Confidential

Detailed Energy Audit

Kanoria PG MahilaMahavidyalaya

JawaharLal Nehru Marg, Jaipur, Rajasthan-302015

By

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(Accredited Energy Auditor of BEE)
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Location: Jaipur, Rajasthan
Audit Period: From 29/06/2021 to 15/07/2021
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ACKNOWLEDGMENT

Usha Management Consultants thanks the management of *Kanoria PG MahilaMahavidyalaya,* Jaipur for having given us the opportunity to conduct the Detailed Energy audit of Kanoria College. (Order No.KNM2021-22/0118 dated 26.06.2021)

Director, Principal, Secretary, Dean, College Development and Professor Botany And staff of Kanoria College have been very cooperative and helpful during our audit. We express our sincere gratitude to them and particularly to the following:

Shri V.K. Bhatia – Secretary

Dr. Rashmi Chaturvedi – Director

Dr. Seema Agarwal – Principal

Dr. Ratna Saxena – Vice Principal

Dr. Ranjula Jain - Dean – College Development

Dr. Ritu Jain –Assistant Professor (Botany) – Committee Member

Mr. Vijay Sharma – Administrative Officer

Mr. Ritesh Saini – Civil Engineer

Sh. Sanjay Mathur – Office Superintendent

The audit & its report has been done as per BEE guide lines for "investment grade energy audit" (IGEA) of Buildings & Energy Assessment Guide, 2008 for buildings.

(V. K. Luhadiya)
Accredited Energy Auditor

THE AUDIT TEAM

1. Mr.Vinod K. Luhadiya, CEO of Usha Management Consultants, Jaipur
2. Mr. Rajesh Goyal – Energy Auditor
3. Mr.Prasoon Godika – Energy Auditor
4. Mr.Anshul Goel – Engineer
5. Mr. Ajay Nunia – STP Expert
6. Mr. N SaiBalaji - Engineer

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EXECUTIVE SUMMARY

The staff and management is highly aware of energy use and are being educated to the students of the college. Four recommendations with payback calculations are summarized for taking quick decision. The efforts & thought are in the right direction.

Following actions should always be kept in mind:-

1. ***Only Star Rated products like fans and inverter AC should be purchased preferably from EESL even slightly costly as compare to normal.***
2. ***Lift should be purchased of regenerative type.***
3. ***Solar 120 kWp has been planned in addition to existing 80 kWp working. This will reduce the power bill and the college can be a net zero building. Pl give O&M for five years.***
4. ***In order to reduce LPG consumption in mess, solar parabolic steam generator should be thought to boil Rice, Dal and Milk etc.***
5. ***The STP plant installation will reduce the demand of water being pumped from tubewell and this should be installed on priority as this is also requirement for green audit (NACC accreditation).***

By the above actions the college can become a net zero building.

RECOMMENDATIONS FOR SAVINGS							
S. No.	**Description**	**Potential Electrical Savings /yr In KWH**	**Potential Savings in Rs/yr**	**Cost of implement ation in Rs.**	**Simple pay- back period in years**	**Remark**	**Priority for implementati ons**
1	Housekeeping measure for AC and lighting & Install Fensta Doors and windows in AC rooms.	10000	60000/-	28000/- 100000/- (for fensta doors)	2 Years	Cleaning,checking And temp setting to 26 degree centigrade. This will reduce thermal load and is good insulator.	**Immediate& Regular and is to be done properly**
2A	Repair and Housekeeping measure and AMC for solar water heaters - 9 nos. in use of hostel	6480	42120/-	7650/- 10000/- (AMC)	0.5 Years	Cleaning leakage of the system	**Immediate (Work to be started)**
2B	Reinstallation of 7 nos. solar water heaters which have been removed.	5040	35280/-	100000/- (lumsump)	2.5 Years	These were removed and tank and plumbing work is to be got done. 7 nos. to be reinstalled	**Immediate**
3	Replace existing T-8 & T-12 Tubelights with 18W LED.	12600	81900/-	2,01,200/-	2.5 Years	T8 & T12 are not be used now. Sale them to employees.	**3rd**
		34120	219300/-	446850/-			
4	Parabolic solar steam generator can be put for cooking and milk boiling in hostel mess. (LPG Saving of 200 cylinders)	Rs. 340000/-		7,00,000/-	2.0 Years	This has been in used in MNIT for last 4 years. MNRE subsidy is available	**2nd**

PREFACE

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management programme.

There is now a universal recognition of the fact that new technologies and much greater use of some that already exist provide the most hopeful prospects for the future. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options.

This report is just one step, a mere mile marker towards our destination of achieving energy efficiency and we would like to emphasise that an energy audit is a continuous process.

We did audit in June 2012. And are happy to say that our all recommendation has been implemented. New building of hostel has been made .Language lab has been started. Law College has started but building is under construction. The energy conservation has been kept in mind while architecture.

The number of ACs has increased to 72(including 25 of hostels). The R.O. and water purifier have been installed to give better comfort for study and health. 80KWp solar power generation plant has been put in June 2020. Another 120 KWp is being planned on Law college roof.

Water harvesting system/pits (4 numbers) has been constructed and this water is input to underground.

A composting machine has also been installed in March 20 to handle green and kitchen waste. Solar water heaters (16nos.) of 330 liters per day capacity were installed for bathing in hostels. Seven have been removed due to new hostel construction few years back. Balance 9 are not working satisfactory (due to tank level problem and gasket failures and most of the time electrical heaters installed as stand-by are running.) However a repair and maintenance contract has been advised to original equipment supplier who can easily maintain. This will save electrical energy being consumed now for hot water generation

This report can be used for NAAC accreditation of the college.

1. INTRODUCTION

The Kanoria PG MahilaMahavidyalaya is centrally located on JLN Marg just opposite to the Rajasthan University Campus and is spread over an area of 8.67 acres of land.

The foundation stone of College was done in 1965. The main college building is on 3500 sq.mt. area. The air conditioned area of main campus and hostel is 650 sq. Mtr.

About 6500 students enrol every year in 24 subjects in Science, Arts , Commerce and law streams for Bachelor's programme and 15 Master's programme. Maintaining a lead in premier educational location, the college has clocked an enviable growth keeping abreast with the needs and aspirations of times. About 350 girls student lives in the hostels. The facilities for hostellers are – Furnished rooms, Swimming pool, gym, spacious playground, Water-cooler/Water-purifier, solar water heaters, Tata sky Television with LCD, Newspapers, Sanitary Napkin Vending machine and AC rooms.

There is a large swimming pool with an automatic filtration plant. An air-conditioned auditorium with the capacity of about 500 seats is the venue of almost all important events of the college. The law college building (under construction) is being constructed above swimming pool with A.C. lecture halls and their is also provision of lift to go to law college office and lecture halls and library.

College Library is the member of N-LIST Project entitled "National Library and Information Services Infrastructure for Scholarly Content", being jointly executed by the UGC-INFONET Digital Library Consortium, INFLIBNET Centre and the INDEST-AICTE Consortium, IIT-Delhi. This Project provides access to E-Resource (6000+ E-Journals and 31,35,000+ E-books) to students ,researchers and faculty members from college through servers installed at the INFLIB NETCentre. The library has internet facility also. Students can borrow books from the book-bank on yearly basis till the annual examinations.

Two Well equipped computer laboratories with 60 computers are there in the campus. Computers are installed in both the labs, all networked to facilitate teaching in batches,

with adequate faculty attention. Cyber café is there to provide internet facility. The college has Bio- tech, Botany, Chemistry, Drawing & Painting, Geography, Home science, Physics, Psychology and Zoology labs .All the laboratories are well- equipped aided by a staff to ensure adherence to practical methodology in the relevant subjects. The college has an Art-room to facilitate the department of Drawing and Painting and a Music room for Music department. There is English Language lab also.

College has a cafeteria where students can take variety of healthy snacks, mini-meals.. Vending machine for tea and coffee is also there in the cafeteria.

The college compound is embellished with sprawling gardens which boast of rare trees and herbs. The college has fully computerised and air-conditioned office.

There are two hostel buildings to accommodate 350 students. These are well ventilated rooms, furnished with tables, chairs, beds and ward robes.And also has 4 seater AC rooms.

The college campus has two separate parking areas, the space near to the NandlalKanoria complex is exclusively for the staff members and the other one near the cafeteria is for the students, where they can park there two wheeler . The college has basket-ball court, volley ball and hand ball court, badminton court, hockey and football ground and the cricket pitch in the

Staff-room is a place where the meeting of mind takes place and the preparation of future course of action is designed and is in the centre of the campus.

1.1 Energy audit objective:

The audit assumes significance due to the fact that the Kanoria PG Mahila Mahavidyalaya, Jaipur is growing and wants to apply for NAAC accreditation and have planned a law college.The electricity bill (import)may cross Rs. 50 lacs during 2021-22 (presently college is closed due to Covid-19 pandemic) and it is aimed at obtaining a detailed idea about the various end use energy activities and identifying, enumerating and evaluating the possible energy savings opportunities. The target is to achieve savings in the electrical energy and LPG usage to the extent of minimum possible. The electrical wiring & fitting of the college is good and safe fully with proper earthling.

1.2 Present energy scenario:

The energy Usage on campus is mainly in the form of electricity, apart from theuse of LPG as cooking fuel in the mess of hostels and canteen The campus had a connected electrical load and contract demand of 250kW. Minimum billing demand is 187.5 kvA which is 75% of the contract demand. The monthly recorded highest maximum demand for the month May-21 was 14315 Kwh and lowest recorded demand is 2654 kwh from June-20 to May-21.The bi-directional net meter is of secure make has been installed because of solar power generation. Its multiplying factor is 30. The supply voltage is 11 KV and metering voltage is 230 volts.

