carried out diligently and truthfully;
- All reasonable professional skill, care and diligence had been taken in preparing the Energy Audit report, and the contents thereof are a true representation of the facts.
- Adequate training has been provided to personnel involved in daily operations after the recommendations for the implementation; and the energy audit has been carried out in accordance with EC ACT 2001.

Signature:

Name of the BEE Accredited Energy Auditor:

Anoop Kumar Gupta

Registration no. AEA No. - 0125

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ACKNOWLEDGEMENT

M/s Ganges Consultancy, Kanpur expresses sincere thanks to the Kashi Institute of Pharmacy, Varanasi, for expressing their willingness and assigning us the Energy Audit of their college.

We are also thankful to the management of the Kashi Institute of Pharmacy, Varanasi U.P. We also express our thanks to the Director, HOD, Assistant Professor, Lab Assist & staffs, who have rendered their valuable assistance directly or indirectly to carry out this Energy Audit study, particularly,

- Dr. Ashutosh Misra -: Director
- Dr. Vivek Keshari -: H.O.D
- Sh. Shashi Bhushan Singh -:Asst. Professor
- Sh. Anurag Vishwakarma -: Lab Asst.

M/s GANGES CONSULTANCY
KANPUR-UP-INDIA

Abbreviation

◊ A	➢ Ampere
◊ A.Cs	➢ Air Conditioners
◊ APFC	➢ Automatic Power Factor Correction
◊ CD	➢ Contract Demand
◊ Cons.	➢ Consumed/ consumption
◊ CO_2	➢ Carbon dioxide
◊ ENCONs	➢ Energy Conservation Opportunities
◊ kV	➢ kilovolt
◊ KVA	➢ kilovolt Ampere
◊ kVAh	➢ kilovolt Ampere hour
◊ kVAr	➢ kilovolt Ampere (Reactive)
◊ kW	➢ kilowatt
◊ kWh	➢ kilowatt hour
◊ LED	➢ Light Emitting Diode
◊ P.F	➢ Power Factor
◊ PIR	➢ Passive Infrared
◊ Qty	➢ Quantity
◊ SFC	➢ Specific Fuel Consumption
◊ SQM	➢ Square Meter
◊ tCO2	➢ Ton of carbon dioxide
◊ TR	➢ Ton of Refrigeration
◊ UPS	➢ Uninterrupted Power Supply
◊ V	➢ Phase to Neutral Voltage

Executive Summary

With the advent of energy crisis and exponential hikes in the costs of different forms of energy, The Energy Audit is manifesting its due importance in buildings. Energy Audit helps to understand more about the ways energy and fuels are used in any establishment and help to identify areas where waste energy may occur and scope for improvement exists.

The Energy Audit is the preliminary systematic approach for decision-making in the area of energy management as it attempts to balance the total energy inputs with its use and serves to identify all the energy streams in a facility/ establishment.

With this objective, M/s Ganges Consultancy Kanpur was entrusted with the job of conducting an Energy Audit involving the analysis of electrical consumption in last two financial years, Lighting System, ACs etc. at **Kashi Institute of Pharmacy Varanasi** - U.P.

Basic Details

A		
Brief description of assignment	:	To carry out Energy Audit of **Kashi Institute of Pharmacy Varanasi - UP**
Name & Address of Institution / agency on behalf of energy audit conducted	:	**Kashi Institute of Pharmacy, 23 KM Milestone, Varanasi –Prayagraj Road, Varanasi - UP**
Address of communication of auditing agency	:	M/s GANGES CONSULTANCY, 273 /Y - 1, Block Kidwai Nagar Kanpur-UP
	:	gangesconsultancy@gmail.com 9464005209/ 85108109
B		
Nature of building	:	Academic Institute
C		
Working hours	:	8 hr
Annual working days	:	250 days

D		
Area	:	10269.04 m^2
Total area	:	8093.71 m^2
Total Build area	:	5338 m^2
Total no. floor	:	4
E		
Sanctioned contract demand	:	440 kVA (Oct 2022)
Annul grid import power consumption FY 2022-23	:	469836 kWh
Annul solar export power to grid FY 2022-23	:	16908 kWh
Annul Monthly energy bill FY 2022-23	:	Rs. 64.87Lakh (from Nov-2020 to Oct-2021)
Tariff	:	1) Fixed Charges Rs. 430/ kVA 2) Energy Charges a. Energy Charges Rs. 8.32/ kVAh up to 2500 kVAh b. Energy Charges Rs. 8.68/ kVAh above 2500 kVAh c. Excess SPV power is fed to grid and it adjusted to import power
D		
Net import power cost to institute FY 2022-23	:	Rs. 14.32/ kWh*
HSD Cost	:	Rs. 90.25 /litre*

***cost considered for all onward calculation**

IDENTIFIED ENERGY SAVING OPPORTUNITIES

ENCONs

Energy Saving Measures	Annual Energy Saving		Estimated Investments	Simple Payback Period
	kWh	(Rs Lakh)	(Rs Lakh)	(Months)
Replace 707 no. 36 W Tube light with 20 TW LED Tube light in phase manner	43834	6.28	3.54	7
Replace 223 no ceiling fans of 60 W with 30 W energy efficient BLDC in phase manner	10704	1.53	5.58	44
Replace 3 no 40W Wall fans with 20 W BLDC Wall fans in phase manner	96	0.01	0.06	53
Total	54634	7.82	9.18	15

Energy saving in toe (Tonne of oil equivalent)

1 kWh = 860 kcal

1 toe =1000000 kcal

Total Energy Saving = 4.69 toe

Other Energy Saving Measures

- Installation of Occupancy sensors in offices/ class rooms and galleries. Now, PIC based technology occupancy sensors are available in market, which operates on vibration and temperature difference technology.
- Periodic cleaning ACs suction filters,
- Installation of an energy meter at each DG Set, for better monitoring of the performance of DG Set.
- Regular cleaning of solar panel.
- Installation of a water level controller in an overhead water storage tank to avoid over flow of tanks.

CHAPTER-1
INTRODUCTION

With the widening demand-supply gap, reliability of energy supply, increasing energy cost, and the huge impact of unsustainable energy consumption on the environment, energy conservation and efficiency have assumed enormous important of late. Commercial Building owners are facing significant challenges with rising operating budgets directly attributed to increase of energy cost for lighting, air-conditioning and office services etc.

Energy cost in buildings is the key issue and plays a major role to maintain ECO-III norms/ star rating. With the advancement of energy efficiency practices and technologies, it is possible to cut down energy cost significantly in these new technology facilities without affecting any ECO-III norms. This can normally be achieved by the office management by initiating a systematic energy assessment/ audit of their entire building, followed by implementation of cost-effective energy efficiency measures.

1.1. Kashi Institute of Pharmacy (KIP), Varanasi

Kashi Institute of Pharmacy (KIP) got its existence in 2008 with the vibrant vision of Jain Education Society to give an outstanding ambience of technical education in the entire Uttar Pradesh and especially in Purvanchal, it is approved by Pharmacy Council of India (PCI) and is affiliated to Dr. A.P.J. Abdul Kalam Technical University (AKTU) Lucknow (formerly U.P.T.U Lucknow).

KIP is maintaining its leading position amongst all private Pharmacy Institutes in Eastern Uttar Pradesh. It is run by a team of visionary and motivated IIT Alumni with the strong dedication to provide best technical education and world class qualitative environment to the students of Uttar Pradesh.

Kashi Institute of Pharmacy (KIP) is one the top most Pharmacy colleges in Varanasi providing technical education in B.Pharm & D.Pharm at graduation level. KIP is situated inside the KIT Varanasi periphery.

1.2. Ganges Consultancy, Kanpur

M/s Ganges Consultancy Kanpur is a registered organization under Partnership act 1932. M/s Ganges Consultancy Kanpur is a BEE empanelled organization for **PAT M & V (placed at 46th position) & BEE ESCO Grading 4.** **M/s Ganges Consultancy Kanpur** is a team of experienced **BEE (Bureau of energy efficiency) Accredited Energy Auditor, Certified Energy Auditor** and young, experienced, and futuristic sector experts with an extensive technocrat professional background. It provides consultancy for technical services in the areas of energy, environment study, renewable energy and utility & process designing system, waste energy management, energy conservation, and provides appropriate training modules for improving awareness in the society about energy efficiency.

