INVESTMENT GRADE ENERGY AUDIT REPORT OF UTTARANCHAL UNIVERSITY

Study Conducted from 18th to 22nd April 2018

Study Conducted by

Association of Energy Conservation & Environment Protection

GMS Road, Dehradun

Summary of Electrical Energy Saving Potential

Ch No.	Narration	Saving potentials			
		kWh lacs	Amount Rs. Lacs	Investment Rs. Lacs	PBP
	Power factor improvement & voltage reduction				
1	Using servo stabalisers properly	0.012	0.073	0	0
i	Improving power factor from 0.95 to 0.99	0.53	3.02	0.9	4
		0.54	3.09	0.90	3
2	**Solar PV Cells Power Plant (Proposed)**				
i	Install 200 kwp solar cells on roof tops	2.9	17.5	89.4	61
3	**Lighting**				
i	Replacing 1000 fluorescent tubes installed on walls without reflectors with LED at proper angle	0.31	1.82	1.6	11
ii	Replacing 25 nos 3*36 W CFL with LED	0.04	0.22	0.25	14
	Total saving	**0.35**	**2.04**	**1.85**	11
4	**Ceiling fans**				
i	Purchase all new star rated fans – 500 nos.	0.21	1.19	3.75	38
5	**Air conditioners**				
i	Operate all conditioners at 26-27 oC	0.09	0.519	0	0
	Total Electrical saving	**4.1**	**24.3**	**95.9**	**47**

Summary of HSD saving potential

Ch no.	Item	Saving potentials			
		kL	Amount Lacs	Expenditure Lacs	PBP
1	Insulation of all flue gas pipes, proper clearance from openings, less voltage & frequency during operation, monitoring of specific fuel consumption etc	**1.68**	**1.01**	**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	18.20	
Total covered area of university - m2	82082	
So specific energy consumption or EPI – kwh/ m2/ year	**22.17**	26

So EPI is less than standard limit. It is good but more potential is available.

GENERAL

About Report: This is a brief report covering all energy consuming equipment. The audit was conducted during April 2018. The construction work of most of buildings had been completed remaining was on last legs. Some classes had started & remaining was to start next year. This report coverage line Voltage, Power Factor, Lighting, Celling fan, Air conditioners, DG sets and Safety aspects. Plantation at so many locations in University campus are undergoing on status. This will create Cozy and comfortable weather for staff and students. We are recommended to University management for conduct Energy Audit every year for better analysis controlling on optimum side. We are also proposing for conduct Green and water audit of University campus.

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. Whole campus had not started working. Based upon expected hours of operation, we based our calculations of expected energy consumption of fans, lighting, air conditioners etc. During 2017-18, much of consumption was on construction machinery.

1) Most of equipment like fans, luminaries, air conditioners had already been purchased. Some were yet to be purchased. Taking expected fresh purchases, we calculated saving potential by purchasing energy efficient appliances.

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 management got this study done to explore energy saving potential. Management also planning to conduct energy audit every year to analyses the actual fact of losses and make habit for Energy saving of every person related to University.

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.

Uttaranchal University is one of the leading educational hubs of professional courses with innumerable students enrolled in different educational programs. It offers an array of multi–disciplinary courses making it a knowledge portal where excellence matters. In Uttaranchal University, we understand the potential of young minds and nurture them with passion.
Uttaranchal University can boast of being an institution par excellence. It is located in a fascinating geological setting. It is flanked by NH-72 on one side and a beautiful broad slithering river on the other side. The pine trees surrounding the area lend a pristine and wholesome ambience to the campus.

University offer a unique life, for every student to access the comprehensive facilities, cultural activities, wide range of academic courses and industry interface. The University has built up the world class learning resources which consist of the focused learning space in the form of lecture halls, series of computer centers, digital centralized library, laboratories, residential accommodation on-campus for boys and girls, sports facilities, cafeteria, canteen and Wi-Fi campus with 24×7 internet facilities.

Uttaranchal University offers multi-disciplinary study programs under its following institutes:

- Law College Dehradun (LCD) – Established in 2002
- Uttaranchal Institute of Technology (UIT) – Established in 2006
- Uttaranchal Institute of Management (UIM) – Established in 2006
- Uttaranchal Institute of Pharmaceutical Sciences (UIPS) – Established in 2016
- School of Applied & Life Sciences (SALS) – Established in 2016
- School of Agriculture (SOA) – Established in 2016

About Energy Audit Team:

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.

