ENERGY AUDIT REPORT

JSS ACADEMY OF HIGHER EDUCATION AND RESEARCH

MYSURU, KARNATAKA

SAVE ENERGY SAVE OUR PLANET

ENERGY AUDIT CONDUCTED BY

JSS CONSULTANTS, MYSURU

ACKNOWLEDGEMENT

Our sincere thanks to the following dignitaries, for having given us an opportunity to conduct the Energy Audit in JSS AHER, Mysuru.

1. Dr. B. Suresh, Pro Chancellor
2. Dr. Surinder Singh, Vice Chancellor
3. Dr. B. Manjunatha, Registrar
4. Dr. M N Purohit, Dean IQAC
5. Mrs. Kokila M.S, Deputy Registrar
6. Principals and Heads of all Constituent colleges and Departments

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

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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 Five-days 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. JSS Consultants, 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 ***JSS Consultants*, Mysuru** has successfully conducted **Energy Audit** at **JSS AHER, Mysuru, Karnataka** from 31 **July 2023 to 16 September 2023**.The work of energy audit was completed on **16 September 2023**.

Thanking you and assuring you our best service always.

Audit Report BY:

Dr Mohan N, **Co – Assessor** **Electrical Engineer** **JSS Consultants,** **Mysuru -570006**	**Dr Dayakar G. Devaru,** **Certified Energy Manager** **Principal Assessor** **JSS Consultants,** **Mysuru -570006**

Date: 16/9/23
Place: Mysuru

Chief Executive Officer

Chief Executive
JSS CONSULTANTS
JSS Technical Institutions Campus
MYSURU-570 006

Principal Assessor

CERTIFIED ENERGY MANAGER
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EXP. 12/31/2025
Dr. Dayakar G. Devaru

ENERGY AUDIT TEAM

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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 Medical College, Dental College and School of Life Sciences uses energy in the following forms**
   - **A. From Chamundeshwari Electricity supply corporation Limited, Mysuru.**
   - **B. From 484 kW Solar Photo voltaic Power Plant**
   - **C. From 500 kVA and 380 kVA Diesel Generators**
2. **JSS College for Pharmacy, Mysuru uses energy in the following forms**
   - **A. From Chamundeshwari Electricity supply corporation Limited, Mysuru.**
   - **B. From 132 kW Solar Photo voltaic Power Plant**
   - **C. From 160 kVA Diesel Generator**
3. **JSS DHSMS, Ramanuja Road uses energy in the following forms**
   - **A. From Chamundeshwari Electricity supply corporation Limited, Mysuru.**
4. **JSS College for Pharmacy, Ooty uses energy in the following forms**
   - **A. From Tamil Nadu Generation and Distribution Corporation Ltd., Nilgiris**
   - **B. From 250 kVA Diesel Generator**

   Electrical energy is used for various applications, like: Medical Equipment, AC Units, Cold Rooms, Laboratory Equipment, Computers, Lighting, Fans, Printers, Xerox machines, UPS, LCD Projector, Router system, Compressors, Pumps, motors, etc.
5. After the measurement and analysis, we propose herewith following Energy Conservation Opportunities as shown in Table 2.

The total energy used is **29,07,246 kWh/yr** (Table 1). Total energy costs for this period was **₹ 2,52,38,658/-**. The Energy Conservation Opportunities (ECOs) contained in this Report could save **5,76,777 kWh/yr.** which is equivalent to reduction in CO_2 emissions of **5,47,938 Kgs** or equal to planting **26,092 Trees**. The total energy cost savings would amount to approximately **₹ 49,20,505/-** or approximately **19.5%** of the annual energy costs for this facility. The total estimated implementation cost is **₹ 1,91,37,910/-** which gives an average simple payback of around **47 months.**

Table 1: Annual Energy Consumption of different Campuses of JSS AHER

Name of the Campus	kWh	Rupees
JSS Medical, Demtal and LifeSciences Colleges CESC	1,050,825	10,259,784
JSS Medical, Demtal and LifeSciences Colleges Solar	695,419	4,311,599
JSS College of Pharmacy, Mysuru CESC	308,430	3,144,940
JSS College of Pharmacy, Mysuru Solar	191,088	1,184,746
JSS College of Pharmacy, Ooty TG&DC	557,084	5,479,949
JSS DHSMS, Ramanuja Road	1,04,400	857,640
Total	**29,07,246**	**2,52,38,658**

Table 2: Energy Conservation Opportunities

Sl. No.	Energy Conservation Opportunity	Annual Energy Savings (kWh)	CO_2 Savings (Kgs)	Annual Energy Cost Savings	Implementation Cost	Payback in Months
1	Replace Fluorescent Tube Lights with LED Tube Lights	93,421	88,750	7,94,080	5,51,760	9
2	Replace the existing induction motor fans with new BLDC motor fans in JSS AHER Campus	165,615	1,57,335	14,18,714	75,94,400	64
3	Retrofit existing inefficient and old Fan Regulators with Electronic Regulators in Dental college campus to Save Energy	6,750	6,413	57,375	56,250	12
4	Replace the existing old Air Conditioners with 5 Star Air Conditioners with inverter technology.	1,83,090	1,73,936	15,56,265	77,75,000	60
5	Install Occupancy/Motion Sensors in Designated Areas	17,006	16,156	144,551	100,500	8
6	Use solar water heater in conjunction with heat pumps to reduce water heating energy consumption for the hostel	1,03,512	98,336	8,79,852	28,50,000	39
7	Install Variable Speed Drives on the Refrigerant Compressors of Air conditioner used for Animal House	2,775	2,636	23,588	30,000	16
8	Paint the roof with white Reflective Roof-Top Coating to reduce heat load in JSS Ramanuja Road Campus Building	4,608	4,378	46,080	1,80,000	47
Total		**5,76,777**	**5,47,938**	**₹ 49,20,505**	**₹ 1,91,37,910**	**47 Months**

It should be noted that a "law of diminishing returns" applies to the total cost savings. That is, the figure of **₹49,20,505** is based on the sum of the cost savings for each ECO as if they were independent, but they are not.

Proposal: It is recommended to install Solar Rooftop Photovoltaic power plant in JSS College of Pharmacy, Ooty Campus to generate electivity and save money on electric bills and also reduce carbon footprint. Table 3 shows the details of this proposal.

Table 3: Proposal for Solar Rooftop Photovoltaic Power Plant

Sl. No.	Energy Generation Opportunity	Energy Generation (kWh)	CO_2 Savings (Kgs)	Annual Cost Savings	Implementation Cost	Payback in Months
1	Install Solar PV Rooftop in JSS College of Pharmacy, Ooty Campus	1,92,000 kWh	3,936 Tones Co_2	16,32,000	45,93,408	34 months

Prioritizing Energy Conservation Opportunities: Energy Conservation opportunities can be prioritized based on the payback period and the ECOs with less than 12 months payback can be considered for implementation with high priority. So, the ECOs shown in Table 4 can be considered for immediate implementation.

Table 4: Energy Conservation opportunities with payback of less than 12 months

Sl. No.	Energy Conservation Opportunity	Annual Energy Savings (kWh)	CO_2 Savings (Kgs)	Annual Energy Cost Savings	Implementation Cost	Payback in Months
1	Replace Fluorescent Tube Lights with LED Tube Lights	93,421	88,750	7,94,080	5,51,760	9
2	Retrofit existing inefficient and old Fan Regulators with Electronic Regulators in Dental college campus to Save Energy	6,750	6,413	57,375	56,250	12
3	Install Occupancy/Motion Sensors in Designated Areas	17,006	16,156	144,551	100,500	8

6. Best Practices found in the institution.

a. LED Tube lights in campus
   JSS AHER is replacing the fluorescent lighting with LED lighting and more than 70% of the lights have been already replaced.
b. BLDC Fans in Pharmacy College Hostel
   JSS College for Pharmacy, Mysuru has started replacing its induction motor fans in the hostel with Brushless DC Motor fans and the other campuses are planning to follow them.
c. Capacitor banks for Power factor correction
   All the campuses have capacitor banks installed for power factor correction and are maintaining good power factor.
d. Air Conditioners with inverter technology
   JSS AHER has started replacing its non-inverter air-conditioners with inverter air-conditioners in all the campuses. For any new extension, it is procuring only inverter air conditioners.
e. Motion sensors and timers on lights
   JSS College for Pharmacy, Mysuru has installed motion sensors on lights in the hostel corridors and the other campuses are planning to follow them. Timers are installed on Street lights in the same Campus.
f. LED Street Lights
   Street lights on all the JSSAHER campuses are replaced to LED street lights.
g. Solar Power Plant connected to the grid - wheeling to the grid

In the Medical and Pharmacy college campuses in Mysuru, Solar Power Plant of 85% capacity of the contract demand are installed and are generating electricity and exporting the excess energy generated to the grid.

h. Conventional fans with Electronic Regulators that save energy

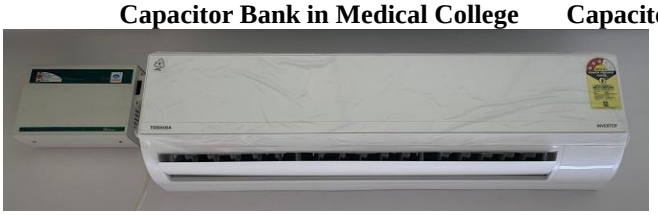
BLDC Fan

Motion Sensor

Electronic Fan Regulator

Capacitor Bank in Medical College

Capacitor Bank Panel in Pharmacy College, Mysuru



Air Conditioner with Inverter Technology

LED Lighting

Solar Panels installed at the campus Left: Dental College, Right: Pharmacy College, Mysuru

Fig 1: Photos of the Best Practices found in the JSSAHER Campus

Positive Observations

a. Electrical Cables laid in the Underground
b. Continuous replacement of conventional lights with LED lights
c. All open conduits are being concealed
d. In Medical and Pharmacy campus, 40% of campus electrical energy consumption is generated from Solar Power Plant.
e. Charging points for Electric Vehicles

CHAPTER 1
INTRODUCTION
JSS MEDICAL COLLEGE

Introduction:

JSS Medical College, a constituent college of JSS Academy of Higher Education and Research, holds an esteemed position in the realm of medical education, research, and healthcare excellence. Accredited with an exemplary A+ Grade by the National Assessment and Accreditation Council (NAAC), this institution stands as a beacon of academic distinction.

Located in the tranquil and verdant environs of Sri Shivarathreeshwara Nagara, Mysuru, Karnataka, India, JSS Medical College has been a cornerstone of medical education since its establishment in the year 1984. Nestled within an expansive 43-acre campus, the college provides an ideal setting for fostering the growth and development of future healthcare professionals.

During its formative years, JSS Medical College was affiliated with the University of Mysore from 1984 to 1995 and subsequently with the Rajiv Gandhi University of Health Sciences, Bangalore, until 2008. Since May 28, 2008, it has proudly served as a constituent college of JSS Academy of Higher Education and Research, established under Section-3 of the UGC Act. This affiliation to a prestigious academic institution further enhances the college's commitment to excellence in medical education, research, and healthcare services.

JSS Medical College's standing in the medical community is underscored by its recognition by the National Medical Council (NMC). The college is dedicated to imparting high-quality medical education that not only uplifts the health sector but also caters to the healthcare needs of all segments of society. This commitment to inclusivity and excellence is at the heart of JSS Medical College's mission and vision.

As part of our energy audit report, we will delve into the energy consumption patterns and sustainability initiatives at JSS Medical College. We will analyze the institution's dedication to optimizing energy utilization while upholding its exceptional standards of medical education, pioneering research, and healthcare delivery. Our report aims to provide a comprehensive assessment of the college's energy management strategies, current energy consumption, and recommendations for energy efficiency improvements. By aligning with JSS Medical College's overarching goals of excellence and inclusivity, our findings will contribute to the institution's ongoing mission to enhance healthcare and medical education in India.

JSS DENTAL COLLEGE

Introduction:

J.S.S. Dental College & Hospital, Mysore, has firmly dedicated itself to becoming a beacon of excellence in Dental Education and a global leader in the field of Dental Sciences, including hospital practice, with the noble objective of strengthening healthcare across the nation. Nestled in the enchanting city of Mysore, Karnataka State, this institution epitomizes both academic distinction and a commitment to superior healthcare. Mysore, renowned for its palaces and gardens, is conveniently located approximately 150 kilometers from Bangalore, ensuring easy accessibility via well-connected roads and railways.

Founded in 1986-87, the Dental College offers a comprehensive range of educational programs, including BDS and MDS courses in nine specialized divisions, along with Post Graduate Diploma courses in five distinct specialties. It has earned recognition from both the Dental Council of India and the Government of India, solidifying its position as a respected institution in the field. Affiliated to the JSS Academy of Higher Education & Research (JSSAHER), Mysuru since 2008-09, it was previously affiliated to the Rajiv Gandhi University of Health Sciences, Karnataka, from 1996-97, and the University of Mysore from 1986-87.

Nestled within the lush expanse of the JSS Medical Institutions Campus, spanning over 38 acres, JSS Dental College & Hospital occupies five acres exclusively for its operations. The institution is steadfast in providing separate hostel facilities for both male and female students, ensuring a comfortable and conducive learning environment.

Notably, JSS Dental College & Hospital extends its mission beyond education, actively contributing to the healthcare needs of the community. The institution is dedicated to delivering top-notch treatment to all patients in need, while also reaching out to rural populations by providing essential dental education and healthcare services.

As part of our energy audit report, we will delve into the energy consumption patterns and sustainability initiatives at JSS Dental College & Hospital. Our aim is to analyze the institution's dedication to optimizing energy utilization while maintaining its exceptional standards of dental education, healthcare, and community outreach. This report will provide a comprehensive assessment of the college's energy management strategies, current energy consumption, and recommendations for energy efficiency improvements. Our findings will align with JSS Dental College & Hospital's commitment to excellence in dental education,

research, and healthcare delivery, furthering its mission of strengthening healthcare across the nation.

JSS COLLEGE OF PHARMACY, MYSORE

Introduction:

JSS College of Pharmacy, a pivotal component of the prestigious JSS University, Mysore, stands as an emblem of excellence in pharmaceutical education, research, and healthcare practice. The institution's roots can be traced back to the visionary leadership of Jagadguru Sri Dr. Shivarathri Rajendra Mahaswamjigalavaru, the 23rd pontiff of Sri Suttur Veerasimhasana Math, who played a pivotal role as the architect and founder president of JSS Mahavidyapeetha in 1954. Under the divine inspiration of Sri Swamiji, the JSS College of Pharmacy commenced its journey in 1973 in the vibrant city of Mysuru.

Located within a sprawling campus of [square meter measurement], JSS College of Pharmacy stands as a dynamic hub of pharmaceutical education and innovation. Its infrastructure is thoughtfully designed to cater to the evolving needs of students, faculty, and researchers. It features modern classrooms, well-equipped laboratories, an extensive pharmacy library, and state-of-the-art research facilities.

The institution offers a comprehensive range of pharmacy education and training opportunities, including Diploma in Pharmacy (D.Pharm), B.Pharm (Practice), Bachelor of Pharmacy (B.Pharm), Doctor of Pharmacy (Pharm.D.), Master of Pharmacy (M.Pharm), and Doctoral (PhD) programs, along with Residency Programs in Oncology & Nephrology. Supplementary postgraduate diploma and certificate courses enhance the educational experience.

JSS College of Pharmacy's commitment to excellence is underscored by its recognition by the Ministry of Human Resource Development, Government of India, in 2008. Jagadguru Sri Shivarathreeshwara University (JSSU), Mysore, Karnataka, was declared a deemed university, solidifying its reputation as a center of academic distinction.

The institution proudly hosts a Drug Testing Laboratory, approved by the Government of Karnataka and accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL). This laboratory reflects the institution's dedication to pharmaceutical research and quality assurance.

JSS College of Pharmacy has earned national acclaim through accreditation by the National Board of Accreditation (NBA), India, and international recognition with the certification of its Pharm.D. Program by the Accreditation Council for Pharmacy Education (ACPE), USA. It is

also consistently ranked among the top 10 pharmacy colleges in India, according to the National Institutional Ranking Framework (NIRF) by the Ministry of Human Resource Development, Government of India.

The institution boasts an active Training and Placement Cell, facilitating annual campus drives with the participation of a diverse pool of pharmaceutical companies and research organizations. This initiative ensures that students are well-prepared for opportunities in the pharmaceutical industry.

In our forthcoming energy audit report, we will delve into the energy consumption patterns and sustainability initiatives at JSS College of Pharmacy. Our aim is to analyze the institution's commitment to optimizing energy utilization while maintaining its exceptional standards of pharmaceutical education, cutting-edge research, and healthcare practices. This report will provide a comprehensive assessment of the college's energy management strategies, current energy consumption, and recommendations for energy efficiency improvements. Our findings will align with JSS College of Pharmacy's dedication to excellence in pharmaceutical education, research, and healthcare delivery, furthering its mission of advancing healthcare and pharmaceutical sciences nationally and internationally.

SCHOOL OF LIFE SCIENCES (SLS), JSS ACADEMY OF HIGHER EDUCATION & RESEARCH

Introduction:

The School of Life Sciences (SLS) at JSS Academy of Higher Education & Research, Mysuru, was founded in the year 2013, under the auspicious blessings of His Holiness Sri Shivarathri Deshikendra Mahaswamiji, the esteemed Chancellor of the institution. Today, the School stands as a distinguished and unparalleled institution in India, renowned for its multidisciplinary and interdisciplinary approach to teaching and research in the field of life sciences.

SLS finds its place within the comprehensive Strategic Planning Framework of JSS Academy of Higher Education & Research, guided by a clear vision and mission of achieving both national and international recognition while upholding local relevance. The School offers a diverse array of courses spanning biological, biomedical, and environmental sciences, with a particular emphasis on interdisciplinary research. Graduates of SLS are poised for a multitude of career opportunities, ranging from biotechnology and agriculture to pharmaceutical

industries, research and development organizations, and teaching institutions across India and overseas.

At the heart of SLS's ethos lies a profound appreciation for the equivalence of teaching and research as essential components of continual professional and scientific development. Pioneering efforts have been made to fuse principles from physical, chemical, and computer sciences with life sciences, aligning with the norms set forth in the National Education Policy (NEP) of 2020. The ongoing objective is to attain excellence in both research and education, constantly striving to interweave research and life science skill sets into the curriculum at every conceivable juncture. The academic programs maintain a rigorous curriculum that prioritizes the development of students' problem-solving abilities, critical and lateral thinking, and communication skills—preparing them not only for employment but also for personal growth and development.

SLS extends a warm welcome to students from every corner of the world, who are eager to embark on a journey of knowledge acquisition and practical application in the realm of life sciences. The famous words of Victor Hugo, "An invasion of armies can be resisted, but not an idea whose time has come," resonate deeply with the spirit of SLS—a place where groundbreaking ideas and innovations in life sciences find their fertile ground.

The strategic plan of the institute is encapsulated in the acronym "JEEVAM," which stands for Jubilate Life Science Education and Research by Empowering Value-based Accomplishments through Mentorship. This plan reflects the commitment of SLS to celebrate and advance the fields of life sciences through education, research, and mentorship.

In our forthcoming energy audit report, we will explore the energy consumption patterns and sustainability initiatives within the School of Life Sciences. Our goal is to assess the institution's dedication to optimizing energy utilization while maintaining its exceptional standards in multidisciplinary life sciences education and groundbreaking research. This report will provide a comprehensive assessment of the School's energy management strategies, current energy consumption, and recommendations for energy efficiency improvements. Our findings will align with SLS's commitment to excellence in life sciences and its broader mission of advancing knowledge and fostering sustainability in the field.