M/s Ganges Consultancy provides a comprehensive and integrated consultancy package in the field of Energy Management through its experienced team of engineers, which includes industry/ specific technology experts as well as specialists in Chemical, Electrical, and Instrumentation fields, backed up by an extensive data bank, library and latest sophisticated instrumentation. The team is an expert in following functions:

- Collection of all type of data & information including equipment designing, their energy consumption pattern and historical data etc.
- Compilation and analysis of data collected at site.
- Trying to establish specific energy consumption index for the client.
- In-depth analysis of the plant operations, equipments and systems established for improvement energy efficiency in plant/ building.
- Suggesting specific measures for energy saving/ conservation.
- On the Spot Assistance to the plant/ building management for implementation of the measures recommended for Energy Savings.
- Training the staff in the client companies in the specifics of Energy Conservation to enable them in implementing the recommendations and for monitoring the progress thereafter.

1.3. Scope of Work

To carry out Energy Audit of Kashi Institute of Pharmacy, Varanasi Uttar Pradesh.

- **Purchased Power Analysis**

- Purchased power bill analysis for last one year with pf, kWh, kVAh, and over all power cost to college. Study of Contract demand and for this, college has to provide monthly electricity bills copy.

- **Capacitor Bank**

- Measure performance of each capacitor bank, Identify the default capacitor bank, study their location and suggest further improvement if feasible.
- Study the location of capacitor banks.

- **DG Set**

- Study of the Power Generated vis-à-vis fuel consumption; evaluate the specific Fuel consumption kW/ litre and suggest measures for improvements if any

- **AC**

- Study of the present package AC system and possibility to installation of new energy efficient ACs.

- **Study of Pump Performance**

- Study of operation of different pumps installed in campus and suggests if any energy conservation measures possible.

- **Lighting & Fans System**

- Study of the Lighting systems in respect installation of type of fixtures and their control system.

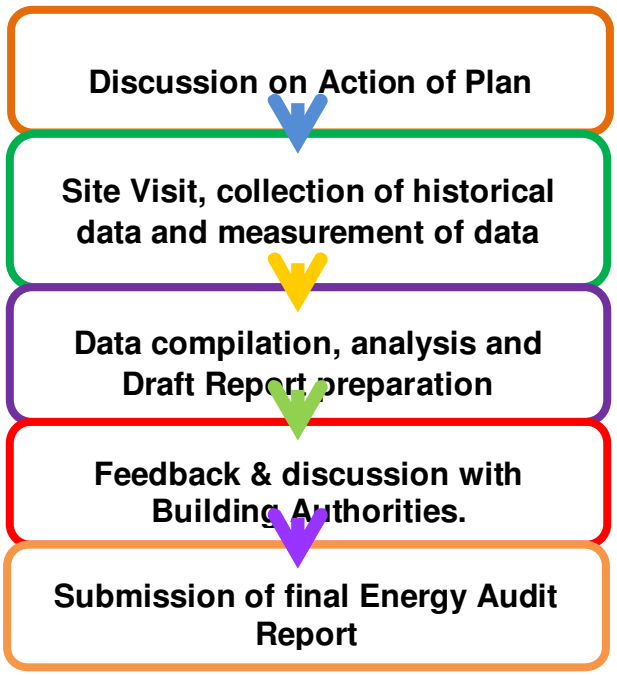
1.4. Methodology

Methodology adopted for achieving the desired objectives viz: assessment of the current energy consumption pattern in college.

1. Discussions with the concerned officials for identification of major areas of focus and other related systems.
2. Discussions with the concerned officials/ supervisors to collect data/ information of the operations and power consumption in the college.

3. The data was analyzed to arrive at a **base line energy consumption pattern**.

   Computation and **in-depth analysis** of the collected data, including utilization of computerized analysis and other techniques considered appropriate were adopted to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.



1.5. List of Equipment Installed

Detail of equipment installed is depicted as below Tables,

Table 1-1: List of Transformer Installed

Sr. no.	Make	Rating kVA	Voltage Ratio	Year of Manufacturing
1	Technical Association	630	11 kV/ 433 V	2004

Table 1-2: List of DG Installed

Sr. no.	Make	Rating kVA	Voltage Output	Year of Manufacturing
1	Jackson Limited	320	415 V	2012

Sr. no.	Make	Rating kVA	Voltage Output	Year of Manufacturing
2	Jackson Limited	125	415 V	2008
3	Jackson Limited	62.5	415 V	2010

Table 1-3: List of Water Pump Installed

Sr. no.	Type	Motor Rating	Capacity Litre / hr	Head m
1	Submersible Pump	3 HP	-	-

Table 1-4: Package AC Installed

Sr. no.	Type	Rating TR	No.	BEE Star
1	Window AC	1.5	1	3
2	Split AC	1.5	2	2
3	Duct AC	5.5	5	3

Table 1-5: Light Fixture Installed

Sr. no.	Type	Watt Including Choke	No.
1	Tube Light	51	707
2	LED Lamp	9	26

Table 1-6: Fan Installed

Sr. no.	Type	Watt	No.
1	Ceiling Fan	60	223
2	Wall Fan	40	3

CHAPTER-2
POWER CONSUMPTION

2.1. Power Supply

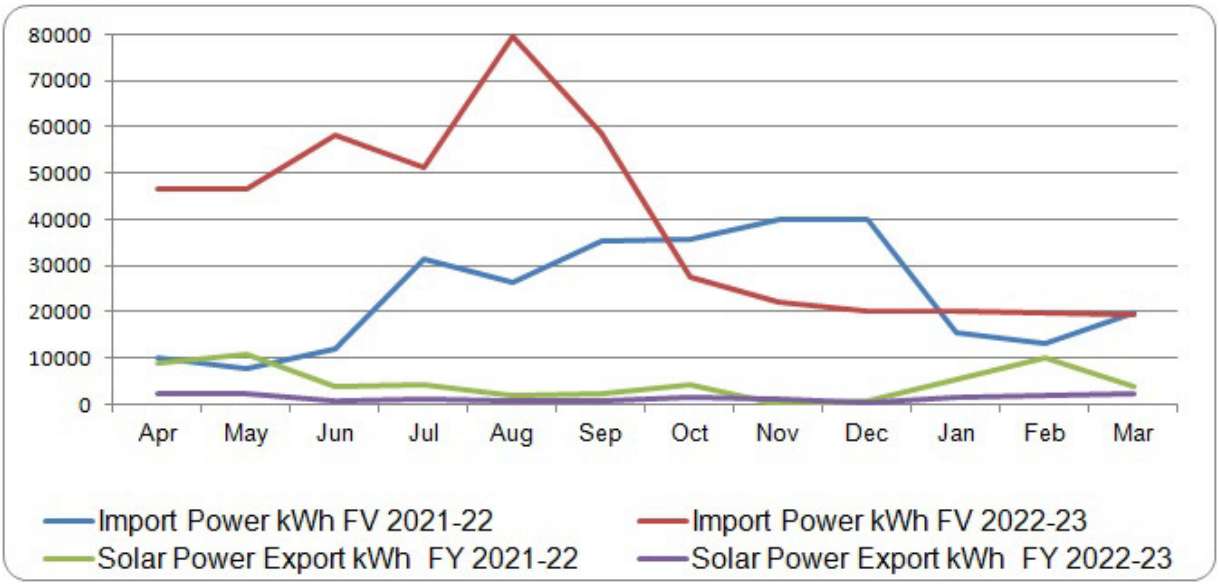
KIP is situated inside the periphery and all utility activities are handled by KIT, Varanasi. There is no direct supply grid to Kashi Institute of Pharmacy Varanasi. Grid power is supplied from KIT Varanasi and then, it supplied to KIP through two feeder AC feeder and Lighting feeder from main distribution panel. There is no separate energy meter is installed in KIP premises. Beside the power supply grid power and DG Set, 50 kW solar power generation system is installed at roof of institute building.

Grid power is supplied by Electricity Distribution Division-II, Varanasi at 11 kV and step down 433V through a transformer of 630 kVA transformer, which is installed in KIT Kashi and LT power is supplied to main distribution panel. Three DG sets are also installed in KIT Varanasi as a backup power source, in case of grid power supply restriction.

Energy balance month wise for last 24 months from Apr-2021 to Mar-2023 is depicted as below in a Table 2-1.