About Electricity 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, some brief of appliances already installed are as follows:

Particulars	Ending 31.3.18
Supply voltage - KV	11
No of transformers – 11/ 0.433 kV, 500 kva	2
Contract Demand - KVA	300
Total Energy consumption / annum – Grid, D G Set , Solar - lacs kWh	1246378
Total HSD Consumption – KL	24.400+31.683
Total D.G. Sets	2
Major loads – Nos	
Air conditioners	66
Various luminaries	4265
Fans	2988
LED TV	21
240W Desktop computers	912
Water coolers	81
Some other miscellaneous equipment	
Solar	
Solar Power plants capacity	-
Solar water Heater plants	20000Lpd

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. **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 196291 kWH.

Summary of energy consumption is as follows:

Source	Total	%age	~ cost Rs Lacs
Grid	Grid	kWh	1246378
D G Sets	dgs	56.083 kl	196291
Total	Total		1442669

Thus Electricity cost alone comes to about Rs 14.43Lacs

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

ı. **Contract demand**: The sanctioned contract demand is 300 KVA. The running demand is also coming near about this. So it is satisfactory. However, it may increase when all classes start in next academic year.

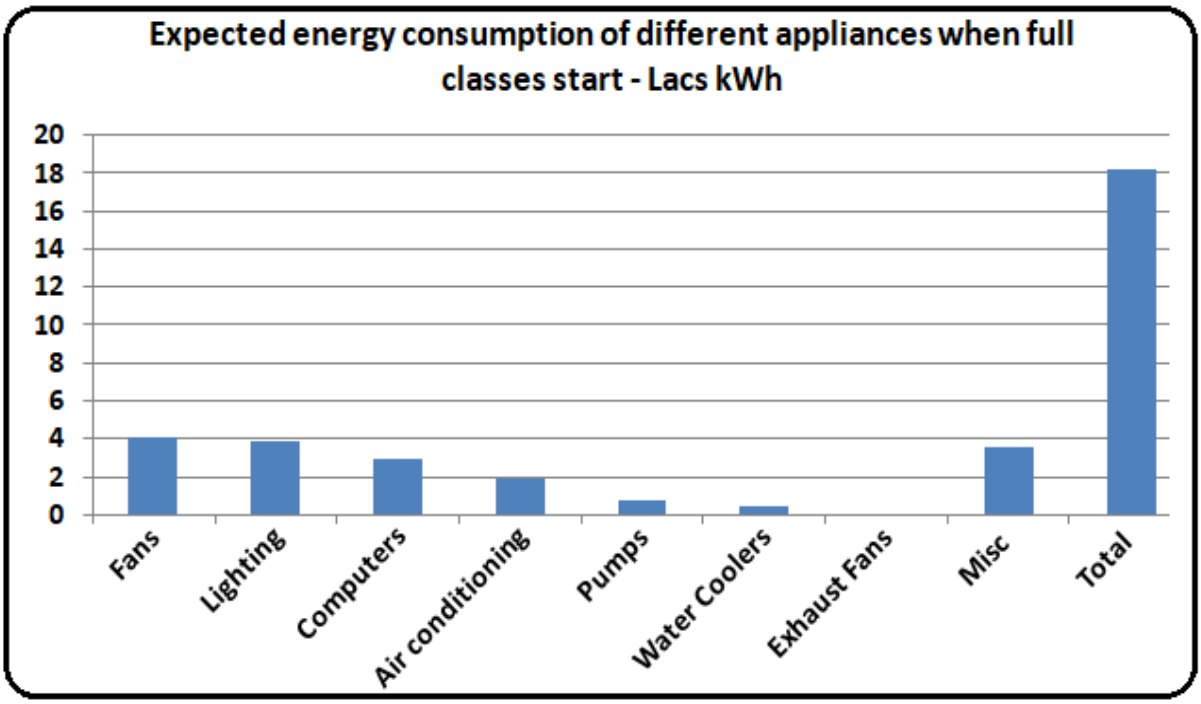
ıı. **Power factor**: The average power factor from Electricity bills was found 0.95. But it is based upon some fixed & some temporary load running due to construction. The energy charges are based on kVAH reading. It is suggested that power factor be increased to average 0.99. Saving on this score is as follows:

Narration	Values
Annual kWh from grid - Lacs	12.46
Existing PF	0.95
Proposed PF	0.99
kVAH with existing power factor	13.120
kvah with proposed power factor	12.590
Saving in kVAH - Lacs	0.5301
Rate / kvah	5.7
Amount savable - Rs lacs	3.02
Remaining more careful & proper operation of APFC panel	0.9
Payback period - months	4

3) Share of Energy consumption in different processes- Since, presently, construction work is going on & few classes are in operation, exact classification is not possible. But future energy consumption is expected as follows:

	Lacs kWh	**% age**
Fans	4.11	24%
Lighting	3.99	23%
Computers	2.99	17%
Air conditioning	1.9941	12%
Pumps	0.87	5%
Water Coolers	0.50	3%
Exhaust Fans	0.12	1%
Misc	3.61	21%
Total	**18.20**	**100%**

Thus fans and lighting consumptions are predominant in this building. Expected 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

Based upon expected energy consumption & expected completed area, expected specific energy consumption or Energy performance index for buildings in this university is as follows:

	Expected in this university after start of full classes	Limit for day use
Expected Electricity consumption - lacs kwh	18.20	
Expected total covered area of university - m2	82081.8	
So specific energy consumption or EPI – kwh/ m2/ year	22.17	26

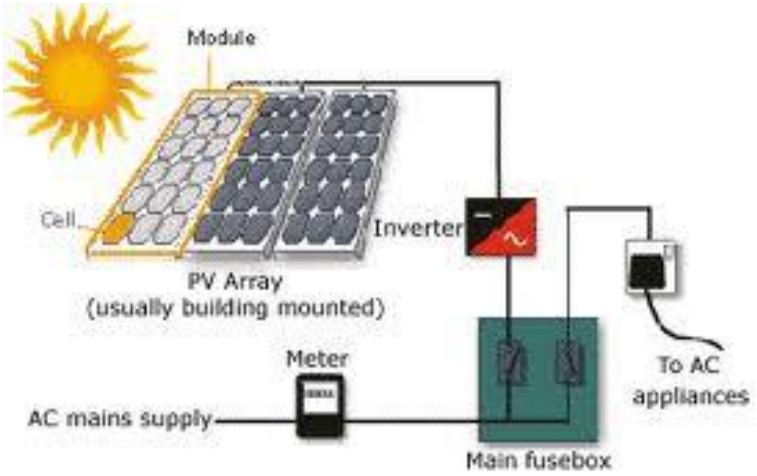
The maximum limit by BEE for day use is 26 kWH/m2/year. Administrative blocks, lectures halls laboratories etc are used during day time and hostels are used from evening to morning. No standards for such use are available. Still, the assessed energy consumption would be less than BEE standard.

3) USE OF RENEWABLE ENERGY IN UNIVERSITY (PROPOSED)

In a bid to reduce dependence on fissile fuel produced energy, world over all governments & particularly government of India is laying great stress on installing solar generating plants at roof tops. All buildings in this university have pucca roofs where there is no obstruction to sun rays. It is suggested that about 200 kwp solar panels be installed on roof tops like solar heaters installed on hostels. It is also in the mind of university authorities and they are working on it. Expected saving pot & investment is as follows:

Narration	Unit	Value
Capacity	kW	200
Area required @ 12 sq m/ kW	Sq m	2400
Rate of solar system	Rs.lacs / kW	0.52
Cost of solar system	Rs lacs	104
Accelerated depreciation @40%	Rs lacs	42
Tax saving @ 35%		14.6
Net investment	Rs lacs	89.4
Maintenance @ 3% assuming investment from own resources	Rs lacs	2.7
Net cost	Rs lacs	92.1
Electricity generation/ year @ kwh/kw	kWh /kw	1460
Electricity generation/ year	lacs kWh	2.9
Gross amount saved for this self generation @ Rs. 67/ kWh	lacs Rs.	17.5
Payback period - Months	Month	63

Solar Photovoltaic panels for lighting of Hotel sinage generates electricity of 15000 watts per day (a pilot project)



3. Solar Water Heaters 10 nos solar water heaters each of 2000 litre per day totalling 20000 Lpd capacity are already 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.

