ENERGY AUDIT REPORT OF

SAMRAT PRITHVIRAJ CHAUHAN GOVERNMENT COLLEGE, AJMER

Energy Audit carried out by :-

1. **Er. Prahlad Chandra Tiwari,**
   Accredited Energy Auditor (AEA-0130)
2. **Dr. Krishan Gopal Sharma,**
   Certified Energy Auditor (EA-7210)

CERTIFICATE

This is to certify that **Energy Audit** of **Samrat Prithviraj Chauhan Government College, Ajmer** is carried out by **Er.Prahlad Chandra Tiwari, Accredited Energy Auditor (AEA-0130)** and **Dr. Krishan Gopal Sharma, Certified Energy Auditor (EA-7210)** in the month of January-February, 2022 on request of the **Principal, Samrat Prithviraj Chauhan Government College, Ajmer** vide letter no. **204 dtd. 18/1/2022** at free of cost treated on honorary basis **as a social service**.

The **Energy Audit** conducted covers verification, monitoring and analysis of use of energy including submission of **technical report containing recommendations for improving energy efficiency with cost benefit analysis** and an **action plan** to **reduce energy consumption** as well as recommendation for **safe use of electricity**.

Date :23-02-2022	**(Dr. K.G.Sharma)**	**(Er.P.C.Tiwari)**
Place: Ajmer	Certified Energy Auditor	Accredited Energy Auditor
	Registration # EA-7210	Registration # AEA-0130

सम्राट पृथ्वीराज चौहान राजकीय महाविद्यालय

अजमेर - 305001 (राज.)

(Naac Accreditation Grade - 'A)

Estd 1836

0145-2460946 (C)
0145-2561946 (O)
Website : gca.rajasthan.gov.in
Email : principalgca@rediffmail.com

Ref. No. 204

Date 18/1/22

P. C. Tiwari,
A-159, Maharshi Dayanand Colony,
Naka Madar, Ajmer-305007

Subject:- Conducting Energy Audit (EA) of college campus of GCA, Ajmer.

Sir,

GCA is identified as an energy intensive entity. So, college intends to conduct energy audit, which can help us understand the whole picture of our college's energy use. This audit can help us determine how much energy our college uses, where our college is losing energy, and which problem areas and fixes we should prioritize to make our college more efficient.

As per discussion held with Mr. P C Tiwari, BEE Accredited Energy Auditor, working in Ajmer Vidyut Vitran Nigam Ltd., Ajmer and Dr. K. G. Sharma, Associate Professor(EE)/Energy Auditor, working in Engineering College Ajmer, both are agreed to conduct energy audit of GCA campus at free of cost treated on honorary basis as a social service.

On basis of discussion with you, we are pleased to appoint you as energy auditor for carrying out Energy Audit (EA) of college campus of GCA, Ajmer. The aforesaid activities shall be completed at the earliest possible and shall be carried out on holydays.

Principal
S.P.C. Govt. College, Ajmer

प्राचार्य
सम्राट पृथ्वीराज चौहान
राजकीय महाविद्यालय, अजमेर

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Date :23-02-2022
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(Dr. K.G.Sharma)
Certified Energy Auditor
Registration # EA-7210

Krishan Gopal Sharma
Certified Energy Auditor
Regn.No.EA-7210

(Er.P.C.Tiwari)
Accredited Energy Auditor
Registration # AEA-0130

Prahlad Chandra Tiwari
BEE (India) Reg'n No. AEA-0130
Accredited Energy Auditor

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 emphasis that an energy audit is a continuous process.

Acknowledgement

We are sincerely thankful to the Principal, Government College Ajmer, for giving us the opportunity for carrying out Energy Audit of College Campus of GCA, Ajmer. We express our sincere gratitude to Dr. Meenakshi Gahlot, Associate Professor, Department of Zoology for her valuable inputs, co-operation and support during the conduct of this exercise.

We take this opportunity to express our appreciation for the excellent support provided by faculty member for their active involvement and their valuable inputs in making the Energy Audit successful.

We are also thankful to all the not teaching staff for their support by providing necessary documents during the energy audit.

Action Plan to reduce energy consumption and summary:-

SN	Energy Saving Opportunity	Annual Saving in kWh	Investment	Annual Amount Saving in Rs.	Payback period in months	Emission reduction kg CO_2 / annum
1	Replacement of T-12 FTL's with 20W LED Tubes	10584	₹ 85,201	₹ 47,250	6.7	16934
2	Replacement of T-8 FTL's with 20W LED Tubes	8382	₹ 42,250	₹ 67,478	7.5	13411
3	Replace General Electric make old fans with energy efficient BLDC Fans	71005	₹ 1,027,200	₹ 571,592	21.6	113608
4	Replace conventional fans with energy efficient BLDC Fans	35808	₹ 1,193,600	₹ 288,254	49.7	57292
5	To retrofit the Air Conditioners with AC ENERGY SAVER" Genie"	6000	₹ 224,000	₹ 48,300	55	9600
6	To install cyclic time controller in ACs	6000	₹ 224,000	₹ 48,300	55	9600
7	To install Solar Water Heating System	23760	₹ 339,000	₹ 191,268	19	38016
	Total	161539	₹ 3,135,251	₹ 1,262,442	214.5	258461

1. INTRODUCTION

Samrat Prithviraj Chauhan Government College, Ajmer is the oldest college of North India in Ajmer city of Rajasthan state in India. SPCGCA is celebrating 185 years of existence in the ocean of knowledge. Establishment In 1868, Samrat Prithviraj Chauhan Government College, Ajmer is Affliated to Maharishi Dayanand Saraswati University.

Rabindranath Tagore has very aptly defined the goal of education by stating that "the highest education is that which does not merely give us information but makes our life in harmony with all existence".

Education is now seen as an instrument for fostering values that constitute the well-being of the individual on one hand and that of humanity on the other.

Samrat Prithviraj Chauhan Government College, Ajmer, which began its journey in 1836 as a school established by the directors of East India Company, today enjoys the status of an illustrious and highly distinguished institute in higher education in northern India. Presently, celebrating 185 years of its existence in the Ocean of Knowledge, this Post-graduate College maintains the traditions, utility, quality and richness of bygone years. The college is one of the most reputed, renowned, and leading institutions of India financially supported by UGC, FIST, RUSA, State and Central Government bodies.

The journey of Samrat Prithviraj Chauhan Government College, Ajmer, has witnessed many iconic moments. The institute has been selected as a model college by the Higher and Technical Education of Rajasthan. The college has been re-accredited by the National Assessment and Accreditation Council (NAAC) with Grade 'A' in the year 2016.

Presently, around 9000 students are enrolled. (ARTS 4000, Commerce 2500 and Science 2500). It is the only college in Rajasthan where 7 languages are taught -

English, Hindi, Sanskrit, Urdu, Farsi, Sindhi and Rajasthani. Recently in 2021, Mahatma Gandhi Addhyan Kendra has also been set up at the college.
At present, out of twenty-two subjects, the institute offers Post-graduate courses in 20 subjects (12 in Arts, 5 in Science and 3 in Commerce) and Honours in 7 subjects (Arts: 4, Science: 2 and Commerce: 1).
BBA course is available for undergraduate degree level, under a self-financing scheme.
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To transform the dreams and aspirations of the youth into reality the college is highly equipped with facilities that make it a national level institute. It has adequate infrastructure that caters to the needs of around eight thousand students and strives unceasingly to achieve the highest goals of education.

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To transform the dreams and aspirations of the youth into reality the college is highly equipped with facilities that make it a national level institute. It has adequate infrastructure that caters to the needs of around eight thousand students and strives unceasingly to achieve the highest goals of education. The campus has a dedicated 30 Mbps leased line and Wi-Fi facility for an ICT-enabled teaching-learning atmosphere. All departments are connected through LAN and the college administration’s major thrust is on paperless communication to conserve the environment. The college provides research facilities in various departments and

several advanced research laboratories with high precision instruments are available.

