JSS MAHAVIDYAPEETHA

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING

- Constituent College of JSS Science and Technology University
- Approved by A.I.C.T.E
- Governed by the Grant-in-Aid Rules of Government of Karnataka
- Identified as lead institution for World Bank Assistance under TEQIP Scheme

ENERGY AUDIT REPORT

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE (AUTONOMOUS) OOTY ROAD, MYSURU, KARNATAKA

SAVE ENERGY SAVE OUR PLANET

ENERGY AUDIT CONDUCTED BY

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

&

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING

CONSTITUENT COLLEGE

OF

JSS SCIENCE AND TECHNOLOGY UNIVERSITY, MYSURU.

ACKNOWLEDGEMENT

We express our sincere gratitude to the Principal of Sri Jayachamarajendra College of Engineering, for having given us an opportunity to conduct Energy Audit at JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.

We express our thanks to the Principal of JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru for having authorized the JSS Science and Technological University, Mysurufor conducting the Energy Audit at the Academic Campus of the JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.

We hope that JSS Science and Technological University has been able to fulfill the duty entrusted to it in a satisfactory manner.

We look forward to associate with the JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru in similar matter in future.

We express sincere thanks and gratitude to the employees of JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru for the co-operation and the needful assistance extended to us, during the conduct of Energy Audit.

Our sincere thanks to the following dignitaries, for having given us an opportunity to conduct Energy Audit in JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.

1. **Dr. S. B. Kivade**, Principal & Dean (E&T), Sri Jayachamarajendra College of Engineering, Mysuru.
2. **Prof. B.V. Sambashivaiah**, Chief Executive Officer, JSS College of Arts, Commerce and Science, Ooty Road, Mysuru.
3. **Prof. H. C. Honnappa**, Principal, JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.
4. **Dr. M.S.Shashikala,** Professor & Head (E&EE), Sri Jayachamarajendra College of Engineering, Mysuru.
5. **Dr.V Ramesh,** Professor & Head (I&PE), Sri Jayachamarajendra College of Engineering, Mysuru.
6. **Dr. N Rajendra Prasad**, Assistant Professor of Chemistry & IQAC Coordinator, JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.
7. **Dr.Mallikarjunaswamy C**, Assistant Professor of Chemistry, JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.
8. **Mr.Parashivamurthy**, Electrical Maintenance, JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.

We tried our best to present this energy report as per the requirements of the college.

CONTENTS

DISCLAIMER

The primary objective of this Energy Audit is to identify and evaluate opportunities for energy conservation through visits to your facility. Data was gathered during Three day site visit and energy conservation opportunities were identified. When an energy conservation opportunity involving engineering design and capital investment is attractive to the institution and engineering services are not available in-house, it is recommended that a consulting engineering firm be engaged to do the detailed engineering design and cost estimations for implementing the energy conservation opportunity.

In addition, since the site visits by our team are brief, they are necessarily limited in scope and a consulting firm could be more thorough. The contents of this report are offered only as guidance. Sri Jayachamarajendra College of Engineering, constituent college of JSS Science and Technology University, Mysuru and all technical sources referenced in this report do not

(a) Make any warranty or representation, expresses or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method or process disclosed in this report may not infringe on privately owned rights.

(b) Assume any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report. This report does not reflect official views or policies of the previously mentioned institutions. The assumptions and equations used to arrive at the energy consumption and cost savings for the energy conservation opportunities are given in the report. These assumptions are intended to be conservative. If the client does not agree with the assumptions made, the assumptions may be adjusted and, using the same equation, new values for the energy and cost savings for each energy conservation opportunity may be determined.

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WORK COMPLETION REPORT

This is to certify that **Sri Jayachamarajendra College of Engineering (SJCE)** Constituent college of **JSS S & TU, Mysuru**has successfully conducted **Energy Audit** at **JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru, Karnataka** from **15 Dec 2021 to 31 Dec 2021**.The work of energy audit was completed on **31 Dec 2021**.

Thanking you and assuring you our best service always.

Audit Report BY:

Dr. Mohan N, **Co – Assessor 1** **Assistant Professor,** **Dept. of Electrical & Electronics Engineering** **SJCE, JSSSTU, Mysuru - 570006**	**Mr. Ravishankar B S,** **Co – Assessor 2** **Assistant Professor,** **Dept. of Electrical & Electronics Engineering** **SJCE, JSSSTU, Mysuru - 570006**	**Dr. Dayakar G. Devaru,** **Certified Energy Manager** **Principal Assessor** **Professor,** **Dept. of Industrial & Production Engineering** **SJCE, JSSSTU, Mysuru - 570006**

Date: 31/12/21

Place: Mysuru

CERTIFIED ENERGY MANAGER
CEM®
20475
EXP. 12/31/2022
Dr. Dayakar G. Devaru

ENERGY AUDIT TEAM

Name	Designation
Dr. Dayakar G. Devaru	Certified Energy Manager & Professor, Dept. of Industrial & Production Engineering SJCE, JSSSTU, Mysuru – 570006
Dr. Mohan N	Assistant Professor, Dept. of Electrical & Electronics Engineering SJCE, JSSSTU, Mysuru -570006
Mr. Ravishankar B S	Assistant Professor Dept. of Electrical & Electronics Engineering SJCE, JSSSTU, Mysuru -570006
Mr. Pradeepa K P	Lab Instructor Dept. of Electrical & Electronics Engineering SJCE, JSSSTU, Mysuru -570006
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Shankar H C	PG Scholar (2020-2022) Dept. of Electrical & Electronics Engineering SJCE, JSSSTU, Mysuru -570006
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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.

1. JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru uses energy in the following forms:

A. From Chamundeshwari Electricity supply corporation Limited, Mysuru.

B. Electricity SOLAR Grid connected solar plant (180 kW).

C. Diesel Generator (DG)

Electrical energy is used for various applications, like: Computers, Lighting, Air-Conditioning, Fans Other Laboratory Equipment, and Printers, Xerox machines, CCTV, UPS, LCD Projector, Router system, Flood light, Pumping motor etc.

2. Clean the Installed 180kW Rooftop Solar plant regularly to increase 30 to 40% Electricity Generation at Campus.

3. After the measurement and analysis, we propose herewith following Energy Conservation Opportunities as shown in Table 1.

The total energy used is **229812 kWh/yr**. Total energy costs for this period was **₹16,80,597**. The Energy Conservation Opportunities (ECOs) contained in this Report could save **109.880 kWh/yr** which is equivalent to reduction of CO_2 emission of **93,398 Kgs** or equal to planting **4,448 Trees**. The total energy cost savings would amount to approximately **₹3,25,640/-**or approximately **19.38%** of the annual energy costs for this facility. The total estimated implementation cost is **₹2,05,200/-**which gives an simple payback of around **16 months.**

Best Practices found in the institution

1. Roof top Solar Photo-voltaic Panel of installed capacity 180 KW

2. Roof top solar water heater (flat plate collectors)

3. LED Tube lights in library & newly constructed buildings.

Table 1: Energy Conservation Opportunities

Sl. No.	Energy Conservation Opportunity	Fittings to be replaced /Installed	Energy Savings (kWh)	Energy Cost Savings	Implementation Cost	Payback in Months
1	Replace Fluorescent Tube Lights (FTL) with LED Tube Lights	800	28,800	2,05,920	1,75,200	10 Months
2	Retrofit existing inefficient and old Fan Regulators with Electronics Regulators	40	1,080	7,720	10,000	16 Months
3	Increase the efficiency of Power generation from Solar PV by regular maintenance	-	80,000 (generated additionally)	1,12,000	20,000 (Annual Maintenance Cost)	-------
Total			**109.880**	**₹ 3,25,640**	**₹2,05,200**	**16 Months**

CHAPTER 1

INTRODUCTION

JSS Mahavidyapeetha is a socio-cultural institution that has pioneered the concept of education as a tool for social change. While the focus has been on providing opportunities for formal education, there is a strong parallel thrust on values, ethics, and the meeting of societal obligations. This is an institution that adopts a multipronged approach to ensure a better quality of life.

The present Pontiff H.H Jagadguru Sri Shivarathri Deshikendra Mahaswamiji, the 24thspiritual Head of Suttur Math and President of JSS Mahavidyapeetha has been the torchbearer of its tradition of providing educational excellence.

JSS College of Arts, Commerce and Science are a co-educational College established in 1964 under the aegis of JSS Mahavidyapeetha, Mysuru. The College was started as an affiliated college of University of Mysuru with undergraduate programmes in BA, BSc, B.Com, BBM and was given permanent affiliation in 1993. The College is recognised by UGC under section 2(f) and 12(B) of the UGC Act 1956 and is receiving central assistance. The college has been functioning as an autonomous college from the academic year 2005-06. The distinctive features of autonomy are that the college is empowered to frame the syllabi, introduce new courses and conduct examinations independently. The degree is awarded by the University of Mysuru.

The college is situated on a sprawling 7.08 acres plot with a spacious building and a hostel in a picturesque surrounding at the foot of Chamundi Hills. The third floor to the existing building created additional space to meet the growing needs of the college. The women's hostel has also been extended to accommodate 200 students. It has excellent infrastructure required for the pursuit of academic excellence

Since then the College is offering a total of 55 programmes in BSc and BA in different combinations along with B.Com, BCA, BBA, MSc (Physics, Chemistry, Mathematics, Computer Science, Biotechnology, Biochemistry, Botany, and Zoology), M.Com, MA (English, Kannada), Social Work and PhD (Biochemistry, Biotechnology, Social Work, Kannada, English, Commerce, Physics, Chemistry and Mathematics). COCs and PG Diploma programmes are also offered.

The college has undergone assessment & accreditation by NAAC with four Star grade in 2001, ‘A’ grade in 2008 (Cycle 2), 2014 (Cycle 3) and 2019 (Cycle 4). In 2010, the College was recognized by UGC as ‘College with Potential for Excellence’ and continued for II phase in 2015. Further, UGC-DDU KAUSHAL Kendra was established with financial assistance from UGC. The KAUSHAL Kendra is offering B.Voc/M.Voc in Food Processing & Engineering, B.Voc/M.Voc in Software Development, Certificate, Diploma and Advanced Diploma courses in Animation & Multimedia under Community College Scheme.

As per the new provisions provided by UGC for autonomous colleges, a total nine PG Departments viz., Social Work, Biotechnology, Biochemistry, Chemistry, Commerce, English, Kannada, Mathematics and Physics have been recognized as Research Centres by the University of Mysuru. Govt. of Karnataka has recognized the College as Training Centre under Kaushalya Karnataka Scheme to train in 3 job roles, Animator, Editor & Baking Technician. Government of Karnataka granted financial assistance for five years to offer PG Diploma in Protein Expression and Scale-up under Biotechnology Finishing School (BTFS) in 2011 and in phase II the assistance is continued for five more years

with a new nomenclature, Biotechnology Skill Enhancement Programme (BiSEP). In 2020-21 (current year), a total of 3404 students are pursuing their education in various programmes mentioned above and are well supported by 162 teaching staff and 67 non-teaching staff.

