REPORT ON ENERGY AUDIT

TRC LAW COLLEGE

Vasudev Nagar,
Satrikh, Barabanki-225122,
U.P. – India

Submitted by

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Retd. Executive Director UP Power Corporation

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Energy Audit Committee

S. No.	Name	Designation	Role
1	Dr Sujeet Chaturvedi	Secretary TRC Law College	Coordinator
2	Ashoutosh Kumar	Audit Agency	Engineer & Certified Energy Auditor
3	Siddharth Srivastava	Audit Agency	Assistant

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ENERGY AUDIT CERTIFICATE

This is to certify that Walk-Through Energy Audit for TRC Law College Satrikh, Basudev Nagar Barabanki Pin code 225122 has been conducted in June 2022 to assess energy costs, availability, and reliability of supply of energy, energy conservation technologies and to explore energy saving avenues to reduce energy consumption.

Place: Lucknow

Date: June 27, 2022

Dr Sujeet Chaturvedi

Director Administration

Ashutosh Kumar

Certified Energy Auditor

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ACKNOWLEDGEMENTS

An energy audit study is a joint exercise of consultant and organization to account & contain energy usage without sacrificing the purpose of usage of energy. The contribution of organization's team is equally important in this endeavor.

We take this opportunity to convey our sincere thanks and gratitude for the kind cooperation extended by the management and staff of TRC Law College and acknowledges the contribution of the following dignitaries and site engineering personnel for providing timely assistance and guiding the team for conduct of this vital energy audit study.

Dr Sujeet Chaturvedi Secretary

Dr Aswini Gupta Principal TRC Law College

We are sure; this report will be quite useful for Energy Management to intensify and implement energy conservation measures in the organization and achieve desired savings.

We appreciate the keen interest taken by the management and maintenance staff to save precious energy in the interest of the organization as well as our Nation.

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Executive Summary

The objective of the audit was to study the energy consumption pattern of the facility, identify the areas where potential for energy/cost saving exists and prepare proposals for energy/cost saving along with investment and payback periods.

The salient observations and recommendations are given below. Electricity bill of TRC Law College monthly electricity bill varies from maximum Rs 36147/- to minimum Rs 6766/-.

TRC Law College uses energy in the following forms:

a. Electricity from MVVNL
b. High Speed Diesel (HSD)
c. Solar Power Plant

1. Electrical energy is used for various applications, like:
   a. Computers
   b. Lighting
   c. Air-Conditioning
   d. Fans
   e. Water lifting submersible Pumps
   f. Photo copier
   g. Water Coolers
   h. Projector
   i. Sound System in Moot Court
2. Institute has paid Rs 4,14,772/as electricity charges during last 24 hrs. i.e., the average cost of energy is around Rs. 17,282/Month.
3. Area Of Campus

Area of Campus in Square Meters	
Total area covered at ground	1220.7
Round and open area	867.3
Total ground area of campus	2088.0
Total floor area	3662.1
Ground coverage	1220.7*100/2088.0 = 58.45 %

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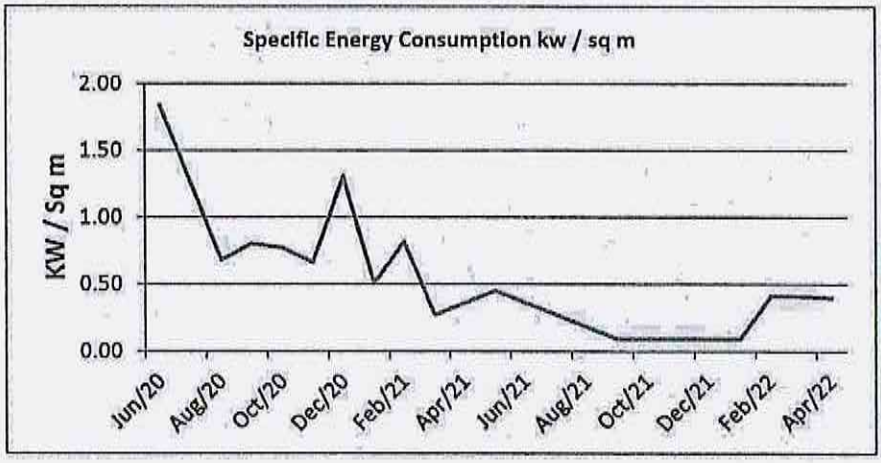
4. The Specific Energy Consumption (SEC) is the ratio of energy required per square meter. In this case the SEC is evaluated as electrical units consumed per square meter of area. SEC is calculated and plotted as below.