The Institute has a semi-automated, well-organized, and well-equipped library, with reference books, textbooks, national and international research journals, and periodicals. Presently more than 1.80 lakh books are available in the library. Moving with the times, the college library has an active subscription of INFLIBNET-National Library and Information Services Infrastructure for Scholarly Content (N-LIST)". By using this facility faculty members and students can have free access to 6000+ e-journals and 199500+ ebooks.

The college has well-equipped Smart Classrooms, Lab, and lecture theatres to impart quality education to the students, using contemporary teaching aids. It has facilities including grounds and equipment for various sports, auditorium, seminar rooms, girls' hostels, parking lots, girls' common rooms, botanic garden, and sprawling lavish grounds.

Educational tours are conducted by various departments on a regular basis to enhance experiential learning for the students. Hostel facilities are available for girl students, within the premises.

Education is basically the holistic development of an individual and to keep up the pace, the institute facilitates it through a series of extension, co-curricular and extra-curricular activities. NSS and NCC programs in the institution cater to the comprehensive development of its scholars and serve as an active link between the institution and society. The college also boasts of its heritage lineage, visionary academicians, and able administrators who have carved the college into the present illustrious institution of Rajasthan.

1.1 Energy audit objective

This energy audit assumes significance due to the fact that the **Samrat Prithviraj Chauhan Government College, Ajmer** electricity bill had crossed Rs. 2.95 lacs during consumption month November, 2021 inspite of having distributed energy resource of 100kWp Solar PV Plant even during lock down period due to Covid-19 pandemic and it was aimed at obtaining a detailed idea about the various end use energy Usage activities and identifying, enumerating and evaluating the possible energy savings opportunities. The target is to achieve savings in the electrical energy Usage to the extent of 15%. The Electrical Wiring & fitting of the college is very old and at many locations, wiring insulation has been deteriorated & removed with nacked wires exist at many locations which might result into possibilities of electrical accidents and fire hazards. Hence it is to access the need of wiring renovation work as per Indian Electricity Rules, 1956 and to safeguard the persons using and operating the electrical gadgets in the college premises.

1.2 Present energy scenario

The energy Usage on campus is mainly in the form of electricity with Electric Connection from M/s Tata Power Ajmer Distribution Limited at 11kV Incoming supply stepped down to 433V (L-L)/ 250V (L-N) having sanctioned load of 160kW, Contract Demand of 150kVA with billing demand of 112.50kVA which is 75% of the contract demand. The Capacity of the Distribution Transformer is rated for 200kVA, HV-11000V/LV-433V, HV-10.5A/ LV-266.67A, Oil Natural Air Natural 3-phase, manufactured in year 2005.

The electricity supply is taken in the Bulk Supply for Mixed Load under schedule ML/HT-4). The consumer under this schedule as per applicability however can keep his contract demand even below 50kVA.

The applicable electricity tariff for the category 24th November, 2021 w.e.f. is as follows:

1. Energy Charges, @ Rs. 8.05 per kWh or unit
2. Fixed Charges, @ Rs. 215/- per kVA of billing demand per month

An incentive of 0.15% on energy charges and fixed charges shall be allowed in his next bill where the payment is received before seven days from the due date of the bill. An incentive of 0.35% on energy charges and fixed charges shall be allowed in his next bill where the payment is received before ten days from the due date of the bill.

In case payment by cheque, rebate shall be applicable only if cheque is realised before seven/ten days, as applicable from due date.

Delay payment surcharge shall be levied @2% of unpaid dues in case of monthly billed consumers

The consumer shall not cause a demand more than his contract demand. In case he causes a demand of more than 105% of his 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 charges and energy charges (excluding the electricity duty and other charges, if any) by which percentage the excess demand has actually been caused.

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 0.01(1%) fall in average power factor below 0.90 (90%), shall be charged.

Also an incentive of 0.5% of Energy Charges shall be provided for each 0.01 (1%) improvement above 0.95 (95%) till 0.97 (97%). if average power factor is above 0.97 (97%) and incentive of 1% of energy charges shall be provided for each 0.01 (1%) improvement above 0.97 (97%).

If the average power factor falls below 0.70 (70%), the installation shall be disconnected and will not be reconnected till the average power factor is improved to the satisfaction of the M/s TPADL/Ajmer DisCom.

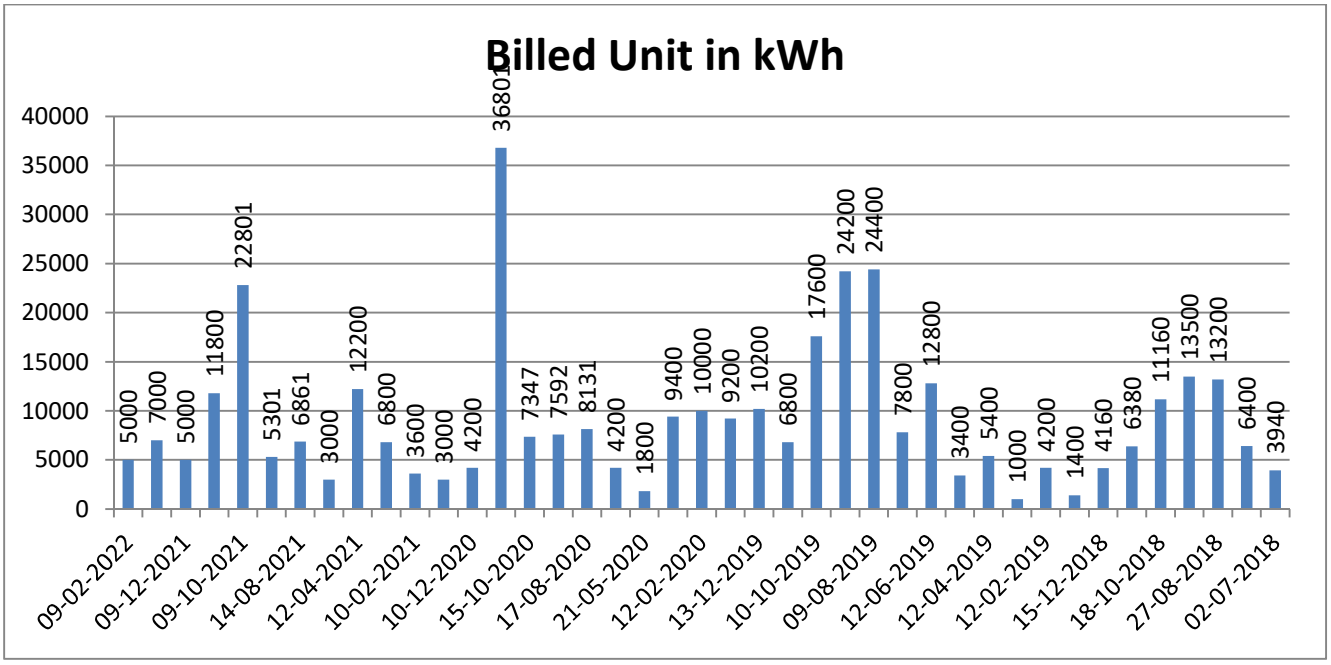
Rooftop Grid Interactive Solar Photo Voltaic Power Plant :