4) VOLTAGE

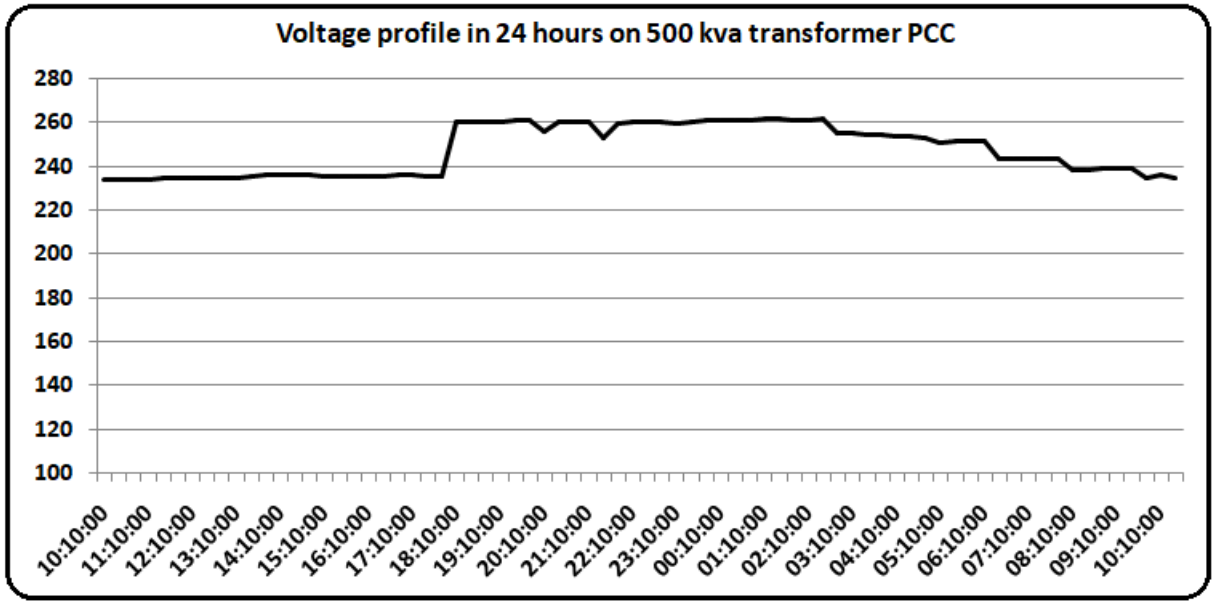
The university authorities have installed 2*500 kva, 11000/433 volts transformers for receiving electrical supply from grid. It is a good arrangement. The auditors measured power supply for 24 hours with an on line power analyzer. The voltage profile of those 24 hours is as follows:

Time	V1	v2	v3	Avg V
10:10:00	232	234	237	234
10:30:00	232	234	237	234
10:50:00	231	234	237	234
11:10:00	232	234	238	234
11:30:00	232	234	237	234
11:50:00	232	234	238	235
12:10:00	232	234	238	235
12:30:00	232	234	238	235
12:50:00	232	234	238	235
13:10:00	232	234	238	235
13:30:00	232	235	238	235
13:50:00	233	236	239	236
14:10:00	233	235	239	236
14:30:00	233	235	239	236
14:50:00	233	235	239	236
15:10:00	233	235	239	235
15:30:00	233	235	239	235
15:50:00	233	235	239	236
16:10:00	233	235	239	236
16:30:00	233	235	240	236
16:50:00	233	235	240	236
17:10:00	233	235	240	236
17:30:00	233	235	239	236
17:50:00	232	234	239	235
18:10:00	258	260	265	261
18:30:00	258	260	265	261
18:50:00	258	260	265	261
19:10:00	258	259	265	261
19:30:00	258	260	265	261
19:50:00	258	260	265	261
20:10:00	250	253	266	256
20:30:00	258	259	264	261
20:50:00	258	260	264	261
21:10:00	258	260	264	261
21:30:00	251	252	257	253
21:50:00	257	259	264	260
22:10:00	258	259	264	260
22:30:00	258	259	264	260
22:50:00	258	259	264	260
23:10:00	257	258	264	260
23:30:00	258	259	265	261
23:50:00	258	259	265	261

