ENERGY AUDIT CERTIFICATE

This is to certify that Walk Through Energy Audit for Government Kamala Raja Girls Post Graduate (Autonomous) College, Gwalior Madhya Pradesh was conducted in April – 2022 to assess Energy Costs, Availability and Reliability of Supply of Energy, Energy Conservation Technologies and to Explore Energy Saving Avenues to Reduce Energy Consumption.

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Govt. Kamla Raja Girls Post Graduate Autonomous College * GWALIOR (M.P.) *

REPORT OF ENERGY AUDIT

Submitted to

GOVERNMENT KAMLA RAJA POST GRADUATE GIRLS AUTONOMUS COLLEGE GWALIOR

Date of Audit:

25 APRIL 2022 - MONDAY

Submitted by

VISION INFRA DEVELOPER LIG-950 DARPAN COLONY THATIPUR GWALIOR-474011

Contents

1. Introduction

An energy audit is a survey in which the study of energy flows for the purpose of conservation is examined at an Organization. It refers to a technique or system that seeks to reduce the amount of energy used in the Organization without impacting the output. The audit includes suggestions of alternative means and methods for achieving energy savings to a greater extend. Conventionally, electrical energy is generated by means of fossil fuels, hydraulic and wind. The availability of fossil fuels and their depletion rate, insist the need for alternate energy systems and conservation of electric energy. In general, the primary objective of an energy auditing and management of energy consumption is to offer goods or services at the lowest possible cost and with the least amount of environmental impact. The need for an energy audit is to identify the savings potential and cost reducing methods, understand the ways in which fuel is used, where; the waste occurs and find the scope for improvement.

An energy audit is proposed and conducted to ensure that energy saving practices is implemented and followed in Educational Institutions and Industrial sectors in a sustainable way. Preparation and completion of a questionnaire, physical examination of the campus, observation and examination of documentation, key person interviews,data analysis, measurements and suggestions are all part of the audit process. Energy audit involves several facts including energy savings potential, energy management, finding alternatives, etc. With these facts in mind, the audit's specific objectives are to assess the competence of the sustainability management and control system, as well as the departments' compliance with applicable rules, policies and standards. It has the potential to have a significant influence on the organization's operational cost as well as the environmental impact.

Energy Conservation Building Code (ECBC) is established in the year 2017 which provides minimum requirements for the energy-efficient design and construction of buildings across India. It also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements. Bureau of Energy Efficiency (BEE) came into force in 2002 towards implementation of energy saving practices in an Organization. Energy-efficiency labels are information affixed to manufactured products and usually communicate the product energy performance. BEE has developed a scheme for energy efficiency labeling of buildingscoinciding with the star ratings of the building at accelerating energy efficiencyactivities. BEE Star Rating Scheme is based on actual performance of the building as well as equipment in terms of specific energy usage termed as 'Energy Performance Indicator' by means of star ratings labeled items used which will be useful for energy savings in a sustainable manner.

Energy audit programme provide aid in maintaining a focus on energy price variations, energy supply availability and efficiency, determining an appropriate energy mix, identifying energy-saving technology, retrofitting for energy-saving equipment and so on. In general, an energy audit process dealt with the driving conservation concepts into reality by giving technically possible solutions within a specified time limit while also considering the economic and other organizational issues. It also dealt with the uncover ways to cut operating expenses or reduce energy use per unit of production in terms of savings. It serves as a "benchmark" (reference point) for managing energy in the organization for planning more energy- efficient use across the board.

2. Need for an Energy Audit

In any Organization, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a "bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

Eco-campus concept mainly focuses on the efficient use of energy and its conservation including savings opportunities in a sustainable manner. It also focuses on the reduction of contribution to carbon emissions, carbon footprint calculation, procurement of star rated equipment for a cost effective and secure supply of energy, encourage and enhance energy use conservation in all buildings, reduce the organization's energy consumption, reduce wastes to landfill, and integrate environmental considerations into all contracts and services considered to have significant environmental impacts.

Auditing for Energy Management may be studied in terms of energy savings and opportunities. In general, energy cannot be seen, but we know it is there in wire, pipes and other non-living materials because we can see its effects in the forms of heat, light and power. This indicator addresses energy consumption, energy sources, energy monitoring, lighting, vehicle movement, electrical and electronics appliances, and transportation. Energy use is clearly an important aspect of campus sustainability and thus requires no explanation for its inclusion in the assessment. However, energy saving and opportunities may be taken into consideration while energy is extensively used. Anold incandescent (tungsten) bulb uses approximately 60W to 100W while an energy efficient light emitting diode (LED) uses only less than 10W which indicated the positive indication on energy savings. Energy auditing deals with the conservation and

Methods to reduce its consumption related to environmental degradation. In addition, suggestions and recommendations might be given after auditing which in turn useful for energy savings. It is therefore essential that any environmentally responsible institution examine its energy use practices at least once in two years using internal and external auditors.