It has an enviable academic record as students secure ranks and honours almost every year in the examination. Many Alumni of the institution are successful literati, politicians, administrators and bureaucrats. They are still nostalgic and maintain emotional attachment with the institution. The college has an active placement cell and also conducive atmosphere for sports and cultural activities. It has a well maintained playground and a well-equipped national level Basketball Court. Students have brought laurels to the college in Games, Multi gym, Sports, Debate and Music at Inter-College and University level events. The college has an NCC wing and two NSS Units, the volunteers of which have participated in state and national level camps. Rovers and Red Cross units also have been started.

Under the spiritual guidance of H.H Jagadguru Sri Shivarathri Deshikendra Mahaswamiji, the institution is desirous of scaling new heights in the days to come. The entire spectrum of management, staff and students are committed to put in their best to make this dream come true.

Vision of the college:

To be known as an institution providing need-based, skill-integrated, cost- effective, quality and holistic education, transforming the students into globally competitive, employable and responsible citizens and to be recognized as a centre of excellence.

Mission of the college:

To create and acquire relevant knowledge along with skills and global competencies and disseminate the same among students.

To provide holistic education through relevant curricula, programmes and pedagogic innovations focusing on employability and self-employment.

To undertake research work contributing to the creation of knowledge, skills and its applications for sustainable development.

To establish linkage and collaborations for the betterment of teaching, learning, research and extension

To provide good infrastructure, human resource and necessary support-services for the betterment of students' progress and welfare.

To promote national integration, human rights, universal brotherhood and community development activities through inclusive practices.

OVERVIEW OF WHOLE CAMPUS AT A GLANCE:-

TOTAL CAMPUS AREA & COLLEGE BUILDING SPREAD AREA

The total land area of campus : 7.08 acres

Total plinth area of buildings : 29,662.59 Sqm

Total paved area in the campus : 3, 18,855 Sqft

NAAC GRADING IN ASSESSMENTS NAAC

NAAC accreditation First cycle : 4 Stars

NAAC re-accreditation Second cycle: A Grade (CGPA-3.03)

NAAC re-accreditation Third cycle : A Grade (CGPA-3.04)

NAAC re-accreditation Fourth cycle : A Grade (CGPA-3.21)

CHAPTER 2

INTRODUCTION TO ENERGY AUDIT

2.1 General

The JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru entrusted the work of conducting a Detailed Energy Audit to the SJCE campus at Mysuru with the main objectives as below:

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

2.2 Scope of Work, Methodology, and Approach

The 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 so as to generate a normal/representative pattern of energy consumption at the facility.

2.2.1 Approach to Energy Audit

We focused our attention on energy management and optimization of energy efficiency of the systems, subsystems, and equipment3. The key to such performance evaluation lies in the sound knowledge of the performance of equipment and system as a whole.

2.2.2 Energy Audit

The objective of Energy Audit is to balance the total energy inputs with their 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 a financial analysis basis.

2.2.3 Energy Audit Methodology

Energy Audit Study is divided into the following four steps

2.2.4 Historical Data Analysis

The historical data analysis involves the establishment of energy consumption patterns to establish baseline data on energy consumption and its variation with change in production volumes.

2.2.5 Actual measurement and data analysis

This step involves actual site measurement and field trials using various portable measurement instruments. It also involves input to output analysis to establish actual operating equipment efficiency and find out losses in the system.

2.2.6 Identification and evaluation of Energy Conservation Opportunities

This step involves the evaluation of energy conservation opportunities identified during the energy audit. It gives the potential of energy-saving and investment required to implement the proposed modifications with a payback period. All recommendations for reducing losses in the system are backed with its cost-benefit analysis.

2.3 List of Instruments used for Energy Auditing

2.3.1 FLUKE 434-II POWER ANALYZER

2.3.2 Clamp Meter.

CHAPTER 3

STUDY OF ENERGY CONSUMPTION PROFILE

3.1 Source of Energy:

JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru uses Energy in the following forms:

1. Electricity from CESC

JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru receives Electricity from Chamundeshwari Electricity Supply Corporation Limited, Mysuru.

Fig: Incoming Supply Bus-Bar installed at campus

2. Diesel Generator

Diesel is used as a fuel for Diesel Generator which is run whenever power supply from Chamundeshwari Electricity Supply Corporation Limited, Mysuru is not available.

Fig: Name Plate Details of Cummins Diesel Generator installed at campus

3. Electricity SOLAR Grid connected solar plant (180 kW)

JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru installed 180kW rooftop solar power which is used to feed the Campus load and export the remaining energy to Chamundeshwari Electricity Supply Corporation Limited, Mysuru.

Fig Shows Solar Panels installed at campus.

CHAPTER 4

STUDY OF ELECTRICAL SYSTEMS

4.1Electrical Supply Details

The electrical supply to JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru campus comes from CESC, Mysuru supply at 11kV.

4.1.1 Tariff and electricity charges

The electric supply at JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru campus is charged under HT-2C1of the Chamundeshwari Electricity Supply Corp Ltd (CESCOM) the tariff structure of HT-2C1 general is given in table.

HT-2C1 Shall be given for Educational Institutions.

