ENERGY AUDIT REPORT

Kashi Institute of Technology

23 KM Milestone, Varanasi-Prayagraj Road,
Mirzamurad, Varanasi-221307 (Uttar Pradesh)

July-2022

CONDUCTED BY:

Petroleum Conservation Research Association
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The study team is thankful to the Dr Gaurav Sinha, Director, KIT, Kashi and Mr Yashvant Mohan (Assistant Professor) for their whole hearted support in providing data related to Energy Audit work and providing access to all Electrical equipment. We are also great full to electrical staff, who took pain along with us to gather data and cooperation in carrying out of work.

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CHAPTER-1

EXECUTIVE SUMMARY

1.1 An executive summary provides an overview of the energy audit report. The purpose of an executive summary is to summarize the key points of the energy audit study such as energy saving potential, recommendations, cost savings, investment requirement etc. for each sub system for which energy audit done.

1.2 The study was carried out based on various data provided by Kashi Institute of Technology, Varanasi, however, depending upon the requirement, additional measurements using various measuring instruments, were taken during the study. Various Energy Conservation measures were explored and possible saving in energy is also listed in Table-1.1

1.3 Observations & Possible Energy Saving

The institute was visited and discussions were held with officers/staff regarding institute's equipment and process. Some records such as Energy bills, log book and log sheets were also studied. After those measurements of parameters of various equipment were recorded. Based on records and measurements, it was found that there is scope of energy savings in following fields:

1. Lighting accessories
2. Air conditioners

1.4 Cost Benefit Analysis

Sr No	Name of Activity	Quantity	Energy saved (kWh) / Year	Cost of Energy saved/Year @ Rs 8.50 per unit (Rs)	Cost of replacement (Rs)	Pay back period (Year)
1	Replacement of 36 W FTL with 20 W LED Tube light @ Rs 300 per Tube light	1833	70387.2	598291.2	549900	0.92
2	Replacement of 1.5 T Non Star Window Air Conditioner with Five Star rated 1.5 T Window Air Conditioners	7	5655	48067.50	224000	4.66
3	Replacement of 1.5 T Non Star Split Air Conditioner with Five Star rated 1.5 T Split Air Conditioners	6	6084	51714.00	240000	4.64
	Grand Total		**82126.2**	**698072.7**	**1013900**	

Table-1.1 Summary of EE Strategy

1.5 Savings in TOE basis:

Percentage Saving has been shown in Table-1.2 to Table-1.3

1) Electricity (Including Solar Energy):

Annual Consumption			Savings Identified			Percentage Saving Identified (%)		
(kWh)	(TOE) (*)	Amount @ Rs 8.50/ unit (Rs)	(kWh)	(TOE)	Amount @ Rs 8.50/ unit (Rs)	(kWh)	(TOE)	Amount (Rs)
369167	31.748	3137919.50	82126	7.06	**698072.7**	22.25	22.25	22.25

Table-1.2: Percentage Saving in Electricity

2) Diesel Energy

Annual Consumption				Savings Identified				Percentage Saving Identified (%)		
Diesel (Liter)	Diesel (kWh)	TOE (*)	Amount @ Rs 90.60 (Rs)	Diesel (Liter)	Diesel (kWh)	TOE	Amount @ Rs 90.60 (Rs)	Diesel	TOE	Amount
3754	37540	3.2284	340112.4	0	0	0.00	0	0.00	0.00	0.00

Table-1.3: Percentage Saving in Diesel Energy

***Note:** 1 KWH=860 Kcal and **1 TOE = 10^7 K Cal**

CHAPTER-2

INTRODUCTION

2.1 Introduction

Kashi Institute of Technology Varanasi (KIT Varanasi) is counted among the top-rated technical institutes of North India. Kashi Group of Institutions was established in the year 2008. The institute is approved by the All-India Council of Technical Education (AICTE), New Delhi, and is affiliated with Dr. A.P.J. Abdul Kalam Technical University (AKTU). The institution has seen remarkable growth in the past fourteen years.

2.2 Address of Institute:

23 KM, Varanasi–Prayagraj Road, Mirzamurad, Varanasi-221307 (Uttar Pradesh)

2.3 Location of Institute

Fig-2.1: Location of Institute

2.4 Campus View of KIT, Varanasi

Fig-2.2: Campus View of KIT, Varanasi

2.5 Scope of Work

2.5.1 Review of Electricity Bills, Contract Demand and Power Factor: For the last one-year, in which possibility will be explored for further rationalization of contract demand and improvement of P.F.

2.5.2 Electrical System Network: Which would include study of Transformer operations, their Operational Pattern, Loading, Harmonic level measurement, Sufficiency and performance of capacitors bank (consider only LT Capacitor panel). Measurement on the Main Power Distribution Boards and scope for improvement, if any. The study would also cover possible improvements in energy metering systems for better control and monitoring.

2.5.3 Air Conditioners: Performance shall be evaluated as regards, their input power vis-à-vis TR capacity and performance will be compared to improve to the best in the category.

2.5.4 Illumination: Study of the illumination system, LUX level in various areas, area lighting etc. and suggest measures for improvements and energy conservation opportunity wherever feasible.

2.5.5 DG Set: Study the operations of DG Sets to evaluate their average cost of Power Generation, Specific Energy Generation and subsequently identify areas wherein energy savings could be achieved after analyzing the operational practices etc. of the DG Sets.

2.6 General Details:

Brief description of assignment	:	Energy Audit
Name & Address	:	Kashi Institute of Technology, Varanasi
Contact Officials	:	Dr Gaurav Sinha Director
Name of PCRA Team Leader	:	Mrs. Puja Prasad Dy. Director & Field Engineer (NR) nrfe4@pcra.org
Address of communication of PCRA	:	Petroleum Conservation Research Association, Sanrakshan Bhawan, 10, Bhikaji Cama Place, New Delhi – 110 066 Ph: 011 – 2619 8856; Fax: 011 – 2610 9668 e-mail: crcnr@pcra.org Website: http://www.pcra.org
Operational Days	:	300
No. of Shifts	:	1

CHAPTER-3

METHODOLOGY ADOPTED FOR ENERGY AUDIT

3.1 Energy Audit Methodology

A team of certified energy auditors and domain experts were involved in the energy study at KIT, Varanasi, with primary focus on identification of areas of energy conservation within the existing set-up. During the study, all the facilities within the complex were visited and surveyed for techno-commercial analysis. The analysis includes not only the energy savings' estimation through recommended energy conservation measure, but also simple payback calculations where investments shall be required to achieve the energy savings as estimated, in order to high-light the individual ECM economic viability. The major areas of study are: -

- Electrical Distribution
- Illumination & Lighting system
- Diesel Generators
- Air Conditioning System

Audit study used latest, sophisticated, portable, diagnostic and measuring instruments to support our energy audit investigations and analyses, for carrying out various measurements and analyses.

The following methodology was adopted for this Study:

1. Familiarization with KIT, Kashi and understanding of its operation
2. Interaction and discussion with concerned stakeholders' Visual inspection and preliminary data collection with respect to various end use application (as available with KIT, Kashi)
3. Identification and collection of energy consumption data (as available with KIT, Kashi)
4. End use application wise necessary measurement taken using required instruments
5. Analysis of measured Data
6. Identification of potential Energy

3.2 Audit Team

College Work Group

- Dr Gaurav Sinha, Director
- Mr. Yashwant Mohan (Assistant Professor)

PCRA Audit Team

- Mr. Umesh Prasad Singh, Additional Director & CRC (NR)
- Mrs. Puja Prasad Dy. Director & Field Engineer (NR)

CHAPTER-4

ELECTRICAL SYSTEM NETWORK

4.1 Sources of Energy being used in the Institute

The Institute is using both conventional and non-conventional sources of energy.

4.2 Electricity Distribution System:

The electric supply of KIT, Varanasi is being fed from Purvanchal Vidyut Vitran Nigam through 11 KV feeder. There is single common power connection for two separate institutes namely Kashi Institute of Technology and Kashi Institute of Pharmacy. The study of electrical parameters was done on joint electricity connection. The details of Distribution Transformer are as shown in Table-4.1. Contracted Load of the joint connection is 280 KW.

Sl. No.	Transformer No.	Rated Voltage Ratio	Make	Rated Capacity (KVA)	Winding Material	No Load Current (A)	Full Load Current (A)	Year of Manufacture
1	T/F-1	11KV/ 433 volt	Kirloskar	650	copper	Not available		

Table-4.1: Details of 11/0.4 KVA Transformers installed in the premises

Fig-4.1: 11/0.4 Transformer (650 KVA)

4.3 Study of operational pattern and quality of Power Supply of Transformers

Power Analyzer was installed on Main Bus bar of incoming Distribution Panel of Distribution Transformer of 650 KVA from 10.25 AM to 11.25 AM to on dated 27.07.2022.