The conduct of energy audit using internal and external energy auditors is playing important role in any organization in terms of energy management. It is able to measure the impact of energy potential in an organization so that we can determine better ways to manage the impact on environment. In addition to the water, liquid and solid wastes, biomedical and electronic wastes energy potential and biodiversity audits, attempts may be made to measure the carbon footprint in the organization based on the amount of carbon emissions created by the electrical appliances, vehicles and human population. It undertakes the measure of bulk of carbon dioxide equivalents exhaled by the organization through which the carbon accounting is done. It is necessary to know how much the organization is contributing towards sustainable development in terms of energy management is being done. It is therefore to recommend to measure the carbon footprint in each organization which may be useful for maintaining the eco friendly campus to the stakeholders.

3. Aims and Objectives of an Energy Audit

An energy audit is a useful tool for developing and implementing comprehensive energy management plans of an Organization. The aim of an energy audit is to identify the energy efficiency, conservation and savings opportunities at the premises of the audit sites in a systematic manner. The audit process is carried out as per the following.

- Review of energy saving opportunities and measures implemented in the audit sites.
- Identification of additional various energy conservation measures and saving opportunities.
- Implementation of alternative energy resources for energy saving opportunities and decision making in the field of energy management.
- Providing a technical information on how to build an energy balance as well as guidance to be sought for particular applications.
- Detailed analysis on the calculation of energy consumption, analysis of latest electricity bill of the campus, understanding the tariff plan provided by the central and State Electricity Board.
- List ways that the use of energy in terms of electricity, electric stove, kettle, microwave, LPG, firewood, Petrol, diesel and others.
- Analysis of electricity bill amount for the last two to three years, amount paid for LPG cylinders for last one year and amount paid for water consumption for human beings and watering to the plants.
- Use of incandescent (tungsten) bulb and CFL bulbs, fans, air conditioners, cooling apparatus, heaters, computers, photo copiers, inverter, generators and laboratory equipment and instruments installed in the organization (for example- 60 watt bulb x 4hours x number of bulbs = kwh).

- Alternative energy sources / nonconventional energy sources are employed / installed in the organization (photovoltaic cells for solar energy, windmill, energy efficient stoves, Biogas, etc.).
- Creating awareness among the stakeholders on energy conservation and utilization.

4. Benefits of an Energy Audit

- **Reduced Energy Expenses:** The most obvious benefit is that the less energy the Organization uses the less money that the Organization will have to spend on energy costs.
- **Identify Problems:** An energy audit can also help to identify any issues that the equipment might have. For example, the auditor could find small leaks in the compressed air system. These leaks would cost a significant amount of money if it is not noticed. Auditors can also detect dangerous health risks like the carbon monoxide that's emitted from equipment that hasn't been vented properly. With a regular energy audit, the organization will be able to address these kinds of issues promptly to help ensure the health and safety of the staff members.
- **Increased Employee Comfort:** During the audit, the Organization might learn about changes that have been made regarding insulation and air sealing. Completing these enhancements will help create a more reliable and more efficiently cooled or heated space for the employees. In turn, more comfortable employees tend to be more productive, so not only will the Organization save on energy costs, but may also improve overall well-being.
- **Personalized Recommendations:** Working with an energy expert can help learn about new energy-efficient technologies. The professional will customize a plan, recommending which upgrades will give the most return on investment. These might include updated lighting systems, a new HVAC system, weatherization measures like insulation and air sealing, and more. While some of the recommendations might have a substantial up-front cost that many of them will pay for themselves in a short period of time with significantly reduced energy expenses.
- **Show Environmental Concern:** By taking steps to be more energy efficient, the Organization will be showing the employees and clients that the organization cares about the impact on the environment.
- **Increased Property Value:** Using the recommendations of an energy auditor to make facility more energy efficient could also help to increase its overall worth. Things like solar panels, high-efficiency LED lighting, and weatherization procedures are all things that contribute to a higher property value.
- **Longer Equipment Lifespan:** An energy auditor might recommend updating some of the equipment for maximum energy savings. If the Organization decides to upgrade, it will not only save on energy costs, but also expect the equipment to last a long time. This is because newer, more energy-efficient equipment doesn't have to work as hard as older, outdated units to provide the same level of performance.
- **Energy audit evaluation:** Energy audits will evaluate the Organization "as a whole", the goal is not to evaluate single measures but to consider a wide range of available alternatives (Electrical, Mechanical, Envelope and Water).

- **Energy audit Opportunities:** The audit will not only inform about the opportunities but also provide information with financial analysis. This will enable prioritization based on financial benefit and return on investment. It provides technical information regarding the proposed energy conservation measures.
- **Energy audit quality analysis:** A good quality audit will analyze the historical energy use and find potential issues using statistical methods. Provide information with emissions analysis to help understand the benefits of the decisions from an environmental standpoint. Understand where energy is used and which areas are worth focusing on the most. Provide benchmark information to help understand the energy use performance compared to others.

5. Procedures followed in an Energy Audit

In order to conduct an energy audit, several methods are adopted in the audit sites in which walk-through audit is conducted. The balance of total energy inputs with total energy outputs and identification of all energy streams in a facility are taken into account. The amount of energy used by each of its energy streams are calculated as per the methodology mentioned in the Manual of B.E.E. The top three operating expenses of the Organization are typically observed to be energy (both electrical and thermal), labour and materials. During the audit, physical verification ofLighting, Ceiling, Table and Exhaust Fans, A/C machines, Solar panels, Heaters, Generators, Uninterrupted power supply machines and ventilators load fixtures and verification of installed energy efficient system's capacities are carried out. Inspection of when the cost or prospective cost savings in each of the above components are considered, energy always wins, and the energy management task becomes a key cost reduction area. The energy audit assisted in better understanding how energy and fuel are used in the Organization as well as identifying waste factors and development potential towards energy savings opportunities. Finally after the audit process, the energy audit included suggestions for energy cost reduction, preventive maintenance and quality control activities, all of which are critical for the utility operations in the auditee (Organization).