Table- Tariff structure- HT-2C1* (CESC Electricity Tariff 2021)

Fixed Charges	Rs.240 per kVA of billing demand/month.	
Energy Charges	For the first one lakh units	715 paisa per unit
	For the Balance units	755 paisa per unit

*indicates Present Tariff structure

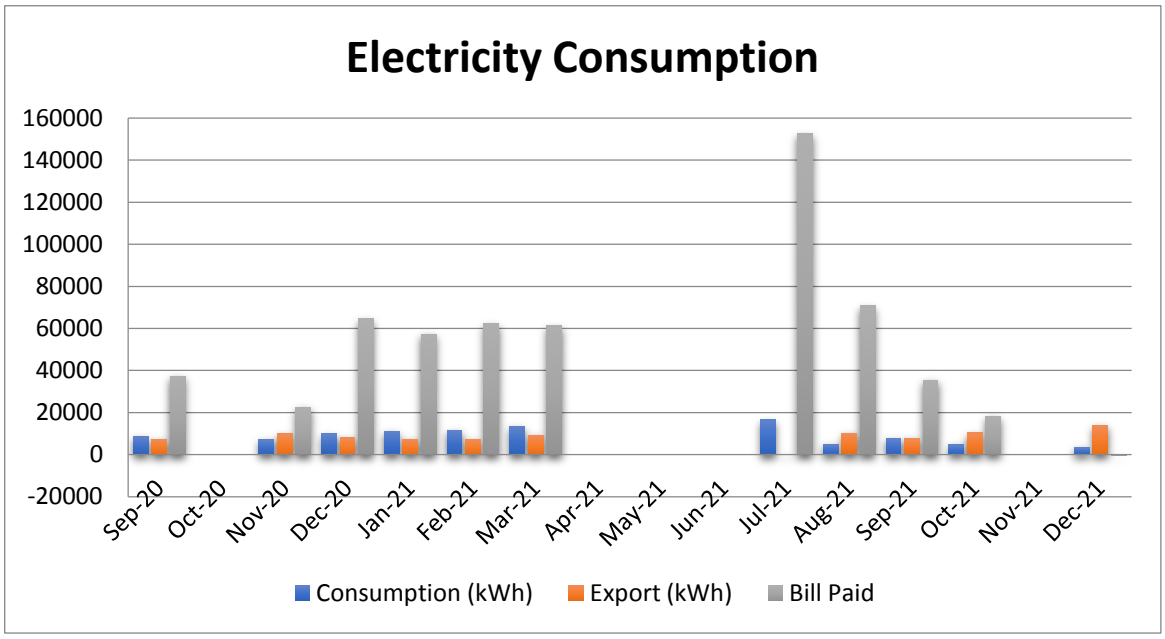
4.2 Electrical Energy Cost Analysis

4.2.1 CESC Consumption

The monthly energy consumption in kWh from CESC*, Mysuru for the past 12 months is shown in Table.

SL. No	Month	Contract Demand In kVA	Consumption from CESC (kWh)	Export to CESC (kWh)	Total Bill Paid to CESC* in Rs.
1	Sep 2020	150	8595	7387.5	37367
2	Nov 2020	150	7252.5	9922.5	22592
3	Dec-2020	150	9930	8152.5	64613
4	Jan2021	150	11182.5	7440	57206
5	Feb 2021	150	11662.5	7260	62211
6	Mar2021	150	13485	9225	61207
7	Jul 2021	150	16695	255	152598
8	Aug 2021	150	4882.5	10290	70809
10	Sep 2021	150	7695	7770	35320
11	Oct 2021	150	4860	10342.5	18202
12	Dec 2021	150	3540	13927.5	-192
TOTAL			**99,780**	**91,972.5**	**5,81,933/-**

*Indicates the data extracted from the CESC Monthly Consumption bill.

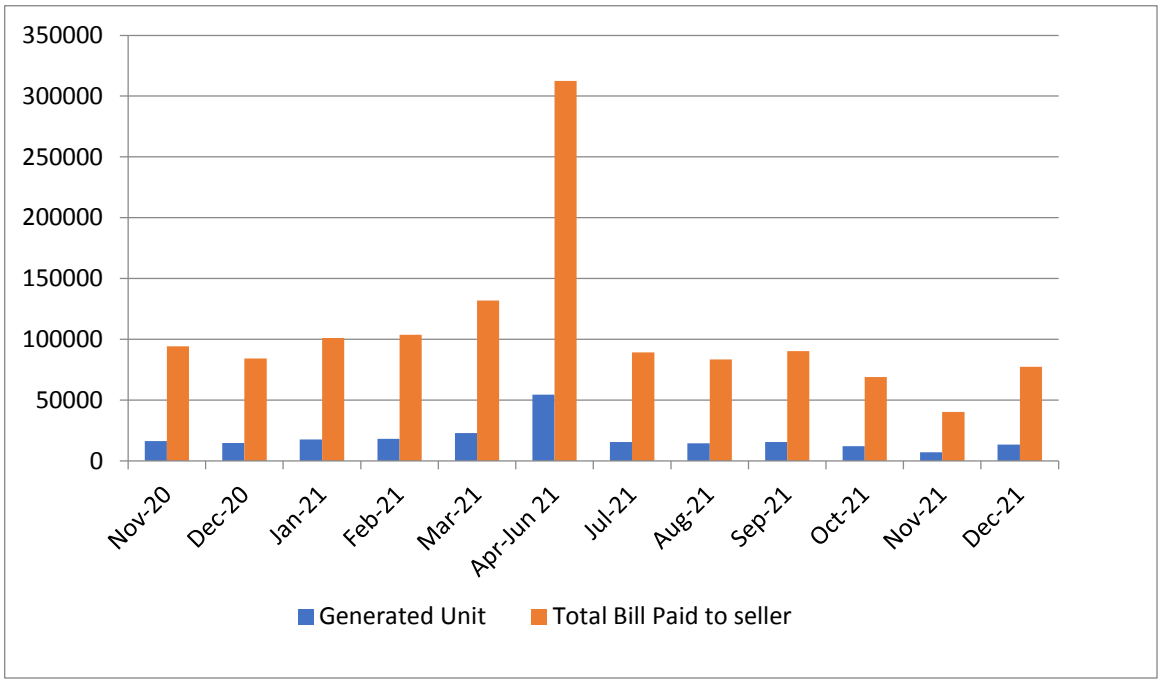


4.2.2 Roof Top 180 kW Solar Power Plant.

The monthly Bill paid to SANGAM rooftop solar private limited, Mumbai for installed **180Kw Roof Top solar Power Plant** at JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru for the past **14 months** is shown in below table.

