Energy Audit Report

JAN 2023

Kamla Nehru Institute of Physical and Social Sciences, Sultanpur UP

Audit Conducted by:

ENGINEERING FACILITY SERVICES

Office No.778-779, Gaur City Mall, Sector-04, Greater Noida (Uttar Pradesh)India,201318; E-mail.; efs_info@yahoo.com; Mo: 8826682703

Energy Service Companies empaneled with Bureau of Energy Efficiency (BEE)

Acknowledgement

We take the opportunity to express our deep sense of gratitude towards of **KNIPSS**, in particular, the support and disposition of the **Dr. Praveen Kr. Singh (Director IQAC), Dr. Sanjay Kumar (Dy. Director IQAC)** Teaching& Supporting Staff of College for awarding the work of executing Energy Audit in KNIPSS. In particular we wish to thank them for their timely initiative, advice and valuable support extended to the project.

We are also grateful for extending all sorts of help while carrying out energy audit and also for their valuable help regarding the data collection and details at various stages of the project. We are also thankful to them for providing support while conducting survey in KNIPSS.

We would be failing in our duty if we do not thank our respondents, who gave their valuable time and answered the survey questions with tremendous patience and understanding.

(Mr. DEEPAK BAJPAI)
CERTIFIED ENERGY AUDITOR & CHARTERED ENGINEER

Contents

List of Figures

List of tables

1) Introduction

The working details of assignment are as follows:

Project	**Energy Audit**
Client	**Kamla Nehru Institute of Physical and Social Sciences, Sultanpur UP**
Industry	**University**
Contact	**Mr. Sanjay Kumar** **Ph:91 9837586908**
Site	Kamla Nehru Institute of Physical and Social Sciences, Sultanpur UP
Consultant	**Engineering Facility Services**
Duration	Jan 2023
Project Scope	Examination of detail energy audit in the utility and process to assess the loss in the system.
Report	This document gives recommendations, details of findings and the way forward
Consultants involved	Mr. Deepak Bajpai (Certified Energy Auditor EA-19771) Mr. Vikrant Pal Mr. Deepak Kumar
Notes	- The critical points are marked in red - The assumptions are marked in blue - The suggestions / alternatives in the audit report are based on the present operating conditions of equipment/systems and to the best of our knowledge. - Investment figures are estimated values and recommended to obtain cost from vendors.

1.1 Summary of Energy Conservation Measures

Table 1. **Summary of Energy Conservation Measures**

S. No	Energy Conservation Measure	Annual Savings Electricity		Investment	Payback
		kWh	Rs. Lakhs	Rs. Lakhs	Month
	Payback >24 months				
1	**Conventional ceiling fan replacement with BLDC fan** It is recommended to replace the ceiling fan with BLDC fan	28800	2	7.5	38
2	**Old AC replacement with 5-star AC** It is recommended to replace the 2/3 star with 5-star AC	77983	6	15.05	28
Total		**106783**	**9**	**23**	**30**

2) University description and energy sources

2.1 About Institute

The growth of the Institute with leaps and bound in only four decades period provided the way to rise as a multi faculty Institution with Commerce, Arts, Science, Law and Education faculties at undergraduate level and by the end of decade the Institution had post graduate programs in 8 subjects representing the aforesaid faculties. In the advent of having a full-fledged faculty of Engineering and Technology in the year 1976, the needful initiatives were taken by the Trust and as a result of consistent efforts. It was established in 1980 as a fully financed institution by government of Uttar Pradesh which is presently being looked after by a separate management committee. As a result of this development the original name as Kamla Nehru Institute of Science and Technology has also been rechristened as Kamla Nehru Institute of Physical and Social Sciences. In the same continuity two more institutions i.e., Kamla Nehru Krishi Vigyan Kendra in 1976 and Kamla Nehru Institute of Child Education in 1984 were established. With a dream to maintain academic excellence at par with any best institution of the national and international repute in the country, he created a very congenial environment and the infrastructure which is essential for the purpose. In the year 2004 a full-fledged campus on 75-acre land which falls in boundary of village Faridipur at a distance of four kilometre from the main campus, has been established under the dynamic leadership of Shri Vinod Singh, the son and successor of the founder Late Sri. K. N. Singh to cope up the demand from a large number of students in professional and technical subjects. The new campus has got six faculties viz. a college of Pharmacy, Management Studies, Education, Law, Engineering and Nursing. The new campus has got distinction bestowed with unique natural and pollution free peaceful environment on the state highway Ayodhya-Allahabad bypass which also connects Lucknow, Varanasi, Allahabad & upto extreme east of U.P**.** In 1973 the Society was rechristened as Kamla Nehru Memorial Trust. to achieve the under mentioned objectives.

THE OBJECTIVE:

- To establish, maintain and administer institutions for elementary, higher secondary, professional and higher education to benefit each and every section of the society.
- To organize & coordinate government/ non-government sponsored activities for socio-economic and cultural empowerment of the under privileged/ economically depressed people.
- To organize and coordinate activities sponsored by state, central and international agencies for health cover, drinking water, housing, disaster management and environmental protection

including soil and water conservation, land reclamation, drainage and irrigation, social and farm forestry, village sanitation and energy conservation/ management.

- Advancement of Science and Technology through teaching, research, location specific testing and technology dissemination for large scale application by the people.
- To establish libraries, information, education and communication centres for awareness, people education and advancement of welfare programmes in rural and urban areas.
- To organize non-formal, adult and continuing education for people representing rural and urban areas through Krishi Vigyan Kendra, Jan Sikshan Sansthan Industrial Training Institutes, Polytechniques and other vocational institutions.
- To organize and promote government/ non-government supported activities in public private and people partnership mode to generate greater income and employment opportunities for resource poor people in rural and urban areas.
- To aid and financially support the meritorious students/ scholars of socially and economically disadvantaged sections of the society.
- To organize government/ non-government sponsored health and welfare camps for animals and human being and to help the physically challenged people.
- To help men, women workers and artisans to organize self-help groups for promotion and management of social and economic development activities.
- To create government/ non-government assisted infrastructure for capacity building, entrepreneurship development in marketing, insurance, transportation, storage, processing etc. in farm and non-farm sectors.
- To create resources like land, building, funds and other moveable/ immoveable assets for initiating, organizing, managing and maintaining the aforesaid activities/ institution

2.2 Energy Sources and Cost

Electricity & Fuel are major energy sources of the plant. Electricity is supplied at 11 kV. There is one 100 KVA, 11/0.44 kV power transformers to cater electricity demand.

The KNIPSS has installed solar plant 200 KW.

The energy cost from various sources of energy is given below:

Table 2. **Energy cost component of energy sources**

Source of energy	Unit	Cost
Electricity (Grid)	Rs. /kWh	8.32

2.3 Electricity

The energy demand of the plant is fulfilled by the electricity from Grid. The annual energy consumption from electricity grid sources is as follows:

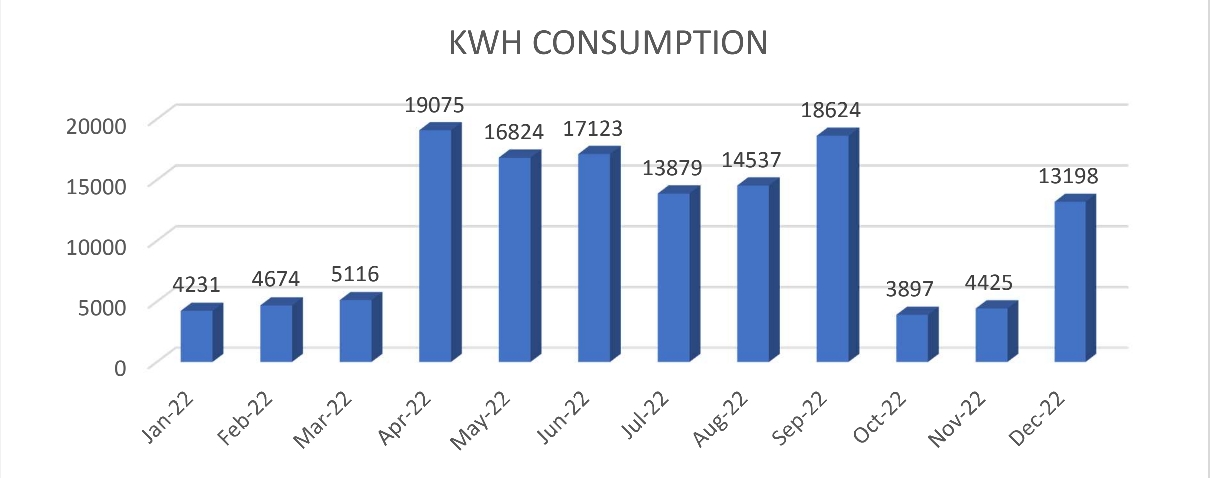
Table 3. **Month wise electrical Energy Consumption**

3) Electricity consumption of Faridipur

DETAILS OF ELECTRICITY CONSUMPTION FOR THE 2021-2022								
MONTH	KWH CONSUMPTION	KVAH CONSUMPTION	FIXED CHARGE	ENERGY CHARGES (INR)	PF	SANCTIONED LOAD (KVA)	MDI (KVA)	NET AMOUNT PAYABLE (INR)
Jan-22	4231	4481	25200	37282	0.944	84	18.08	67169
Feb-22	4674	4780	25200	29307	0.978	84	19.36	27090
Mar-22	5116	5078	25200	21332	1.01	84	40.40	50023
Apr-22	19075	19397	40736	167466	0.983	84	101.84	238090
May-22	16824	17058	44192	147163	0.986	84	55.24	226892
Jun-22	17123	17356	49504	149750	0.987	84	61.88	246007

DETAILS OF ELECTRICITY CONSUMPTION FOR THE 2021-2022								
MONTH	**KWH CONSUMPTION**	**KVAH CONSUMPTION**	**FIXED CHARGE**	**ENERGY CHARGES (INR)**	**PF**	**SANCTIONED LOAD (KVA)**	**MDI (KVA)**	**NET AMOUNT PAYABLE (INR)**
Jul-22	13879	14023	41024	120820	0.990	84	51.28	188830
Aug-22	14537	14697	40224	126670	0.989	84	50.28	192660
Sep-22	18624	18721	25200	161598	0.995	84	29.40	200809
Oct-22	3897	3800	26464	32084	1.026	84	33.08	62940
Nov-22	4425	4362	25200	36962	1.014	84	21.40	66825
Dec-22	13198	13199	25200	113667	0.9999	84	25.50	149283
Max	**19075**	**19397**	**49504**	**167466**			**102**	**246007**
Min	**3897**	**3800**	**25200**	**21332**	**0.944**		**18**	**27090**
Avg	**11300**	**11413**	**32779**	**95342**	**0.992**		**42**	**143052**