Table 2-1: Grid Import and Export Power

Month	Import Power kWh FV 2021-22	Import Power kWh FV 2022-23	Solar Power Export kWh FY 2021-22	Solar Power Export kWh FY 2022-23
Apr	9936	46488	8908	2472
May	7752	46488	10680	2472
Jun	12104	58208	3928	860
Jul	31380	51052	4148	1172
Aug	26216	79784	1812	584
Sep	35120	58744	2216	888
Oct	35764	27656	4064	1636
Nov	39884	22252	104	1084
Dec	39924	20068	552	360
Jan	15520	20224	5284	1424
Feb	13104	19608	10072	1752
Mar	19716	19264	3876	2204
Total	**286420**	**469836**	**55644**	**16908**



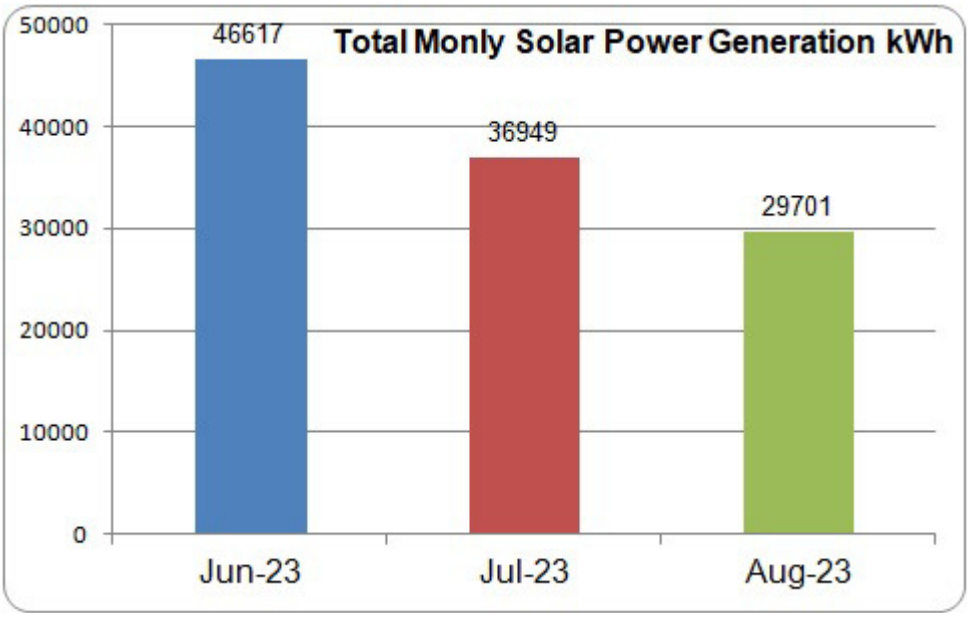
- Import power from the grid has increased in FY 2022–23 by 1.6 times compared to grid power consumption in FY 2021–22.
- Solar power exports in FY 2022–23 have been reduced by more than two-thirds of solar power consumption in FY 2021–22.

2.2. Solar Power Generation

50 kW solar power generation system with nine inverters is installed on the roof of KIP Varanasi. Daily power generation in last three months is depicted below in table.

Table 2-2: Daily Solar Power Generation

Month	Inverter									Total
	1	2	3	4	5	6	7	8	9	
	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
Jun-23	0	5375	5816	5246	6913	5552	6564	5351	5800	46617
Jul-23	0	4254	4123	3826	5543	4450	5173	4509	5071	36949
Aug-23	0	4018	102	3481	5673	4675	4578	2929	4245	29701
GT										



- Monthly solar Power generation has reduced from the month Jun 2023 to Jul-2023 by approx 20%.
- Similarly Monthly solar Power generation has reduced from the month Jul 2023 to Aug-2023 by approx 19.6%.

2.3. Tariff

Electricity Distribution Division-II, Varanasi has adopted two tier tariff structures i.e. fixed charges based on MDI or min CD and variable energy charges based on total power consumed in a particular month.

1) Fixed Charges Rs. 430/ kVA
2) Energy Charges
   a. Energy Charges Rs. 8.32/ kVAh up to 2500 kVAh
   b. Energy Charges Rs. 8.68/ kVAh above 2500 kVAh.

2.4. Power Cost

Power Cost per unit is depicted as below,

Table 2-3: Power Cost

Month	Net Power kWh	Monthly Electrical Bill Rs.	Power Cost Rs./ kWh
Apr-22	44016	531549	12.1
May-22	44016	591688	13.4
Jun-22	57348	767861	13.4
Jul-22	49880	633869	12.7
Aug-22	79200	1019096	12.9

Month	Net Power kWh	Monthly Electrical Bill Rs.	Power Cost Rs./ kWh
Sep-22	57856	908687	15.7
Oct-22	26020	394368	15.2
Nov-22	21168	349094	16.5
Dec-22	19708	335471	17.0
Jan-23	18800	326998	17.4
Feb-23	17856	318190	17.8
Mar-23	17060	310762	18.2
Apr-23	28314	415773	14.7
May-23	46404	584571	12.6
Jun-23	46404	584571	12.6
Jul-23	45918	580036	12.6
Aug-23	24216	377535	15.6

- Power cost varies from 12.1 Rs. / kWh to 18.2 Rs. / kWh.
- Average power cost from Apr-2023 to Aug-2023 is 13.6 Rs./ kWh
- **For all onward calculation, average power cost Rs. 13.6 per kWh is considered**

CHAPTER-3
POWER DISTRIBUTION

3.1. Tranformer

One number transformer of rating 630 kVA is installed to supply power to whole campus and technical detail of it is depicted as below in Table 2-5,

Table 3-1: Monthly Grid Power Consumption Pattern

Description	Technical Detail	Unit
Make	Technical Association	
Rating	630	kVA
HV	11	KV
LV	415	V
HA	33.1	Amp
LA	874.46	Amp
Phase	3	phase
Type of Cooling	ON AN	
Frequency Voltage	50	Hz
Impedance	4.5	%
Manufacturing Year	2004	
TAP Change	Manual	

Table 3-2: Typical 3 Phase Transformer Losses

Typical 3 Phase Transformer losses of various capacities (for CRGO Core Transformers)		
Rating (KVA)	**No Load Loss (W)**	**Load Loss (W)**
100	320	1950
160	455	2800
250	640	4450
500	900	6450
630	1260	9300
1000	1800	13300
1600	2600	19800
2000	3200	21000
3150	4600	28000
5000	6500	38000
6300	7700	45000
10000	11000	63000
12500	13000	77000
20000	18000	107000
31500	25000	150000
40000	30000	180000

Source: Siemens Electrical Engineers Hand Book

From above no load losses and load loss of 630 kVA transformer is almost double no load & load loss of 250 kVA as shown in Table 2-6.

3.2. Transformer Loading In Working Hr

Transformer Loading is depicted as below,

Table 3-3: Main Transformer Power Loading IN Working Hrs

	Voltage			**Current**			**Pf**	Power	
	Ur	Uy	Ub	Ar	Ay	Ab		kWh	kVAh
Transformer 630 kVA									
Min	378	376	384	147.4	149.0	95.5	0.63	88.6	94.6
Max	407	409	406	378.0	415.5	358.3	0.99	221.3	259.3
Avg	390	389	393	302.4	318.4	260.6	0.83	175.0	199.6