SL.NO	MONTH	Generated unit	Rate per unit	Total Bill Paid to Seller Company* (Rs)
1	**Nov-20**	16,400	5.75	94,300
2	**Dec-20**	14632	5.75	84,134
3	**Jan-21**	17,560	5.75	1,00,970
4	**Feb-21**	18,056	5.75	1,03,822
5	**Mar-21**	22,928	5.75	1,31,836
6	**Apr-Jun 21**	54,368	5.75	3,12,616
7	**Jul-21**	15,504	5.75	89,148
8	**Aug-21**	14,504	5.75	83,398
9	**Sep-21**	15,596	5.75	90,252
10	**Oct-21**	11976	5.75	68,862
11	**Nov-21**	7,008	5.75	40,296
12	**Dec-21**	13,472	5.75	77,464
TOTAL		**2,22,004**		**12,77,098/-**

***** Indicates Payments made to **SANGAM** rooftop solar private Limited, Maharashtra from JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru.


350000
300000
250000
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150000
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Nov-20
Dec-20
Jan-21
Feb-21
Mar-21
Apr-Jun 21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Generated Unit
Total Bill Paid to seller

CHAPTER 5

ACTUAL MEASUREMENTS AND ITS ANALYSIS

5.1 Load Pattern of College Campus* (Full)

Sl. no	Name of Appliance	Power rating (Watts)	Quantity	Power Consumption (Watt)	Usage per Day in hr.	Power Consumption/day (Watt-Hr)
A	B	C	D	E=C*D	F	G=E*F
1	Fluorescent Lamp(FTL)	40	800	32000	6	1,92,000
2	Fan	60	392	23520	2	47,040
3	Computer	250	485	121250	5	6,06,250
4	LED(9W)	9	20	180	6	1,080
5	LED (10W-Two Fitting)	10	23	230	6	1380
6	LED Surface fitting	15	110	1650	8	13,200
7	LED Tube light	20	480	960	6	5,760
8	Xerox Machine	750	6	4500	2	9000
9	Exhaust Fan	60	91	5460	3	16380
10	LCD Projector	282	78	21996	2	43992
11	TV	80	3	240	3	720
12	Water Purifier	2000	6	12000	1	12,000
13	Refrigerator	2KWhr/Day	2	40000	24	9,60,000
14	UPS	1 KVA	24	24000	24	5,76,000
		2 KVA	1	2000	24	48,000
		3 KVA	3	9000	24	2,16,000
		5 KVA	10	50000	24	12,00,000
		7.5 KVA	15	112500	24	27,00,000
		10 KVA	3	30000	24	7,20,000
15	Kitchen Load	8000W	1	8000	2	16,000
16	LED Street lights	40	25	1000	8	8,000
17	LIFT	3700	1	3700		
18	CCTV	40W (1 DVR)	4	160	24	3840
19	Weighing Balance	24	3	72		
20	Microwave	1000	3	3000	4	12000
21	Garden area motor	5HP	2	7355	7	51,485

22	Sump Motor	2HP	2	1471	2	2,942
		3HP	2	2206.5	5	11,032.5
23	Air Conditioners	1.5TR	6		As per Usage	
		2TR	4			
		2TR(Cold Storage)	4			
		5.5TR	2			
		11TR	4			
24	Auditorium Load	36W CFL	136			
		Focus Light-2kW	10			
		Focus Light-1kW	32			
		LED Colour light-100W	8			
		Face ceiling light-44W	13			
		(Speaker -1000W +Woofer -1000W)	12	12000		
		Curtain Raising Motor-8 HP**	1	5884		
25	Major lab Loads	14.5 HP	1	10664.75		
26	Stove	3000	5	15000	5	75000
27	Kettle	2500	5	12500	6	75000
28	Diesel Generator	100kVA	1	100000	As per usage	
		160kVA	1	160000		
		30kVA	1	30000		
*This is total load consumption considered approximately. Actual load consumption might be different according to actual use of power for particular time period. **Indicates 1HP=735.5W						

CHAPTER 6

DIESEL GENERATORS

6.1 Diesel Generator System.

Total 250 kVA Diesel Generator set is installed, for giving supply to the entire Campus.