JSS COLLEGE OF PHARMACY, OOTY

Introduction:

Established in 1980 with its pioneering D.Pharm. program, JSS College of Pharmacy, Ooty, has emerged as a cornerstone of pharmaceutical education and research. This institution is a constituent college of the prestigious Jagadguru Sri Shivarathreeswara University (JSS University), Mysuru, since 2008, and it has firmly established itself as a premier postgraduate and research institution. JSS College of Pharmacy, Ooty, offers a comprehensive range of programs, including D.Pharm., B.Pharm., M.Pharm. (with 10 specializations), Pharm.D., and PhD. The institution also provides "Add-On" PG Diploma and Certificate courses, enriching students' knowledge in interdisciplinary subjects.

Renowned for its commitment to academic excellence, JSS College of Pharmacy, Ooty, has earned accolades from prestigious accrediting bodies. The institution and the JSS Academy of Higher Education & Research (JSS AHER) hold the distinguished `A+` Grade accreditation from the National Assessment and Accreditation Council (NAAC). The B.Pharm. Program at the college is accredited by the National Board of Accreditation (NBA), New Delhi, and its Pharm.D. Program is internationally certified by the Accreditation Council for Pharmacy Education (ACPE), USA—the first in the Asia Pacific Region to achieve this honour. The Drug Testing Laboratory at the institution is accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL). Additionally, both the college and CADRAT (Centre for Advanced Drug Research, Analysis, and Training) hold ISO 9001:2015 certifications for their quality management systems.

JSS College of Pharmacy, Ooty, has also made its mark in national rankings, securing the 8th position in India according to the National Institutional Ranking Framework (NIRF) for the year 2019.

With a core belief in 'Team Play,' the institution emphasizes collaboration over competition, resulting in a multitude of national and international Memorandums of Understanding (MoUs). These agreements foster teaching, learning, research, and knowledge exchange through faculty and student interactions, consultancy services, training programs, and more.

JSS College of Pharmacy, Ooty, boasts a distinguished legacy of advancing pharmaceutical education, practice, and research. It stands as a beacon for pharmacy professionals, shaping their capabilities to align with international standards and meet the ever-evolving requirements of the pharmaceutical industry.

In our forthcoming energy audit report, we will delve into the energy consumption patterns and sustainability initiatives at JSS College of Pharmacy, Ooty, analyzing the institution's commitment to optimizing energy utilization while maintaining its exceptional standards of pharmaceutical education, research, and healthcare practices. This report will provide a comprehensive assessment of the college's energy management strategies, current energy consumption, and recommendations for energy efficiency improvements. Our findings will align with JSS College of Pharmacy, Ooty's mission of advancing pharmaceutical education and research while contributing to its sustainability goals.

DEPARTMENT OF HEALTH SYSTEM MANAGEMENT STUDIES, JSS ACADEMY OF HIGHER EDUCATION & RESEARCH

Introduction:

The Department of Health System Management Studies at JSS Academy of Higher Education & Research (JSS AHER) has been at the forefront of healthcare management education and research since its establishment in 2012. Under the benevolent guidance of His Holiness Shri Shivarathri Deshikendra Mahaswamiji, the revered Chancellor of JSS AHER, this department has evolved into a hub of excellence dedicated to nurturing future healthcare administrators.

Within its modern infrastructure, the department offers a diverse array of academic programs, including MBA in Hospital Administration, MBA in Pharmacy Administration, and BBA in Hospital & Health System Management. These programs are designed to equip students with the skills and knowledge required to excel in the dynamic healthcare industry.

Our well-equipped classrooms, enriched with modern audiovisual aids, facilitate an interactive and immersive learning experience. Our unique teaching approach, with a blend of classroom interaction and integrated practical work, enables students to grasp the nuances of Hospital Management effectively. Practical work involves data collection, analysis, and interpretation, contributing to continuous improvement in healthcare systems.

Our libraries, both central and departmental, are equipped with Wi-Fi connectivity and house a vast collection of Management and Hospital Administration books, complemented by subscriptions to national and international journals. The computer lab, also featuring Wi-Fi, provides access to over 50 computer systems, fostering research and practical learning.

The practical aspect of our programs is further enhanced through hospital training, where students gain real-world exposure to healthcare management at JSS Hospital and other healthcare institutions.

As part of our commitment to academic enrichment, we actively organize conferences, workshops, and seminars, encouraging students to participate in events hosted by other institutions. Collaborations with national and international organizations and institutes further enhance our academic and research endeavors, as well as faculty and student exchange programs.

In addition to academic pursuits, we offer a range of value-added programs, including hospital and industrial visits, soft skill courses, international tours, outbound programs, yoga and meditation sessions, stress management programs, and values and ethics education.

Our students also benefit from exclusive hostels with modern amenities, sports facilities, leisure spaces, and a multi-cuisine food court, creating a conducive learning environment.

The Department of Health System Management Studies at JSS AHER is committed to excellence in healthcare management education and research. In alignment with our commitment to sustainability, this Energy Audit Report will delve into our energy consumption patterns and initiatives. We aim to optimize energy utilization while maintaining our exceptional standards in healthcare management education, research, and practice. This report will provide a comprehensive assessment of our energy management strategies, current energy consumption, and recommendations for energy efficiency improvements. Our findings will align with our dedication to excellence and sustainability, contributing to our broader mission of advancing healthcare management on a global scale.

CHAPTER 2

INTRODUCTION TO ENERGY AUDIT

2.1 General

The JSS AHER, Mysuru entrusted the work of conducting a Detailed Audit to the JSS Consultants 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 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 equipment. 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

Fig 2: FLUKE 434-II POWER ANALYZER

2.3.2 Clamp Meter

Fig 3: Clamp Meter

CHAPTER 3

STUDY OF ENERGY CONSUMPTION PROFILE

Sources of Energy:

JSS Medical College, Dental College and School of Life Sciences, Mysuru uses Energy in the following forms:

3.1. Electricity from CESC

Electricity from Chamundeshwari Electricity Supply Corporation Limited, Mysuru. Medical College campus has two 500 kVA Transformers and Pharmacy college has one 250 kVA transformer.

Fig 4: Transformers installed for incoming supply in Medical College and Pharmacy College

Fig 5: Transformers installed for incoming supply at JSS College of Pharmacy, Ooty

3.2. Electricity from Grid connected Solar Power Plant (484 kW & 132 kW)

Fig 6: Shows Solar Panels installed at Left: Dental College, Right: Pharmacy College, Mysuru

3.3. 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 7: Diesel Generators (500 kVA & 380kVA) installed at the Medical College Campus

Fig 8: 160kVA Diesel Generator installed at the College of Pharmacy, Mysuru Campus

Fig 9: 250 kVA Diesel Generator installed at the Pharmacy, Ooty Campus

CHAPTER 4
STUDY OF ELECTRICAL SYSTEMS

4.1 Electrical Supply Details

The electrical supply to JSS AHER come from CESC, Mysuru at 11 kV.

Fig 10: Incoming Supply Bus-Bar installed in the campus, JSSCPM, JSSMC, JSSCPO

4.1.1 Tariff and electricity charges at Medical College Campus

The electric supply at JSS AHER is charged under HT-2C2of the Chamundeshwari Electricity Supply Corp Ltd (CESCOM) the tariff structure of HT-2C2 general is given in Table 5.

HT-2C2 Shall be given for Educational Institutions.

Table 5: Tariff structure- HT-2C2* (CESC Electricity Tariff 2021 Annexure V)

Fixed Charges	Rs.240 per kVA of billing demand/month.	
Energy Charges	For the first one lakh units	815 paisa per unit
	For the Balance units	855 paisa per unit
	Current Flat Rate* (Sept 2023)	850 paisa per unit

* Average kWh Charge used for calculation

4.2 Electrical Energy Cost Analysis of JSS Medical, Dental and Life Sciences Campus

4.2.1 CESC Consumption

The monthly energy consumption in kWh from CESC*, Mysuru for the past 12 months is shown in Table 6.

Table 6: Energy consumption in kWh from CESC in JSSAHER main campus

SL.	Month	Contract Demand in kVA	Metered Demand in kVA	Consumption from CESC (kWh)	Total Bill Paid to CESC* in Rs.
1	Jan 2022	450	226	77,675	6,75,788
2	Feb 2022	450	250	69,675	6,17,601
3	Mar 2022	450	277	97,850	9,06,315
4	Apr 2022	450	324	1,00,125	8,78,794
5	May 2022	450	317	99,325	9,38,762
6	June 2022	450	293	95,000	9,33,284
7	July 2022	450	296	91,550	9,30,024
8	Aug 2022	450	235	86,425	8,18,499
9	Sep 2022	450	288	84,750	9,03,907
10	Oct 2022	450	263	76,400	8,24,850
11	Nov 2022	450	277	84,400	9,00,594
12	Dec 2022	450	274	87,650	9,31,366
TOTAL				**10,50,825**	**1,02,59,784**

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

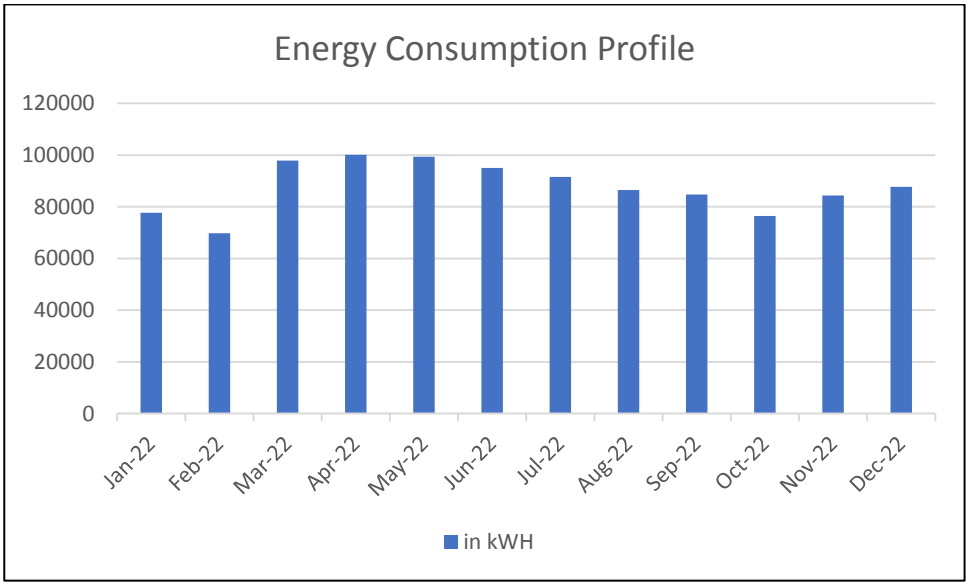


Fig 11: Energy Consumption profile from CESC in JSSAHER main campus

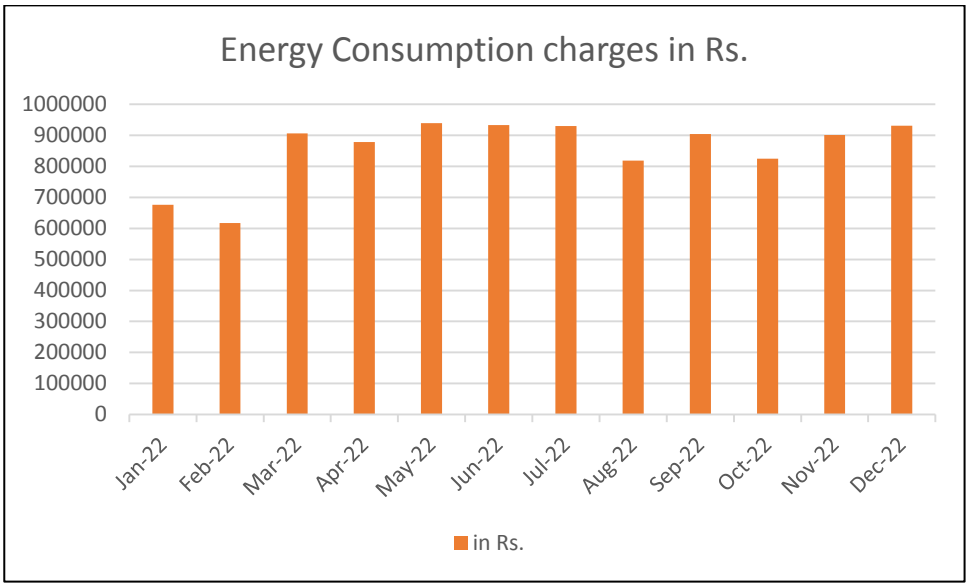


Fig 12: Energy Consumption charges from CESC in JSSAHER main campus

4.2.2 Roof Top 484kWp Solar Power Plant.

The monthly Bill paid to CLEANMAX IPP 1 PRIVATE LTD for installed **484kWp Roof Top solar Power Plant** at JSS AHER is shown in Table 7.

Table 7: Energy generation in kWh from Roof Top 484 kWp Solar Power Plant

SL.NO	MONTH	Generated unit	Rate per unit	Total amount (Rs) paid to seller
1.	Jan 2022	63,498	6.2	393,688
2.	Feb 2022	64,668	6.2	4,00,942
3.	Mar 2022	70,094	6.2	4,34,583
4.	Apr 2022	58,009	6.2	3,59,656
5.	May 2022	53,900	6.2	3,34,180
6.	June 2022	59,705	6.2	3,70,171
7.	July 2022	48,273	6.2	2,99,293
8.	Aug 2022	60,759	6.2	3,76,706
9.	Sep 2022	49,892	6.2	3,09,330
10.	Oct 2022	59,435	6.2	3,68,497
11.	Nov 2022	51,697	6.2	3,20,521
12.	Dec 2022	55,489	6.2	3,44,032
TOTAL		**6,95,419**		**43,11,599**

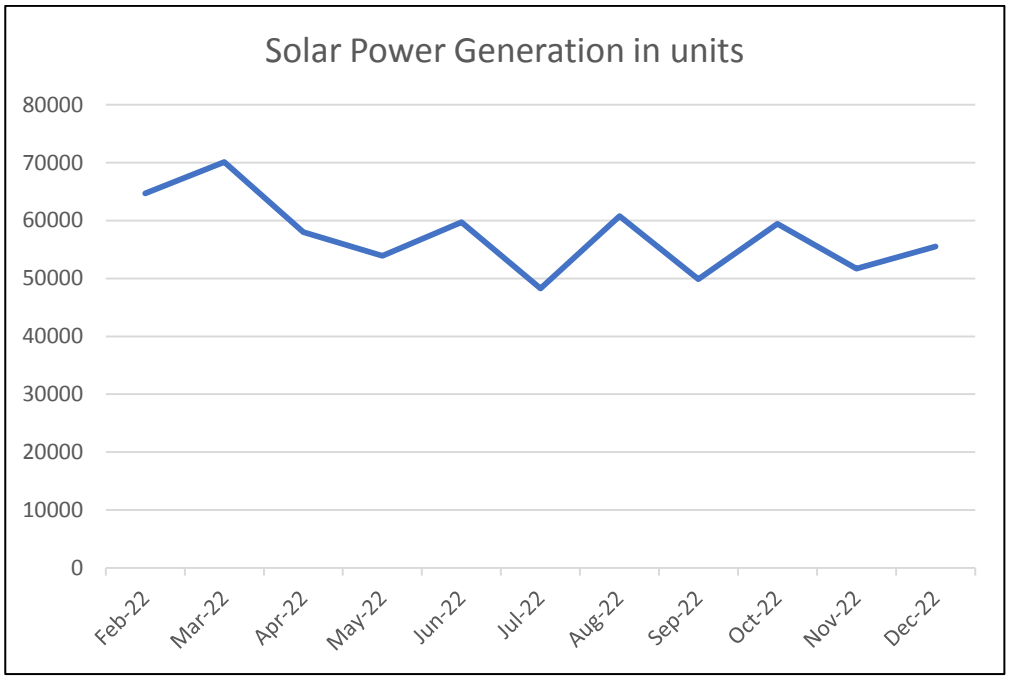


Fig 13: Energy generation profile from Solar in JSSAHER main campus

4.3 Electrical Energy Cost Analysis at Pharmacy College, Mysuru Campus

4.3.1 CESC Consumption

The monthly energy consumption in kWh from CESC*, Mysuru for the past 12 months is shown in Table 8.

Table 8: Energy consumption in kWh from CESC in Pharmacy College, Mysuru

SL.	Month	Contract Demand in kVA	Metered Demand in kVA	Consumption from CESC (kWh)	Total Bill Paid to CESC* in Rs.
1	July 2022	150	89	24,968	2,46,716
2	Aug 2022	150	93	24,750	2,39,505
3	Sep 2022	150	136	28,942	2,91,544
4	Oct 2022	150	125	24,555	2,31,469
5	Nov 2022	150	133	29,775	3,03,616
6	Dec 2022	150	95	24,795	2,48,867
7	Jan 2023	150	95	20,648	1,87,586
8	Feb 2023	150	121	23,258	2,28,843
9	Mar 2023	150	132	28,875	2,88,206
10	Apr 2023	150	155	29,205	2,74,879
11	May 2023	150	116	25,598	3,50,768
12	June 2023	150	133	23,063	2,52,941
TOTAL				**3,08,430**	**31,44,940**

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

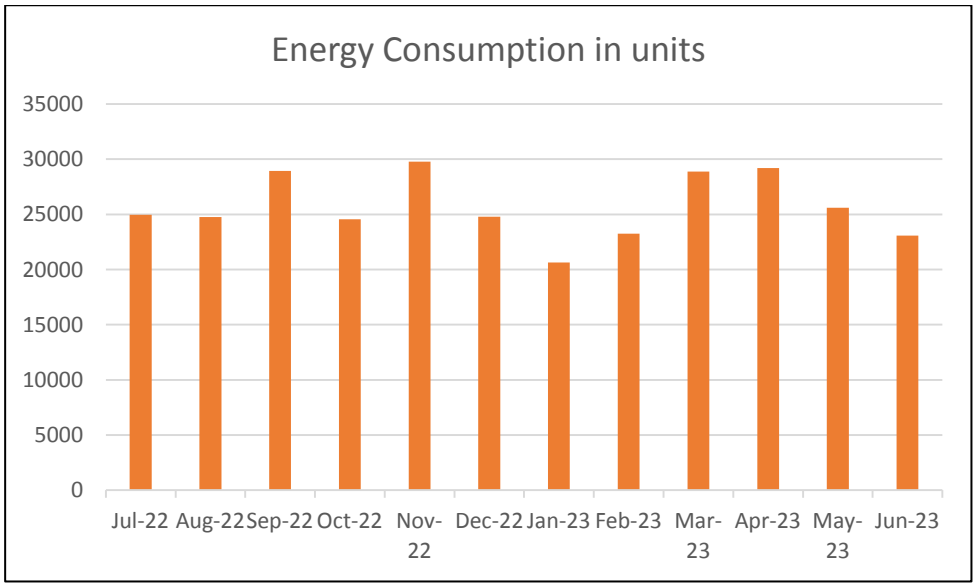


Fig 14: Energy Consumption profile from CESC in Pharmacy College, Mysuru

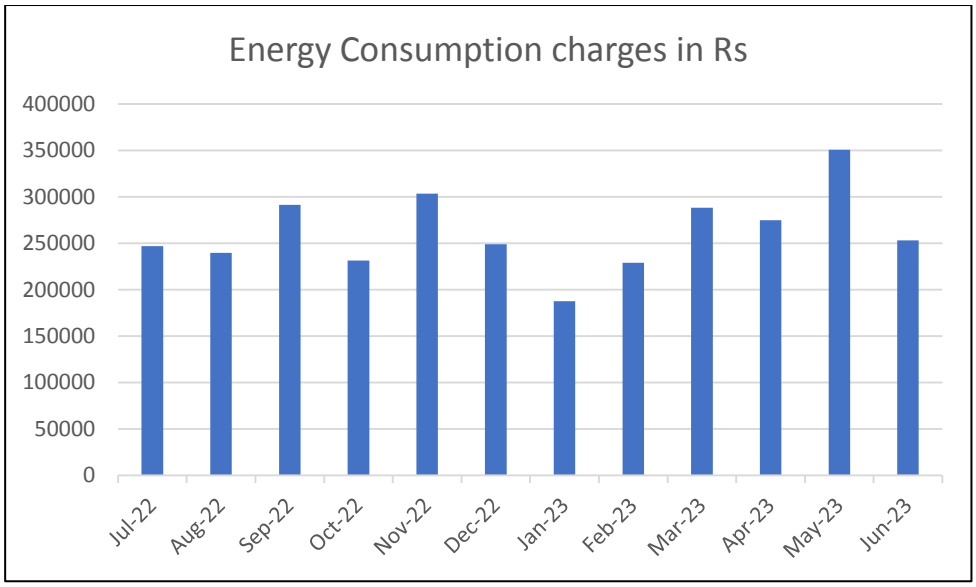


Fig 15: Energy Consumption charges from CESC in Pharmacy College, Mysuru

4.3.2 Roof Top 132 kWp Solar Power Plant.

The monthly Bill paid to CLEANMAX IPP 1 PRIVATE LTD for installed **132kWp Roof Top solar Power Plant** at JSS PCM is shown in Table 9.