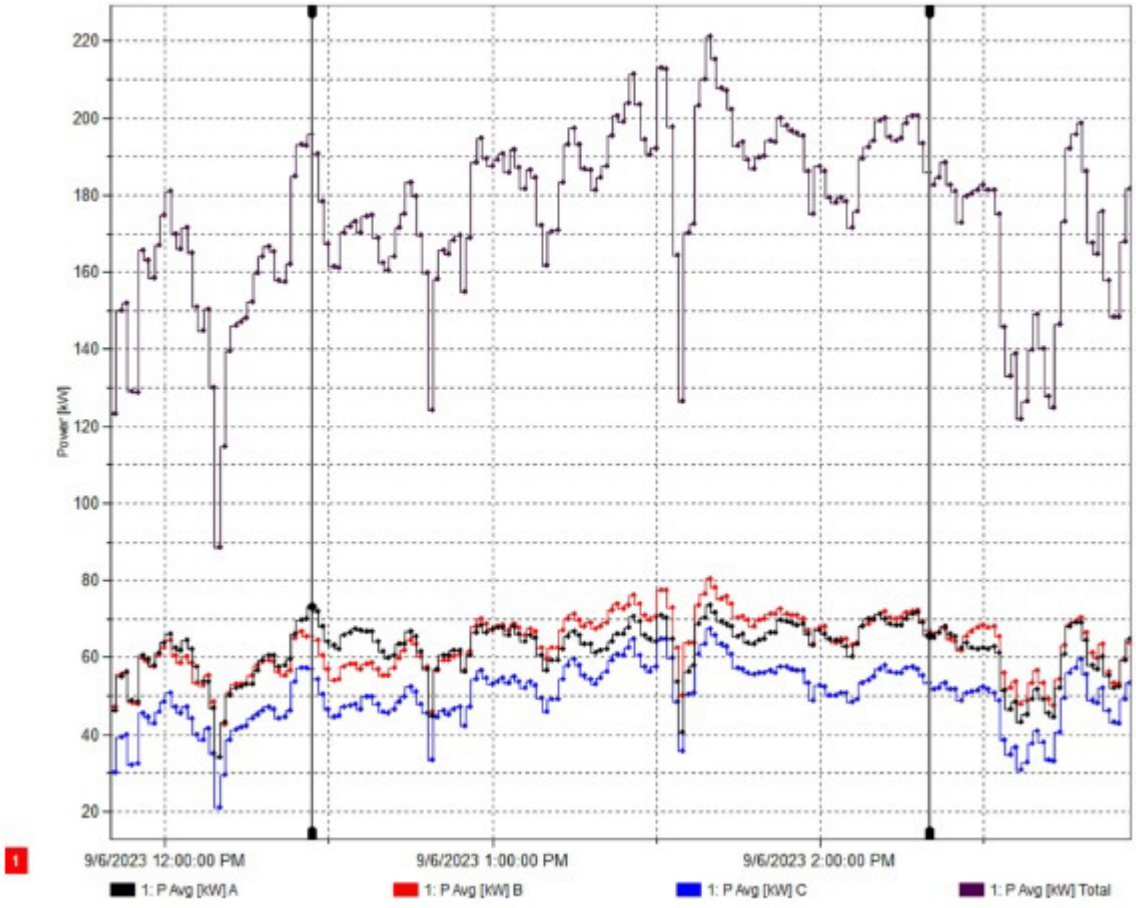
- Supply voltage is lower side and need to maintain near 420 V or above. It may be maintain by adjustment of tap changer of transformer. At low voltage, current supply will be high, which ultimately increases distribution losses (cable los is proportional to square of current flow in cable).

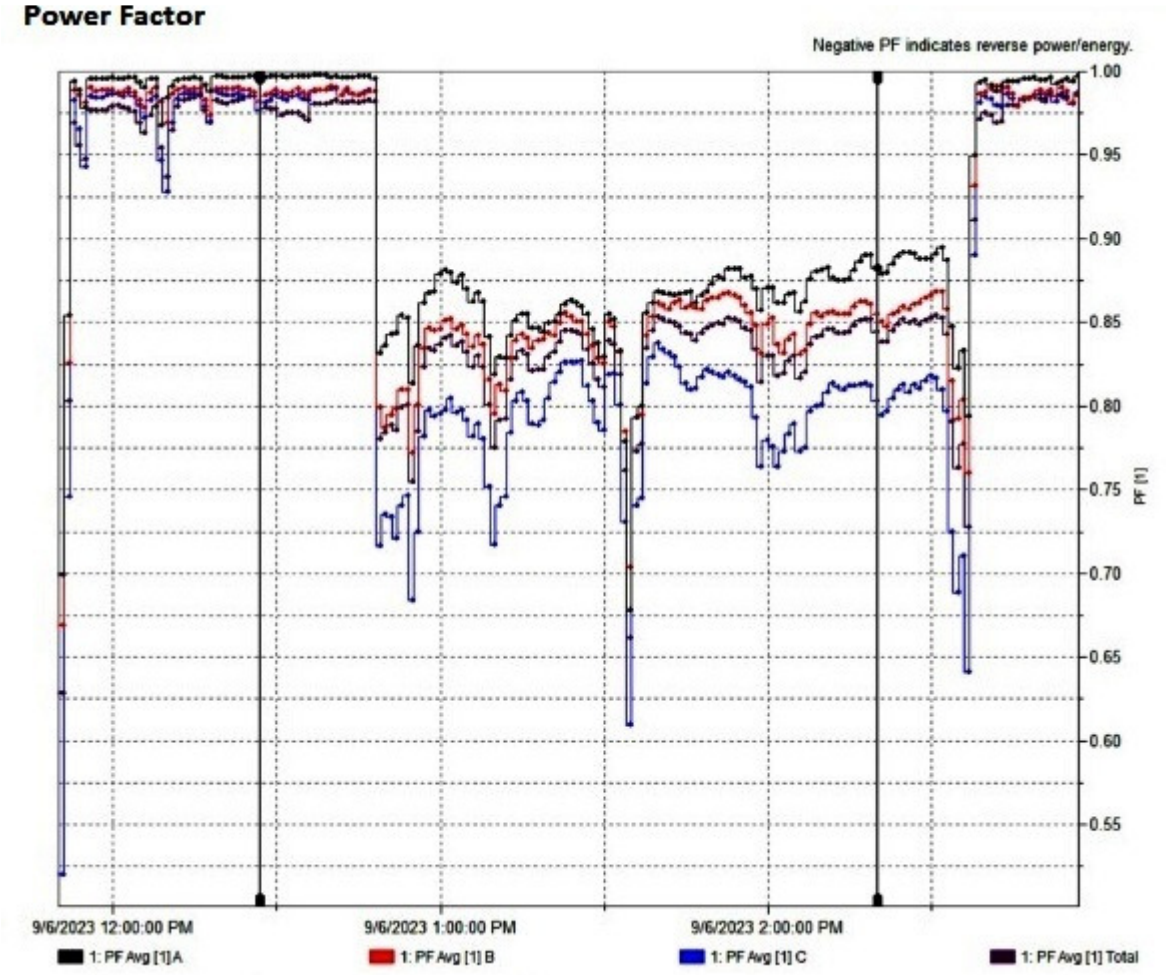
Table 3-4: Harmonics at Main Transformer in Working Hrs

	Freq	Voltage Harmonics			Current Harmonics		
Transformer 630 kVA							
	Hz	**Thd Ur**	**Thd Uy**	**Thd Ub**	**Thd Ar**	**ThdAy**	**Thd Ab**
Min	49.85	0.81	0.89	0.85	3.13	3.07	4.15
Max	50.11	1.52	1.86	1.98	12.99	14.27	31.91
Avg	49.99	1.08	1.37	1.31	5.34	5.60	8.79

- Voltage harmonics at transformer end is found below 5%.
- Current harmonics in Blue phase is found above IEEE limit.

RMS Power graph





- As the load decreases power factor is also, thus need to adjust lower capacity rating (1, 2, 3 and 5 kVAr rating) capacitor banks

3.3. Main Transformer Power Loading In Evening Hrs

Transformer loading has measured from 16.31 hrs to 19.57hr and summery of loading pattern is depicted as below,