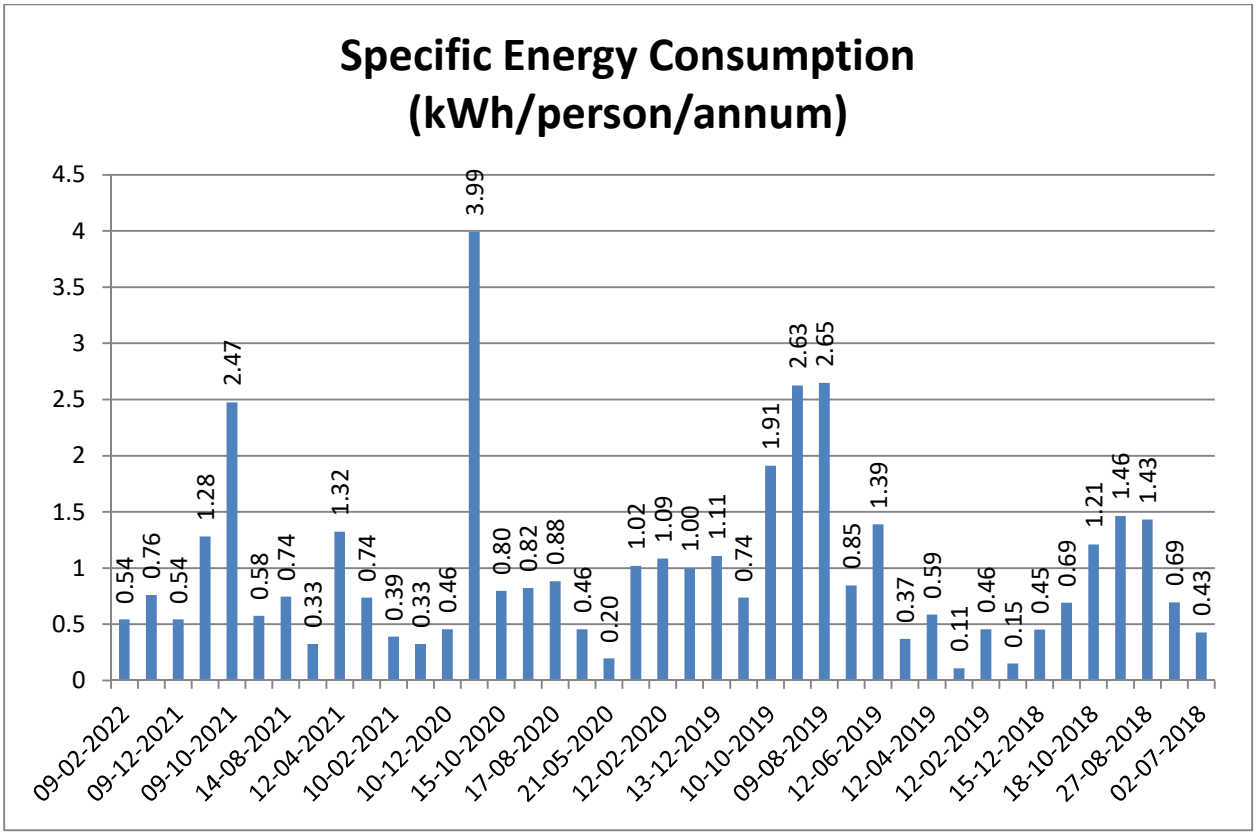
The GCA has installed 100 kWp Rooftop Solar PV Plant. However, regular care is required for preventive maintenance of the plant and it is necessary to record daily generated energy from solar meter and keep the panels clean.

1.3 Specific Energy Usage (SEC)

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 calculated to be 11.81 kWh/person/annum during pre-covid bill period (13/12/19 to 10/12/2020) and 10.02 kWh/person/annum during covid period in aggregate (for 11/1/21 to 9/2/22)

Monthwise Usage of Electricity in kWh




Specific Energy Consumption
(kWh/person/annum)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.54
0.76
0.54
1.28
2.47
0.58
0.74
0.33
1.32
0.74
0.39
0.33
0.46
3.99
0.80
0.82
0.88
0.46
0.20
1.02
1.09
1.00
1.11
0.74
1.91
2.63
2.65
0.85
1.39
0.37
0.59
0.11
0.46
0.15
0.45
0.69
1.21
1.46
1.43
0.69
0.43
09-02-2022
09-12-2021
09-10-2021
14-08-2021
12-04-2021
10-02-2021
10-12-2020
15-10-2020
17-08-2020
21-05-2020
12-02-2020
13-12-2019
10-10-2019
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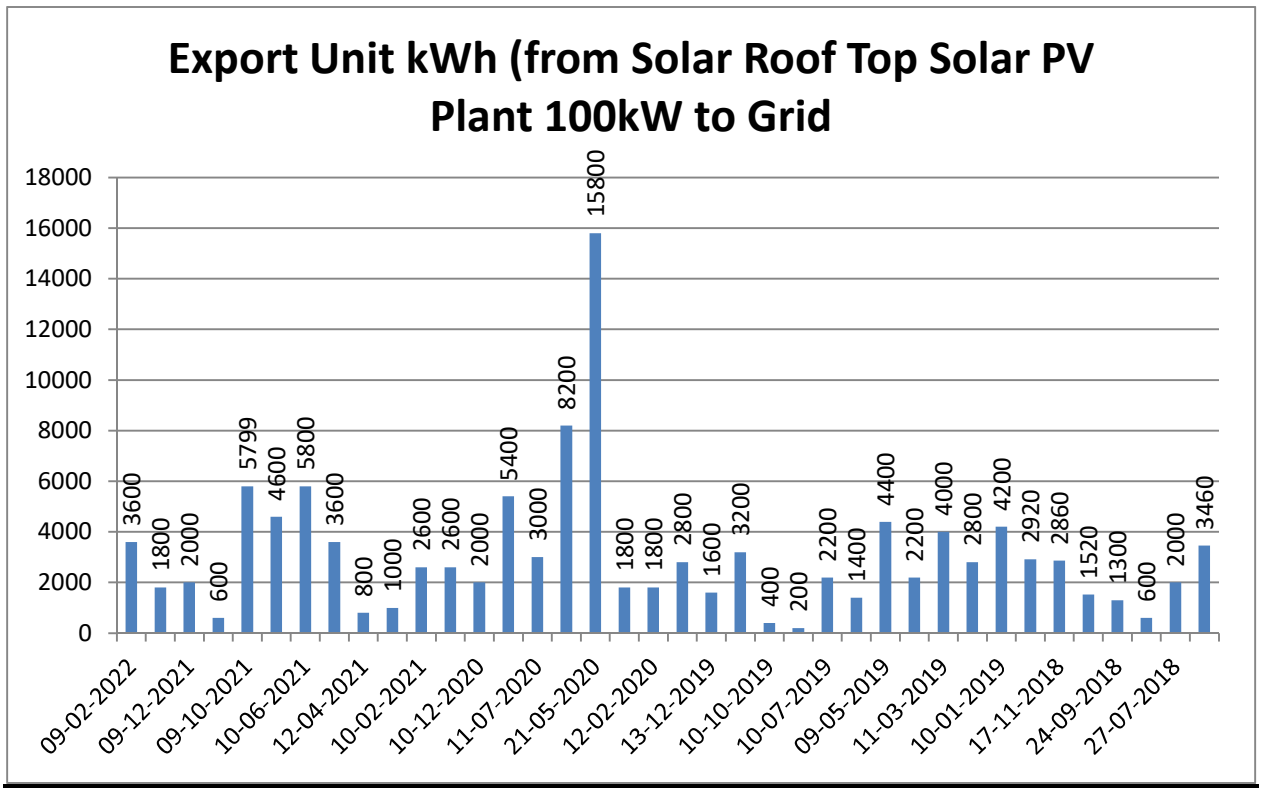
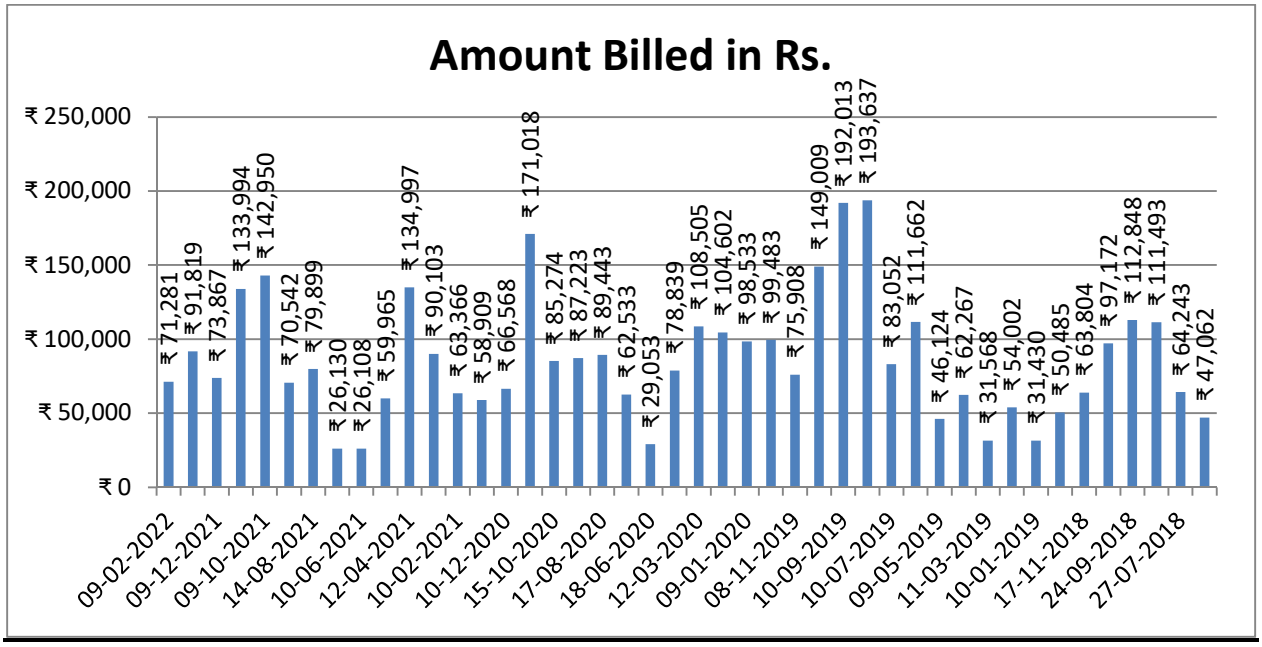
15-12-2018
18-10-2018
27-08-2018
02-07-2018