Fig-4.2: Checking Load & Electrical Parameters through Load Analyzer

The energy parameter except THD and only THD were as per Table-4.2.
Date of recording: 27.07.2022

Time:	U12 rms	U23 rms	U31 rms	A1 rms	A2 rms	A3 rms	AN rms	P1 (W)	P2 (W)	P3 (W)	PT (W)	PFT
	V	V	V	A	A	A	A	W	W	W	W	
10:25:00 AM	409.5	413.2	411.8	324.7	325.3	327.1	35.4	74189	73354	75000	222542	0.96
10:26:00 AM	408.9	412.8	411.3	322.9	325.2	326.9	35.6	73657	73160	74897	221714	0.96
10:27:00 AM	409.6	413.3	412.2	318.7	324.1	327.9	33.4	72775	72970	75172	220917	0.96
10:28:00 AM	410.6	414.4	413.2	317.9	324.2	327.4	32.8	72752	73175	75181	221108	0.96
10:29:00 AM	411.2	415.4	414	320.6	327.1	322.6	35.6	73510	73820	74042	221372	0.96
10:30:00 AM	410	414	412.7	322.8	327.7	322.6	36.3	73852	73838	73892	221582	0.96
10:31:00 AM	409.4	413.1	412	319	326.4	323.6	34.5	72803	73494	74026	220323	0.96
10:32:00 AM	409.1	412.7	411.4	319.6	322.8	326.3	34	72835	72581	74655	220071	0.96
10:33:00 AM	409.7	413.2	412	322.6	322.8	326.5	34.7	73733	72723	74870	221326	0.96
10:34:00 AM	409	412.4	411.4	323	320.4	324.3	35.3	73701	72036	74155	219892	0.96
10:35:00 AM	408.4	411.9	410.9	325.7	317.9	322.5	38.3	74317	71346	73661	219325	0.96
10:36:00 AM	407.1	411	409.6	325.4	319.4	322	38.8	74046	71576	73419	219040	0.96
10:37:00 AM	406.5	410.8	409	318.3	320.4	322.3	35.6	72251	71791	73443	217485	0.96
10:38:00 AM	407.2	411	409.8	310.4	314.6	320.2	33	70585	70731	73084	214400	0.96

Time:	U12 rms	U23 rms	U31 rms	A1 rms	A2 rms	A3 rms	AN rms	P1 (W)	P2 (W)	P3 (W)	PT (W)	PFT
	V	V	V	A	A	A	A	W	W	W	W	
10:39:00 AM	406.9	411	409.4	304.7	309.1	315.9	33.3	69101	69253	71993	210346	0.96
10:40:00 AM	407	410.5	409.3	303.5	307.8	314.2	33.2	68747	68914	71526	209187	0.96
10:41:00 AM	406.8	410.5	409.3	305.4	314.5	308.6	34.6	69183	70435	70011	209629	0.96
10:42:00 AM	406.6	410.6	409.2	308.9	320.9	312.6	35.1	69834	71753	70880	212467	0.96
10:43:00 AM	408.2	412.4	411.3	298.1	310.2	303.3	35.5	67824	69609	69050	206483	0.96
10:44:00 AM	407.6	411.8	410.6	299.2	313.2	306.7	35.2	68064	70405	69848	208317	0.96
10:45:00 AM	407.2	411.4	410.3	297.2	311.9	305.7	35.9	67514	70004	69486	207003	0.96
10:46:00 AM	407.5	411.5	410.3	287.7	303.4	299.3	35.1	65147	67764	67829	200740	0.95
10:47:00 AM	408.4	412.4	410.9	283.4	290.4	295.4	33.4	64091	64531	66984	195606	0.95
10:48:00 AM	408.9	413.4	411.5	283.5	289.7	292.3	33.9	64199	64328	66361	194887	0.95
10:49:00 AM	410.9	415.3	413.5	280.4	287.6	290.4	32.6	63625	63899	66088	193613	0.95
10:50:00 AM	413.5	417.5	416.3	273.5	284.9	288.5	30.4	62127	63543	65811	191481	0.94
10:51:00 AM	413.9	418	417.1	272.8	283.4	287	30.3	62059	63161	65519	190739	0.94
10:52:00 AM	414.4	418.4	417.7	273.8	287.1	286.7	30.8	62382	64204	65415	192001	0.94
10:53:00 AM	414.9	418.5	417.7	279.2	287.6	286.5	32.2	63829	64368	65401	193598	0.94
10:54:00 AM	415.2	418.8	418	278	283.6	287.5	30.7	63591	63436	65668	192694	0.94
10:55:00 AM	414.9	418.5	417.7	275.4	279.7	285.3	30.8	62802	62348	65098	190247	0.94
10:56:00 AM	413.6	417.2	416.5	274.1	280.3	285.6	30.9	62328	62378	64996	189702	0.94
10:57:00 AM	412.3	415.8	415	275	284.7	286.4	31.4	62407	63398	65099	190904	0.94
10:58:00 AM	411.9	415.7	414.8	271.7	285.5	283.5	32.8	61599	63455	64243	189297	0.94
10:59:00 AM	411.5	415.4	414.6	266.1	283	282.6	32.7	60166	62675	63775	186616	0.94
11:00:00 AM	411.1	414.9	413.9	267.6	283.1	280.2	33.9	60452	62595	63160	186207	0.94
11:01:00 AM	416.6	420.3	420	270	284.4	277.7	35	61822	63451	63243	188517	0.94
11:02:00 AM	418.2	421.7	421.3	271.7	279.4	281.2	31.2	62449	62631	64249	189329	0.94
11:03:00 AM	419.8	423.2	422.5	270.4	277.2	284.6	29.8	62306	62344	65180	189830	0.94
11:04:00 AM	421.1	424.2	424	265.6	272.4	277.2	29.7	61308	61291	63621	186219	0.93
11:05:00 AM	420.7	424	423.8	269.9	275.5	278.4	30.9	62370	61981	63921	188271	0.94
11:06:00 AM	421.1	424.4	424	268.9	276	278.5	31	62213	62181	64055	188448	0.94
11:07:00 AM	420.1	423.6	423	264.4	273.2	278.1	30.8	61015	61354	63898	186267	0.94
11:08:00 AM	420.5	424.1	423.5	258.4	273.6	277.2	30	59485	61405	63766	184657	0.93
11:09:00 AM	419.5	423.1	422.6	264.6	282.2	284.5	30.7	60676	63297	65276	189250	0.93
11:10:00 AM	416.6	420.2	419.2	269.2	286.3	286.8	31.3	61165	63882	65357	190404	0.93
11:11:00 AM	415.6	419.2	418	271.2	287.6	277.6	34.6	61762	64252	63110	189125	0.94
11:12:00 AM	415.7	419	417.7	278.9	287.2	274.8	37.3	63794	64386	62636	190816	0.94
11:13:00 AM	414.5	417.9	416.3	283.7	291.2	277.7	38.8	64829	65277	63291	193396	0.94
11:14:00 AM	414.8	418.2	416.3	281.8	290.4	280.1	36.3	64290	65160	63864	193314	0.94
11:15:00 AM	414.1	417.8	415.9	273.6	286.2	279.3	33.1	62160	64174	63626	189960	0.94
11:16:00 AM	412.5	416.1	414.9	286.2	307	299.5	34.3	64628	68529	67825	200982	0.94
11:17:00 AM	411.5	415.1	414.2	298.7	321.4	314.2	35.2	67422	71694	71092	210208	0.94
11:18:00 AM	413	416.5	415.4	304.8	324.7	320.1	34.4	69094	72679	72516	214289	0.94
11:19:00 AM	414	417.4	416.1	308.3	323.2	325.8	31.8	70078	72552	74191	216821	0.94
11:20:00 AM	413.8	417.1	415.8	304.3	316.5	323.4	31.8	68969	70716	73551	213236	0.94
11:21:00 AM	413.8	416.7	415.8	295.2	309	320.5	33.2	66561	68804	72704	208069	0.94
11:22:00 AM	413.7	416.4	415.2	303.5	308.9	319.3	32.3	68603	68763	72416	209782	0.94
11:23:00 AM	413.4	416.2	415	302.4	311.3	315.4	31.7	68324	69309	71393	209026	0.94
11:24:00 AM	412.7	415.8	414.7	303.2	313.6	314.9	33.1	68717	69757	71219	209693	0.94

Table-4.2: Energy Parameters except THD

Name	Date	Time	AVG	MIN	MAX	Units	Duration	Units
A1 rms	7/27/2022	10:25:00 AM	292.7	199.5	362.0	A	1:00:00	(h:min:s)
A2 rms	7/27/2022	10:25:00 AM	301.5	197.0	390.5	A	1:00:00	(h:min:s)
A3 rms	7/27/2022	10:25:00 AM	301.8	243.5	376.5	A	1:00:00	(h:min:s)
AN rms	7/27/2022	10:25:00 AM	33.51	29.10	41.40	A	1:00:00	(h:min:s)