00:10:00	258	259	265	261
00:30:00	258	259	265	261
00:50:00	259	260	265	261
01:10:00	259	260	266	262
01:30:00	259	260	266	262
01:50:00	259	260	266	261
02:10:00	259	260	266	261
02:30:00	259	260	266	262
02:50:00	252	254	260	255
03:10:00	253	254	260	255
03:30:00	252	253	259	255
03:50:00	251	253	259	254
04:10:00	251	253	258	254
04:30:00	251	252	258	254
04:50:00	250	252	258	253
05:10:00	248	250	256	251
05:30:00	249	250	256	252
05:50:00	249	250	256	252
06:10:00	249	250	256	252
06:30:00	241	242	248	244
06:50:00	241	242	248	244
07:10:00	240	242	248	243
07:30:00	240	242	248	243
07:50:00	240	242	248	243
08:10:00	235	237	243	238
08:30:00	235	237	243	238
08:50:00	236	238	243	239
09:10:00	236	238	243	239
09:30:00	236	238	243	239
09:50:00	233	234	238	235
10:10:00	234	235	239	236
10:30:00	234	235	236	235
Average	**245**	**246**	**252**	**248**
Max	**259**	**260**	**266**	**262**
Min	**231**	**234**	**236**	**234**

The voltage is more as grid supplier has to ensure +- 6% voltage at every consumer. Many at are at far end. So they keep sending end voltage a bit higher. University gets supply at 11 kv & hence some higher voltage.

It is represented by following graph:



Here, we can see that the voltage remains high all the time. It ranged from 234 to 262 volts, with average of 248 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 .

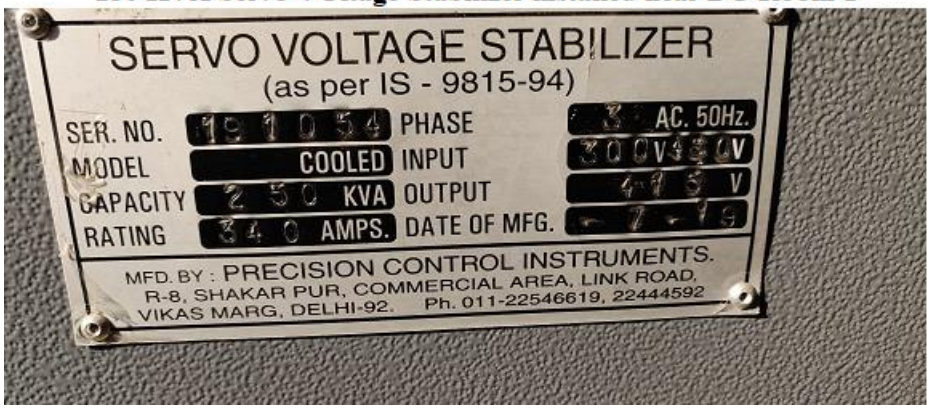
4) Remedial measures: Following can be done without much investment:

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 0.95.

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. Presently following luminaries are installed:

		Near about audit time	
S.No	**Location**	**Nos.**	**Watts**
1	Fluorescent Tubes	3769	46
2	LED Tubes	1601	20
3	LED bulbs	1206	6
4	LED outdoor fitting	19	36
5	CFL troffer fittings	30	3*36
6	CFL bulb	105	12
	Total	6730	

During audit, classes had not started in full swing. Last leg construction was going on. We calculated possible consumption next year, when full academic season starts. Expected energy consumption on luminaries as shown earlier is 3.99 lacs kWh & it will form 23% of total consumption.

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. <u>All Fluorescent tubes approximately 3769 nos. are without reflectors & most of these are installed on walls. .</u>

3) Fluorescent tubes:

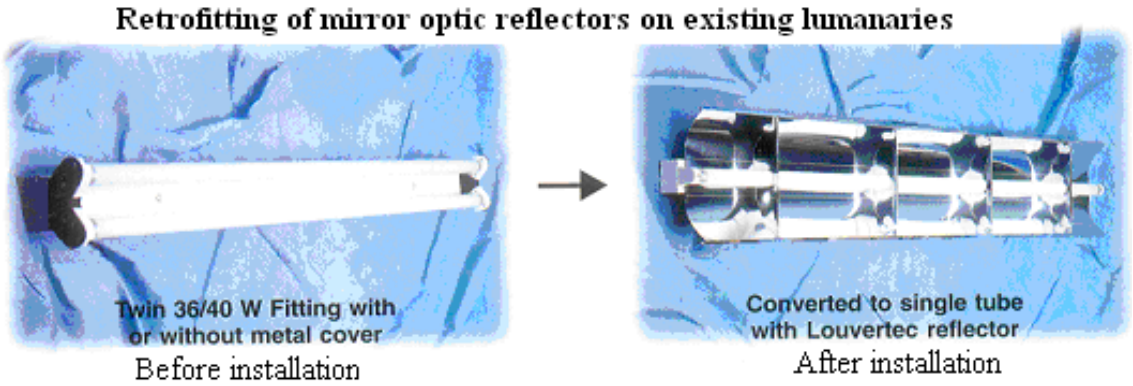
3.1) Reflectors/ Reflection Factor: *Depending upon quality of reflector surface, some light is absorbed by it and some is reflected to working plane. A good reflector increases light output by over 50% than ordinary reflector, thereby decreasing no. of light points. The quantity of reflected light depends 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