Presently maximum specific energy consumption with summer load in normal functioning of institute is around 1.84 and we should try to achieve around 1.5 in one year and finally settle for 1.25.

5. After the analysis of data and equipment installed, we propose herewith following Energy Efficiency Improvement measures.

Sr. No	Recommendations	Payback Period (Months)	Remarks
1	By Increasing contracted Demand	Immediate	Without Delay
2	Depositing Electricity Bill within due date	Immediate	Without Delay
3	By providing electronic regulators for ceiling fans every year	6 months	Medium cost – Medium Payback
4	By providing additional 5KW Solar PV Plant	48 months	Medium cost- Medium Payback
5	By Replacing 42 Nos Desktops by Laptops	72	Heavy Cost- Long Payback

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CHAPTER 1

INTRODUCTION TO ENERGY AUDIT

General

The TRC Law College entrusted the work of conducting an Energy Audit of campus at Satrikh, Barabanki with the main objectives as below:

a. To study the present pattern of energy consumption
b. To identify potential areas for energy optimization
c. To recommend energy conservation proposals with cost benefit analysis.

Scope of Work, Methodology and Approach

Scope of work and methodology were as per the proposal. While undertaking data collection, field trials and their analysis, due care was always taken to avoid abnormal situations to generate normal / representative pattern of energy consumption at the facility.

Approach to Energy Audit

We focused our attention on energy management and optimization of energy efficiency of the systems, sub systems and equipment. The key to such performance evaluation lies in the sound knowledge of performance of equipment and system.

Energy Audit

The objective of Energy Audit is to balance the total energy inputs with its use and to identify the energy conservation opportunities in the stream.

Energy Audit also gives focused attention to energy cost and cost involved in achieving higher performance with technical and financial analysis. The best alternative is selected on financial analysis basis.

Energy Audit Methodology

Energy Audit Study is divided into following three steps:

A. Historical Data Analysis

The historical data analysis involves establishment of energy consumption pattern to establish base line data on energy consumption and its variation with change in different months of year.

B. Identification and evaluation of Energy Conservation Opportunities

This step involves evaluation of energy conservation opportunities identified during the energy audit. It gives potential of energy saving and investment required to implement the proposed modifications with

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payback period. All recommendations for reducing losses in the system are backed with its cost benefit analysis.

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CHAPTER 2

About TRC Law College

S. No.	Particulars	Details
1	Name of the Institute	TRC Law College
2	Address	Vasudev Nagar, Satrikh Barabanki-225112
3	Year of Establishment	2006
4	Courses Offered	L.L.B. 3 years B.A. L.L.B. 5 years Likely to introduce shortly L.L.M.
5	Affiliation	Dr. Ram Manohar Lohia Awadh University Ayodhya Approved by Bar Council of India New Delhi
6	Total Building Carpet Area	3602.1 Sq Meter

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CHAPTER 3

HISTORICAL DATA ANALYSIS of ENERGY SOURCES

Electricity from MVVNL Barabanki Division:

Study of Variation of Monthly Units consumption:

In this Chapter, we study the details of last 24 months Electricity Bills. Main points of study are as follows.