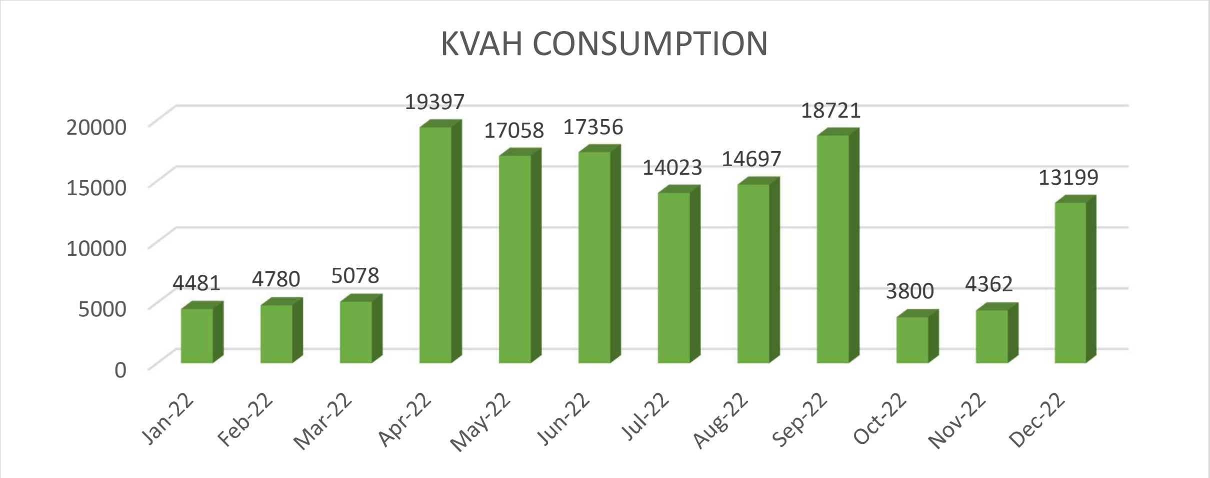
Figure 1. Graph between month & KWH



Observation:

- The maximum Energy consumption (kWh) from Jan 22 to Dec 22 was 19075 kWh in Apr-2022 and minimum Energy consumption was 4231 kWh in Jan-2022.

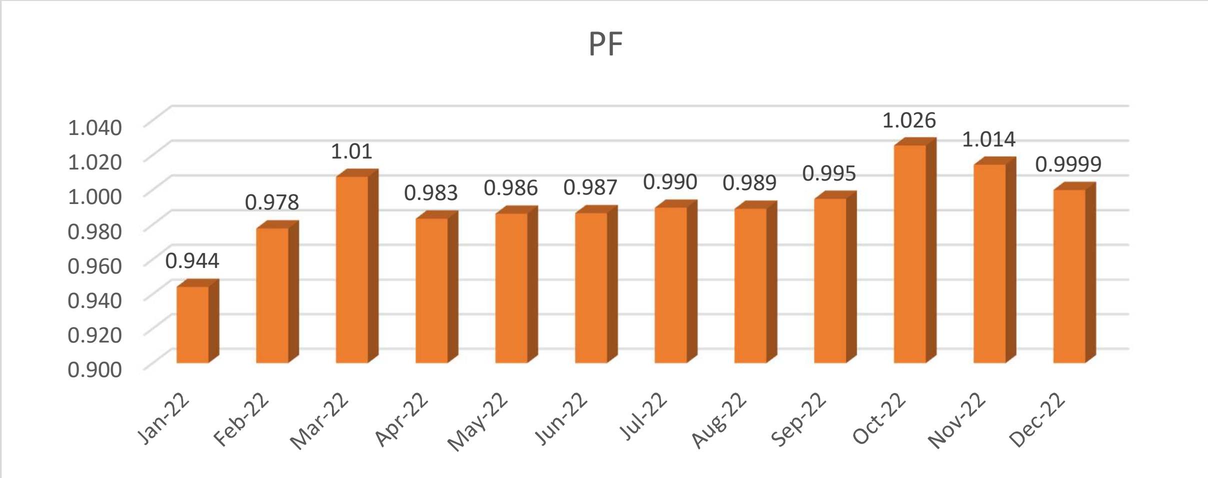
Figure 2. Graph between Month & KVAH



Observation:

- The maximum Energy consumption (kvah) from Jan 22 to Dec 22 was 19397 (kvah) in Apr-2022 and minimum Energy consumption was 3800 kWh in Nov-2022.

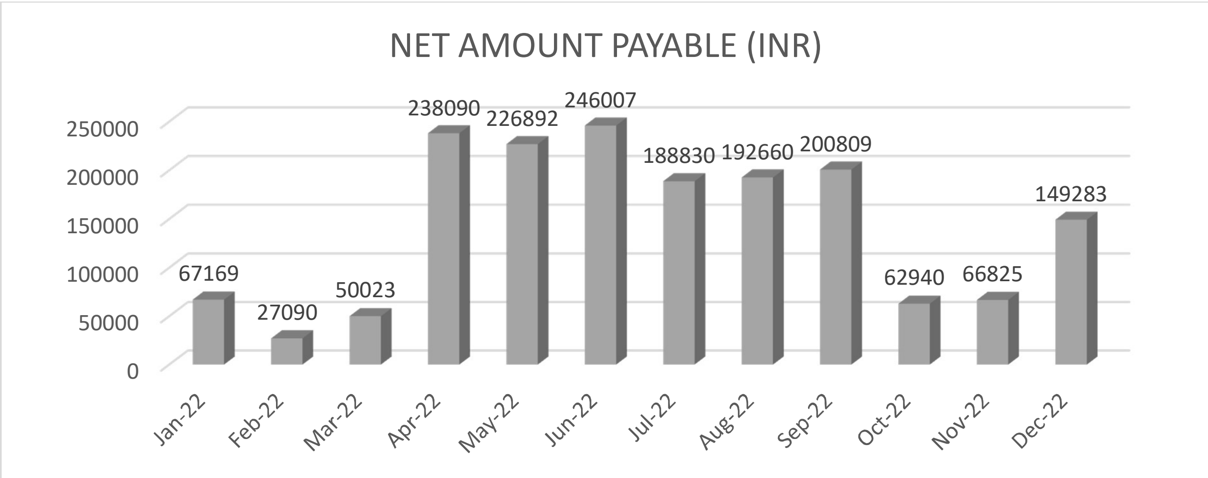
Figure 3. Graph between Month & PF



Observation:

- The maximum Power factor from Jan 22 to Dec 22 was 1.02 in Oct-2022 and minimum Power Factor was 0.944 in Jan-2022.

Figure 4. Graph between Month & Net Amount Payable



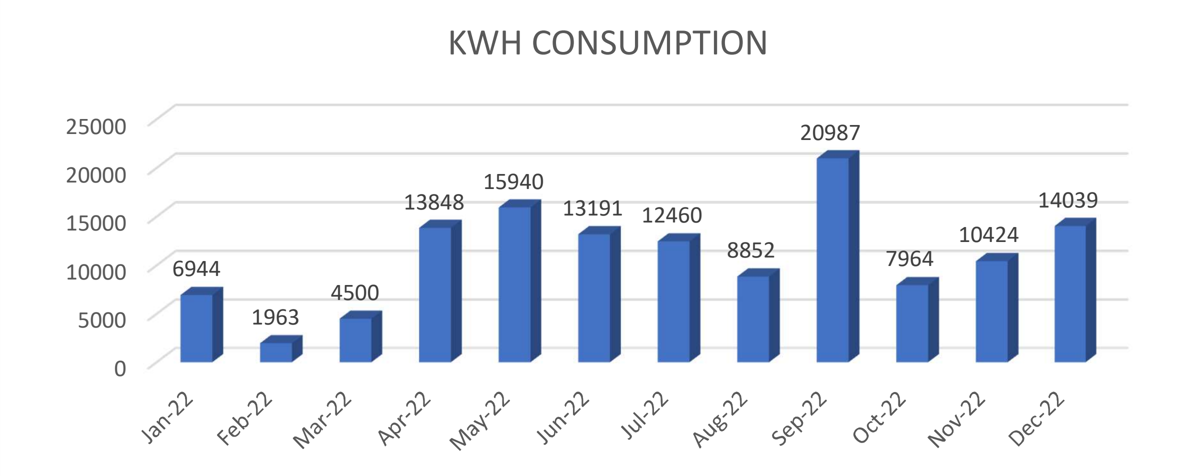
Observation:

- The maximum net amount from Jan 22 to Dec 22 was 246007 in Jun-2022 and minimum net amount was 27090 in Feb-2022.