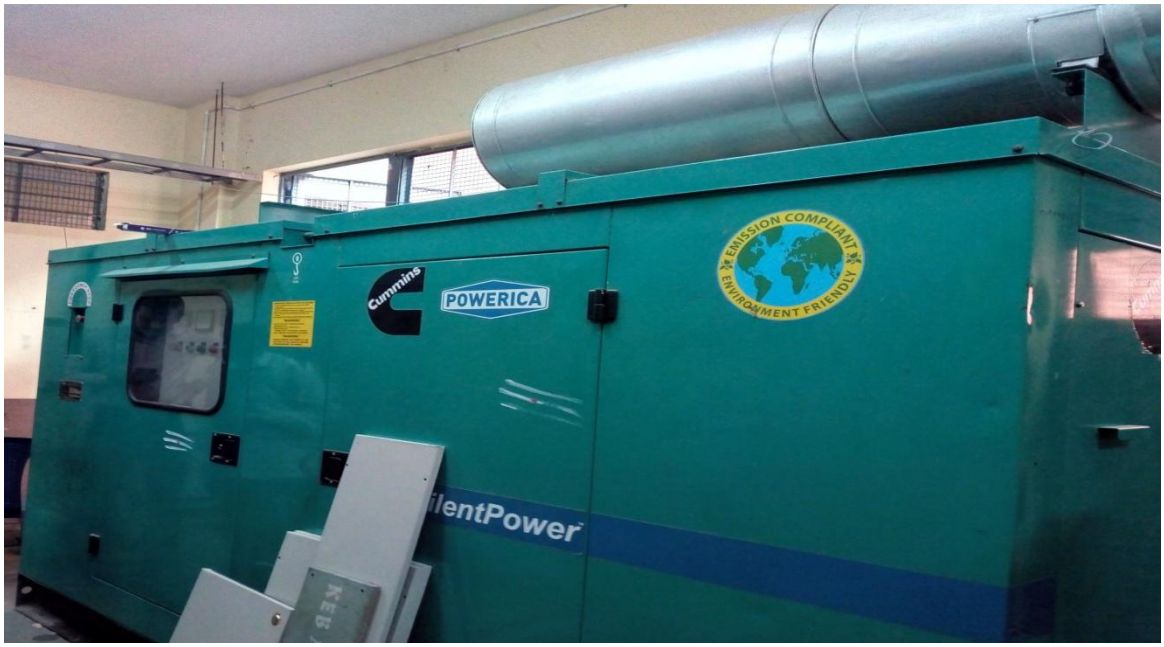


Fig. 100 kVA Cummins Diesel Generator

Energy Saving Measures for DG Sets

- Ensure steady load conditions on the DG set, and provide cold, dust free air at intake (use of air washers for large sets, in case of dry, hot weather, can be considered.
- Improve air filtration.
- Ensure fuel oil storage, handling and preparation as per manufacturers' guidelines/oil company data.
- Consider fuel oil additives in case they benefit fuel oil properties for DG set usage.
- Calibrate fuel injection pumps frequently.
- Ensure compliance with maintenance checklist.
- Ensure steady load conditions, avoiding fluctuations, imbalance in phases, harmonic loads.
- In case of a base load operation, consider waste heat recovery system adoption for steam generation or refrigeration chillers unit incorporation. Even the Jacket Cooling Water is amenable for heat recovery, vapour absorption system adoption.
- In terms of fuel cost economy, consider partial use of biomass gas for generation. Ensure tar removal from the gas for improving availability of the engine in the long run. (Biogas may be generated from the degradable waste generated at the college campus Kitchen/Canteen.
- Carryout regular field trials to monitor DG set performance, and maintenance planning as per requirements.

CHAPTER 7

MEASUREMENT OF HARMONICS AND LOAD CURRENT

7.1 Readings recorded by Fluke 434-ll power analyser

Parameters	R-Phase	Y-Phase	B-Phase	Neutral
Voltage in volts	247	248.7	245.8	3.2
Voltage Phase Shift in Degree	0	-120	-240	NA
Current in Amps	45.7	49.4	76.2	38.4
Current Phase Shift in Degree	-4	-121	-259	NA
Voltage Harmonics in %	5.6%f			
Current Harmonics in %	108%f with K-factor – 28.9			
Frequency in Hz	50Hz			
Power Factor	0.98			

