COMPLIANCE VERIFICATION REPORT

On Implantation of
Energy Savings Suggestions based on EA report 2020

September'2021

Study Conducted At

UTTARANCHAL UNIVERSITY

Uttaranchal University

Premnagar, Dehradun

Study Conducted By

Association of Energy Conservation & Environment Protection

Bhagirathi Puram, Dehradun

ACKNOWLEDGEMENT

We would like to thank all those who Contributed in the completion of this project and creating a mile stone. We wish to thank The University management and staff who give us their precious time to respond all our queries and help us in collecting the data as required for the Energy Audit of University campus.

Further we wish to thank Mr. Jagdeesh Joshi, Dr. Nirmal Chandra Uniyal, Dr. Kartikey Gaur, Mr. Akram Ansari senior management and College staff who contributed in providing and gathering data of University Departmental buildings to complete this study. We also acknowledge the hard and leadership of the core team member Mr. R.K.Aggarwal, Mr. Ashish Vashishth, Mr. Vibhor Aggarwal and Mr. Naresh Tariyal of Association of Energy Conservation & Environment Protection.

Last but not the least we thank Mr. Jitendra Joshi, Chancellor Uttaranchal University and all senior Officials for their guidelines, unconditional support & Interest which made the study possible.

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. Sanjeev Walia – Data Compiler

About AECEP & Energy 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. I am running the Society called as "Association of Energy Conservation and Environment Protection" since 2007 and we are also empanelled with PCRA,UREDA, CREDA (SDA of BEE) as well as APITCO for which we have 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

Work Experience in Services: -

- Conducting Energy Audit.
- Conducting Training Programme.

- Preparation of case studies in energy efficiency/conservation sector.
- Preparation of Database of Product & Services.
- Feasibility studies for setting up projects.
- Preparation of Detailed Project Reports for setting up Projects.
- Environmental Impact Assessment.
- Supervision of Project Implementation.
- Project Management.
- Operation & Maintenance of Project.
- Advising on Procurement matters.

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 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 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. 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) and many more…

Objective of the Study:

- Verify the steps adopted for Energy management in the campus
- Spot the Inefficient or Inadequate practices, if any
- Improve the Energy preserving measures and methods
- Identify potential Energy saving opportunities
- Formulate feasible steps and measures to be adopted in the campus

The Uttaranchal University, Dehradun authorities got this study done to explore energy saving potential.

About Electrical Consuming Equipment Installed in University – This university is having lot of buildings with so many equipment installed in it. While details have been dealt in respectively chapters, brief is as follows:

Particulars	Nos.
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	8.23
Total HSD Consumption – KL	8.55
Total D.G. Sets – 380 Kva and 500 Kva	1+1
Major Loads	**No.**
Air conditioners	93
Various luminaries	7257
Fans	3453
LED TV	35
240 W Desktop computers	1132
Water coolers	82
& some other miscellaneous equipment	
Solar	
Solar Power plants capacity	210 KWp
Solar water Heater Units	44000 Lpd

CONTENTS

COMPLIANCE VERIFICATION

The auditors had carried out an investment grade energy audit during October 2020 **for the energy consumed during 2019-20** and had suggested some energy saving schemes. The university authorities implemented many of these & requested us to verify the same. The verification was carried out on 16th to 18th August 2021. The results are discussed below:

1**) Improvement in power factor**: During 2019-20, average annual power factor was 0.91. We had suggested them to improve the same by replacing faulty APFC relay. The university authorities have got same done. This year average was 0.94. So management had Implemented this suggestion. It can still be improved by installing more capacitors. This will reduce some electricity bill.

2) Energy purchased from Grid : During 2019-20, the 11.87 Lacs Kwh units were consumed. While during 2020-21, only 5.095 Lacs Kwh units consumed. This all is not only due to saving, the University remained closed for classes due to Govt. guidelines on Covid'19. On-line classes were held for whole year. The same for student's hostels. Only office & some construction work continued. The compliance part is university kept on trying to save energy by implementing our suggestions.

3) Luminaries: We had suggested replacement of some left over conventional luminaries with latest LED luminaries. The University authorities had earlier replaced most conventional luminaries in campus area with LED. Following more were replaced during 2020-21

Location	Existing Type	No	Date of replacement
Street light	T5	7	Sep-20
Hostels	T5	300	Nov-20
Academic building	T5	7	Dec-20
Academic building	T5	79	Jan-21
Street light	T5	13	Jan-21
Academic building	T5	60	Feb-21
Boundary	T5	12	Mar-21

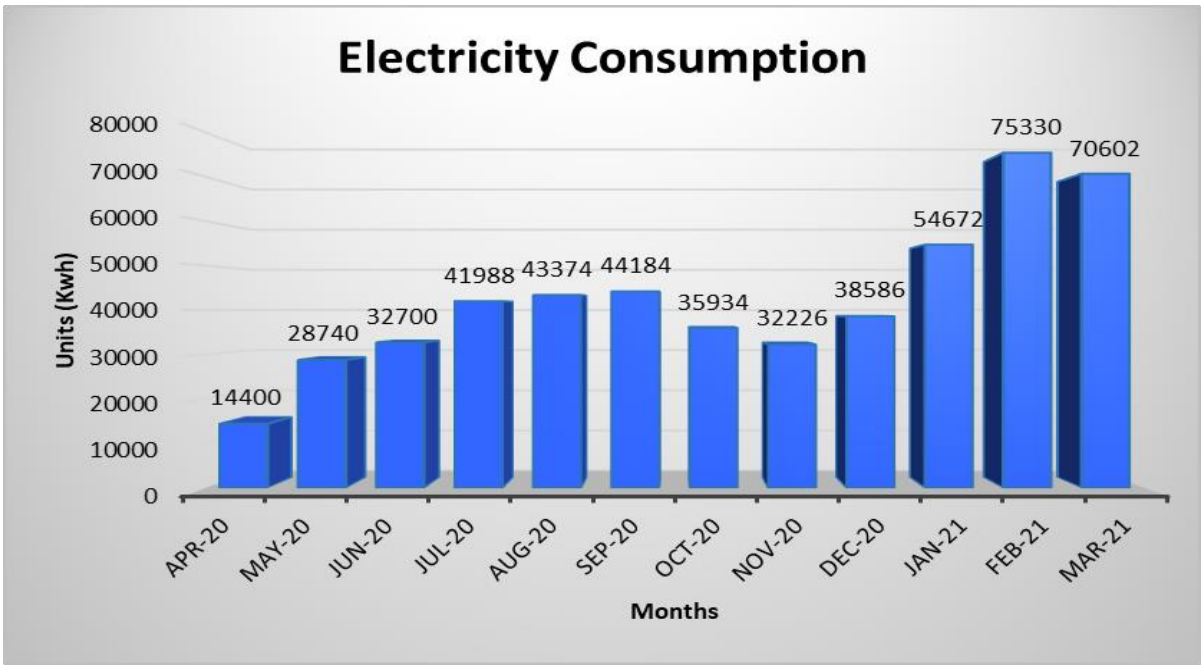
4) Ceiling fans : Most of the fans installed earlier were branded standard fans. These consume 68 Watts. We had suggested their replacement with star rated energy efficient fass. The university authorities replaced 24 nos in hostels. So this is also compliance of suggestions.

5) Renewable / Solar energy: The university authorities had already installed 210 kWp Solar panels. We had suggested more. They had also installed 24000 lph solar heaters in hostels. We had suggested their augmentation. The university authorities increased Solar heater capacity from 24000 lpd to 44000 lpd. So this is also compliance of suggestions.