Luminaries 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.



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 1000 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 / fluorescent tubes - Watts	29
Saving for 1000 tubes in 5 hours 9 months 24 days - lacs kwh	0.313
Money savable -Rs@ Rs 5.8/KWH	1.82
Investment @ Rs160 per bulb	1.60
Payback period- Months	11

1) **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:

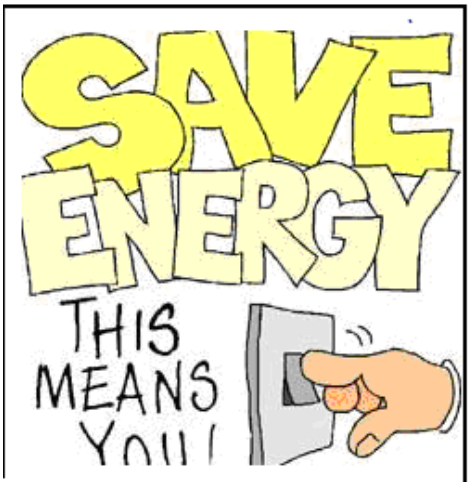
i. CFL lamps being compact version of fluorescent tubes are less efficient than latter.
ii. With passage of time, conventional reflectors installed on these have become dull. So light reflection is less.
iii. The cover on these has also become dirty.

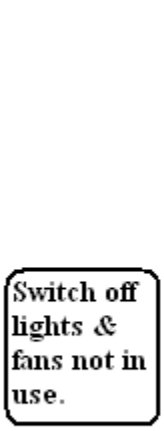
3*36 W CFL Troffer lights. Some dirty also

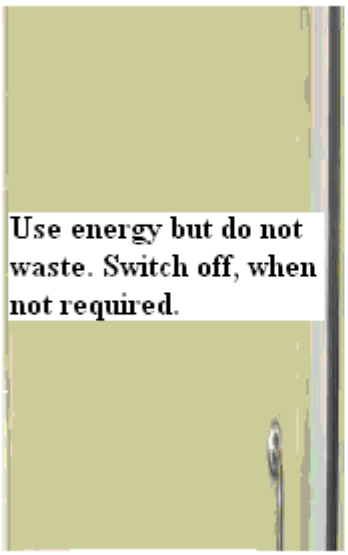
It is suggested that these be replaced on priority. Approximate saving potential & investment is as follows:

Narration	Values
Wattage for 1 lumanary + Ballast (3*36+ 3*6)	126
Wattage for LED bulb + Ballast	40
Saving / troffer fitting - 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) 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.

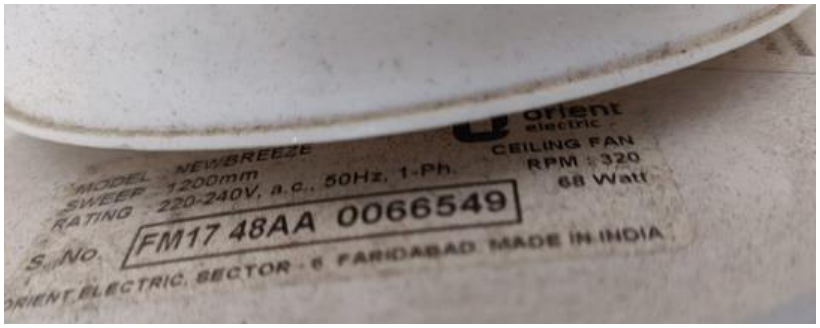
7) Summery of saving potentials in lighting: -