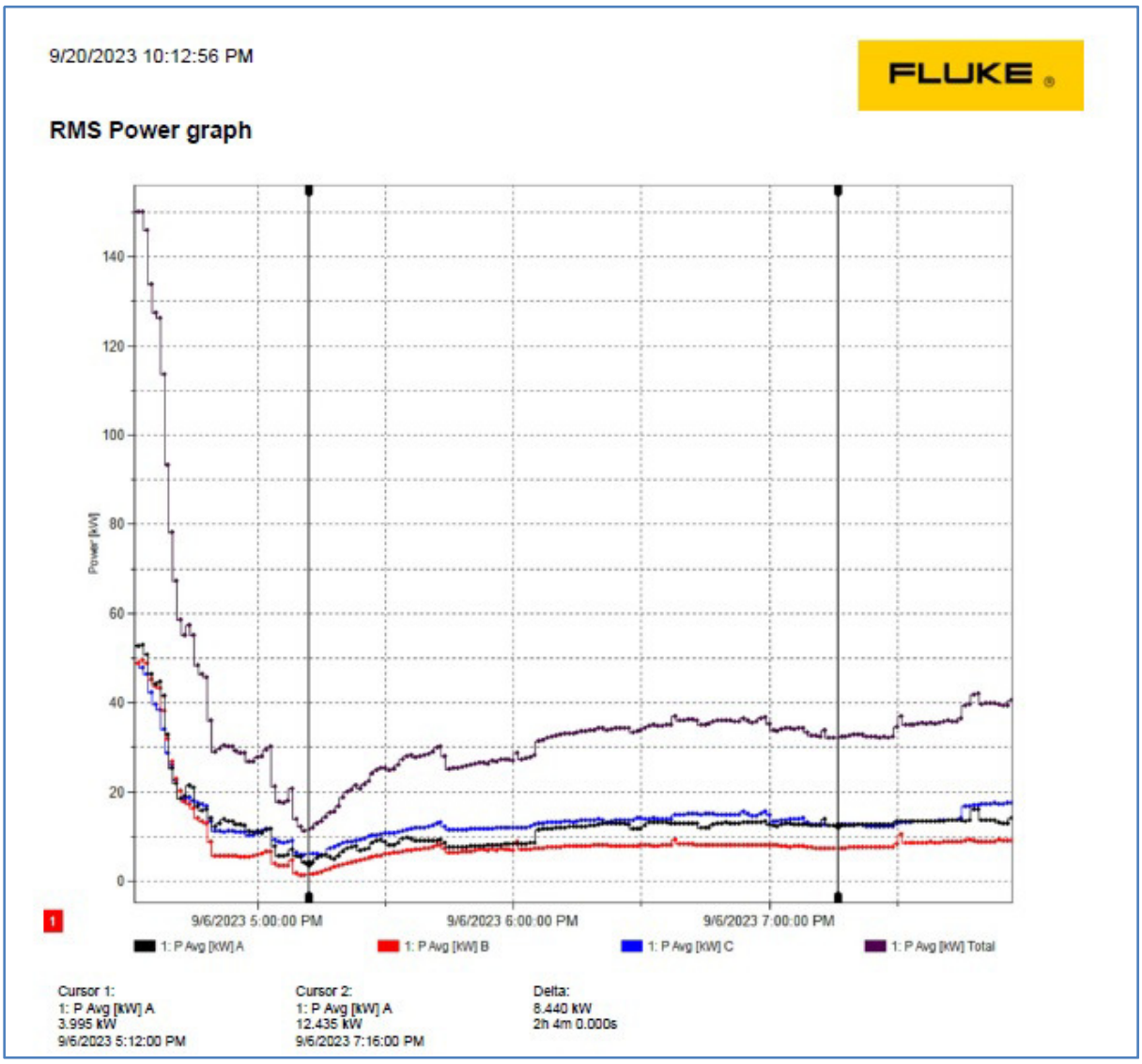
Table 3-5: Power Loading Main Transformer in Evening Time

	Voltage			Current			Pf	Power	
	Ur	Uy	Ub	Ar	Ay	Ab		kWh	kVAh
Transformer 630 kVA									
Min	396	398	392	22.5	12.5	26.5	0.98	11.1	18.0
Max	415	417	411	230.5	218.5	213.6	0.99	150.1	152.0
Avg	404	406	400	58.2	40.4	60.8	0.99	35.6	40.9

Table 3-6: Harmonics Level at Transformer End

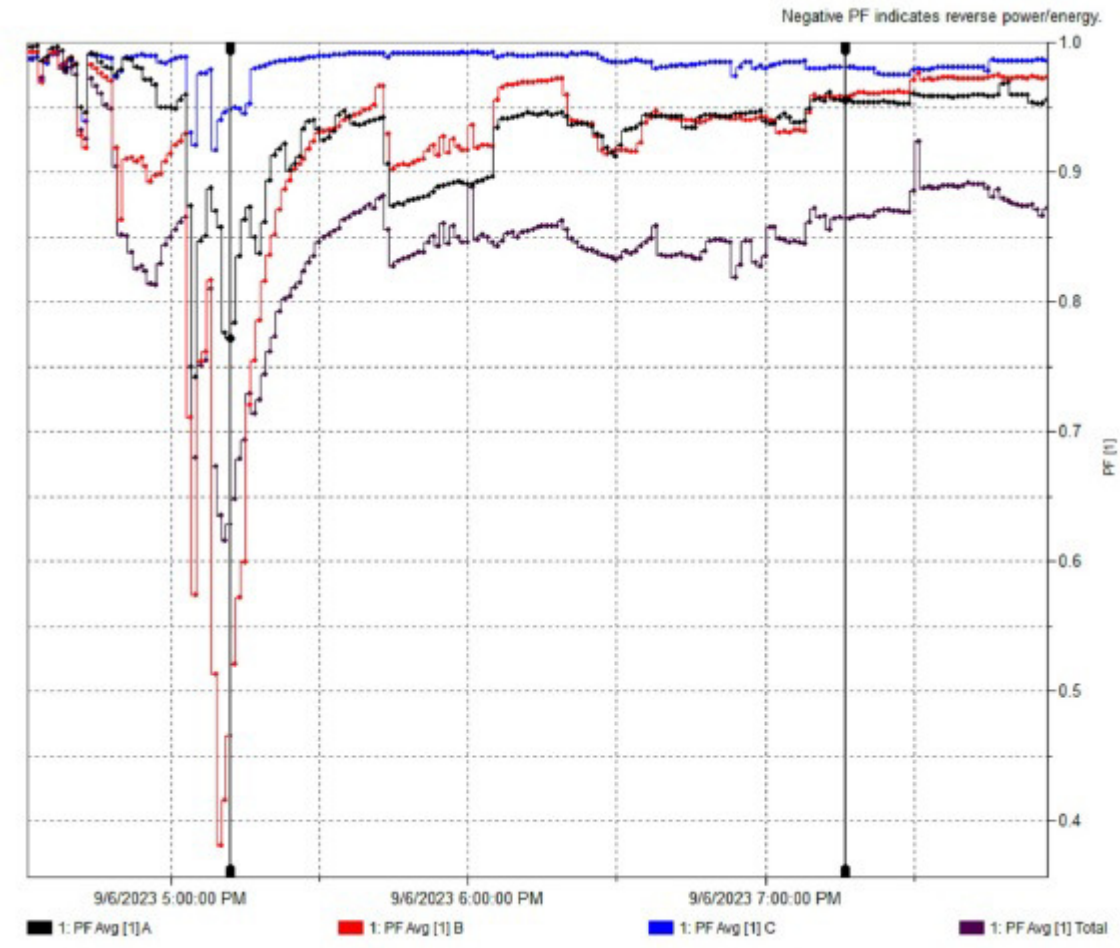
	Freq	Voltage Harmonics			Current Harmonics		
Transformer 630 kVA							
	Hz	**Thd Ur**	**Thd Uy**	**Thd Ub**	**Thd Ar**	**ThdAy**	**Thd Ab**
Min	**49.8**	**0.4**	**0.6**	**0.6**	**6.8**	**8.5**	**10.4**
Max	**50.2**	**1.1**	**1.7**	**1.7**	**25.8**	**54.6**	**23.8**
Avg	**50.0**	**0.6**	**0.9**	**1.0**	**18.2**	**21.6**	**15.6**

- Supply voltage is found low and need to increase 420 (min)
- Voltage harmonics is within IEEE limits.
- Current harmonics in Blue phase is found above IEEE limit.



Power Consumption trend from 16.31hrs to 17.57 hrs.

- In evening period, average power consumption is reduced from 175 kW to 40 kW, as ACs load switch off and only lighting load remains.



- Power factor at lighting load is recorded near unit.

3.4. Pharmacy Block Power Load

AC feeder load

Table 3-7: Power Load Pharmacy Block AC Feeder

	Voltage			Current			Pf	Power	
	Ur	Uy	Ub	Ar	Ay	Ab		kWh	kVAh
AC Pharmacy Block Feeder									
Min	382	385	381	33.8	38.2	35.3	0.90	21.4	23.9
Max	389	392	389	34.1	38.7	35.9	0.91	22.2	24.4
Avg	385	388	385	33.9	38.4	35.6	0.90	21.9	24.2

- Supply Voltage is found too low. Voltage drop from main transformer to pharmacy block is around 20 V.