Table 9: Energy generation in kWh from Roof Top 132 kWp Solar Power Plant

SL.NO	MONTH	Generated unit	Rate per unit (Rs)	Total amount (Rs) paid to seller
1.	Apr 2022	17,351	6.2	1,07,576
2.	May 2022	14,713	6.2	91,221
3.	June 2022	15,710	6.2	97,402
4.	July 2022	12,502	6.2	77,512
5.	Aug 2022	15,936	6.2	98,803
6.	Sep 2022	13,300	6.2	82,460
7.	Oct 2022	16,065	6.2	99,603
8.	Nov 2022	13,593	6.2	84,277
9.	Dec 2022	14,553	6.2	90,229
10.	Jan 2023	19,381	6.2	1,20,162
11.	Feb 2023	18,356	6.2	1,13,807
12.	Mar 2023	19,628	6.2	1,21,694
TOTAL		**1,91,088**		**11,84,746**

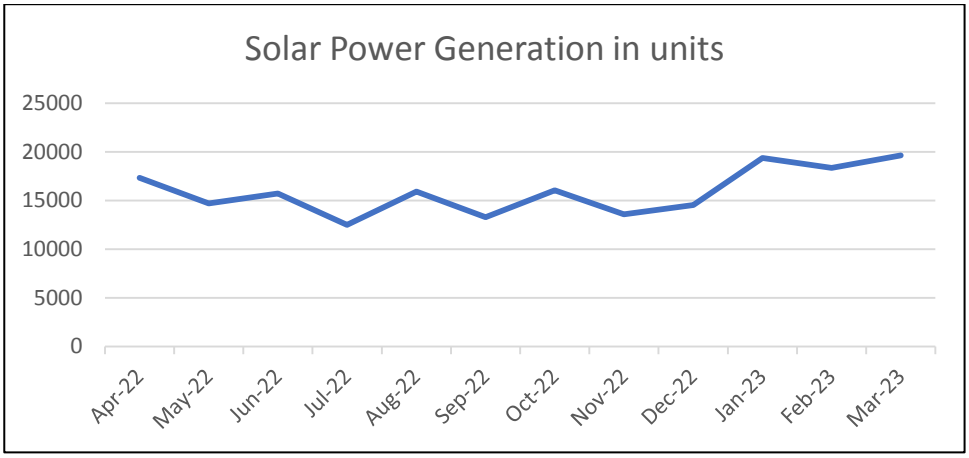


Fig 16: Energy generation profile from Solar in Pharmacy College, Mysuru

4.4 Electrical Supply Details of JSS College of Pharmacy (JSS CPO), Ooty

The electrical supply to JSS College of Pharmacy (JSS CPO), Ooty, Nilgiris supply at 11kV.

4.4.1 Tariff and electricity charges

The electric supply at JSS College of Pharmacy, Ooty has the tariff structure as given in Table 10.

Table 10: Tariff structure- TG&DC, Ooty

Industrial Consumption*	Rs.7.5 /unit
Peak Hour consumption	Rs. 1.27/unit
Night Hour consumption (rebate)	Rs. 0.3175/unit
Demand Charges	Rs. 350 per kVA
Average kWh Charge used for calculation	Rs. 8.5 /unit

*indicates Present Tariff structure

4.5 Energy Cost Analysis of JSS College of Pharmacy (JSS CPO), Ooty

4.5.1 TG&DC Consumption

The monthly energy consumption in kWh from **TG&DC**, Ooty for the past 12 months is shown in Table 11.

Table 11: Energy consumption in kWh from TG&DC in Pharmacy College, Ooty

SL.	Month	Contract Demand in kVA	Metered Demand in kVA	Consumption from TG&DC (kWh)	Total Bill Paid to TG&DC * in Rs.
1	July 2022	150	135	46,740	3,63,597
2	Aug 2022	150	135	46,220	3,60,883
3	Sep 2022	150	135	48,204	4,56,360
4	Oct 2022	150	135	44,297	4,61,369
5	Nov 2022	150	135	50,666	5,16,227
6	Dec 2022	150	135	49,458	5,05,091
7	Jan 2023	150	135	49,570	5,05,423
8	Feb 2023	150	135	46,646	4,82,023
9	Mar 2023	150	135	50,578	5,15,840
10	Apr 2023	150	135	45,472	4,70,851
11	May 2023	150	135	42,809	4,49,536
12	June 2023	150	135	36,424	3,92,749
TOTAL				**5,57,084**	**54,79,949**

* data extracted from electricity bills

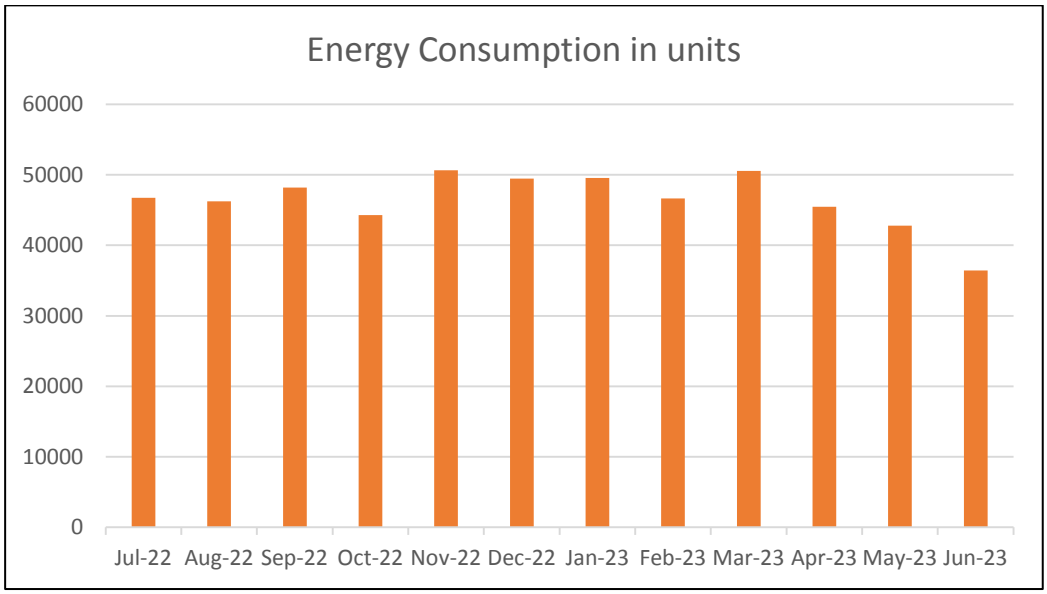


Fig 17: Energy Consumption profile from TG&DC in Pharmacy College, Ooty

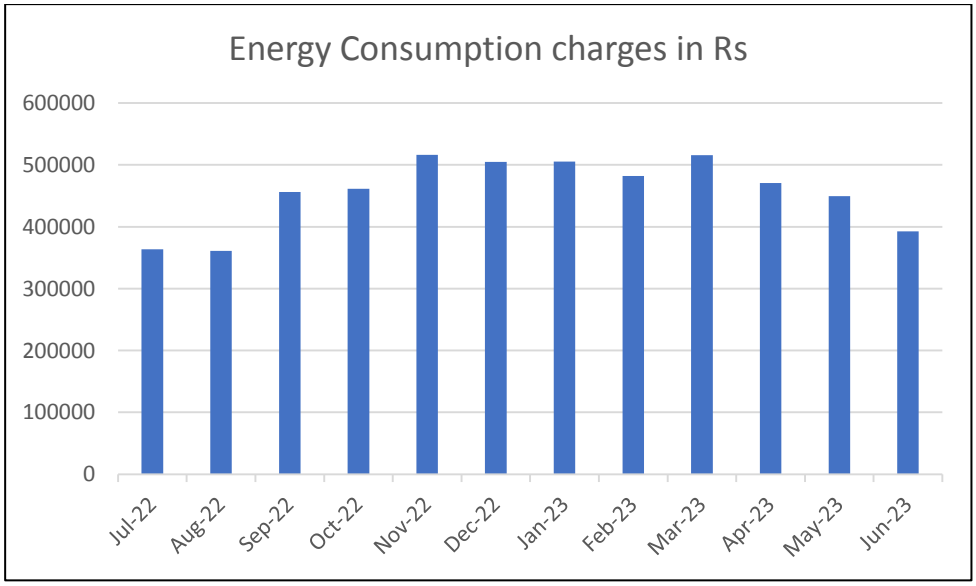


Fig 18: Energy Consumption charges from TG&DC in Pharmacy College, Ooty

4.5.2 Electrical Energy Cost Analysis at DHSMS, Ramanuja Road, Mysuru Campus

4.5.3 CESC Consumption

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

Table 12: Energy consumption in kWh from CESC in DHSMS, Mysuru

SL.	Month	Consumption from CESC (k195Wh)	Total Bill Paid in Rs.
1	July 2022	7,330	58,640
2	Aug 2022	7,260	58,080
3	Sep 2022	7,330	58,640
4	Oct 2022	7,620	60,960
5	Nov 2022	7,300	58,400
6	Dec 2022	6,870	54,960
7	Jan 2023	7,400	59,200
8	Feb 2023	7,810	62,480
9	Mar 2023	12,060	96,480
10	Apr 2023	13,560	1,08,480
11	May 2023	8,640	69,120
12	June 2023	11,220	1,12,200*
Total		**1,04,400**	**8,57,640**

* Rs. 10/kWh used for calculation for this facility as per June month bill

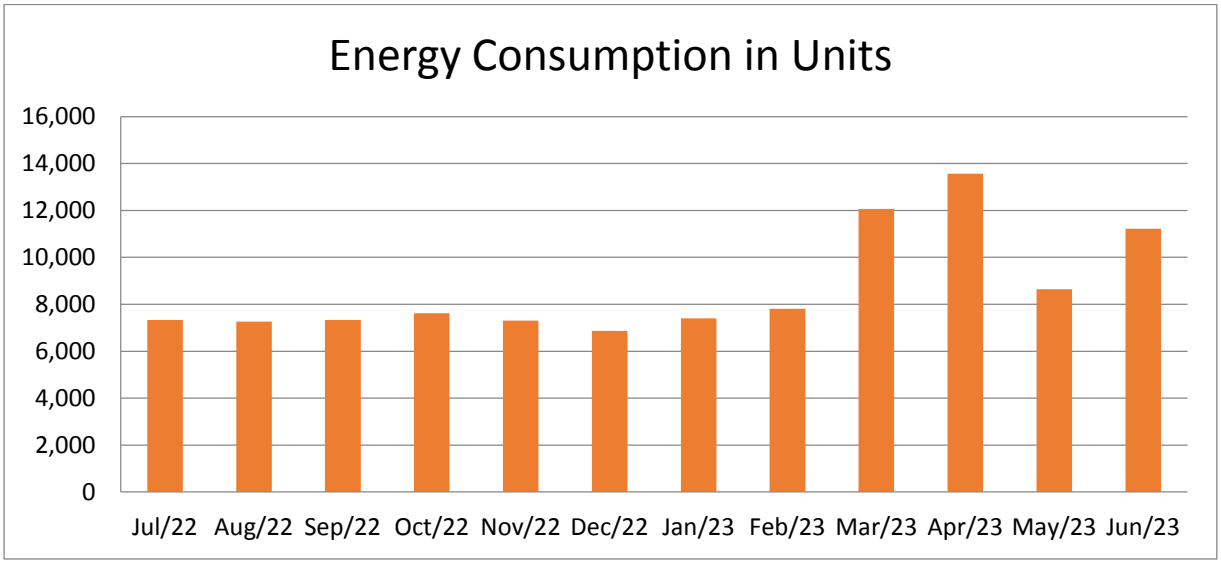


Fig 19: Energy Consumption profile from CESC in DHSMS, Mysuru

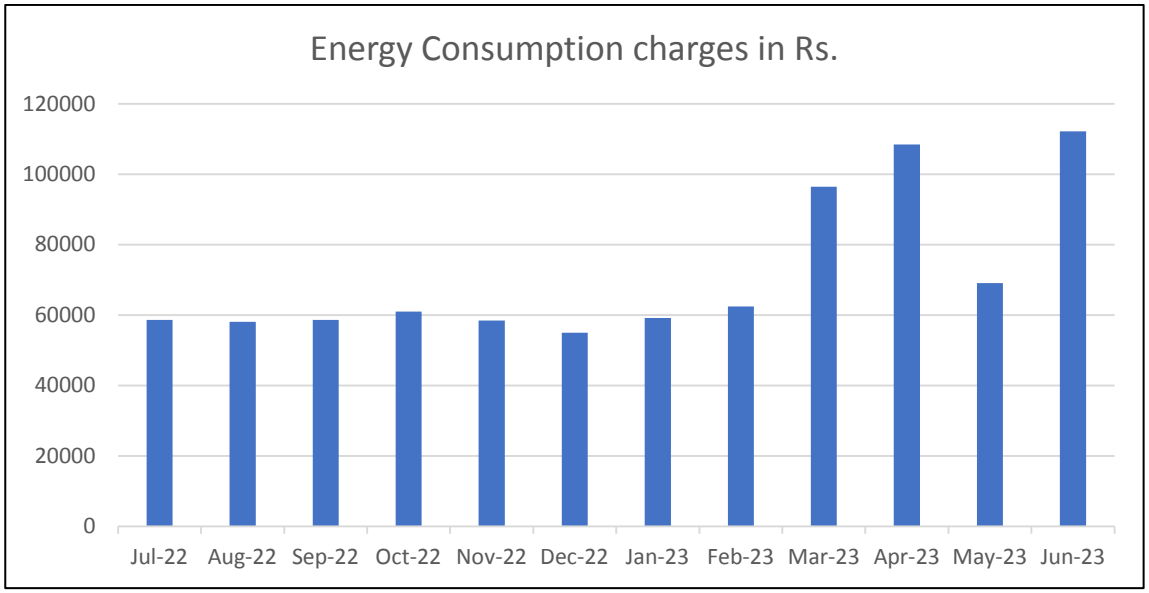


Fig 20: Energy Consumption charges from CESC in DHSMS, Mysuru

CHAPTER 5

CONNECTED LOAD AND ITS ANALYSIS

5.1 Load Pattern of AHER Campuses

*This is total load consumption considered approximately. Actual load consumption might be different according to actual use of power for particular time period. 1hp = 735.5W

Table 13: CONNECTED LOAD DETAILS at Medical College Campus

Sl No.	Name of the appliance	Power Rating (Watts)	Quantity	Power Consumption (Watts)	Usage per day (Hr)	Power Consumption/ day (Watts)
A	B	C	D	E=C*D	F	G=E*F
Computer and Equipment Microbiology						
1	Incubator	600	7	4200	24	100800
2	Co2 Incubator	1000	2	2000	24	48000
3	Bact/Alert 3d Blood Culture System	2000	2	4000	24	96000
4	Vitek -2 Compact	1000	2	2000	24	48000
5	Biosafety Cabinet Class 2	1000	4	4000	4	16000
6	Autoclave	6000	3	18000	4	72000
7	Centrifuge	350	2	700	12	8400
8	Bod Incubator	1000	1	1000	24	24000
9	Waterbath	270	1	270	4	1080
10	Laminar Airflow	1000	1	1000	4	4000
11	-80 Deep Freezer	260	1	260	24	6240
12	Microplate Washer	300	1	300	4	1200
13	Micro Plate Reader	300	1	300	4	1200
14	Abbott I 1000sr	1700	1	1700	24	40800
15	Vitros Immunodiagnostics System	1000	1	1000	24	24000
16	Hot Air Oven	1800	2	3600	4	14400
17	Digital Weighing Balance	80	1	80	4	320
18	VDRL shaker	500	1	500	8	4000

19	-20 deep freezer	80	1	80	24	1920
20	Walk in cold room	1000	1	1000	24	24000
21	MiniVidas	100	1	100	24	2400
22	CFX96DX REAL TIME PCR machine	850	1	850	6	5100
23	Cepheid GeneXpert Systems	500	1	500	6	3000
24	Immunofluorescence Microscope	500	1	500	6	3000
25	Micro centrifuge	1000	2	2000	4	8000
Computer and Equipment Pathology						
1	Hot Plate	3000	1	3000	8	24000
2	Cytospin 4	150	1	150	0.5	75
3	Centrifuge	500	1	500	8	4000
4	Lab Centrifuge	500	1	500	8	4000
5	Centrifuge	300	2	600	8	4800
6	Roche Binocular U 601 Urine Analyser	500	1	500	12	6000
7	6 Part Sysmex Xn-1000	270	2	540	8	4320
8	6 Part Cell Counter Mindray	500	2	1000	12	12000
9	T Coag Destiny Plus (Automated)	300	1	300	12	3600
10	Centrifuge	368	1	368	0.5	184
11	Remi Laboratory Refrigerator	2000	1	2000	24	48000
12	Refrigerator Reagent	1500	1	1500	2	3000
13	Hot Air Oven	1000	1	1000	24	24000
14	Ortho workstation	150	1	150	0.5	75
15	Centrifuge	322	1	322	12	3864
16	Refrigerator Samsung	1000	1	1000	24	24000

17	Leica Fullt Automatic Microtome	350	1	350	3	1050
18	Leica Paraffin Cold plate	1000	1	1000	3	3000
19	Leica Immuno Stainer	1000	1	1000	4	4000
20	Histokinette Thermoscienctific	2000	1	2000	16	32000
21	Auto stainer	300	1	300	5	1500
22	Grossing station	1500	1	1500	3	4500
23	Olympus CX43 Microscope Penra head	100	1	100	1	100
24	Olymus BX53F2 Microscope Deca Head	100	1	100	1	100
25	Research Microscope Polarizer	100	1	100	0.5	50
26	WIIS Digital Scanner Morphle (Slide scanner)	300	1	300	0.5	150
27	Digital PH Meter	250	1	250	1	250
28	Incubator	250	1	250	2	500
29	VOC/ Formaldehyde monitor table top	100	1	100	24	2400
30	Electronic Weighing Machine	500	1	500	0.5	250
31	Tissue Flotation bath	500	2	1000	3	3000
32	Hot plate	3000	1	3000	5	15000
33	Ultr Low Freezer- REMI (-80 Degrees)	2000	1	2000	24	48000
34	Leica Fully- SEMI Automatic Microtome	350	1	350	2	700
35	Cryostat Leica	1500	1	1500	24	36000
36	Leica Cryostat	1500	1	1500	24	36000
37	Tissue Processor Leica	1650	1	1650	18	29700