Sr. no	Item	Saving Potentials		Investment	PB P
		KWH lacs	Amount Rs. Lacs	Rs. Lacs	Months
1	Replacing 1000 fluorescent tubes installed on walls without reflectors with LED at proper angle	0.31	1.82	1.6	11
2	Replacing 25 nos 3*36 W CFL with LED	0.04	0.22	0.25	14
	Total saving	**0.35**	**2.04**	**1.85**	11

6) CEILING FANS

1) **Existing fans**- In this university about 2988 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. As stated earlier, this year, academic session was not fully started. Based upon full session, which is expected next year, expected energy consumption comes to 4.11 lacs kwh & is 24% of total plant's consumption.

2) Power consumption per fan: 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.

3) 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.

4) Saving potential by replacing fans with star rated fans:

	Replacement	**While purchasing new**
Wattage of standard fan - W	68	68
Wattage of 5 star rated fan	50	50

Power savable by replacing - W	18	18
Power savable by replacing - %	26%	26%
Energy saving potential in average 10 hours 190 days - kWh	41	41
Amount savable @Rs5.8/KWH	238	238
Average cost - Rs	2500	750
Payback Period - months	126	38

The above shows that replacing existing fans has a very long payback period. But a fan for initial purchase has a payback period of only 38 months. The university authorities are yet to purchase about 500 fans. It is suggested that all these should be 5 star rated.

Expected saving potential & investment are as follows:

Narration	New fan new location
As calculated above- saving in 5 star rated fan / year - kwh	41
Energy saving potential for 500 fans - kWh	20500
Amount savable @Rs5.8/KWH	118900
Average cost - Rs	375000
Payback Period - months	38

4) 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.

7) AIR CONDITIONING

66 air conditioners whose expected energy consumption will be 1.99 lacs kwh are installed.
Out of all these about 30% are 2 star rated, 30% are 3 star rated and rest are non-star rated. The non stars 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). 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.

3) Air conditioned room temperature – *Every 1^0C decrease in room temperature increases energy consumption by 3%*. Mostly these are operated at 24 ^{O}C. In an air conditioned space, a fan breeze make 26^0C room feels like 22.5^0C. Thus by increasing thermostat setting, 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. 99
%age saving expected	%	4.5%
Total Saving	KWH	0.090
Amount savable @Rs. 5.8 /KWH	Rs	0.519
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

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	12.46	86.4%	74.8
D G Set	56.083 kl	1.96	13.6%	34.9
Total		14.4		109.7

Following was also noted /observed/assumed:

i. About 56.08 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 and hence reduces D.G.Set efficiency.

Uninsulated Exhaust pipe of the DG set

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	1.68249	1.01	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 overlaod 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 2.2 & 2.5 ohms respectively. It is within limits.

Electrical Safety Tips:

Here are some tips to help keep electrical injuries from happening in the workplace.

1. Always identify any electrical hazards before starting work. These hazards should be labelled clearly so anybody passing by can easily identify them.
2. Always keep your equipment away from energy sources. On top of that, only ever use equipment specifically made for the job at hand.
3. Use non-conductive ladders to keep from being shocked at large heights. This can help prevent falls, as well.
4. Be wary of outlets that are hot to the touch. This may indicate bad wiring and could result in an electrical fire.
5. Never nail or staple extension cords into place. Only ever use electrical tape for this purpose. Damaged cords can lead to electrical fires and shocks. Because of this, you should also thoroughly inspect all electrical cords before use and never use a cord that shows signs of damage.
6. Always wear proper protective clothing and use insulated tools when around electrical hazards.

Fire Safety Tips

Fire safety tips that can save your life in an emergency

- Memorise all emergency service numbers.
- Stay calm.
- Stay low to the ground.
- Never use the elevator.
- Familiarise yourself with **fire safety** procedures.
- Conduct a **fire safety** audit.

11. Energy Efficient BEE Star Rating:

Meaning, Measurement, Types of Labels…

BEE, BEE Star Label, BEE Star rating, Energy Conservation methods are some of the terms which often come across while purchasing a new electrical appliance. Learn the exact meaning of these terms and how they are useful in energy conservation.

What is BEE and its full form?