Table-4.3: Current Profile

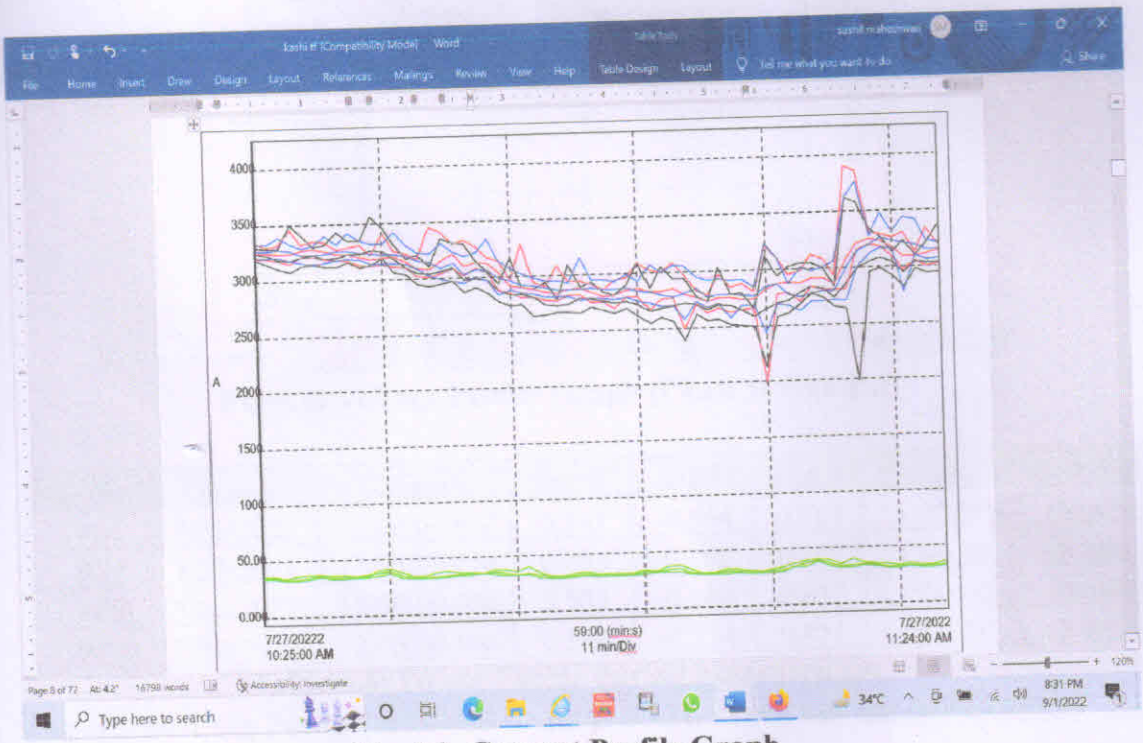


Fig-4.3: Current Profile Graph

From Table-4.3, it is observed that Load on all the three phases is almost balanced.

Name	Date	Time	AVG	MIN	MAX	Units	Duration	Units
U12 rms	7/27/2022	10:25:00 AM	412.5	392.6	423.9	V	1:00:00	(h:min:s)
U23 rms	7/27/2022	10:25:00 AM	416.1	401.2	427.2	V	1:00:00	(h:min:s)
U31 rms	7/27/2022	10:25:00 AM	415.0	384.4	426.7	V	1:00:00	(h:min:s)

Table-4.4: Voltage Profile (Phase to Phase)

Name	Date	Time	AVG	MIN	MAX	Units	Duration	Units
V1 rms	7/27/2022	10:25:00 AM	238.6	222.1	245.4	V	1:00:00	(h:min:s)
V2 rms	7/27/2022	10:25:00 AM	239.2	233.2	245.6	V	1:00:00	(h:min:s)
V3 rms	7/27/2022	10:25:00 AM	240.1	228.7	247.1	V	1:00:00	(h:min:s)

Table-4.5: Voltage Profile (Phase to Neutral)

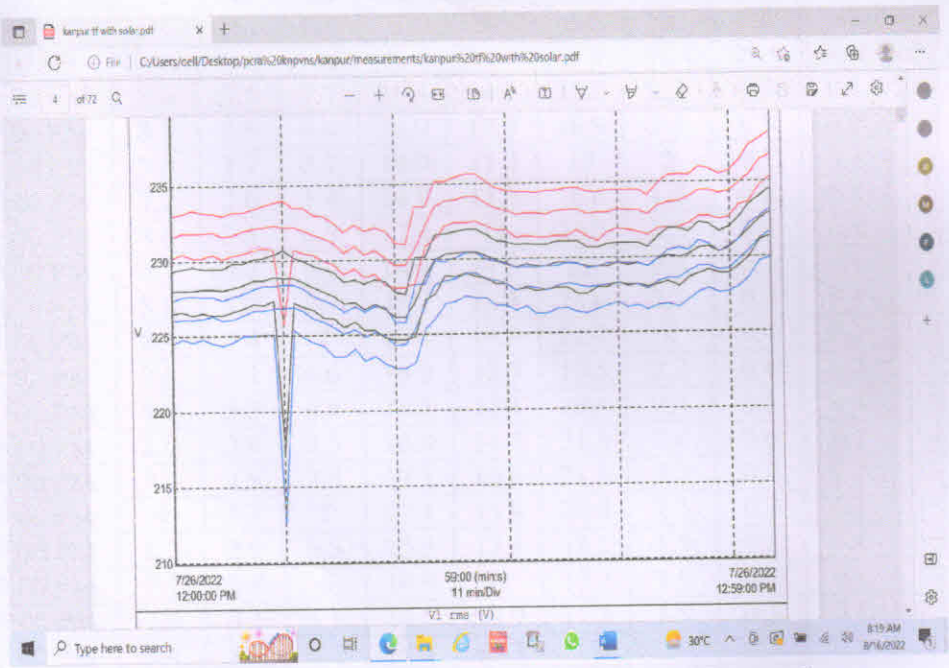


Fig-4.4: Voltage Profile Graph (Phase to Neutral)

Name	Date	Time	AVG	MIN	MAX	Duration	Units
PF1	7/26/2022	12:00:00 PM	0.347	-0.544	0.761	1:00:00	(h:min:s)
PF2	7/26/2022	12:00:00 PM	0.693	0.062	0.867	1:00:00	(h:min:s)
PF3	7/26/2022	12:00:00 PM	0.533	-0.280	0.817	1:00:00	(h:min:s)
PFT	7/26/2022	12:00:00 PM	0.543	-0.224	0.821	1:00:00	(h:min:s)

Table-4.6: Power Factor during Measurement

The instantaneous Power Factor was found as 0.821, which was not satisfactory.

4.3 Harmonic distortion and Total Harmonic Distortion (THD)

The individual current Harmonics distortion have been shown in Table-4.7

Time:	A1 H4	A2 H4	A3 H4	A1 H5	A2 H5	A3 H5	A1 H6	A2 H6	A3 H6	A1 H7	A2 H7	A3 H7
	% f	% f	% f	% f	% f	% f	% f	% f	% f	% f	% f	% f
12:00:00 PM	5.3	2.2	4.1	10.2	9.1	13	1.4	0.1	0	9.4	6.4	8.2
12:01:00 PM	5.7	2.2	4.1	10.8	9.3	13	1.4	0.1	0.1	10.1	6.8	8.4
12:02:00 PM	6.2	2.4	4.5	12	9.9	14.1	1.6	0.2	0	11	7.1	9.1
12:03:00 PM	6.8	2.5	5.1	13.4	10.1	15.5	1.8	0.2	0.1	12.2	7.3	10.4
12:04:00 PM	7.3	2.6	5.5	14.5	10.7	16.5	2	0.3	0.1	13	7.7	11
12:05:00 PM	7.4	2.7	5.5	15.1	11	17	2	0.3	0.1	13.4	7.9	11.2
12:06:00 PM	7.6	2.7	5.5	15.4	11.3	17.7	1.9	0.2	0.1	13.6	7.9	11.4
12:07:00 PM	8.2	2.9	6	17	12.6	19.9	2	0.1	0.2	14.5	8.5	12.1
12:08:00 PM	8.5	3.1	6.5	17.7	12.7	20.2	2.3	0.3	0.2	15.1	8.6	12.7
12:09:00 PM	9.8	3.9	8.1	20.5	16.1	24.7	2.6	0.5	0.3	16.7	10.2	14.5
12:10:00 PM	9.1	3.9	8.2	18.9	16.7	24.2	2.3	0.4	0.1	15.6	11.2	15.1
12:11:00 PM	8.4	4.3	8.1	17.8	19.4	24.9	2	0.4	0.3	13.8	12.3	14.3
12:12:00 PM	7.7	4.5	7.7	16.1	20.2	24.1	1.8	0.4	0.3	12.9	12.8	13.9
12:13:00 PM	8.2	4.4	8	16.5	18.5	23.8	2	0.5	0.2	13.8	12.3	14.2

