ENERGY AUDIT REPORT

Uttaranchal University Dehradun

15th to 20th October. 2018

Audit Conducted by

Association of Energy Conservation & Environment Protection
Dehradun, Uttarakhand

Acknowledgement

We would like to thank all the staff of University whose assistance was a milestone in the completion of this Energy Audit project. We wish to give thanks to University management and staff who took the time to respond on our query and help us to collect data as required for Energy Audit of entire University campus.

We also like thank to Mr. Jagdeesh Joshi, Dr. Kartikey Gaur, Dr. Nirmal Chandra Uniyal, Mr. Akram Ansari senior management and College staff who took the time to provide and gather data from University Departmental buildings to complete this study. We also acknowledge the hard work and leadership of our core team member Mr. R.K.Agarwal, Mr. Ashish Vashishth, Mr. Vibhor Agarwal and Mr. Naresh Tariyal of Association of Energy Conservation & Environment Protection.

Last but not the least we thank to Mr. Jitendra Joshi, Chancellor Uttaranchal University and all senior Officials for their guidelines, unconditional support & Interest who directed this study.

Energy Audit Team

- Mr. Ashish Vashishth (BEE Certified Energy Auditor) - Project Head
- Mr. R.K. Aggarwal (BEE Accredited EA) – Project Guide
- Mr. Vibhor Aggarwal (B.Tech.) – Energy Auditor
- Mr. Naresh Tariyal – Data Compile

Summary of electrical energy saving potential

Ch No.	Narration	Saving potentials			
		kWh lacs	Amount Lacs	Expenditure Lacs	PBP
1	**Power factor improvement**				
i	Improving power factor from 0.915 to 0.99 by repair, replacement of relay, additional capacitors, 2nd APFC for 2nd transformer	1.014	5.88	1.8	4
2	**Reducing voltage**				
i	Shifting transformer taps to normal position (3); using both servo stabalisers for buildings	0.13	0.77	0.40	6
3	**Lighting**				
1	Replacing 500 fluorescent tubes installed on walls without reflectors with LED at proper angle	0.16	0.91	0.8	11
2	Replacing 25 nos 3*36 W CFL with LED	0.04	0.22	0.25	14
	Total saving	**0.19**	**1.12**	**1.05**	11
4	**Ceiling fans**				
	Purchase all new star rated	0.398	2.3	6.95	36
5	**Air conditioners**				
i	Operate all conditioners at 26-27 oC	0.02849	0.165	0	0
	Total Electrical saving	**1.368**	**7.934**	**3.250**	**5**

Summary of HSD saving potential

Ch no.	Item	Saving potentials			
		kL	Amount Lacs	Expenditure Lacs	P BP
1	Insulation of all flue gas pipes, proper clearance from openings, less voltage & frequency during operation, monitoring of specific fuel consumption etc	1.8	1.05	0.15	2

Specific energy consumption or Energy performance index for buildings in this university is as follows:

	This university	Limit for day use
Total Electricity consumption - lacs kwh	1724739	
Total covered area of university - m2	82081.8	
So specific energy consumption or EPI – kwh/ m2/ year	**21.01**	26

GENERAL

About Report: This is a brief report covering all energy consuming equipment. It contains one words and one xls file. It has been prepared in the order of saving potential with least payback period. All rough calculations in xls are attached to explain formulae's etc and enable staff to understand basics of calculations. Print only those sheets, where annexure no. is given. All remaining are rough calculations or basic data for reference. Everything mentioned in this report is implementable

Important point to check : We wanted to arrive at energy consumption of air conditioners, fans, lighting etc. For this, we measured load of some samples as well as relied upon standard data. Then hours of working were collected from staff after discussion. Based upon it, we worked out annual energy consumption. Then we co-related it with actual and applied suitable factor like 75% & 85%. On this basis of this energy consumption, we calculated saving potential. All this is given in xls sheets.

1) All saving potential calculations are reliable. But in some cases, investment figures may vary as it is difficult to track latest rates.

2) Mostly saving potential calculations are based upon actual measurement/ standards and very few unavoidable cases on assumption

CONTENTS

Objective of study: Due to rising tariff, everybody is making efforts to reduce energy consumption with the twin aim of reducing energy bill, fast depleting natural resources and pollution. With this aim in mind, the Uttaranchal University, Dehradun authorities got this study done to explore energy saving potential.

About Uttaranchal University, Dehradun : Uttaranchal University is constituted with the merger of professional institutes of Sushila Devi Centre for Professional Studies & Research Society, namely Law College Dehradun, Uttaranchal Institute of Technology and Uttaranchal Institute of Management. It is ranked amongst one of the best universities in the country. It offers an array of multi–disciplinary courses and great placement opportunities for all the students. Uttaranchal University offers multi-disciplinary study programs under its following institutes:

- Law College Dehradun (LCD)
- Uttaranchal Institute of Technology (UIT)
- Uttaranchal Institute of Management (UIM)
- Uttaranchal Institute of Pharmaceutical Sciences (UIPS)
- School of Applied & Life Sciences (SALS)
- School of Agriculture (SOA)
- University Polytechnic (UP)

About Electrical consuming equipment installed in University – It is a big university with lot of equipment installed in it. While details have been dealt in respectively chapters, brief is as follows:

Particulars	**Fy. Yr. 18-19**
Supply voltage - KV	11
No of transformers – 11/ 0.433 kV, 500 kva	2
Contract Demand - KVA	500
Total Energy consumption / annum – Grid, D G Set , Solar - lacs kWh	15.282
Total HSD Consumption – KL	58.62
Total D.G. Sets	2
Major loads – Nos	
Air conditioners	74
Various luminaries	5521
Fans	3189
LED TV	23
240W Desktop computers	984
Water coolers	81
& some other miscellaneous equipment	
Solar	
Solar Power plants capacity	208 KWp
Solar water Heater plants	40000 Lpd

About AECEP & Audit Team:

"Association of Energy Conservation and Environment Protection" working in the field of Energy Consultancy, ISO 50001 (An Energy Management System), Solar Power plant consultancy as well as Green & Environment Audit and Certification, we provide a complete solution for Energy Conservation and Monitoring for Organizations.

Our members are working in the Energy Conservation Consultancy field from a long time and having all required Instruments to conduct Audit. We are born to deliver the best solutions in the field of Energy Management as well as Quality Management Systems which adds even more value, modernize and provide efficient solutions for Organization's existing Management systems.

Er. R K Aggarwal

He is BE (Elect). After retirement from Bhakra Management Board as Member (Power), started consultancy in energy conservation in 2000. He is BEE's certified (EA-0179) (Passed their examination in first batch of 2004) as well as accredited energy auditor (Accredited energy auditor-0111) and PCRA's empanelled energy auditor (Since 2001). Some of his achievements in energy audit field are as below:

i) He has carried out energy audit of more than 435 industries & buildings. It includes 7 DC's during base line M& V, 5 M & V during 15-16 & 5 mandatory audits of DC's during 15-16 & 14 during 2017-20 & more than 15 DC's otherwise than mandatory.

ii) Possess all imported & branded energy audit instruments.

iii) His contributions to draft codes on transformers, motors, refrigeration, lighting, driers, piping were found very well by BEE during 2005 for which they gave me both cash (Highest amongst 3 selected for contribution) and commendation certificate.