S. No	Month	KWH	MD	Bill Amount	Specific Energy Consumption KWH/Sqm
1	Jun 20	2243.00	5.18	15553.32	1.84
2	Aug 20	830.00	6.41	11999.16	0.68
3	Sep 20	975.00	6.08	12976.00	0.80
4	Oct 20	940.00	3.60	12201.00	0.77
5	Nov 20	805.00	7.30	12905.00	0.66
6	Dec 20	1593.00	5.80	36147.00	1.30
7	Jan 21	613.00	6.00	24598.00	0.50
8	Feb 21	996.00	5.00	27414.00	0.82
9	Mar 21	330.00	5.00	13676.00	0.27
10	May 21	550.00	0.00	16730.00	0.45
11	Sep 21	113.00	5.00	6766.00	0.09
12	Oct 21	113.00	5.00	6510.00	0.09
13	Dec 21	113.00	5.00	3228.00	0.09
14	Jan 21	113.00	5.00	6510.00	0.09
15	Feb 21	503.00	6.09	11903.00	0.41
16	Mar 21	500.00	9.86	73451.00	0.40
17	Apr 22	486.00	7.86	21705.00	0.40
Total				414772.00	

Table: Unit Consumption Specific Energy Consumption

Power Factor (KWH/KVAH) is a measure to reduce the utility power bill as most utility bills are based on KVAR usage. Difference between KWH and KVAH is loss due to reactive power generated internally. A good Power Factor provides a better voltage, reducing the pressure on electrical distribution network, reducing cable heating, cable over loading and cable losses, reducing over loadings of control gears and switchgears etc. Above all good power factor indicates efficiency of electrical energy utilization.

However same is not applicable here as sanctioned load is less than 10KW and billing is being done on KWH.

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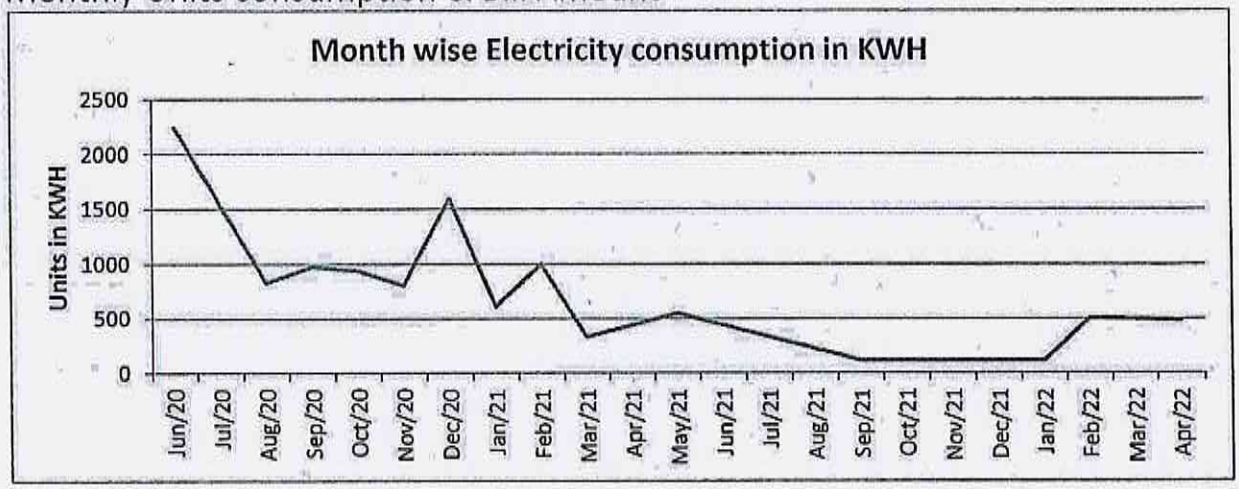
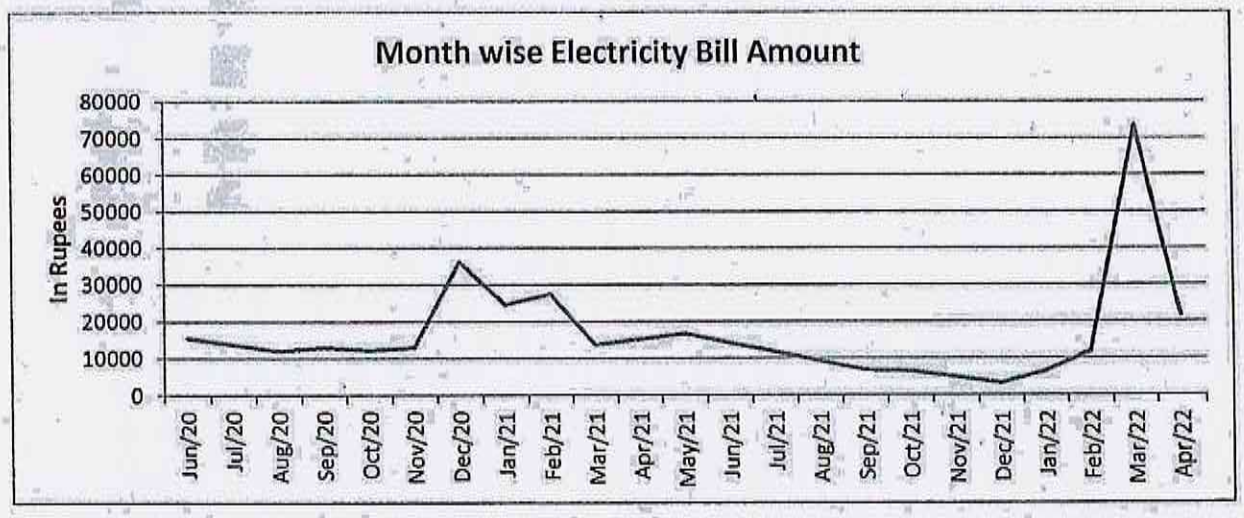
Monthly Units consumption & Bill Amount