38	Paraffin embedding station-Leica (Hot plate embedder)	2500	1	2500	3	7500
39	Paraffin embedding station-Leica (Coldplate embedder)	1000	1	1000	3	3000
Computer and Equipment Biochemistry						
1	Microplate reader	50	1	50	3	150
2	-80ºC Deep freezer	300	2	600	24	14400
3	Liquid nitrogen tank	300	3	900	-	
4	Gentle Tissue Dissociator	300	1	300	1	300
5	Magnetic assorted cell sorter	250	1	250	1	250
6	Refrigerated centrifuge	300	1	300	5	1500
7	-40ºC deep freezer	300	1	300	24	7200
8	Biosafety cabinet	200	1	200	4	800
9	CO2 incubator	300	1	300	24	7200
10	Water Bath	1000	2	2000	5	10000
11	Weighing balance	500	1	500	2	1000
12	Thermocycler	1000	1	1000	6	6000
13	Electrophoretic unit	80	1	80	4	320
14	Ice flake Machine	550	1	550	6	3300
15	Microcentrifuge	20	1	20	3	60
16	Vortex Mixer	24	2	48	3	144
17	Gel documentation system	50	1	50	2	100
18	Inverted Microscope	50	1	50	1	50
19	Nanodrop	45	1	45	2	90
20	Delfia Multilable counter	30	1	30	4	120
21	Magnetic stirrer	550	1	550	2	1100
22	pH meter	5	2	10	1	10
23	Fluorescent microscope	200	1	200	1	200
24	Refrigerated centrifuge	110	1	110	4	440

25	Shaker incubator	50	1	50	6	300
26	Western blot unit	200	2	400	5	2000
27	Hot air oven	1500	2	3000	3	9000
28	Incubator	100	1	100	3	300
29	Autoclave	1500	1	1500	2	3000
30	Gel Electrophoresis Unit(100well)	80	1	80	6	480
31	Microwave Oven	800	1	800	2	1600
32	Heat Block LED Digital Dry bath	800	1	800	5	4000
33	4º Refrigerator	500	1	500	24	12000
34	Binocular research Phase contrast Microscope	20	2	40	2	80
35	Binocular research Stereo zoom Microscope	20	3	60	2	120
36	Slide Hybridisation System	50	1	50	1	50
37	Photoelectric Colorimeter	50	1	50	1	50
38	Vortex Mixer	24	1	24	2	48
39	Cooling Centifuge	200	1	200	3	600
40	Electrophoresis	200	1	200	5	1000
41	-20 freezer	520	1	520	24	12480
42	Slide Warming table	200	1	200	2	400
43	Chem doc Imaging System	120	1	120	1	120
44	-25ºC deep freezer	520	1	520	24	12480
45	Cold Centrifuge Neuation	200	1	200	3	600
JSS MEDICAL COLLEGE						
1	CFL	18	57	1026	4	4104
2	LED 4 feet tube light	20	1604	32080	6	192480
3	LED 2 feet tube light	10	724	7240	4	28960
4	LED surface/down light	15	906	13590	5	67950
5	LED Bulb	9	249	2241	6	13446

6	FAN	50	1684	84200	6	505200
7	ordinary Tube light fitting	36	1250	45000	6	270000
8	Led fancy light	20	40	800	1	800
9	Geyser	2000	1	2000	0.5	1000
10	Street light	50	105	5250	12	63000
JSS MEDICAL COLLEGE(AC DETAILS)						
Sl no	Department	Capacity in TR	Power used in (watts)	Power used in (KW)	Usager per day (hours)	Average KWH per day
1	Medical College(AC)	225.5	789250	789.25	3	2367.75
2	Animal House(AC)	23.2	81200	81.2	3	243.6
JSS MEDICAL COLLEGE(LIFT DETAILS)						
Sl no	Location	Capacity	Stop's	Power (KW)	Usager per day (hours)	Average KWH per day
1	JSSMC - 1	13 Passenger	G+3	15	6	90
2	JSSMC - 2	13 Passenger	G+3	6.3	6	37.8
3	Girls hostel 'D' Block - 1	13 Passenger	G+7	6.3	7	44.1
4	Girls hostel 'D' Block - 2	8 Passenger	G+7	3.9	7	27.3

Table 14: CONNECTED LOAD DETAILS at Dental College:

Sl No.	Name of the appliance	Power Rating (Watt)	Quantity	Power Consumption (Watt)	Usage per day (Hr)	Power Consumption/day (Watt)
A	**B**	**C**	**D**	**E=C*D**	**F**	**G=E*F**
HVAC						
1	AUTOCLAVE	2000	40	80000	2	160000
2	COOKER TYPE	2000	5	10000	2	20000

	AUTOCLAVE					
3	REFRIGERATOR	2000	9	18000	24	432000
4	DENTAL CHAIR	2000	336	672000	6	4032000
5	OPG DIGITAL	630	1	630	6	3780
6	CBCT IMAGING	2500	1	2500	6	15000
7	SCALER	20	25	500	2	1000
8	X RAY IOPAR	7500	13	97500	5	487500
9	SPOT WELDER	8500	4	34000	1	34000
10	MODEL TRIMMER	500	10	5000	3	15000
11	PHYSIO DISPENSER	500	2	1000	2	2000
12	FURNACE	400	2	800	4	3200
13	LIGHT CURE	80	10	800	2	1600
14	UPS6 KV	6000	1	6000	6	36000
15	UPS 5 KV	5000	3	15000	6	90000
16	UPS 700 VA	7000	35	245000	6	1470000
17	UPS KV 3	3000	2	6000	6	36000
18	GEYSER 2KV	2000	2	4000	2	8000
19	AUDIO SYSTEM	1000	4	4000	1	4000
20	TV LED	150	13	1950	3	5850
21	LIFT	6500	1	6500	7	45500
LIGHTINING						
1	TUBE LIGHT REGULAR	40	254	10160	5	50800
2	LED 20W TUBE LIGHT	20	294	5880	5	29400
3	FANS CEILING	80	552	44160	5	220800
4	FANS WALL MOUNT	80	10	800	5	4000
5	AIR	2300	21	48300	5	241500

	CONDITIONER					
6	EXACUST FAN	60	20	1200	1	1200
7	FOCUS LIGHT	100	4	400	1	400
8	CCTV	10	12	120	7	840
9	FAX MACHINE	30	2	60	2	120
COMPUTER AND ITS EQUIPMENT						
1	DESK TOP COMPUTERS	200	65	13000	6	78000
2	LAP TOPS	200	12	2400	5	12000
3	LCD PROJECTORS	280	15	4200	2	8400
4	PRINTER	40	20	800	2	1600
5	LAN MAIN POINTS	40	15	600	6	3600
KITCHEN and APPLIANCES						
1	ELECTRIC STOVE	3000	5	15000	1	15000
2	OVEN	3000	2	6000	1	6000
3	WATER PURIFIER	60	4	240	6	1440
OTHER EQUIPMENT						
1	COMPRESSOR 25 HP	18000	2	36000	7	252000
2	COMPRESSOR 7.5HP	5000	1	5000	7	35000
3	COMPRESSOR 5HP	3700	2	7400	7	51800
4	OXYGEN ROOM WITH COMPRESSOR	3700	1	3700	4	14800

Table 15: CONNECTED LOAD DETAILS at Pharmacy College, Mysuru:

Sl No	Name of the appliance	Power Rating (Watts)	Quantity	Power Consumption (Watts)	Usage per day (Hr)	Power Consumption/day (Watts)
A	B	C	D	E=C*D	F	G=E*F
Department of Pharmaceutics						
Computer and equipment						
1	Hot air oven	2000	06	12000	1	12000
2	Orbital shaking incubator	500	01	500	2	1000
3	Dissolution apparatus	100	02	200	1	200
4	Refrigerator	500	06	3000	24	72000
5	UV-1800	400	01	400	1	400
Kitchen and appliances						
6	Hardness tester	250	01	250	1	250
7	DST -SERBZETA	250	01	250	1	250
8	Shimadju, UFLC	100	01	100	3	300
9	Direct-Q	250	01	250	24	6000
Other equipments						
10	Rimek(minipress)	200	01	200	1	200
11	Tablet counter	100	01	100	1	100
12	Ezee blist	100	01	100	1	100
13	Pharmaceutical Surgical equipments	100	01	100	1	100
Pharmaceutical Chemistry						
Lighting						
7	Led Tube	20	388	7760	06	46560
8	Florescent tube	26	240	6240	05	31200
9	Street light	50	44	2200	10	22000
10	LED	35	256	8960	03	26880

11	LED	30	58	1740	10	17400
Computer and equipments						
12	Spectrophotometer	100	03	300	01	300
13	pH meter	50	02	100	01	100
14	Electrophoresis	50	01	50	00	0
15	Melting point APP	200	01	200	00	0
16	Conductivity meter	50	02	100	00	0
17	UFLC	200	01	200	06	1200
18	HPLC	200	03	600	06	3600
19	Moisture balance	250	01	250	00	0
20	Photofluorometer	100	02	200	01	200
Kitchen and appliances						
21	Fridge	500	04	2000	24	48000
Other equipments						
22	Nephlophotometer	500	01	500	01	500
23	UV visible photometer	500	01	500	02	1000
24	Hot air oven	1500	01	1500	04	6000
25	Deep freezer	500	01	500	24	12000
26	Fuming cupboard	250	04	1000	02	2000
27	Computer	250	203	50750	06	304500
28	Xerox machine	1500	01	1500	06	9000
Department of Pharmacology						
1	UV spectrophotometer	500	01	500	0.5	250
2	Cooling centrifuge	1500	01	1500	1	1500
3	ICE flaker	500	01	500	4	2000
4	Tissue homogenizer	250	01	250	0.5	125
5	Hot air oven	1500	01	1500	24	36000
Kitchen and appliances						
6	Deep freezer	500	01	500	24	12000

7	Cell frost	250	01	250	24	6000
8	Vest frost	250	01	250	24	6000
9	Refrigerator	500	01	500	24	12000
Department of Pharmacognosy						
1	LG Refrigerator	500	01	500	24	12000
2	Hot air oven	1500	01	1500	0.5	750
3	UV-visible spectrophotometer	500	01	500	0.25	125
4	FLASH chromatography	200	01	200	1	200
5	Serological water both	500	01	500	3	1500
Kitchen and appliances						
6	Muffle Furnace	1000	01	1000	3	3000
7	Hot air oven	1500	01	1500	1	1500
8	Rotary evaporator	1500	01	1500	1	1500
Other equipments						
9	Hematology analyzer	500	01	500	01	500
10	Centrifuge	1500	01	1500	01	1500
11	Vacuum oven	1500	01	1500	01	1500
12	Vacuum pump	1000	01	1000	01	1000

Table 16: CONNECTED LOAD DETAILS at School of Life Sciences, Mysuru

Sl No.	**Name of the appliance**	**Power Rating (Watt)**	**Quantity**	**Power Consumption (Watt)**	**Usage per day (Hr)**	**Power Consumption/day (Watt)**
A	**B**	**C**	**D**	**E=C*D**	**F**	**G=E*F**
HVAC						
1	AC	2500	19	47500	24	1140000

2	Exhaust fans	55	3	165	8	1320
3	Ceiling Fan	20	209	4180	6	25080
LIGHTINING						
1	Ceiling Light	40	455	18200	7	127400
COMPUTER AND EQUIPMENT						
1	DESK TOP COMPUTERS	200	84	16800	6	100800
KITCHEN AND APPLIANCES						
1	Induction Stove	1700	2	3400	As an when required	
2	Microwave Oven OTG (small)	2000	1	2000	0.3	600
3	Blender	500	1	500	0.3	150
4	Toaster	1000	1	1000	0.3	300
5	Mini Grinder	350	1	350	0.3	105
6	Mixer	750	1	750	0.3	225
7	Electrical Beater	350	1	350	0.5	175
8	Electical weighing balance	30	1	30	0.5	15
9	Dryer	200	1	200	0.3	60
10	Juicer	200	1	200	0.5	100
11	Inbuilt cooking stove and oven toaster griller	4000	8	32000	1	32000
12	Eleactrical Steamer	300	1	300	24	7200
OTHER EQUIPMENT						
1	Atc Probe	2.5	1	2.5	1	2.5
2	Autoclave	5000	4	20000	2	40000

3	Bacteriological incubator	1000	4	4000	24	96000
4	Biorad Themal cycler	700	1	700	4	2800
5	BOD Incubator	1000	2	2000	24	48000
6	Body Compostion Analyser	200	1	200	0.5	100
7	Centrifuge	150	7	1050	1	1050
8	CO2 Incubator	1000	1	1000	24	24000
9	COD Digester	750	1	750	3	2250
10	Colony counter	50	3	150	2	300
11	Colorimeter	50	16	800	1	800
12	Compund Microscope	55	10	550	0.5	275
13	Conductivity Meter	200	1	200	1	200
14	Cooling Centrifuge	710	2	1420	4	5680
15	Cryostat Microtome	1000	1	1000	3	3000
16	Cyclo Mixer {CM - 101}	58	1	58	0.5	29
17	Deep Freezer	1300	2	2600	24	62400
18	Digital Flocculator (Jar Test Apparatus)	50	1	50	1	50
19	Digital Photo Electric Colorimeter	20	3	60	0.6	36
20	Digital rotary evaporator	1400	1	1400	3	4200
21	Distillation Unit	1000	2	2000	8	16000

22	Double Distillation Unit	1500	2	3000	24	72000
23	Dry bath	85	1	85	0.5	42.5
24	Equiptronics Dual Channel potentiometer	10	1	10	1	10
25	Electronic Balance	10	1	10	1	10
26	Electrophoresis unit (Horizontal)	80	2	160	6	960
27	Electrophoresis unit (Vertical)	80	2	160	6	960
28	Electrospinning	20	1	20	6	120
29	ELISA reader	75	1	75	6	450
30	ESPIN-Nano High voltage	20	1	20	1	20
31	Flame Photometer	20	1	20	3	60
32	Fridge	750	4	3000	24	72000
33	Gel shaker	15	1	15	6	90
34	GM Counting System	100	1	100	1	100
35	Horizontal Laminar air flow	450	1	450	1	450
36	Hot Air Oven	1750	8	14000	3	42000
37	Hot Plate	1200	1	1200	1	1200
38	IC Checker	150	2	300	2	600
39	Ice flaker	200	1	200	2	400
40	Incubator	250	6	1500	24	36000
41	Inverted microscope	50	2	100	0.5	50
42	KEL PLUS Automatic	400	1	400	2	800

	Distillation System					
43	KEL PLUS Automatic Nitrogen/Protein Estimation System	220	1	220	1	220
44	KjeldLal Operating System	250	1	250	2	500
45	Biosafety cabinet	100	1	100	8	800
46	LABQUEST Borosil HME500-Mantel heater	100	1	100	3	300
47	Laminar Air Flow	200	5	1000	1.5	1500
48	Magnetic Stirrer	200	13	2600	0.5	1300
49	Melting and Boiling point apparatus	120	2	240	4	960
50	MICROPLATE SPECTROMETER-Elisa Reader	75	1	75	0.5	37.5
51	Microscope	200	23	4600	0.5	2300
52	Microwave	1200	2	2400	4	9600
53	Minispin Centrifuge	70	1	70	0.5	35
54	Muffle Furnace	3000	2	6000	24	144000
55	Orbital Shaking Incubator	1000	1	1000	24	24000
56	Oscilloscope	150	2	300	2	600
57	Oven	1000	1	1000	0.5	500
58	pH meter	2.5	15	37.5	0.5	18.75
59	Photoelectric Colorimeter	20	1	20	2	40

60	Plant Growth Chamber	2750	1	2750	24	66000
61	Precice Weighing Balance	10	4	40	0.5	20
62	Probe sonicator	150	1	150	2	300
63	projector (Hitachi)	250	1	250	2	500
64	Radiation Counting System	1000	1	1000	1	1000
65	Refrigerator	350	7	2450	24	58800
66	Resisistance Box	100	2	200	2	400
67	Ring Water Bath	1500	1	1500	1	1500
68	Rotor Heads (Model : R-244M)	3000	1	3000	2	6000
69	Rotor Heads (Model : R-247M)	4000	1	4000	1	4000
70	Semi Auto Analyser	80	1	80	1	80
71	Shaking incubator	1500	2	3000	24	72000
72	Siplab Flat Electrode	2.5	4	10	1	10
73	Sonicator	50	2	100	6	600
74	Sonicator Bath	50	1	50	1	50
75	Soxhlet Extraction Unit	750	3	2250	4	9000
76	Spectrofluorimeter	40	1	40	2	80
77	SPINX vortex	66	2	132	1	132
78	Stereo microscope	50	1	50	6	300
79	Table top centrifuge	110	1	110	2	220
80	ULTRASONIC Cleaner	100	1	100	1	100
81	UPS Battery	1000	1	1000	24	24000

82	UV Cabinet cL-705	200	1	200	3	600
83	UV Spectrophotometer	200	5	1000	1	1000
84	UV transilluminator	200	3	600	0.5	300
85	Vacuum Pump	1400	1	1400	1	1400
86	Vortex	30	4	120	4	480
87	Water bath	270	6	1620	4	6480
88	Water Bath Shaker	500	1	500	0.5	250
89	Water bath- stirred	1500	1	1500	4	6000
90	Weighing balance	80	10	800	8	6400
91	Wrist Action Shaker	50	2	100	1	100

Sl. No.	Name	Rating	Qty.	Usage per day
92	Analytical weighing balance	220V	4	<1 H
93	Atc Probe	2.5W	1	1hr
94	Autoclave	230V	4	2 H
95	Bacteriological incubator	220V	4	24 H
96	Biorad Themal cycler	700 Watts	1	4
97	BOD Incubator	230 V	2	24hr
98	Body Compostion Analyser	60.500W	1	10 Minutes to1hr
99	Centrifuge	220-230V	7	1hr
100	CO2 Incubator	220 V	1	24 H
101	COD Digester	240V	1	3hr
102	Colony counter		3	2
103	Colorimeter	50-100V	16	1hr
104	Compund Microscope	55W	10	<1 H
105	Conductivity Meter	230V	1	1hr
106	Cooling Centrifuge	710 W	2	4
107	Cryostat Microtome	220V	1	~ 3 H
108	Cyclo Mixer {CM - 101}	58W	1	30 Minutes
109	Deep Freezer	1300 W	2	24 H
110	Digital Flocculator (Jar Test Apparatus)	110-220V	1	1hr
111	Digital Photo Electric Colorimeter	20W	3	40 Minutes