2). Published material- One book on **"**Over hauling, Life assessment, Refurbishment & Up rating of hydro power plants". To the best of his knowledge, this is the only exhaustive book on this subject.

Er. Ashish Vashishth

18 years of Experience in Manufacturing Industries, Assy. Plants, Residential & Commercial Buildings, Steel Sector, Forging Sector in all aspects of Energy Conservation. Head of the Society "Association of Energy Conservation and Environment Protection" since 2007 also empaneled with PCRA, UREDA, CREDA (SDA of BEE) as well as APITCO for which carried Energy Audit at State as well as National Level. I have also conducted a number of Seminars, Quiz Programmes and Workshops etc. regarding Energy Conservation in various parts of Uttarakhand. I have been also awarded as The Best Energy Auditor for the year 2010 under Uttrakhand Energy Conservation by UREDA

Er. Vibhor Aggarwal

i. He is B.E. (Electronics & communication). He is in energy audit & conservation consultancy for the last 5 years. He has carried out 3 M & V, 8 MEA audits of designated consumers and 56 medium & small scale consumers and buildings. He has Attended 3 nos two day's training courses of PEDA for green buildings & learned proper operation of building software. He was associated with safety audit of 50 bank buildings. He has also passed NPC's industrial & buildings safety on line safety examination.

1) REVIEW OF PRESENT ENERGY CONSUMPTION

The Electricity demand is met from following sources:

i. **Purchase from Grid** : It is major source of power
ii. **Solar** : The university authorities have installed 210 KWp capacity over roof top.
iii. **D G Sets** are also used when grid supply fails. This use is rare. Proper running record & HSD consumed is maintained. But energy meters are not installed. Assuming average production of 3.5 kwh/liter of HSD, total production comes to about 205167 kWH.

Summary of energy consumption is as follows:

Source	Total	%age	~ cost Rs Lacs
Grid	1319845	76%	79.2
Solar	208334	12%	0.0
D G Sets	205167	12%	35.2
Total	1733346		114.4

Thus Electricity cost alone comes to about Rs 140 Lacs
The Grid supply is supplemented by 210 KWp Solar power plant spread across 5 separate buildings.

2) **The tariff is discussed as follows**:

i. **Contract demand**: The sanctioned contract demand is 353 KVA. The running demand is also coming near about this. So it is satisfactory.

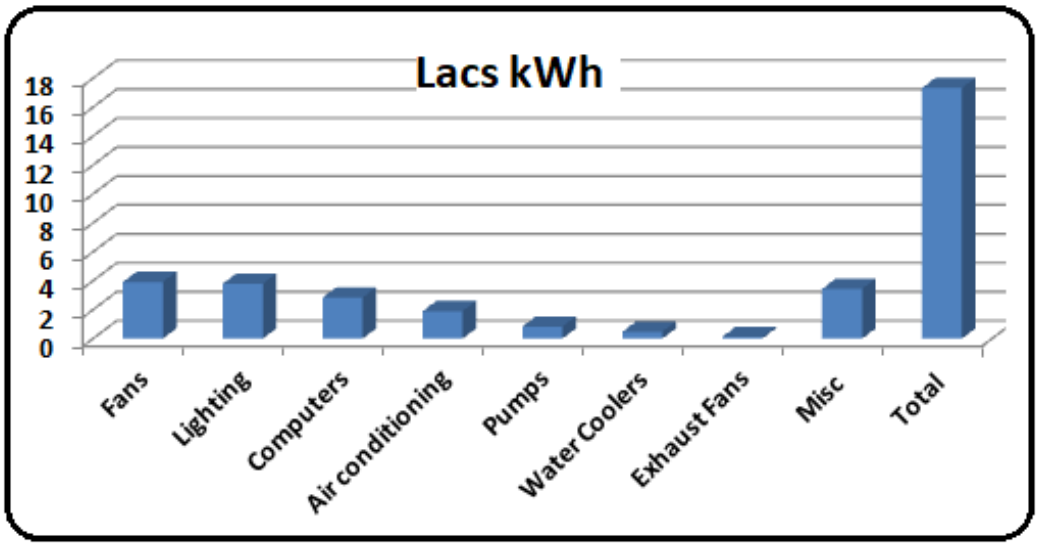
ii. **Power factor**: The average power factor from Electricity bills was found 0.92. The energy charges are based on kVAH reading. It is suggested that power factor be increased to average 0.99. Saving on this score is as follows:

Narration	Values
Annual kWh- Lacs	13.20
Existing PF	0.92
Proposed PF	0.99
kVAH with existing power factor	14.346
kvah with proposed power factor	13.331
Saving in kVAH - Lacs	1.0143
Rate / kvah including other variable charges	5.8
Amount savable - Rs lacs	5.88
Expected investment on replacement of damaged capacitors, relay , APFC on 2nd transformer	1.8
Payback period – Months	4

3) Share of energy consumption in different processes- The auditors tried to calculate energy consumption of various equipment as independent meters are not installed. Details have been given in respective xls sheets and dealt separately. The summary of the same is as follows:

	Lacs kWh	**age**
Annual Energy Cons	**17.33**	100%
Fans	3.917	23%
Lighting	3.798	22%
Computers	2.849	16%
Air conditioning	1.899	11%
Pumps	0.831	5%
Water Coolers	0.475	3%
Exhaust Fans	0.119	1%
Misc Mess & Canteen refrigerators, Construction, lifts, misuse, etc	3.442	20%
Total	**17.330**	**100%**

Thus fans and lighting consumptions are predominant in this building. Consumption is graphically shown as follows:



Specific energy consumption: Government of India has made audit of building with contract demand of more than 120 KVA compulsory. Some guide lines for energy consumption of buildings is as follows:

Narration		KWH/ Sq. m/year
Normal for fully air conditioned building 24 hours working		200 to 400
Possible for fully air conditioned building 24 hours working		120 to 140
Mandatory for fully air conditioned building for day use		140
Mandatory for non air conditioned building for day use		26
Star rating for composite climate	**Air conditioned area >50%**	**Air conditioned <50%**
5	Below 90	Below 40
4	90-115	40-50
3	115-140	50-60
2	140-165	60-70
1	165-190	70-80

Specific energy consumption or Energy performance index for buildings in this university is as follows:

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So specific energy consumption or EPI – kwh/ m2/ year	21.01	26

The maximum limit by BEE for day use is 26 kWH/m2/year. Administrative blocks, lectures halls laboratories etc are used during day time and hostels are used from evening to morning. No standards for such use are available. Still, the assessed energy consumption is less than BEE standard.