4) Electricity consumption of KNIPSS Campus

DETAILS OF ELECTRICITY CONSUMPTION FOR THE 2021-2022								
MONTH	KWH CONSUMPTION	KVAH CONSUMPTION	FIXED CHARGE	ENERGY CHARGES (INR)	PF	SANCTIONED LOAD (KVA)	MDI (KVA)	NET AMOUNT PAYABLE (INR)
Jan-22	6944	7476	18225	56947	0.929	90	32.40	80810
Feb-22	1963	2099	18225	15812	0.935	90	21.76	35591
Mar-22	4500	4431	18225	33653	1.016	90	23.20	55769
Apr-22	13848	14310	18225	109227	0.968	90	57.76	137011
May-22	15940	16312	18225	127783	0.977	90	32.24	156959
Jun-22	13191	13504	18225	105656	0.977	90	58.96	133173
Jul-22	12460	12660	18225	99005	0.984	90	78.00	129071
Aug-22	8852	9013	18225	70267	0.982	90	33.92	95129
Sep-22	20987	21339	25650	167396	0.984	90	95.00	210225
Oct-22	7964	8094	18225	63025	0.984	90	35.96	87345
Nov-22	10424	10453	18225	81614	0.997	90	20.96	107328
Dec-22	14039	14157	18225	110802	0.992	90	31.36	138704
Max	**20987**	**21339**	**25650**	**167396**			**95**	**210225**
Min	**1963**	**2099**	**18225**	**15812**	**0.929**		**21**	**35591**
Avg	**10926**	**11154**	**18844**	**86766**	**0.977**		**43**	**113926**

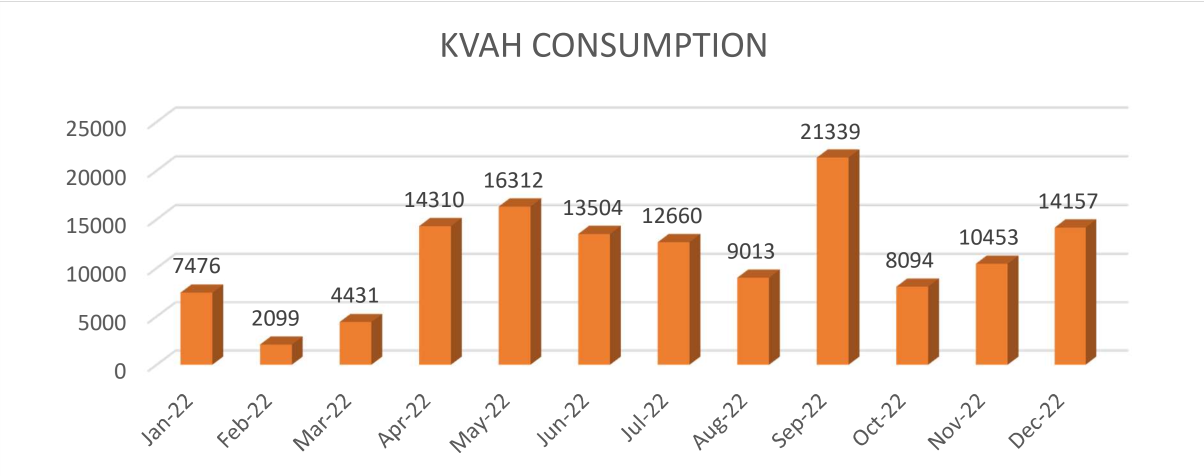
Figure 5. Graph between month & KWH



Observation:

- The maximum Energy consumption (kWh) from Jan 22 to Dec 22 was 20987 kWh in Oct-2022 and minimum Energy consumption was 1963 kWh in Jan-2022

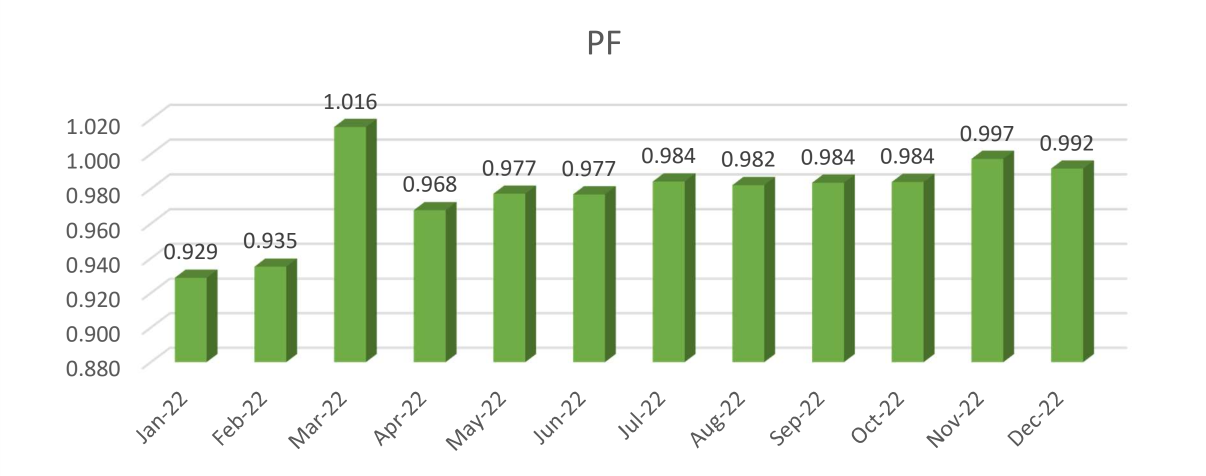
Figure 6. Graph between Month & KVAH



Observation:

- The maximum Energy consumption (kvah) from Jan 22 to Dec 22 was 21339 (kvah) in Sep-2022 and minimum Energy consumption was 2099 kvah in Feb-2022.

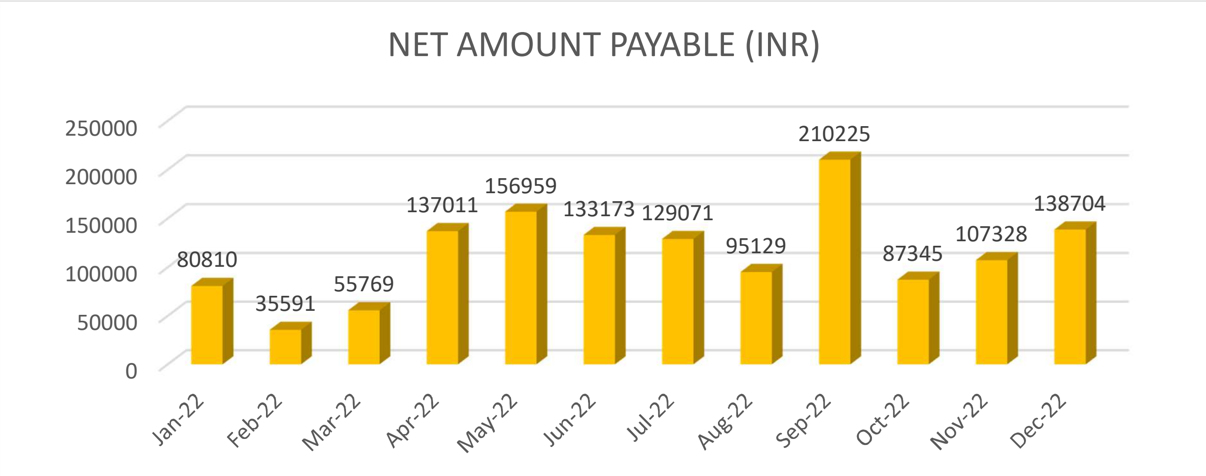
Figure 7. Graph between Month & PF



Observation:

- The maximum Power factor from Jan 22 to Dec 22 was 1.01 in Mar-2022 and minimum Power Factor was 0.929 in Jan-2022.

Figure 8. Graph between Month & Net Amount Payable



Observation:

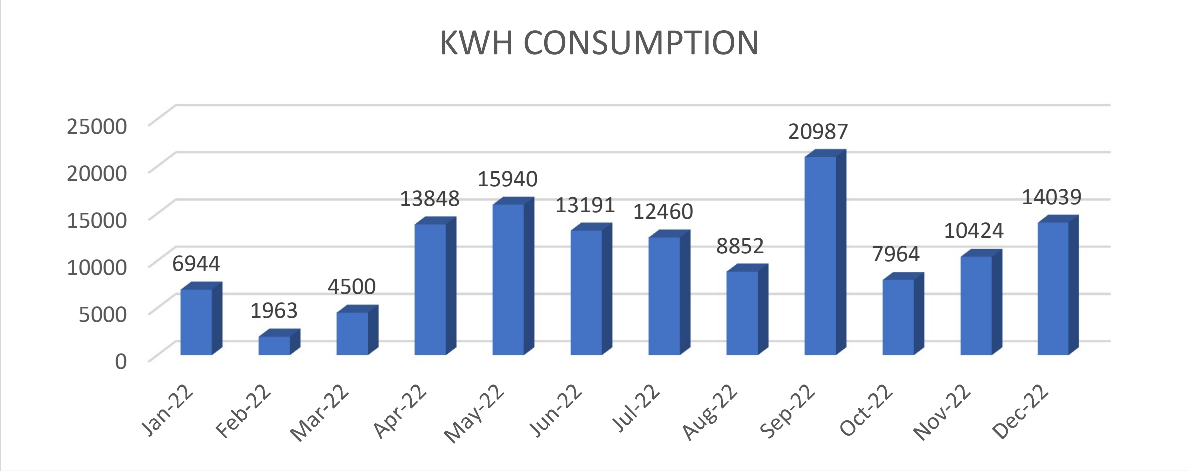
- The maximum net amount from Jan 22 to Dec 22 was 210225 in Sep-2022 and minimum net amount was 35591 in Feb-2022.

5) BASELINE ENERGY DESCRIPTION

Building is consuming different sources of energy - Grid Electricity, Electricity from Diesel Generating Sets. Electricity is generally used for all electrical devices while diesel is used to operate the DG sets.

The building is obtaining the power supply from Electricity Distribution Division through 11kV line which directly feeds into transformer which steps down voltage from 11kV to 433V.

Graph shows the total billed amount in KWH



Lighting, pump/ motor load and HVAC are the major energy consuming components in the building, followed by diesel (very less consumption) used in DG sets.

The building utilizes various energy resources to provide best of the amenities in the management, break up of different resources is given below and this consumption of resources forms the baseline/ benchmarking of the energy use.

6) Energy Conservation Measure

6.1 Replace BLDC fans with ceiling fans

6.1.1 Background

During energy audit we found that the institute uses 60 KW ceiling fans.

Findings

We found that the ceiling fan which is of 60KW consume more power.

Recommendations

It is recommended to replace the Institute ceiling fan with BLDC fan immediately and plan to replace the 300 fans with BLDC fan.

Benefits

We can replace the existing ceiling fans with the energy efficient BLDC fans. Savings should be taken as when the fan is needed to be changed as when they get faulty. Saving calculation given below.