The college energy bill for the FY 2020-21 was examined. This consumption is less due to stoppage of college due to Covid-19.It has two components: Energy KWH exported are the net units given to Discom during the month by solar PV plant after use of solar power during day from generated from 80 KWp. And given back to system (export) through recording in net metering and the other is units taken/imported from Discom during night when there is no generation or shortfall during day time. The net (which is difference of import and export) is billed with fixed charges.

1. Energy Charges, @ Rs. 5.90 per kWh or unit
2. Fixed Charges, is Rs 50625
3. Electricity Duty, @ Rs.0.40 per kWh
4. Urban Cess, @ Rs. 0.10 per kWh
5. Water Cess, @ Rs. 0.15 per kWh

Apart from the above charges, the consumer shall not cause a demand more than his contract demand. In case he causes a demand of more than 105% of the contract demand in a particular month, apart from being disconnected, he shall be required to pay an extra charge equal to the same percentage of the fixed and energy charges (excluding the electricity duty and other charges) by which percentage the excess demand has actually being caused.

Delayed payment surcharge shall be levied @ 2% on unpaid dues of Jaipur Discom. Consumer shall maintain an average power factor of not less than 0.90 (90%). In case the average power factor falls below 0.90 (90%), a surcharge @ 1% of energy charges for every 0.0.(1%) fall in average power factor below 0.90 (90%), shall be charged. Also an incentive of 1% of Energy Charges shall be allowed if average power factor is above 0.95 (95%) for each 0.01(1%) improvement above 0.95 (95%).

If the average power factor falls below 0.70(70%), the installation can be disconnected and will not be reconnected till the average power factor is improved to the satisfaction of the Jaipur Discom.

1.3 Study of Electricity Bills (Net Bills):

Month wise Usage of Electricity (net) in kWh is as follows: (Also see Annexure-1)

DETAILS OF RSEB BILLS OF POWER CONSUMPTION AND SOLAR POWER EXPORTED TO GRID AFTER 1ST CONSUMPTION BY THE COLLEGE

SSVPS generator Meter No.			XE431915		
Tariff code-			2011 XN		
Category			NDS-HT		
Sanctioned Load			250 KW		
Solar Generation			80 KWp		
S.NO	**Months**	**PF**	**KWH (Solar) Export from Solar**	**KWH (Import)**	**Net Billed Units**
1	Jun-20	0.92	2676	2860.5	184.5
2	Jul-20	0.935	1611	8518.5	6907.5
3	Aug-20	0.943	2685	5809.5	3124.5
4	Sep-20	0.932	2265	7311	5046
5	Oct-20	0.929	2670	6072	3402
6	Nov-20	0.941	5913	2653.5	-3259.5
7	Dec.20	0.921	6132	2511	-3621
8	Jan-21	0.962	4707	3601.5	-1105.5
9	Feb-21	0.962	3588	5352	1764
10	Mar-21	0.946	1854	11932.5	10078.5

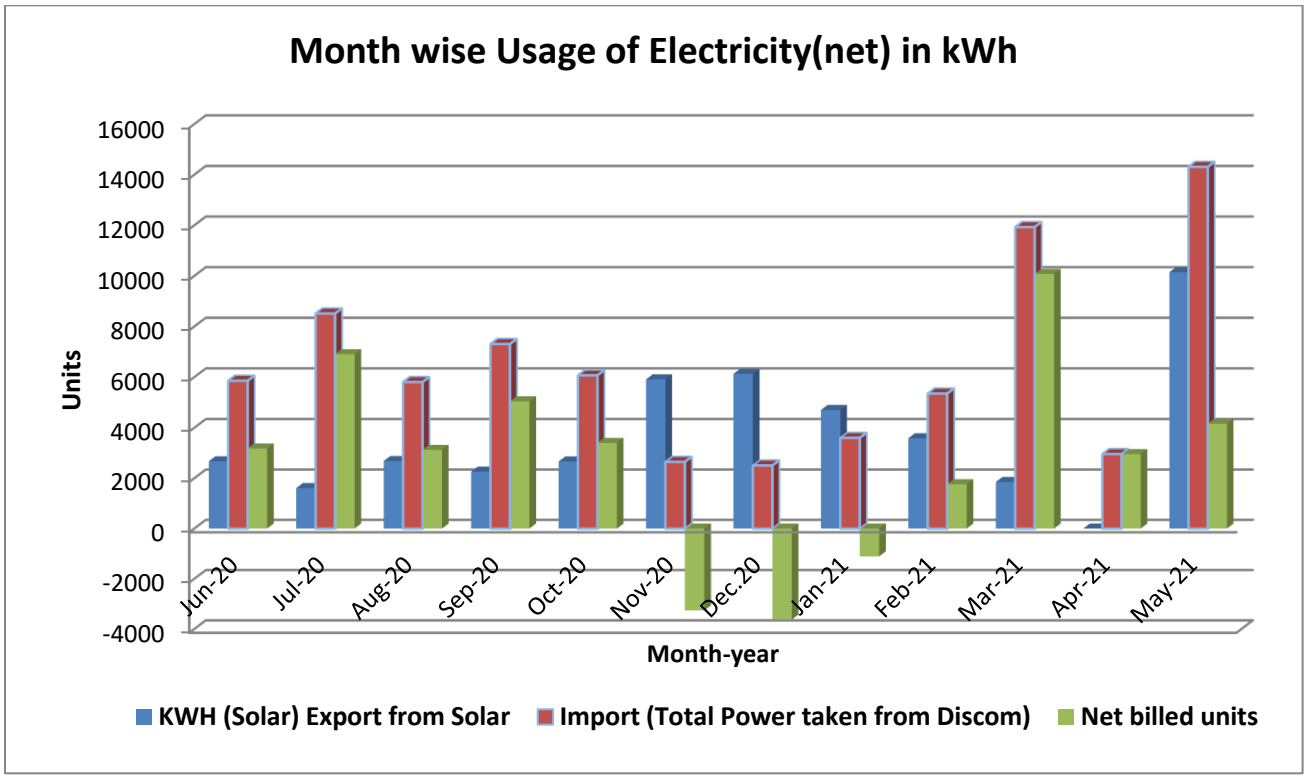
11	Apr-21	0.92	0	2961	2961
12	May-21	0.967	10152	14314.5	4162.5
TOTAL			**44253**	**73897.5**	**29644.5**
AVERAGE			**3687.75**	**6158.125**	**2470.375**
MIN			**0**	**2511**	
MAX			**10152**	**14314.5**	

The Specific Energy Usage (SEC) is defined as the energy Usage per unit of product output. The specific energy Usage considering students, faculty and staff members were calculated which forms the institute SEC and was taken as reference for comparison. The SEC was not calculated to due to stoppage of activities due to Covid-19.

Remarks:

1. *The contract demand was increased to 250 KVA.*
2. ***The solar PV plant was put in June, 2020s. The net meter installed and the readings taken of export is what is really going to grid after use of solar power during generation in the campus. The monthly export in May-2021 bill is highest (as the reading of export are recorded is of two months i.e. of April and May-21).***
3. *The average solar export is 3688 units which is 1/3rd of the capacity of the solar plant. The 2/3 generation is being consumed directly in the college. The plant is generating good units.*
4. *The average import of power is 6185 units but it is due to Covid-19 and the college is completely stopped. Only essential staff are coming for duty and consumption has started increasing from March-21 onwards due to AC operation.*

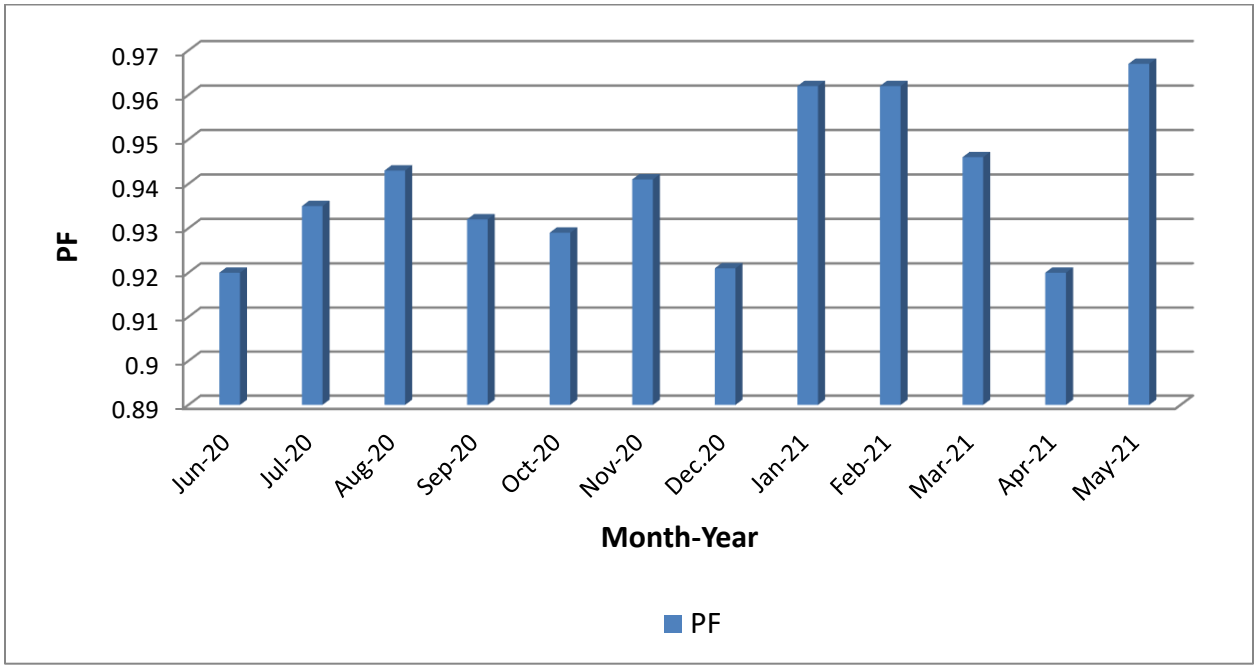
Month wise Usage of Electricity (net) in kWh:



It is interesting to note that since June-20 to Oct-20, the power export from solar was recorded in the range of 2600-2700 kwh as the 6900 kwh units of plant capacity was used in the college. The generation capacity of solar plant is average more than 9500 kwh (320*30) per month. The plant was generating to the full capacity wise. This matter should be taken up with them by management and solar plant supplier who coordinated with RSEB.