112	Digital rotary evaporator	1400 Watts	1	3
113	Distillation Unit	1000W	2	8 hour
114	Double Distillation Unit	1.5 KW	2	24hr
115	Dry bath	85W	1	<1 H
116	Eaviptronics Dual Channel potentiometer	1.08V	1	1hr
117	Electronic Balance	220V	1	<1 H
118	Electrophoresis unit (Horizontal)	80W	2	6
119	Electrophoresis unit (Vertical)	80W	2	6
120	Electrospinning	20 watt	1	5-6 hours
121	ELISA reader	75 W	1	6
122	ESPIN-Nano High voltage	Electrode Spinning	1	1hr
123	Flame Photometer	150-200V	1	3hr
124	Fridge	220V	4	24 H
125	Gel shaker	15 W	1	6
126	GM Counting System	1500 V	1	1hr
127	Horizontal Laminar air flow	450W	1	1hr
128	Hot Air Oven	1760W	8	~ 3 H
129	Hot Plate	220V	1	hr
130	IC Checker	150w	2	2
131	Ice flaker	200W	1	2 H
132	Incubator	0.25 KWatts	6	24
133	Inverted microscope	220V	2	<1 H
134	KEL PLUS Automatic Distillation System	400W	1	2hr
135	KEL PLUS Automatic Nitrogen/Protein Estimation System	220W	1	1hr
136	KjeldLal Operating System	220-230V	1	2hr
137	Biosafety cabinet		1	8
138	LABQUEST Borosil HME500-Mantel heater		1	3
139	Laminar Air Flow	220 V	5	~2 H
140	Magnetic Stirrer	220V	13	<1 H
141	Melting and Boiling point apparatus	120 W	2	4
142	MICROPLATE SPECTROMETER-Elisa Reader	75W	1	30 Minutes
143	Microscope	220V	23	<1 H
144	Microwave	1200 Watts	2	4
145	Minispin Centrifuge	70W	1	<1 H
146	Muffle Furnace	230V	2	24hr
147	Orbital Shaking Incubator	230V	1	24 H

148	Oscilloscope	150w	2	2
149	Oven	230V	1	<1 H
150	Ovtex	10-20 V	1	1hr
151	pH meter	12V DC	15	<1 H
152	Photoelectric Colorimeter	20W	1	2hr
153	Plant Growth Chamber	2760W	1	24 H
154	Precice Weighing Balance	220V	4	<1 H
155	Probe sonicator	150W	1	2
156	projector (Hitachi)		1	2
157	Radiation Counting System	1500 V	1	1hr
158	Refrigerator	350W	7	24
159	Resisistance Box	100W	2	2
160	Ring Water Bath	230V	1	<1 H
161	Rotor Heads (Model : R-244M)	3000W	1	2hr
162	Rotor Heads (Model : R-247M)	4000W	1	1hr
163	Semi Auto Analyser	80W	1	1hr
164	Shaking incubator	220 V	2	24 H
165	Siplab Flat Electrode	2.5W	4	1hr
166	Sonicator	50 W	2	6
167	Sonicator Bath	220 V	1	<1 H
168	Soxhlet Extraction Unit	230 V	3	4hr
169	Spectrofluorimeter	40 W	1	2
170	SPINX vortex	66W	2	<1 H
171	Stereo microscope		1	6
172	Table top centrifuge	110 W	1	2
173	ULTRASONIC Cleaner	100W	1	1hr
174	UPS Battery	200V	1	24hr
175	UV Cabinet cL-705	150-220V	1	3hr
176	UV Spectrophotometer	Kw 40A	5	1hr
177	UV transilluminator	240V	3	<1 H
178	Vacuum Pump	1400W	1	1hr
179	Vortex	30W	4	4
180	Water bath	500 W	6	4
181	Water Bath Shaker	1500W	1	30 Minutes
182	Water bath- stirred	1500 Watts	1	4
183	Weighing balance	15 W	2	8
184	Weighing balance		1	30 minutes
185	weighing balance	8 Watts	1	4
186	Weighing Balance (2)	12-15 V	1	3hr
187	Weighing machine sartorius		1	3
188	Wrist Action Shaker	230 V	2	1hr

Table 17: CONNECTED LOAD DETAILS at DHSMS, Mysuru Campus

SI. No.	Name of Appliance	Power Rating (Watt)	Quantity	Power consumption (watt)	Usage per day/hr	Power consumption /day (watt)
1	LED tube light	24	173	4152	8	33216
2	Fan	60	113	6780	8	54240
3	Projector	30	20	600	8	4800
4	Desktop	200	30	6000	8	48000
5	Printer	50	8	400		0
6	Scanner	50	3	150		0
7	UPS I	20,000	1	20000		0
8	UPS II	40,000	1	40000		0
9	CCTV	35	33	1155	8	9240
10	LCD Projector	80	18	1440	8	11520
11	LED Projector	74	4	296	4	1184
12	TV	100	7	700	8	5600
13	Water cooler	200	1	200	8	1600
14	Refrigerator I	800	1	800	24	19200
15	Refrigerator II	800	1	800	24	19200
16	Water purifier	500	1	500	24	12000
17	Electrical bell	100	2	200		0
18	Lift	4000	2	8000		0
19	Surface fitting	12	180	2160	8	17280
20	PA system	100	3	300		0
21	Photocopying machine	2000	2	4000		0
22	Network switch	500	1	500	8	4000
23	AC 2TR		7	0		0
24	AC 1.5 TR		1	0		0
25	Laptop	65	20	1300	8	10400
26	Tab	5	2	10	8	80
27	Patient monitor	65	6	390	7	2730
28	Amplifier					
High Fidelity Manikins						0
1	Sim Man 3G	115.2	1	115.2	1	115.2
2	Sim MOM	115.2	1	115.2	1	115.2
3	Sim Junior	115.2	1	115.2	1	115.2
4	Sim Baby	115.2	1	115.2	1	115.2
5	Sim Newborn	115.2	1	115.2	1	115.2
						0
Surgical Simulators						0
1	GI- Broncho mentor	12500	1	12500	1	12500
2	Ortho mentor	12500	1	12500	1	12500

3	Laparoscopic mentor	12500	1	12500	1	12500
4	Pelvic examination mentor	12500	1	12500	1	12500
5	Ultrasound mentor	12500	1	12500	1	12500
6	Hystero turp mentor	12500	1	12500	1	12500
7	Uro perc mentor	12500	1	12500	1	12500
				0		0
Task trainers				0		0
1	Megacode kid	115.2	1	115.2	1	115.2
2	Resusci Anne Advanced skill trainer	115.2	1	115.2	1	115.2
3	SAM II Auscultation trainer	115.2	1	115.2	1	115.2
4	laerdal sonosim procedure trainer (Ultrasound)	65	1	65	1	65
5	Nebulizer machine	50	1	50	1	50
6	Anesthesia machine	127	1	127	1	127
7	Defibrillator	100	1	100	1	100
8	OT light -I	55	1	55	1	55
9	OT light -II	55	1	55	1	55
10	Ventilator machine	38	1	38	1	38
11	Medical gas pipeline with din outlet and air compressor, vacuum pump including manifolds with cylinder	330	1	330	1	330

Table 18: CONNECTED LOAD DETAILS at Pharmacy College, Ooty:

Sl no	Name of the Appliance	Power rating in Watts	Quantity	Usage per day in hr
Lighting				
1	LED Stret Light	45	34	11 hr
2	LED Panel Light	30	12	9 hr
3	LED Tube Light	20	620	9 hr
4	LED bulb	8	90	9 hr
5	LED Light	12	50	9 hr
6	LED bulb	15	235	9 hr
7	LED Panel Light	20	140	9 hr
8	LED Panel Light	30	20	9 hr
9	LED Panel Light	50	10	9 hr
10	PL Lamp	11	42	9 hr
11	CFL	18	40	9 hr
12	T 5 Light	20	340	9 hr
13	Fluorescent Tube Light	40	345	9 hr

Computer and Equipments				
14	LCD Projcter	500	20	6 hr
15	Monitor	36	150	8 hr
16	CPU	45	140	8 hr
17	Printer	500	56	8 hr
18	Camera & Accessories	3000		24 hr
19	Network & Accessories	3000		24 hr
20	TV	100	30	4 hr
21	LED Panel	2000	1	8 hr
Kitchen and Appliances				
22	Wet Grainder	736	6	4 hr
23	Chapathi Making	4000	1	4 hr
24	Exist Fan	100	50	6 hr
25	Exist Duck	736	5	4 hr
26	Vegetable Cutting Machine	736	2	1 hr
27	Aata Mixing	736	2	1 hr
28	Coconut Scraper	736	3	1 hr
29	Potato Scraper	736	2	1 hr
30	Compriser	1472	1	2 hr
31	Mixer	750	3	1/2 hr
32	Fridge	750	10	24 hr
33	Freezer	750	5	24 hr
Other Equipments				
34	Washing Machine	1000	1	2 hr
35	Water Pumps	736	7	3 hr
36	R.O Water systems	736	3	2 hr
37	Drinking Water system	2000	15	24 hr
38	Lift	736	1	8 hr
39	UPS	80 KVA	14	24 hr
40	Water Heater	2000	58	12 hr
41	Air Water Heater	5000	3	6 hr

CHAPTER 6
DIESEL GENERATORS

6.1 Diesel Generator System

One 500 kVA, one 380 kVA, one 160 kVA and one 250 kVA Diesel Generator sets are installed for giving supply to different campuses in case of power outage.

Fig 21: 160kVA Diesel Generator installed at the College of Pharmacy, Mysuru Campus

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 eventually. (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 in Medical College Campus

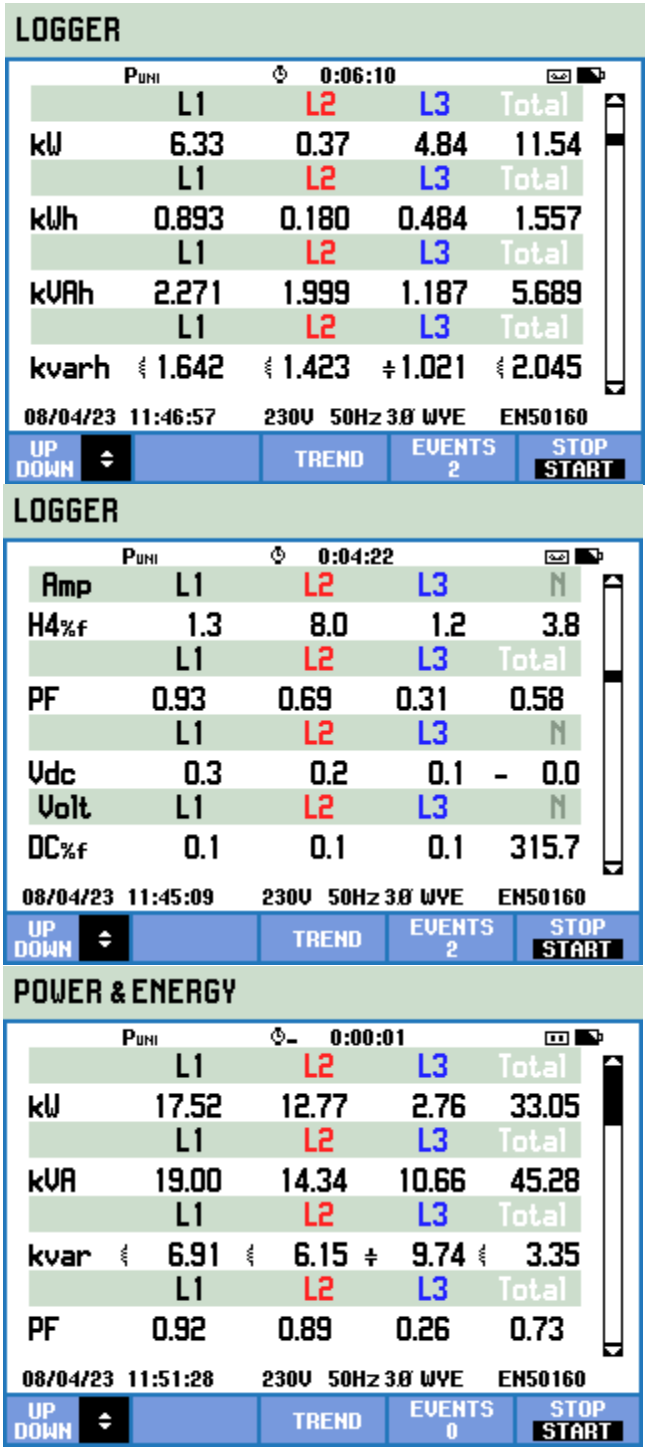


Fig 22: Electrical Readings recorded by Fluke 434-ll power analyser

7.2 Waveforms from Fluke 434-ll Power Analyser in Medical College Campus

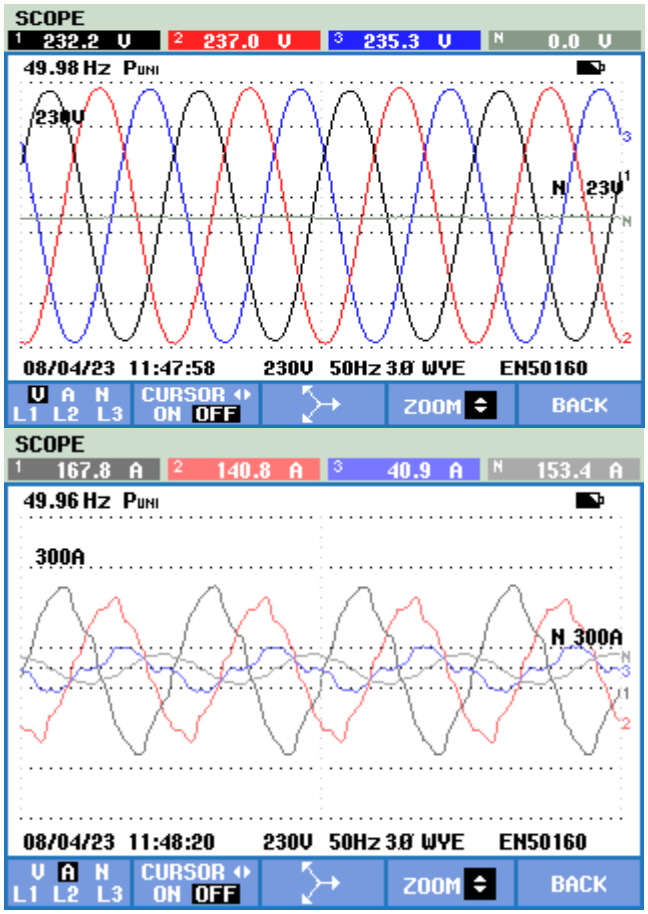


Fig 23: Voltage and Current (Distorted) Sinusoidal Waveform of the Campus

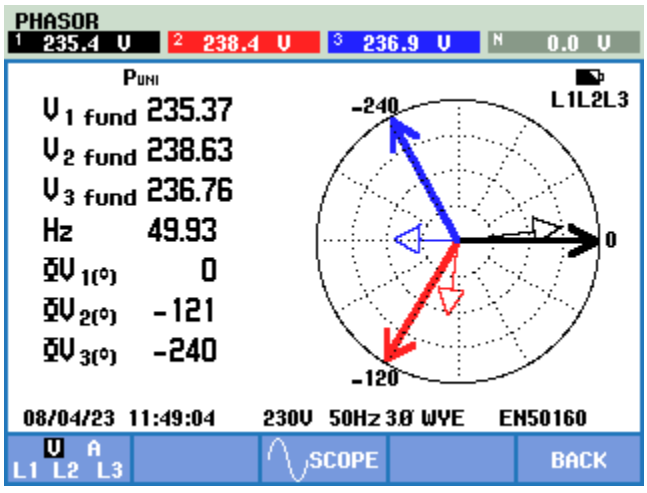


Fig 24: Phasor Diagram of Voltage

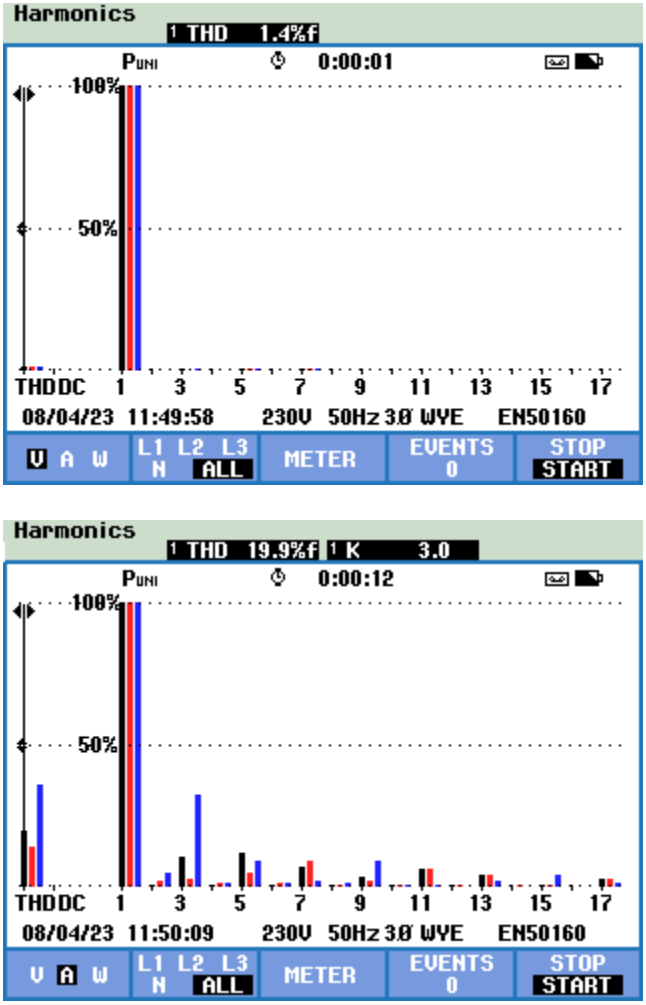


Fig 25: Voltage and Current Harmonics of Campus

Observations: Analysis using Power Analyzer shown that the current load on each phaseis 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 eachphase of the bus bar properly by redistributing the load on each phase.