Time:	A1 H4	A2 H4	A3 H4	A1 H5	A2 H5	A3 H5	A1 H6	A2 H6	A3 H6	A1 H7	A2 H7	A3 H7
	% f	% f	% f	% f	% f	% f	% f	% f	% f	% f	% f	% f
12:14:00 PM	9.6	3.5	7.7	19.4	14.7	23.2	2.3	0.3	0.1	16.5	10	14
12:15:00 PM	8.5	2.9	6.4	16.9	12.2	18.9	2.1	0.3	0.1	14.6	8.4	12.1
12:16:00 PM	7.6	2.7	5.7	14.9	11.2	17	2	0.3	0.1	13.5	7.9	11.4
12:17:00 PM	7.2	2.6	5.4	14.8	11.2	16.6	1.8	0.2	0.1	13	7.6	10.8
12:18:00 PM	8.6	3.4	6.9	17.4	14	20.9	2.3	0.4	0.1	15.4	9.6	13.1
12:19:00 PM	8.9	3.3	7.2	18.4	14.3	22	2.3	0.3	0.1	15.9	10	13.7
12:20:00 PM	8.8	3.7	7.7	18.2	16.1	23.6	2.1	0.4	0.1	15.2	11.2	14.5
12:21:00 PM	8.4	3.4	7	17.4	14.9	21.7	2	0.4	0.1	14.2	9.9	12.8
12:22:00 PM	8.6	3.1	6.6	16.9	12.7	19.5	2.2	0.4	0.2	15.2	9.2	12.6
12:23:00 PM	8.9	3.2	6.8	16.7	12.1	19.4	2.4	0.5	0.4	15.1	9	12.6
12:24:00 PM	8.9	3.8	7.5	16.9	14.7	21.8	2.4	0.6	0.3	14.9	10.2	13.6
12:25:00 PM	9.3	3.5	7.5	17.2	14.6	21.6	2.3	0.4	0.2	15.7	10.2	13.9
12:26:00 PM	9	3.3	7	17.1	13.9	20.4	2.1	0.3	0.1	15.5	9.9	12.5
12:27:00 PM	8.3	2.9	6.3	15.5	12.4	18.5	1.9	0.2	0.1	13.9	8.7	11.3
12:28:00 PM	7.7	2.9	6	14.9	12	17.2	1.9	0.2	0.1	13.4	8.5	10.7
12:29:00 PM	7.9	3.3	6.1	14.6	12.9	17.2	1.8	0.3	0.1	13.5	9.3	10.7
12:30:00 PM	8.4	3.5	6.2	15.7	13.3	17	2	0.3	0.1	14	9.4	10.6
12:31:00 PM	7.9	3.3	5.5	15.4	13.2	16.2	1.8	0.2	0	13.1	8.7	9.5
12:32:00 PM	7.5	3	5.2	14	12.1	15.4	1.8	0.2	0	12.5	8.4	9.5
12:33:00 PM	7	2.8	5.1	13.1	11.9	14.8	1.7	0.3	0.1	11.7	8.1	9
12:34:00 PM	6.4	2.6	5	12.2	11.4	14.4	1.5	0.3	0.1	10.8	7.6	9
12:35:00 PM	6.1	2.6	4.9	11.7	11	14	1.4	0.3	0.1	10.5	7.8	8.9
12:36:00 PM	6	2.5	4.8	11.5	11.1	14.1	1.4	0.3	0	10.4	7.9	9
12:37:00 PM	5.9	2.5	4.7	11.2	11.2	14	1.4	0.3	0.1	10.5	7.7	8.7
12:38:00 PM	6.6	2.7	5.2	13	12.5	15.7	1.5	0.2	0.1	11.8	8.5	9.4
12:39:00 PM	8.1	3.1	5.8	15	13.9	17.9	1.7	0.3	0.2	13.7	9.6	10.9
12:40:00 PM	6.7	2.7	5.1	13	12.2	15.5	1.5	0.2	0.1	11.7	8.5	9.5
12:41:00 PM	6.6	2.6	5.1	12.8	11.8	15	1.6	0.2	0.1	11.3	8.3	9.4
12:42:00 PM	7.3	2.9	5.7	14.1	12.3	16	1.8	0.3	0	12.7	8.9	10.2
12:43:00 PM	7.5	3.1	6	14.3	12.4	16.9	1.8	0.3	0.1	12.9	9.2	10.8
12:44:00 PM	7.5	2.9	6	14.2	12.3	17.2	1.8	0.2	0.1	13	8.8	11
12:45:00 PM	7.3	2.7	5.5	13.8	11.9	16.3	1.7	0.2	0.2	12.4	8.5	10.4
12:46:00 PM	7.2	2.7	5.3	14.3	12.6	16.2	1.7	0.2	0.2	12.7	8.6	10.2
12:47:00 PM	7.8	2.9	5.7	15	13.1	17	1.9	0.2	0.1	13.5	9	10.8
12:48:00 PM	9.8	4.6	8.1	20	19.4	24.3	2.3	0.5	0.2	16.8	12.8	14.2
12:49:00 PM	9.5	4.8	8.5	19.2	20.6	24.9	2.2	0.6	0.2	16.7	13.6	14.9
12:50:00 PM	9.2	4.9	8.4	18.3	21.3	25.3	2.1	0.6	0.2	16.1	13.8	14.9
12:51:00 PM	8.4	5.1	8.5	17.1	22.1	25.1	1.9	0.5	0.2	14.7	14.8	15
12:52:00 PM	8.2	5.1	8.6	16.8	22.5	24.6	1.8	0.4	0.2	14.4	15.2	15
12:53:00 PM	9.6	4.9	8.8	18.8	21.2	25.1	2.1	0.6	0.2	16.8	14.3	15.7
12:54:00 PM	9.8	4.2	7.6	19.2	17.2	21.6	2.2	0.5	0.1	17.2	12.2	13.7
12:55:00 PM	9	3.7	6.8	17.5	15.3	19.3	2.1	0.5	0.2	15.8	10.7	12.5
12:56:00 PM	9.2	3.6	7	17.8	15.3	20.1	2.1	0.4	0.1	15.9	10.4	12.9
12:57:00 PM	9.6	3.9	7.5	18.2	16.4	21.9	2	0.3	0.2	16.5	10.9	13.4
12:58:00 PM	10.2	4.6	8.1	19	18.7	24.1	2	0.3	0.3	17.3	12.1	14
12:59:00 PM	9.6	3.9	7.2	17.3	15.3	19.9	2	0.4	0.1	16.6	10.6	12.4

Table-4.7: Individual current Harmonics distortion

From Table-4.7, it is observed that individual current Harmonics are highest at 5th Harmonics.

Total Harmonic Distortion (THD) have been tabulated in Table-4.8.

Time:	V1 THDf	V2 THDf	V3 THDf	U12 THDf	U23 THDf	U31 THDf	A1 THDf	A2 THDf	A3 THDf
	% f	% f	% f	% f	% f	% f	% f	% f	% f
12:00:00 PM	0.7	0.9	0.9	0.8	0.9	0.8	16.9	13.1	17.1
12:01:00 PM	0.7	0.8	0.8	0.7	0.9	0.7	18.2	13.6	17.2
12:02:00 PM	0.7	0.9	0.9	0.7	0.9	0.7	20	14.4	18.5
12:03:00 PM	0.7	0.9	0.9	0.8	0.9	0.8	22.2	14.7	20.7
12:04:00 PM	0.7	0.9	0.9	0.8	0.9	0.8	23.8	15.6	22.1
12:05:00 PM	0.8	0.9	0.9	0.8	0.9	0.8	24.6	15.7	22.5
12:06:00 PM	0.8	0.9	0.9	0.8	0.9	0.8	25.2	16.1	23.2
12:07:00 PM	0.8	0.9	0.9	0.8	0.9	0.9	27.2	17.7	25.6
12:08:00 PM	0.8	0.9	0.9	0.8	0.9	0.8	28.3	17.8	26.5
12:09:00 PM	0.8	0.9	1	0.9	1	0.9	32.1	22	32
12:10:00 PM	0.8	0.9	0.9	0.8	0.9	0.8	29.9	23.2	32
12:11:00 PM	0.8	1	1	0.9	1	0.9	27.4	26.8	32
12:12:00 PM	0.8	1	1	0.9	1	0.9	24.9	27.8	31
12:13:00 PM	0.7	0.9	0.9	0.8	0.9	0.8	26.3	26.2	31.1
12:14:00 PM	0.7	0.9	0.8	0.7	0.9	0.7	31.1	20.7	30.1
12:15:00 PM	0.8	0.9	0.9	0.8	1	0.8	27.3	17.4	24.9
12:16:00 PM	0.7	0.9	0.9	0.8	0.9	0.8	24.6	16.1	22.6
12:17:00 PM	0.8	0.9	0.9	0.8	0.9	0.8	23.8	16.5	21.9
12:18:00 PM	0.8	0.9	0.9	0.8	1	0.8	28.2	20.3	27.4
12:19:00 PM	0.8	0.9	0.9	0.8	0.9	0.8	29.4	20.6	28.8
12:20:00 PM	0.8	0.9	0.9	0.8	1	0.8	28.9	23.4	30.7
12:21:00 PM	0.9	1	1.1	0.9	1.1	1	27.3	21.4	27.9
12:22:00 PM	0.8	0.9	0.9	0.8	0.9	0.8	27.7	18.7	25.9
12:23:00 PM	0.7	0.9	0.9	0.8	1	0.8	27.9	18.2	25.9
12:24:00 PM	0.8	1	1.1	0.9	1.1	0.9	28	22.7	28.8
12:25:00 PM	0.6	0.8	0.8	0.7	0.9	0.7	29	22.1	28.8
12:26:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	28.6	20.2	26.8
12:27:00 PM	0.6	0.7	0.8	0.6	0.8	0.6	25.8	17.7	24.3
12:28:00 PM	0.6	0.7	0.8	0.6	0.8	0.6	24.7	17.2	22.7
12:29:00 PM	0.6	0.7	0.8	0.6	0.8	0.6	24.6	18.8	22.8
12:30:00 PM	0.7	0.8	0.9	0.7	0.9	0.8	26.1	19.4	22.6
12:31:00 PM	0.7	0.9	1	0.7	0.9	0.8	24.8	18.7	21.1
12:32:00 PM	0.7	0.9	0.9	0.7	0.9	0.8	23	17.5	20.2
12:33:00 PM	0.6	0.9	1	0.7	1	0.8	21.6	17.9	19.5
12:34:00 PM	0.6	0.9	0.9	0.7	1	0.8	20.1	17.4	19
12:35:00 PM	0.6	0.8	0.8	0.6	0.8	0.7	19.2	16	18.6
12:36:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	19	16.6	18.8
12:37:00 PM	0.6	0.8	0.8	0.6	0.8	0.7	18.8	16.5	18.4
12:38:00 PM	0.6	0.8	0.9	0.6	0.9	0.7	21.4	18.1	20.5
12:39:00 PM	0.6	0.8	0.8	0.7	0.9	0.7	25.2	20.9	23.5
12:40:00 PM	0.6	0.8	0.8	0.6	0.8	0.7	21.5	18.5	20.4
12:41:00 PM	0.6	0.8	0.8	0.6	0.8	0.7	21	17.8	19.9
12:42:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	23.2	18	21.3
12:43:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	23.6	18.3	22.7