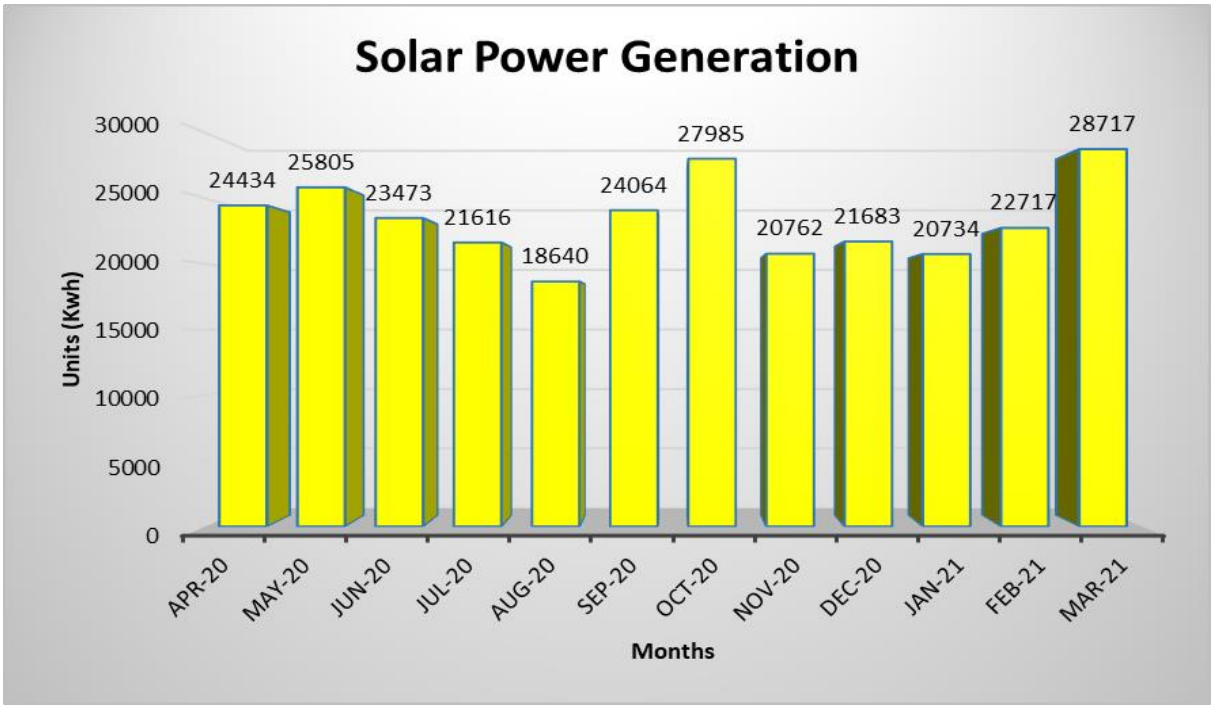
6) Air conditioners: We had suggested increasing set temperature from existing 23-24 ^{o}C to 26-27 ^{o}C with fan on. It was partially implemented, wherever possible. So this is also compliance of suggestions. During the year 3 more air conditioners were installed.

7) LPG burner : During last audit, we had suggested frequent cleaning of gas burners & also even replacement. This time, these were found cleaner. So this is also compliance of suggestions

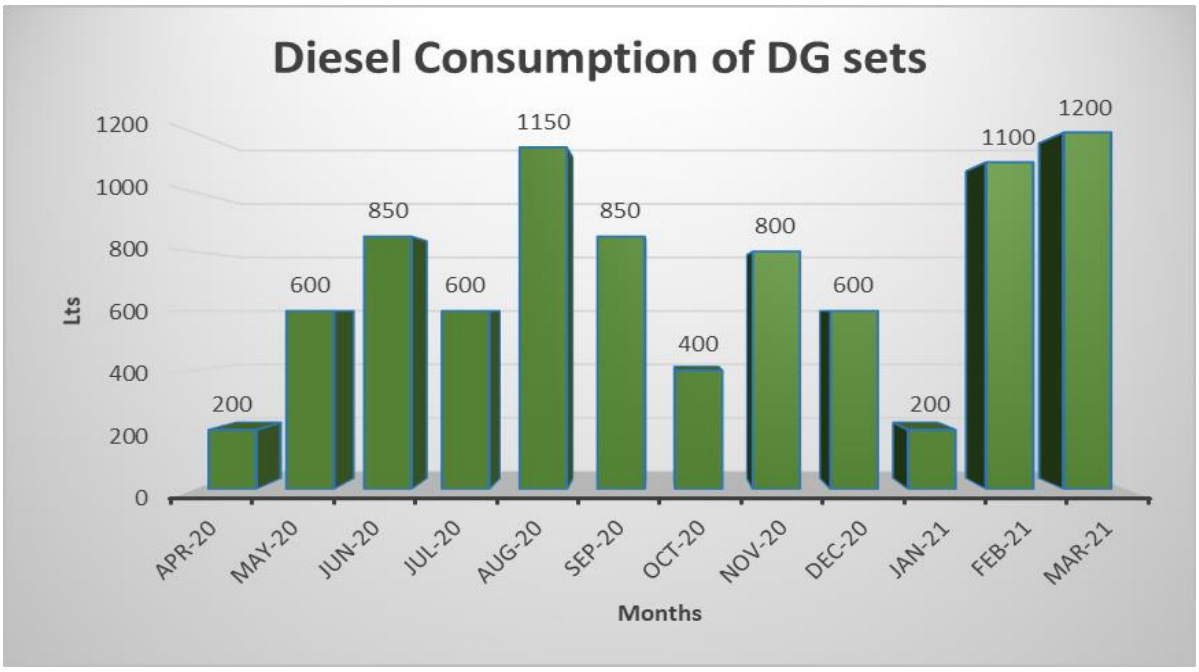
Total Grid Electricity consumption of University campus during 2020-21:



Solar Power Generation in 2020-21: Total Installed capacity of plant – 210 KW



Diesel Consumption of both DG sets (380+500 KVA) in 2020-21:



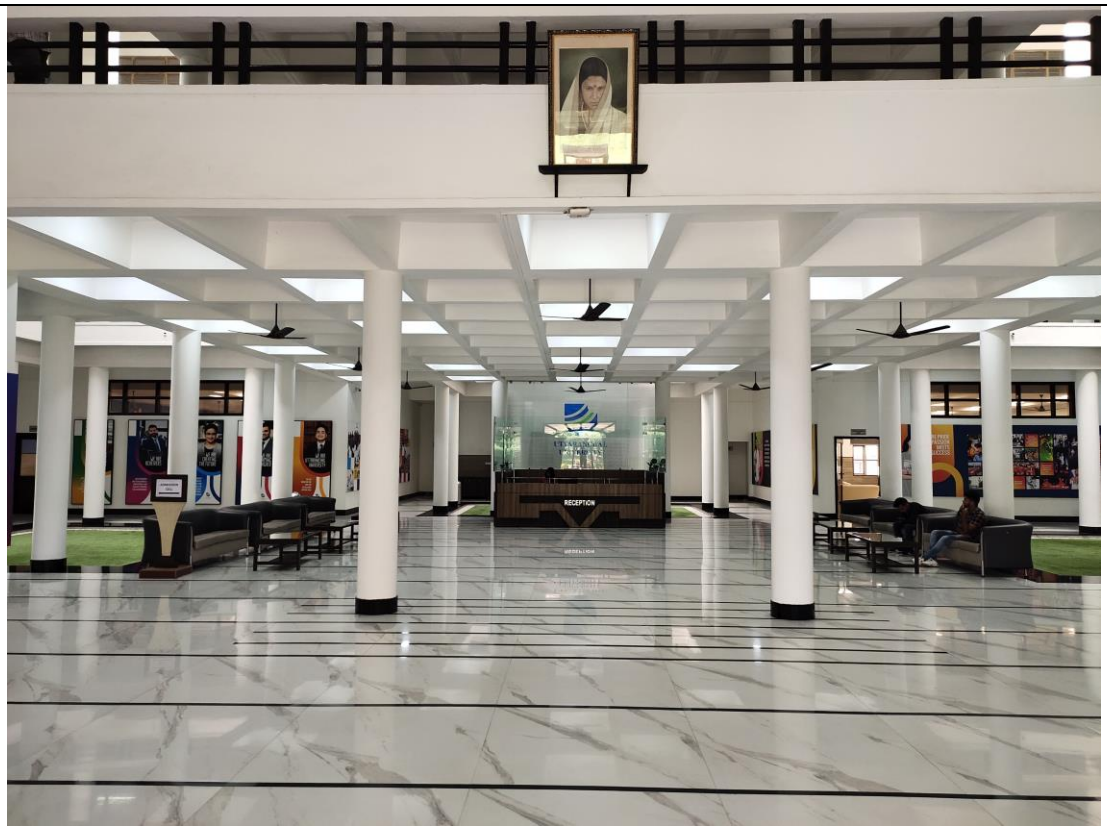
8) Quantification of saving: It is not possible as university classes nor hostel were closed during Covid & so power purchased from grid was about half. During 2019-20, these were open for 6-7 months. So comparison of energy consumption is not possible. The replacement with energy efficient devices has sufficiently been done. Solar power generation has increased from previous 2.51 lacs to 2.80 lacs. Solar heaters have been added.