7.3 Readings recorded by Fluke 434-ll power analyser in Pharmacy Campus, Mysuru

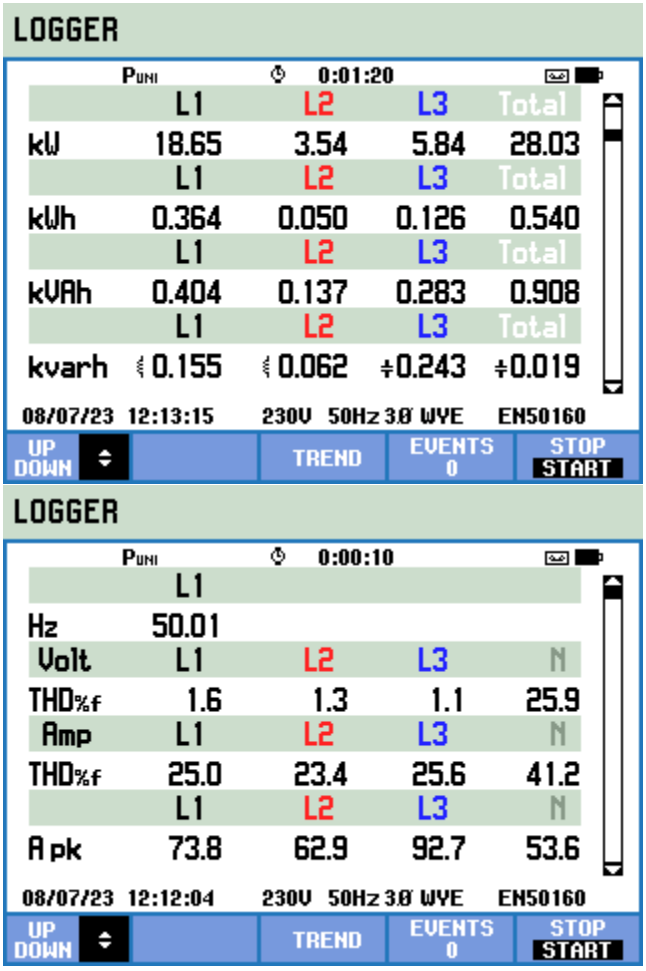
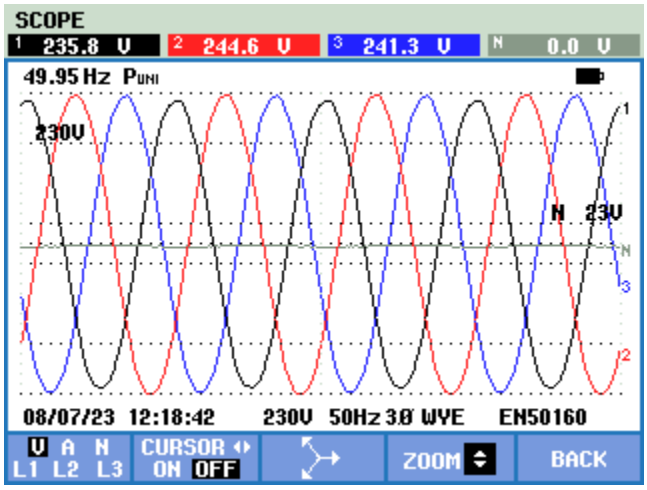


Fig 26: Electrical Readings recorded by Fluke 434-ll power analyser

7.4 Waveforms from Fluke 434-ll Power Analyser in Pharmacy Campus, Mysuru



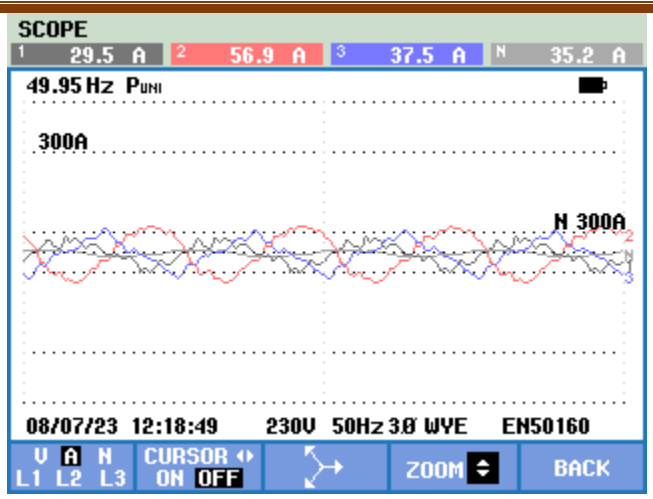


Fig 27: Voltage and Current (Distorted) Sinusoidal Waveform of the Campus

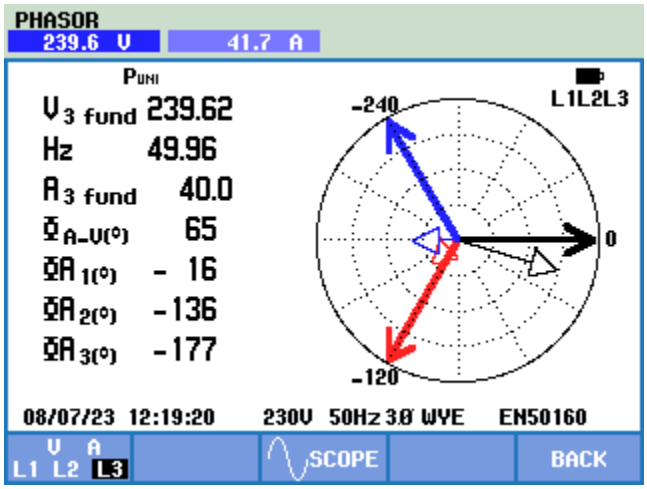


Fig 28. Phasor Diagram of Voltage

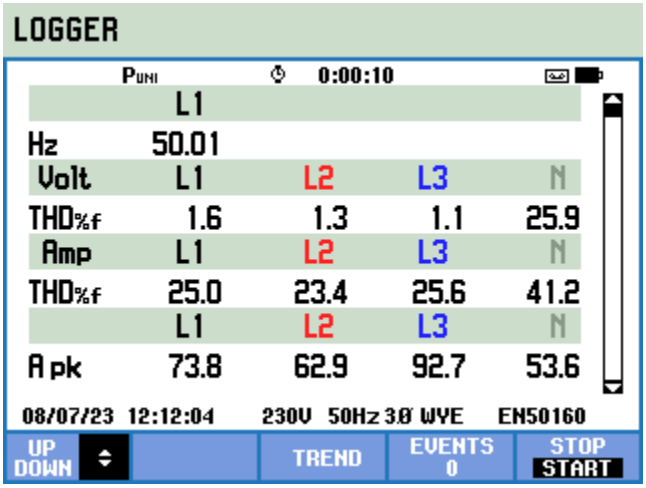


Fig 29: Voltage Harmonics of Campus

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.

7.5 Readings recorded by Fluke 434-ll power analyser in Pharmacy Campus, Ooty

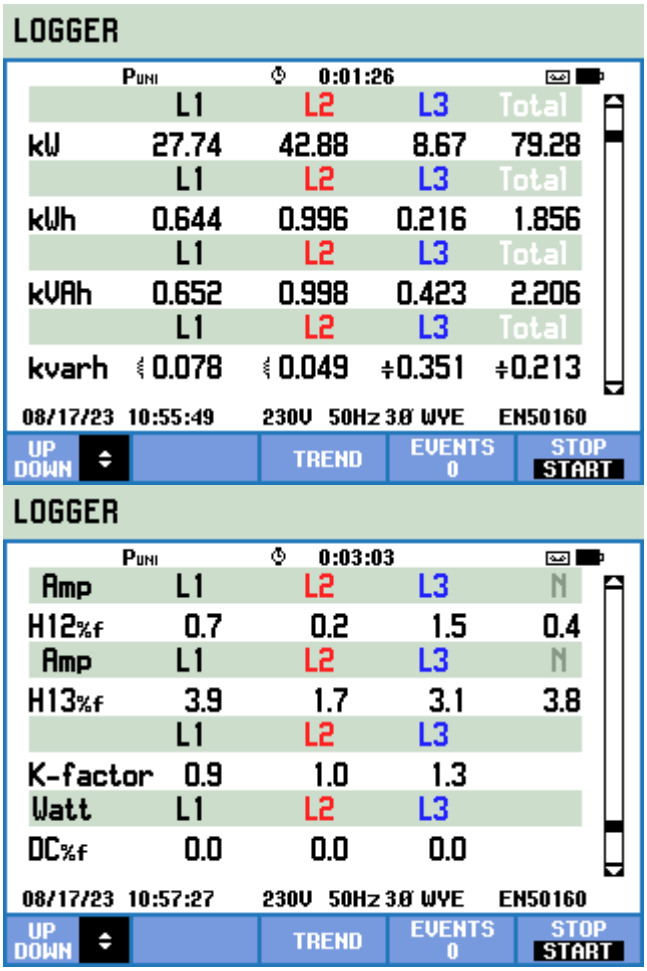
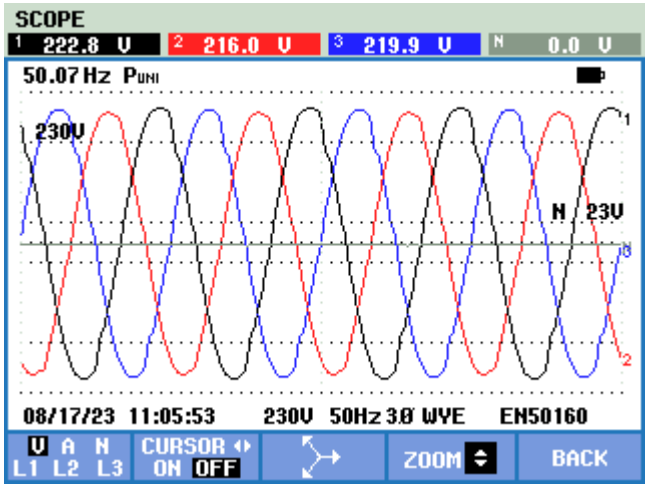


Fig 30: Electrical Readings recorded by Fluke 434-ll power analyser

7.6 Waveforms from Fluke 434-ll Power Analyser in Pharmacy Campus, Ooty



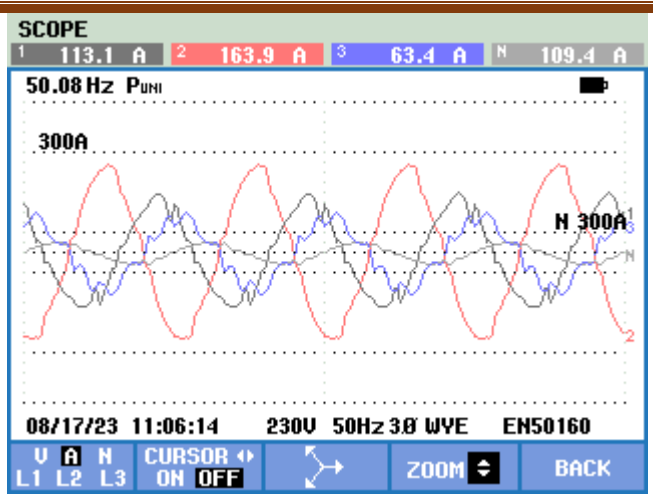


Fig 31: Voltage and Current (Distorted) Sinusoidal Waveform of the Campus

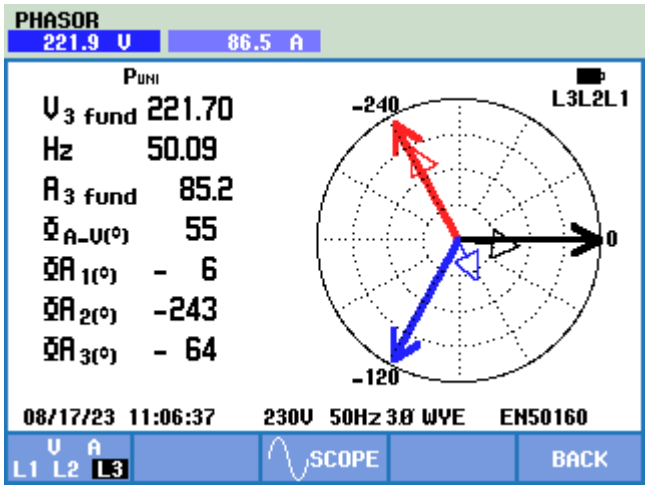


Fig 32: Phasor Diagram of Voltage

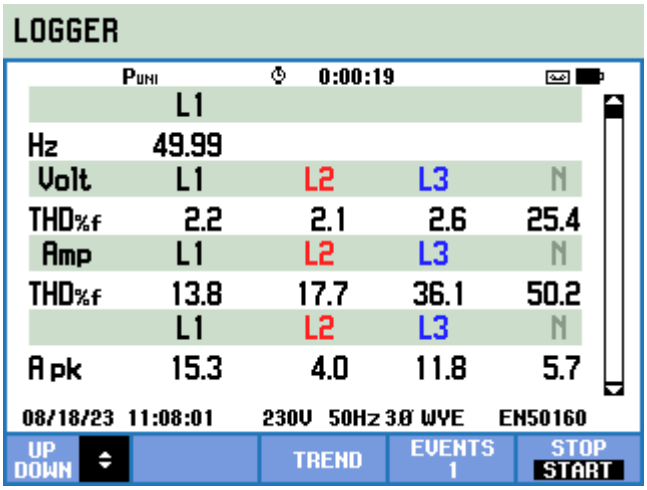


Fig 33: Voltage Harmonics of Campus

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 AHER, Mysuru.

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

The 36 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 8 hours per day running).

Following calculations (Table 19) are done for 5 hours working for JSS College of Pharmacy Mysuru Campus:

Table 19: Calculations to Replace Fluorescent Tube Lights (FTL) with LED Tube Lights

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 = 5 h/day x 300	= 1500 h/year.
Tube Light Yearly savings	= 1500 x 20 W = 30 kWh/year/Tube Light.
Average Cost of electricity	= Rs. 8.5/ kWh.
Saving	= 30 kWh x 8.5 = Rs. 255 / year / Tube light.
Approximate investment on single LED Tube lights	= Rs. 219. (Panasonic LED20W Batten, 1 pc).
Number of Tube Lights to be replaced	**= 350**
Electrical Energy Saved	**= 30 x 350** = 10500 kWh / yr
Total Yearly Saving =350 x 255	=**Rs. 89250 /-year**
Total Investment =350 x Rs.219	**=** Rs.76,650/-
Payback	**(**76,650/89250**)*** 12 months **= 11 months**

Summary of replacing fluorescent light with led lights in all the campuses is listed in the Table 20.

Table 20: Summary of Energy Savings, Cost Savings and Implementation Cost

Sl, No,	Location	Wattage		Nos.	Working Hours per day	No. of days in a year	Energy Savings kWh/yr	Cost Savings	Imp Cost	Payback Period
		Current	Proposed							
1	JSSCPM	40	20	350	5	300	10,500	89,250	76,650	11
2	JSSMC	40	20	840	6	300	30,240	2,57,040	1,83,960	9
3	JSSMC Girls Hostel	40	20	410	6	300	14,760	1,25,460	89,790	9
4	JSSAHER Canteen	40	20	27	6	300	972	8,262	5,913	9
5	JSSAHER	18	9	134	4	300	1,447	12,301	13,400	14
6	JSSDC	40	20	313	5	300	9,390	79,815	68,547	11

7	SLSM	40	20	155	7	300	6,510	55,335	33,945	8
8	JSSCPO	40	20	345	9	300	18,630	1,58,355	75,555	6
9	JSSCPO	18	9	40	9	300	972	8,262	4,000	6
Total	**-**			**2,614**			**93,421**	**794,080**	**5,51,760**	**9**

This recommendation has a annual savings Rs. 7**,94,080** and an implementation cost of Rs. **5,51,760** with a simple payback of **9** months.

8.2 Replace the existing induction motor fans with new BLDC motor fans in JSS AHER Campus

Brush-Less Direct Current (or BLDC) fans are advanced fans that use special motors known as brushless motors. These motors have special electronics that helps them to spin, so that they use less electricity and also these fans have higher life than normal fans due to this new technology. Since they have lesser moving parts, they need less maintenance. BLDC fans produce less heat since they do not have brushes and hence last longer than conventional fans.

A BLDC motor fan consumes approximately 28 watts, while the induction motor fan in the campus consumes 55 Watts[1] on average. The list of fans in the campus is shown in the Table 21.

Table 21: List of fans used in the JSSAHER Campus

Location	Quantity	Wattage	Average Consumption	Usage per day	No of days
Medical College	820	70	55	6	300
Boys Hostel	272	70	55	6	300
Girls Hostel	592	70	55	6	300
Dental College	414	70	55	5	300
Dental College	225*	70	75	5	300
School of Life Sciences	169	70	55	7	300
JSSAHER Guest House	71	70	55	4	300
JSSAHER Admin Bldg	45	70	55	6	300
JSSAHER Canteen	18	70	55	6	300
JSSCPM	713	70	55	5	300
JSS Ramanuja Road Campus	113	60	55	8	300

*Old Rheostat type Fan Regulator

It is recommended to replace the existing fans as listed above with BLDC fans since the usage is higher in these areas. Sample calculation to replace the existing induction motor fans with new BLDC motor fans are shown in the Table 22.

[1] https://www.crompton.co.in/product-category/consumer-fans/ceiling-fans/energy-efficient-and-low-voltage/

Table 22. Sample Calculation to replace induction motor fans with BLDC motor fans

Energy Consumption per Year	Electricity Cost /Year	Total Energy Savings (w.r.t BLDC fans every year)	Total Cost Savings (w.r.t BLDC fans every year)	BLDC fans cost*	Pay Back Period
820 fans x 55 W/Fan x 6 hours/day x 300 days/yr = 81,180 kWh	81,180 kWh x ₹8.5 /kWh = 690,030	820 fans x (55–28) W/fan x 6 hours/day x 300 days/yr = **39,852 kWh**	= 39,852 x ₹8.5 /kWh = ₹338,742	= (₹2,200 x 820 fans = **₹1,804,000**	=₹1,804,000/₹338,742 x 12 months/yr = 64 **months**

*The existing old fans can be traded in for new fans for ₹ 300 which is not considered here

Table 23 shows the summary of Energy savings, Cost Savings, implementation cost and payback period.

Table 23: Summary of Energy Savings, Cost Savings, Implementation Cost & payback

Qty	Wattage	Hours / day	No. of days	Current Electricity Cost	Proposed Wattage	Energy Savings	Cost Savings	BLDC Fan Cost	Payback period
820	55	6	300	6,90,030	28	39,852	3,38,742	18,04,000	64
272	55	6	300	2,28,888	28	13,219	1,12,363	5,98,400	64
592	55	6	300	4,98,168	28	28,771	2,44,555	13,02,400	64
414	55	5	300	2,90,318	28	16,767	1,42,520	9,10,800	77
225	75	5	300	2,15,156	28	15,863	1,34,831	4,95,000	44
169	55	7	300	1,65,916	28	9,582	81,450	3,71,800	55
71	55	4	300	39,831	28	2,300	19,553	1,56,200	96
45	55	6	300	37,868	28	2,187	18,590	99,000	64
18	55	6	300	15,147	28	875	7,436	39,600	64
713	55	5	300	4,99,991	28	28,877	2,45,450	15,68,600	77
113	55	8	300	1,49,160	28	7,322	73,224	2,48,600	41
3,452				**28,30,472**		**1,65,615**	**14,18,714**	**75,94,400**	**64**

This recommendation has a annual savings Rs. 14,18,714 and an implementation cost of Rs.75,94,400 with a simple payback of 64 months.

Fig 34: BLDC Fan in JSS College of Pharmacy Hostel, Mysuru Campus

8.3 Retrofit existing inefficient and old Fan Regulators with Electronic Regulators in Dental college campus to Save Energy

The difference between the electronic and ordinary electrical regulator is that in electronic regulator power losses are less because as we decrease the speed the electronic regulator gives the power needed for that speed but in case of ordinary rheostat type regulator, the power wastage is same for every speed and no power is saved. In electronic regulator, triac is employed for speed control by varying the firing angle speed and it is controlled but in rheostatic control resistance is decreased by steps to achieve speed control[2]. Also, capacitive type fan regulators are available that will save energy compared to rheostat type of regulators. Following calculations (Table 24) are done for 5 hours working:

Table 24: Calculations to Replace old Fan Regulators with Electronic Regulators

Power consumption by 70 W with conventional regulator from full speed to minimum speed	**= 75 W/ fan**
Equivalent Energy Efficient Regulator	**= 55 W/ Fan**
Savings in power	**= 20 W/ Fan**
Operating hours = 5 h/day x 300	**= 1,500 h/year**
Fan Energy Yearly savings = 1,500 x 20	**= 30 kWh/year/Fan**
Average Cost of electricity	**= Rs. 8.5/ kWh**
Saving = 30 kWh x 8.5	**= Rs. 255 / year / Fan**
•Approximate investment on single Electronics Regulators	**= Rs.250 (Approximate)**
Number of Fan Regulators to be replaced	**= 225**
Electrical Energy Saved = 30 x 225	**= 6,750 kWh / yr.**
Total Yearly Saving =225 x 255	= Rs. 57,375 /year
Total Investment = 225 x Rs. 250	= Rs. 56,250/-
Payback	**= (56,250/57,375) = 0.98** Year = around 12 months.

This recommendation has a annual savings Rs. 57,375 and an implementation cost of Rs. 56,250 with a simple payback of 12 months.

[2] https://engineeringslab.com/all_interview_questions/what-is-the-difference-between-electronic-regulator-and-ordinaryelectrical-rheostat-regulator-for-fans-3655.htm#:~:text=regulator%20for%20fans%3F-, The%20difference%20between%20the%20electronic%20and%20ordinary%20electrical%20regulator%20is, wastage%20is %20same%20for%20every

Fig 35: Old Rheostat type Fan Regulator in the campus & Proposed Electronic Regulator

8.4 Replace the existing old Air Conditioners with 5 Star Air Conditioners with inverter technology

The main difference between an inverter and non-inverter AC lies in their compressor speed. An inverter AC has a variable speed compressor, while a non-inverter AC has a fixed speed compressor. Variable speed compressors are more energy efficient than their fixed counterparts and make less noise as well.