There is very large variation in energy usage over period under study, from max 2243 to min 113 units which is obvious due to seasonal change but sharp decay from Jan 21 onwards is due to generation from solar PV plant as well as due to billing dispute.



From above it is apparent that bill unit and amount remained lowest during Mar 21 to Jan 22 which may be due to corona epidemic up to Aug 21 and thereafter due to non-billing or minimum billing which was corrected in Month of Jan 22.

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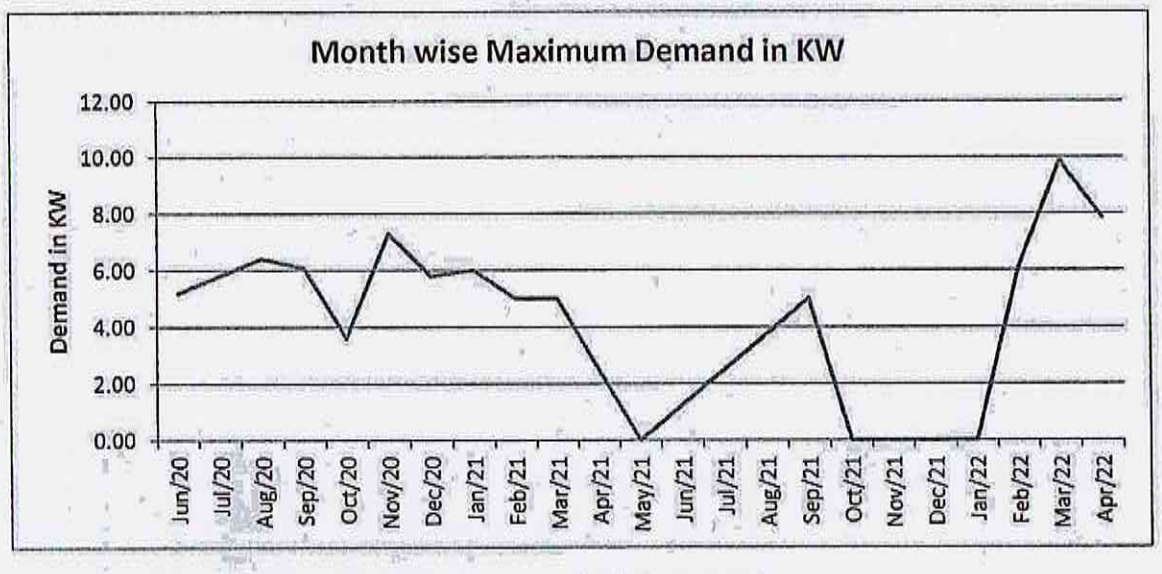
Maximum Recorded Demand/ Demand Charges

There is very large variation in maximum recorded monthly demand over period under study, from max 9.86 KW to min 5.0 KW which is obvious due to seasonal change but sharp decay from Jan 21 onwards is owing to suspension of activities on account of corona. But appreciable rise has been observed in year 2022 probably due to addition of few gudgets.