The Specific Energy Consumption earlier was within limits prescribed under guide lines issued by Bureau of Energy Efficiency, Ministry of power, Government it of India.

Some areas where moficiation done are Illustrated below

Implementation of Covid'19 Protection guidelines- Thermal screening and sensitization

Covid Protection awarness & other Signage at all Public dominating places



Replaement of CFL with High efficiency LED lights

Replacement of Old fans with High efficiency Fans

Replaced 36 W T5 with 18 W LED with Occupancy sensor at Public utility

Replacement of 3*36 Watt CFL light with 36 Watt LED

Better Utilization of Day light

Better Utilization of Day light to save Electricity

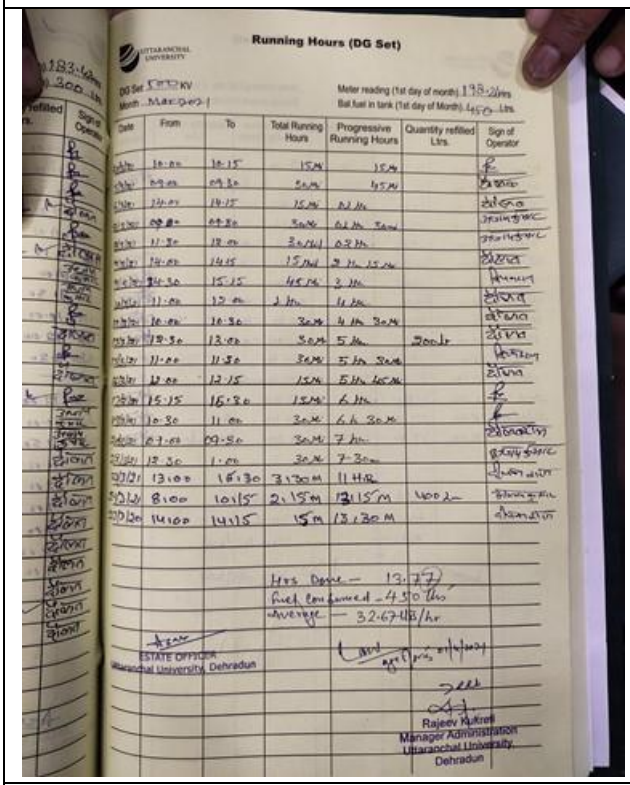
Facelift of Pantry with new aminities and energy efficient Fan & Lighting fixtures

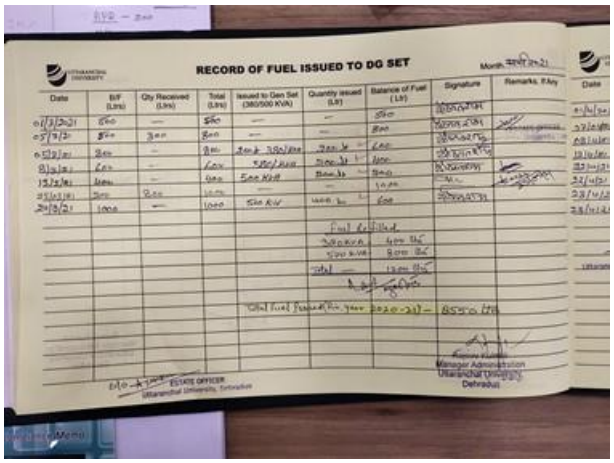
Replaced all Old taps with sensor based water saver fixtures

Installation of sensor based flushing system in Public urinals

Develop Renewable energy based Botonic garden for Students awarness and motivation

Replaced Old battey car with High efficiency battery vehicle for campus visit of Visitors





Maintain all relevent data and record for Electricity/Solar/Diesel consumption

RECOMMENDATIONS:

The University management had accepted and executed so many earlier suggestions given by Energy audit team, this is the reason University have achieved so many set targets this year. **Now It is highly recommended that the University must plan for implementation of ISO 50001 (Energy Management System) to adopt a continual improvement system in EnMS.**

Base Report of Energy consumption in 2019-20

The Electricity demand is met from following sources:

i. **Purchase from Grid** : It is major source of power & forms 81.2% of total use

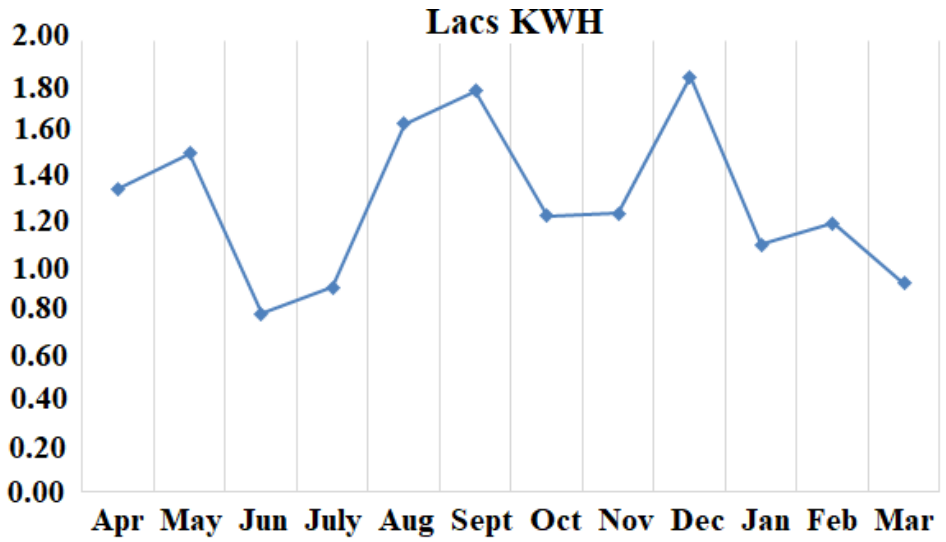
ii. **Solar** : The university authorities have installed 210 KWp capacity over roof top. Its share is about 17.1% of total consumption

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 25000 Kwh. It forms 1.74% of total use.

The details of electrical consumption copied from electricity bills for 2019-20 is given below. It is at xls file sheet "Energy" row 1 to 33. Summary of the same is as follows:

Month	Total Solar	Grid KWH	Grid kvah	Appr DG Set - kwh	Total kWH lacs
	210 KWp				
Apr	27310	99919	107440	845	1.28
May	25979	118150	124368	1925	1.46
Jun	21348	52049	57832	3150	0.77
July	18398	65110	72344	1400	0.85
Aug	19879	133622	143680	3150	1.57
Sep	20836	149378	157240	2030	1.72
Oct	20836	88455	101672	845	1.10
Nov	20266	89934	103372	1925	1.12
Dec	19617	148041	164490	3150	1.71
Jan	15608	86515	94038	1400	1.04
Feb	17445	92607	101766	3150	1.13
Mar	23342	63767	69312	2030	0.89
Total in lacs	2.509	**11.88**	**12.98**	0.25	14.63

Thus, electrical energy of about 14.63 lacs kWh costing Rs 81.96 lacs is consumed annually. The Grid supply is supplemented by 210 KWp Solar power plant spread across 5 separate buildings. The Annual Energy amount mentioned above is final billed amount considering Solar Power plant and Solar water heater rebate.