7.2 Waveforms from Fluke 434-ll Power Analyser

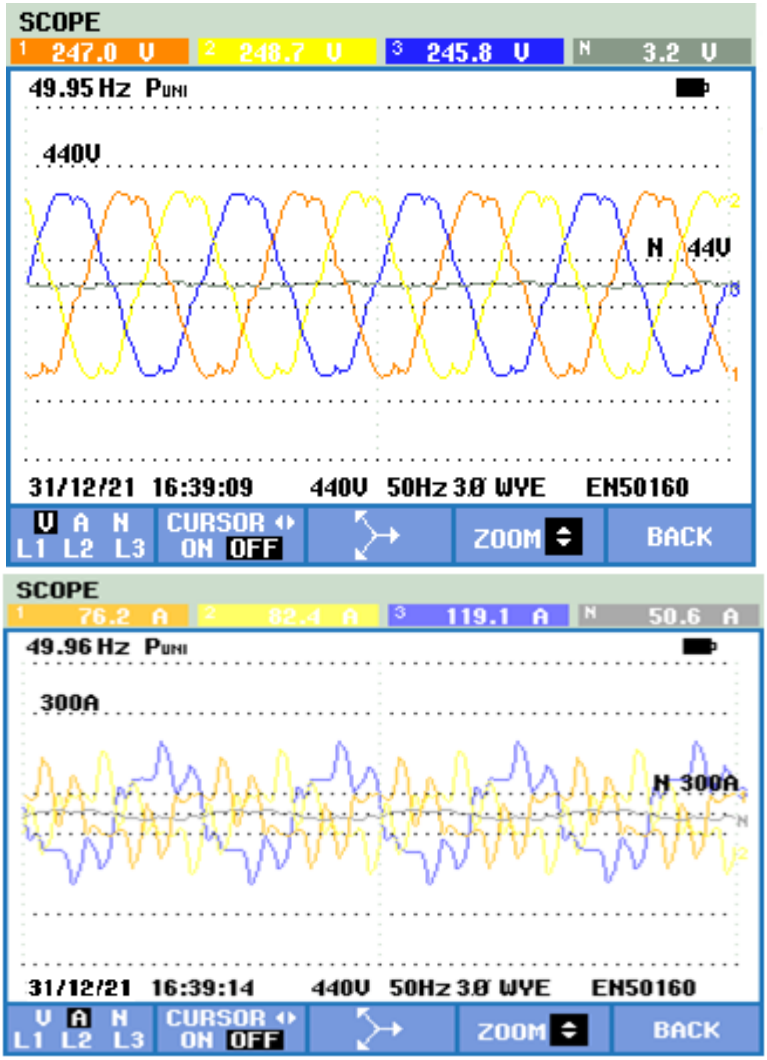


Fig. Voltage and Current (Distorted) Sinusoidal Waveform of the Campus

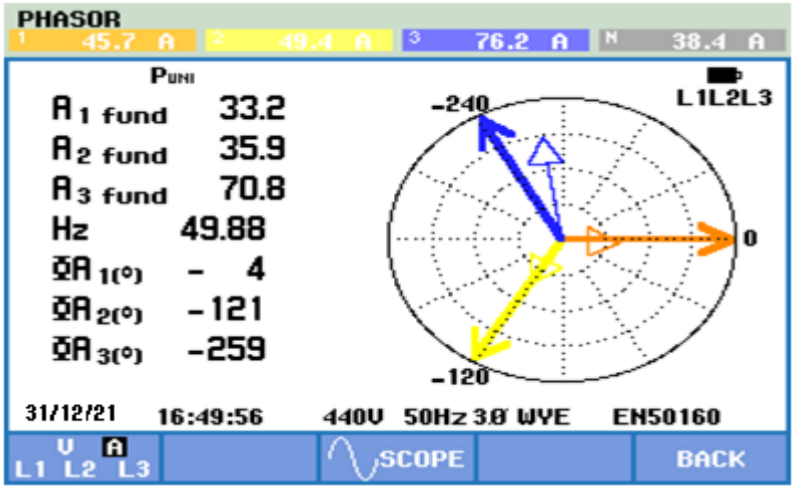
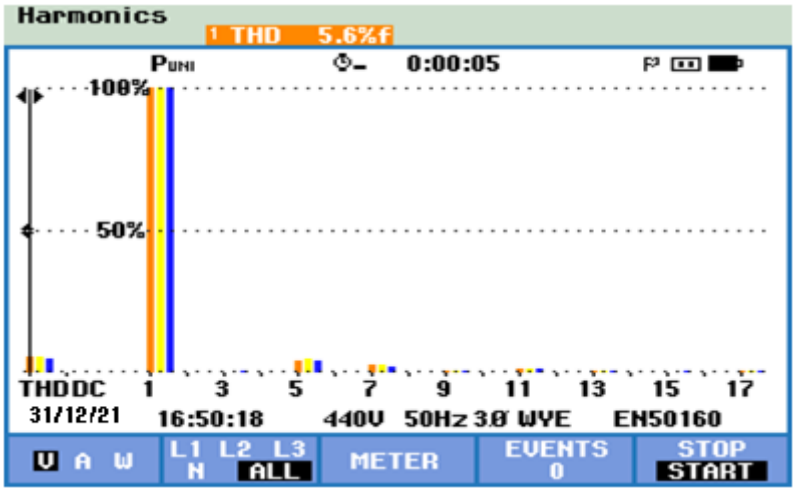


Fig. Phasor Diagram of Current



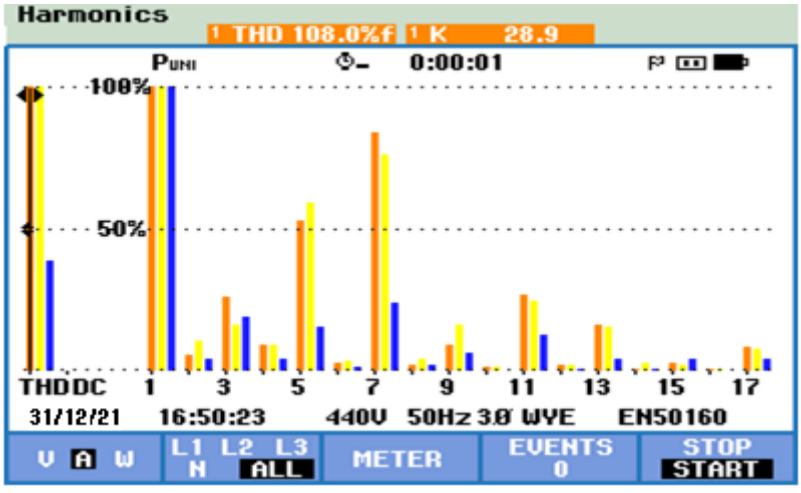


Fig. Voltage and Current Harmonics of Campus

Observations: Analysis using Power Analyzer shown that the current load on each phase is not balanced properly and unbalanced current is flowing through the neutral conductor. This is causing harmonic distortions which will adversely affect the life of the electrical

equipment used in your campus. Hence it is recommended to balance the loads on each phase of the bus bar properly by redistributing the load on each phase.

CHAPTER 8

ENERGY CONSERVATION MEASURES

The following energy conservation measures can be adopted at JSS College of Arts, Commerce & Science (Autonomous) Ooty road, Mysuru.

8.1 Replace Fluorescent Tube Lights (FTL) with LED Tube Lights

The 40 W FTLs can be replaced with the LED tube lights 20 W. These changes can be made at the places where the usage is higher. Usually minimum of 1 years warranty is given and approximate burning hours is 40,000. (15 years considering 6 hours per day running).