The audit involved visiting the campus and physical verification of the loads and sources installed. The entire campus is divided into different sections and those sections are audited in which electrical fittings and energy supplies are monitored. The productionprocess flow is studied and electricity consumption is measured. Location of the electrical machines, conditions of them and their accessories are inspected through physical verification is observed as per the regulation of Indian Green Building Council(IGBC, 2021) and World Green Building Council (WGBC, 2021). The energy bill fromthe supply utility is audited and assessed for the load demand requirementand efficient consumption of energy. Stakeholders are interacted with the scope for improvement and energy management during the audit. Potential areas in which the scope of energy conservation and saving opportunities available in the current context have been identified and suggested for implementation to the Organization. The level of carbon dioxide might be measured in different places across the Organization campus using a portable CO_2 Analyzer to calculate the carbon footprint. It may be useful to check where carbon emission is prominent which could be taken into account to reduce.

The audit involves visiting physical position of load & carry out inventory of load. Due measurement of electrical load of equipment & circuit is carried out. Energy bill received from M.P.M.K.V.V.C.L is audited & studied for KWH requirement & how efficiently energy is used. Various positions are interacted, familiarized with energy audit & involved for successful & result oriented energy audit. Energy conservation & saving opportunities are identified during round & measurement for implementation.

6. Types of Energy Audit

The type of Energy Audit to be performed depends on:

- Function and type of industry
- Depth to which final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following types.

I. Preliminary Energy Audit
II. Detailed Energy Audit
III. Potential and magnitude of Energy Audit
IV. Comprehensive Energy Audit

6.1. Preliminary Energy Audit Methodology

Preliminary energy audit is a relatively quick exercise to:

- Establish energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely (and the easiest areas for attention
- Identify immediate (especially no-/low-cost) improvements/ savings
- Set a 'reference point'
- Identify areas for more detailed study/measurement
- Preliminary energy audit uses existing, or easily obtained data.

6.2. Detailed Energy Audit Methodology

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost. In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges. Detailed energy auditing is carried out in three phases: Phase I, II and III.

Phase I - Pre Audit Phase
Phase II - Audit Phase
Phase III - Post Audit Phase

6.3. Potential and Magnitude of Energy Audit

A structured methodology to carry out an energy audit is necessary for efficient working. An initial study of the site should always be carried out, as the planning of the procedures necessary for an audit is most important.

Initial Site Visit and Preparation Required for Detailed Auditing

An initial site visit may take one day and gives the Energy Auditor/Engineer an opportunity to meet the personnel concerned, to familiarize him with the site and to assess the procedures necessary to carry out the energy audit.
During the initial site visit the Energy Auditor/Engineer should carry out the following actions: -

- Discuss with the site's senior management the aims of the energy audit.
- Discuss economic guidelines associated with the recommendations of the audit.
- Analyze the major energy consumption data with the relevant personnel.
- Obtain site drawings where available – building layout, steam distribution, compressed air distribution, electricity distribution etc.
- Tour the site accompanied by engineering/production

The main aims of this visit are:

- To finalize Energy Audit team
- To identify the main energy consuming areas to be surveyed during the audit.
- To identify any existing instrumentation/ additional metering required.
- To decide whether any meters will have to be installed prior to the audit eg. KWh,steam, oil or gas meters.
- To identify the instrumentation required for carrying out the audit.
- To plan with time frame
- To collect macro data on major energy consuming centers
- To create awareness through meetings/ programme.

6.4. Comprehensive Energy Audit

Depending on the nature and complexity of the site, a comprehensive audit can take from several weeks to several months to complete. Detailed studies to establish, and investigate, energy and material balances for specific plant departments or items of process equipment are carried out. Whenever possible, checks of plant operations are carried out over extended periods of time, at nights and at weekends as well as during normal daytime working hours, to ensure that nothing is overlooked.

The audit report will include a description of energy inputs and product outputs by major department or by major processing function, and will evaluate the efficiency of each step of the Organization. Means of improving these efficiencies will be listed, and at least a preliminary assessment of the cost of the improvements will be made to indicate the expected payback on any capital investment needed. The audit report should conclude with specific recommendations for detailed engineering studies and feasibility analyses, which must then be performed to justify the implementation of those conservation measures that require investments. The comprehensive energy audit may be useful to identify the consuming areas to be surveyed during the audit and to identify any existing instrumentation/ additional metering required. A care should be taken to identify the instrumentation required for carrying out the audit and to plan with time frame including the collection macro data on major energy consuming centers. It will be definitely useful for energy management towards energy savings opportunities.

The information to be collected during the detailed audit includes:

1. Energy consumption by type of energy, by department, by major items of process equipment, by end-use
2. Energy cost and tariff data
3. Generation and distribution of site services (eg. compressed air, steam).
4. Sources of energy supply (e.g. electricity from the grid or self-generation)
5. Potential for fuel substitution, process modifications, and the use of co-generation systems (combined heat and power generation).
6. Energy Management procedures and energy awareness training programs within the establishment.