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

i. **Contract demand**: The sanctioned contract demand is 500 KVA against maximum 516 actual during 2019-20. But this was only in 1 month. The average maximum demand is 352 KVA. Earlier, the Contract demand was 353 KVA but due to increase in some months & penalties, it was got increased to 500 KVA in January 2020. It is satisfactory

ii. **Power factor**: The average power factor from Electricity bills found as follows :

Month	Grid KWH	Grid KVAh	PF
Apr	99919	107440	0.93
May	118150	124368	0.95
Jun	52049	57832	0.9
July	65110	72344	0.9
Aug	133622	143680	0.93
Sep	149378	157240	0.95
Oct	88455	101672	0.87
Nov	89934	103372	0.87
Dec	148041	164490	0.9
Jan	86515	94038	0.92
Feb	92607	101766	0.91
Mar	63767	69312	0.92
Total (MW/MVA)	11.88	**12.976**	0 .915
Average	98962		0.91

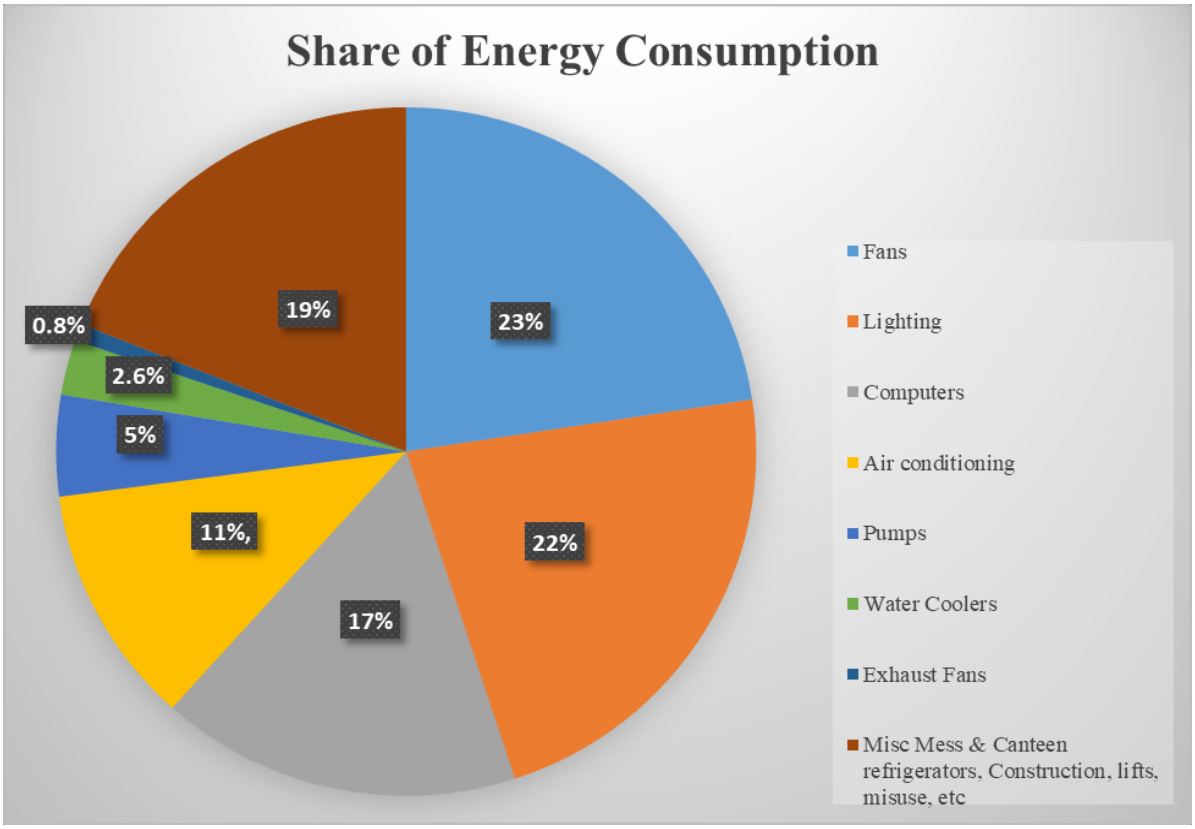
The energy charges are based on kVAH reading. It is suggested that power factor be increased to average 0.99. Saving on this score is as follows:

Narration	Values
Annual kWh- Lacs	11.87
Existing PF	0.915
Proposed PF	0.99
KVAH with existing power factor	12.973
KVah with proposed power factor	11.990
Saving in kVAH - Lacs	0.9828
Rate / kvah including other variable charges	5.94
Amount savable - Rs lacs	5.84
Expected investment on replacement of damaged capacitors, relay , APFC on 2nd transformer	1.6
Payback period – Months	3

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	Sheet name of xls file
Annual Energy Consumption	**14.6**	100%	
Fans	3.3	22%	Fans
Lighting	3.2	22%	Lighting
Computers	2.4	16%	Computers
Air conditioning	1.6	11%	AC
Pumps	0.7	5%	Pumps
Water Coolers	0.4	2.5%	Water Coolers
Exhaust Fans	0.1	0.8%	Fans
Misc Mess & Canteen refrigerators, Construction, lifts, misuse, etc	3.0	20%	
Total	**14.63**	**100%**	

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



4) Total Electricity bill : Contract Demand and monthly charges are of the university in year 2019-20 are as follows:

Month	Contract Demand - KVA	Grid KWH	Solar Adjusted	Grid MDI	PF	Electricity Bill after Solar Rebate
Apr	353	99919	0	340	0.93	6.33
May		118150	0	328	0.95	7.57
Jun		52049	0	216.3	0.9	3.74
July		65110	0	350.5	0.9	4.38
Aug		133622	0	480.9	0.93	8.84
Sep		149378	0	516.3	0.95	9.7
Oct		88455	0	338	0.87	6.62
Nov		89934	44	301.1	0.87	6.72
Dec		148041	0	480.2	0.9	10.79
Jan	500	86515	24	306	0.92	6.21
Feb		92607	0	285.8	0.91	6.67
Mar		63767	0	290.4	0.92	4.39
Total		1187547				**82.0**
Average		98962	6	353	0.91	6.83

The Average consumption of year 2019-20 was 0.99 Lacs Kwh. The original Contract demand was 353 KVA but in months of July, August, September the MDI crossed demand so it was got increased to 500 KVA in January 2020.

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:

Total Electricity Consumption - lacs kwh	14.63
Total Covered Area of University - m^2	82881.8
So Specific Energy Consumption or EPI – kwh/ m^2/ year	17.7

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 210 KWp. All of the Power Plants are properly installed in shade free area. These are well maintained.

Solar Power Plant installed on top of Central Library

The electricity production from that is as follows:

Month	Total Solar	Grid KWH	From DG Set	Total kWh	% of Solar
	210				
April	27310	99919	845	128074	21%
May	25979	118150	1925	146054	18%
June	21348	52049	3150	76547	28%
July	18398	65110	1400	84908	22%
August	19879	133622	3150	156651	13%
September	20836	149378	2030	172244	12%
October	*20836*	88455	845	110136	19%
November	20266	89934	1925	112125	18%
December	19617	148041	3150	170808	11%
January	15608	86515	1400	103523	15%
February	17445	92607	3150	113202	15%

March	23342	63767	2030	89139	26%
Total in lacs	2.509	11.875	0.25	14.634	17.1%

Thus about 17.1 % 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. The plant authorities plan to cover some more available area in near future.

2) The split up of solar Electricity produced from April to September from different plants is given below (detailed is covered in Xls sheet "Uttaranchal Univ Solar" in tab Energy):

Month	**Library 1**	**Library 2**	**Library 3**	**Law college**	**Management**	**Civil Block**	**Polytechnic**	**Total Solar**
Installed Capacity	**30**	**30**	**30**	**50**	**20**	**20**	**30**	**210**
April	2695	3536	3385	7399	2589	2665	4113	26382
May	2742	3606	3443	7377	2169	1935	4113	25385
June	3095	3029	3270	6187	1900	2274	3449	23204
July	3495	2306	3278	5526	1625	2034	3087	21351
August	2977	1933	2794	4848	2036	1772	2691	19051
September	3637	3323	3415	6087	*2036*	2220	3386	24104
Total in 180 Days	18641	17733	19585	37424	12355	12900	20839	139477
Days	180	180	180	180	180	180	180	180
KWH/KW/Day	3.45	3.28	3.63	4.16	3.43	3.58	3.86	**3.69**
Generation in 365 Days	37800	35959	39714	75888	25053	26158	42257	282828
Should be Value	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
Should be KWH in 180 Days	22950	22950	22950	38250	15300	15300	22950	160650
Short Fall in 180 Days	4309	5217	3365	826	2945	2400	2111	21173
Should be KWH in 365 Days	46538	46538	46538	77563	31025	31025	46538	325763
Short Fall in 365 Days	27897	28805	26953	40139	18670	18125	25699	42934
Cost of Shortfall / Year @ Rs 5.94 / Unit					**Rs 2.55 lacs**			

The above table shows that average generation from April to September is 3.69 kwh/KWp /day. Ideally it should have been 4.00 to 4.25 kwh/KWp/day. **Thus about 42934 kwh/ year** costing Rs 2.55 Lacs has been produced less**.**

Looking at this shortfall, the plant authorities started close monitoring & cleaning of panels in October. The 10 days results of October are as follows:

	Capacity KWp		Location	Capacity	Location	Capacity	Location	Capacity	Location	Capacity	Location	Capacity	Location	Capacity
Management	20	**KWH/ KW/day**	**Civil**	20	**Law**	50	**Polytechnic**	30	**Library 1**	30	**Library 2**	30	**Library 3**	30
Date	**Kwh**		**Kwh**	**KWH/ KW/day**	**Kwh**	**KWH/ KW/day**	**Kwh**	**KWH/ KW/day**	**Kwh**	**KWH/ KW/day**	**Kwh**	**KWH/ KW/day**	**Kwh**	**KWH/ KW/day**
11-10-2020	73	**3.65**	87	4.35	247	4.94	136	4.53						
12-10-2020	72	**3.60**	52	2.60	233	4.66	128	4.27						
13-10-2020	67	**3.35**	81	4.05	231	4.62	126	4.20						
14-10-2020	56	**2.80**	79	3.95	215	4.30	116	3.87						
15-10-2020	64	**3.20**	81	4.05	214	4.28	116	3.87	120	4.00	120	4.00	114	3.80
16-10-2020	62	**3.10**	83	4.15	220	4.40	120	4.00	124	4.13	123	4.10	117	3.90
17-10-2020	60	**3.00**	85	4.25	224	4.48	121	4.03	125	4.17	124	4.13	118	3.93
18-10-2020	58	**2.90**	84	4.20	225	4.50	121	4.03	81	2.70	81	2.70	78	2.60
19-10-2020	63	**3.15**	87	4.35	234	4.68	126	4.20	135	4.50	132	4.40	126	4.20
20-10-2020	58	**2.90**	89	4.45	234	4.68	128	4.27						
Average	63.3	**3.2**	80.8	4.0	227.7	4.6	123.8	4.1	117.0	**3.9**	116.0	**3.9**	110.6	**3.7**

The results are discussed as follows:

i. Up to September 2020, average generation was 3.69 kwh/kwp/day.

ii. In October 2020, in most of buildings average is 4 to 4.6

iii. Still it is only 3.2 in management building and 3.7 in library 3.

iv. It is suggested that individual cells of these solar cells be got checked to plug this shortfall :

- Management building -3.2 only
- Library 1 & 2 – 3.9 only
- Library 3- 3.7 only

Approximate less generation from these solar plants are as follows:

Location	Installed	Existing	Possible	Shortfall/annum	Amount @5.9
Library Inverter 1	30	3.9	4.1	2190	12921
Library Inverter 2	30	3.9	4.1	2555	15074
Library Inverter 3	30	3.7	4.1	4526	26703
Law college	50	4.6			
Management	20	3.2	4.1	6826	40270
Civil Block	20	4.0			
Polytechnic	30	4.1			
Total/ Average	210	3.9	4.1	16097	94969

Thus there is scope of minimum 16097 kwh costing Rs 94969 more generation.

3. Solar Water Heaters

12 nos solar water heaters each of 2000 litre per day totalling 24000 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 heater plant and insulated tanks of 2000 l each on top of hostels

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

3) 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 19 hours with an on line power analyzer. The voltage profile of those 19 hours is as follows

Time	Phase V	Line V
15:00:00	237	410
16:00:00	238	412
17:00:00	241	417
18:00:00	239	415
19:00:00	244	422
20:00:00	249	431
21:00:00	252	436
22:00:00	250	433
23:00:00	252	437
00:00:00	253	439
01:00:00	255	442
02:00:00	256	443
03:00:00	257	444
04:00:00	256	443
05:00:00	252	437
06:00:00	247	428
07:00:00	242	418
08:00:00	235	407
09:00:00	233	404
Average	**247**	**427**

3 Phase Power Quality measurement being carried out at DG room 1

Here, we can see that the voltage remains high all the time. It ranged from 233 to 257 volts, with average of 247 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 .

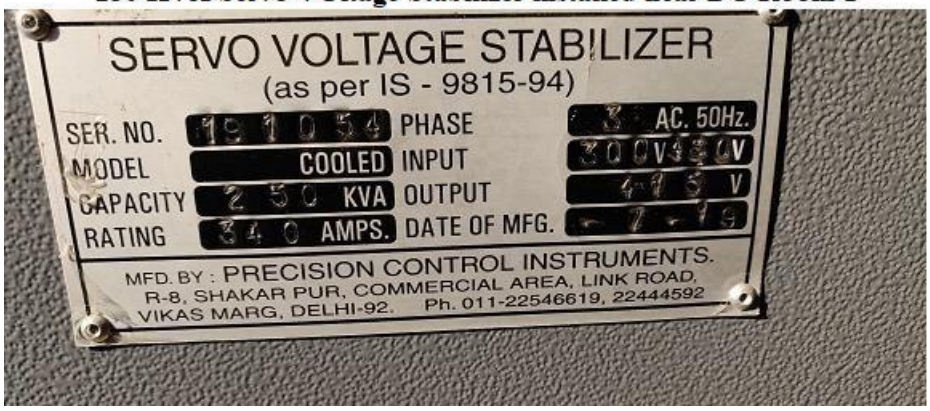
4) Remedial measures: Following can be done without much investment:

i. **Transformer Taps**: One transformer tap is at no. 1 position and 2nd is at no. 2 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	KWH	1549594
Assume modest 1% Saving by reducing voltage	KWH	15496
Amount savable @ Rs5.94/KWH	Rs	92046

4). 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 0.91 and lowest being 0.87 for 2 months. 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 annual average Maximum Demand is 352.8 KVA, the capacity of the APFC panel required here is calculated below:

Narration	Units	Values
Present Power Factor		0.91
Should be Power Factor		0.99
Average Maximum Demand	KVA	352.8
Maximum Load	KW	321.1
Additional Capacitors required	KVAR	99.5
KVA after installation		324.3
Reduction in demand	KVA	28.5

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

5) 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	3398	46	229585
2	LED Tubes	2266	20	66566
3	LED bulbs	1428	6	12585
4	LED outdoor fitting	34	36	3525
5	CFL troffer fittings	47	3*36	8771
6	CFL bulb	84	12	1481
	Total	7257		322513

Thus total energy consumption as per above table is 3.22 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 3398 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. A comparative study of all luminaries is given at annexure no. 3/1 (xls file sheet "Lighting" row 1 to 34) to Some of saving potentials are as follows:

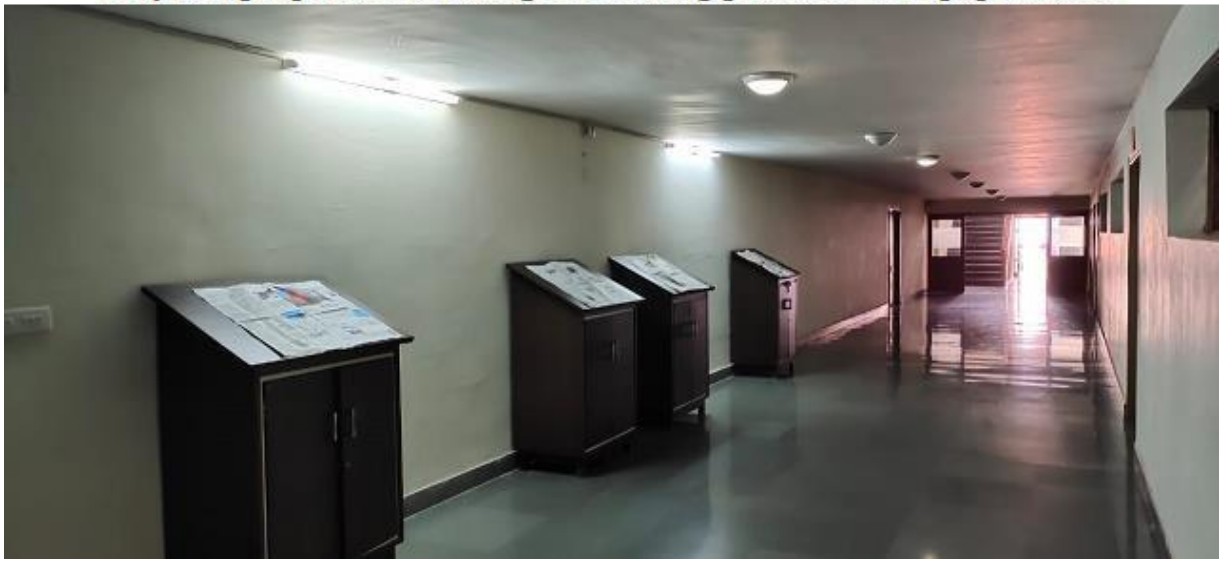
3) Fluorescent tubes:

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

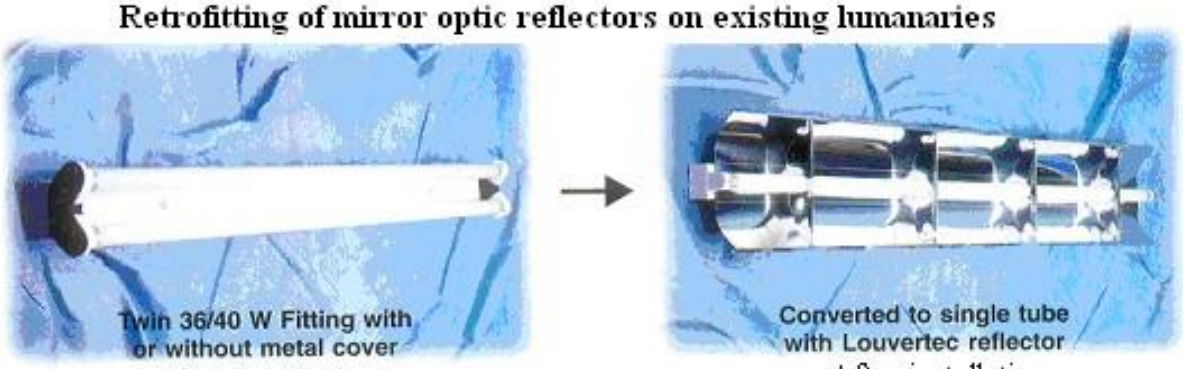
Fluorescent tubes installed without reflectors -
Very less proportion is falling on working plane-the newspaper stand



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

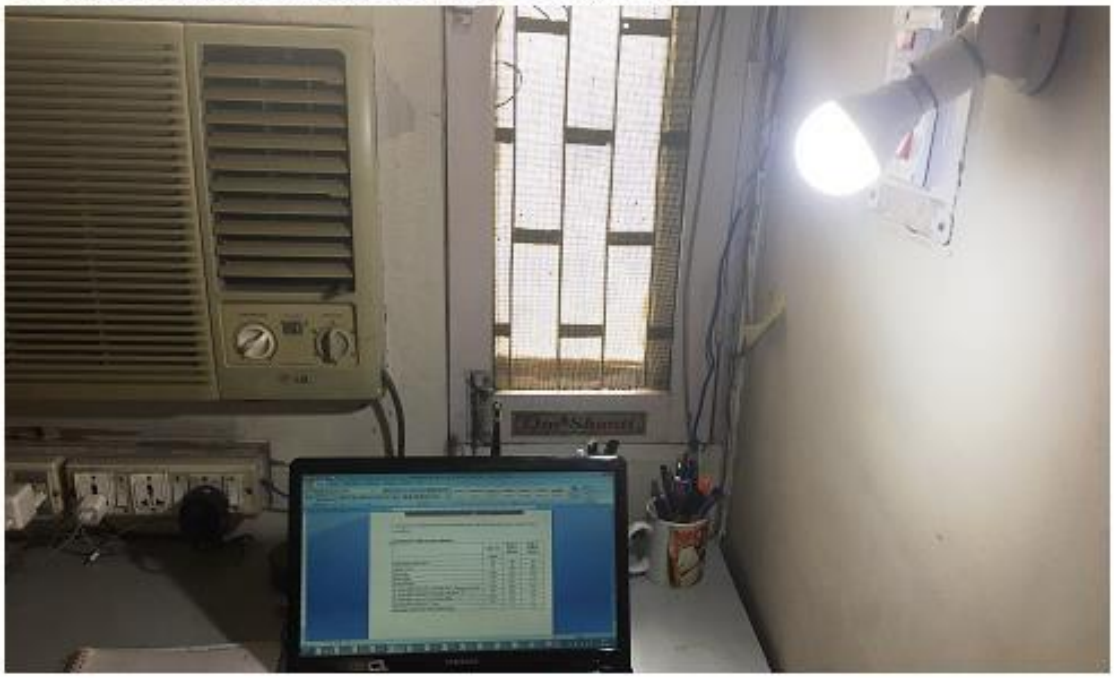
Effect of installation on walls: It has been discussed above. Light does not fall on working plane. It is illustrated with following images:

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. The actual calculations are available in Excel sheet in tab Lighting.

Particulars	**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
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. They are already installing the LED tubes in a phased manner. Still there are around 3400 Nos fluorescent tubes existing over the university campus that can be retrofitted with these reflectors. To keep issue alive, we suggest replacement of 500 fluorescent tubes with 12 Watt lamps. 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 500 tubes in 5 hours 9 months 24 days - kwh	15660
Money savable -Rs@ Rs 5.94/KWH	93020
Investment @ Rs120 per bulb	60000
Payback period- Months	8

4) **3*36 Watts CFL Troffer lights**: 47 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 luminary + 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 5.94/KWH	22068
Investment @ Rs 800 per LED	20000
Payback period- Months	11

5) LUX Level measurement-

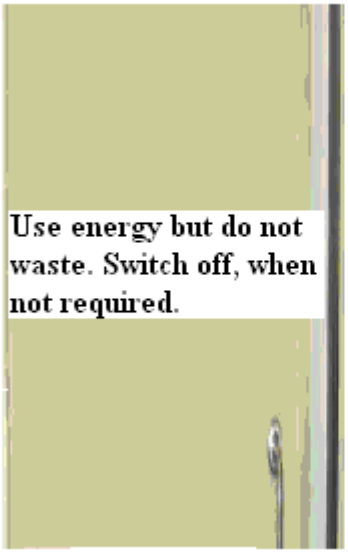
Lux level at various places was measured by LUX meter. The values are as follows:

Sr. No.	Location	LUX	
		Working plane	**Non-Working plane**
1	Accounts office	278,301, 280	250, 180,270
2	Reception	61	
3	Placement Class 101	74.5,82,171,116	82,83
4	Polytechnic Chemistry Lab	68,47,61,83	71,62
5	HM Building CHM Class	67,44,58,61	47,54

The LUX levels is satisfactory in office areas, hostels, corridors but it is not good in classrooms. In the previous section, it is discussed that the Fluorescent tube should be fitted with silver optic reflectors so the amount of light falling on the working plane is achieved either directly or through reflection from the high emissivity surface of the reflector. This will solve this low lux problem.

Lux level being measured at verious points in a classroom

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	0.1566	0.93	0.6	8
2	Replacing 25 nos 3*36 W CFL with LED	0.037	0.22	0.2	11
	Total saving	**0.1936**	**1.15**	**0.8**	8

6) CEILING FANS

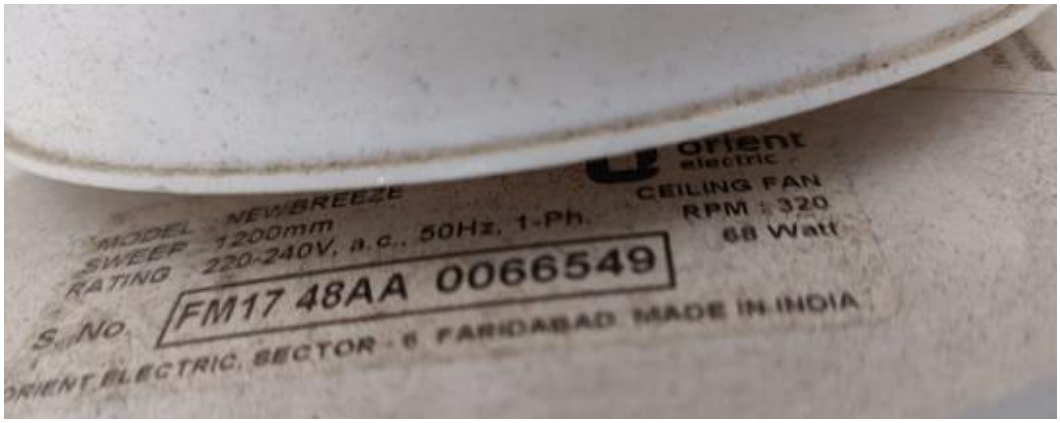
1) **Existing fans**- In this university about 3539 fans are installed. All fans are of 3 blades and 1200 mm sweep. These are installed in all air conditioned as well as non- air conditioned rooms. It is a good practice. In an air conditioned space, a fan breeze make 26 ^{0}C room feel like 22.5 ^{0}C. 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	159	8	7	14531
2	Library	276	8	6	21621
3	Pharmacy	252	8	6	19741
4	T & P building	84	8	6	6580
5	Workshop building	73	8	6	5719
6	Mechanical building	76	8	6	5954
7	UIBS /HM building	84	8	6	6580
8	Civil building	256	8	6	20054
9	Diploma building	143	8	6	11202
10	UIM building	201	8	6	15746
11	Agricultural building	296	8	6	23187
12	Law building	334	8	6	26164
13	Project Office	6	8	6	470
14	Estate Office	5	8	6	392
15	cafeteria	5	8	6	392
16	Security Office	5	8	6	392
17	DG Room	5	8	6	392
18	food Court	59	8	6	4622
19	Guest House	21	10	6	2056
20	Messes	195	6	6	11457
21	AlI Hostel Boys & Girls	1004	12	6	117974
	Total	3539			315224