Table 4. **Saving by Ceiling fan replacement with BLDC fan**

Parameter	Unit	Value
Average power consumption of the ceiling fan at present	Watt	60
Average power consumption of energy efficient star rated (BLDC) fans	Watt	28
Equivalent Power saving per fan	Watt	32
Numbers of fans to be replaced	Nos	300
Working Hours Per annum	Hr.	3000
Overall electric Power Cost	Rs/KWH	8.32

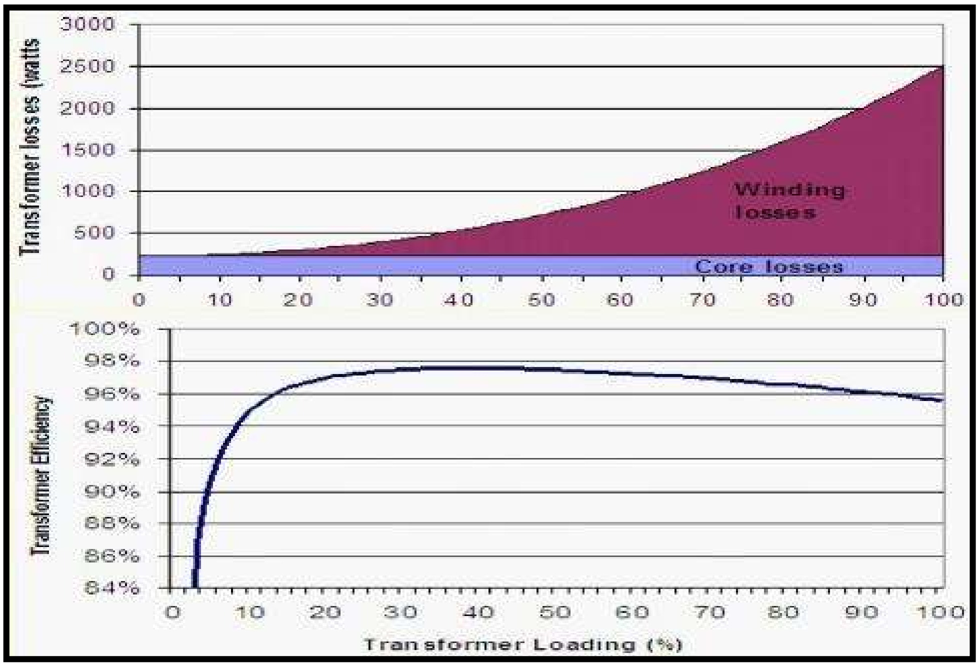
Annual Energy Saving	KWH	28800
Monetary saving	Rs/Year	239616
Investment	Rs	750000
Payback	Month	38

7) Observation and analysis

7.1 Transformer loading

The efficiency of the transformers not only depends on the design but also, on the effective operating load. The variable losses depend on the effective operating load on the transformer. The maximum efficiency of the transformer occurs at a condition when the constant loss is equal to variable loss. For distribution transformers, the core loss is 15 to 20% of full load copper loss. Hence, the maximum efficiency of the distribution transformers occurs at a loading between 40 – 60%. For power transformers, the core loss is 25 to 30% of full load copper loss. Hence, the maximum efficiency of the power transformers occurs at a loading between 40 – 60%.

Transformer loading Vs Efficiency



All the electrical parameters required evaluating percentage loading & losses of Transformers were recorded for old building transformer.

No load and full load losses of the transformer are obtained from standards to calculate the transformer losses same is as follows.

Description	Transformer Capacity	No-load loss	Full load loss	Power factor	Maximum Apparent power	Average Apparent Power	Max Loading	Average Loading	Total loss
	kVA	kW	kW	PF	kVA	kVA	%	%	kW
TR1	100	0.32	1.95	0.988	61.67	43.7	62%	44%	1.06

Note: Total loss = No load loss+ Full load loss*(% Loading ^{2})

7.2 Lighting system

The college has already implemented energy efficient measures in lighting area at different places. Most of the conventional lamps are replaced by LED Lamps. Replacement of conventional lamp with LED is going on with phase manner. Recommended value of illumination given as per National Building Code of India, 2005 clause 4.1.3, 4.1.3.2, 4.3.2 and 4.3.2.1

7.2.1 AREA WISE LUX LEVEL

Lux is measured during the audit and listed below.

AREA WISE LUX				
Sr No.	Location	Minimum LUX	Maximum LUX	Recommendation
1	Law Library	164	174	150-200
2	Law HOD Room	144	150	150-200
3	Staff Room	141	144	150-200
4	LLB 1/2 Semester	145	154	150-200
5	LLB 3/4 Semester	151	160	150-200
6	Computer Lab	170	181	150-200
7	Legal Aid Clinic	127	138	150-200
8	HOD Room	122	130	150-200
9	L1 Room	134	143	150-200
10	L2 Room	160	167	150-200
11	L3 Room	159	172	150-200
12	L4 Room	160	170	150-200
13	L5 Room	164	170	150-200
14	L6 Room	170	180	150-200
15	L7 Room	164	172	150-200
16	L8 Room	150	162	150-200
17	L9 Room	171	183	150-200
18	Moot Court	166	171	150-200
19	Agriculture Department Main entry	155	160	150-200
20	Health Center	143	168	150-200
21	Staff Room	150	165	150-200
22	PP Lab	154	167	150-200
23	GNB Lab	145	167	150-200
24	UG Section-A	145	165	150-200
25	UG Section-B	141	144	150-200
26	UG Section-C	145	154	150-200
27	UG Section-D	151	160	150-200
28	UG 3rd Semester	170	181	150-200
29	Library	127	138	150-200
30	Discipline Building	122	130	150-200
31	Admin Building	145	176	150-200

AREA WISE LUX				
Sr No.	Location	Minimum LUX	Maximum LUX	Recommendation
32	Admin Office	154	176	150-200
33	Faculty of Arts Main Gate	143	168	150-200
34	Medical Room	150	165	150-200
35	MA Geography	154	167	150-200
36	Laboratory Staff	160	170	150-200
37	IQAC Office	164	170	150-200
38	Study Center	170	180	150-200
39	Learning Center	164	172	150-200
40	Psychological Lab	150	162	150-200
41	Body Balance Department	171	183	150-200
42	Central Library	166	171	150-200
43	Technical Section	155	160	150-200
44	Botany Department UG Lab	143	168	150-200
45	Botany Department Staff Room	150	165	150-200
46	Botany Department HOD room	167	178	150-200
47	Chemistry Lab	156	178	150-200
48	Boys Common Room	156	167	150-200
49	Zoology Department Room	164	172	150-200
50	Zoology Department PG lecture Room	150	162	150-200
51	Zoology Department Mathematics	171	183	150-200
52	Physics Department	165	172	150-200

OBSERVATIONS

It was observed that the building has opted for the Energy-efficient lighting system i.e., LED which a was good option to save energy and we personally felt good to observe it and checked whether the lux level we are getting is sufficient or not and was observed that the lux level was good.

It was observed that the lux level in some of the areas is within limits and in some areas, it is a bit more.

RECOMMENDATION

LED lights are highly recommended as they are the best in technology available in the illumination market and will provide a good amount of energy and monetary savings since major lighting includes halogens which are the most inefficient light in the market.

LED also helps in heat load reduction since the heat dissipated by the halogens is much higher than the heat dissipated by LED lights thus intangible savings by reduction in cooling can be easily be achieved. Also, we recommend not using GLS Bulbs as they are inefficient lights and also dissipate heat increase HVAC load.

- **It is recommended to install a photo sensor for all the outdoor light and also in the working floor near to the glass's envelope in the building.**
- **It is recommended to install occupancy sensors in Stores/office cabins and toilets to save energy.**
- **It is recommended to install the daylight sensor on the outdoor lights for automation and control of the lights and this will also help us reduce the unwanted running hours of the lights.**

7.3 List of Assets & Electrical Equipment's

ASSET LIST OF KNIPSS			
Sno.	**Location**	**LED**	**Fan**
1	AG New	63	102
2	AG Old	64	79
3	B.Ed.	82	66
4	LAW Faculty	185	178
5	Admin Block	25	10
6	Arts Faculty	98	75
7	Commerce Faculty	22	43
8	Ambedkar Hall	6	2
9	Science Faculty	105	139
Total		**650**	**694**

7.4 List of AC

List of AC'S in KNIPSS	
Location	**Qty**
Principle office	2
Computer Lab	4
B.Ed. Principal office	2
Law principal office	1
AL-015	1
Moot Court	10
HOD Room	1
Science Facility	6
Admin Block	8
Ambedkar Hall	2
Arts Faculty	9
Commerce Faculty	1
Total	**47**

7.4.1 Air conditioners

The plant has installed AC for BDL plant & township. The analysis was done to identify the measures that could be undertaken to reduce the energy consumption. The following parameter has studied in each unit.

- Air flow rate
- Air flow cross section area
- Return dry bulb temperature
- Return wet bulb temperature
- Power consumption
- Supply dry bulb temperature
- Supply wet bulb temperature

Table 5. **Performance Analysis of AC in B.Ed. Faculty**

Parameters	Units	KNIPSS							
Location		Principle office	Principle office	Computer Lab	Computer Lab	Computer Lab	Computer Lab	B.Ed. Principal office	B.Ed. Principal office
Design Capacity	TR	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Area	m^2	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085
Measured avg. Velocity	m/s	2.01	1.9	1.9	1.98	2.12	2.65	2.23	2.25
Calculated Flow	m^3/hr	615.1	581.4	581.4	605.9	648.7	810.9	682.4	688.5
Supply Air Dry Bulb Temp.	C^0	25	23	26	26	24	27	25	28
Supply Air Wet Bulb Temp.	C^0	17	17	17	18	19	21	17	19
Enthalpy supply air	KCal /Kg	11.4	11.4	11.4	12.1	12.9	14.5	11.4	12.9
Return Air Dry Bulb Temp.	C^0	27	27	29	28	29	29	29	30
Return Air Wet Bulb Temp.	C^0	24	24	24	24	25	26	24	25
Enthalpy return air	KCal /Kg	17.22	17.3	17.22	17.21	18.19	19.22	17.2	18.18
Density of Air	Kg/ M^3	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225

Parameters	Units	KNIPSS							
Calculated Capacity	TR	1.46	1.39	1.38	1.25	1.40	1.55	1.61	1.49
Power Consumption	KW	2.1	2	2.1	2	2.3	2.35	2.32	2.33
KW/TR		1.441	1.434	1.522	1.595	1.648	1.516	1.440	1.567
EER		8.329	8.366	7.887	7.525	7.280	7.917	8.336	7.656
COP		2.439	2.450	2.309	2.204	2.132	2.318	2.441	2.242
Proposed									
Design Power of AC	kW	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Present power consumption of AC	kW	2.1	2	2.1	2	2.3	2.35	2.32	2.33
Expected saving	%	28	28	28	28	28	28	28	28
Reduction in power consumption	kW	0.588	0.56	0.588	0.56	0.644	0.658	0.6496	0.6524
Running hours of AC fan	Hr./day	10	10	10	10	10	10	10	10
Running days of AC fan per annum	Days/Year	288	288	288	288	288	288	288	288
Cost of electrical energy	INR/kWh	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32
Energy Saving/yr.	kWh	1693.44	1612.8	1693.44	1612.8	1854.72	1895.04	1870.848	1878.912
Monetary saving per year	INR	14089.4	13418.5	14089.4	13418.5	15431.3	15766.7	15565.5	15632.5
Investment	INR	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
Payback period	month	29.81	31.30	29.81	31.30	27.22	26.64	26.98	26.87

- **Observation:** AC can be replaced with five-star AC. Saving calculation given in above table.