Time:	V1 THDf	V2 THDf	V3 THDf	U12 THDf	U23 THDf	U31 THDf	A1 THDf	A2 THDf	A3 THDf
	% f	% f	% f	% f	% f	% f	% f	% f	% f
12:44:00 PM	0.6	0.8	0.8	0.6	0.8	0.6	23.8	18.4	22.9
12:45:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	23	17.8	21.6
12:46:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	23.4	18.8	21.3
12:47:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	24.7	19.5	22.4
12:48:00 PM	0.8	0.9	1	0.7	1	0.8	31.7	26.9	31.5
12:49:00 PM	0.6	0.8	0.8	0.7	0.8	0.7	30.9	28.7	32.7
12:50:00 PM	0.6	0.8	0.8	0.7	0.8	0.7	29.6	29.6	33.1
12:51:00 PM	0.7	0.8	0.8	0.7	0.8	0.7	27.2	31.3	33.1
12:52:00 PM	0.6	0.7	0.8	0.6	0.8	0.6	26.8	33	32.7
12:53:00 PM	0.6	0.8	0.8	0.7	0.8	0.6	30.8	33	33.5
12:54:00 PM	0.6	0.7	0.8	0.6	0.8	0.7	31.4	24.6	28.7
12:55:00 PM	0.6	0.7	0.7	0.6	0.7	0.6	28.7	22.3	25.9
12:56:00 PM	0.6	0.7	0.7	0.6	0.8	0.6	29.4	23.1	26.8
12:57:00 PM	0.6	0.7	0.7	0.6	0.7	0.6	30.3	24.1	28.9
12:58:00 PM	0.6	0.7	0.7	0.6	0.7	0.6	31.7	26.3	31.4
12:59:00 PM	0.5	0.7	0.6	0.6	0.7	0.5	29.9	22.8	26.6

Table-4.8: Total Harmonic Distortion (THD) of 1000 KVA Transformer

The abstract of Current and Voltage THD have been shown in Table-4.9.

Name	Date	Time	AVG	MIN	MAX	Units	Duration	Units
A1 THDf	7/26/2022	12:00:00 PM	25.76	16.90	32.10	% f	1:00:00	(h:min:s)
A2 THDf	7/26/2022	12:00:00 PM	20.48	13.10	33.00	% f	1:00:00	(h:min:s)
A3 THDf	7/26/2022	12:00:00 PM	25.19	17.10	33.50	% f	1:00:00	(h:min:s)
U12 THDf	7/26/2022	12:00:00 PM	0.707	0.600	0.900	% f	1:00:00	(h:min:s)
U23 THDf	7/26/2022	12:00:00 PM	0.873	0.700	1.100	% f	1:00:00	(h:min:s)
U31 THDf	7/26/2022	12:00:00 PM	0.738	0.500	1.000	% f	1:00:00	(h:min:s)
V1 THDf	7/26/2022	12:00:00 PM	0.678	0.500	0.900	% f	1:00:00	(h:min:s)
V2 THDf	7/26/2022	12:00:00 PM	0.827	0.700	1.000	% f	1:00:00	(h:min:s)
V3 THDf	7/26/2022	12:00:00 PM	0.857	0.600	1.100	% f	1:00:00	(h:min:s)

Table-4.9: THD Profile

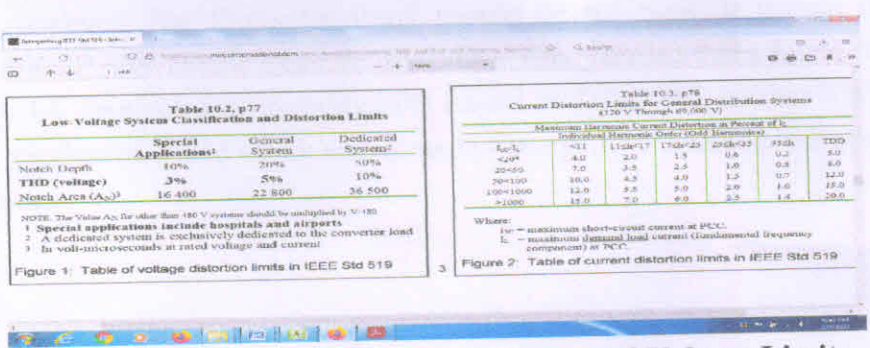


Fig-4.5: Recommended Harmonic Current &Voltage Limits

4.4 Installation of Harmonic Filters

The value of (*I*SC/*I*L) can be taken as 50<100) in Table of Fig-4.5 for current Distortion. The maximum individual harmonics as per Table-4.8 were found at 5th order. The measured Maximum Current harmonics of all the three phases were 32.1% to 33.5% as shown in Table-4.10, which, are not in limit of 10% as per IEE Std 519-2014, followed in India. It is recommended to install Harmonic Filters in consultation of any Harmonic Expert.

4.5 Installed Capacity & Performance of Capacitors Banks

Installed Capacity, rated performance and actual performance of Capacitors installed in the Institute are shown in Table-as per Manufacturer on 440 V is as per Table- 4.10.

Sr No	Capacity of each capacitor (KVAR)	Rated current at rated voltage of 440 volts (A)	Interpolated Voltage at actual voltage 415 Volts (A)	Actual Current measured (A)			Remarks
				R	Y	B	
1	25	32.8	30.94	9.6	2	0.05	Not OK
2	25	32.8	30.94	26.5	14	14.8	Partly working
3	25	32.8	30.94				
4	25	32.8	30.94				
5	25	32.8	30.94				
6	20	26.2	24.71	17.1	0	19.5	Not OK
7	10	13.14	12.39				
8	7.5	9.8	9.24	7.3	7.2	0.1	Not OK
9	15	19.71	18.59				
10	4	5.256	4.96				
11	2	2.628	2.48				
12	1	1.314	1.24				
	184.5						

Table-4.10: Installed Capacity & Performance of Capacitors installed

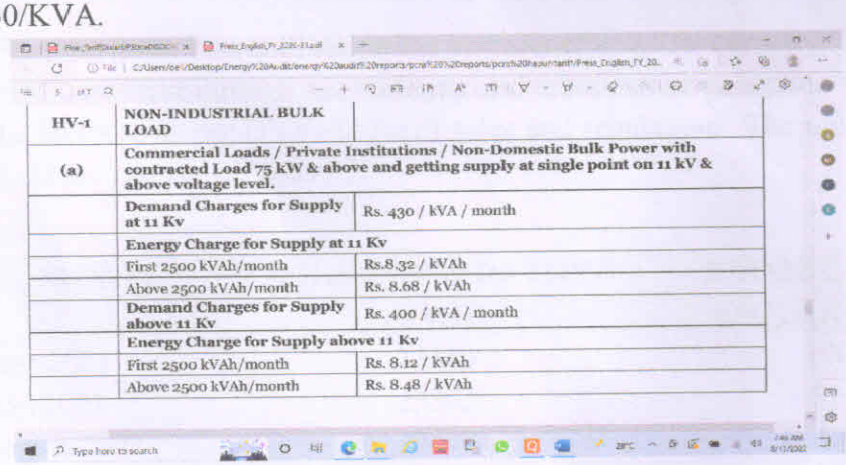
Total capacity of Capacitor Bank is 184.5 KVAR. Performance of only few capacitors which were in circuit could be checked. It could not be checked for all capacitors because Incoming penal of second Bank was not working and also Manual switch of Capacitors was not working. The Capacitor Bank should be set right. It should be noted that instantaneous Power Factor measures by Power Analyzer has been found 0.821 (low) as per Table-4.6. In electricity monthly bills issued by DISCOM, neither KWH nor Power Factor is mentioned due to which assessment of energy loss/ revenue loss of the Institution can be done.

CHAPTER-5

REVIEW OF ELECTRICITY BILLS, CONTRACT DEMAND

5.1 Electrical Energy Consumption from Grid

The power is supplied to KIT, Varanasi by Purvanchal Vidyut Vitran Nigam. The Tariff applicable for KIT, Varanasi is under HV-1 category and shown in Fig-5.1. The fixed charges are Rs 8.12 to 8.48 per KVAH depending upon consumption and Demand charges are Rs 430/KVA.



HV-1	NON-INDUSTRIAL BULK LOAD	
(a)	Commercial Loads / Private Institutions / Non-Domestic Bulk Power with contracted Load 75 kW & above and getting supply at single point on 11 kV & above voltage level.	
	Demand Charges for Supply at 11 Kv	Rs. 430 / kVA / month
	Energy Charge for Supply at 11 Kv	
	First 2500 kVAh/month	Rs.8.32 / kVAh
	Above 2500 kVAh/month	Rs. 8.68 / kVAh
	Demand Charges for Supply above 11 Kv	Rs. 400 / kVA / month
	Energy Charge for Supply above 11 Kv	
	First 2500 kVAh/month	Rs. 8.12 / kVAh
	Above 2500 kVAh/month	Rs. 8.48 / kVAh

Fig-5.1: Tariff applicable for Institute

5.2 Grid Energy Consumption

Grid Energy Consumption for year 2021 – 2022 have been tabulated in Table-5.1.