Sanctioned Load Vs Maximum recorded demand

From above table it is very much clear that in last two years recorded monthly demand has gone beyond sanctioned load for all months of operation has attracted maximum demand penalty. For specific purpose to evaluate and recommend reduction in contracted demand, maximum demand attained, study of above period was done. Meaning thereby in total period of 24 months i.e., June 20 – Apr 22, maximum recorded demand is 9.86 KVA in month of Mar 22. So safely contracted demand can be increased to 9 KW.

General Observations based on Electricity Bill

1. For TRC Law College Campus the Contract Demand (CD) is 5 KW and minimum billing Demand is 75% of the Contract Demand (3.75 KW) or the 75% of actual recorded Demand whichever is higher. Since the MD recorded in last 24 months is only 9.86 KW, contacted demand should be increased to 9 KW to avoid maximum demand penalty. Contracted demand is recommended 9 KW because demand charges will be as per actual between 6.75 to 9.0 KW which will cover most of monthly demand.
2. The average electricity cost is Rs. 24398/- considering the last 24 months consumption and amount paid.
3. Out of 17 months data analyzed demand charges penalty, two times extra, have been paid in 10 months.

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Solar PV Power Generating Plant

College campus has an Off grid solar PV plant of 5 KW with following components

1. 14 Nos Poly Solar Panels 330 W each
2. 2 Nos Mono Solar panels 445 W each
3. ENERTECH Solar Inverter 5 KVA Capacity
4. 8x15 AH Lead acid battery for backup

At the time of site visit at 13:00 hrs. solar plant was producing only 3.2 KW power.

General Observations on Solar PV Plant

1. Plant was generating less than its capacity
2. Solar PV panels were of two different types of Mono & Poly which are not compatible to each other, so at a time only poly panels were generating, and Mono panels were just lying redundant.
3. One panel was found damaged with cracks
4. Wires from solar PV panels were just connected by twisting each other in place of recommended MC connectors resulting in loss of generation and heating of joints.
5. Panels maintenance & cleaning was not satisfactory at the cost of generation
6. Inverter does not have provision for storing data of generated instantaneous units and historic data enabling monitoring of generation.
7. Battery maintenance is not up to mark and thus sufficient backup is not available which may not have propped up as in day hours equipment connected with solar plant gets power directly from PV cells.

Diesel Generating Set

College has one 25 KVA Diesel generating set to ensure backup supply during power failure condition which is quite frequent due to supply from town feeder.

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CHAPTER 4

Details of Energy consuming Equipment's Installed

4.1 Lighting Fixtures

S. No.	Tube LED		LED Bulbs		Down Lights	
	No	Watt@28W	No	Watt @7 W	No	Watt @18
1	61	1708	139	973	36	648
Total						3329

4.2 Fans

S. No.	Fans		Wall Fan		Pedestal	
	No	Watt @50	No	Watt @70W	No	Watt @80
1	296	14900	3	210	1	80
Total						15190

4.3 Air Conditioners

S. No.	Tonnage	Numbers	@ Watt	Make
1	1.5T 3Star	1	2.3	2016 Carrier
Total			2300	

4.4 Computers

S. No.	Computers	No	Watt
1	Desktop @80 W	44	3520
2	Laptop @30 watt	4	120
Total		3640	
Heavy Duty Printers/Copiers		17	17000
1	Laser Printer	4	2000
2	Photo copiers	2	4000
Total			6000
Submersible Pumps			
1	1 HP	1	746
Total			746
1	Water Cooler Volts	1	1500
2	Projector Zebronics	1	500

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3	LED TV	2	400
4	Amplifier Sound system	1	200
5	Inverter	1	2000
Total		4600	

Total Connected Load: (4.1 to 4.6 above) =

3329+15190+2300+3640+6000+746+4600 = 35805 W i.e., 35.8 KW

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CHAPTER 5

STUDY OF ELECTRICAL SYSTEMS

TRC Law College has three sources of Electricity Supply:

Electricity Connection

College is getting power from Madhyanchal Vidyut Vitaran Nigam Ltd against account no 761634040351 with sanctioned load of 5 KW under LMV 40 under EDD-I Barabanki.