2) USE OF RENEWABLE ENERGY IN UNIVERSITY

In a bid to reduce dependence on fossil fuel produced energy, the university authorities have made efforts to use as much renewable energy as possible. For this, they have installed PVC solar cells for producing Electricity and solar water heaters for producing hot water for students for bating & other purposes. It is a very good step.

1) Solar Power Plant

5 Nos Solar power plants distributed under 7 nos inverters have been installed across the university with the total installation of 208 KWp were commissioned during last week of of September 2018. All of the Power Plants are properly installed in shade free area. These are well maintained.

Solar panels installed on most of University offices

The electricity production from that has already been discussed earlier. The same is reproduced as follows:

Source	Total	%age	~ cost Rs Lacs
Grid	1319845	76.5%	79.2
Solar from October 18 to march 2019	208334	12.1%	0.0
D G Sets	205167	11.4%	35.2
Total	1733346		114.4

Thus about 12.1 % electricity is met through Solar power. It is very good. Most the roof space available is either covered by solar power plants or by solar water heaters at hostels. Most of roofs of constructed area are covered.

3. Solar Water Heaters

10 nos solar water heaters each of 2000 litre per day totalling 20000 Lpd capacity are installed on top of hostels for hot water requirements of students. To provide hot water during cloudy days or when proper heat is not available, Hybrid system has been installed here that enables the authorities to turn on electric heaters to get hot water. The water heated in the solar heaters is stored in the insulated tanks each of 2000 liter capacity. The water is used by the students in the morning/ evening hours.

As the hot water is mostly needed in winter season, it is suggested that in summers, the hot water be utilized in mess kitchens where electric water heaters are provided for heating food at the time of serving food and also in cleaning. If need be, additional storage capacity can be created.

Solar water heaters installed on roof top of each hostel

Some observations are as follows:

i. As stated, some hot water can be used in kitchen in summer
ii. Install energy meter for each block to measure power consumed by electric heaters. If found more, then remedial measures like providing additional hot water tank can be taken.
iii. The maintenance was satisfactory

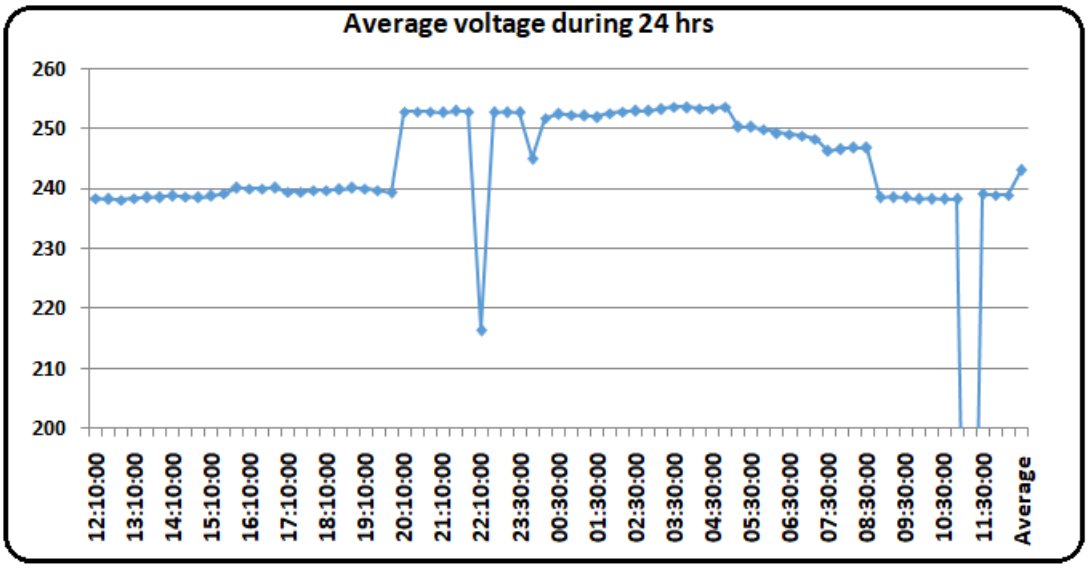
4) VOLTAGE

The university authorities have installed 2*500 kva, 11000/433 volts transformers for receiving electrical supply from grid. It is a good arrangement. The auditors measured power supply for 24 hours with an on line power analyzer. The voltage profile of those 24 hours is as follows:

Time	V1	v2	v3	Avg V
12:10:00	236	238	241	238
12:30:00	236	238	241	238
12:50:00	235	238	241	238
13:10:00	236	238	242	238
13:30:00	236	238	241	238
13:50:00	236	238	242	239
14:10:00	236	238	242	239
14:30:00	236	238	242	239
14:50:00	236	238	242	239
15:10:00	236	238	242	239
15:30:00	236	239	242	239
15:50:00	237	240	243	240
16:10:00	237	239	243	240
16:30:00	237	239	243	240
16:50:00	237	239	243	240
17:10:00	237	239	243	239
17:30:00	237	239	243	239
17:50:00	237	239	243	240
18:10:00	237	239	243	240
18:30:00	237	239	244	240
18:50:00	237	239	244	240
19:10:00	237	239	244	240
19:30:00	237	239	243	240
19:50:00	236	238	243	239
20:10:00	250	252	257	253
20:30:00	250	252	257	253
20:50:00	250	252	257	253
21:10:00	250	251	257	253
21:30:00	250	252	257	253
21:50:00	250	252	257	253
22:10:00	214	215	220	216
22:50:00	250	251	256	253
23:10:00	250	252	256	253
23:30:00	250	252	256	253
23:50:00	243	244	249	245
00:10:00	249	251	256	252
00:30:00	250	251	256	252
00:50:00	250	251	256	252
01:10:00	250	251	256	252
01:30:00	249	250	256	252
01:50:00	250	251	257	253
02:10:00	250	251	257	253
02:30:00	250	251	257	253
02:50:00	250	251	257	253

03:10:00	251	252	257	253
03:30:00	251	252	258	254
03:50:00	251	252	258	254
04:10:00	251	252	258	253
04:30:00	251	252	258	253
04:50:00	251	252	258	254
05:10:00	247	249	255	250
05:30:00	248	249	255	250
05:50:00	247	248	254	250
06:10:00	246	248	254	249
06:30:00	246	248	253	249
06:50:00	246	247	253	249
07:10:00	245	247	253	248
07:30:00	243	245	251	246
07:50:00	244	245	251	247
08:10:00	244	245	251	247
08:30:00	244	245	251	247
08:50:00	236	237	243	239
09:10:00	236	237	243	239
09:30:00	235	237	243	238
09:50:00	235	237	243	238
10:10:00	235	237	243	238
10:30:00	235	237	243	238
10:50:00	235	237	243	238
11:10:00	112	113	115	113
11:30:00	236	238	243	239
11:50:00	236	238	243	239
12:10:00	236	238	243	239
Max	251	252	258	254
Min	214	215	220	216
Average	**240**	**242**	**247**	**243**

It is represented by following graph:



Here, we can see that the voltage remains high all the time. It ranged from 225 to 254 volts, with average of 243 volts. Electrical equipment is rated for 230 volts in the range of 220-240 volts. Higher voltage results in high Energy consumption & has detrimental effect on equipment.