Table 6. **Performance Analysis of AC in Science Faculty**

Parameters	Units	SCIENCE FACULTY KNIPSS							
Location		Law principal office	AL-015	HOD Room	Science Facility	Science Facility	Science Facility	Science Facility	Science Facility
Design Capacity	TR	1.5	1.5	1.5	1.5	2	1.5	2	2
Total Area	m^2	0.085	0.085	0.085	0.085	0.108	0.085	0.108	0.108
Measured avg. Velocity	m/s	2.12	2.21	2.35	2.12	3.25	2.7	3.56	3.5
Calculated Flow	m^3/hr	648.7	676.3	719.1	648.7	1263.6	826.2	1384.1	1360.8

Parameters	Units	SCIENCE FACULTY KNIPSS							
Supply Air Dry Bulb Temp.	C^0	23	24	26	26	28	24	27	28
Supply Air Wet Bulb Temp.	C^0	17	18	18	17	20	19	22	17
Enthalpy supply air	KCal/ Kg	11.4	12.1	12.1	11.4	13.7	12.9	15.4	11.4
Return Air Dry Bulb Temp.	C^0	28	27	29	29	30	29	29	29
Return Air Wet Bulb Temp.	C^0	24	24	24	24	24	25	26	22
Enthalpy return air	KCal/ Kg	17.21	17.3	17.2	17.2	17.19	18.19	19.22	15.35
Density of Air	Kg/M^3	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225
Calculated Capacity	TR	1.53	1.42	1.49	1.52	1.81	1.77	2.16	2.21
Power Consumption	KW	2.2	2.2	2.3	2.2	3	2.98	3.1	3.1
KW/TR		1.441	1.547	1.548	1.443	1.656	1.683	1.436	1.406
EER		8.328	7.755	7.751	8.314	7.248	7.130	8.356	8.535
COP		2.439	2.271	2.270	2.434	2.122	2.088	2.447	2.499
Proposed									
Design Power of AC	kW	1.5	1.5	1.5	1.5	1.937	1.5	1.937	1.937
Present power consumption of AC	kW	2.2	2.2	2.3	2.2	3	2.98	3.1	3.1
Expected saving	%	28	28	28	28	28	28	28	28
Reduction in power consumption	kW	0.616	0.616	0.644	0.616	0.84	0.8344	0.868	0.868
Running hours of AC fan	Hr/day	10	10	10	10	10	10	10	10
Running days of AC fan per annum	Days /Year	288	288	288	288	288	288	288	288
Cost of electrical energy	INR/ kWh	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32
Energy Saving/yr	kWh	1774.08	1774.08	1854.72	1774.08	2419.2	2403.072	2499.84	2499.84
Monetary saving per year	INR	14760.3	14760.3	15431.3	14760.3	20127.7	19993.6	20798.7	20798.7
Investment	INR	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
Payback period	month	28.45	28.45	27.22	28.45	20.87	21.01	20.19	20.19

Observation: AC can be replaced with five-star AC. Saving calculation given in above table.

Table 7. **Performance Analysis of AC in LAW Faculty**

Parameters	Units	LAW FACULTY MOOT COURT									
Location		Moot Court	Moot Court	Moot Court	Moot Court	Moot Court	Moot Court	Moot Court	Moot Court	Moot Court	Moot Court
Design Capacity	TR	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Area	m^2	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085
Measured avg. Velocity	m/s	1.9	1.78	1.9	2.12	2.24	2.09	1.9	2.1	2.5	1.89
Calculated Flow	m^3/hr	581.4	544.7	581.4	648.7	685.4	639.5	581.4	642.6	765.0	578.3
Supply Air Dry Bulb Temp.	C^0	25	24	23	26	24	25	23	24	24	25
Supply Air Wet Bulb Temp.	C^0	17	17	17	18	19	19	17	16	19	17
Enthalpy supply air	KCal /Kg	11.4	11.4	11.4	12.1	12.9	13.7	11.4	10.7	12.9	11.4
Return Air Dry Bulb Temp.	C^0	29	27	28	29	29	29	27	29	28	29
Return Air Wet Bulb Temp.	C^0	24	24	24	24	25	26	24	23	24	24
Enthalpy return air	KCal /Kg	17.2	17.3	17.21	17.2	18.19	19.22	17.3	16.25	17.21	17.2
Density of Air	Kg/M^3	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225
Calculated Capacity	TR	1.37	1.31	1.37	1.34	1.47	1.44	1.39	1.46	1.34	1.37
Power Consumption	KW	2.1	2.1	2.2	2.1	2.35	2.23	2.35	2.42	2.1	2.12
KW/TR		1.529	1.605	1.608	1.567	1.594	1.554	1.685	1.663	1.565	1.552
EER		7.846	7.477	7.464	7.659	7.529	7.723	7.120	7.216	7.668	7.731
COP		2.298	2.189	2.186	2.243	2.205	2.262	2.085	2.113	2.245	2.264
Proposed											
Design Power of AC	kW	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Present power consumption of AC	kW	2.1	2.1	2.2	2.1	2.35	2.23	2.35	2.42	2.1	2.12
Expected saving	%	28	28	28	28	28	28	28	28	28	28
Reduction in power consumption	kW	0.588	0.588	0.616	0.588	0.658	0.6244	0.658	0.6776	0.588	0.5936
Running hours of AC fan	Hr/day	10	10	10	10	10	10	10	10	12	12

Parameters	Units	LAW FACULTY MOOT COURT									
Running days of AC fan per annum	Days /Year	288	288	288	288	288	288	288	288	250	250
Cost of electrical energy	INR/ kWh	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32
Energy Saving/yr	kWh	1693.44	1693.44	1774.08	1693.44	1895.04	1798.272	1895.04	1951.488	1764	1780.8
Monetary saving per year	INR	14089.4	14089.4	14760.3	14089.4	15766.7	14961.6	15766.7	16236.4	14676.5	14816.3
Investment	INR	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
Payback period	month	29.81	29.81	28.45	29.81	26.64	28.07	26.64	25.87	28.62	28.35

Observation: AC can be replaced with five-star AC. Saving calculation given in above table.

Table 8. **Performance Analysis of AC in Administrative Block**

Parameters	Units	ADMIN BLOCK KNIPSS							
Location		Admin Block	Admin Block	Admin Block	Admin Block	Admin Block	Admin Block	Admin Block	Admin Block
Design Capacity	TR	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Area	m^2	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085
Measured avg. Velocity	m/s	1.8	1.89	1.9	2.2	2.1	2.8	2.8	2.8
Calculated Flow	m^3/hr	550.8	578.3	581.4	673.2	642.6	856.8	856.8	856.8
Supply Air Dry Bulb Temp.	C^0	26	23	26	28	27	24	28	26
Supply Air Wet Bulb Temp.	C^0	17	17	17	19	18	19	17	19
Enthalpy supply air	KCal/ Kg	11.4	11.4	11.4	12.9	12.1	12.9	11.4	12.9
Return Air Dry Bulb Temp.	C^0	27	27	28	30	29	29	29	30
Return Air Wet Bulb Temp.	C^0	24	24	24	25	24	25	24	25
Enthalpy return air	KCal/ Kg	17.22	17.3	17.21	18.18	17.21	18.19	17.2	18.18
Density of Air	Kg/M^3	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225
Calculated Capacity	TR	1.31	1.39	1.38	1.45	1.33	1.84	2.03	1.84
Power Consumption	KW	2.1	2.23	2.1	2.25	2.23	2.21	2.23	2.21
KW/TR		1.606	1.608	1.524	1.548	1.673	1.199	1.098	1.199
EER		7.472	7.463	7.873	7.752	7.172	10.007	10.926	10.007
COP		2.188	2.185	2.305	2.270	2.100	2.930	3.199	2.930
Proposed									
Design Power of AC	kW	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Parameters	Units	ADMIN BLOCK KNIPSS							
Present power consumption of AC	kW	2.1	2.23	2.1	2.25	2.1	2.21	2.23	2.21
Expected saving	%	28	28	28	28	28	28	28	28
Reduction in power consumption	kW	0.588	0.6244	0.588	0.63	0.588	0.6188	0.6244	0.6188
Running hours of AC fan	Hr/day	12	12	12	12	12	12	12	12
Running days of AC fan per annum	Days/ Year	250	250	250	250	250	250	250	250
Cost of electrical energy	INR/KWh	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32
Energy Saving/yr	kWh	1764	1873.2	1764	1890	1764	1856.4	1873.2	1856.4
Monetary saving per year	INR	14676.5	15585.0	14676.5	15724.8	14676.5	15445.2	15585.0	15445.2
Investment	INR	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
Payback period	month	28.62	26.95	28.62	26.71	28.62	27.19	26.95	27.19

Observation: AC can be replaced with five-star AC. Saving calculation given in above table.