- Power is found near 0.9o and needs to install capacitor bank at pharmacy AC feeder.

Table 3-8: Pharmacy Block AC Feeder Harmonics Level

	Freq	Voltage Harmonics			Current Harmonics		
AC Pharmacy Block Feeder							
	Hz	**Thd Ur**	**Thd Uy**	**Thd Ub**	**Thd Ar**	**ThdAy**	**Thd Ab**
Min	50.0	0.76	0.80	0.85	1.6	2.2	1.2
Max	50.1	0.91	0.95	1.02	1.8	2.5	1.5
Avg	50.0	0.82	0.88	0.92	1.7	2.3	1.3

- Voltage and current harmonics is found within the IEEE limit.

Table 3-9: Pharmacy Block Light Feeder

Lighting feeder load

Table 3-10: Power Loading Pharmacy Block Feeder

	Voltage			Current			Pf	Power	
	Ur	**Uy**	**Ub**	**Ar**	**Ay**	**Ab**		**kWh**	**kVAh**
Pharmacy Block Lighting feeder									
Min	398	403	401	23.5	29.6	36.3	0.81	18.9	23.2
Max	409	414	412	41.4	47.4	53.4	0.91	32.3	35.1
Avg	406	411	408	34.0	42.6	48.9	0.88	28.3	31.7

- Supply Voltage is found on lower side.

Table 3-11: Harmonics Level Pharmacy Block Feeder

	Freq	Voltage Harmonics			Current Harmonics		
Pharmacy Block Lighting feeder							
	Hz	**Thd Ur**	**Thd Uy**	**Thd Ub**	**Thd Ar**	**ThdAy**	**Thd Ab**
Min	50.0	1.0	1.2	1.1	7.1	5.5	5.2
Max	50.1	1.1	1.4	1.3	12.2	9.2	8.0
Avg	50.0	1.1	1.3	1.2	8.7	6.5	5.8

- Voltage and current harmonics is found within the IEEE limit.

3.5. Oberservation

- Voltage drop in AC feeder of at Pharmacy Block is approx 20V, which is on higher. It indicates that cable loss is high or joint loss at main junction point is high. Need further study.

CHAPTER-4
DG SET

4.1. System Installed

Three DG Sets of capacity 320 kVA, 125 kVA, & 62.5 kVA are installed in KIP Varanasi, for in-house for power generation, in case of grid supply failure.

Technical Specification of 320 kVA, 125 kVA, & 62.5 kVA, as shown in below Table,

Table 4-1: 3200 kVA, 125 kVA & 62.5 kVA Set Technical Specification

Rating	320 kVA	125 kVA	62.5 kVA	Unit
Make	Jackson r	Kirlosker	Kirlosker	
Engine Power	380	200	66	kW
AC VOLT	415	415	425	V
AC Amp	445	200	87	A
Phase	3	3	3	
Pf	0.8	0.8	0.8	PF
RPM	1500	1500	1500	RPM
Connection	STAR	STAR	STAR	STAR
Insulation Class	H	H	HP	Class

Normally, 320 kVA and 125 kVA DG Sets taken in line in case of grid failure as per requirement. 62.5 kVA DG set is used for lighting load particularly in night.

4.2. 320 kVA DG Set Loading

Power loading of 320 kVA is recorded and summary of it is depicted as below table,

Table 4-2: 320 kVA DG Power Loading Pattern

	Voltage			Current			Pf	Power	
	Ur	Uy	Ub	Ar	Ay	Ab		kWh	kVAh
320 kVA DG									
Min	408	409	409	277.2	278.7	272.9	0.88	186.2	197.1
Max	409	410	410	367.2	364.6	371.5	0.92	229.8	260.5
Avg	409	409	410	313.4	312.4	316.4	0.90	205.2	222.8

- Average loading is recorded 70% (approx)..

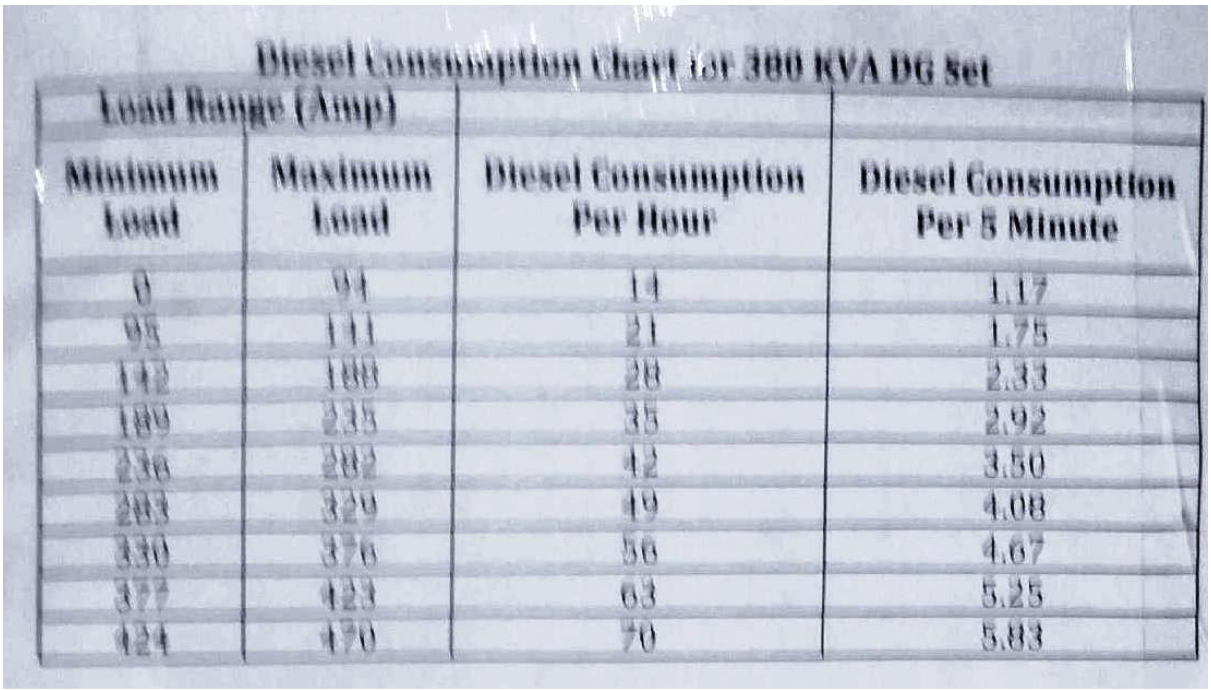
Table 4-3: 320 kVA DG Harmonics Level

	Freq	Voltage Harmonics			Current Harmonics		
320 kVA DG							
	Hz	Thd Ur	Thd Uy	Thd Ub	Thd Ar	ThdAy	Thd Ab
Min	50.3	1.9	1.9	2.2	3.0	3.3	3.0
Max	50.7	2.3	2.3	2.6	3.6	4.5	3.5
Avg	50.5	2.0	2.0	2.3	3.2	3.8	3.1

- Voltage and current harmonics is found within the IEEE limit.
- Since fuel tank dimension is not known, that why, unable to calculate specific fuel consumption.