   Existing baseline information and reports are useful to get consumption pattern. The audit team should collect the following baseline data:

   - Technology, processes used and equipment details
   - Capacity utilization
   - Water consumption
   - Fuel Consumption
   - Electrical energy consumption
   - Steam consumption
   - Efficiencies / yield

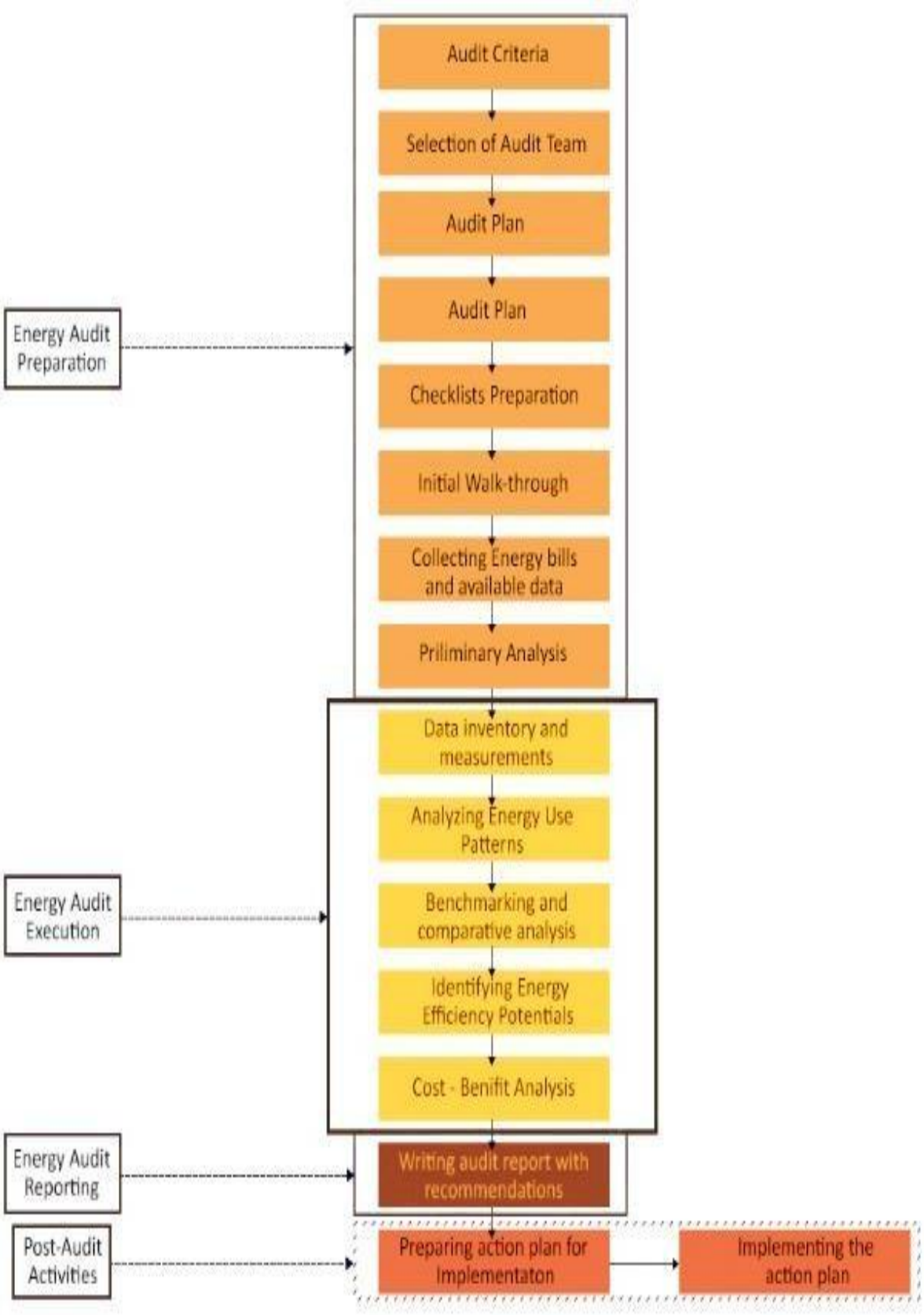
7. Carbon footprint by measuring Carbon dioxide level in the Campus

The level of Carbon dioxide is measured in different places across the Organization campus using a portable CO_2 Analyzer (Non dispersive infra-red meter). In addition, CO_2 meter is also displayed the readings of atmospheric temperature, relative humidity and dew point in the places, where the level CO_2 is measured. The meter started measurements of CO_2 level in the atmosphere after powered ON and updated the readings every second in the display screen. If the operating environment is changed (example from high to low temperature) which took 30 seconds for CO_2 sensor to respond and 30 minutes for flexibility in relative humidity. The meter features an audible alarm to give warnings when CO_2 concentration exceeds the set limit. It emits beeps (Abt.80Db) when CO_2 level goes over the set value and stops when any key (except SET) is pressed or the readings fall below the set values.