During November – December - 2020 the units exported are in the range of 5913-6132 kwh. And this appears to be correct as the consumption in these months are generally low. From Jan-21 till May-21 they are recording average export of solar which is 4060 kwh, which is less as the consumption has increased due to summer.

Monthwise Power Factor (PF):



The power factor is being maintained within limits and the capacitor banks installed are working correctly. However an observation should be kept when the load will increase when the college restarts say in Sept-21.

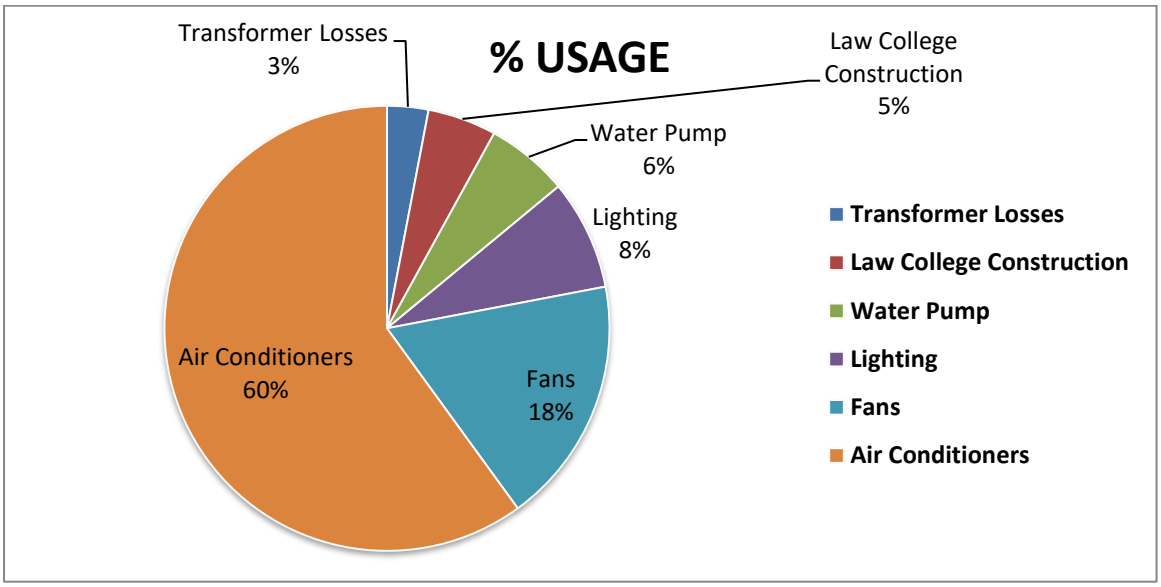
Month wise Recorded Maximum Demand in kVA – The maximum demand is within limits of allowed by Discom. However it should be always kept in mind ones the college restart. A maximum demand controller can be put to avoid to cross the 187.5kVA demand any time in future.

Segmentation(Use of power activity-wise):

Presently, there is no separate energy metering for various sections of the college like swimming pool area, college building, canteen, kitchen etc. Even though energy meters are installed for both hostel but there is no recording of energy usage hence segregation of energy for college and hostels and Law College etc. can't be done.

Separate meters will increase control. It is recommended to install whole current meters and at least monthly readings to be recorded on 1st date of every month. However the layout has to be taken in consideration.

However, based on the connected load and their operating hours, following bifurcation is made for FY: 2020-21: It shows that most of the Usage is for ACs, lighting and fans and it is ~ 90% The balance power is being consumed in water pumping. The swimming pool is not working and not consuming the power as construction is going on of Law college. The power consumption in the new Law college building construction is about 5%.



2. ENERGY AUDIT

2.1 Energy audit methodology

The methodology adopted for this audit was Formation of audit team comprises of Certified Energy Auditors who checked the connected load and performance assessment of the various electrical loads like lighting systems, coolers & fans, pump sets, air conditioners, etc. Following activities are used:

A. Visual inspection and data collection
B. Observations on the general condition of the facility and equipment and quantification
C. Identification / verification of energy Usage and other parameters by measurements
D. Detailed calculations, analyses and assumptions
E. Validation
F. Potential energy saving opportunities

RECOMMENDATIONS ON ENERGY SAVING MEASURES:

Based on the energy audit carried out, following Energy Saving Measures are hereby recommended for implementation as per the investment level and priority mentioned.

The recommendation no. 1: of housekeeping of ACs (Annual cleaning) and cleaning of lighting fixtures is being done by the college but it needs more attention like checking of cold air flow, refrigerant quantity etc. The temperature setting should be plus 26 degree centigrade. The air-tight door (Fensta make) and windows should always be put in the rooms where the ACs are installed to avoid cold air leakage.

The recommendation no. 2: is for making effective and correct use and repair of solar water heater (16 nos.) for getting water at 45-50 degree centigrade and keep stopped electrical heaters. The heaters should be off all the time and should only be got started with permission of warden or hostel staff or electrician and should be informed before starting. The electrician should be given responsibility of solar water heater and solar PV panels and power generation like by DG set .The DG set operation was checked and found efficient as per design.

The offer given for solar heater supplier should be awarded (from OEM solar max or other) for repair and AMC at the top most priority before start of the winter.

RECOMMENDATION NO. – 3

A. Title of Recommendation	:	Replace existing T-8 & T-12 Tubelights with LED.
B. Description of Existing System and its operation	:	The college has still 503 nos. T-12, and T-8 tubelights of 40W with choke. 40W Fluorescent tube lights with Electromagnetic ballast (14W choke) in different departments, labs and hostels. The total lighting load from the above is about 27 kW (including ballast/choke power).

C. Description of Proposed system and its operation	:	Existing T-8 & T-12 Tube lights of 40W+14W= 54W can be replaced with 19 W LED. The lux is more at lower power consumption and the life is more than 10 years.
D. Energy Saving Calculations		
Reduction power consumption	=	The Average power consumption is 27kW/hr and proposed will be 10 kW. The Reduction will be 17kW i.e. 63%
E. Cost Benefits		
Annual Energy Saving Potential	=	10*1260= 12600kwh (10 kwh for 5hrs/day)
Annual Cost Savings @ Rs. 6.5/- per unit	=	12600*6.5/- = Rs. 81900/-
Investment	=	2,01,200/- (503 LED @ 400/- each)
Simple Pay back period	=	2.5 years
Remark	=	The existing tubelights can be either sold to staff at a nominal price for returning two number of incandescent bulbs being used and are in good condition. This will give some revenue but we are not accounting that in investment but it will add to national saving and create better good will in the staff.

Case Study #1

Lighting:

The college has still about 503 nos. T-12& T-8 tube lights of 40W with choke. 40Wfluorescent tube lights with Electromagnetic ballast(14W Power) are in use in different departments, labs and hostels. There are 40 nos. Mercury CFL's of 14W and 28W are in use. These can be replaced with 9W LED lamp for same lighting in the area. These CFL lamps can be kept as reserved or can be shifted to areas like pump house of swimming pool, water pump house and electrical room etc. The total lighting load from the above is about 27kW (including ballast power).

Recommendation # 1 : Replace existing T-8 & T-12 FTL's with 19W LED tube lights

Existing T-8 & T-12 Tube lights of 40W+14W= 54 W can be replaced with 19 W LED T/L . Comparison of T-8 or T-12 FTL Standard of 40W shows that 19W LED FTL gives more lumens at lower power Usage.

FTL	Dia.	Wattage	Flux	Efficacy	Lumens
TL'D' Stand (T-8)	26 mm	40	2425 Lumens	67 Lm/W	2412 lumens
LED 19W	16 mm	19 W	3920 Lumens	205 Lm/W	3912 lumens

LED is shorter in length than the conventional T-8 or T-12 (40W) lamps and therefore cannot fit into existing fittings. PYROTECH or EES Lmodule provides straight & easy replacement of the conventional FTL without any change in wiring.