Thus average 3.15 Lacs kWh which is 21% 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) :

	Superfans			**5 star rated**	**Existing**
Make	**Gorilla**	**Superfan**	**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	**708**	**708**			
Energy consumption of 20% fans - kWh	73068	73068			
Energy saving potential - kWh	39758	19342			
Amount savable @Rs5.94/KWH	236160	114889			
Average cost/ fan after considering Rs 1000 as resale value	2000	1500			
Total investment - Rs	1416000	1062000			
Payback Period - months	72	111			
Purchase of new fans					
Price difference	1000	750			
Total investment - Rs	708000	531000			
Payback period - months	36	55			

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	10	2	10	6	39600
2	Main Building	3	1.5	10	6	8910
3	Main Building	5	1	10	6	9900
4	Library	11	1.5	10	6	32670
5	Pharmacy	3	1.5	8	6	7128
6	T & P Building	6	1	8	6	9504
7	UIBS /HM building	2	1	8	6	3168
8	Diploma building	3	1.5	8	6	7128
9	UIM building	5	1.5	8	6	11880
10	law Building	10	1	8	6	15840
11	Project Office	1	1.5	10	6	2970
12	DG Room	1	1.5	15	6	4455
13	Guest House	17	2	1	6	6732
14	Auditorium	13	100	20		2200
Total		**90**				**162085**

Out of all these, 30-35 Nos are 2 star rated, 30-35 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. However for comparison and approximate calculations, this is the only field method and is followed.

Air flow: Air flow of 1 Air conditioner measurements is shown below:

Location **Central Library**

AC Rated 2 TR

Split AC Condenser side			
Air velocity m/s - Inlet air			**Average**
1.1	0.6	1.1	0.93
0.5	0.5	0.4	0.47
0.9	0.7	0.6	0.73
		Average m/s	0.71
Duct Dimensions		**Area m²**	0.44
(0.58*0.21)+(0.64*0.5)		**Volume m³/Hr**	1131
Air velocity m/s -Outlet air			**Average**
1.5	0.4	2	1.3
2.7	1.6	1.6	1.97
		Average m/s	1.63
Duct Dimensions		**Area m²**	0.23
Diameter = 54 cm		**Volume m³/Hr**	1346

The summary of all these measurement and calculations is as follows:

Location - >>>	**Library**
Tons	2
Ambient air temp – Dry	26.4
Ambient air temp – Wet	21.3
Dry bulb temperature at inlet	26.9
Wet bulb temperature at inlet	22.5
Enthalpy of inlet air - K J / kg	66.31
Dry bulb temperature at outlet	45.7
Wet bulb temperature at out let	26.5
Enthalpy of outlet air - K J / kg	81.77
Heat shed at evaporator - KJ/kg	15.46
outlet duct area -Square m	0.23

Air speed - m/second	1.63
Flow- Cubic meter/ hour	1346.0
Flow - Kg/ hour at inlet temperature	1491
Total enthalpy KJ/ hour	23047
Total enthalpy KCal/ hour	5508
Total tons/ hour	1.82

This Air Conditioner is working in good condition. The air flow was satisfactory and the fins and tubes were clean. Due to space constraint at the inlet air side, we were not able to take much readings there but we were able to measure the outlet air speed at various points properly.

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 ℃ 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	1.62
%age saving expected @1.5%	%	1.5%
Total Saving	KWH	2430
Amount savable @Rs. 5.94/KWH	Rs	14434
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 ^{O}C. It would save about 2430 kwh costing Rs 14430/- without any investment

8) D G SETS

1). DG sets installed in the building: 2 nos. D G Set are installed. There details are shown at xls file sheet DG Sets row 1 to 20. These are used only on failure of grid supply. One register which indicate running hours & HSD drawn is maintained. The HSD consumption has been assumed as drawn from stores.

DG NO 1- 500 kVA			DG NO 2- 380 kva			Total			
						Hours	Liters	Liters /Hr	Generation @ 3.5 KWH/Liter
Month	Hours	Liters		Hours	Liters	8	241	30.2	845
April	5	41.4	April	3	200	18	550	30.6	1925
May	2	50	May	16	500	27.5	900	32.7	3150
June	18	600	June	9.5	300	14	400	28.6	1400
July	6	200	July	8	200	39.6	900	22.7	3150
August	23.6	500	August	16	400	25	580	23.2	2030
Sept	15	550	Sept	10	30	22	595	28	2083
Total for 12 months on prorate basis						264.2	7143	336	24999.8

Following was also noted /observed/assumed:

i. About 7143 liters 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.

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 Lacs	Investment 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	214.28	0.15	0.15	12

9) MISCELLANEOUS

9.1) Kitchens

Various observations were noted in the kitchens:

1. LPG is the main source of heat in the kitchens in canteens and messes for preparing food. Approximate yearly consumption in University is around 7500 Kg.
2. The auditors enquired the kitchen waste from the mess in-charge which is about 112 Tons/ year. The Solid organic waste is used as manure in the huge green garden areas and wet waste is sent to the STP plant and further that water is used for watering the plants.
3. The auditors checked the various burners in the canteen. The flame from the burners was observed to be yellowish indicating that the burners were not burning the fuel properly and the fuel was being wasted. These burners are consumable items and must be regularly checked and replaced. New Energy Efficient burners are also available in the market. They may be installed this time.

Yellowish flame can be seen from the burners

Bad condition of burner. Needs replacement

By proper maintenance & timely replacement of burners, we expect about 5% saving in LPG gas. It will come to about 370 kg costing about Rs 0.15 Lacs with an expenditure of about Rs 0.05 lacs

9.2) 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 trip 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

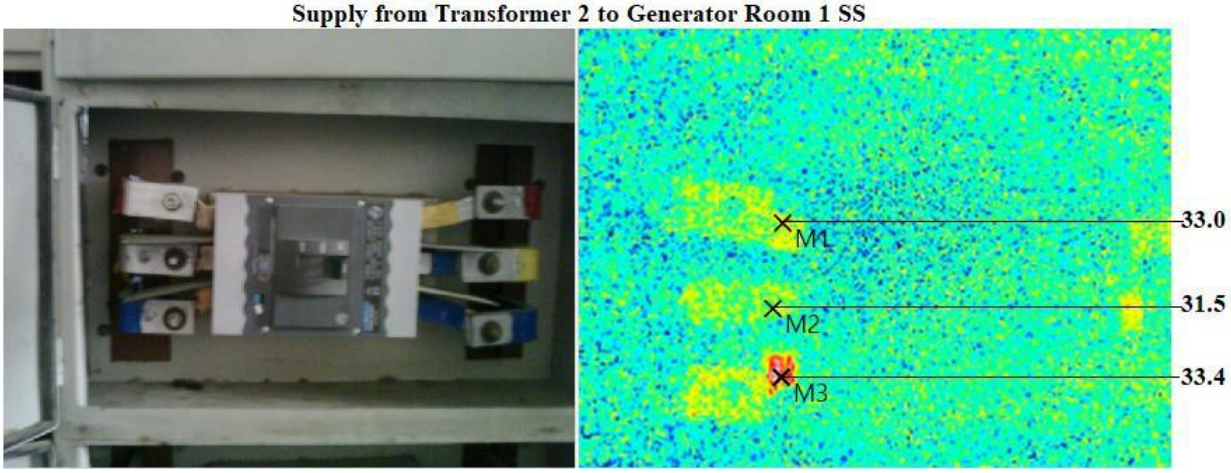
9.3) Thermography

The auditors checked some joints with thermo vision camera. The aim was to to check any loose connections. The temperature of loose connection rises & this rise is captured by thermo vision camera.