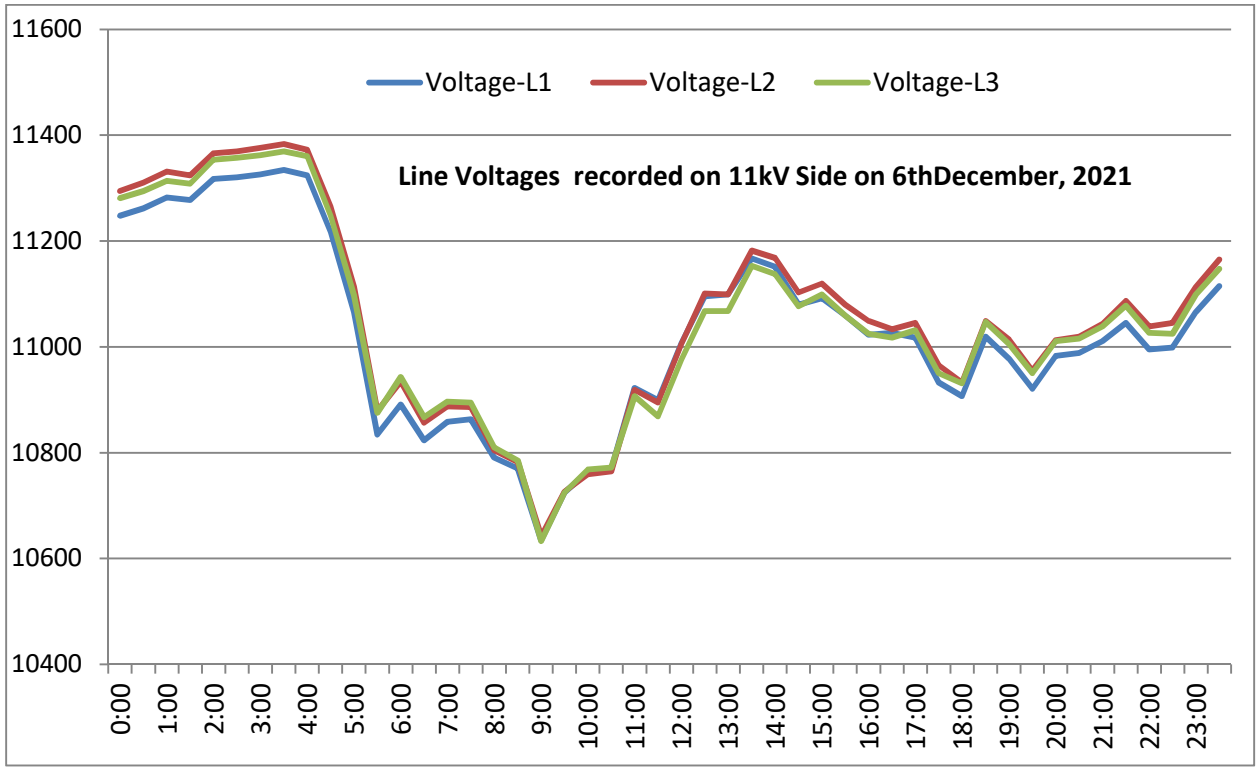

Export Unit kWh (from Solar Roof Top Solar PV
Plant 100kW to Grid
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
3600
1800
2000
600
5799
4600
5800
3600
800
1000
2600
2600
2000
5400
3000
8200
15800
1800
1800
2800
1600
3200
400
200
2200
1400
4400
2200
4000
2800
4200
2920
2860
1520
1300
600
2000
3460
09-02-2022
09-12-2021
09-10-2021
10-06-2021
12-04-2021
10-02-2021
10-12-2020
11-07-2020
21-05-2020
12-02-2020
13-12-2019
10-10-2019
10-07-2019
09-05-2019
11-03-2019
10-01-2019
17-11-2018
24-09-2018
27-07-2018