Additional advantage of EESL modules:

- Operates from 130 V to 300V A.C., 50 Hz.
- Flicker free starting & illumination
- No stroboscopic effect.
- Hum free operations
- Safety from shock hazards due to plastic body

- Unique wing reflectors delivers uniform light
- Programmed pre heat ensures full utilization of lamp life of 10 years
- Harmonics contents confirms to IEC 1000-3-2
- High CRI reveals true colours and textures of objects.
- EMI &RFI conforms to IS 6842
- Also available in constant Lux & low harmonics (< 10% THD) module.
- LED are available in three colour temperature Daylight (6000 K), Cool white (4000 K), and warm white (3000 K) and in decorative design
- The college is using LED Tubelight and are happy

Efficiency Comparison:-

Parameter	LED	Conventional 40 W FTL	Advantage
Power Cons.	19+ 1Watt	52 +1Watt	24 watts saving
Power factor	0.95 & higher	0.0.54	0.30 Pf more
Rated tube life	28000 Burning Hours	5000 burning Hrs as per IS	13000 hrs more
HF Noise/ harmonics	Conforming to IEC	Not confirming to IEC	+ve
Striking voltage	Less then 120 V	More then 180 V	+ve
VA	30	81	51 VA less
CRI	85	55	30 more
DLOR Lux up to 20 % higher then conventional tube light of 40W			

Saving Calculation:

Power Usage of existing conventional T-8 & T-12 FTL (54W with choke)

503 nos.X54W = 27 kW

Power Usage of proposed LED Super FTL's= 503 nos. X 19 W = 10 kW

Power Saving = 27kW- 10kW = 17kW

Annual Energy Saving (assuming 4 -5 hours average lighting hrs)

= 17kW X 4hrs/day X 300days per annum = 20400 kWh(lower side)

Annual amount saved @ Rs 7/kWh = 20400 kWh X 7 per kWh = Rs 142800/-

Energy Saved at Generating station = 2 X Energy consumed at demand side

= 2X20400 kWh= 40800 kWh

Reduction in CO2 emission = 40800 X 0.8 kg CO2 /kWh

= 32 tones of CO2/ year

National Saving in Capital cost of power plant

= 2X10kW X 60,000/kW = Rs. 1200000/-

Investment = 503nos. X Rs 400 per LED = 201200/-

Simple payback period = Investment / Savings per year = 201200/-

/ 142800 = 1.4 years ~ 15months

Method of Calculating ILER (Ref Annexure-12): ILER is an important activity to know the wastage of lighting compared to the target lux recommended by BIS for various activities. We have done calculation of 25 area to know ILER. If ILER is less than 0.7, then it needs review urgently. Between 0.7-1 is satisfactory. And more than that is wastage of light. In college since it works in day time ,we should use maximum day light and can switch off some of the lights easily. The director and other senior staff should use table lamp for focus study and all other area can be in the average lux of 100 for safety. The corridor lights are satisfactory. Outside light near the hostel and main entrance is ok for cctv cameras installed. An Example of how we can calculate ILER is as follows:

"This process of comparing the installed load efficacy (ILER) with the target value for the Room Index and type of application can also be used to assess the efficiency of designs for new or replacement general lighting installations. If, when doing so, the calculated ILER (lux/W/m²) is less than the target value then it is advisable to

ascertain the reasons. It may be that the requirements dictate a type of luminare that is not as efficient as the best, or the surface reflectance are less than the normal maxima, or the environment is dirty, etc., Whatever the reasons, they should be checked to see if a more efficient solution is possible." Step/method to calculate ILER is as follows :

STEP 1	Measure the floor area of the interior:	*Area = 45 m²*
STEP 2	Calculate the Room Index	*RI = 1.93*
STEP 3	Determine the total circuit watts of the installation by a power meter if a separate feeder for lighting is available. If the actual value is not known a reasonable approximation can be obtained by totalling up the lamp wattages including the ballasts:	*Total circuit watts = 990 W*
STEP 4	Calculate Watts per square metre, 3 ÷1 :	*W/m² = 22*
STEP 5	Ascertain the average maintained illuminance, Eav. Maintained (average lux levels measured at 18 points)	*Eav.maint. = 700*
STEP 6	Divide 5 by 4 to calculate the actual lux per watt per square Metre	*Lux/W/m² = 31.8*
STEP 7	Obtain target Lux/W/m² lux for type of the type of interior/application and RI (2):(Refer Table 10.2)	*Target Lux/W/m² = 46*
STEP 8	Calculate Installed Load Efficacy Ratio (6 ÷ 7).	*ILER = 0.7*

Case Study #2

FANS: Use of Electronics regulators:

The college is having 820 nos. fans in different departments, Law college, labs and hostels. Out of which about 280 fans are with resistant type (RR) regulator and 50fans are without any regulator. The connected fan load is 62kW where some fans are still very old.

Power is measured for the fan with resistance regulator and electronic regulator and concluded that power is saved if speed of the fan is controlled using electronic regulator. It is envisaged that at least 20% energy usage can be saved if the fans are fitted with electronic type regulator instead of resistance type regulator or without regulator.

Ceiling Fan Speed	Resistance regulator				Electronic Regulator				Saving envisaged
	Voltage	Current	Power Factor	Power Usage	Voltage	Current	Power Factor	Power Usage	
1	224.7	0.43	0.791	76	234	0.26	0.385	23	53
2	225.6	0.43	0.9	87	234	0.396	0.66	61	26
3	223.81	0.453	0.956	97	234	0.382	0.815	73	24
4	223.4	0.45	0.984	99	234	0.394	0.906	83	15
ON	223.3	0.452	0.996	101	233	0.432	0.997	100	0

Saving Calculation:

Total no. of fans = 820 nos.

Fans without any regulator = 50 nos.

Fans with resistance type regulator = 280 nos.

Fans with electronic regulator = 490

Estimated Annual Energy usage of all fans = 73,720 kWh

Estimated power Usage of fans without regulator and with resistance regulator = 73720 X(50+280)/820= 29670 kWh

By installing electronic regulators, at least 20% power can be saved on conservative basis i.e. Annual energy saved = 29670 X 20% = 5934 kWh

Annual amount saved @ 6.55/ kWh,5934 kWh X 6.55 per kWh = Rs. 38867/-

Energy Saved at Generating station = 2 X Energy consumed at demand side

= 2X5934 kWh= 11868 kWh

Reduction in CO_2 emission = 11868 X 0.8 kg CO_2 /kWh

= 9494.4 kg = 9.5 tones of CO_2/ year

Investment = 330 nos. X 150 per regulator = Rs. 49,500/-

Simple payback period = Investment / Savings per year = 49,500/38,867 = 1.27 years ~ 15 months

Air Conditioners:

On using the rated capacity details supplied by the manufacturers, the total room AC load is about 144 kW. The total AC load (rated) is about 120 tons of refrigeration.

SN	Location where AC is installed	No. of AC's installed	Rated Power in kW	Rated Ton of refrigeration	Area in m2	kW/TR
1	Director room	2 nos.	2 nos. X 3.5 kW = 7kW	2X 2 TR = 4TR	64.64	1.75
2	Office I	4nos.	2 nos.X 1.8 kW=3.6kW	2X1.5TR = 3TR	32.0	1.83(Panasonic)
3	Office II	2 nos.	2 nos. X 1.8 kW=3.6kW	2X1.5TR = 3 TR	32.0	1.13(hitachi)
4	Computer Lab (Room no. 48)	4 no.	4 no. X 2 kW= 8 kW	4 X 1.5TR = 6TR	83.05	1.33
4	Culture room	1 nos.	1 no. X 1.8kW = 1.8kW	1 X 1.5TR = 1.5 TR	3.72	1.2
5	Conference Hall	8 nos.	8 nos.X2.5kW = 20kW	8 X 2TR = 16 TR	297.29	1.25
Total		**21 nos.**	**44 kW**	**33.5TR**		

Performance Evaluation of various makes of Air Conditioners installed in College

Make	Panasonic	HITACHI	Panasonic	Blue Star	LG	Hitachi
Model	CSZC20MKYP3	RAU0023HQDG	CS-ZC20NYK	2HW241YK	INTELLO AIR-LSA81RAB-I	RAU023HQDG
Rated TR	2 TR	1.5 TR	1.5 TR	1.5 TR	1.5 TR	2 TR
Star Rating	2- Star	2- Star	2- Star	-	-	3- Star
Location where AC installed	Director room	Office -I	Office-II	Server Room	Culture room	Conference Room

SN	Particulars	Unit	Parameters	Parameters	Parameters	Parameters	Parameters	Parameters
1	Pressure at Sea Level	Mm/water gauge	101325	101325	101325	101325	101325	101325
2	Latitude in degree	degree	26.89	26.89	26.89	26.89	26.89	26.89
3	Latitude in radian	Radian	0.47	0.47	0.47	0.47	0.47	0.47
4	Gravitational acceleration "g" at site	m/sec	9.79	9.79	9.79	9.79	9.79	9.79
5	Altitude of the site	Msl	440	440	440	440	440	440
6	Pressure at the site	Mm	96151	96151	96151	96151	96151	96151
7	Length of discharge window	Cm	51	85	88.5	80	96	96
8	Width of discharge window	Cm	48	8.5	8.5	6	7	7
9	Area of discharge window	m^2	0.220	0.065	0.068	0.043	0.060	0.060
10	Avg. Velocity of discharge air	m/sec	1.33	4.22	4.34	3.67	4.00	3.65
11	Air flow rate	$m^{3/}$hour	1055.7	988.8	1057.5	570.4	870.9	794.2
12	Dry bulb temperature of suction air	^oC	27	36	35	27	34	35
13	Wet bulb temperature of suction air	^oC	20	23	24	21	26	24
14	Density of suction air	Kg/m^3	1.108	1.075	1.077	1.107	1.079	1.077
15	Enthalpy of Suction air	kj/hr	58.879	69.783	73.847	62.195	82.544	73.847
16	Dry bulb temperature of discharge air	^oC	13	17	16	14	17	15
17	Wet bulb temperature of discharge air	^oC	12.5	16	15	13	16	14
18	Density of discharge air	Kg/m^3	1.164	1.147	1.151	1.16	1.147	1.156
19	Enthalpy of discharge air	Kj/hr	36.106	45.759	42.841	37.416	45.759	40.045
20	Heat flow rate in suction air	kJ/hr	68871	74179	84105	39275	77568	63167
21	Heat flow rate in discharge air	kJ/hr	44368	51900	52144	24759	45710	36766

22	Refrigeration effect	kJ/hr	24503	22280	31960	14516	31857	26401
23	Heat Load in Tons of Refrigeration	TR	1.94	1.76	2.52	1.15	2.52	2.09
24	Total Power Input	kW	2.08	2.68	2.38	2.71	1.97	2.48
25	Specific Power Consumption	kW/TR	1.07	1.52	0.94	2.36	0.78	1.19
26	Coefficient of Performance	CPU	3.27	2.31	3.73	1.49	4.49	2.96
27	Energy Efficiency Ratio, EER	BTU/h-W	11.17	7.88	12.73	5.08	15.33	10.09

Observation on Air Conditioners:

The use of air conditioner has increased many folds during the last 10 years. This has made the working condition better and productivity has increased (less staff and more students). However due to increase in ACs in stages, a big central plant could not be planned and now these split ACs are being operated. If we compare the power consumption for 100 TR AHU plant with the present power consumption of split ACs, this would have been half.
In future if the management is going to increase air conditioned area like in lecture halls or in labs or in common places like library, the central plant of required capacity should also be studied.