Sr. No.	Details of electricity Demand	Tariff	HV-2/H21T
1	Sanctioned Demand	5	KW
2	Minimum Billable Demand	3.75	KW
3	Recorded Maximum Demand	9.86	KW

Diesel Generators

For back power College has one Ashok Leyland India make diesel generators of 25 KVA capacity.

Annual expenditure of diesel is Rs 45000/ Lts and

1. Solar PV generating plant 5 KW

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CHAPTER 6

Analysis of Data & Saving Avenues

Based on detailed discussion, analysis of data in chapter 3 above following conclusions has been arrived.

Study of Utility Bill

Demand Charges: As it is evident from above table and discussed in detail at S. No. 3 A that demand was mostly more than contracted demand of 5KW. So, it is recommended to increase contracted demand to 9 KW from present 5 KW.

Solar PV Generating Plant

Solar PV plant has average capacity to generate 20 KWH (Units) per day whereas is it generating on 14-15 units i.e., working at less than 75% capacity So close monitoring of generation by improving maintenance of Plant and battery backup is to be ensured. System of generation monitoring is also recommended to be installed.

Further though college being run in day hours and major part of electricity requirement can be met from solar PV generation hence keeping in view large roof area still available additional 5 KW solar plant be installed so that import from MVVNL can be brought to level of 100 units or less.

Since battery is almost five years old and has led almost full life. Following may be implemented for maintaining battery set.

1. **Check Battery Only When Fully Charged**
2. **Check the Acid Level**
3. **Clean the Battery Terminal Area**
4. **Keep the Battery Surface Spotless**
5. **Damaged / loose Wire Affects Performance and induce local heating**

Diesel Generating Set

As diesel generating set is of 25 KVA and load connected on it is not even 50 %, which affect its performance badly as can be seen from table given below:

Generator Size (kW)	1/4 Load (gal/hr.)	1/2 Load (gal/hr.)	3/4 Load (gal/hr.)	Full Load (gal/hr.)
20	0.6	0.9	1.3	1.6
30	1.3	1.8	2.4	2.9
40	1.6	2.3	3.2	4.0

So, it is recommended that care be taken for running generator not below 75% load.

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Study of Equipment/Appliances

Lighting equipment

Almost all lighting fixtures and equipment are LED based and most energy efficient available in market, no need to go for any change.

Ceiling Fan

All fans installed too are energy efficient fans and thus no recommendation for them. However, it has been observed that none of the ceiling fans are equipped with regulator which is big source of loss of energy. By installing electronic regulators almost 50% saving in consumption of energy on fans can be achieved. To emphasize same following case study be referred.

A case study with comparative performance of both types of regulators are tabulated below, wherein it is evident that saving % is maximum at lowest speed and same keep on decreasing with increase in speed. There will be an average reduction in energy consumption by 27 % with an electronic type of regulator as against a conventional type of regulator.

Regulator Position	With Conventional Regulator		With Electronic Regulator		Relative Energy Saving %
	Watt	Energy Saving %	Watt	Energy Saving %	
1	50	32	28.4	61.4	43.2
2	54	26.5	37.5	49.0	30.5
3	60.5	17.7	47.5	35 .4	21.5
4	65.3	11.1	57.3	22 .0	12.2
5	75.0	0	75.0	0	0

Saving Economics: Assuming that ceiling fan is operated for12 hrs./day, 200 days per year and saving achieved is 40% in energy consumption:

Annual Energy Consumed by one ceiling fan w/o regulator=Annual Cost of Energy Consumed by one ceiling fan w/o regulator= 50X12X200x8.5=Rs 960

Annual cost of energy saved for one ceiling fan = 960x0.40 = Rs 384/year

Total saving by providing electronic regulator = 298*384= 114432/-

Cost of providing regulator @200 =150*298=44700/-Payback period =114432/44700=0.39 years say five months' time.