Sr No	Month	Elect. Consumption (Grid) (KWH)	Export (Solar) (KWH)	Max Demand (KVA)	Chargeable Demand (KVA)	Power Factor
1	June-2021	12104	10680	NA	NA	NA
2	July-2021	31380	3928	NA	NA	NA
3	August-2021	35120	4148	NA	NA	NA
4	September-2021	26216	1812	NA	NA	NA
5	October-2021	35088	2216	288.1	288.1	0.98
6	November-2021	35764	4064	NA	NA	NA
7	December-2021	39924	4064	NA	210	NA
8	January-2022	15520	552	NA	210	NA
9	February-2022	13104	5284	NA	210	NA
10	March-2022	19716	10072	NA	210	NA
11	April-2022	46488	3876	263.5	263.5	NA
12	May-2022	52348	2472	392.8	392.8	NA
	Total	**327652**	**53168**	**944.4**	**1784.4**	

Table-5.1: Grid Energy Consumption Year 2021-22

Note: Bill of May/ June was issued jointly. As such 50% consumption and solar export shown in bill has been considered in May 2022

From Table-5.1, among the data provided by the institute, it is observed that while the Contract Load is 280 KVA, the actual maximum demand recorded throughout the year was 210 KVA in winter season but in summer season it reached to 392.8 KVA (under penalty). Decision on contract demand increase can be taken only after receipt of full year data. Monthly reading slips of Electricity Meter were not available in the Institute.

5.3 Non-Conventional Electrical Energy Source

There is Rooftop Solar Power Plants in the institute of 215 KW capacity. The Solar Plant is connected with Grid through net metering and extra Power generated is accounted in bills of the Institute as per DVVNL Tariff rules and regulations. The units generated in year 2021-22 are shown in Table-5.2.

S. NO.	MONTH	SOLAR GENERATION (KWH)	EXPORT TO GRID (SOLAR) (KWH)
1	June-2021	24180	10680
2	July-2021	23302	3928
3	August-2021	22447	4148
4	September-2021	21875	1812
5	October-2021	17111	2216
6	November-2021	15970	4064
7	December-2021	13221	4064
8	January-2022	13402	552
9	February-2022	21133	5284
10	March-2022	23676	10072
11	April-2022	23707	3876
12	May-2022	26139	2472
	Total	**246163**	**53168**

Table-5.2: Solar Power Generation of Year 2021-22

From Table-5.2, it is being observed that in year 2021-22, 53168 units were exported to grid at negligible cost. Attempt should be made to utilize these units by running non scheduled load such as pumps during 7 AM to 2 PM.

5.4 Total Electrical Power Consumption

The total Electrical power consumption (Grid+ Solar) for year 2021 & 2022 has been shown in Table-5.3.

Sl. No.	Month	Electy. Consumption (Grid) (KWH)	Total Solar Generation (KWH)	Export (Solar) (KWH)	Total Electy Consumption (KWH)
1	June-2021	12104	24180	10680	25604
2	July-2021	31380	23302	3928	50754
3	August-2021	35120	22447	4148	32904
4	September-2021	26216	21875	1812	46279
5	October-2021	35088	17111	2216	49983
6	November-2021	35764	15970	4064	47670
7	December-2021	39924	13221	4064	49081
8	January-2022	15520	13402	552	28370
9	February-2022	13104	21133	5284	28953
10	March-2022	19716	23676	10072	31496
11	April-2022	46488	23707	3876	33351
12	May-2022	52348	26139	2472	68751
	Total	**327652**	**246163**	**53168**	**460292**

Table-5.3: Total Electrical Power Consumption for Year 2021-2022

The total consumption of joint Connection with Kashi Institute of Pharmacy is 460292 KW per year. Assuming Diversity factor as 0.5, the electricity consumption of Kashi Institute of Pharmacy (connected Load 67.5 KW) based on 300 working days and 9 Hrs working basis can be assumed as 91125 units. As such electricity consumption of Kashi Institute of Technology can be taken as 369167 per year.

CHAPTER-6

DETAILS OF MAJOR EQUIPMENT CONNECTED WITH SYSTEM

6.1 Contract Load:

The contract load of the Institute is 280 KVA.

6.2 Connected Load of Electrical Appliances

Sl. No.	Name of Item	Capacity (W)	Total Nos.	Connected Load (KW)
1	Plug in fluorescent Lamps 36X2	72	929	66.89
2	LED Lamps	12	210	2.52
		9	657	5.91
3	Tube light	36	1833	65.99
4	LED Tube light	18	30	0.54
5	Pole Lights Halogen	250	5	1.25
6	LED Pole Lights (street)	60	26	1.56
7	Wall Fans	40	201	8.04
8	Ceiling Fan (no regulators)	60	1325	79.50
9	Exhaust Fan 9 inch	100	16	1.60
10	**Air Conditioners 1.5 Tons**			
	Window	1700	16	27.20
	Split	1500	22	33.00
11	**Packaged Air Conditioners**			
	5.5 T	6050	51	308.55
	8.5 T	9350	2	18.70
	11 T	12100	4	48.40
12	Desert Coolers	500	14	7.00
13	Computer system	150	1222	183.30
14	Printers	450	27	12.15
15	Photocopier	500	3	1.50
16	Room Heaters (geyser)	2000	123	246.00
17	Refrigerator	575	19	10.93
18	Projectors	800	12	9.60
19	Motors 3 HP	2205	1	2.21
20	Motors 5 HP	3730	4	14.92
21	Fire Motors 5 HP	3730	5	18.65
Grand Total				**1175.90**

Table-6.1: Connected Load of Electrical Appliances

The total connected load was found 1175.90 KW including Air conditioning load. As such Contract load of 280 KVA is on lower side using Diversity factor as 0.6. In summer season, penalty is being imposed by PuVVNL (DISCOM). In winter season excess money is being paid as demand charges due to lower demand.

CHAPTER-7

LIGHTING AND ILLUMINATION

7.1 Lighting Load

Following are the Lighting Load details of luminaries installed in the Institute Premises

Sl. No	Name of Item	Capacity (W)	Total Nos.	Connected Load (KW)
1	Plug in Fluorescent Lamps 36X2	72	929	66.89
2	LED Lamps	12	210	2.52
	LED Lamps	9	657	5.91
3	Tube light	36	1833	65.99
4	LED Tube light	18	30	0.54
5	Pole Lights Halogen	250	5	1.25
6	LED Pole Lights (street)	60	26	1.56

Table-7.1: Lighting Load

7.2 Illumination Levels

The Lux levels measured at various places have been shown in Table-7.2

Sr No	Particulars	Lux Level	Sr No	Particulars	Lux Level
1	C R C Admission Room	145	30	Boy's Hostel guest room	73
2	Chairman's Office	161	31	Room no 19	84
3	CRC 4th floor room no 2	70	32	Gallery Boy's Hostel 1 st floor	54
4	4 th floor room dining hall	128	33	Room no 117	67
5	Academic Block A	204	34	Room no 213 2nd floor	60
6	L R I 02	83	35	Gallery Boy Hostel 2nd floor	64
7	L R I 01	77	36	Room no 317	91
8	Chemistry lab	165	37	Gyatri Hostel guest room	97
9	Examination control room	99	38	Gyatri Hostel gallery ground floor	41
10	Faculty room	160	39	Room no 008	56
11	LRA 304	167	40	Room no 011	65
12	Toilet A Block	88	41	Room no 14	74
14	Library	54	42	Room No 110	46
15	Computer lab	68	43	Room no 103	61
16	L RB 107 B block	141	44	Gallery 2nd floor	36
17	Civil department HOD	43	45	Room no 106	62
18	Faculty room B block	72	46	**Street Light (Night Time)**	
19	Canteen	95	47	CRC Block	15

Sr No	Particulars	Lux Level	Sr No	Particulars	Lux Level
20	Mess	147	48	Near Canteen	18
21	Store room	69	49	Near Pharma building	10
22	EV 789	51	50	Near Boy hostel	15
23	CC Room no 438	148	51	Near K I S L 2	21
24	E V 2 LAB 1	94	52	Near E V 9	22
25	E V3 LAB 2	79	53	Near Block A	9
26	E V 4 Server room	144	54	Near Mandir	20
27	E V 4 U P S room	92	55	Near Girl's hostel	10
28	ECEN room	51	56	Inside Main Gate	19
29	Computer HOD room B block	183	57	Outside Main gate	24

Table-7.2: Lux Levels of various Places

7.3 EE Measure

It has been observed that 36 W FTL (1833 nos.) are installed in the Institute, which can be replaced by 20 W LED Tube Light.