An inverter air conditioner is a type of air conditioning unit that can adjust the compressor's motor speed to regulate the temperature. The use of an inverter switch allows for greater flexibility in terms of power usage. Inverter ACs are more energy efficient than non-inverters because they can change their power consumption depending on how hot it is outside, or if you have multiple people in your home at any given time.

Another difference worth mentioning is that the refrigerant used in non-inverter AC emits harmful emission which adversely impacts the environment. Modern inverter ACs use efficient refrigerants such as R32 which provides better cooling capacity and emits less harmful emissions to the environment.

Inverter ACs save up to 30% of electricity compared to non-inverters[3].

Non-inverter air conditioners use the on/off method, where the compressor is switched on and off at regular intervals to maintain the desired temperature. This uses more energy than inverters and can result in more wear and tear on your system. Compressors that are non-inverters do not run at full speed all the time, making them less efficient than their inverter counterparts.

As said before, an inverter AC uses variable speed compressors, which have a wider range of speeds compared to on/off compressors used by non-inverters. This allows it to operate in more modes that take advantage of different conditions and load requirements, thereby improving its efficiency throughout a wide range of operating conditions. Table 25 shows the sample calculations for replacing old Ac with 5 Star inverter AC in Dental College.

Oytput wattage for 1.5 ton AC	Star Rating (Split AC)	Min EER needed	Input Wattage
(Watts)	Stars	W/W	(Watts)
5275	*	2.7	1954
5275	**	2.9	1819
5275	***	3.1	1702
5275	****	3.3	1598
5275	*****	3.5	1507

Fig 36: Output and Input Wattage of Air Conditioners based on Star Rating

[3] https://www.tcl.com/global/en/blog/what-is-the-difference-between-inverter-and-non-inverterac#:~:text=Inverter%20ACs%20save%20up%20to,electricity%20compared%20to%20non%2Dinverters.

Table 25: Sample calculations for replacing old AC with 5 Star inverter AC

Existing Energy Consumption per Year	Proposed Energy Consumption per Year	Total Energy Savings	Total Cost Savings	Air Conditioner cost	Pay Back Period
2.3 kW x 21 units x 5 hours/day x 300 days/yr. = 72,450 kWh	1.5 kW x 21 units x 5 hours/day x 300 days/yr. = 47,250 kWh	= 72,450 - 47,250 =25,200 **kWh**	= 25,200 x ₹ 8.5 /kWh = ₹ 214,200	= 21 x ₹ 37,500 = ₹ 7,87,500	= ₹ 7,87,500 /₹ 214,200 x 12 months/yr. = 44 **months**

Following tables 26 & 27 shows the AC Details, AC rating, Energy Savings, Energy Cost Savings, and payback period for this recommendation.

Table 26: AC Details and rating

Sl. No.	Equipment	LOCATION	Usage per day	No. of Units	Capacity in TR	Old AC Input Kilo Watts	New AC Input Kilo Watts	Implementation Cost per unit
1	SPLIT AC	Dental College	5	21	1.5	2.3	1.5	37,500
2	SPLIT AC	Pharmacy College	5	29	2	2.9	2.0	50,000
3	SPLIT AC	Medical College	3	23	1.5	2.3	1.5	37,500
4	SPLIT AC	Medical College	3	28	2	2.9	2.0	50,000
5	SPLIT AC	Medical College	3	38	3	4.3	3.0	75,000
6	SPLIT AC	School of Life Sciences	4	8	1	1.4	1.0	25,000
7	SPLIT AC	School of Life Sciences	24	4	1.5	2.5	1.5	37,500
8	SPLIT AC	School of Life Sciences	4	2	1.5	2.5	1.5	37,500

Table 27: Energy Savings, Energy Cost Savings, and payback period

Sl. No.	Current Energy Consumption	Proposed Energy Consumption	Energy Savings	Total Cost Savings	Implementation Cost	Payback Period
1	72,450	47,250	25,200	2,14,200	7,87,500	44
2	1,26,150	87,000	39,150	3,32,775	14,50,000	52
3	47,610	31,050	16,560	1,40,760	8,62,500	74
4	73,080	50,400	22,680	1,92,780	14,00,000	87
5	1,47,060	1,02,600	44,460	3,77,910	28,50,000	90
6	13,440	9,600	3,840	32,640	2,00,000	74
7	72,000	43,200	28,800	2,44,800	1,50,000	7
8	6,000	3,600	2,400	20,400	75,000	44
Total	**5,57,790**	**3,74,700**	**1,83,090**	**15,56,265**	**77,75,000**	**60**

This recommendation of replacing old AC with 5-star Inverter AC will result in energy savings of 183,090 kWh, cost savings of ₹15,56,265 per year with implementation cost of ₹ 77,75,000 and a payback of 60 months.

Fig 37: Old Non-inverter AC in the campus

Fig 38: New Inverter AC in the campus

8.5 Install Occupancy (Motion) Sensors in Designated Areas

Install occupancy sensors with ultrasonic motion sensing in the Gallery 05 of Medical College, Class rooms of Pharmacy College, Mysuru and Hostel areas of Pharmacy College, Ooty to reduce the electrical usage for lighting and fans during unoccupied periods. The list of areas identified for installing occupancy sensors is shown in Table 28. Gallery 05 is a big classroom and many times there will be very few students and it was the situation at the time of assessment.

By wiring occupancy sensors into this area, the lighting and fan usage could be reduced during unoccupied periods. It is estimated that by installing occupancy sensors, usage of lighting and fans can be reduced by at least 2 hours per day. It is recommended to install one occupancy sensor for every 2 lights and 2 fans and the calculations are shown in Table 29.

Table 28: List of lights and fans identified to install occupancy sensors

Location	Type of Unit	Total No. of Units	Wattage per unit (W)	Total Wattage (W)	Hours of Energy Saving (hr/yr)
JSS Medical College					
Gallery 05, JSSMC	Fluorescent Lights	21	40	840	600
Gallery 05, JSSMC	Ceiling Fans	14	55	770	600
Gallery 05, JSSMC	Wall mount fans	10	55	550	600
Total		**45**		**2,160**	
JSS College of Pharmacy, Mysuru					
10 Class rooms, JSSCPM	Fluorescent Lights	100	40	4000	600
10 Class rooms, JSSCPM	Ceiling Fans	80	55	4400	600
Total		**180**		**8,400**	
JSS College of Pharmacy, Ooty					
Boys Hostel Bath Rooms	LED Lights	24	20	480	4,380
Boys Hostel Bath Rooms	LED Lights	64	9	576	4,380
Boys Hostel Corridor	LED Lights	36	9	324	4,380
Girls Hostel Bath Rooms	LED Lights	32	20	640	4,380
Girls Hostel Bath Rooms	LED Lights	16	20	320	4,380
Girls Hostel Corridor	LED Lights	8	12	96	4,380
Total	**-**	**180**	**-**	**2,436**	**-**

Table 29: Calculations for Installing Occupancy (Motion) Sensors

Energy Savings for JSSMC, ES1	= 2,160 x 600 / 1,000 = 1,296 kWh/yr
Energy Savings for JSSCPM, ES2	= 8,400 x 600 / 1,000 = 5,040 kWh/yr
Energy Savings for JSSCPO, ES3	= 2,436 x 4,380 / 1,000 = 10,670 kWh/yr
Total Energy Savings = ES1 + ES2 + ES3	=1,296 + 5,040 +10,670 = 17,006
Energy Cost Savings, ECS	= ES x (unit cost of electricity) = 17,006 kWh/yr x 8.5 Rs./kWh

	= Rs. 144,551/-
No of occupancy Sensor required for JSSMC	45/4 = 11.25 ~ = 12
No of occupancy Sensor required for JSSCPM	18/4 = 4.5 ~ = 5 x 10 Classrooms = 50
No of occupancy Sensor required for JSSCPO	16 Bath Rooms x 3 + 8 Corridors x 3 = 72
Total no. occupancy Sensors required	12 + 50 + 72 = 134
Cost of one occupancy sensor in Rs.	450/-
Capital cost (CC) for the occupancy sensors in Rs.	134*450 =60,300/-
Installation and wiring cost per sensor in Rs.	300/-
Total Installation cost in Rs.	134*300 = 40,200/-
total implementation cost	60,300 + 40,200 = 100,500
Payback period	(100,500/144,551)*12 months = 8 months

The occupancy sensors recommended would work in conjunction with the existing switches. Several types of controls are available, including motion sensors. An ultrasonic motion-sensing controller, which produces a low intensity, inaudible sound and detects changes in the sound waves caused by any type of motion, can be used for the designated areas. Also, Passive infrared sensors can be used. PIR (passive infrared) sensors utilize the detection of infrared that is radiated from all objects that emit heat. This type of emission is not visible to the human eye, but sensors that operate using infrared wavelengths can detect such activity.

Fig 39: Occupancy Sensor

The total cost savings of Rs. **1,44,551/yr** will pay for the implementation cost of **Rs. 100,500** in **8** months.

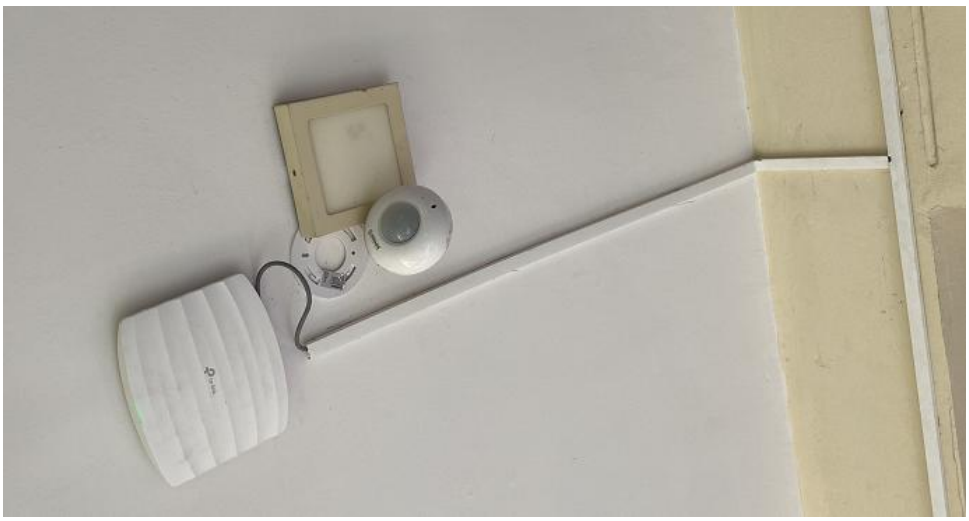


Fig 40: Occupancy / Motion Sensor in Pharmacy College Hostel, Mysuru Campus

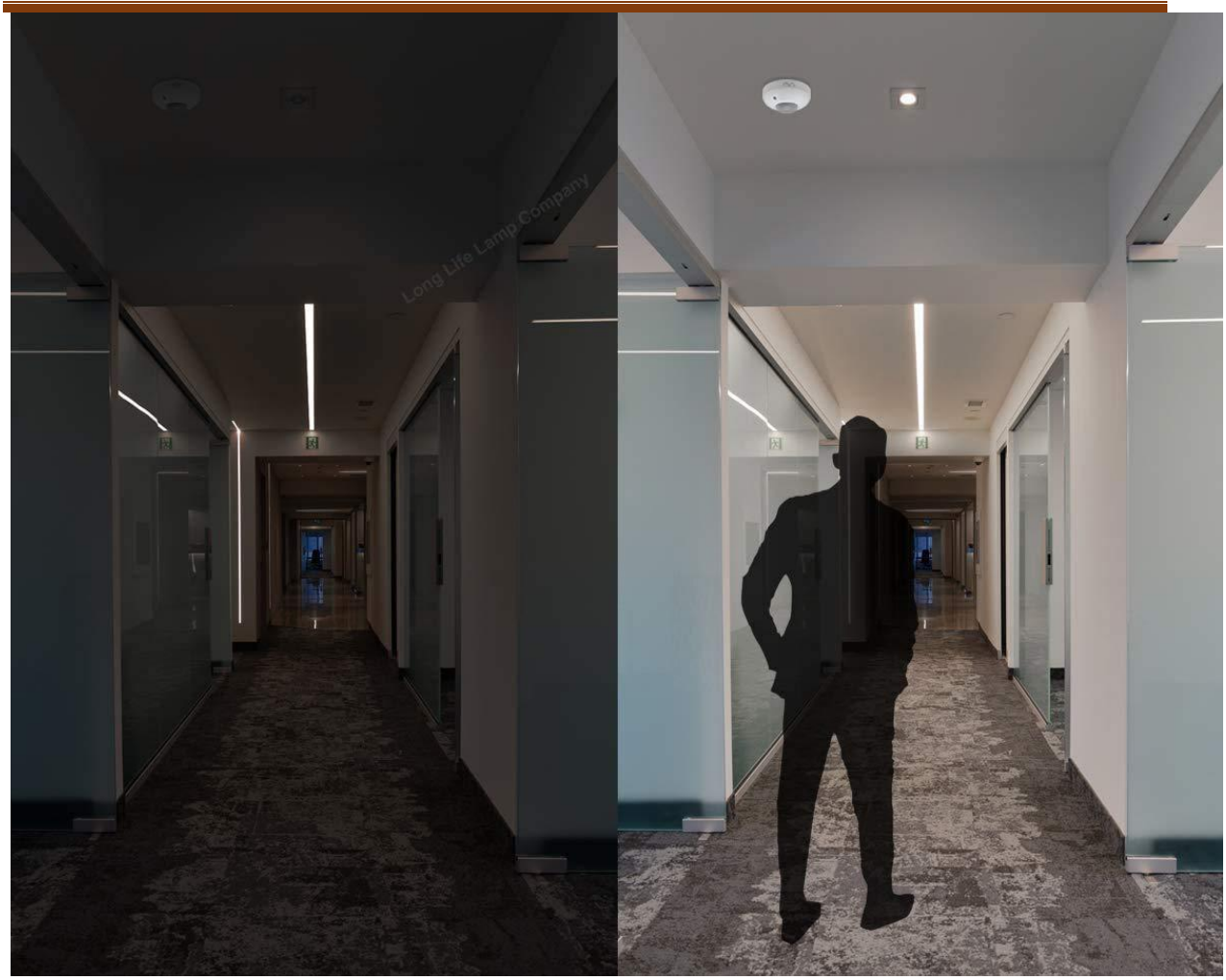


Fig 41: Working of Lights with and without Occupancy / Motion Sensor

8.6 Use solar water heater in conjunction with heat pumps to reduce water heating energy consumption for the hostel

Currently the campus has heat pumps of different ratings as shown in the Table 30 to heat the water for hostel students. Earlier, Solar water heaters were used in conjunction with heat pumps and have been disconnected now. It is recommended to use solar water heaters to heat the water along with heat pumps to save energy. Also, regular maintenance of solar water heater will help to increase its life. It is estimated that solar water heater can provide hot water for 80% of the time in a year due to climatic condition of Mysuru and heat pump has to be used during remaining 20% of the time.

Table 30: Heat pumps in the Campus

Sl. No,	Location	Rating in kW	No. of Units
1	JSSCPM	5	2
2	JSSMC	4.28	7
3	JSSMC	4.8	5
4	JSSMC	4.5	2
5	JSSMC	2.4	2
6	JSSMC	4.9	1
7	JSSMC	3.6	1
	Total	**29.48**	**20**

Sample calculations are shown Table 31 for 5 kW rated heat pump in JSSCPM.

Table 31: Calculations for using solar water heater in conjunction with heat pump

Rated Heating capacity	5kW
No. of heat pumps	2
Water capacity	7 LPM or 420 liters per hour
Usage per day	5 hours or 2100 ltrs
Energy consumed per heat pump	5 kW x 5 hours = 25 kWh
Total Energy consumed by two heat pumps per day	25 kWh x 2 = 50 kWh
Current Annual energy consumption	50 kWh*300 days/yr = 15,000 kWh
Current Electricity Cost per year	15,000 kWh*8.5 = 1,27,500/-
Total Cost savings in Rs.	= 0.8 x 1,27,500 = 1,02,000
Cost of Solar water heater 1000 L	75,000/-
No. of Solar water heaters required	2 x 2 = 4
Total Cost of Solar water Heater	3,00,000/-
Payback period	(3,00,000/1,02,000)*12 months = 36 months

It is recommended to install 2 Solar water heaters of 1000 liters capacity in place of one 5 kW heat pump. So, totally 4 Solar water heaters of 1000 liter capacity are

required for the above example. Similarly calculations are done for other heat pumps for 5 hours usage in a day and 300 days in a year and are summarized as shown in the Table 32.

Table 32: Energy Savings, Energy Cost Savings, and payback period

Sl. No.	Rating in kW	No of Units	Water supplied in Liters	Current Energy used in kWh	Current Energy Cost	Energy Savings	No of Solar Water heaters reqd.	Imp Cost	Payback in months
1	5	2	4,200	15,000	1,27,500	1,02,000	4	3,00,000	36
2	4.28	7	14,000	44,940	3,81,990	3,05,592	14	10,50,000	42
3	4.8	5	10,000	36,000	3,06,000	2,44,800	10	7,50,000	37
4	4.5	2	4,000	13,500	1,14,750	91,800	4	3,00,000	40
5	2.4	2	2,000	7,200	61,200	48,960	2	1,50,000	37
6	4.9	1	2,000	7,350	62,475	49,980	2	1,50,000	37
7	3.6	1	2,000	5,400	45,900	36,720	2	1,50,000	50
Total	**29**	**20**	**38,200**	**1,29,390**	**10,99,815**	**8,79,852**	**38**	**28,50,000**	**39**

The total energy savings is **103,512** kWh/yr, the total cost savings is Rs. **8,79,852**/yr and will pay for the implementation cost of Rs. **28,50,000** in **39** months.

Fig 42: Existing Heat pump in Pharmacy Hostel

Fig 43: Disconnected Solar Water Heater in Pharmacy Hostel

Fig 44: Proposed Solar Water Heater with Evacuated Tube Collector Technology

8.7 Install Variable Speed Drives on the Refrigerant Compressors of Air conditioner used for Animal House

Replace the single speed drives on the refrigerant compressors with variable speed drives (VSD) to save electrical energy usage.

An adjustable speed drive (ASD) is a device that controls the rotational speed of motor-driven equipment. Variable frequency drives (VFDs), the most common type of ASDs, efficiently meet varying process requirements by adjusting the frequency and voltage of the power supplied to an AC motor to enable it to operate over a wide speed range. External sensors monitor flow, or pressure or temperature or some parameter and then transmit a signal to a controller that adjusts the frequency and speed to match process requirements.