Monthwise amount billed and paid against electricity bill to M/s TPADL

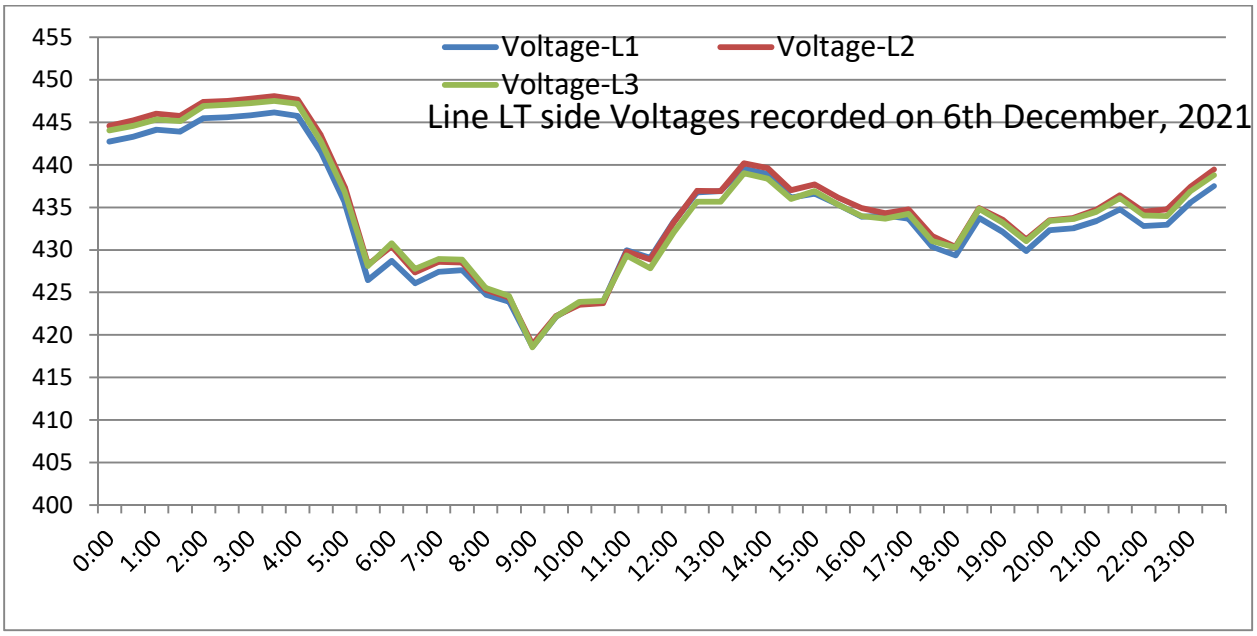


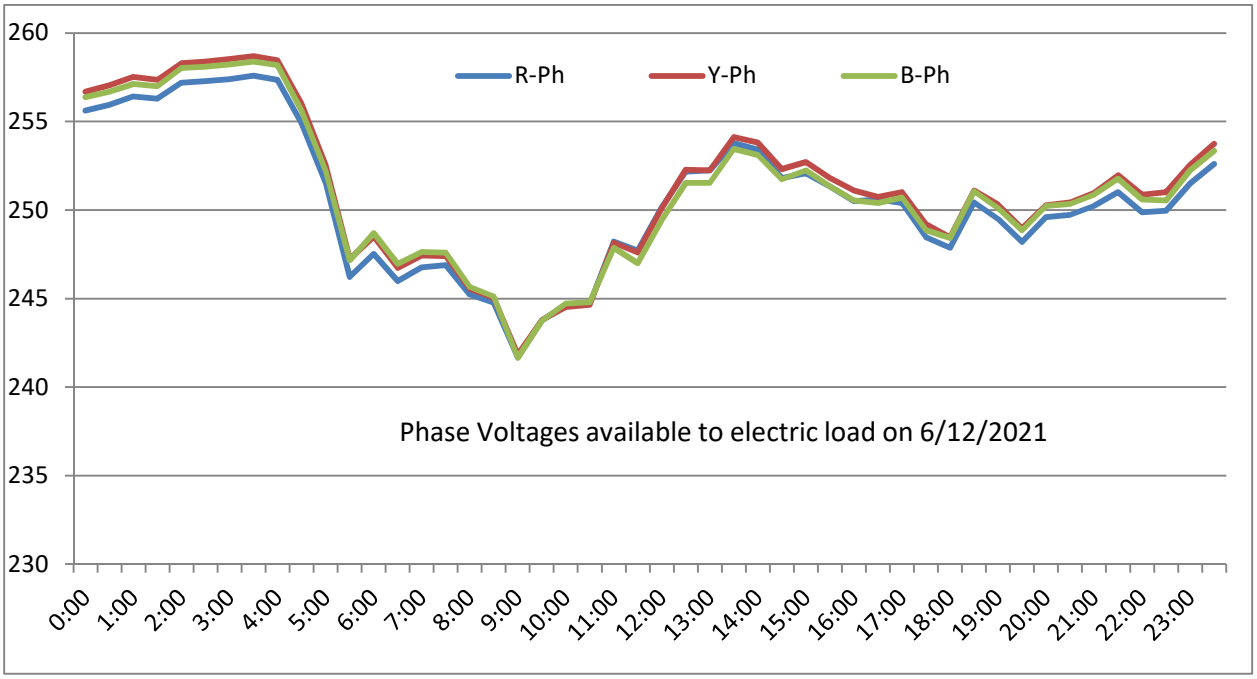
Power Quality :

Line Voltages on HT Side of the Distribution Transformer



Voltage on LT Side of Transformer :



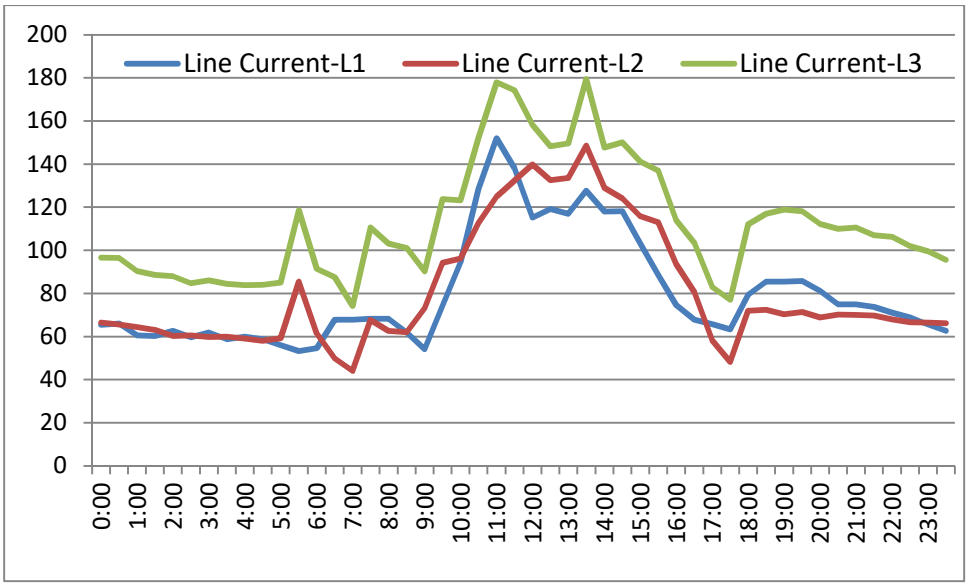


This graph for 6/12/2021 shows that system voltage varies from 241.65V to 258.69 V against 433V and hence all the electric load connected rated generally for 230V consume more power proportionate to square of the voltage and it is recommended to change the voltage at Distribution Transformer off load tap changer such that load do not get voltage more than its rated 230V.

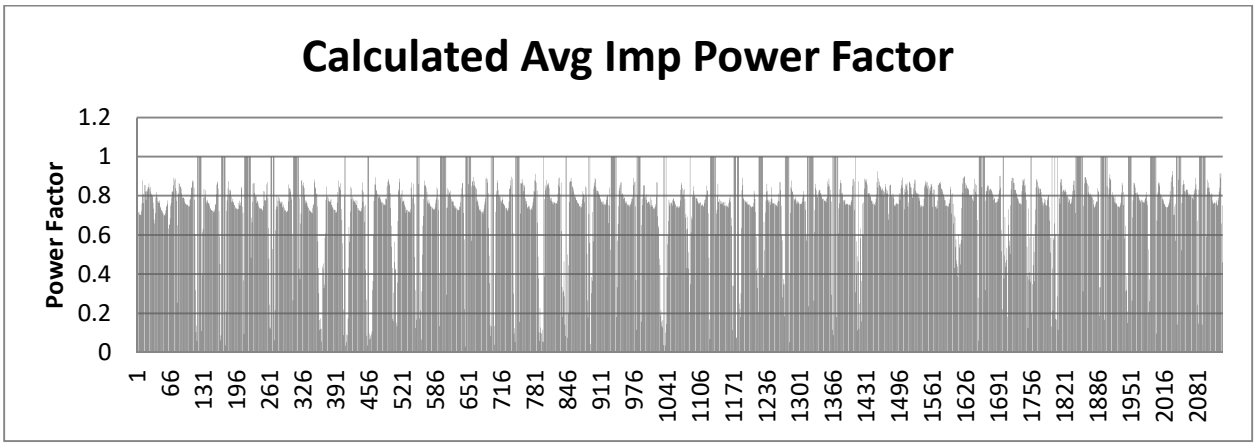
The load current during 6/12/2021 to 19/1/2022, maximum load current in all three phase as recorded is 325.6A, 262.4.6A and 281.0A on 5/1/2021 at 11:00AM with average power factor 0.842 and average current of 289.67A against rated capacity 266.6A of the Distribution Transformer and hence one phase of the transformer get overloaded for some time, this overloaded the transformer by 22.1%, however, average loading on the Distribution Transformer has remained 41% of the rated capacity. Therefore, it is required to balance the load on the Distribution Transformer and essential to control power factor.