The full form of BEE is the Bureau of Energy Efficiency. BEE was established by the Government of India on March 1, 2002 under the provision of Energy Conservation Act, 2001. With the world facing major departmental calamities of climate change and global warming, there was a need to regulate the emission of Co2 in the environment. Renewable sources like solar and wind energy are identified as capable climate-friendly energy sources of no Co2, these sources have not reached a stage where they can completely replace our existing electricity generation methods. Hence, the BEE was created with a mission to form policies and develop constructive strategies with an intend of self-regulation and marketing principles to achieve energy efficiency.

What is BEE star rating?

BEE sets the standards and labels for marking star-rating of various appliances. Star ratings are provided to all the major kinds of appliances in the form of labels. These star ratings are given out of 5 where higher the rating, lower is the energy consumption. The label provides a basic sense of how energy efficient each product is, just at a single glance.

What is the purpose of BEE star rating?

The prime purpose of BEE star rating is to educate and inform the consumers about the energy efficiency of the product they are buying. Usually, the consumer can find a **BEE Star Label** on heavy electrical home appliances like Air conditioners, Refrigerators and Washing machines, etc. with a number of stars it has got and estimated power consumption of the appliance in a year that it is expected to consume (Power consumption = 1 electrical unit). This also makes the manufacturer responsible for creating energy-efficient products as consumers may eventually prefer better-rated products.

How is BEE star rating decided?

The BEE star rating of a product is decided on factors more than one. Usually, there is a preconceived myth that a star rating is generally based upon the appliance's power consumption. However, this is not true. BEE sets all the standards and norms which need to be followed while rating an appliance and the manufacturer labels the product accordingly.

The BEE Star rating Program is updated every year. As technology improves and more and more energy-efficient appliances are introduced in the market, the labels are adjusted accordingly. For eg: The Ministry of Power announced that two more electrical appliances microwave ovens and washing machines will now be assigned star ratings based on their energy efficiency metrics. The program of star rating of Microwave Ovens and Washing Machines will be implemented voluntarily and will be valid up to December 31, 2020.

The Star rating is mandatory for only the following heavy appliances: Frost-free refrigerator, Tubular Fluorescent Lamps, Room Air-Conditioners, Distribution Transformer, Colour TV, CST AC, Direct Cool Refrigerator and Electric Geyser. For other appliances getting the star label is optional. The appliances with the lowest energy consumption in a product category are given the most stars and those with the highest energy consumption are given the least.

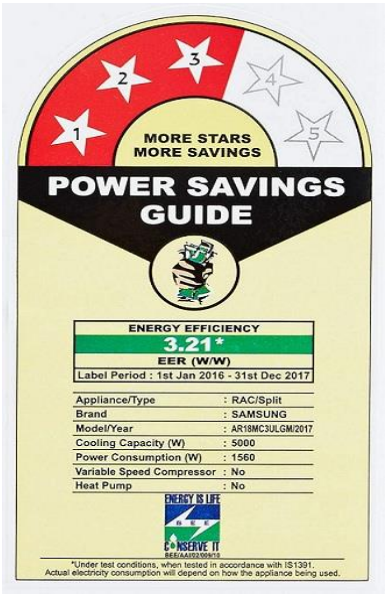
Let's understand with the help of an example. The stars on refrigerators depend not only on the energy used but also on the volume of the refrigerator. A formula using annual energy use, constant multiplier, adjusted storage volume, and constant fixed allowance is used to calculate the star rating for a particular refrigerator.

	Example of 3 Star Refrigerator (Check Here)	**Example of 4 Star Refrigerator (Check Here)**
Brand	Whirlpool	Whirlpool
Capacity	292 Ltrs.	292 Ltrs.
Price	24,490/-	27,490/-

Though **the price of 4 star refrigerator is higher** than that of the 3 star refrigerator for the same capacity, **the 4-star refrigerator is more energy efficient**, hence it will save you more money on your electricity bill.

There are 2 variants of the star labels given according to the appliance's usage and consumption.

1. Big Label



The big energy label rating is for appliances that consume more electricity and are used for a longer period. These labels show additional information such as the yearly energy consumption of the product, brand name, product category and much more. This label allows consumers to calculate the cost of using the product.

2. Small Label

Small labels can be found in appliances that usually don't consume more energy. These labels just give you a visual representation of the energy consumption levels by showing star ratings. This label is for products like ceiling fans, tube-lights, computers, etc.

SAVE ENRGY …..SAVE WORLD…..