The ACs of Panasonic make should not be purchased as their KW/TR is high (1.75 to 1.83). All 5 star inverter ACs of make like Voltas (which are being supplied by EESL) should only be purchased or if in single location the requirement is of more than 15 TR then the VRF designed AC system of companies like O-General, Mitsubhi should be purchased. This is being done in the purchase(tender) floated for the Law College.

It is observed that the AC's installed for office and Conference hall and all other many places are split type and their outdoor unit comprising of condenser is affixed and exposed to sun radiation directly most of the time. The outdoor unit should be covered with FRP sheet. In fact refrigeration effect depends upon the heat transferred from condenser to the ambient air and is proportional to the difference in temperature between condenser surface and surrounding air temperature. Due to the fact that surrounding temperature is more hot than when the unit is kept in shadow where sunlight do not falls. The more heat shall be rejected and hence for the same power Usage, refrigeration effect is more hence COP shall be more. Hence it is suggested that the outdoor units are either placed in shadow locations or an overhang is to be installed so that efficiency can be improved. Secondly, for the rooms where sunlight enters into rooms through window glass, external louvers are to be installed to prevent solar gain in the room so that AC load can be lowered. Special type window and doors of make

Fensta which are tight and does not allow cold air to leak should be installed. (UPVC Windows and doors)

The AC's in conference hall are used rarely whenever there is a meeting/programme.
Performance of the ACs installed in office of the Director is assessed and found satisfactory.

To retrofit the Air Conditioners with AC ENERGY SAVER" Genie"

The Genie is a conceptual engineering marvel, which saves electric power and improves efficiency in all air cooled Air conditioning units. The blue colored units are custom designed for any type of air conditioner and can be retrofitted to any capacity of Air conditioning plant provided they have air cooled condensers.

The unit is an excellent power saver for all air cooled air conditioners like window air-conditioners, split AC units, package unit's right from 1 TR capacity to about 20TR capacity. It saves from 10% to 20% of the electric power together with reduced noise, vibration and maintenance stress on the compressors.

The added advantages are: Fall in the grill temperatures by about 20% to 30% gives faster cooling and quicker thermostatic tripping.

The discharge pressures of refrigerant after the compressor falls putting less stress on the compressor, reducing the amperage drawn by the AC unit and also reducing the vibration and the noise level in the AC unit. The reduced operating refrigerant pressure also reflects favourably on the maintenance making it last longer.

This is a retrofit on any air-cooled AC unit without touching any thing in the refrigerant circuit and also not disturbing the existing aesthetic in the room.
Already a number of satisfied users and installations exist in Baroda which can be witnessed by the technical team.

The Genie AC power saves the electric energy by 10% to 20% in three different ways:

I. There is a direct fall in the amperage by 7% to 15% drawn by the air conditioner. This fall in amperages (power Usage) is due to the fall in the discharge pressure of the compressor which go down by 5 % to 15%. It is well understood that lesser is the discharge pressure lesser will be the stress on the compressor and all moving components. The life of the compressor & all moving parts will be more as the stress level due to high pressure are now reduced. Additional advantage is the fall in vibrations and also the noise levels are reduced (again due to reduced discharge compressor pressures). This also reflects positively on the reduced maintenance cost as well.

II. The grill temperature (evaporator side) falls by 20% to 30%. This reflects in faster cooling and quicker thermostatic tripping of the compressor. This leads to reduced on time and stretched off time of the compressor. The faster cooling also permits the shorter preoccupation cooling time and leads to earlier tripping of compressor.

III. As the grill temperature is reduced, the room humidity is also reduced. Now room temperature setting (on thermostat) can be increased by 10C to 20C. Since the humidity of chilled air is reduced further, one feels the same comfort even at a little higher (1 to 20^{o}C) temperatures. This will additionally reduce the ON time of the compressor.

Thus, one can achieve 10% to 20% of power saving in the air cooled air conditioning units with the additional advantage of reduced maintenance, less noise and less vibrations.

The Genie is boxed in hot dip galvanized steel with powder coating on both sides for long life. Additionally, for corrosion protection all the water contact areas are FRP lined. There is a submersible circulating pump, connecting pipes, solenoid valve, magnetic auto high & low level controllers, a very innovative auto blow down mechanism and a thermostatic cut off relay to avoid too low condenser temperatures so that liquid refrigerant doesn't flow to the compressor. The vital part of the unit is a multilayered

corrugated cellulose wick-effect media for enhancing the wetting and increasing the skin contact area with incoming air for better condenser efficiency.

Suppliers:

Syguru Technology Services

820, Siddharth Complex, R.C.Dutt Road, Alkapuri

Vadodara – 390 007 Tel: 0265 2325024, Telefax: 0265 2325034

EMAIL: info@syguruace.com&sii2k@rediffmail.com

Saving Calculation:

Present installed capacity of 72 nos. Air-conditioners are127TR with connected load of 170kW. Estimated Annual Energy Usage of these AC's will be~1LakhkWh. (170*4*25*6)

Expected energy saving by installing AC Energy Saver Genie is 15% of the energy usage i.e. 1LakhkWh X 15% = 15000 kWh

Annual amount saved @ ` 6.55/ kWh = 15000 kWh X ` 6.55 per kWh = ` 97000/-

Energy Saved at Generating station = 2 X Energy consumed at demand side

= 2X15000 kWh= 30000 kWh

Reduction in CO2 emission = 30000 X 0.8 kg CO2 /kWh

= 24000 kg = 24 tones of CO2/ year

Investment = 72 nos. (For the AC's of Office, Principal room and server room & seminar room and all other rooms) X ` 8,000 per saver = 5,76,000/-

Simple payback period = Investment / Savings per year = ` 576000/ ` 265000 = 2.17 years ~ 26 months. But this should be tried first in few .

TO INSTALL AC CYCLIC TIMER CONTROLLER:

Digital AC cyclic timer power saver, which is specially designed for air conditioners to reduce compressor-running hours based on room temperature.

It has many unique features besides the power savings like over & under voltage protection, electronic lock, digital display, time delay, menu driven etc.
Any Air Conditioner consumes maximum power in running the compressor. Very little power is consumed in blower also which circulates the cooled air in the AC space. The DIGI Guard optimizes the AC compressor running with timer delays to optimize the compressor power Usage without sacrificing the comforts.

Normally, the thermostats used in the commercially available units are not very sensitive and accurate. Over a period of time the dust also tend to deposit on the sensing probe making the measurement more inaccurate. The compressor stop signal is sent only after the return air temperature has reached the set point on thermostat. There is considerable time lapse between the sensing of the return air temperature and tripping of the compressor, which some time allows the room to be sub-cooled below the set point. This is sheer waste of energy, which can be saved once the settings are timer based.

As the return air temperature depends on the air distribution in the room and if the air circulation is hindered due to the man movement and location of the AC, it is quite likely to get wrong signals in the thermostats and the purpose of comforts are defeated without even saving any energy.

The cyclic time settings on timer are very easy & simple. The menu is with digital display and settings can be changed easily any time to suit individual preferences and the atmospheric variations. Once set, it can be locked to avoid any disturbance.

The unit is digital & microprocessor controlled with many features like the following:

- ✓ It cuts off the peaks variations in room temperature and saves energy by customized settings.
- ✓ The cyclic timings are user settable.
- ✓ There is an electronic lock to prevent the disturbance of individualized settings by others.
- ✓ The unit can be given along with MCB along with a high amperage 3-pin plug.
- ✓ The unit is guaranteed for 1 year against any manufacturing defects.
- ✓ Voltage protection is available below 180V& above 260 V.
- ✓ Protects AC against surges & spikes.
- ✓ Provides delay timer & auto start.
- ✓ Eliminates the need for bulky and power consuming stabilizer.

Due to non-volatile memory it retains last programmed setting even during total power failure. Due to optimized running the running of the AC compressors is reduced there by saving energy and maintenance cost.

Suppliers:

Syguru Technology Services
820, Siddharth Complex, R.C.Dutt Road, Alkapuri
Vadodara – 390 007 Tel: 0265 2325024, Telefax: 0265 2325034
EMAIL: info@syguruace.com&sii2k@rediffmail.com

Computers

Computers and monitors account for 30%-40% of the energy used by office equipment. Their energy Usage is third only to lighting and AC

Approximately there are total 60computers. In computer Lab I- there are 30computers and in computer lab II- there are 30nos. of computers.

LED monitors are being used for the computers installed in Air Conditioned area as LED type monitors usage less power and hence require less power for air conditioning. Keep the CPU on standby when not in use for less than half an hour and shutdown if not in use for more that one hour. This will save energy usage by the computers.

Hostels

There are two hostels in Kanoria College, having an aggregate connected load of 66 kW out of which 24kW load is of Geysers. About 20kW is for Lighting and 22 kW is for fans. The ILER checked for various rooms and found that it is below 0.75 and hence lighting system is to be reviewed. Mainly students need light for study purpose and general lighting of the room. Table lamps are ideal and best for study in sharing rooms. Natural light is sufficient from windows.