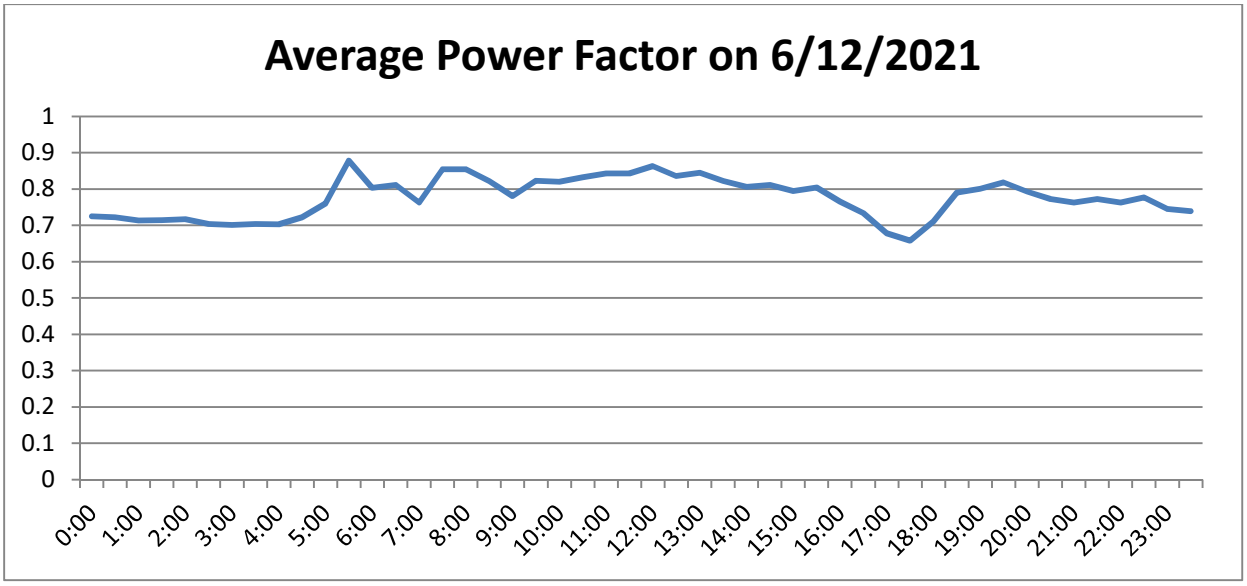
Current drawn on 6/12/2021 showing unbalance:

The current is highly unbalanced and need balancing of load.



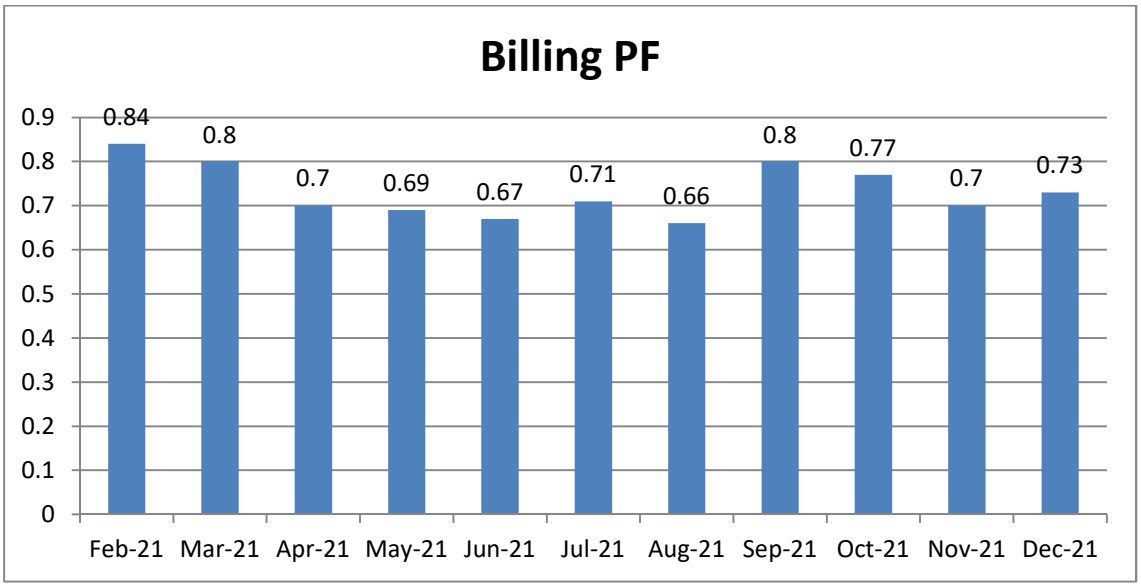
Power Factor between during 6/12/2021 to 19/1/2022





The power factor has been recorded as min as 0.030 (on 19/12/2021, 10:30AM) with 135A load and as maximum as 1.000 with average power factor 0.747. It is necessary to maintain average power factor (both lagging & leading) with minimum value of 0.900, failing which penalty is imposed in every energy bill and sometimes becomes liability on the administration for paying penalty amount.

Therefore, it it is recommended to install a automatic power factor correction panel with PID controller and meeting out the Power Factor requirement. The APFC panel track the real time power factor and automatically switch ON & OFF the capacitors as per requirement to maintain the power factor at set value. It is necessary to have APFC panel looking to the lighting load/motive load unpredictable and looking to the large variation of the load and power factor.



The Poor Power factor from Feb-21 to Dec-21 have resulted into payment of cost of 13442 kWh as penalty (>Rs. 1.0 lacs), and therefore, it is recommended to install APFC panel to maintain power factor >0.90.

Segmentation

Presently, there is no separate energy metering for various department of the college. Hence it is recommended to install whole current meters and at least monthly readings to be recorded on 1st date of every month.

2. ENERGY AUDIT

2.1 Energy audit methodology

The methodology adopted for this audit was Formation of audit team comprises of P.C.Tiwari, Accredited Energy Auditor, Dr. K.G.Sharma, Certified Energy Auditor, Final Year Students of B.Tech..in Electrical Engg from Govt. engineering College, Ajmer 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

2.2 Load of various departments/ sections are recorded with their quantity, however, some of the load has no name plate rating being very old. However, based on the year of installation and actual measurement at site, the load of the various electricity guzzling appliances are measured/ estimated.

Load of following areas are covered in study:-

1. Arts Block ; Class Room, Auditorium, Office
2. Nehru Bhawan
3. Biology Department
4. Botany Block
5. Chemistry Block: Office, Lab
6. Geography Block & corridor
7. Girls hostel (Kasturba Gandhi girls hostel) (Mess)
8. Girls hostel (Kasturba Gandhi girls hostel)
9. Girls hostel (Kasturba Gandhi girls hostel) (washrooms)
10. Girls hostel (Kasturba Gandhi girls hostel) (Office/indoor/outdoor/Caltural Hall)
11. Girls hostel (Kamla Nehru girls hostel) (Office/indoor/outdoor)
12. Girls hostel (Kamla Nehru girls hostel)
13. Library Room
14. Mahatma Gandhi Bhawan
15. Canteen/Temple area
16. Maths Block: Office, Lab
17. Motor / pump Load

18. NCC Block
19. Outside area
20. Physics Department (Class Room 4105/4106/4107)
21. Physics Department (Lab) 4015/4017/4014/4024/4026/4022/4109
22. Sangeet Block (1101/1102)
23. SCB BLOCK (UG)
24. Sports/ Gym
25. VARDHMAN MAHAVEER OPEN UNIVERSITY BLOCK
26. Zoology department (class room 4101/4102/4103/4104)
27. Zoology department 4012/ 4010/ 4001/ 4002/ 4009/ 4008/ 4007/ 4003/ 4004