Sr No	Particulars	Quantity	Unit
1	Total nos. of FTLs of 36 W capacity	1833	Nos.
2	Cost of 20 W LED Tube light@ Rs 300 per LED Tube lite	549900	Rs
3	Energy saved by replacing 36 W FTLs by 20 W LED Tube light @ 16 watts for 8 hours/day and 300 days per year	70387.2	KWH
4	Cost of electricity savings per year @ Rs 8.5 per unit	598291.2	Rs
5	**Payback period (Year)**	**0.92**	**Years**

Table-7.3: Pay Back Calculations for replacement of Traditional Tube lights to LED Tube light

CHAPTER-8

DG SETS

8.1 Specifications of DG Sets

DG sets of the specifications as per Table-8.1 are installed in the Premises

S. No.	Make	Rating (KVA)	Stand by or Continuous operation
1	Jackson-Cummins	62.5	STAND BY
2	Jackson-Cummins	125	STAND BY
3	Jackson-Cummins	320	STAND BY

Table-8.1: Specifications of DG Sets

Fig-8.1: DG Set 320 KVA

8.2 Running hours and Diesel consumption for Year 2021-22

DG Set No	Capacity (KVA)	Month/Year 2022	Running Hrs	Diesel Consumption (Litres)	Diesel Consumption/ Hour
1	62.5	May	9.2	93	10.11
2	62.5	June	8.15	83	10.18
3	125	May	35.2	707	20.09
4	125	June	20.2	407	20.15
5	320	May	10.35	794	76.71
6	320	June	23.5	1670	71.06
Total running hours of all Gen set during May & June 2022			**106.6**	**3754**	**35.22**

Table-8.2: Running Hours and Diesel Consumption of DG Sets

Average running Hours per day of all DG Sets:1.78 Hr., which are very less.

8.3 Performance Test of DG Set

As the running Hours per day of DG sets are very less, performance evaluation is not necessary. However, DG Set of 320 KVA capacity was chosen for Performance Test and was run for 58 minutes from 12.08 PM to 13.08 PM on dated 27.07.2022 and Diesel consumption was noted. Units produced along with load were recorded, which have been tabulated in Table-8.3.

Date:	Time:	EpT (Wh)
7/27/2022	12:08:00 PM	0
7/27/2022	12:09:00 PM	2425
7/27/2022	12:10:00 PM	4842
7/27/2022	12:11:00 PM	7324
7/27/2022	12:12:00 PM	9815
7/27/2022	12:13:00 PM	12409
7/27/2022	12:14:00 PM	15198
7/27/2022	12:15:00 PM	18061
7/27/2022	12:16:00 PM	21373
7/27/2022	12:17:00 PM	24540
7/27/2022	12:18:00 PM	27642
7/27/2022	12;19:00 PM	30859
7/27/2022	12:20:00 PM	33833
7/27/2022	12:21:00 PM	36734
7/27/2022	12:22:00 PM	39696
7/27/2022	12:23:00 PM	42821
7/27/2022	12:24:00 PM	45979
7/27/2022	12:25:00 PM	49040
7/27/2022	12:26:00 PM	51935
7/27/2022	12:27:00 PM	54660
7/27/2022	12:28:00 PM	57370
7/27/2022	12:29:00 PM	60151

Date:	Time:	EpT (Wh)
7/27/2022	12:30:00 PM	63145
7/27/2022	12:31:00 PM	65846
7/27/2022	12:32:00 PM	68402
7/27/2022	12:33:00 PM	71390
7/27/2022	12:34:00 PM	74361
7/27/2022	12:35:00 PM	77411
7/27/2022	12:36:00 PM	80740
7/27/2022	12:37:00 PM	84715
7/27/2022	12:38:00 PM	88647
7/27/2022	12:39:00 PM	92625
7/27/2022	12:40:00 PM	96691
7/27/2022	12:41:00 PM	100775
7/27/2022	12:42:00 PM	104885
7/27/2022	12:43:00 PM	108984
7/27/2022	12:44:00 PM	113121
7/27/2022	12:45:00 PM	117151
7/27/2022	12:46:00 PM	121004
7/27/2022	12:47:00 PM	124819
7/27/2022	12:48:00 PM	128600
7/27/2022	12:49:00 PM	132364
7/27/2022	12:50:00 PM	136174
7/27/2022	12:51:00 PM	140077
7/27/2022	12:52:00 PM	144087
7/27/2022	12:53:00 PM	146924
7/27/2022	12:54:00 PM	149768
7/27/2022	12:55:00 PM	152443
7/27/2022	12:56:00 PM	154944
7/27/2022	12:57:00 PM	157360
7/27/2022	12:58:00 PM	159940
7/27/2022	12:59:00 PM	162421
7/27/2022	1:00:00 PM	165305
7/27/2022	1:01:00 PM	167961
7/27/2022	1:02:00 PM	170626
7/27/2022	1:03:00 PM	173571
7/27/2022	1:04:00 PM	176732
7/27/2022	1:05:00 PM	179875
7/27/2022	1:06:00 PM	182952
7/27/2022	1:07:00 PM	186052
7/27/2022	1:08:00 PM	189201

Table-8.3: Energy Parameters recorded by Power Analyzer

From Table-8.3, Unit produced during 60 minutes time are 189201 WH i. e. 189.201 kWh

The Diesel consumption was 52.5 Liters.

Name	Date	Time	AVG	MIN	MAX	Units	Duration	Units
D1 (var)	7/27/2022	12:08:00 PM	7.132	5.919	9.144	kvar	1:00:00	(h:min:s)
D2 (var)	7/27/2022	12:08:00 PM	8.257	7.176	9.799	kvar	1:00:00	(h:min:s)
D3 (var)	7/27/2022	12:08:00 PM	8.034	6.845	9.903	kvar	1:00:00	(h:min:s)
DT (var)	7/27/2022	12:08:00 PM	23.72	20.41	29.01	kvar	1:00:00	(h:min:s)
P1 (W)	7/27/2022	12:08:00 PM	64.43	46.94	86.54	kW	1:00:00	(h:min:s)
P2 (W)	7/27/2022	12:08:00 PM	63.97	49.01	81.79	kW	1:00:00	(h:min:s)
P3 (W)	7/27/2022	12:08:00 PM	60.80	44.52	80.86	kW	1:00:00	(h:min:s)
PT (W)	7/27/2022	12:08:00 PM	189.2	145.0	248.2	kW	1:00:00	(h:min:s)

Fig-8.4: Load Parameters recorded by Power Analyzer

Name	Date	Time	AVG	MIN	MAX	Units	Duration	Units
PF1	7/27/2022	12:08:00 PM	0.849	0.773	0.916		1:00:00	(h:min:s)
PF2	7/27/2022	12:08:00 PM	0.843	0.783	0.911		1:00:00	(h:min:s)
PF3	7/27/2022	12:08:00 PM	0.834	0.769	0.894		1:00:00	(h:min:s)
PFT	7/27/2022	12:08:00 PM	0.842	0.779	0.907		1:00:00	(h:min:s)

Fig-8.5: Power Factor recorded during Test

From Fig-8.4, the average load recorded by Power analyzer was 189.2 KW and from Fig-8.5, Average Power factor was 0.907, which means load of 208.6 KVA. As such percentage loading of Genset is 208.6/320*100= 65.2%.

Specific Fuel Consumption= 60/190.457=0.315 Liters/KWH

Also, the Specific Fuel Consumption of DG set is satisfactory. It is less than to 0.335 for 320*0.65=240 KVA as per Fig-8.6 (Ref. Table 9.5, page 176, Book 3 BEE Sr No 16) for equivalent capacity.

TABLE 8.5TYPICAL FORMAT FOR DG SET MONITORING

DG Set No.	Electricity Generating Capacity (Site), kW	Derated Electricity Generating Capacity, kW	Type of Fuel used	Average Load as % of Derated Capacity	Specific Fuel Cons. Lit/kWh	Specific Lube Oil Cons. Lit/kWh
1.	480	300	LDO	89	0.335	0.007
2.	480	300	LDO	110	0.334	0.024
3.	292	230	LDO	84	0.356	0.006
4.	200	160	HSD	89	0.325	0.003
5.	200	160	HSD	106	0.338	0.003
6.	200	160	HSD			
7.	292	230	LDO	79	0.339	0.006
8.	292	230	LDO	81	0.362	0.005
9.	292	230	LDO	94	0.342	0.003
10.	292	230	LDO	86	0.335	0.006
11.	292	230	LDO	76	0.335	0.005
12.	292	230	LDO	69	0.353	0.006
13	400	320	HSD	75	0.334	0.004
14.	400	320	HSD	65	0.349	0.004
15.	880	750	LDO	85	0.318	0.007
16.	400	320	HSD	70	0.335	0.004
17.	400	320	HSD	80	0.337	0.004
18.	880	750	LDO	78	0.345	0.007
19.	800	640	HSD	74	0.324	0.002
20.	800	640	HSD	91	0.290	0.002
21.	880	750	LDO	96	0.307	0.002
22.	920	800	LDO	77	0.297	0.002

Fig 8.6: Specific Fuel Consumption of DG sets as per BEE for monitoring purpose

CHAPTER-9

HEATING, VENTILATION & AIR-CONDITIONING (HVAC) SYSTEM

9.1 Details of HVAC System

The details of Air conditioning equipment installed in the premises are as per Table-9.1.