INSTALLED LIGHTING EFFICIENCY RATIO (ILER)

Area	length in metre	Width in metre	Area in m2	Height above work plane	Room index	Wattage	Watts/ m2	Measured lux	Actual lux/ W/ m2	Target lux/ W/m2	ILER	Assessment
Library Office	4.7	3.3	15	1.8	1.1	40	2.6	84	32.0	40	0.80	Satisfactory
Library room	19.5	9.0	176	2.0	3.1	720	4.1	66	16.0	52	0.31	Action required
Old Hostel Room #2	4.8	5.1	24	2.0	1.2	80	3.3	80	24.1	40	0.60	Review suggested
Pricipal Office	9.0	7.2	64	2.3	1.7	450	7.0	251	35.9	46	0.78	Satisfactory

In library room, as above, ILER is 0.31 with actual lux/W/m2 of 16 only against required 52 lux/W/m2. The existing fixtures are to be hanged just above the table with 2X28W T LED . This will improve ILER and hence required lux level. T-8 and T-12 should be replace with 19 W LED T/L/

In hostel rooms, It is suggested that task lighting to be used in hostels for study purpose and table lamp with 6 W LED lamp is recommended to be installed. This will improve the ILER on the study table and satisfaction of the students.

CALCULATIONS FOR SOLAR WATER HEATING SYSTEMS (SWHS) FOR HOSTELS

A calculation for the storage tank volume, collector area requirement and payback period for the hostels has been done below.

Total no. of hot water users in hostel = 350

Assume that amount of hot water used per student = 15 litres / day.

Total amount of hot water required per day in the hostel = 5250 litres.

The Evacuated vacuum tube type(EVT) solar water heater were installed for 330*16=5280 Litre capacity/day.

The option selected by is natural circulation. Forced circulation was not done as it requires various accessories and proper control of the pump. Hence natural circulation system was selected.

Out of the 16 solar water heater installed, 7 have not been used . These should be commissioned now with tank and plumbing arrangements.

Total cost estimates for reinstallation of these 7 solar water heater for the hostel is Rs 1 Lacs Approx.

The 9 working solar water heater needs minor repair and cleaning so that that gives satisfactory performance. The estimate by the original supplier Solar Max is Rs. 850/- per water heater. They will also provide AMC for all 16 water heaters for Rs. 10,000/- per year. In this way it is recommended and required to make efforts to restart the

solar water heater system for use in coming winter months. This will save 2kw per heater power which is now in used for 9 working heaters.

The total energy consumption in the hostel having 18kW capacity electric heater installed as stand by in solar water heater.
Considering 6 hours of operation for 4 months operation a year, It can save be 18kW X 3 hours per day X 120 days= 6480 kWh per year
Cost of electricity as Rs 6.5 / kWh,
Total electricity bill due to electric heater in the hostel = 42120/
Simple Payback period = (Repair & Maintenance cost of SWHS / Electricity bill per year) = 17650/42120 ~ 0.5 years.

Water pumping

The water supply to the swimming pool, gardening and college building is taken from two nos. submersible pumps. These pumps are being operated at higher heads that these are designed ad hence discharge of water is very low. Also, due to ageing, the performance of the pump sets are very-very poor and hence needs replacement by energy efficient star rated submersible pumps. The power drawn by the pumps are very low and efficiency is lower than 6%. These pumps are used to fill the tanks installed at 86m and 80m net head and discharge is only 0.43 and 0.18 Litre per second with input power of 6.7kW&5.31kW.
Site parameters:

Latitude of location in degree	:	26.89
Latitude of location in radian	:	0.4692
Altitude of site in metre	:	440
Gravitational Acceleration m/sec2	:	9.790

Pure water Density v/s temperature		
Pure Water Temp.	30	(Deg. C)
Density r(T)	995.68	(kg/m^3)
Impure water density v/s temperature		
Water Salinity (S)	0.3	(gm/kg)
Density r(T,S)	995.90	(kg/m^3)

Energy Performance Assessment of Submersible pump near swimming pool:

Test Results

Duty Point	**Suction head/lift in metre (+/-)**	**Delivey head in metre**	**Net operating head in metre**	**Measured Discharge cum/hr**	**Hydraulic Power generated in kW**	**Average Voltage in volt**	**Average Current in amper e**	**Average Power factor**	**Total power input in kW**	**Discharge in Ltr/sec.**	**Max. attainable pump efficiency (As per Curve)**	**Overall efficiency (%)**
Normal	0	86	86.0	4.620	1.08	404	11.9	0.805	6.70	1.28	75%	16.05 %

Saving Calculation

Parameters	**Net Head in m**	**Discharge in cum/hr**	**Discharge in Ltr/sec**	**RPM**	**Specific Speed**	**Hydraulic Power**	**Power Input in kW**	**Overall Efficiency**	**Operating hours**	**Energy charges in one year**	**Investment in INR**	**Payback period in months**	**Reduction in CO2 emission tonnes/year**
Existing	86.00	4.62	1.28	-	-	1.08	6.70	16.05 %	2.00	Rs. 23,243			
Proposed	90.00	4.60	1.28	2950	13.17	1.12	1.76	63.75 %	2.01	Rs. 6,125			
Saving	-4.00	0.02	0.01	-	-	-0.05	4.94	47.70 %	-0.01	Rs. 17,119	Rs. 30,000.00	21.03	7.25

Recommendations:

The new pump is proposed of following parameters

Rated Head in metre	Rated Discharge in cum/hr	Rated RPM	Overall Efficiency
90.00	4.60	2950	63.75%

Energy Performance Assessment of Submersible pump near Canteen:

Test Results:

Duty Point	Suction head /lift in metre (+/-)	Delivey head in metre	Net operating head in metre	Measured Discharge cum /hr	Hydraulic Power generated in kW	Average Voltage in volt	Average Current in amper e	Average Power factor	Total power input in kW	Discharge in Ltr/sec.	Max. attainable pump efficiency (As per Curve)	Overall efficiency (%)
Normal	0	80	80.0	1.920	0.42	408	11.2	0.671	5.31	0.53	75%	7.83 %

Saving Calculation

Parameters	Net Head in m	Discharge in cum/hr	Discharge in Ltr/sec	RPM	Specific Speed	Hydraulic Power	Power Input in kW	Overall Efficiency	Operating hours	Energy charges in one year	Investment in INR	Payback period in months	Reduction in CO_2 emission tonnes/year
Existing	80.00	1.92	0.53	-	-	0.42	5.31	7.83 %	10.00	Rs. 92,076			
Proposed	80.00	4.00	1.11	2950	13.42	0.87	1.36	63.75 %	4.80	Rs. 11,313			
Saving	0.00	-2.08	-0.58	-	-	-0.45	3.95	55.92 %	5.20	Rs. 80,763	30,000.00	4.46	13.85

Recommendation:

The new pump was proposed of following parameters and was installed

Rated Head in metre	Rated Discharge in cum/hr	Rated RPM	Overall Efficiency
80.00	4.00	2950	63.75%

Recommendations (which were implemented after 1st audit):

The pump efficiency was very poor as the operating parameters were not matching with designed parameters. The flow is inversely proportional to head. When head is low with compare to rated, the flow shall be high and vice versa that is only up to head and flow range of the pump.

It is clear from the operating parameters that pump was running out of its design parameter and also may be impeller ageing and hence giving poor efficiency.This was replaced with correct pump. Swimming pool was stopped due to construction. Also, the pump was very old and replaced.

The water being pumped for overhead tank filling as well as gardening. It is observed that gardening water for lawn is given in day time which is evaporated and this method is not desired at all. Rather, gardening water to lawn is to be given in evening time after 5:00 PM and tank filling is to be done in morning hours at about 8:00 AM in order to utilise the boring water and pumping energy effectively. Drip or fountain system is good for plants and Gardening . Recycled water should be used.

It is also suggested that the pipes used underground for bore well to be checked as it is quite possible that the pipes are damaged and part of water pumped is returning to ground water and not coming outside.

Energy Performance Assessment of pump installed for Swimming pool (Non Starter Side)

Name plate rating of the pumping machinery:

Rated duty of pump						Rated duty of motor					
Size	**Model/ Type**	**Discharge(cum/hr)**	**Head(m)**	**Hydraulic Power kW (calculated)**	**Efficiency as per pump curve**	**Capacity in kW**	**Voltage in Volt**	**Rated Current (Amp)**	**Rated Power Factor**	**Rated RPM of Motor**	**Rated Efficiency in %**
80X65 mm	Monoblock	36	23.5	2.3	P/C NA	3.70	400	11	0.84091	2870	90.0 %

Test result of testing at various duty condition:

Duty Point	**Suction head/lift in metre (+/-)**	**Deliveyhead in metre**	**Net operating head in metre**	**Measured Discharge cum/hr**	**Hydraulic Power generated in kW**	**Average Voltage in volt**	**Average Current in amper e**	**Average Power factor**	**Total power input in kW**	**Measured RPM**	**Specific Speed**	**Discharge in Ltr/ sec.**	**Max. attainable pump efficiency (As per Curve)**	**Over all efficiency (%)**
Normal	2.68	11.23	8.6	47.9	1.11	406.4	6.7	0.704	3.32	2870	242	13.31	71%	33.37%

Saving Calculation at Normal Duty Point:

Parameters	Net Head in m	Discharge in cum/hr	Discharge in Ltr/sec	RPM	Specific Speed	Hydraulic Power	Power Input in	Overall Efficiency	Operating hours	Energy charges in one year	Investment in INR	Payback period in months	Reduction in CO2 emission tonnes/year
Existing	8.55	47.91	13.31	2870	241.69	1.11	3.32	33.37%	8.00	Rs. 15,140			
Proposed	10.00	40.00	11.11	2870	196.36	1.08	1.72	63.00%	9.58	Rs. 9,381			
Saving	-1.45	7.91	2.20	0.00	45.33	0.03	1.60	29.63%	-1.58	Rs. 5,759	30,000.00	62.51	3.69

Recommendations:

The new pump is proposed of following parameters:

Saving Calculation at Normal Duty Point	Saving Calculation at Normal Duty Point	Saving Calculation at Normal Duty Point	Saving Calculation at Normal Duty Point
10.00	**40.00**	**2870**	**63.00%**

The pump efficiency is very poor as the operating parameters are not matching with designed parameters. The flow is inversely proportional to head. When head is low with compare to rated, the flow shall be high and vice versa that is only up to head and flow range of the pump.