The Carbon footprint per year is calculated (www.carbonfootprint.com) based on electricity usage per year in which CO_2 emission from electricity and the sum of transportation per year in terms of number of the shuttle buses service operated by the Organization and number of cars, motorcycles and trucks entering in the Organization campus. These factors are multiplied with total number of trips in each day and approximate travel distance of vehicles covered in each day with a coefficient (0.01) to calculate the emission of CO_2 in metric tons per year.

Humans contribute an increase of carbon dioxide emissions by burning fossil fuels, deforestation, and cement production. Methane (CH_4) is largely released by coal, oil, and natural gas industries. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. The largest source of greenhouse gas emissions from human activities is from burning fossil fuels for electricity, heat, and transportation.

The Methodology of the Audit is presented in the following chart:



Flow chart of Energy Audit Methodology

Calculating Carbon footprint

8. Energy Audit Process

Energy audit is a sequence of tasks performed in a planned manner. It requires discussion, survey, collection of data, analysis, and reporting.

Open Meeting for the conduct of Energy Audit process

Walk through Energy audit process

8.1. Steps involved in an Energy Audit

Step 1: Opening meeting among the audit team and auditees
Step 2: Planning and organizing the energy audit
Step 3: Conduct a walk-through audit at different sites
Step 4: Macro data collection and observation
Step 5: Analysis of data collected from the Organization
Step 6: Best practices followed in the Organization towards energy savings
Step 7: Recommendations for further improvement
Step 8: Exit meeting after the audit to discuss about the audit findings

8.2. Systems studied during the Energy Audit

- Physical verification of lighting, fan a/c machines, ventilators load fixtures.
- Verification of installed energy efficient systems.
- Inspection of Solar panel, Generators, Uninterrupted power supply machines.
- Inspect and verify the maintenance aspects of installed Generators and additional backup power sources.
- Analyze the electricity consumption through the supply utility company (Example: Tamil Nadu Electric Generation and Distribution Corporation Limited, Chennai).
- Review the potential usage of alternative energy resources.
- Review the energy conservation awareness among the stakeholders for optimum use of electricity and its savings.

8.3. Planning and organizing the Energy Audit

Planning and organizing are the integral part of the energy audit. An initial visit to the audit sites is organized and the areas to be inspected are listed. Following the listing, information on the energy consumption of various blocks in the recent past is obtained, and a planned analysis is carried out.

8.4. Walk-through Audit Process

Simple audit, screening audit or visual audit are the other names, by which walk-through audits are addressed. The main purpose of the walk-through audit is to obtain general information about the sites in which electrical energy is being used at the maximum. More specific information has been obtained from the maintenance and operational people during the time walk-through audit. It also included a walk-through of the facility to become familiar with the building's operation and a brief evaluation of facility utility bills (amount paid for electricity) and other operating data. During the audit the primary problem areas are discovered.

8.5. Macro Data collection and observation

Current level operation and practices within the campus are assessed and then the data regarding the number of electrical loads connected in each section are collected. The power ratings of each component and their respective hours of operation are also observed and documented for preparing the recommendations to the Organization.

8.6. Measurements in the Energy Audit process

An energy audit required measurements, such as the energy identification and quantification, and these quantities necessitate the instruments used in a consistent way. Some of the basic electrical parameters are monitored during the energy audit such as Voltage (V), Current (I), Power factor, active power (Kw), apparent power (demand in Kva), reactive power (Kvar), energy consumption (Kwh), frequency (Hz), harmonics, illumination level, etc. Temperature and heat flow, radiation, air and gas flow, liquid flow, speed, air velocity, noise and vibration, dust concentration, TDS, Ph, moisture content, relative humidity, flue gas analysis – CO_2, O_2, CO, SO_x, NO_x, combustion efficiency are the mechanical, thermal and other parameters that are analysed during the audit depending upon the requirements.

9. About the Institution

Government Govt. Kamla Raja Girls Post Graduate (Autonomous) College is conveniently situated in a prominent location of south-west Gwalior and having a sprawling campus. Established in 1937 A.D., the college occupies a prominent place and has wide reputation among the institutes of higher education not only in the state of Madhya Pradesh but also in other states of Northern India, because of the academic achievements, the infrastructural properties and the financial richness of the college. The college is affiliated to Jiwaji University, Gwalior and recognized by UGC under section 2(f) and 12(b) of the Act, 1956.

In recognition of its significant achievements, the UGC and the state government granted autonomy to the college in 1996. As an Autonomous college, it has created many opportunities inside for the inclusion of new courses apart from the courses which have already been regularized by the Govt. of Madhya Pradesh. Apart from a good amount of financial aid from the University Grants Commission, New Delhi, it receives rupees twenty lacs as autonomous grants each year for the expenses of Autonomy. The National Assessment and Accreditation Commission awarded the college 'B' grade in 2004 and 2010, and in 2016 it is reaccredited with the grade 'A'.

The college aims to facilitate and promote studies; research and extension work in the emerging area of higher education with the expansion of women education. It offers courses in disciplines of Arts, Social Science, Commerce, Management, Computer Science, Life Sciences, Physical Science, Home Science and

law. Presently the student strength is nearly ten thousand and 232 research scholars are doing research work in various disciplines. The college has a phenomenal range of 112 qualified regular and 59 guest faculty members. Besides, Commerce and Home Science faculty, seventeen undergraduate departments under the faculty of Arts and seven Science departments under the faculty of Science, offer various courses. Twenty departments offer twenty three master's degree and one Post Graduate Diploma course. It is the only institution in this region where Urdu language is taught at the Post Graduate level. The college has a marvelous central library, computer labs, sports wing and a canteen to cater the needs of college family. The units of N.S.S. and N.C.C. of this college organize popular lectures on health and hygiene programs, social work, AIDS awareness, moral education and women empowerment in collaboration with NGO's in the area.