Details of Load Connected:-

SN	Appliance	Total quantity	SN	Appliance	Total quantity
1	LED Bulbs	164	39	Mercury	1
2	Air Conditioner 1.5TR	16	40	Micro Wave	1
3	Air Conditioner 1TR	1	41	Microphone	12
4	Air Conditioner 2 TR	14	42	Microwave	1
5	Amplifier	8	43	Mobils	105
6	Bulb (100W)	8	44	Motor-0.5HP	2
7	Bulb (40W)	11	45	Motor-10HP	2
8	Camera	65	46	Motor-1HP	2
9	Ceiling fan (Assorted New)	373	47	Motor-2HP	2
10	Ceiling fan (General Electric)	321	48	Motor-3HP	1
11	CFL	142	49	Motor-5HP	1
12	Computers	97	50	Motor-7.5HP	2
13	D Fridge	2	51	Murcury Light	7
14	Desert cooler	22	52	Oven	1
15	Disco Lights	20	53	Printer	38
16	Egg Incubator	1	54	Projecter	13
17	Electric Catle	9	55	RO	12
18	Electric Podium	4	56	Router	15
19	Exhust Fan	27	57	Scanner	1
20	Exhust Fan (Big)	6	58	server	4
21	Fridge	15	59	Short Lights	12
22	Fridge (180L)	1	60	Smart Board	3
23	Fridge (240L)	2	61	Speaker	5
24	Fridge(218L)	4	62		
25	Garden Equipment (1HP)	2	63	Squre LED(40cm*40cm)	14
26	Geyser	11	64	Street LED (Small)	2
27	Halogen	8	65	Table Fan	20
28	Heater (1400W)	6	66	Tube (T12)	189
29	Induction Heater	3	67	Tubes (T5)	634
30	Invertor	5	68	Tubes (T8)	169
31	Iron (1000W)	1	69	TV	3
32	LAB Instrument	186	70	UPS	6
33	Laptop	100	71	Wall Fan	18
34	LED Blubs	23	72	Washing Machine	5
35	LED Halogen	6	73	Water Cooler	14
36	LED Tubes	199	74	Water Cooler with RO	2
37	LED(Squre 20*20)	32	75	Xerox	9
38	LED(Squre 50*50)	21			

Case Study #1

Lighting

The Institute has about 189 nos. T-12, 40W and 169 nos. T-8, 36W Fluorescent tube lights with Electromagnetic ballast (15W Power) in different departments, labs and hostels. There are 634 nos. T-5 FTL's and only 142 nos. CFL's. Apart from these, there are 164 nos. LED Bulbs, 142 nos. CFL, 19 nos. IC Bulbs, 199 nos. LED Tubes, and 103 nos. Other light fittings including Disco lights, halogens, LED squares etc.

The total lighting load from the above is about 51.8 kW (including ballast power).

Recommendation # 1 : Replace existing T-8 & T-12 FTL's with LED Tube 20W

Existing T-8 & T-12 Tube lights have efficacy of 57 lumens / W (including ballast power) can be replaced with state of art new generation LED Tube Light 20W which give 100 lumens /W and cost Rs.250 .

LED Batten lights are **energy-efficient, environment-friendly**, produce less heat, maintenance-free and durable as compared to fluorescent tube lights. Also, LED batten lights provide uniform lighting and offer significant savings on account of voltage and less power consumption.

LED Tubelights are replacements for regular tubelights. They are a line source of light and thus they cover a larger area. These days several options of LED Tubelights are available in the market: 18 Watt, 20 Watts, 22 Watts, etc. In terms of light output (or lumens output), a 20 Watt LED Tubelight is similar to an old 40 Watt T-8/T-12 or 28 Watt T-5 tubelight.

LED Batten lights are energy-efficient, environment-friendly, produce less heat, maintenance-free and durable as compared to fluorescent tube lights. Also, LED batten lights provide uniform lighting and offer significant savings on account of voltage and less power consumption. The LED technology is more sophisticated than fluorescent, incandescent or halogen lights. They are the future of lighting because of its durability and performance. Given below are some of the advantages of LED batten lights:

1. Requires less current.

2. Higher light output compared to other sources.

3. You can choose the colour.

4. 90% longer lifespan than fluorescent tube lights. And even at the end of their lifespan, you can easily dispose of and there will be no toxic waste left or no special treatment will be required in the procedure.

5. The light remains constant, but you can dim LEDs manually as per your convenience.

6. Energy efficient.

7. No mercury is used.

8. Produce less heat.

9. Environment-friendly, as it does not contain toxic chemicals, which represents virtually no hazard to the surroundings.

10. Best to use in schools, hospitals, factories and residential areas.

11. Flicker-free operation.

12. Virtually zero maintenance costs.

13. Lightweight and sleek design.

Saving Calculation:

Replacement of T-12 FTL's with 20W LED Tubes

Type of Load	Load incl. ballast/choke	
Total nos. of T-12 FTL	189	Nos.
Rated Capacity of T-12 FTL	55	Watt
Rated Load of LED Tube	20	Watt
Power Saving per point	35	Watt
Total Power can be Saved	6615	Watt
Average operating hours per day	8	hours
Average Working days per year	200	days
Energy can be Saved per annum	10584	kWh
Amount can saved per kWh	₹ 8.05	
Total Amount can be saved	₹ 85,201.20	
Cost of 20W LED Tube	₹ 250.00	
Investment required for 20W LED Tube	₹ 47,250.00	
Simple Payback period	6.7	month
Energy that can be saved at generation end	21168	kWh

Reduction of CO2 emission	16934.4	kg CO2
Saving of Coal	10160.64	kg
National Saving in terms of augmentation of Power Plant	₹ 79,380,000	

Replacement of T-8 FTL's with 20W LED Tubes

Type of Load	Load incl. ballast/choke	
Total nos. of T-8 FTL	169	Nos.
Rated Capacity of T-8 FTL	51	Watt
Rated Load of LED Tube for replacement	20	Watt
Power Saving per point	31	Watt
Total Power can be Saved	5239	Watt
Average operating hours per day	8	hours
Average Working days per year	200	days
Energy can be Saved per annum	8382.4	kWh
Amount can saved per kWh	₹ 8.05	
Total Amount can be saved	₹ 67,478.32	
Cost of 20W LED Tube	₹ 250.00	
Investment required for 20W LED Tube	₹ 42,250.00	
Simple Payback period	7.5	month
Energy that can be saved at generation end	16764.8	kWh
Reduction of CO2 emission	13411.84	kg CO2
Saving of Coal	8047.104	kg
National Saving in terms of augmentation of Power Plant	₹ 62,868,000	

Case Study #2 Very Old Fans

The Institute is having ~321 nos. very robust Ceiling fans of General Electric Co. Ltd., model Everest manufactured in the year 1929 nos. with resistance type step regulator for speed control. These ceiling fans are never overhauled and their bush/ bearing are found generally jammed and not self start and consume more energy during starting period as well as during running period.

The power consumption of these fans is ~190 W .

Particulars	Parameters	
Total nos. of General Electric make fans	321	Nos.
Power Consumption of very old Geneal Electric Fans	190	Watt
Rated Load of BLDC Fans proposed for replacement	32	Watt
Power Saving per fan	158	Watt
Total Power can be Saved	50718	Watt
Average operating hours per day	7	hours
Average Working days per year	200	days
Energy can be Saved per annum	71005.2	kWh
Amount can saved per kWh	₹ 8.05	
Total Amount can be saved	₹ 571,591.86	
Cost of BLDC fan	₹ 3,200.00	
Investment required for BLDC fans	₹ 1,027,200.00	
Simple Payback period	21.6	month
Energy that can be saved at generation end	142010.4	kWh
Reduction of CO2 emission	113608.32	kg CO2
Saving of Coal	68164.992	kg
National Saving in terms of augmentation of Power Plant	₹ 608,616,000	

Case Study #3 Conventional fans

The Institute is having ~373 nos. Ceiling fans of different makes and rated for ~70W with electronic regulator. It is proposed that these conventional fans be replaced with BLDC Fans. These ceiling fans are also never overhauled and of more than 5 years old. The power consumption of these fans is increased by time from 70W to 85W due to no maintenance.