Its effect is discussed as follows:

1. **Effect of voltage on lighting-** At present about 3300 fluorescent tubes are installed. *Normal fluorescent tubes are designed for 230 volts. Best efficiency of conventional fluorescent tubes is obtained at about 215 volts .It is brought out that higher voltage besides causing premature damage to luminaries, also unnecessarily increases power consumption as illustrated by following table-*

Sr. no	Lamp	90% voltage	110% voltage
1	**Fluorescent tube light**		
	Light output	-9%	+8%
	Power input	**-15%**	**+18%**

Thus net effect of 110% voltage is 10% excess consumption in fluorescent tubes & about 5% in other tubes.

2. **Effect on fans**: The increase in voltage increases fan power consumption as well as noise level. University authorities have already installed electronic regulators on all fans. But if this regulator is used at maximum point, then both energy consumption & noise level increases. So as far as possible about 220 volts should be supplied.

3. **Other equipment**: For best efficiency, voltage should be 220-230 volts .

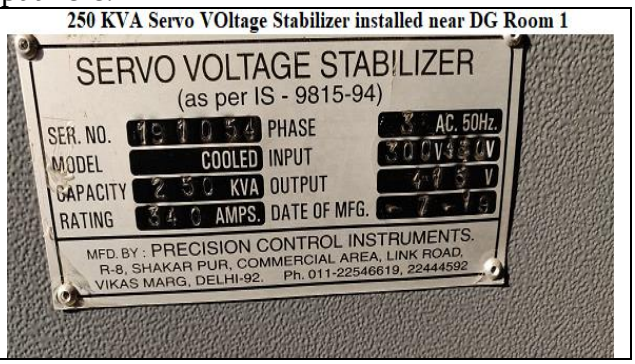
4) Remedial measures: Following can be done without much investment:

i. **Transformer Taps**: One transformer tap is at no. 1 position and 2nd is at no. 3 position. It is suggested that both be kept at no. 3 position.

Location	Rated kVa	Tap	Effect
DG Room 1	500	2	2.5% higher
DG Room 2	500	1	5% higher

ii. One 250 kva voltage stabilizer is installed for computer labs & library. It is under-leaded. Load of some adjoining buildings can be put here.

250 KVA Servo VOltage Stabilizer installed near DG Room 1



iii. One stabilizer installed for the auditorium remains idle for most times as auditorium is used rarely. A changeover switch can be fitted and it can feed stable voltage to the other

buildings and hostels. By this, detrimental effect of high voltage and unnecessary high energy consumption of various equipment can be avoided.

Approximate saving & investment are as follows

Narration	Units	Values
Present annual Energy Consumption from grid	KWH	1319845
Assume modest 1% Saving by reducing voltage	KWH	13198
Amount savable @ Rs5.8/KWH	Rs	76551

5. POWER FACTOR

Presently, automatic Power Factor Controller (APFC) Panel has been installed on transformer 1 only. The auditors checked the Annual Power Factor coming out to average 0.915. Following reasons were found responsible:

1) The relay was faulty. It may be got repaired or replaced so that proper nos of capacitors remain ON. It is an 8 step relay; this time 12 step relay should be installed.
2) The capacitors installed are of bigger size. It is suggested that 5-6 smaller capacitors of capacities 1-5 KVAR be installed so they can cater to the smaller adjustments needed for proper Reactive Power supply.
3) Capacitor panel is not installed on Transformer 2. It was informed that it is already planned. This work can be done on priority. The capacity is calculated in the following table.

The effect of low power factor has already been discussed in earlier chapter.

6) LIGHTING

The university authorities gave us complete details of luminaries installed in all institutes under university. The auditors surveyed about 50 % area and compared type of fittings, their height, and type of reflectors. Some data was collected verbally. Based upon this survey and data obtained from plant authorities, hours and days of running, the energy consumption is calculated as follows (xls file sheet "Luminaries" row 44 to 103) :

S.No	Location	Nos	Watts	Annual KWH
1	Fluorescent Tubes	3560	46	240531
2	LED Tubes	1910	20	56108
3	LED bulbs	1310	6	11545
4	LED outdoor fitting	30	36	3110
5	CFL troffer fittings	39	3*36	7278
6	CFL bulb	90	12	1586
	Total	**6939**		**320159**

Thus total energy consumption as per above table is 3.2 lacs kWh.

2) Following is observed plant data, verbal discussion & field checking-

i. Most of the Fluorescent & LED tubes in hostels are installed in on walls rather than ceiling. Due to this, very less direct light falls on the working plane; most of it reaches working plan after reflection. It is suggested that tubes be shifted to ceiling wherever possible so direct light falls on working plane and proper utilization of light is done.

ii. All Fluorescent tubes approximately 3560 nos. are without reflectors & most of these are installed on walls. .

Though the authorities have already taken many steps for reduction, yet some more need to be taken. Energy conservation is an endless task. After each step another is ready. Some of saving potentials are as follows:

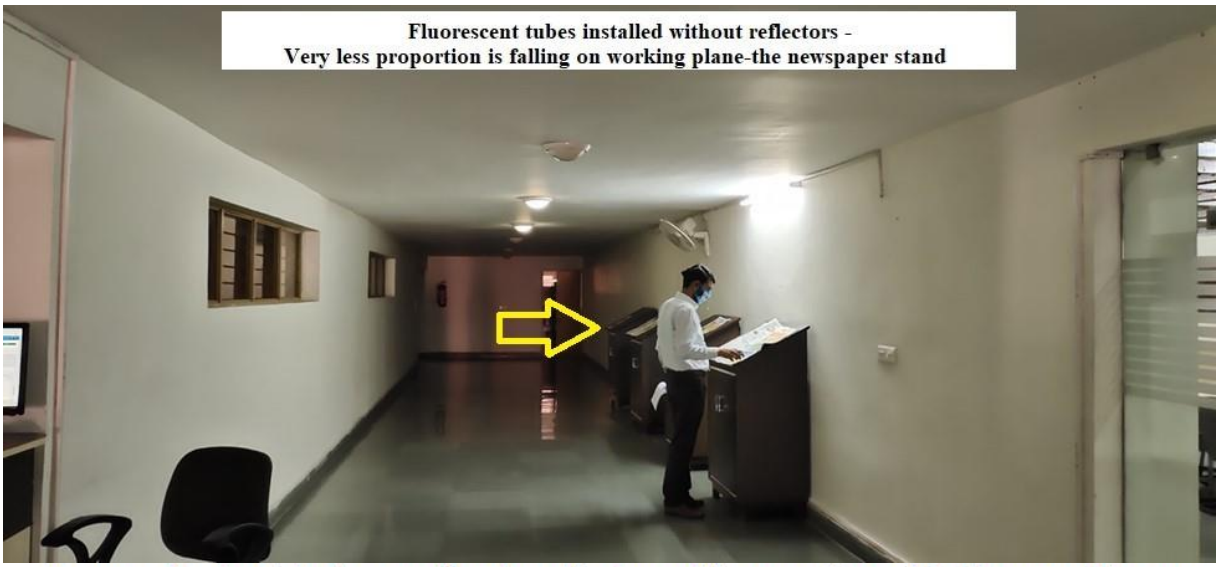
3) Fluorescent tubes:

3.1) Reflectors/ Reflection Factor: *Depending upon quality of reflector surface, some light is absorbed by it and some is reflected to working plane. A good reflector increases light output by over 50% than ordinary reflector, thereby decreasing no. of light points. The quantity of reflected light depends upon reflection factor, which is the ratio of reflected light to incident light. For different surfaces, it is as follows: -*

- *Silvered glass - 0.5 to 0.85*
- *Stainless steel - 0.55 to 0.60*
- *Chromium plate - 0.55 to 0.60*
- *Vitreous enamel - 0.60 to 0.70*
- *Plastic Polymer in mirror optic finishing -0 .80 to 0.85*

- *Aluminum Sheet: High purity aluminium sheet, anodized* -0.85

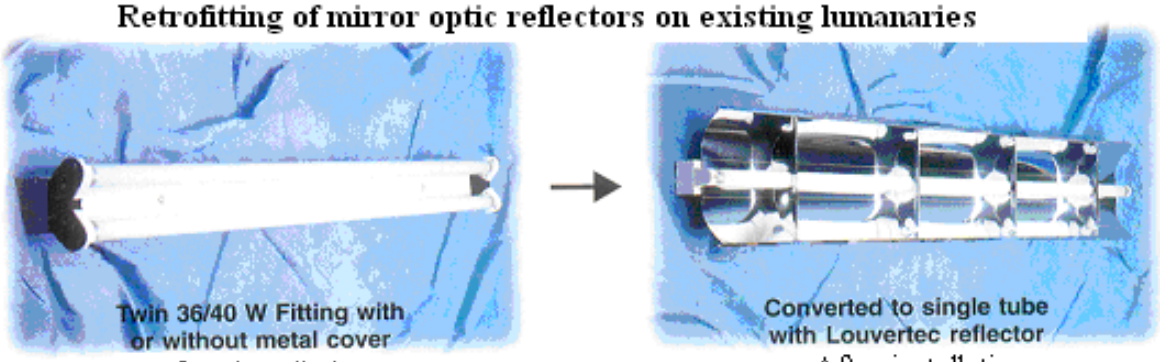
All 40 W Flourescent tubes without reflectore. In hostels, all installed on walls



Lumanaries installed on walls w/o reflectors. Minor portion of light on working area

In the picture given above, most of the light is directed at the opposite wall, the ceiling, the wall below and ground which are called non-working planes. Very less light is directed at the intended table that is the working plane. The light received on the working plane comprises of direct light as well as reflected light reflected from ceiling and wall. This effect is well explained and backed with a calculation further in this chapter.

Retrofitting of mirror optic reflectors on existing lumanaries



Before installation

After installation

Effect of installation on walls: It has been discussed above. Light does not fall on working plane. It is illustrated with following images:

2*36 Watts tubes on walls- Light does not fall on working plan

Proper angle lamp bracket to enable light to fall on working plan

The bracket can be made better, good looking as well as can be tilted to suit any angle

A small study table. Existing lux level with 9 W LED is better than earlier 40 watt on wall. This can be further improved

By this method lux level will increase & wattage of tube can be decreased. It may also become possible to de-lamp some fluorescent tubes.

4) Replacement of fluorescent tubes with LED lamps: A comparative table of fluorescent tubes installed on walls with LED lamp installed at proper angle with a reflector is is shown below.

	40 W Fluorescent	**28 W -T5**	**20W LED**
	w/o reflectors	**Silver optic reflectors**	**20 W**
Total Watts with choke	**44**	**32**	**24**
Lumen/ watt	**55**	**90**	**75**
Total light	100%	100%	100%
Direct light	33%	33%	100%
Reflected light	67%	67%	0%
Average reflection factor	40%	80%	100%
Average light transmitted through reflection -%	27%	54%	0%
So total light received on working plane	60%	87%	100%
Actual lumen received / Watts	33	78	75
Possibility of energy saving by installing LED			
Expected wattage of LED including system	**11**	25	24
%age saving	76%		

Considering the actual Lumens/Watt received, only 11W LED light will be sufficient in comparison to 40W Fluorescent tubes. Next size available in the market is 12W that can be installed. The University authorities are aware of the saving potential of LED tubes. We suggest replacement of 500 fluorescent tubes with 12 Watt lamps with proper angle bracket. The saving & investment is as follows:

Narration	Values
Wattage for 1 Fluorescent tube + Ballast	44
Wattage for 1 LED bulb + Ballast	15
Saving / flo - Watts	29
Saving for 500 tubes in 5 hours 9 months 24 days - kwh	15660
Money savable -Rs@ Rs 5.8/KWH	90828
Investment @ Rs160 per bulb	80000
Payback period- Months	11

4) **3*36 Watts CFL Troffer lights**: 39 such lights are installed in central library & some more are installed at different locations. These have following defects:

i. CFL lamps being compact version of fluorescent tubes are less efficient than latter.

ii. With passage of time, conventional reflectors installed on these have become dull. So light reflection is less.

iii. The cover on these has also become dirty.

3*36 W CFL Troffer lights. Some dirty also

It is suggested that these be replaced on priority. Approximate saving potential & investment is as follows:

Narration	Values
Wattage for 1 lumanary + Ballast (3*36+ 3*6)	126
Wattage for LED bulb + Ballast	40
Saving / flo - Watts	86
Saving for 25such troffer lights 8 hours 9 months 24 days - kwh	3715
Money savable -Rs@ Rs 5.8 /KWH	21548
Investment @ Rs 1000 per LED	25000
Payback period- Months	14