Strengthened by the benefits of Autonomy and commendably supported by the Janbhagidari Samiti, the college has expended its resources productively and has ensured their optimal use. By the well planned and well-thought schemes of the Principal, the College has expanded some new blocks for the studies of Job-Oriented courses such as B.B.A, P.G.D.C.A., B.A.L.L.B. (Honors'), B.C.A. and a few others. Apart from 23 regular departments a few departments such as Computer Science, Management, Bio-technology and Law have been expanded recently. Besides regular courses subjects like Micro-biology, Bioinformatics, Industrial Chemistry and Electronics are run under self-finance scheme in the science faculty.

Short Term Certificate Courses have been introduced by the college since 2016 to provide students additional vocational skills along with the regular degree courses offered. The college has also adopted a comprehensive view to develop professionalism. At the time of admissions a special counseling cell is set up for giving proper guidance to students in the right selection of subjects and combinations.

Many of the faculty members have attended national and international seminars and published their papers in national, international refereed journals and anthologies. They have also published reference and text books. The alumni of the College occupy distinguished positions in almost all spheres of society, government, bureaucracy, banking, finance, academics, business, politics, journalism and media. Many are successfully managing their own business establishments and doing social work. Our students have been performing remarkably well in all spheres of life. A large number of our students get selected by national and multinational companies through campus interviews.

It has been a long journey through the eighty years and yet the journey has perhaps just begun. However, the college continuously spread its wings to onwards march in scaling the new heights for pursuing the progress of women higher education

10. Audit Details

Date/Day of Audit	: 25 Apr 2022 – Monday
Venue of Audit	: Government Kamla Raja Girls P.G Autonomous College Gwalior
Audited by	: M/s Vision Infra Developer, Gwalior
Audit type	: Energy Audit
Name of Lead Auditors	: (1) Dr. Sanjay Swarnkar (Coordinator IQAC) (2) Prof. Anand Kumar Singh (HOD computer Dept.)
Name of Energy Auditors	: Er. Mrs. Kratika Gupta BEE Certified Energy Auditor,

11. Observations of the Energy Audit

11.1. Facilities visited during the Energy Audit

Sl No.	COLLEGE DEPARTMENTS	POWER CONSUMPTION IN Kw
1	ACADEMIC BLOCK	58.453
2	POLITICAL SCIENCE DEPT.	4.476
3	COMPUTER DEPT.	4.65
4	MUSIC DEPT.	7.548
5	PSYCHOLOGY DEPT.	12.784
6	BIO TECH DEPT.	1.35
7	CHEMISTRY DEPT.	3.459
8	PHYSICS DEPT.	1.7
9	SMART CLASS	8.378
10	ZOOLOGY DEPT.	8.748
11	ECONOMICS DEPT.	3.13
12	COMMERCE DEPT.	4.228
13	HISTORY DEPT.	4.13
14	MATHS DEPT.	1.5
15	GEOGRAPHY DEPT.	1.574
16	PRINCIPAL OFFICE	6.944
17	HINDI DEPT.	28.346
18	HOME SCIENCE DEPT.	6.845
19	PHILOSOPHY DEPT.	0.8
20	FINE ART DEPT.	3.456
21	LIBRARY	5.069
22	GANGA HOSTEL	41.554
23	SARASWATI HOSTEL	28.99

In the sections, the services offered are monitored, verified and analyzed on the aspects of energy consumption. In all these areas lighting systems forms the major consumer of electrical energy. Three phase electricity service connections available in the campus are provided by Madhya Pradesh Madhya Kshetra Vidhut Vitran Nigam Limited .The electricity consumption charges are audited and studied for the load demand requirement and efficient consumption of energy. Stakeholders are interacted and the scope for improvement has been discussed. Potential areas in which scope of energy conservation and saving opportunities available have been identified and suggested for implementation.

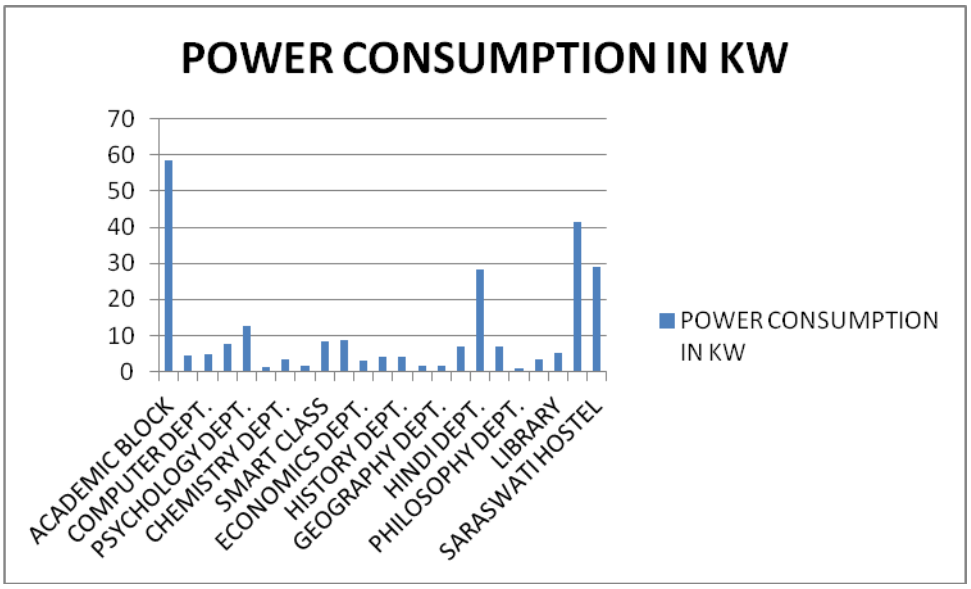
11.2. Systems Studied during the Energy Audit