It is clear from the operating parameters that pump is running out of its design parameter and also may be impeller ageing and hence giving poor efficiency.

Energy Performance Assessment of pump installed for Swimming pool (Starter Side)

Name plate rating of the pumping machinery

Rated duty of pump							Rated duty of motor				
Size	**Model/ Type**	**Discharge(cum/hr)**	**Head(m)**	**Hydraulic Power kW**	**Efficiency as per pump curve**	**Capacity in kW**	**Voltage in Volt**	**Rated Current**	**RatedPower Factor**	**Rated RPM of Motor**	**Rated Efficiency in %**
Size 80X65 mm	Mono block	36	23.5	2.3	P/C NA	3.70	400	11	0.84091	2870	90.0%

Test result of testing at various duty condition

Duty Point	**Suction head/lift in metre (+/-)**	**Delivey head in metre**	**Net operating head in metre**	**Measured Discharge cum/hr**	**Hydraulic Power generated in kW**	**Average Voltage in volt**	**Average Current in ampere**	**Average Power factor**	**Total power input in kW**	**Measured RPM**	**Specific Speed**	**Discharge in Ltr/sec.**	**Max. attainable pump efficiency (As per Curve)**	**Over all efficiency (%)**
Normal	2.68	11.23	8.6	39.1	0.90	404.2	6.78	0.799	3.79	2870	218	10.85	71%	23.83%

Saving Calculation:

Discharge in Ltr/sec	RPM	Specific Speed	Hydraulic Power	Power Input in kW	Overall Efficiency	Operating hours	Energy charges in one year	Investment in INR	Payback period in months	Reduction in CO2 emission tonnes/year
10.85	2870	218.26	0.90	3.79	23.83%	8.00	Rs. 17,294			
11.11	2870	196.36	1.08	1.72	63.00%	7.81	Rs. 7,650			
-0.26	0.00	21.90	-0.18	2.07	39.17%	0.19	Rs. 9,644	30,000.00	37.33	11.84

Recommendations:

The new pump is proposed of following parameters

Rated Head in metre	Rated Discharge in cum/hr	Rated RPM	Overall Efficiency
10.00	**40.00**	**2870**	**63.00%**

The pump efficiency is very poor as the operating parameters are not matching with designed parameters. The flow is inversely proportional to head. When head is low with compare to rated, the flow shall be high and vice versa that is only up to head and flow range of the pump.

It is clear from the operating parameters that pump is running out of its design parameter and also may be impeller ageing and hence giving poor efficiency.

Water Coolers

Particulars	WATER COOLER #1	WATER COOLER #2	WATER COOLER #3	WATER COOLER #4
Make	VOLTAS	VOLTAS	Blue Star	Blue Star (AT CORRIDOR)
Cooling Capacity	150 Litre/h	150 Litre/h	150 Litre/h	150 Litre/h
Storage Capacity	150 Litre	150 Litre	150 Litre	150 Litre
Refrigerant	R-22, 0.85kg	R-22, 0.85kg	R-22, 0.95kg	R-22, 0.95kg
Supply voltage	230 V, Single phase	230 V, Single phase	230 V, Single phase	230 V, Single phase
Current	7.5A	7.5A	7.5A	7.5A
Rated Power	1550 W	1550 W	1630 W	1630 W
Measurement				
Voltage	229.4V	221.6 V	227 V	227
Cureent	9 Amp	6.5 A	7.1 A	7.4
Power	2030 kW	1300 W	1440W	1625 W

It is found that water cooler no.1 of 1550W rating is using 2030W power, which shows that the cooler needs maintenance and mass of refrigerant to be checked.

Transformer:

The institute is connected with 11/0.433 kV, 500 kVA Distribution Transformer. The Name plate rating of the transformer is as follows:

Make	**Indian Transformers & Electricals, Jaipur**		
Rated kVA	500 kVA	Core losses	375W
Volts HV/LV	11kV/0.433kV	Full load losses	5200 W
Ampere HV/LV	11.4 A/ 313A	Total Weight	720 kg
% Impedance	4.5%	Volume of Oil	305 Litre
Cooling	ONAN	Year of Mfg.	2019
		Tap Changer	Off Load Tap Changer

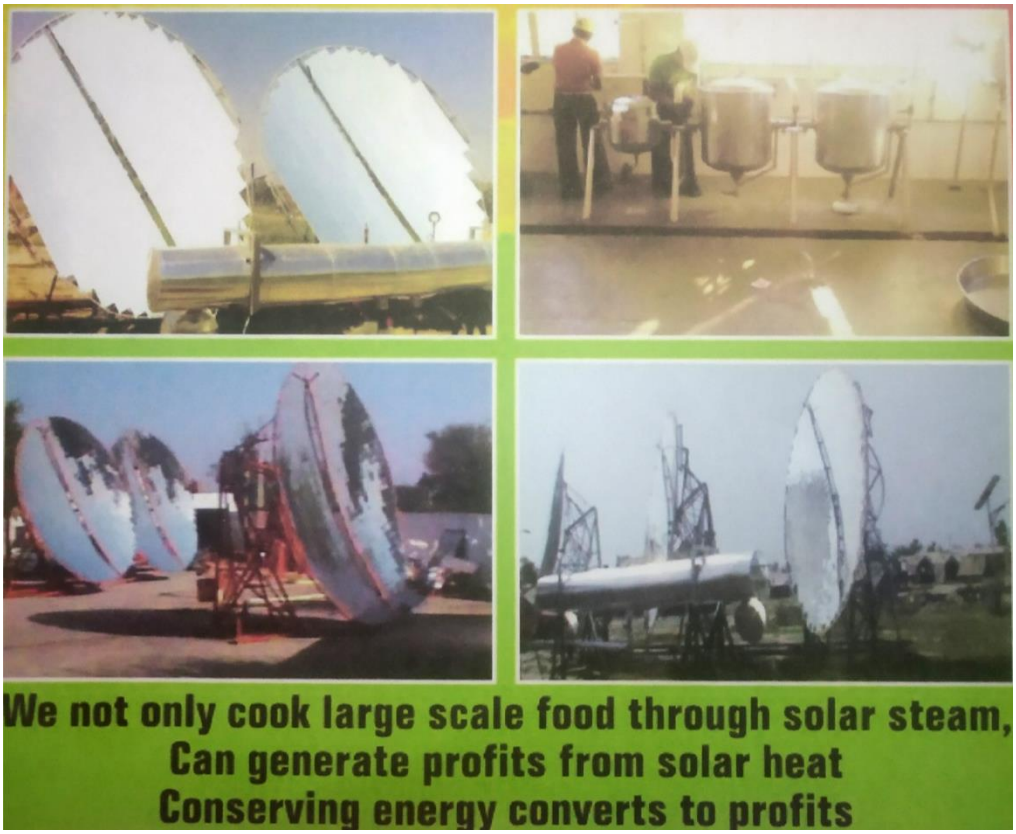
50% Loading for maximum efficiency - 190 kVA (38% of Rated kVA) was working on load less than 190 kVA (100 kVA due to covid-19).

Solar parabolic steam generator:

RECOMMENDATION NO. – 4

Use of Solar parabolic steam generator for use in cooking in mess: MNRE approved solar parabolic collector are available for use in big mess and canteens in college/university. They convert solar energy into steam which can be used for boiling of milk and cooking of Dal and Rise. This will save LPG consumption by around 50%. Presently the LPG consumption is of 40-50 cylinders per month.

A. Title of Recommendation	:	Use of Solar parabolic steam generator for use in cooking in mess.
B. Description of Existing System and its operation	:	LPG gas is being used in stove.
C. Description of Proposed system and its operation	:	Use of Solar parabolic steam generator for cooking (of 30 ftdia) and can be installed on the roof of kitchen.
D. Energy Saving Calculations		
Reduction LPG consumption	=	200 Cylinders/year (Commercial)
E. Cost Benefits		
Annual Cost Savings @ Rs. 1700/- per cylinder	=	200*1700/- = 340000/-
Investment	=	7 Lacs (After subsidy)
Simple Payback period	=	2 years
Remarks	=	It is being used in girls hostel mess in MNIT Jaipur and visit can be arranged.



Vendor: M/s K. Energy, Haider Building, Outside Sojati Gate, Jodhpur – 342001, Rajasthan, India
Tele: +91-291-2630432, M:+91-9829022899, Email: info@kenergy.co.in

Safety:

Safety is necessary in every business activity from following aspects:

- ✓ To save lives of personnel engaged in work including self, colleagues, general public & animals.
- ✓ To protect the departmental and public property
- ✓ To reduce loss of revenue
- ✓ To reduce the loss of service due to non availability of men, machines and services.
- ✓ To reduce loss due to reduction in productivity due to loss of man hours & equipment failure etc.
- ✓ To discharge social commitment of responsible industry.

Operating conditions of an electricity distribution & supply undertaking pose a larger scope for accidents. Electricity is a loyal servant but never excuses. If used carelessly, electricity can burn, shock or even kill. Electricity must be treated with respect. Safety precautions are necessary when working with or near electricity so as to significantly reduce the risk of electrical injury to self and others. Looking into the risks and dangers arising from dealing with installation, maintenance or use of electricity, various safety related provisions are enacted & regulations are made.