Table 9. **Performance Analysis of AC in Arts Faculty**

Parameters	Units	ARTS FACULTY KNIPSS							
Location		Arts Faculty	Arts Faculty	Arts Faculty	Arts Faculty	Arts Faculty	Arts Faculty	Arts Faculty	Arts Faculty
Design Capacity	TR	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Area	m^2	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085
Measured avg. Velocity	m/s	2.1	2.6	2.3	3.1	3.6	2.8	3.8	1.5
Calculated Flow	m^3/hr	642.6	795.6	703.8	948.6	1101.6	856.8	1162.8	459.0
Supply Air Dry Bulb Temp.	C^0	25	23	24	26	30	28	26	25
Supply Air Wet Bulb Temp.	C^0	19	17	19	19	23	22	18	19
Enthalpy supply air	KCal/ Kg	12.9	11.4	12.9	12.9	16.3	15.4	12.1	12.9
Return Air Dry Bulb Temp.	C^0	27	25	28	27	29	29	28	29
Return Air Wet Bulb Temp.	C^0	24	21	24	22	26	26	21	26
Enthalpy return air	KCal/ Kg	17.22	14.51	17.21	15.37	19.22	19.22	14.49	19.22
Density of Air	Kg/M^3	1.225	1.225	1.225	1.225	1.225	1.225	1.225	1.225
Calculated Capacity	TR	1.13	1.01	1.23	0.96	1.33	1.34	1.13	1.18
Power Consumption	KW	1.8	1.6	1.9	1.5	2.2	2.2	1.9	2.0
KW/TR		1.593	1.586	1.539	1.555	1.660	1.642	1.688	1.697

Parameters	Units	ARTS FACULTY KNIPSS							
EER		7.532	7.566	7.797	7.716	7.229	7.308	7.110	7.073
COP		2.205	2.215	2.283	2.259	2.117	2.140	2.082	2.071
Proposed (5* AC)									
Design Power of AC	kW	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Present power consumption of AC	kW	1.8	1.6	1.9	1.5	2.2	2.2	1.9	2.0
Expected saving	%	28	28	28	28	28	28	28	28
Reduction in power consumption	kW	0.504	0.448	0.532	0.42	0.616	0.616	0.532	0.56
Running hours of AC fan	Hr/day	10	10	10	10	10	10	10	10
Running days of AC fan per annum	Days/ Year	288	288	288	288	288	288	288	288
Cost of electrical energy	INR/KWh	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32
Energy Saving/yr	kWh	1451.52	1290.24	1532.16	1209.6	1774.08	1774.08	1532.16	1612.8
Monetary saving per year	INR	12076.6	10734.8	12747.6	10063.9	14760.3	14760.3	12747.6	13418.5
Investment	INR	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
Payback period	month	34.78	39.13	32.95	41.73	28.45	28.45	32.95	31.30

Observation: AC can be replaced with five-star AC. Saving calculation given in above table.

Table 10. **Performance Analysis of AC in Commerce & Ambedkar Hall**

Parameters	Units	KNIPSS		
Location		Commerce Faculty	Ambedkar Hall	Ambedkar Hall
Make		Carrier	Voltas	Hauling
Design Capacity	TR	1.5	1.5	1.5
Total Area	m^2	0.085	0.085	0.085
Measured avg. Velocity	m/s	2	1.9	2.2
Calculated Flow	m^3/hr.	612.0	581.4	673.2
Supply Air Dry Bulb Temp.	C^0	26	23	28
Supply Air Wet Bulb Temp.	C^0	18	17	19
Enthalpy supply air	KCal/Kg	12.1	11.4	12.9
Return Air Dry Bulb Temp.	C^0	29	27	30
Return Air Wet Bulb Temp.	C^0	24	24	25
Enthalpy return air	KCal/Kg	17.21	17.3	18.18
Density of Air	Kg/M^3	1.225	1.225	1.225
Calculated Capacity	TR	1.27	1.39	1.45
Power Consumption	KW	2.1	2.2	2.25
KW/TR		1.658	1.578	1.548
EER		7.239	7.605	7.752
COP		2.120	2.227	2.270

Parameters	Units	KNIPSS		
Proposed				
Design Power of AC	kW	1.5	1.5	1.5
Present power consumption of AC	kW	2.1	2.2	2.25
Expected saving	%	28	28	28
Reduction in power consumption	kW	0.588	0.616	0.63
Running hours of AC fan	Hr/day	12	12	12
Running days of AC fan per annum	Days/Year	250	250	250
Cost of electrical energy	INR/kWh	8.32	8.32	8.32
Energy Saving/yr	kWh	1764	1848	1890
Monetary saving per year	INR	14676.5	15375.4	15724.8
Investment	INR	35,000	35,000	35,000
Payback period	month	28.62	27.32	26.71

7.5 List of Genset & Capacity

Genset & Capacity			
S No.	**Location**	**Genset & Capacity**	**Company**
1	Arts Faculty	125 KVA	Kirloskar
2	Agriculture	62 KVA	Cummins
3	LAW Faculty	25 KVA	Kirloskar
4	Home Science	30 KVA	Kirloskar
	Total	**4**	

7.6 List of Projectors

LIST OF PROJECTORS		
Sno.	**Location**	**Projectors**
1	AG New	6
2	AG Old	5
3	B.Ed.	3
4	LAW Faculty	13
5	Arts Faculty	5
6	Admin Block	1
7	Ambedkar Hall	1
Total		**34**

8) Appendix: Profile of electrical parameters (including harmonic)

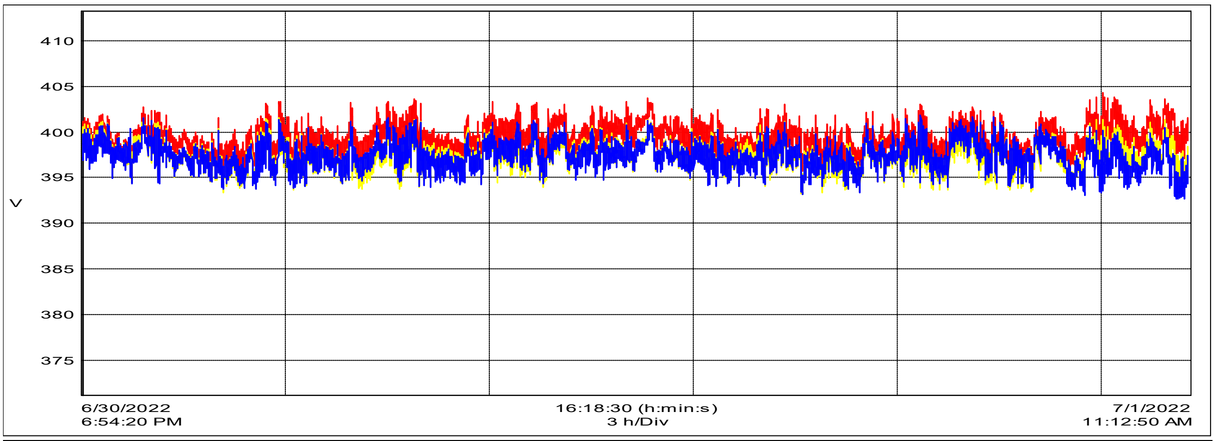
Current, Voltage, Power, Voltage harmonics, current harmonics, power factor, Voltage unbalance & current unbalance profile are given below for transformer, DG sets, CNC machine etc.

8.1 TRANSFORMER

Parameters	Avg.	Min.	Max.
Frequency	49.99	49.71	50.18

Parameters	Avg.	Min.	Max.
Ampere- R phase (A)	74.68	0.0	191.5
Ampere- Y phase (A)	39.52	0.0	347.5
Ampere- B phase (A)	89.27	0.0	138.0
Ampere- Neutral (A)	79.08	43.90	180.4
Voltage- R phase (V)	399.4	390.1	409.7
Voltage- Y phase (V)	397.4	373.7	407.3
Voltage- B phase (V)	397.4	388.6	404.8
P.F. Total	0.824	0.591	0.988
POWER- Total (KW)	38.70	-13.50	60.70
V THD % R phase	1.041	0.500	1.600
V THD % Y phase	1.078	0.400	1.700
V THD % B phase	1.212	0.500	1.900
I THD % R phase	26.80	6.900	313.5
I THD %Y phase	19.82	5.500	786.2
I THD % B phase	9.919	3.700	254.6
Voltage Unbalance %	0.335	0.0	0.800
Current Unbalance %	55.92	20.50	109.1

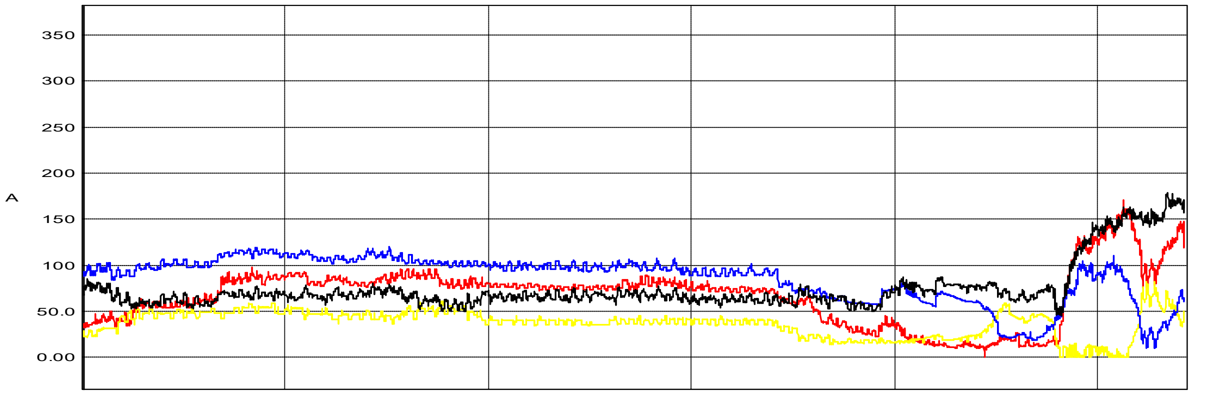
Figure 9. Voltage Profile of TRANSFORMER



Observation:

- The average voltage in Red phase is 399.4V and it varies from 390.1V to 409.7V.
- The average voltage in Yellow phase is 397.4V and it varies from 373.7 V to 407.8V.
- The average voltage in Blue phase is 397.4V and it varies from 373.6V to 404.8V.

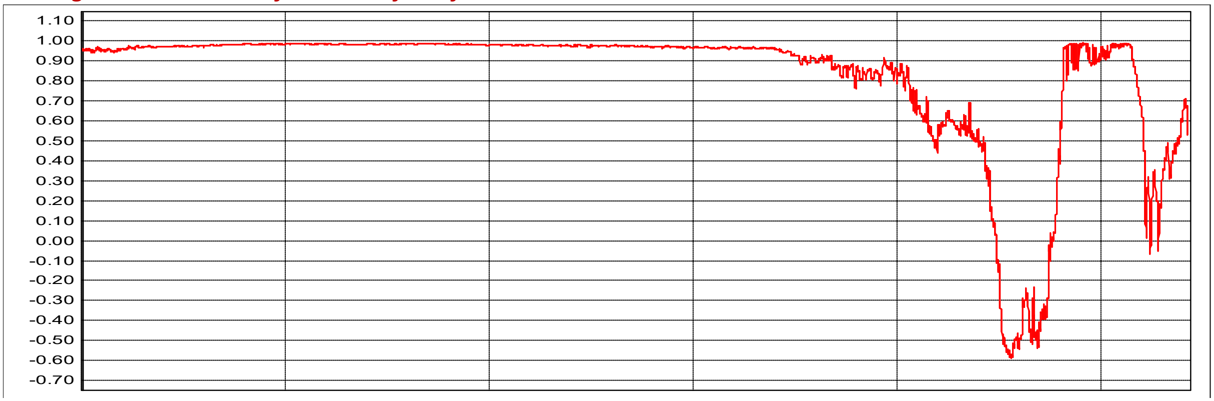
Figure 10. Current Profile of TRANSFORMER



Observation:

- The average current in Red phase is 74.68 A and it varies from 0.0A to 191.5A.
- The average current in Yellow phase is 39.52 A and it varies from 0.0 A to 347.5 A.
- The average current in Blue phase is 89.27A and it varies from 0.0A to 138.0 A.