Particulars	Parameters	
Total nos. of conventional fans	373	Nos.
Power Consumption of conventional fans	80	Watt
Rated Load of BLDC Fans proposed for replacement	32	Watt
Power Saving per fan	48	Watt
Total Power can be Saved	17904	Watt
Average operating hours per day	8	hours
Average Working days per year	250	days
Energy can be Saved per annum	35808	kWh
Amount can saved per kWh	₹ 8.05	
Total Amount can be saved	₹ 288,254.40	

Cost of BLDC fan	₹ 3,200	
Investment required for BLDC fans	₹ 1,193,600	
Simple Payback period	49.7	month
Energy that can be saved at generation end	71616	kWh
Reduction of CO2 emission	57292.8	kg CO2
Saving of Coal	34375.68	kg
National Saving in terms of augmentation of Power Plant	₹ 214,848,000	

Case Study#4 Air Conditioners

On using the rated capacity details supplied by the manufacturers, the total room AC load is about 48.5 kW.

Air Conditioner 1.5TR	13 nos.	1500 W	19500 W
Air Conditioner 1TR	1 no.	1000 W	1000 W
Air Conditioner 2 TR	14 nos.	2000 W	28000 W
Water Cooler	13 nos.	750 W	9750 W
Freeze (200W -400W)	18 nos.	300W	5400W
Desert Cooler	18 nos.	250W	4500W
			48500 W

Conclusion:

The AC's are star rated and AMC for these ACs is not given. It is required to award Annual Maintenance Contract for regular preventive maintenance of these ACs.

Recommendation #1

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 favorably 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 1^0C to 2^0C. Since the humidity of chilled air is reduced further, one feels the same comfort even at a little higher (1 to 2^0C) 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 installed 28 nos. Air conditioners are 48.5 TR with connected load of 48.5kW. Estimated Annual Energy Usage of these AC's is ~40,000kWh.

Expected energy saving by installing AC Energy Saver Genie is 15% of the energy usage i.e.40,000kWh X 15% = 6000 kWh

Annual amount saved @ `8.05/ kWh = 6000 kWh X 8.05 per kWh = 48,300

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

= 2X 6000 kWh=12000 kWh

Reduction in CO_2 emission = 12000 X 0.8 kg CO_2 /kWh

= 9600 kg = 9.6 tones of CO_2/ year

National Saving in Capital cost of power plant

= 2X 7.275 kW X 60,000/kW = Rs.873000

Investment = 28 nos. X 8,000 per saver = 224,000

Simple payback period = Investment / Savings per year = 224000/48,300 = 4.64 years

Recommendation #2

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

Saving Calculation :

Present installed capacity of installed 28 nos. Air conditioners are 48.5 TR with connected load of 48.5 kW. Estimated Annual Energy Usage of these AC's is ~40,000kWh.

Expected energy saving by installing Cyclic Intelligent Timer for Power Saving on Air Conditioner is 15% of the energy usage i.e.40,000kWh X 15% = 6000 kWh

Annual amount saved @ `8.05/ kWh = 6000 kWh X 8.05 per kWh = 48,300

Energy Saved at Generating station = 2 X Energy consumed at demand side
= 2X 6000 kWh=12000 kWh
Reduction in CO_2 emission = 12000 X 0.8 kg CO_2 /kWh
= 9600 kg = 9.6 tones of CO_2/ year
National Saving in Capital cost of power plant
= 2X 7.275 kW X 60,000/kW = Rs.873000

Investment = 28 nos. X 8,000 per saver = 224,000

Simple payback period = Investment / Savings per year = 224000/48,300 = 4.64 years

Case Study# 5 To install Solar Water Heating System :-

Calculations for solar water heating systems (SWHS) for hostels

A sample 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 = 180 students

Assume that amount of hot water used per student = 20 litres / day.

Total amount of water used per day in the hostel = 3600 litres.

The Girls hostel is equipped with 500L Solar Water Heater Plants. However, it is not working properly and need minor repair work.

The Evacuated tube type solar collector is proposed to be installed for 3000 Litre capacity.

Now typically 100 Litre capacity of collector gives 100 Litres per day of hot water output at >60 °C. Normal tolerable hot water temperature by measurement we found to be 40 °C.

The capacity required is about 3000 Litre SWHS.

The option is either to go for forced circulation or natural circulation. Forced circulation requires various accessories and proper control of the pump. Hence selecting natural circulation system,

Cost of collector per 100 Litre = Rs. 11,000 / 100L SWHS

Total capital cost required for installation of solar water heater in the hostel = Rs.11,000 per 100 L SWHS X 30 units of 100 Litre = 3,39,000/-

The total energy consumption in the hostel having 22kW capacity electric geysers, considering 6 hours of geyser operation for 6 months operation a year is found to be 24kW X 6 hours per day X 180 days=23,760 kWh per year

cost of electricity as 8.05 / kWh,

Total electricity bill due to geysers in the hostel = Rs. 1,91,268

Simple Payback period (SPP) = (capital cost of SWHS / Electricity bill per year) = 3,30,000/ 1,91,268 ~ 1.72 years.

Reduction in CO2 emission = 2 X 23,760 X 0.8 = 38016 kg CO_2

Distribution Transformer :

The institute is connected with 11/0.433 kV, 200 kVA Distribution Transformer. The Name plate rating of the transformer is as follows:

Make	Rajasthan Transformers & Switchgears
Rated kVA	200 kVA
Volts HV/LV	11kV/0.433kV
Ampere HV/LV	10.5A/ 266.6A
% Impedance	4.5%
Cooling	ONAN

The distribution Transformer gives best efficiency when operated at load of ~ 40% i.e. ~ 80kVA with balance load i.e. equal currents at equal & highest possible power factor.

The Transformer has its own efficiency depending upon the load on the all three phases and it is recommended to balance the load on all three phases and install a fixed capacitor across Transformer to maintain Power Factor.

Suggestion for improving electrical safety:

Transformer :-

1. Oil level critical so more oil to be filled. Also, the oil to be filtered to avoid failure of Transformer.
2. Silica Jel is not there
3. No oil in Silica Jel
4. Load balancing is required.
5. Cleaning of transformer by Caustic Soda water to arrest oil leakage
6. Earthing pits are not fitted with watering funnel and the pipes may be get choked due to soil/stone etc. Hence cork may be fitted to watering pipes. Also, watering of earth is required on regular basis. Earthing should be as per Code of practice for Earthing (IS3043 – 1966)

Distribution Electric Wiring-

The electricity distribution system is maintained by college itself and there is no permanent staff/post of Energy Manager or Electrician to take care day to day problems. However, a pump operator generally manage the faults and repair the problem by means of temporary arrangement (JUGAAD).

The wiring is very old type and hanging here and there at many places. Following observations are made :-

1. The wiring is nacked at many locations and insulation is not there on wires at few places and it may cause electrical accident including fatal. It is never suggested to have naked wires.
2. The fuse and MCB are not having proper rating and not installed as per standard practices.
3. Size of the wire selected at some locations is undersized and need to be replaced with proper rating and properly wired.
4. The Distribution panels are found open without cover and it is suggested to install proper sized/ quality SMC/ metallic distribution boxes with provision of Air Circuit Breakers.
5. The Distribution panels are not found earthed and in case of earth fault, it may cause electric shock/ may be fatal in some cases.
6. The Distribution boxes are uncovered and may result into entry of squirrel/lizard/mice which can cut the wires and create short circuiting and fire hazard.
7. Earth leakage circuit breakers (ELCB) is not installed as per Electricity Rules and CEA guidelines, 2010.
8. No Moisture proofing for Distribution Box chamber is found
9. Earthing is not proper and the non current carrying parts are not earthed, the three pin socket/ plugs are not having earth connection, earthing of all the freezes/ water coolers/ AC's/ Pumps/ Geysers/ Exhaust fans/ metallic panels is not proper.
10. Earthing is to be tested for earth resistance and need to e renewed if resistance is found more than required.

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	Do not bring a naked light near a battery.

	lifting or removing a heavy apparatus or material	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-authorised 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 Ht UG 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 :

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 :

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-energised 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)

  It is highly recommended and suggested to carry out Thermography of the electrical installation, fitting, all switch boards to avoid heating and fire hazards. Also, it is recommended to replace all the old wiring with new wires of proper size.