Sl. No	Name of Item	Capacity (W)	Total Nos.	Connected Load (KW)
1	**Air Conditioners 1.5 Tons**			
	Window	1700	16	27.20
	Split	1500	22	33.00
2	**Packaged Air Conditioners**			
	5.5 T	6050	51	308.55
	8.5 T	9350	2	18.70
	11 T	12100	4	48.40
Grand Total				**435.85**

Table-9.1 Details of Air Conditioners

9.2 Performance Test

Sr No	Place	Type	Ampere	Voltage	Ton	Year
1	CRC Admission Room	W	8.1	220	1.5	2015
2	Chairmen office	W	8	225	1.5	2015
3	Chairmen office	S	5	223	1.5	2015
4	Chairmen office	S	7.2	224	1.5	2015
5	Director room	S	7.9	224	1.5	2013
6	Deputy director Room	S	5	222	1	2012
7	Computer lab	W	4	220	1.5	2018
8	Surveillance room	W	9	226	1.5	2021
9	E V 789 U P S Room	W	8	229	1.5	2019
10	K I S Building	W	8	228	1.5	2019
11	CC Server room	W	6.9	227	1.5	2018
12	E V Lab Server room	W	8	220	1.5	2015
13	U P S Room	W	6	221	1.5	2019

Table-9.2: Performance Test of various Air Conditioners

From above it is clear that most of the Air Conditioners were taking higher currents.

9.3 Energy Efficiency Measures

Out of 16 nos. Window Air conditioners of 1.5 Tons, 7 nos. were non star and were more than 8 years old. Remaining 9 nos. were found more than 3 Star rating. Further out of 22 nos. Split air Conditioners, 6 nos. were non star and more than 8 years old. Remaining 16 nos. were found to be more than 3 Star rating.

EER of none of the Air conditioner was available with the institute. For EE measures, it was taken from various notifications issued by BEE, based on year of purchase as per Figure-9.1 & Figure-9.2.

Table 3.1

Unitary Type Air Conditioners

Table 3.1(a)

(From 12th January, 2009 to 31st December, 2011)

Energy Efficiency Ratio (Watt/Watt)		
Star level	Minimum	Maximum
1 Star	2.3	2.49
2 Star	2.5	2.69
3 Star	2.7	2.89
4 Star	2.9	3.09
5 Star	3.1	

Table 3.1(b)

(From 1st January, 2012 to 31st December, 2013)

Energy Efficiency Ratio (Watt/Watt)		
Star level	Minimum	Maximum
1 Star	2.3	2.49
2 Star	2.5	2.69
3 Star	2.7	2.89
4 Star	2.9	3.09
5 Star	3.1	

Table 3.2

Split Type Air Conditioners

Table 3.2(a)

(From 12th January, 2009 to 31st December, 2011)

Energy Efficiency Ratio (Watt/Watt)		
Star level	Minimum	Maximum
1 Star	2.3	2.49
2 Star	2.5	2.69
3 Star	2.7	2.89
4 Star	2.9	3.09
5 Star	3.1	

Table 3.2(b)

(From 1st January, 2012 to 31st December, 2013)

Energy Efficiency Ratio (Watt/Watt)		
Star level	Minimum	Maximum
1 Star	2.5	2.69
2 Star	2.7	2.89
3 Star	2.9	3.09
4 Star	3.1	3.29
5 Star	3.3	

Fig-9.1: EER as per BEE Notifications for Year 2009-11 & 2012-13

Table 3.1(f)

(From 1st January, 2021 to 31st December, 2023)

Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star level	Minimum	Maximum
1 Star	2.7	2.89
2 Star	2.9	3.09
3 Star	3.1	3.29
4 Star	3.3	3.49
5 Star	3.5	

Table 3.2(f)

(From 1st January, 2021 to 31st December, 2023)

Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star level	Minimum	Maximum
1 Star	3.3	3.49
2 Star	3.5	3.79
3 Star	3.8	4.39
4 Star	4.4	4.99
5 Star	5.0";	

Fig-9.2: EER as per BEE Notifications for Year 2021-2023

9.4 Pay Back Period per Unit of Air Conditioner

Pay Back Period per Unit of Air Conditioner proposed for replacement has been shown in Table-9.3.

Existing Air Conditioner (Each unit)				Proposed Air Conditioner (Each unit))						
S. No.	Details	Rated Watt	EER	Details	EER of new AC	Effective Power drawn (W)	Energy Saving per year (KWH)	Cost of Energy saving @ Rs 8.50	Cost of Five-star AC (Rs)	Pay Back Period (Yrs.)
1	2	3	4	5	6	7=3*4/6	8=(3-7)* 10 Hr*150 Days / 1000	9=8*8.50	10	11=10/9
1	Window AC 1.5 Ton capacity non star rating more than eight-year-old	1450	2.2	Window AC 1.5 Ton capacity Five Star Rating	3.5	911.43	807.857	6866.79	32000	4.66
2	Split AC non-Star 1.5 Ton non star more than 8 years old	1300	2.4	Split AC Five Star 1.5 Ton	5	624.0	1014	8619.00	40000	4.64

Table-9.3: Pay Back Period per Unit Air Conditioner

9.5 Investment, Energy saving and Pay Back Period for all proposed Air Conditioners

Investment required, Energy saving and Pay Back Period for all the proposed Air Conditioners has been shown in Table-9.4

S. No.	Existing Air Conditioner details	Proposed Air Conditioner details	Qty	Energy Saving per year (KWH)	Total Energy saving per year (KWH)	Total Cost of Energy saving @ Rs 8.50 (Rs)	Cost of new Five star AC/ Unit (Rs)	Total Cost of new Five star AC/ Unit (Rs)	Pay Back Period (Yrs.)
1	2	3	4	5	6=4*5	7=6*8.50	8	9=4*8	10=9/7
1	Window AC 1.5 Ton capacity non star rating more than eight year old	Window AC 1.5 Ton capacity Five Star Rating	7	807.86	5655.00	48067.50	32000	224000	4.66
2	Split AC non Star 1.5 Ton non star more than 8 years old	Split AC Five Star 1.5 Ton	6	1014	6084.00	51714.00	40000	240000	4.64
	Grand Total				11739.00	99781.50		464000	

Table-9.4: Energy saving and Pay Back Period for all proposed Air Conditioners

CHAPTER-10

ENERGY CONSERVATION OPTION & COST BENEFIT ANALYSIS

10.1 Energy Efficiency strategies

The technologies which have been identified in the Demand Side Management are as follows:

I. Replacement of 36 W FTL with 20 W LED Tube Light
II. Replacement of Non Star conventional air-conditioners with Five star rated ACs

The Energy consumption options and cost benefit analysis has been shown in Table-10.1

Sr No	Name of Activity	Quantity	Energy saved (kWh) / Year	Cost of Energy saved/Year @ Rs 8.50 per unit (Rs)	Cost of replacement (Rs)	Pay back period (Year)
1	Replacement of 36 W FTL with 20 W LED Tube light @ Rs 300 per Tube light	1833	70387.2	598291.2	549900	0.92
2	Replacement of 1.5 T Non Star Window Air Conditioner with Five Star rated 1.5 T Window Air Conditioners	7	5655	48067.50	224000	4.66
3	Replacement of 1.5 T Non Star Split Air Conditioner with Five Star rated 1.5 T Split Air Conditioners	6	6084	51714.00	240000	4.64
	Grand Total		**82126.2**	**698072.7**	**1013900**	

Table-10.1: Energy saving, Investment & Payback Period of various EE Measures

CHAPTER-11

ENERGY CONSERVATION TIPS

11.1 Lighting System

- One of the best energy-saving devices is the light switch. Turn off lights when not required.
- Many automatic devices can help in saving energy used in lighting. Consider employing infrared sensors, motion sensors, automatic timers, dimmers and solar cells wherever applicable, to switch on/off lighting circuits.
- As for as possible use task lighting, which focuses light where it's needed. A reading lamp, for example, lights only reading material rather than the whole room.
- Dirty tube lights and bulbs reflect less light and can absorb 50 percent of the light; dust your tube lights and lamps regularly.

11.2 Room Air Conditioners

- Use ceiling or table fan as first line of defence against summer heat. Ceiling fans, for instance, cost about 30 paisa an hour to operate - much less than air conditioners (Rs.10.00 per hour).
- You can reduce air-conditioning energy use by as much as 40 percent by shading your home's windows and walls. Plant trees and shrubs to keep the day's hottest sun off your house.
- One will use 3 to 5 percent less energy for each degree air conditioner is set above22°C (71.5°F), so set the thermostat of room air conditioner at 25°C (77°F) to provide the most comfort at the least cost.
- Using room. ceiling or room fans allows you to set the thermostat higher because the air movement will cool the
- A good air conditioner will cool and dehumidify a room in about 30 minutes, so use a timer and leave the unit off for some time.
- Keep doors to air-conditioned rooms closed as often as possible.
- Clean the air-conditioner filter every month. A dirty air filter reduces airflow and may damage the unit. Clean filters enable the unit to cool down quickly and use less energy.
- If room air conditioner is older and needs repair, it's likely to be very inefficient. It may work out cheaper on life cycle costing to buy a new energy-efficient air conditioner.

11.3 Motors

- Properly size to the load for optimum efficiency. (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Use energy-efficient motors, where found economical.
- Use synchronous motors to improve power factor.
- Check alignment.

- Provide proper ventilation (For every 10 degree 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. (If rewinding is not done properly, the efficiency can be reduced by 5 - 8%)

11.4 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.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return

CHAPTER-12

LIST OF INSTRUMENTS

Followings Instruments were used for carrying Energy audit of the Institute:

i. Three Phase Power Analyzer
ii. Ultrasonic Flow meter
iii. Non-contact Temperature meter
iv. Anemometer
v. Digital Lux meter,
vi. Digital Thermal Hygrometer,
vii. Digital Thermometer,
viii. Digital Capacitance meter,
ix. Digital Clamp on Power, current, voltage meter
x. Measurement Tape