4.3. Specifice Fuel Consumption

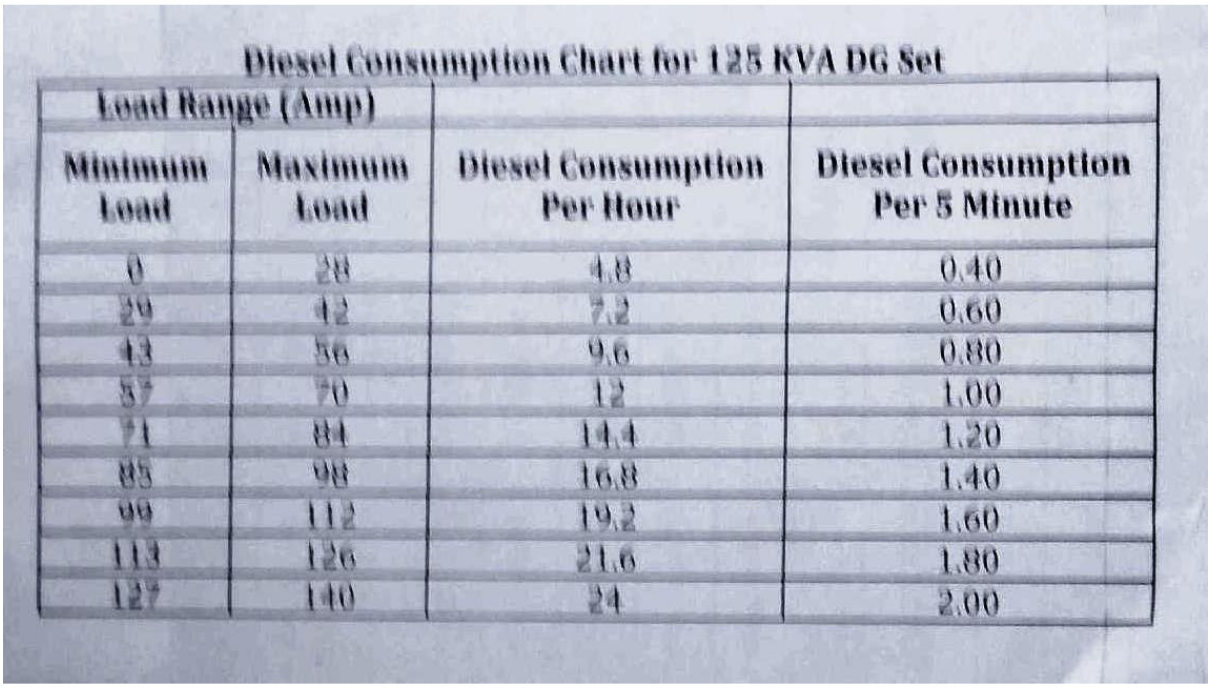
Fuel consumption in 320 kVA DG at different load,



Diesel Consumption Chart for 380 KVA DG Set

Load Range (Amp)			
Minimum Load	Maximum Load	Diesel Consumption Per Hour	Diesel Consumption Per 5 Minute
0	94	14	1.17
95	141	21	1.75
142	188	28	2.33
189	235	35	2.92
236	282	42	3.50
283	329	49	4.08
330	376	56	4.67
377	423	63	5.25
424	470	70	5.83

Fuel consumption in 125 kVA DG at different load,



Diesel Consumption Chart for 125 KVA DG Set

Load Range (Amp)			
Minimum Load	Maximum Load	Diesel Consumption Per Hour	Diesel Consumption Per 5 Minute
0	28	4.8	0.40
29	42	7.2	0.60
43	56	9.6	0.80
57	70	12	1.00
71	84	14.4	1.20
85	98	16.8	1.40
99	112	19.2	1.60
113	126	21.6	1.80
127	140	24	2.00

4.4. DGs Operation History

Operating hours and fuel consumption of all DGs is depicted in below table,

Period		320 kVA				125 kVA				62.5 kVA			
		Running		Total	HSD	Running		Total	HSD	Running		Total	HSD
From	To	Hr	min	HSD Cons. Litre	cons/ hr	Hr	min	HSD Cons. Litre	cons/ hr	Hr	min	HSD Cons. Litre	cons/ hr
01.01.2022	31.01.2022		35	35	60.0	4	35	112	24.4	6	30	66	10.2
01.02.2022	29.02.2022	2		80	40.0	14	10	288	20.3	4	15	45	10.6
01.03.2022	31.03.2022	1	35	111	70.1	10	35	212	20.0	4	55	49	10.0
01.04.2022	20.04.2022	4	45	332	69.9	4	30	90	20.0	4	15	42	9.9
21.05.2022	31.05.2022	10	35	794	75.0	35	20	707	20.0	9	20	93	10.0
01.06.2022	30.06.2022	23	50	1670	70.1	20	20	407	20.0	8	15	83	10.1
01.07.2022	31.07.2022	26	38	920	34.5	4	45	95	20.0	11	5	112	10.1
01.08.2022	31.08.2022	20	5	1169	58.2	4	5	82	20.1	11	35	115	9.9
01.09.2022	30.09.2022	28	50	1701	59.0	12	30	237	19.0	15	20	154	10.0
01.10.2022	31.10.2022	4	20	223	51.5	20	30	380	18.5	3	30	29	8.3
01.11.2022	30.11.2022	8	40	425	49.0	4	55	94	19.1	1	10	11	9.4
01.12.2022	31.12.2022	8	45	300	34.3	4	50	97	20.1		20	4	12.0
01.01.2023	31.01.2023	11	55	475	39.9	1	35	32	20.2		20	4	12.0
01.02.2023	28.02.2023	3	55	158	40.3					2	20	20	8.6
01.03.2023	31.03.2023	36	20	1553	42.7					54	10	476	8.8
01.04.2023	30.04.2023	10	30	530	50.5					10	55	87	8.0

Period		320 kVA				125 kVA				62.5 kVA			
		Running		Total HSD Cons. Litre	HSD cons/ hr	Running		Total HSD Cons. Litre	HSD cons/ hr	Running		Total HSD Cons. Litre	HSD cons/ hr
From	To	Hr	min			Hr	min			Hr	min		
01.05.2023	31.05.2023	12	50	619	48.2		35	12	20.6	3	50	39	10.2
01.06.2023	30.06.2023	23	40	1344	56.8		15	5	20.0	19	50	199	10.0

- In May 2022, HSD consumption is found that in 320 DG is found higher than standard HSD consumption (Highlighted yellow),

CHAPTER-5
CAPACITOR BANK

5.1. Performance of Capacitor

One number APFC panel of rating 343 kVAr is connected with the main LT panel in KIP Varanasi. Details of capacitor banks installed in the APFC panel are depicted below in Tables,

APFC Panel

Table 5-1: Capacitor Bank

Sr. no.	Capacitor Bank Rating	No.	Total Capacitance
1	1 kVAr	1	1 kVAr
2	2 kVAr	1	2 kVAr
3	4 kVAr	1	4 kVAr
4	6 kVAr	1	6 kVAr
5	10 kVAr	1	10 kVAr
6	20 kVAr	1	20kVAr
7	25 kVAr	12	30 kVAr
	Total		**189 kVAr**

5.2. Obeservation

- From above Table 5-1, performance of each capacitor bank is found satisfactory.

CHAPTER-6
ILLUMINATION & FANS

6.1. Light Fixtures

KIP Varanasi established in the year 2008 and conventional light fixtures were installed for illumination purpose. New technology developed, and new energy efficient light fixtures LED got available later in the market with reasonable price. KIP authority has also taken a step towards energy efficiency and replacing conventional light fixtures with LED light fixtures in phase manner. The detail of light is shown in below Table,

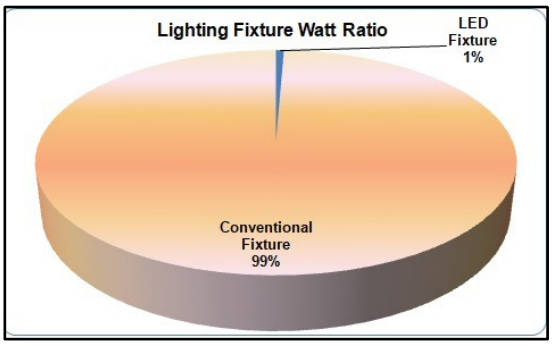
Table 6-1: Light Fixture

Sr. no.	Type	Watt Including Choke	No.	Total Watt
1	Tube Light	51	707	36057
2	LED Lamp	9	26	234
	Total		733	36291

Share of LED fixtures and conventional fixtures load is given below in Table 5-2,

Table 6-2: Light Load

Sr. no.	Description	Total Load Watt
1	LED Fixture	36057
2	Conventional Fixture	234
3	Total	36291



6.2. Fans

Different type of fans are installed in KIP Varanasi and detail of them are depicted below in a Table 5-3,

Table 6-3: Fans

Sr. no.	Fans	No.	Total Load - Watt
1	Ceiling Fan 60 Watt	223	13380
2	Wall Fan 40W	3	120
	Total	**908**	**13500**

6.3. Lux

Value of Lumen per square meter is called lux or lux level in that area.
As per *Illuminating Engineers Society Recommendations Handbook* the recommended lux level is depicted below in a Table 5-4,

Table 6-4: Standard Lux Level

ACTIVITY	CATEGORY	LUX	FOOTCANDLES
Public spaces with dark surroundings	A	20-30-50	2-3-5
Simple orientation for short temporary visits	B	50-75-100	5-7.5-10
Working spaces where visual tasks are only occasionally performed	C	100-150-200	10-15-20
Performance of visual tasks of high contrast or large size	D	200-300-500	20-30-50
Performance of visual tasks of medium contrast or small size	E	500-750-1000	50-75-100
Performance of visual tasks of low contrast or very small size	F	1000-1500-2000	100-150-200
Performance of visual tasks of low contrast or very small size over a prolonged period	G	2000-3000-5000	200-300-500
Performance of very prolonged and exacting visual tasks	H	5000-7500-10000	500-750-1000
Performance of very special visual tasks of extremely low contrast	I	10000-15000-20000	1000-1500-2000

A-C for illuminances over a large area (i.e. lobby space)
D-F for localized tasks
G-I for extremely difficult visual tasks

The first value in the above table is lower limit (min requirement of lux), second value is average value and last value is indicating the higher level of Lux.