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Computers

Computers and monitors account for 30%-40% of the energy used by office equipment. Their energy consumption is second only to office lighting. It is estimated that a power managed computer consumes less than half the energy of a computer without power management.

There are 44 desk top computers and 4 laptops. Apart from this there are 4 heavy duty printers and 2 copiers too.

Saving in this section cam be attained by following measures

Replacing Desktop Computers by laptop

A lot of it depends on the type of screen. A CRT (Cathode Ray Tube) screen consumes more than LCD (Liquid Crystal Display) screens. LCD screens can save up to 75% electricity over a CRT screen. A desktop also requires a UPS (Uninterruptible Power Supply) to keep it running during power loses which can eat significant amount of electricity. Laptops also have various other power management features. 70-80% of power consumption in a laptop is by CPU, and the rest of the components consume very less electricity. Laptops typically consume 20-50 Watts of electricity that can be trimmed down in power saver modes.

Desktop along with UPS normally consumes 200 W with CRT monitor and with LCD monitor it comes down to approx. 100 W whereas Laptop power consumption is around 30 W.

If desktop is replaced with laptop, then assuming average use of 8 hrs. for 300 days in a year saving calculations are as given below.

Power consumed by one desktop / year = 200x300x8/1000=480 **KWH**

Power consumed by laptop= 30x300x8/1000=**72 KWH**

Annual Saving by replacing one desktop = 480-72=408 **KWH**

By replacing one CRT monitor desktop by laptop will result in 408 **units/year**

Yearly Saving in Rs =408x8=**Rs 3264/**

Cost of one new laptop adjusting 10,000/salvage value of desktop=25000/-

So, payback period will be around 7 years.

However, it is recommended that whenever there is replacement / new purchase is required always go for Laptop.

Switching to a laptop may be a smart decision for someone who is concerned about how much energy a computer uses.

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By Replacing Monitors

If replacing desktop by Laptops is not possible due to cost factor replace all CRT and LCD monitors by LED monitors. Power consumed by different type of monitors is follows.

Typical 17" CRT	**80 Watts**
Typical 17" LCD	**35 Watts**
Typical 19" LED	**20 Watts**
Sleeping Monitor	**0-15 Watts**
Monitor Turned OFF	**0-10 Watts**

Other Measures:

Following measures by which considerable saving can be achieved.

1. Laptops are an additional 20 percent more power efficient when running on AC adapter power over battery power so always use laptops with AC adopter on.
2. On stand-by, the power consumption of both a desktop and a laptop computer fall to about a third.
3. Putting the monitor on stand-by reduces its consumption by 15%.
4. If the monitor is switched off completely, then of course it does not use power.
5. Switch off the loudspeakers if you are not using them.
6. Switch off the printer when it's not needed.
7. Switch off the screen if you are not working on the PC just now.
8. Switch off your computer or put it in stand-by mode if you are not going to work on your PC for more than 30 minutes. A multiple socket makes it easy to switch off all your computing equipment.
9. Switch off the modem at night.
10. One common misconception is that using a screensaver saves power, but this is not true

Air Conditioners

There is only one 1.5 Ton window 3-star Carrier Aircon make Ac whose starting current is 9.2 Amp and normal running current is 7.0 Amps. Air conditioner performance is satisfactory by regular servicing and filter cleaning for better performance and energy saving is recommended.

Other Best Practices to save Energy in ACs:

Apart from above following routine maintenance practices and checks should be enforced to get maximum efficiency of existing ACs by periodic checking.