1. Lighting fixtures were verified physically.
2. Installation of energy efficient lighting systems was verified.
3. Installation of safety systems were verified
4. Installation of power backup systems (generators and UPS) was verified on the aspect of maintenance and consumption.
5. Electricity consumption through the MPMKVVCLbills was analyzed.
6. The energy conservation awareness among the stakeholders for optimum use of electricity and its savings were reviewed.

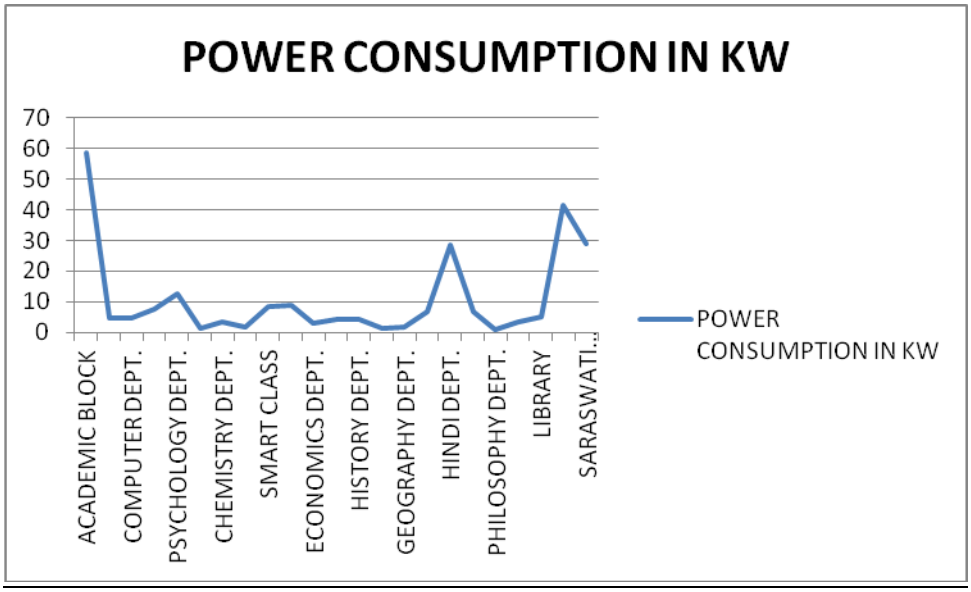
STUDY OF GENERATERS AND PANELS IN GOVERMENT KAMLARAJA P.G. GIRLS COLLAGE

11.3. Energy Consumption and Cost Profile

The following chart shows the profile of energy consumed and the cost for one year by the stakeholders.



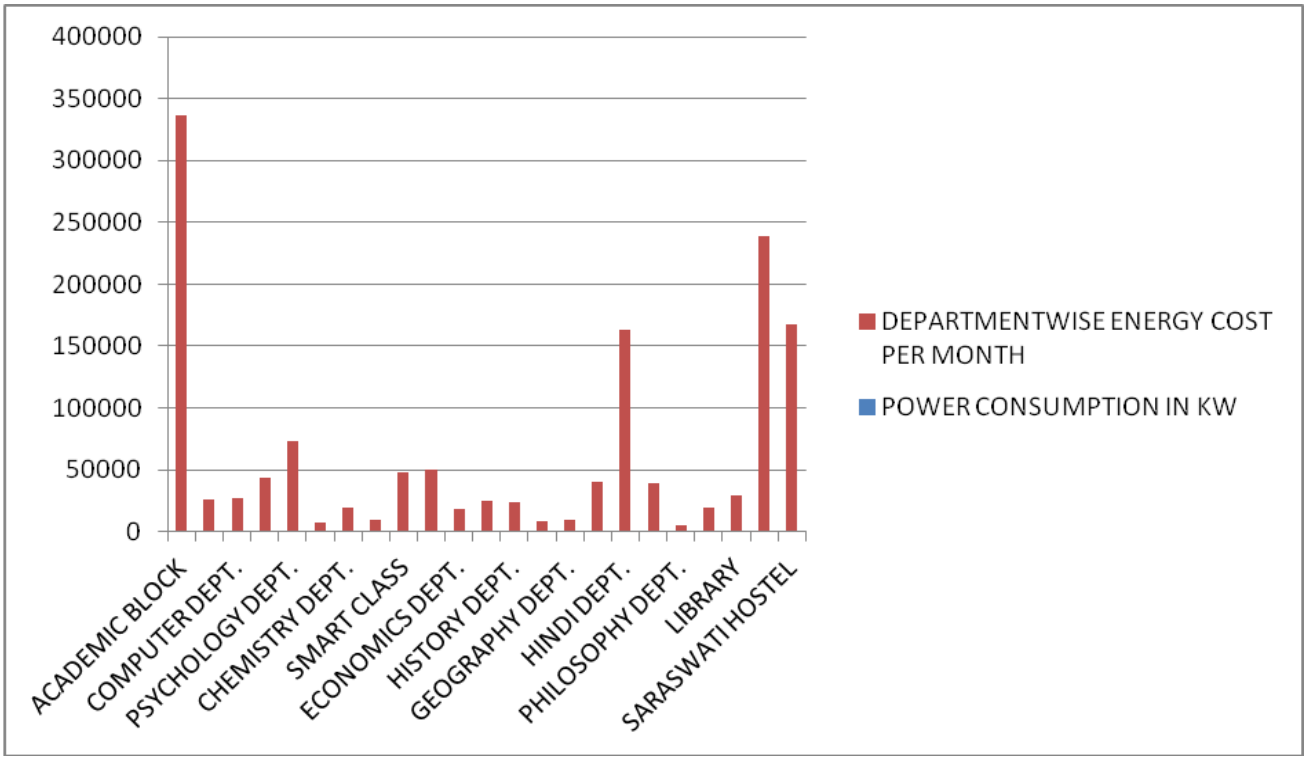
ENERGY CONSUMPTION PROFILE PER DEPARTMENT