Thus, it is suggested here to maintain at least 150-200 LUX in offices/ reading room etc.

6.4. Recommendation

- **Replacement of 36 W Tube Light 707 no with 20 W LED fittings in phase manner.**

Conventional 36 W fluoresce tube light consumes total 51 W power per fixture (including 15 W choke) and produces around 2800 lumen. The operating life of T8 is approx 10000 hrs and these types of tube light have environment issues & contain mercury.

Energy saving has been worked out after replacement all above conventional tube light with 20 W LED tube fixture is depicted below in a Table 5-5,

Table 6-5: 36 W Tube Light Fixture Replacement

No. of 36 W Tube light still installed	707no.
Power consumption in 36 W Tube light (including 15 W choke)	51Watt
Power consumption in 20 W LED	20Watt
Difference in power cons.	31Watt
Annual operation hrs (250 days for 8 hrs)	2000Hrs
Annual power saving	43834kWh
Power cost	14.32Rs./kWh
Annual energy saving	6.28Rs. Lakh
LED Tube light cost @Rs.500/ piece	3.54Rs. Lakh
Simple payback period	7Month

- **Replacement of Fans with BLDC Based motor Fans**

For years, ceiling fans used to come with the same hardware of induction motor which typically consumed **60-80 watts** for a standard ceiling fan. But in the last few years, a new technology called **BLDC** is being used to make fans consume a lesser amount of energy, without compromising much on the air delivery. **BLDC** stands for **brush-less direct-current**

motor, a special type of motor which has permanent magnet instead of electromagnets found in a conventional induction motor. BLDC motor has important advantages over induction motor like low electricity consumption, lesser noise generation and better lifespan.

Efficiency is all about achieving the same results while using lesser electricity. Typical ceiling fans/ wall fans made with the conventional design are made of single-phase induction electric motor. Most of the prevailing fan manufacturers used aluminum than copper in the fan, as it is cheaper. But aluminum is less energy efficient. The end result is that most of the traditional technology fans consumed about 8**0-100 watts** of electricity. The air delivery of these fan ranges between **210 to 250 m^3/min**

BEE 5 star rated fans consumes about 30 **watts** of electricity which were also called **super-efficient fans and** deliver between **230-270 m3/min air flow.**

Prominent advantages of BLDC motor over induction motor is depicted as below,

Lower Electricity Consumption (65% savings)

Longer backup on Inverters (even on Solar)

Improved reliability

Noise reduction

Longer lifetime

Now energy efficient BLDC motor based wall fans & cabin fans are also available in the market and they consumes max power 30 Watt each.

- **Replacement of 223 no. Conventional Fans With BLDC Fans**

Thus, it is advise here to replace all conventional 70 W fans with BLDC based motor fans in a phase manner and annual energy saving has been estimated below in a Table 5-10,

Table 6-6: Ceiling Fan Replacement

No. of 60 W Ceiling Fans installed	223 no.
Power consumption in 60 W Ceiling Fan	60 Watt
Power consumption BLDC Fans	30 Watt
Difference in power cons.	30 Watt
Annual operation hrs (200 days for 8 hrs)	1600 Hrs
Annual power saving	10704 kWh
Power cost	14.32 Rs./kWh

Annual energy saving	1.53 Rs. Lakh
BLDC Ceiling Fans cost @Rs.2500/ Fan	5.58 Rs. Lakh
Simple payback period	44 Month

- **Replacement of 3 no. Conventional Wall Fans With BLDC Fans**

Thus, it is advise here to replace all conventional 40 W wall fans with 20 Watt BLDC based motor wall fans in a phase manner and annual energy saving has been estimated below in a Table 5-7,

Table 6-7: Ceiling Fan Replacement

No. of 40 W Wall Fans installed	3 no.
Power consumption in 40 W wall Fan	40 Watt
Power consumption BLDC Wall Fans	20 Watt
Difference in power cons.	20 Watt
Annual operation hrs (200 days for 8 hrs)	1600 Hrs
Annual power saving	96 kWh
Power cost	14.32 Rs./kWh
Annual energy saving	0.01 Rs. Lakh
BLDC wall Fans cost @Rs.2000/ Fan	0.06 Rs. Lakh
Simple payback period	53 Month

- **Installation Occupancy sensor**

PIR and dual sensors based on vibration and thermal-based occupancy sensors are available on the market. These sensors switch off the power supply to light fixtures, fans, ACs, etc. If there is no occupancy in offices, class rooms, lobbies, wash rooms, etc.

Actual energy saving by installation of occupancy sensors is not possible to estimate exact quantity of energy will save. Trends have shown the use of occupancy sensor-based systems, which give at least 10–15% energy savings in lighting and fan systems.

CHAPTER-7
PUMP

7.1. Pump Installed

One submersible capacity pumps area installed for different purpose and their detail is depicted below in a Table 6-1.

Table 7-1: Pump Installed

Sr. no.	Description	Qty	Rating	Unit
1	Submersible Pump	1	5	HP

The water requirement in KIP Varanasi is fulfilled by the bore water pump. Bore water pump draws underground water and it in storage tanks installed on roofs of institute buildings.

There is no water level controller installed in the water storage tank. It is advised to install level control in water storage tanks in series and synchronies with the bore water pump. It will not only reduce the wastage of water but also energy.

Water flow of pump is measured,

Table 7-2: Pump Installed

Pump Identification	Unit	Pharmacy Building
Rated Parameters		**Pump**
Running Status		Running
Pump Make		Not Available
Speed	RPM	Not Available
Rated Flow	m^3/hr	Not Available
Rated Head	M	Not Available
Rated Power	KW	Not Available
Motor Efficiency	%	Not Available
Parameters Measured		
Measured Flow	m^3/hr	7.26
Discharge Pressure (A)	Kg/cm^2	No pint provided
Suction Pressure (B)	Kg/cm^2	No pint provided
Performance Evaluation		
Power Draw	Voltage	220
	Current	12

Pump Identification	Unit	Pharmacy Building
Rated Parameters		Pump
	KW	2.1
	P.F	0.8

CHAPTER-8
PACKAGE AC

8.1. System Installed

Total six package AC units are installed to maintain air conditioning atmosphere in class room, & offices rooms, r. The detail of package ACs is given below a Table 7-1,

Table 8-1: Package AC

Sr. no.	Type	Rating TR	No.	BEE Star
1	Window AC	1.5	1	3
2	Split AC	1.5	2	2
3	Duct AC	5.5	5	3

8.2. Suggestion

Now inverter AC is available in the Indian market, which can save energy by 30% as claimed by its manufacturer. The detail of benefits and their functions are described below,

Inverter technology is the latest advancement concerning the electromotor of compressors. An inverter is used to regulate the speed of the compressor motor in order to adjust the temperature. The main feature of an **inverter AC** is its ability to control its compressor motor speed. The regulated speed allows the unit to maintain the temperature without having to power down its motor. This means an inverter air conditioning unit is way more energy-efficient than non-inverter ones.

Key Advantages of Inverter AC

- Consumes less power in comparison to a traditional AC.
- No voltage fluctuation.
- Keeps a constant room temperature.
- Effective cooling.
- Suitable for small and large spaces.
- Safe for residential wiring due to lower power consumption.
- Environment-friendly.

The cost of inverter AC is too high; thus, it is advice that priority should be given to inverter AC in the case of procuring new ACs.