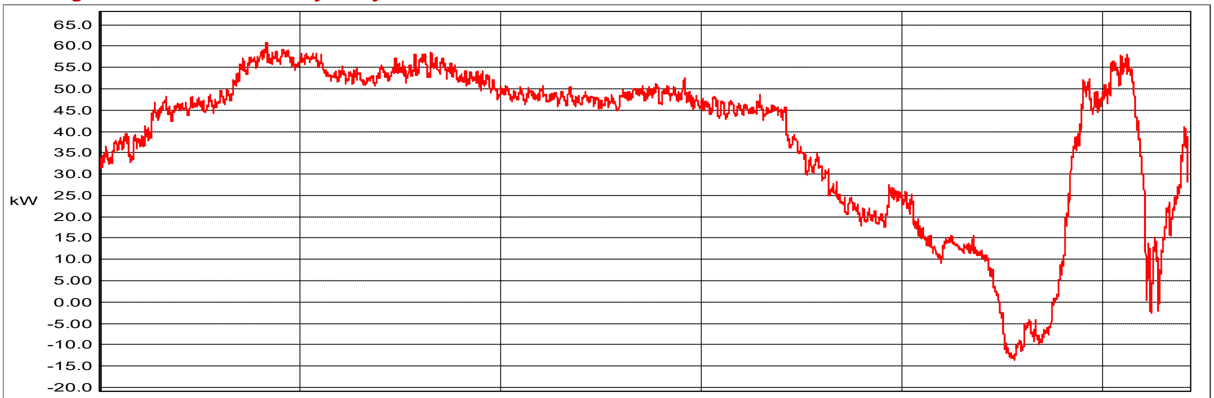
Figure 11. Power factor Profile of TRANSFORMER



Observation:

- The average power factor is 0.824 and it varies from 0.591 to 0.988

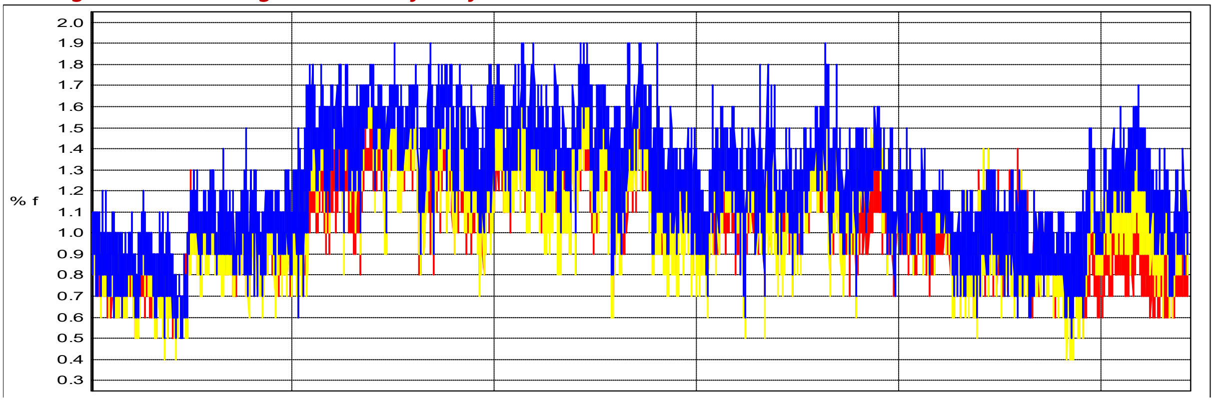
Figure 12. Power Profile of TRANSFORMER



Observation:

- The average power is 38.70KW and it varies from -13.50KW to 60.70 KW.

Figure 13. Voltage THD% Profile of TRANSFORMER



Observation:

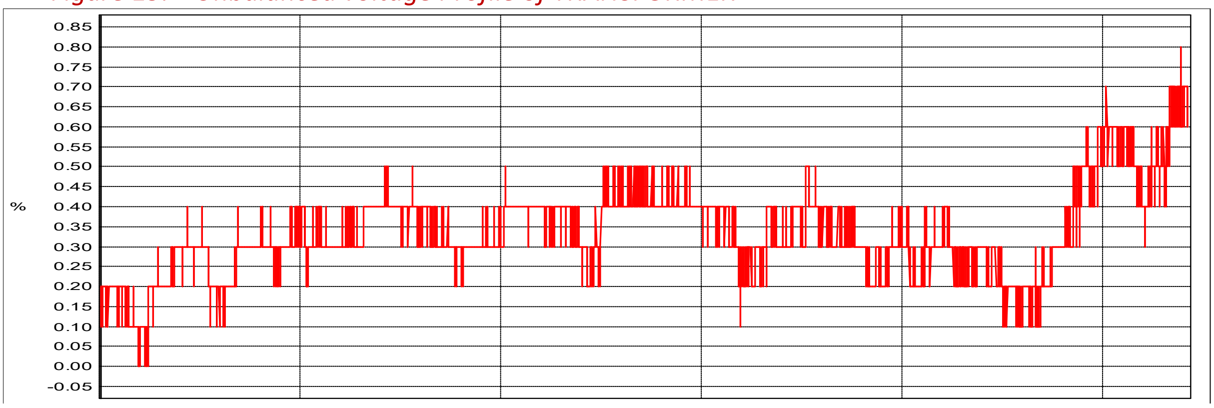
- The average THD% of voltage in Red phase is 1.041 % and it varies from 0.500% to 1.600%.
- The average THD% of voltage in Yellow phase is 1.078% and it varies from 0.400% to 1.700%.
- The average THD% of voltage in Blue phase is 1.212% and it varies from 0.500% to 1.900 %.

Figure 14. Current THD% Profile of TRANSFORMER

Observation:

- The average THD% of current in Red phase is 26.80% and it varies from 6.900% to 313.5 %.
- The average THD% current in Yellow phase is 19.82% and it varies from 5.500% to 786.2%.
- The average THD% of in current Blue phase is 9.91% and it varies from 3.700% to 254.6%.

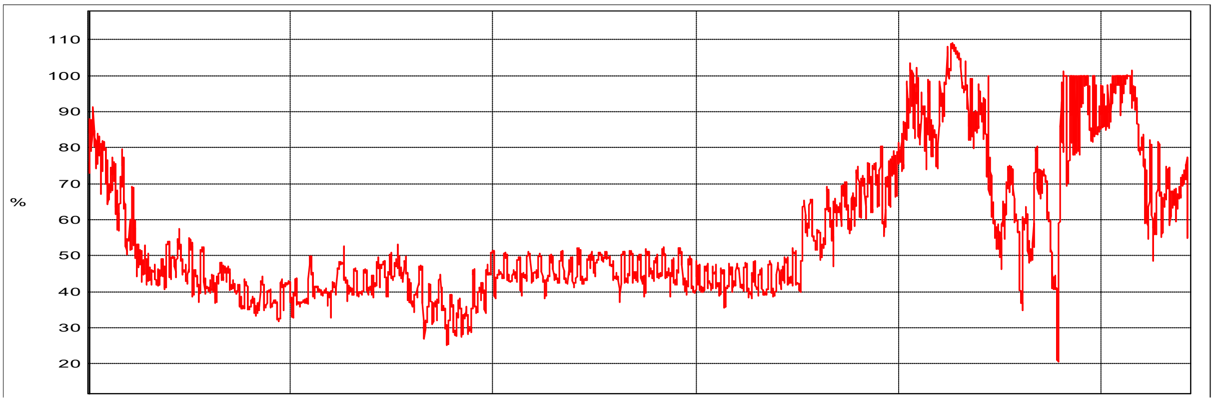
Figure 15. Unbalanced voltage Profile of TRANSFORMER



Observation:

- The average unbalanced voltage is 0.335% and it varies from 0.0 % to 0.800%.

Figure 16. Unbalanced Current Profile of TRANSFORMER



Observation:

- The average unbalanced current is 55.92% and it varies from 20.50% to 109.1%.

9) CHECKLIST & TIPS FOR ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

• Optimise the tariff structure with utility supplier

• Schedule your operations to maintain a high load factor

• Shift loads to off-peak times if possible.

• Minimise maximum demand by tripping loads through a demand controller

• Stagger start-up times for equipment with large starting currents to minimize load peaking.

• Use standby electric generation equipment for on-peak high load periods.

• Correct power factor to at least 0.90 under rated load conditions.

• Relocate transformers close to main loads.

• Set transformer taps to optimum settings.

• Disconnect primary power to transformers that do not serve any active loads

• Consider on-site electric generation or cogeneration.

• Export power to grid if you have any surplus in your captive generation

• Check utility electric meter with your own meter.

• 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)

• Use energy-efficient motors where economical.

• Use synchronous motors to improve power factor.

• Check alignment.

• Provide proper ventilation (For every 10oC 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%)

Drives

• Use variable-speed drives for large variable loads.

• Use high-efficiency gear sets.

• Use precision alignment.

• Check belt tension regularly.

• Eliminate variable-pitch pulleys.

• Use flat belts as alternatives to v-belts.

• Use synthetic lubricants for large gearboxes.

• Eliminate eddy current couplings.

• Shut them off when not needed

Fans

• Use smooth, well-rounded air inlet cones for fan air intakes.

• Avoid poor flow distribution at the fan inlet.

• Minimize fan inlet and outlet obstructions.

• Clean screens, filters, and fan blades regularly.

• Use aerofoil-shaped fan blades.

• Minimize fan speed.

• Use low-slip or flat belts.

• Check belt tension regularly.

• Eliminate variable pitch pulleys.

• Use variable speed drives for large variable fan loads.

• Use energy-efficient motors for continuous or near-continuous operation

• Eliminate leaks in ductwork.

• Minimise bends in ductwork

• Turn fans off when not needed Blowers

• Use smooth, well-rounded air inlet ducts or cones for air intakes.

• Minimize blower inlet and outlet obstructions.