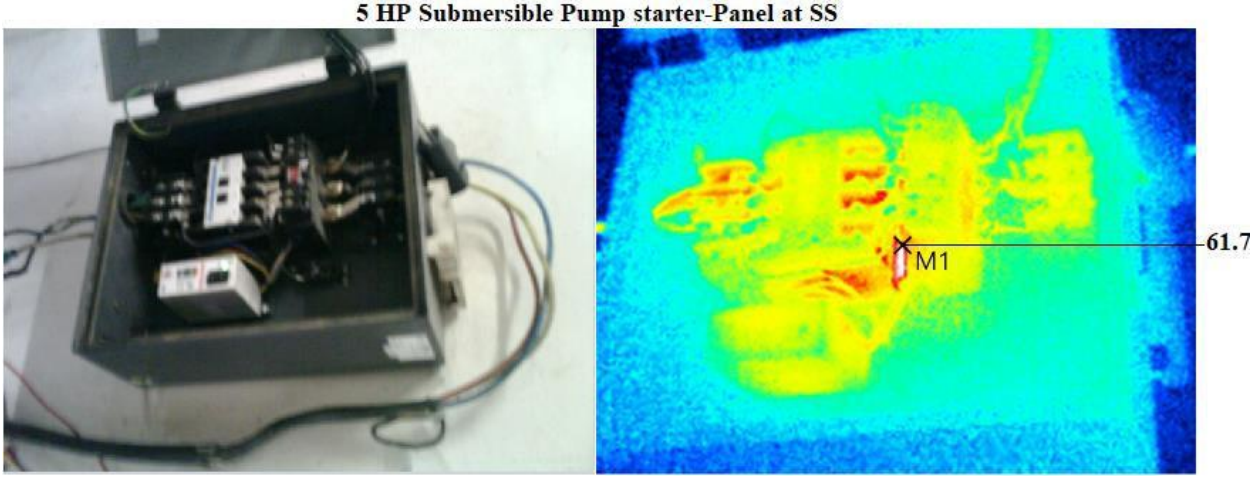
Hotspots being identified with Thermovision Camera

At the time of measurement, the Ambient Temperature was 27.1°C. Maximum temperature rise in electrical joints is 15 °C. Mostly temperatures are within limits. The temperature of 5 hp submersible pump starter is on high side. This may be tightened

Supply from Transformer 2 to Generator Room 1 SS



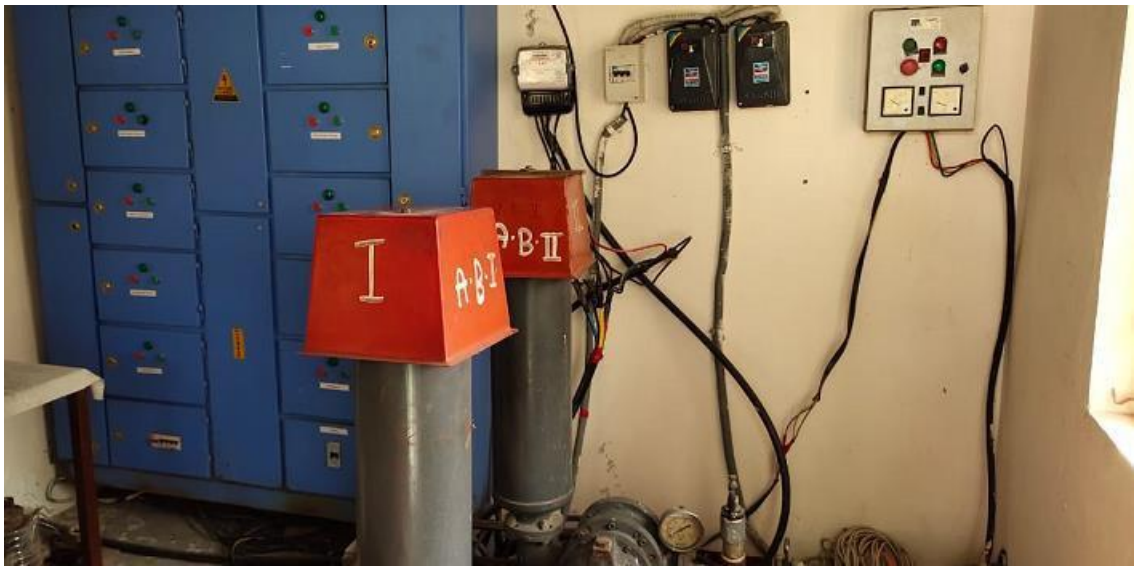
5 HP Submersible Pump starter-Panel at SS



This Hotspot was identified at a submersible pump starter panel at Substation 1. The Temperature of 61.7 ^{o}C is very high. This be immediately checked up and connections be tightened and the panel cover should be closed at all times.

9.4) Root blower in STP

A proper arrangement of treating STP water has been made. Root blowers are installed for blowing air through STP water for proper oxidation. It was not operating during audit but apparently, it is proper specifications. Its intake filter is covered with a steel box. It unnecessarily hinders free flow of intake air. It appears that it was installed by manufacturer for transportation. It is suggested that this cover be removed. This will facilitate checking air filters also.



10) NEW BUILDING: GIRLS HOSTEL BLOCK-B

The university authorities wanted this hostel to be specifically checked for ECBC compliance. Its layout is as follows:

Floor	Rooms			Total Rooms
	Single	Double	Triple	
Ground	9	15	2	26
1st	12	16	2	30
2nd	10	16	2	28
3rd	12	16	2	30
4th	12	16	2	30
5th	12	16	2	30
Total	67	95	12	174

As shown above, a mix of student occupancy rooms have been built so that the students can be accommodated accordingly. The students are allotted rooms as per their requirements of single or double or triple occupancy.

Following are some features of the new building:

1. The Total Covered area of the building is 6418.17 m2.
2. Syska make 20W LED tubes and Orient make 68W PSPO fans are installed here.
3. The Auditors measured LUX level in some rooms on a sunny day on 21 Oct at 05:00PM. The average LUX level in room was 320 with lights and 154 without lights and open windows. This is a good condition.
4. Daylight is judiciously used in the hostel with open area in the centre of the hostel and big windows in each room.

Various equipment installed all over the hostel building is shown below:

Floor	20W LED Tubes		Rooms			Total LED Tubes	68W Fans
	Corridor	Washroom	Single	Double	Triple		
Ground	12	8	18	25	6	69	28
1st	12	8	19	25	6	70	30
2nd	12	8	19	27	6	72	30
3rd	12	8	16	32	6	74	36
4th	12	8	15	32	6	73	35
5th	12	8	16	32	6	74	30
Total	72	48	103	173	36	432	189

Apart from all these lights and fans in rooms & corridors, some appliances for complete hostel for the comfort and productivity of students is as follows :

Sr. No	Equipment	Capacity	Nos
1	Water Coolers	180W	6
2	Solar Water Heater	2* 2000 lpd	1
3	Electric Geyser	1.5 KW	1
4	Lifts	8 persons	2

The calculated Annual Energy consumption of the Hostel Building is as follows:

Equipment	Location	Nos	Hrs	Months	Annual KWH
Tubes	Corridor	72	12	9	4666
	Washroom	48	12	9	3110
	Rooms	432	5	9	9720
Fans	Rooms	189	14	5	22491
Water Cooler		6	6	5	810
Geyser		1			150
Lifts		2			5000
Total					45947

The total calculated energy consumption comes to 45947 KWh/annum. The University authorities also provided us with the total floor area 6418.17 m^2. The Energy performance index comes 45947/ 6418.17 = 7.15 KWH/m^2/Year. It is a non-conditioned building. The maximum limit by BEE for day use is 26 kwh/m2/year. This building is used from evening to morning. The assessed energy consumption is less than BEE standard.

Study Conducted out by

Association of Energy Conservation & Environment Protection, (AECEP)
32-B, Bhagirathi Puram, GMS Road, Dehradun-248001
Contact: 9456583967, E-mail: aecep29@gmail.com
www.aecep.org