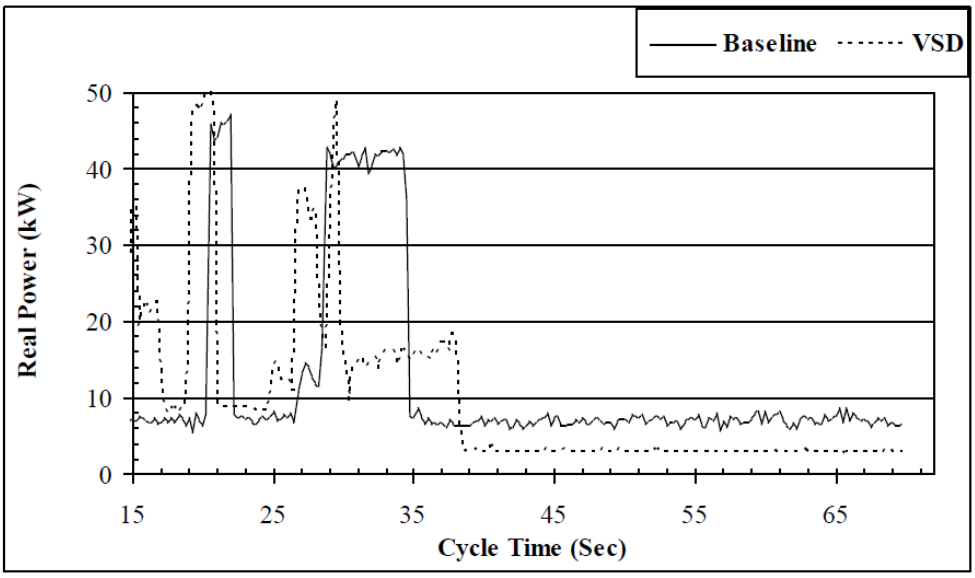


Fig 45: Real power requirement for single speed and variable speed drives

As shown in different case studies, e.g., Figure 45, the real power requirements with variable frequency drives are much less than that with single speed drives. For operations with smaller cycle times, the variable frequency drives are not efficient as they change the speed frequently, which results into inefficient operations.

Currently, the Medical college campus has two air conditioners that supply cold air to animal house at 24^{o}C. These air conditioners are used 24 hours a day throughout the year. These air conditioners operate at part loads for a vast majority of time in a calendar year because of varying ambient conditions. The operating conditions of these air conditioners are shown in Table 33.

Table 33: Air Conditioners Details

Name	Tons of Refrigeration	Input kW	Qty	Load Factor	Usage Factor
Air conditioner (AHU)	8.8	5.4*	**1**	**0.6***	**0.4***
Air conditioner (AHU)	5.5	3.4	**1**	**0.6**	**0.4**
Total	14.3	8.8	**2**	**-**	**-**

* Estimated

Limitations of conventional compressors

Traditionally the part load performance of compressors is modulated through a slide valve mechanism which controls the rate of compression of refrigerant in the compressor and thereby the cooling capacity. Because of its inherent design limiting compression ratios, the slide valve invariably either over-compress or under-compress the refrigerant, resulting in:

- Loss of efficiency.
- Higher power consumption
- High starting current

Also, many compressors work in on and off mode to adjust to the partial load conditions which creates lot of wear and tear on the compressor and its motor. The input power at partial loads for normal compressors and VFD compressors is shown in Figure 46. The VFD compressors can save up to 30% energy depending on the load and for average load of around 60%, the savings is around 15% from the Figure 46. Also, VFD drives can reduce the electrical demand by reducing the startup current requirement.

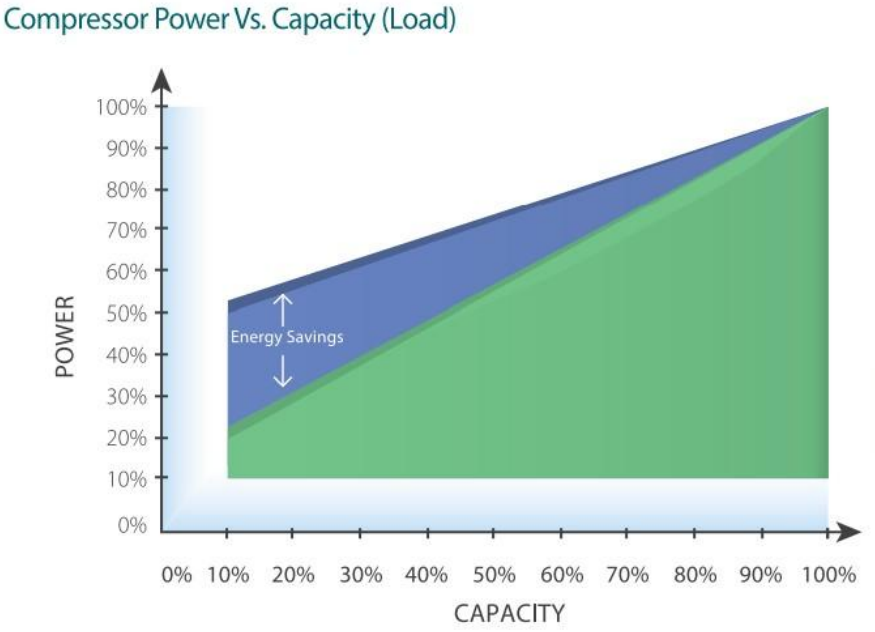


Fig 46: Input Power at Partial loads by different type of compressors[4]

Energy Savings

The energy savings can be estimated as follows.

ES = TkW x LF x UF x OH x %S

Where,

TkW = Total Input power

LF = Load factor

[4] https://www.bluestarindia.com/media/70922/vfd-screw-chiller.pdf

UF	=	Usage factor
OH	=	Operating hours per year, 8,760
%S	=	15%

The energy savings is calculated as,

ES = 8.8 x 0.60 x 0.4 x 8,760 x 0.15
= 2,775 kWh/yr.

The energy cost savings (ECS) is given as follows:

ECS = TES x $/kWh
= 2,775 kWh/yr. x ₹8.5/kWh
= ₹23,588/yr.

Implementation

The implementation of this recommendation involves purchase and installation of VSD on the compressor motors. The capital cost (CC) for the VFD is estimated as ₹ 10,000 per compressor. It is estimated that the installation cost of the VSD drive will be 50% of the capital cost. The installation cost (IC) and capital cost (CC) for the installations can be estimated as,

IC = 2 drives × 5,000
= ₹ 10,000

CC = 2 drives × 10,000
= ₹ 20,000

Therefore, total implementation cost (IC) is given as,

IC = CC + LC
= ₹20,000 + ₹10,000
= ₹30,000

The simple payback period (PP) can be calculated as,

PP = (IC / ECS) x 12 months/yr.
= (₹ 30,000/₹ 23,588) x 12
= 16 months

The cost savings of ₹ 23,588/yr. will pay for the implementation cost of ₹ 30,000 within 16 months.

Note: It may be noted that the non-linear loads on motors and VFDs impose power quality problems. The facility is encouraged to periodically check for problems such as harmonics. These undesirable characteristics should be corrected as soon as possible.

Fig 47: Existing Air Conditioners in the facility that can be fitted with VFD

Fig 48: A Sample VFD

8.8 Paint the roof with white Reflective Roof-Top Coating to reduce heat load on two Air conditioners of 50 tons capacity in JSS Ramanuja Road Campus Building

White roofing can reduce the heat gain of a roof, lower the surface temperature and lessen the cooling load of the building. White roofs also extend the life of the roof since the material will expand and contract less from changing temperatures. White roofs are also easy to maintain as they can be recoated, eliminating the need for tearoff over the life of the building. Due to the high solar reflectance, white roofs are sometimes called "cool roofs."

Ceilings can be hot in summers, but not for those living in apartments (not the top floor). But for most single-family homes or apartments at the top of the building, the ceilings face direct sun. Most construction materials are good conductors of heat. That means a room that is directly facing heat from top remains very hot. Thus to cool it, a lot of energy is required by any air conditioner to cool it. If your electricity bills are high and you have rooms that have ceilings that that are exposed to the sun, then getting the right insulation for the ceiling should be your first target. This is especially important for people living in areas that have hot and dry climate, as sun's radiance levels are very high in such regions.

Reflective Roof-Top Coating can reduce ceiling heat

Several researches have shown that external colors of a building have significant impact on cooling load of the building. A white reflective roof coating can potentially reduce up to 60% of heat coming in from the ceiling. But the results vary in different situations. With various experiments, researchers have found savings to vary from 20% to 60% on AC load. Typical rooftop reflective coating paints are made of acrylics, hypalon, neoprene, silicone, urethane and hybrid materials. A quick search on google can provide a list of companies that make and supply reflective rooftop coating paints. Please note that the efficiency of the paint goes down with each passing year, so regular maintenance of the paint is a must to achieve maximum saving

Other benefits of Rooftop coatings

Rooftop coatings not only prevent extra heat from entering a building, but have many other benefits too:

- It can increase the life of the roof by 15 years or more.
- Dense cities with lot of swellings in a small area have tendencies of getting heated up significantly. If houses have reflective rooftops, then the amount of heat waves can be reduced.
- In general it can add to greening by reducing waste and saving electricity.

Fig 49: Existing Roof in Ramanuja Road Building and Proposed white paint for the roof

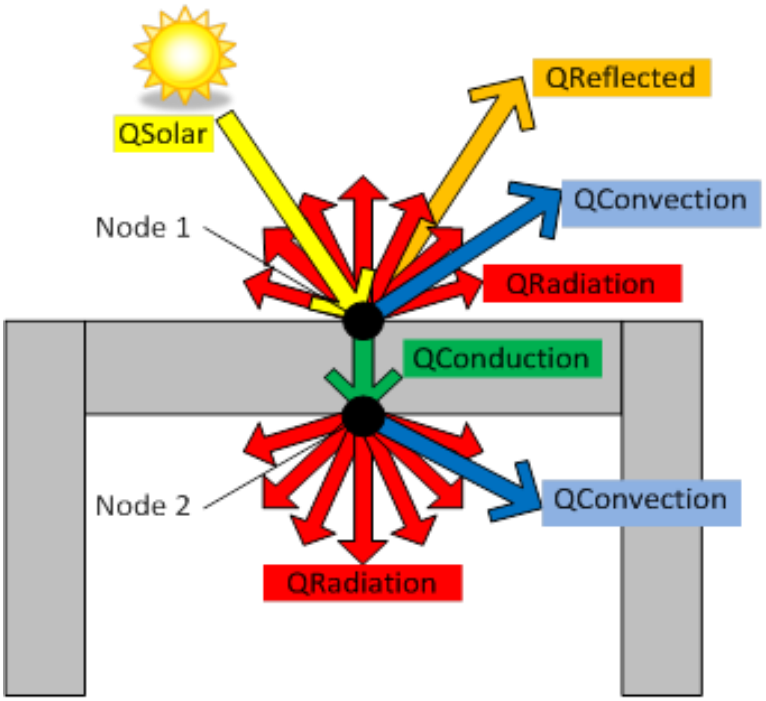


Fig 50: Heat Transfer Schematic for a Roof

The Skill lab of JSS Ramanuja road campus is fully air-conditioned and lies directly beneath the dark roof and has no insulation and hence is receiving heat from sun light that falls on the roof. The roof in JSS Ramanuja Road building is made out of bricks and is red in colour and hence it is recommended to paint the roof with white reflective coat painting. A standard white roof has an absorptivity of about 0.2, meaning 20% of the incident radiation is absorbed and the other 80% is reflected. AC load reduction of 20% is estimated for this recommendation conservatively.

The energy savings on two 50 ton AC can be estimated as follows.

ES = TkW x LF x UF x OH x %S

Where,

TkW	=	Total Input power (2 x 32 hp x 0.746 kW/hp = 48 kW)
LF	=	Load factor
UF	=	Usage factor
OH	=	Operating hours per year, 2 hrs/day x 300 days/yr = 600
%S	=	Percentage Savings, 20%

ES = 48 x 0.8 x 1 x 600 x 0.2

= 4,608 kWh/yr

The energy cost savings (ECS) is given as follows:

ECS = TES x $/kWh

= 4,608 kWh/yr. x ₹10/kWh

= ₹46,080/yr.

The implementation of this recommendation involves painting the roof with white reflective coating and the cost of the coating is estimated as ₹ 15/Sq. Ft. The total area of the roof is approximately 12,000 Sq. Ft. So, the total implementation cost will be as follows.

IC = Paint Cost / Sq. Ft. x Total Sq. Ft.

= ₹ 15/Sq. Ft. x 12,000 Sq. Ft.

= ₹180,000

The simple payback period (PP) can be calculated as,

PP = (IC / ECS) x 12 months/yr.

= (₹ 180,000/₹ 46,080) x 12

= 47 months

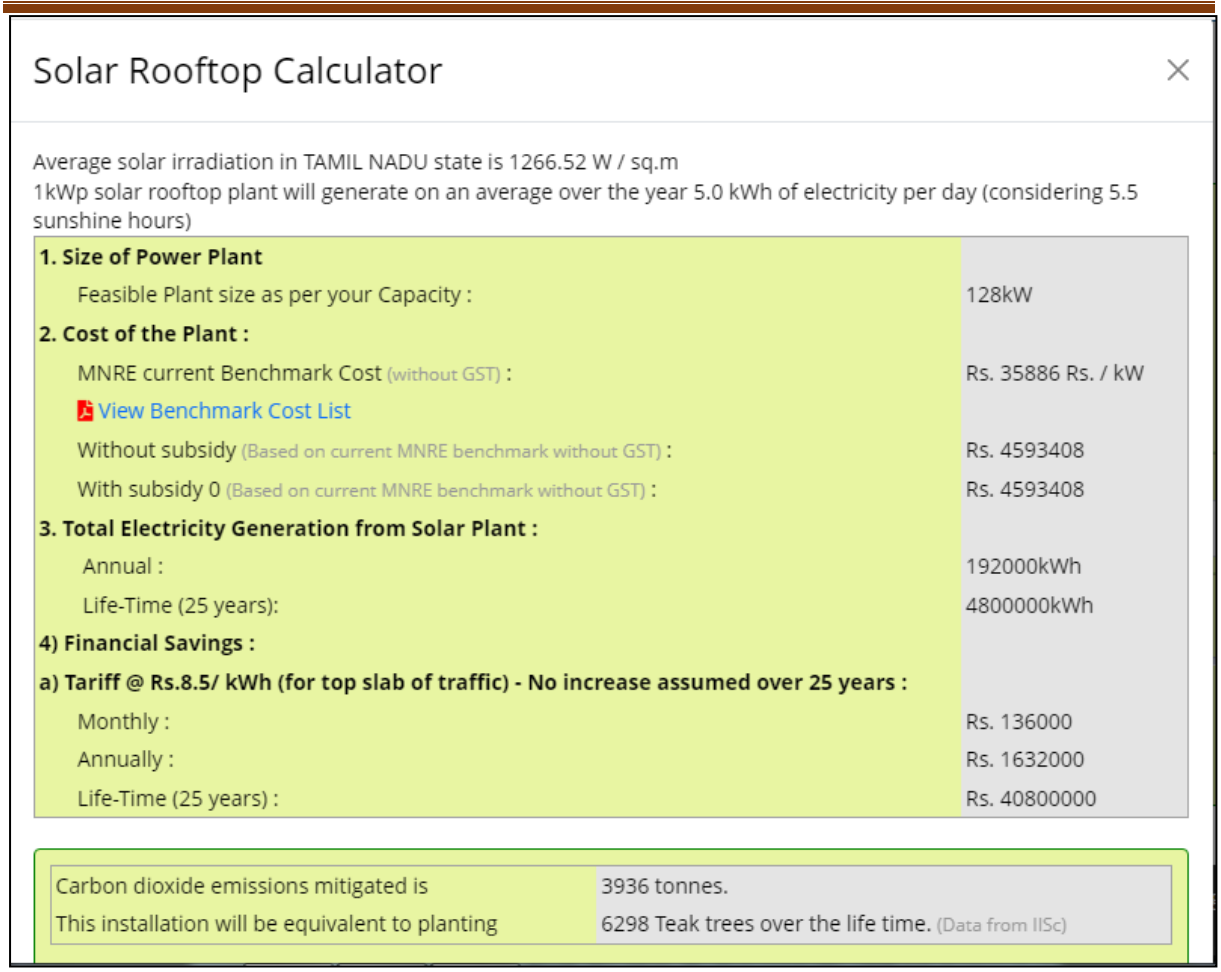
The cost savings of ₹ 46,080/yr. will pay for the implementation cost of ₹ 180,000 within 47 months.

8.9 Install Solar PV Rooftop in JSS College of Pharmacy, Ooty Campus

Average solar irradiation in TAMIL NADU state is 1266.52 W / sq.m. 1kWp solar rooftop plant will generate on an average over the year 5.0 kWh of electricity per day (considering 5.5 sunshine hours). Calculations to Install Solar PV Rooftop in JSS College of Pharmacy, Ooty Campus is shown in Table 34.

Table 34: Calculations to Install Solar PV Rooftop

Recommended Size of Power Plant	128 kW
Cost of the Plant: MNRE current Benchmark Cost (without GST) :	Rs. 35886 / kW
Total cost (without subsidy) in Rs.	Rs. 45,93,408/-
Total Electricity Generation from Solar Plant annually in kWh	1,92,000 per year
Annual Financial Savings in Rs.: Tariff @ Rs.8.5/ kWh (for top slab of traffic) - No increase assumed over 25 years	16,32,000
Carbon dioxide emissions mitigated is	3,936 tonnes.
installation will be equivalent to planting	6,298 Teak trees over the life time
Simple Payback period	(45,93,408/16,32,000)*12 =34 months



Solar Rooftop Calculator

Average solar irradiation in TAMIL NADU state is 1266.52 W / sq.m
1kWp solar rooftop plant will generate on an average over the year 5.0 kWh of electricity per day (considering 5.5 sunshine hours)

1. Size of Power Plant	
Feasible Plant size as per your Capacity :	128kW
2. Cost of the Plant :	
MNRE current Benchmark Cost (without GST) :	Rs. 35886 Rs. / kW
View Benchmark Cost List	
Without subsidy (Based on current MNRE benchmark without GST) :	Rs. 4593408
With subsidy 0 (Based on current MNRE benchmark without GST) :	Rs. 4593408
3. Total Electricity Generation from Solar Plant :	
Annual :	192000kWh
Life-Time (25 years):	4800000kWh
4) Financial Savings :	
a) Tariff @ Rs.8.5/ kWh (for top slab of traffic) - No increase assumed over 25 years :	
Monthly :	Rs. 136000
Annually :	Rs. 1632000
Life-Time (25 years) :	Rs. 40800000

Carbon dioxide emissions mitigated is	3936 tonnes.
This installation will be equivalent to planting	6298 Teak trees over the life time. (Data from IISc)

Fig 51: Solar Roof Top PV Power Plant Calculator

General Recommendations

- All Classrooms 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.
- 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.
- 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.
- Install circuit breakers for each floor of the building to improve electrical safety.
- Check the quality of wiring and replace if required.
- Check old circuit breakers and replace them if required.
- Conduct functionality tests on earthing and earthing pits.

Executive Recommendations

- Energy auditing inside the premises 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 i.e., solar, wind, Biogas energy. College Facility should take initiative to arrange seminars, lectures, paper presentation competition etc., for general awareness.
- Regular electric lines installed above the ground are getting damaged due to wind and rain by trees in some areas of the campus (Figure 52) and these areas are staying darker in the night due to this reason and hence it is recommended to improve street light facility in these dark regions of the campus by installing underground cables.

Fig 52: Trees touching the electric lines in the Medical College campus

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APPENDIX

Fig 53: Pre-audit discussion between JSS Consultants and JSS AHER staff

Fig 54: JSS Consultants Energy Audit Team that visited JSS AHER Campus, Mysuru

Fig 55: JSS Consultants Energy Audit Team that visited JSS Pharmacy Campus, Mysuru

Fig 56: JSS Consultants Energy Audit Team that visited JSS Ramanuja Road Campus, Mysuru

Fig 57: JSS Consultants Energy Audit Team that visited JSS Pharmacy College, Ooty

Fig 58: Organic wet waste stacked in JSS Pharmacy College, Ooty Campus – candidate for Bio-Digester

Fig 59: Torn Insulation on 50 Ton AC in JSS Ramanuja Road Campus, Mysuru