• Clean screens and filters regularly.

• Minimize blower speed.

• Use low-slip or no-slip belts.

• Check belt tension regularly.

• Eliminate variable pitch pulleys.

• Use variable speed drives for large variable blower loads.

• Use energy-efficient motors for continuous or near-continuous operation.

• Eliminate ductwork leaks.

• Turn blowers off when they are not needed.

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.

• 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) returnmall loads requiring higher pressures.

• Increase fluid temperature differentials to reduce pumping rates.

• Repair seals and packing to minimize water waste.

HVAC (Heating / Ventilation / Air Conditioning)

• Tune up the HVAC control system.

• Consider installing a building automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.

• Balance the system to minimize flows and reduce blower/fan/pump power requirements.

• Eliminate or reduce reheat whenever possible.

• Use appropriate HVAC thermostat setback.

• Use morning pre-cooling in summer and pre-heating in winter (i.e. -- before electrical peak hours).

• Use building thermal lag to minimize HVAC equipment operating time.

• In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.

• In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.

• Improve control and utilization of outside air.

• Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.

• Reduce HVAC system operating hours (e.g. -- night, weekend).

• Optimize ventilation.

• Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).

• Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.

• Use evaporative cooling in dry climates.

• Reduce humidification or dehumidification during unoccupied periods.

• Use atomization rather than steam for humidification where possible.

• Clean HVAC unit coils periodically and comb mashed fins.

• Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.

• Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.

• Check pneumatic controls air compressors for proper operation, cycling, and maintenance.

• Isolate air conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.

• Install ceiling fans to minimize thermal stratification in high-bay areas.

• Relocate air diffusers to optimum heights in areas with high ceilings.

• Consider reducing ceiling heights.

• Eliminate obstructions in front of radiators, baseboard heaters, etc.

• Check reflectors on infrared heaters for cleanliness and proper beam direction.

• Use professionally-designed industrial ventilation hoods for dust and vapor control.

• Use local infrared heat for personnel rather than heating the entire area.

• Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).

• Purchase only high-efficiency models for HVAC window units.

• Put HVAC window units on timer control.

• Don't oversize cooling units. (Oversized units will "short cycle" which results in poor humidity control.)

• Install multi-fueling capability and run with the cheapest fuel available at the time.

• Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)

• Minimize HVAC fan speeds.

• Consider desiccant drying of outside air to reduce cooling requirements in humid climates.

• Consider ground source heat pumps.

• Seal leaky HVAC ductwork.

• Seal all leaks around coils.

• Repair loose or damaged flexible connections (including those under air handling units).

• Eliminate simultaneous heating and cooling during seasonal transition periods.

• Zone HVAC air and water systems to minimize energy use.

• Inspect, clean, lubricate, and adjust damper blades and linkages.

• Establish an HVAC efficiency-maintenance program. Start with an energy audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

Compressors

• Consider variable speed drive for variable load on positive displacement compressors.

• Use a synthetic lubricant if the compressor manufacturer permits it.

• Be sure lubricating oil temperature is not too high (oil degradation and lowered viscosity) and not too low (condensation contamination).

• Change the oil filter regularly. • Periodically inspect compressor intercoolers for proper functioning.

• Use waste heat from a very large compressor to power an absorption chiller or preheat process or utility feeds.

• Establish a compressor efficiency-maintenance program. Start with an energy audit and follow-up, then make a compressor efficiency-maintenance program a part of your continuous energy management program.

Compressed air

• Install a control system to coordinate multiple air compressors.

• Study part-load characteristics and cycling costs to determine the most-efficient mode for operating multiple air compressors.

• Avoid over sizing -- match the connected load.

• Load up modulation-controlled air compressors. (They use almost as much power at partial load as at full load.)

• Turn off the back-up air compressor until it is needed.

• Reduce air compressor discharge pressure to the lowest acceptable setting. (Reduction of 1 kg/cm2 air pressure (8 kg/cm2 to 7 kg/cm2) would result in 9% input power savings. This will also reduce compressed air leakage rates by 10%)

• Use the highest reasonable dryer dew point settings.

• Turn off refrigerated and heated air dryers when the air compressors are off.

• Use a control system to minimize heatless desiccant dryer purging.

• Minimize purges, leaks, excessive pressure drops, and condensation accumulation. (Compressed air leak from 1 mm hole size at 7 kg/cm2 pressure would mean power loss equivalent to 0.5 kW)

• Use drain controls instead of continuous air bleeds through the drains.

• Consider engine-driven or steam-driven air compression to reduce electrical demand charges.

• Replace standard v-belts with high-efficiency flat belts as the old v-belts wear out.

• Use a small air compressor when major production load is off.

• Take air compressor intake air from the coolest (but not air conditioned) location. (Every 50C reduction in intake air temperature would result in 1% reduction in compressor power consumption) • Use an air-cooled aftercooler to heat building makeup air in winter.

• Be sure that heat exchangers are not fouled (e.g. -- with oil).

• Be sure that air/oil separators are not fouled.

• Monitor pressure drops across suction and discharge filters and clean or replace filters promptly upon alarm.

• Use a properly sized compressed air storage receiver. Minimize disposal costs by using lubricant that is fully demulsible and an effective oil-water separator.

• Consider alternatives to compressed air such as blowers for cooling, hydraulic rather than air cylinders, electric rather than air actuators, and electronic rather than pneumatic controls.

• Use nozzles or venturi-type devices rather than blowing with open compressed air lines.

• Check for leaking drain valves on compressed air filter/regulator sets. Certain rubber-type valves may leak continuously after they age and crack.

• In dusty environments, control packaging lines with high-intensity photocell units instead of standard units with continuous air purging of lenses and reflectors.

• Establish a compressed air efficiency-maintenance program. Start with an energy audit and followup, then make a compressed air efficiency-maintenance program a part of your continuous energy management program.

10) Energy Auditor Certificates

Regn No. EA-19771

Certificate No. 8890

National Productivity Council

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr. / Mrs. / Ms. ......Deepak.......

son / daughter of Mr.....Vineet Kumar.......

has passed the National certification Examination for Energy Auditors held in September - 2016, conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India.

He / She is qualified as Certified Energy Manager as well as Certified Energy Auditor.

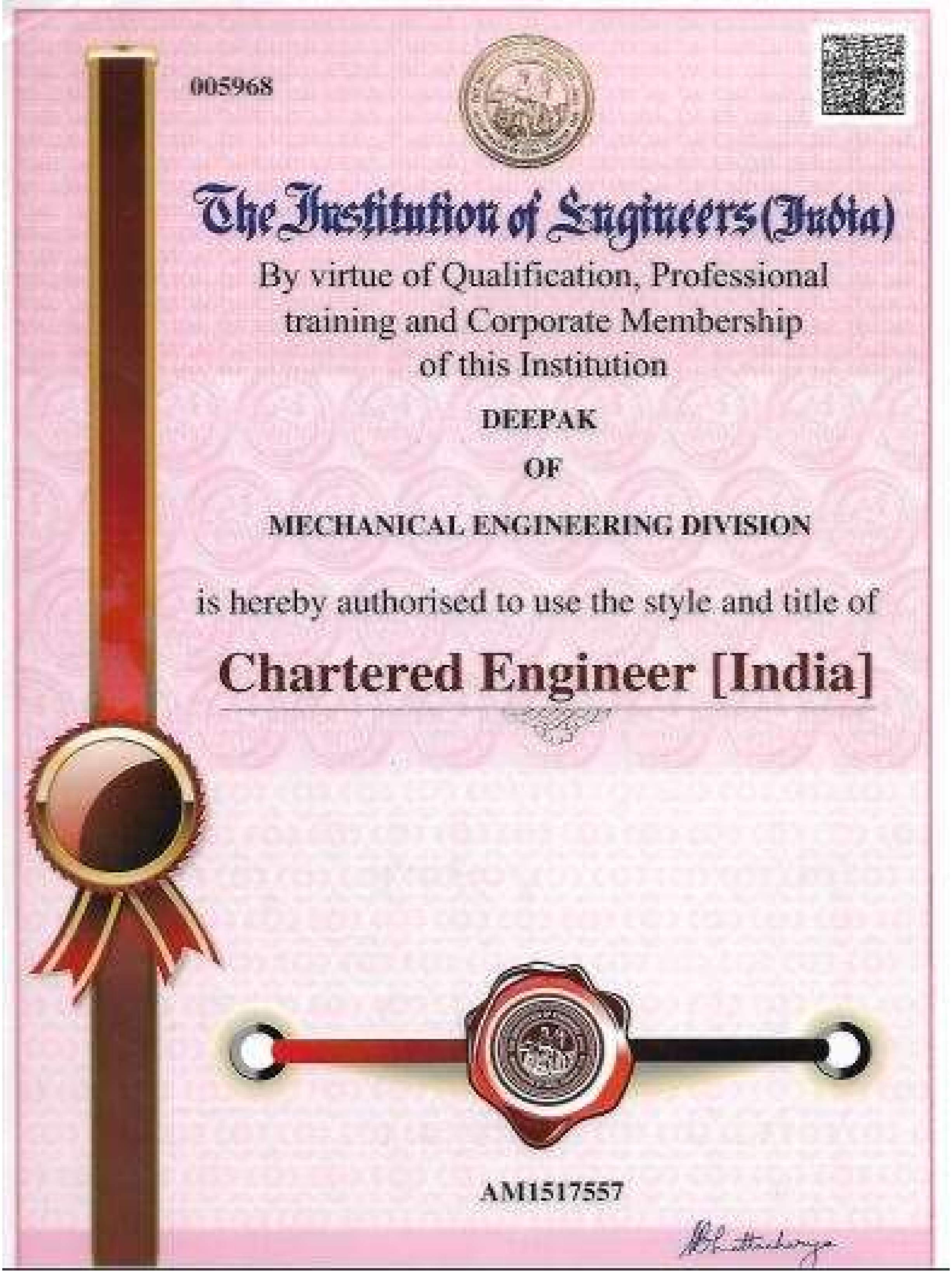
He / She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for the Accredited Energy Auditor and issue of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the issuance of an official certificate by the Bureau of Energy Efficiency.

Place : Chennai, India

Date : 10th March, 2017

Controller of Examination



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The Institution of Engineers (India)

By virtue of Qualification, Professional training and Corporate Membership of this Institution

DEEPAK

OF

MECHANICAL ENGINEERING DIVISION

is hereby authorised to use the style and title of

Chartered Engineer [India]

AM1517557

THANKS