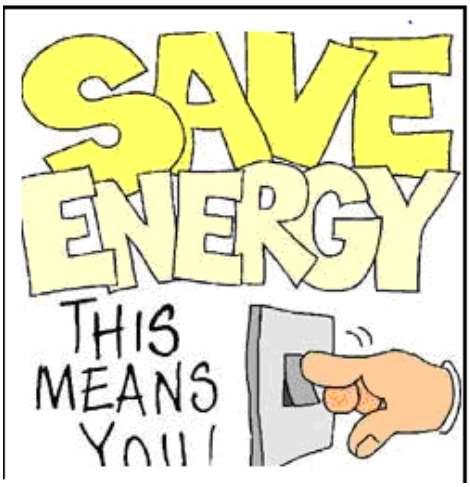
5) LUX Level measurement-

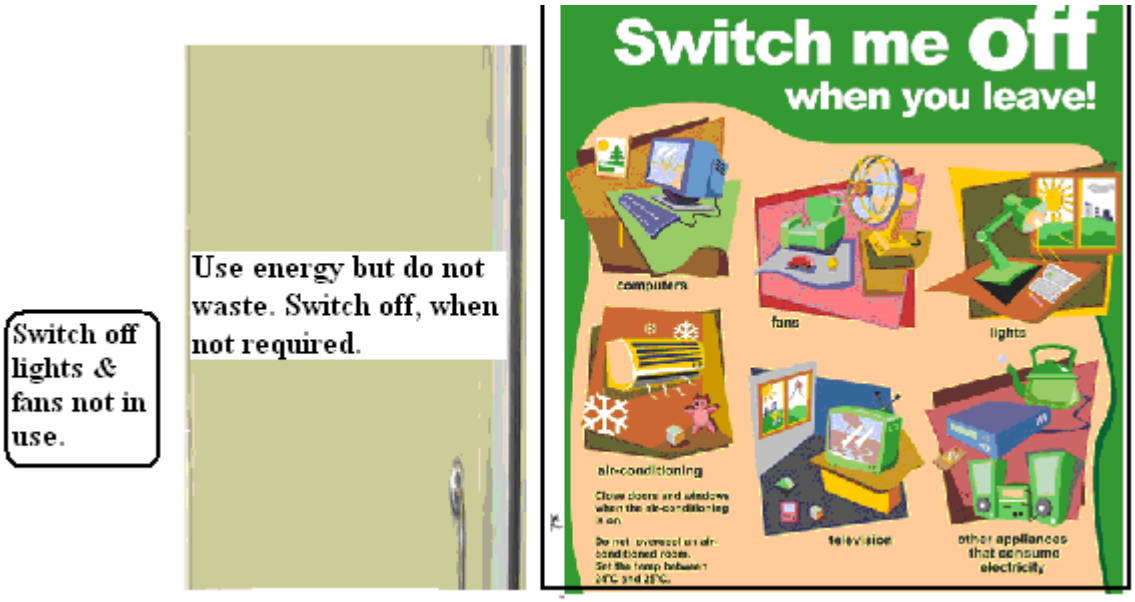
Lux level at various places was measured by LUX meter. The values are as follows:

S.N.	Location	LUX	
		Working plane	Non-Working plane
1	Main office	280,265,233	180,175,300
2	Reception	60,75,45	
3	Workshop area	75,105,125,130	78,75, 65
4	Library	220,230,245,250	124,56,55

Actually, these measurements were taken during day time, when sufficient natural light is also available.

6) Posters & stickers – During our stay, we found some misuse of lighting. Then as informed, students are regularly guided not to misuse energy. It is suggested that postures & stickers be installed at all important locations and in each room. Some samples are attached below.





The university authorities can design their own posters.

7) Summery of saving potentials in lighting: -

Sr. no	Item	Saving Potentials		Investment	PB P
		KWH lacs	Amount Rs. Lacs	Rs. Lacs	Months
1	Replacing 500 fluorescent tubes installed on walls without reflectors with LED at proper angle	0.16	0.91	0.8	11
2	Replacing 25 nos 3*36 W CFL with LED	0.04	0.22	0.25	14
	Total saving	**0.19**	**1.12**	**1.05**	11

6) CEILING FANS

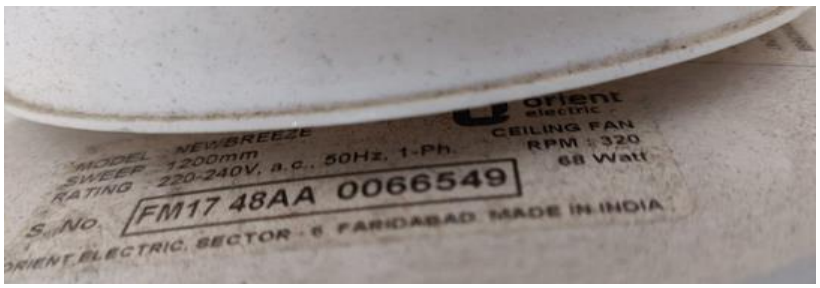
1) **Existing fans**- In this university about 3539 fans are installed. All fans are of 3 blades and 1200 mm sweep. These are installed in all air conditioned as well as non- air conditioned rooms. It is a good practice. In an air conditioned space, a fan breeze make 26 ^{0}C room feel like 22.5 ^{0}C. Thus by lowering the thermostat, air conditioned load can be saved. In hostels, these fans operate for about 12 to 13 hours in hostels and about 7 to 8 hours in class rooms and in offices about 6 to 7 hours. Based upon this, the average annual energy consumption is as follows (xls file sheet "Fans" row 26 to 33):

2) Energy consumption – The consumption of new fans is 68 Watts/ fan & of old fans is about 72 W/fan.. On this basis, the auditors calculated power consumption fans. The calculation can be found at (xls file sheet "Fans" row 29 to 68). The same is reproduced as follows:

S.No	Location	Fans	Hrs/day	Months	kWH
1	Main building	150	9	8	17655
2	Library	276	9	8	32486
3	Pharmacy	248	9	6	21893
4	T & P building	82	8	6	6424
5	Workshop building	68	8	8	7102
6	Mechanical building	73	8	6.5	6195
7	UIBS /HM building	73	8	6.5	6195
8	Civil building	256	9	6.5	24482
9	Diploma building	136	9	6.5	13006
10	UIM building	201	9	6.5	19222
11	Agricultural building	290	9	6.5	27734
12	Law building	334	9	6.5	31942
13	Project Office	6	9	6.5	574
14	Estate Office	5	9	6.5	478
15	cafeteria	5	9	6.5	478
16	Security Office	5	9	6.5	478
17	DG Room	5	9	6.5	478
18	food Court	59	9	6.5	5642
19	Guest House	21	2	7	541
20	Messes	178	7	7	13749
21	AlI Hostel Boys & Girls	1004	14	7	155102
	Total	**3475**			**391857**

Thus average 3.92 Lacs kWh which is 23% of total energy consumption is consumed.

1) **Name plate data: A name plates of a new fan is shown below:**



It indicates power consumption of 68 W & voltage range of 220 to 240 Volts. The air volume produced is not shown over these standard fans.

4) Star rated fans: Considering huge energy consumption and saving potential in ceiling fans, BEE has issued star rating. Fans are rated for 1 to 5 stars depending upon their energy consumption. 5 star rated fans consume 50 to 53 watts. More than 15 companies are on approved for star rating. Using star rated fans means reducing energy consumption from existing 68 Watts to 50 watts i.e. about 26 %. The name plate of star rated fans indicates air volume & noise level also. It is suggested that all future purchases for new works or replacement be of star rated.

5) Super efficient fans: 3 companies in India are manufacturing BLDC fans. Here rotor is of permanent magnet and stator is D C wound with a built in rectifier. It is remotely controlled. They claim its power consumption from 28 to 35 Watts at full speed. But, we don't suggest at present as repair facilities are yet not available in this area.