Do's and Don'ts (Ref IS: 5216 (Part II) – 1982

SN	DO's	Don'ts
1	Preach and practice safety at all times. Good work can be spoiled by an accident	Do not wear loose clothing, metal watch straps, bangles or finger rings while working on electrical appliances. Do not hang clothes and other such things on electrical fittings.
2	Work carefully. Haste causes many accidents. Be sure of what you are doing	Do not use a ladder without a lashing rope, otherwise the ladder should be held firmly by another person.
3	Examine before use of safety devices such as mats, rubber gloves, ladders, insulated pliers for their soundness	Do not work on a pole or other elevated positions if there is a live part on it without a safety belt and rubber gloves unless a competent person stands on the ground nearby to direct operations and give

		warning.
4	Always add acid or soda to water and not vice versa	Do not go carelessly near running belts and machines
5	Always report immediately to the person in charge any dangerous condition or practice observed	Do not remove danger notice plates or other signs or interfere with safety barriers or go beyond them
6	Always be cautious while lifting or removing a heavy apparatus or material	Do not bring a naked light near a battery. Smoking in a battery room is prohibited.
7	Warn others when they seem to be in danger near a live conductor or apparatus.	Do not allow visitors and unauthorized persons to touch or handle electrical apparatus or come within the danger zone of high voltage apparatus
8	Always be careful and take no chance against any possible accident	Do not enter excavations which give obnoxious smell or work in badly lit, ventilated or congested areas
9	Attend at once to all injuries however slight they may be	Do not touch a circuit with bare fingers or hand or other makeshift devices to determine whether or not it is alive.

Accident prevention Methods:

General observations on accidents:

1) Accidents are caused they do not happen.
2) If proper attention is given to the safety aspects and the laid down procedure, majority accidents and consequential damages to the personnel and property can be avoided.
3) Safety is studied at the start of training and forgotten subsequently.
4) Safe work practices have not been accepted to be a force habit.
5) Laxity on the part of personnel actually engaged in the work.
6) Not following safety instructions.
7) Complacent approach of supervisory personnel.
8) Non availability and improper maintenance of safety gadgets.

Causes of accidents:

1) Snapping of Conductors.
2) Accidental contact with live electric wire / equipment.
3) Violation / neglect of safety measures / lack of supervisions.
4) Defective appliances / apparatus / tools.
5) Inadequate / lack of maintenance.
6) Unauthorized work / Sub-standard construction.
7) Others reasons (inadequate knowledge / training of the work force, leakage of current etc.)

1) Snapping of Conductors can be attributed to:

- ✓ Ageing of conductors / insulators. Improper sag.
- ✓ Non-standard spans. Inadequate supervision during construction and monitoring thereafter.
- ✓ Inadequate maintenance. Non-availability of skilled manpower and tools to carry out repair works etc.

Remedial measures to avoid snapping of conductor:

a) Proper inspection during construction and before energisation followed by regular monitoring.
b) History of the line is to be built up as a data base to assess the ageing of conductors / insulators.
c) Replacement of aged conductors / insulators wherever warranted.
d) Maintaining the standard spans and proper stringing

2) Reasons for accidental contact with live electric wire / equipment:

a) This is one of the most common reasons for accident with the employees / operating staff of the utilities.
b) Operating staff not properly skilled / trained.
c) Similarly, the work is not being supervised by qualified personnel
d) Inadequate ground clearance / operational clearance of the live parts.

e) Ignorance about the discharging line / equipment before starting of maintenance work / repair works.
f) Error in isolation of supply.
g) Non-availability of safety tools & devices (as per IE Rule 36)
h) Absence of clear instructions and supervision i.e. standard codified maintenance manuals should be prepared which will guide the maintenance personnel to follow the standard instruction including line clearance / return procedure.

3) Remedial measures to avoid violation / neglect of safety measures / lack of supervisions:

- ✓ Formulation of safety policy
- ✓ Training to the workforce Enforcement of safety practices
- ✓ Adequate supervision Fast acting protection relays / releases may be considered for distribution lines.

4) Remedial measures to avoid unauthorized work / Sub-standard construction/ defective appliance/apparatus/tools:

- ✓ Around 6 to 7% of the reported cases of accidents / fatalities are due to the reason of un-authorized work / defective appliances / apparatus etc
- ✓ Unauthorized work should be checked in accordance with the various available legal / mandatory provisions.
- ✓ Scrupulous follow up of various quality control orders of Govt. may help in reducing the large number of accidents caused by sub-standard appliances / equipment.
- ✓ The owners of the installation should provide approved type of safety tools and protective equipment to operating staff / workmen and ensure use of safety devices.

General precautions to be taken:

1) Consider safety aspects during planning of work.
2) Explain the area which is safe to work & ensure that entire team has understood the same.
3) Restrict entry of unauthorized persons.
4) Nominate one among the team exclusively for close watch during the work.
5) Only authorized work men should be allowed to climb the pole, structure, work on line.
6) Work on live line should be done with due permission from the competent authority and under the supervision of a qualified officer.
7) Before switching on any equipment, check that equipment is in perfect working order and t is properly earthed.
8) Use rubber hand gloves, rubber boots, aprons, safety helmets etc while operating circuit breaker, GOD etc
9) Do not bring food or snacks into the working area like control room, switch yard etc.
10) Use proper pulley block & rope slings for lifting and removing heavy loads since incorrect and careless handling can cause accidents.
11) Position in correct and stable posture while working.
12) Live wire should never be exposed.
13) Use correct size and quality of fuse wire.
14) Do not use sub-standard material.
15) Always ensure that all blades of GOD are operated.
16) In case of HTUG cable, before starting the work ensure that the cable is discharged.
17) In case of cable loop system, the cable shall be identified with source and destination.
18) Ensure that fire extinguishers are in good condition.
19) Fire extinguishers shall have marking for the specific class of fires.
20) Do not avoid using PTW system.

Safety Practices:

Treatment of Electricity

Shock:

1) Act at once - delay is Fatal.
2) Death from electric shock is rarely instantaneous.
3) Heart Fibrillations (Heart Muscle Tremors) persist as long as 30 minutes after Shock. Therefore life can be saved by Immediate Artificial Respiration.
4) Send for but never wait for a Doctor.
5) Continue Artificial Respiration for four hours after apparent death.

Release from contact :

6) Switch off current immediately or send someone to do so. Do not attempt person from contact with high voltage unless suitable articles insulated for voltage are used for this purpose. When attempting to force a person from contact or medium voltage, use rubber gloves, boots, mat or insulated stick, but if available, use a loop of rope, cap or coat to drag the person free. Whatever is be dry and non conducting.

After release :

7) Lay the victim on a dry firm surface and remove any foreign material from the the breathing. If there is no sign of breathing or restlessness start artificial immediately. Do not lose any time, and if possible send for the Doctor and Check that the jaws are lifted and head tilted back so that the mouth and throat Check the pulse and continue respiration till the pulse is felt. Keep the patient allow him to get the fresh air.

Personal protective equipment (PPE):

PPE for electrical work including testing and fault finding must be suitable for the work, properly tested and maintained in good working order.

Training must be provided in how to select and fit the correct type of equipment, as well as training on the use and care of the equipment so that it works effectively.

Depending on the type of work and the risks involved, the following PPE should be considered:

- Eye Protection—metal spectacle frames should not be worn.
- Hand Gloves—use gloves insulated to the highest potential voltage expected for the work being undertaken. Leather work gloves may be considered for de-energized electrical work.
- Clothing—Cotton clothing is recommended. Use non-synthetic, of non-fusible material and flame resistant clothing. Clothing made from conductive material or containing metal threads should not be worn.
- Footwear—use non-conductive footwear for example steel toe capped boots or shoes manufactured to a suitable standard.
- Safety Belt/Harness—safety belts and harnesses should be checked and inspected each time before use with particular attention being paid to buckles, rings, hooks, clips and webbing. No metallic rings in the fingers or chain in the neck or such other metallic ornament be wore by the worker while working with electric lines

Tool safety tips:

- Use gloves and appropriate footwear
- Store in dry place when not using
- Don‘t use in wet/damp conditions
- Keep working areas well lit
- Ensure not a tripping hazard
- Don‘t carry a tool by the cord
- Don‘t yank the cord to disconnect it
- Keep cords away from heat, oil, & sharp edges
- Disconnect when not in use and when changing accessories such as blades & bits Remove damaged tools from use Proper foot protection (not tennis shoes) Rubber insulating gloves, hoods, sleeves, matting, and blankets Hard hat (insulated - nonconductive)

LIST OF ANNEXURES

Sr. No.	Particulars
1.	Details of monthly electric consumption RSEB bills
2.	Lighting load survey/Recommended Lux Level For Various Activities Of College
3.	LED Lights For College Library And Hostel Table Lamps
4.	Performance Evaluation of Air Conditioners of Main Building
5.	Performance Evaluation of Air Conditioners of Law College
6.	Performance Evaluation of Air Conditioners of Hostel
7.	Detail of Plug Load
8.	Detail of Fan Installed & lighting installed and ILER calculation of important place for light use.
9.	Energy Audit of Centrifugal Pump Set B (Starter side)
10.	Efficiency calculation of Pump Set A (Non starter side) & B of swimming pool.
11 & 11A.	Efficiency calculation of submersible pump Near swimming pool & Canteen.
12.	Installed Lightening Efficiency Ratio (ILER)
13.	Building data details – 13A&13B
14.	Photo of building area and drawing
15	Tender Notice for Solar & Ductable ACs
16	List of vendor
17.	Evaluation report of this audit & report