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1. Insulation of room should be properly maintained by keeping all doors/ windows of AC rooms and check for any broken window glasses / door closure malfunctioning to prevent cold air to go out and hot air to go in.
2. AC should be switched on only 15 min before actual use and switched off while going out.
3. Normal air conditioning temperature should be kept not less than 24 degrees present BEE mandate. By thumb rule, increase in 1degrees in indoor air temperatures can save 6% of electricity.
4. If you are spending long hours in an air-conditioned room, try this tip. Keep it on for a couple of hours and then switch off for another one or two hours
5. Keep the ceiling/wall fan switched on when the AC is running. Together, they keep the room ventilated and circulate the cool air in all corners. Also, you will not have to keep decreasing the temperature.
6. All the dirt which gets accumulated in the ducts/filter and vents of the AC just make it work extra hard to ensure the cool air reaches your room. Regular cleaning of filters can lower an AC's energy consumption by 5-15 per cent! Plus, it saves the device from breaking down or in need of repair.
7. Most found defects leading to poor efficiency and consuming extra power are dirty air filters, thermostat not working, ice formation, water leakage, fan and swing not working. Ensure fort nightly checking of these points.

Other Low investment saving options:

1. Providing Master Switch outside every room will make it very easy for a person to switch off all appliances if someone forgets to switch off few appliances of room while leaving. This will save a lot of energy.
2. Regular Cleaning of fiber sheet provided in roof shed of workshop/ labs be ensured and few more opening in shed be provided, which will save considerable electricity being spent on lighting.
3. Regular cleaning of fans and exhaust fan blades be ensured otherwise efficiency will be compromised.
4. Harnessing Solar Power for Energy source substitution: In my view there is huge scope for solar power in TRC Law College as quite big chunk of consumption is during day hour only.
   For generating 20 KWH per day another 5 KW on-grid Solar plant is required. Cost benefit analysis of same is as follows:

Units generated per year (10 months) = 600x10= **6000 KWH**

Saving due to generated units = 6000X8.0 =**Rs 48000**

Payback period 300000/48000= approx. 6 years

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CHAPTER 7

Carbon Di-oxide Emission

In this Chapter we compute the CO2 emissions.

For consumption of 1 Unit (1 kWh) of Electricity, the CO2 emitted is 0.85 Kg. OR the Emission is0.85 Kg/kWh. In the following Table we present the total units consumed and CO2 emitted as under:

Month	KVAH	Carbon Emission in Kgs
Jun-20	2243	1907
Aug-20	830	706
Sep-20	975	829
Oct-20	940	799
Nov-20	805	684
Dec-20	1593	1354
Jan-21	613	521
Feb-21	996	847
Mar-21	330	281
May-21	550	468
Sep-21	113	96
Oct-21	113	96
Dec-21	113	96
Jan-22	113	96
Feb-22	503	428
Mar-22	500	425
Apr-22	486	413
May-22	550	468
Jun-22	309	263
Jun-20	2243	1907
Aug-20	830	706
Sep-20	975	829
Oct-20	940	799
Nov-20	805	684

Less Emission by saving unit electricity saved

- One Unit Electricity Saved = 2.5 Units Less Generation
- One Unit Electricity saved = 5 Units Less use of Fossil fuel like Coal, Furnace oil, Natural Gas etc. other natural resources

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- One Unit Saved = Less Emission of 0.85 Kg Carbon Dioxide

  Less emission of 7 gms of SO2

  Less emission of 4.38 gms of NO

  (Saving Electricity will reduce CO2, SO2 & NO emission and ultimately reduce global warming to save our planet)

Above data is for generation from fossil fuel

Less Emission by Saving in Petrol and Diesel

- One liter Petrol combustion emits 2.653 kg CO2
- One liter Diesel combustion emits emission 2.983 Kg CO2

Though contribution of TRCLC in emission of CO2 is very small but even small contribution by saving will make big if all combined.

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General Recommendations

In addition to the recommendations given above, a few more general ones are presented here. The savings due to their implementation could not be easily quantified, but their importance cannot be understated. Implementing all these measures will result in considerable saving without compromising much on the existing facilities and comforts.

- All Classrooms, hostels, labs, and common places to have Display Messages regarding optimum use of electrical appliances in the room like lights, fans, computers, projectors etc.
- All the tube lights and fans in a classroom be switched off when not needed and natural light be used as much as possible.
- All appliances to be kept OFF or in idle mode if there will not be used for at least next one hour.
- All computers to have power saving settings to turn off monitors and hard discs, say after 10 minutes/30 minutes.
- The comfort air conditioning temperature to be set between 24°C to 26°C.
- Lights

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