6) Saving potential by replacing fans: Based upon above studies and measurement, saving and investment for replacement are as follows (xls file sheet "Fans" row 72 to 91) :

	Super fans			**5 star rated**	**Existing**
Make	**Gorilla**	**Super fan**	**R R Fans**		
First Cost - Rs	3700	3300	3100	2450	2000
Watts	28	35	30	50	68
Assume average	31			50	68
Replacement	**wrt super fan**	**w.r.t 5 star**			
Power savable by replacing - W	37	18			
Power savable by replacing - %	54%	26%			
For 20% Fans- No of fans	**695**	**695**			
Energy consumption of 20% fans - kWh	73068	73068			
Energy saving potential - kWh	39758	19342			
Amount savable @Rs5.94/KWH	230594	112181			
Average cost/ fan after considering Rs 1000 as resale value	2000	1500			
Total investment - Rs	1390000	1042500			
Payback Period - months	72	112			
Purchase of new fans					
Price difference	1000	750			
Total investment - Rs	695000	521250			
Payback period - months	36	56			

It is seen from above calculations that saving potential by replacing with super fans is 54% and with 5 star rated fan is 26%. But due to running for only 5 to 7 months in a year, it is not techno-economically viable to replace. Purchase for new installation is viable. Besides energy saving, at the time of purchase, special fans with 4 blades and low speed can be purchased to reduce noise level. This is necessary in educational institutes for reducing noise level.

7) Miscellaneous

Fan regulators – Electronic regulators are installed in all places. We measured noise level due to running of 6 to 7 fans in class rooms when voltage was around 245. We feel that at this noise level, it must be difficult for teacher to speak properly. Voltage effect has been discussed in chapter 2. If it is resolved, the noise level will drop down, energy consumption will reduce and life span of fans will also be maintained.

Summary of saving potential

Nil as replacement is not justified. However, all new purchases should be of star rated.

7) AIR CONDITIONING

90 nos. air conditioners are installed in various institutions of this university. The location and energy consumption has been calculated at xls file sheet AC row to 1 to 16. Same is shown below:

S. No	Location	Air conditioners	Tons	Hours	Months	Annual KWH
1	Main Building	2	2	10	7	9240
2	Main Building	2	1.5	10	7	6930
3	Main Building	5	1	10	7	11550
4	Library	8	1.5	10	7	27720
5	Pharmacy	3	1.5	8	7	8316
6	T & P Building	6	1	7	7	9702
7	UIBS /HM building	2	1	7	7	3234
8	Diploma building	3	1.5	7	7	7277
9	UIM building	5	1.5	7.5	7	12994
10	law Building	10	1	8	7	18480
11	Project Office	1	1.5	6	7	2079
12	DG Room	1	1.5	10	7	3465
13	Guest House	17	2	7	7	54978
14	Auditorium	13	100	4	0.08	13728
	Total	**78**	**119**			**189692**

Out of all these, 25-30Nos are 2 star rated, 20-25 are 3 star rated and rest are non-star rated. The non star rated are installed at places with less running hours. But new Air Conditioners are installed in the administration building where the running hours are the most.
These operate from Mid March to mid October i.e. for about 7 months.

2) Performance assessment of units – Basically, it is measured at worst and average conditions. So, it should have been measured in April or May or June during day time when ambient temperature is average 40 °C and at night time, when it is about 30 to 32 °C. At the time of measurement, ambient temperature was around 26.4 °C. For performance assessment, the auditors measured following

i. The air conditioners are rated for 35 °C ambient temperature. Normal room temperature is kept 25 °C. To compensate for low ambient temperature, we decreased room temperature setting to minimum. Thus about 13 °C decrease in ambient temperature was to sufficient extent compensated by low room temperature setting.

ii. Area and air inlet & their velocities, ambient and room temperatures – both dry and wet bulb was measured. The same is shown at xls file sheet AC flow annexure no. 5.1. Due to less area and intermixing of air from other nearby units, reliable readings cannot be obtained in field. For this, a duct has to be provided on both in let as well as out let.

5) Maintenance air conditioners: As informed by staff, each air conditioner is cleaned and washed at the beginning of summer season. The Air conditioners were in a good condition being air flow was satisfactory.

7) Air conditioned room temperature – *Every 1^0C decrease in room temperature increases energy consumption by 3%*. Then in offices also, we expect that it is being kept 24 to 25 °C. In an air conditioned space, a fan breeze make 26^0C room feels like 22.5^0C. Thus by lowering the thermostat, air conditioned load can be saved. We suggest that looking into present day cost of electricity and impact on environment, the average temperature kept 26 to 27 °C as fans are installed in all rooms. The office staff can be asked to keep 25 to 26 °C. The Air conditioners to be purchased in the future will have their minimum temperature fixed at 24 °C. Expected saving and investment by increasing set temperature is as follows:

Narration	Unit	Value
Total energy consumption	Lacs kWh	1.899
%age saving expected	%	1.50%
Total Saving	KWH	2849
Amount savable @Rs. 5.8 /KWH	Rs	16521
Investment	Rs	0

8) Miscellaneous: There is following energy saving potential:

- Minimizing heat gains through walls and doors.
- Minimizing heat gain through open doors.
- Using high efficiency lighting producing minimum heat
- Provide double glazing on all windows.
- Provide insulation on all walls exposed to western side.

Heat gain coefficient through different glass surfaces is as below: -

S. No	Product	Solar Heat Gain Coefficient (SHGC)	Thermal Conductivity	Daylight Transmittance
1	Clear Glass	0.72	3.16	79
2	Body Tinted Glass	0.45	3.24	65
3	Clear double layer glass with about 12 mm air film	0. 3	3.0	65
4	Hard Coated Solar Control Glass	0.26	3.27	24
5	Soft Coated Solar Control Glass	0.18	3.08	15
6	Low Emissivity Glass	0.56	2.33	61
7	Solar Control + Low Emissivity Glass	0.23	1.77	41

Summary of saving : Due to proper maintenance, less running & policy of university to make all new purchases of star rated air conditioners, only techno economical potential are increasing set temperature by 1 ^OC. It would save about 2430 kwh costing Rs 14430/- without any investment

9) D G SETS

1). DG sets installed in the building: 2 nos. D G Set are installed. These are used only on failure of grid supply. One register which indicate running hours & HSD drawn is maintained. HSD consumed & approximate energy produced has already been shown in earlier chapter. The same is produced as follows:

Source		Total	%age	Cost
Grid	kWh	1319845	76.5%	79.2
Solar	kwh	208334	12.1%	0.0
D G Sets	**58.16 kl**	**196560 kwh**	**11.4%**	**34.9**
Total		**1724739 kwh**		**114.1**

Following was also noted /observed/assumed:

i. About 58.16 kl of HSD is consumed during whole year.

ii. Energy meters are not installed on these sets. We have assumed 3.5 kwh /liter as running is very less.

iii. Any one of the sets is capable of taking whole electrical load of university.

iv. The gasses exhaust pipes & coolant pipes are not insulated. The former are at about 300 to 400 ^{O}C and latter at 70 to 90 ^{O}C. These increase air temperature slightly. *The specific energy consumption increases by 1% with every 3.5 degree centigrade rise in inlet air temperature*. The D.G.Sets are normally designed for ambient temperature of 25 to 30 degree centigrade. Higher temperature & lower suction pressure decreases efficiency. The sets are enclosed in an acoustic cover. As explained in above tables, all hot flue gas pipes are uninsulated. This heat raises enclosure temperature as and hence reduces D.G.Set efficiency.