Following calculations are done for 6 hours working:

- Power consumption by 36 W FTL with conventional choke = **40 W/ Tube Light.**
- Equivalent LED tube light = **20 W/ Tube Light.**
- Savings in power = **20 W/ Tube Light.**
- Operating hours = 6 h/day x 300 = **1,800 h/year.**
- Tube Light Yearly savings = 1800 x 20 W = **36 kWh/year/Tube Light.**
- Average Cost of electricity = **Rs.7.15/ kWh.**
- Saving = 36 kWh x 7.15 = **Rs. 257.4 / year / Tube light.**
- Approximate investment on single LED Tube lights = **Rs. 219**. (Panasonic LED 20W Batten, 1 pc).
- Number of Tube Lights to be replaced = **800**
- Electrical Energy Saved = 36 x 800 **= 28,800 kWh / yr**

Summary:

Total Yearly Saving =800 x 257.4 =**Rs. 2,05,920 /-year**
Total Investment =800 x Rs.219 = **Rs.1, 75,200**/-

Payback:

(1, 75,200/2, 05,920)= 0.85 **years =around 10 months**.

8.2. Retrofit existing inefficient and old Fan Regulators with Electronics Regulators

Following calculations are done for 6 hours working:

- Power consumption by 60 W with conventional regulator from full speed to minimum speed = 60 W/ fan
- Equivalent Energy Efficient Regulator = 45 W/ Fan
- Savings in power = 15 W/ Fan
- Operating hours = 6 h/day x 300 = 1,800 h/year
- Fan Energy Yearly savings = 1,800 x 15 = 27 kWh/year/Fan
- Average Cost of electricity = Rs.7.15/ kWh
- Saving = 27 kWh x 7.15 = Rs. 193 / year / Fan

- Approximate investment on single Electronics Regulators = Rs. 250 (Approximate)
- Number of Fan Regulators to be replaced = 392
- Electrical Energy Saved = 27 x 40 **= 1,080 kWh / yr**

Summary:
Total Yearly Saving =40 x 193 = **Rs. 7,720 /year**
Total Investment = 40 x Rs. 250 = **Rs. 10,000/-**

Payback:
(10,000/7,720) = 1.30 **Year = around 16 months.**

8.3. Increase the efficiency of Power generation from Solar PV by regular maintenance

As per the reference (No. 6) the reduction in solar efficiency due to dust on PV panel is approximately 40% and the same is indicated by the existing power generation of the solar panels. By cleaning the panels, its efficiency can be improved by a considerable amount.

Existing Power generation from Solar PV / year (2021)	Existing Cost of Energy Bill and Solar Contractor Bill Paid	Proposed Power generated from Solar PV after cleaning	Proposed Savings in Cost of CESC and Solar Contractor Bill Paid
1,90,000 kWh / yr	5,81,933 +10,98,664 =Rs. 16,80,597 / yr	2,70,000 kWh / yr	80,000 x (7.15-5.75) =Rs. 112,000 / yr

Summary:
Total Yearly Saving = **Rs. 112,000 / year**
Annual cleaning charges = **Rs. 20,000**
Net Savings = **Rs. 92,000 / year**

The implementation cost and payback periods for the recommendations are as shown in the following table.

Sl. No.	Energy Conservation Opportunity	Fittings to be replaced /Installed	Energy Savings (kWh)	Energy Cost Savings	Implementation Cost	Payback in Months
1	Replace Fluorescent Tube Lights (FTL) with LED Tube Lights	800	28,800	2,05,920	1,75,200	10 Months
2	Retrofit existing inefficient and old Fan Regulators with Electronics Regulators	40	1,080	7,720	10,000	16 Months
3	Increase the efficiency of Power generation from Solar PV by regular maintenance	-	80,000 (generated additionally)	1,12,000	20,000 (Annual Maintenance Cost)	-------
Total			**109.880**	**₹ 3,25,640**	**₹2,05,200**	**16 Months**

8.4 General Recommendations

- All Class Rooms and labs to have Display Messages regarding optimum use of electrical appliances in the room like lights, fans, computers and projectors. Save electricity. Display the stickers of save electricity, save nature everywhere in the campus. So that all stakeholders encouraged to save the electricity.
- Use **motion sensor** in corridors, passage, library and toilets.
- Most of the time, all the tube lights in a class room are kept ON, even though, there is sufficient light level near the window opening. In such cases, the light row near the window may be kept OFF.
- All projectors to be kept OFF or in idle mode if there will be no presentation slides.
- All computers to have power saving settings to turn off monitors and hard discs, say after10 minutes/30 minutes.
- Lights in toilet area may be kept OFF during daytime.
- Use Automatic Power Factor Correction (APFC) Panel for PF improvement.
- Need to replace FTL by smart LED Tube Need to replace ordinary bulb by LED bulb.
- Need to replace ordinary CRT monitor by LED.
- Need to replace ordinary refrigerator by BEE power saver refrigerator if possible.

Executive Recommendation

- There has to be Institute level student community that keeps track of the energy consumption Parameters of the various departments, class rooms, halls, areas, meters, etc.
- Energy auditing inside the campus has to be done on a regular basis and report should be made public to generate awareness.
- Need to create energy efficiency/ renewable energy awareness among the college campus i.e. solar, wind, Biogas energy. College should take initiative to arrange seminars, lectures, paper presentation competition among students and staff for general awareness.

REFERENCES

1. Central Electricity Authority (CEA) Regulations & Supply Code 2014.
2. Institute of Electrical and Electronics Engineers (IEEE) standards.
3. Bureau of Energy Efficiency (BEE) guide lines and Energy Management Centre web site.
4. Energy Management, Audit and Conservation" by Barun Kumar De.
5. https://solarrooftop.gov.in/rooftop_calculator MNRE, GOI.
6. https://jrenewables.springeropen.com/articles/10.1186/s40807-017-0043-y#citeas

SJCE Energy Audit Team that visited JSS College of Arts, Commerce and Science (Autonomous), Ooty Road, Mysuru