2) Operation of D.G Sets- No record of any operating parameter is kept. It is suggested that whenever DG Set is run, at least one to 2 reading of oil temperature & pressure; water temperature, voltage, frequency & current should be taken. Most of the operators informed that:

i. **Voltage:** It is kept around 415 volts. It is suggested that it may be kept around 400 volts. It will reduce some lumens and speed of some fans but reduce fuel consumption.

ii. **Load:** The DG No 2 of capacity 380 KVA is used most of the time. Best efficiency is at around 80% load. Staff is maintaining this.

9) Summary of all above paras:

Only to keep above issues alive, we assume following saving potential:

S. No	Item	Saving potential			
		HSD-Liters	Amount Rs.Lacs	Investment Rs. lacs	P B P
1	Insulation of flue gas pipes, ccoolant cooling pipes, less voltage & frequency during operation, monitoring of specific fuel consumption etc @ 3% of consumption	1.7448	1.05	0.15	2

10) Safety aspect : MCBs

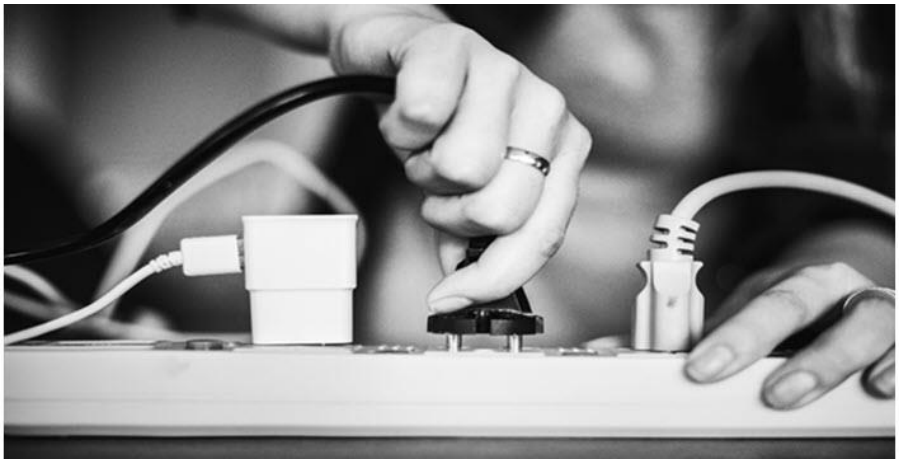
10A MCBs are installed for each room in the hostels in Verandah. Each room contains around 2-3 tube lights, 1-2 fans depending on the occupancy of the particular room and 2 plugs for student's laptops, mobile phones, etc. This comes to a total of 450W which is roughly 2.5A. The hostel warden told the auditors that sometimes students bring electric heaters, electric kettles, etc and for them surprise inspections are also undertaken by hostel staff and they are confiscated.
Presently 10A MCB is provided. This won't on overload except very high loads like 1500 W heater. It is suggested that to minimize the misuse of electricity by the students & also safety aspect, 5A MCBs should be installed for each room. This will trip when any such device is switched on and misuse can be prevented. Many reputed manufacturers like Scheneider, ABB manufacture such low rating MCBs which are ideal for this purpose.

10A MCBs installed for each room

Fire safety : Adequate fire extinguishers are installed as per fire load.

Earthing: Earth resistance of main substation & D G Sets was measured & found 2.5 & 2.8 ohms respectively. It is within limits.

Electrical Safety: Tips to Prevent Workplace Electrical Injuries



Every workplace today operates on electricity, so workplace electrical injuries are a real threat in any location. All electrical systems used in offices have the potential to cause serious harm, especially if improperly used or maintained.

Humans are good conductors of electricity. This means if the open electric circuit comes in contact with our body, we'll get a shock. The electric current will pass through our body from one point to another causing great pain, burns, damage to the tissues, nerves and muscles. This could even lead to death.

Types of Workplace Electrical Injuries

The four types of injuries that can occur due to electricity are:

- Electric shock
- Burns
- Falls
- Electrocution

How Injuries Can Happen

- Direct contact with exposed electrical circuits or energized conductors.
- Electricity arcs (due to exposed energized conductors or circuit) circulating in the air can pass through a person who is grounded.
- If the skin gets in touch with the heat generated from electric arcs, it burns the internal tissues.
- The light emitted from an electric arc flash (UV and IR) can cause damage to the eyes.
- When the potential pressure is released from an arc flash, there is an arc blast, which can collapse your lungs, cause physical injuries, or create noise that can damage hearing.

Common Electrical Hazards

Most injuries are a result of the following:

- Poorly installed, faulty and/or ill-maintained electrical equipment.

- Faulty wiring.
- Overloaded or overheated outlets.
- Use of flexible leads and extension cables.
- Incorrect use of replacement fuses.
- Use of electrical equipment with wet hands or near the source of water.

It is important that you educate your office workers about electrical safety. Here are some important tips to prevent electrical incidents.

Tips to Prevent Workplace Electrical Incidents

- Unplug or switch off electrical appliances when not in use or while cleaning, repairing or servicing.
- Ensure that all electrical appliances are turned off at the end of the day.
- Don't forcefully plug into an outlet if it doesn't fit.
- Refrain from running electrical cords across doorways, under the carpets, or in areas that witness regular activities.
- Maintain a clearance of at least 3 feet from all electrical panels.
- Use only equipment that is double-insulated and properly grounded.
- Don't overload the outlets.
- Ensure that two extension cords are not plugged together.
- Only use electrical equipment that is approved by a national testing laboratory. Buy electrical equipment from trusted electrical liquidators who sell good quality electrical surplus materials.
- Pay attention to the warning signs. Equipment may heat up, spark, smoke or make weird noise; Identify the signs and immediately take it out of service.
- Regularly check for defects in cords and equipment. Report immediately if any.
- Place a cover or guard to exposed electrical components or wires.
- While unplugging, grip the plug and pull. Don't pull the cord from a distance.
- Do not use electrical equipment or appliances with wet hands or near water and wet surfaces.
- Clearly identify potential electrical hazards, such as electrical panels, with appropriate safety signs.

Proper employee training plays a crucial role in avoiding electrical injuries at work. Fortunately, most of the electrical hazards can be easily prevented and controlled with a little caution and regular checks.