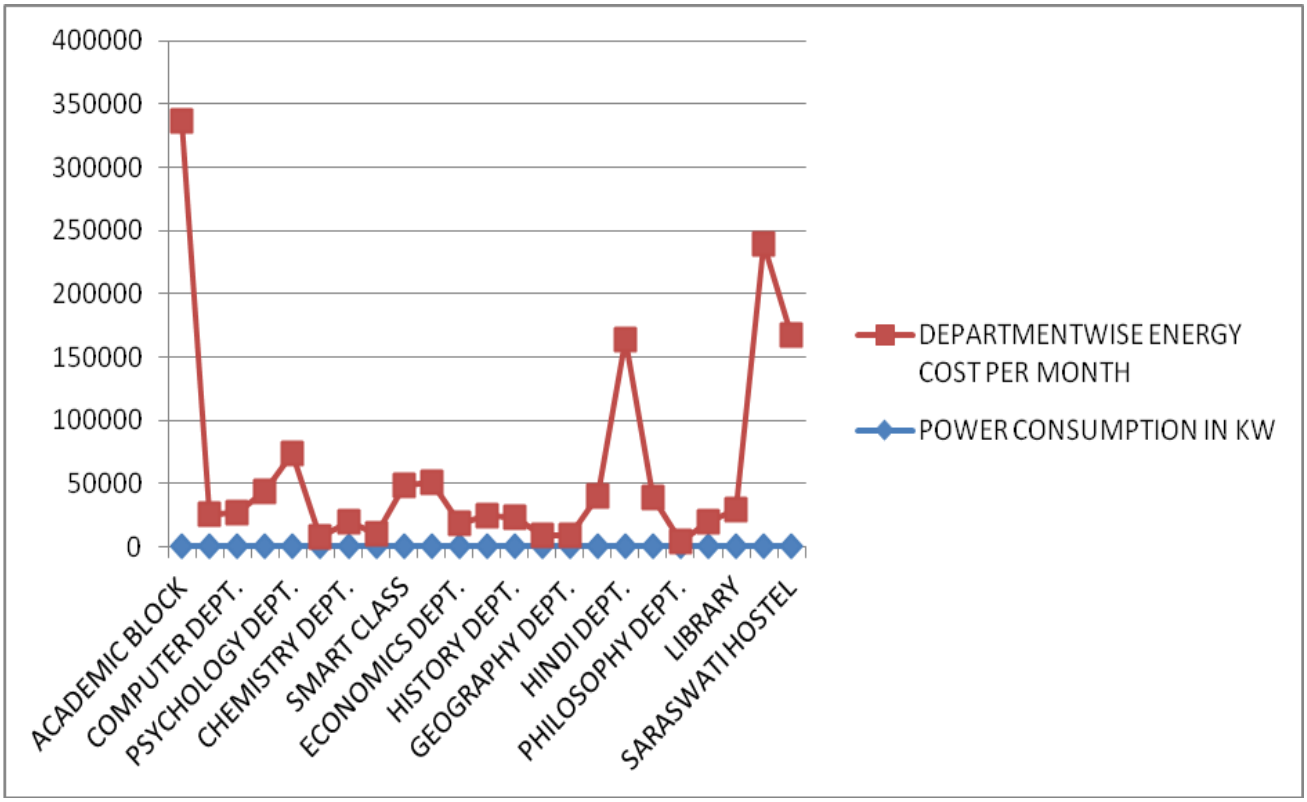
Total Area

Of Kamla Raja Girls Post Graduate (Autonomous) College is 21485.84 sq mtr which means Energy Consumption Per sq Meter of area is 5.88 KWh

Energy cost profile

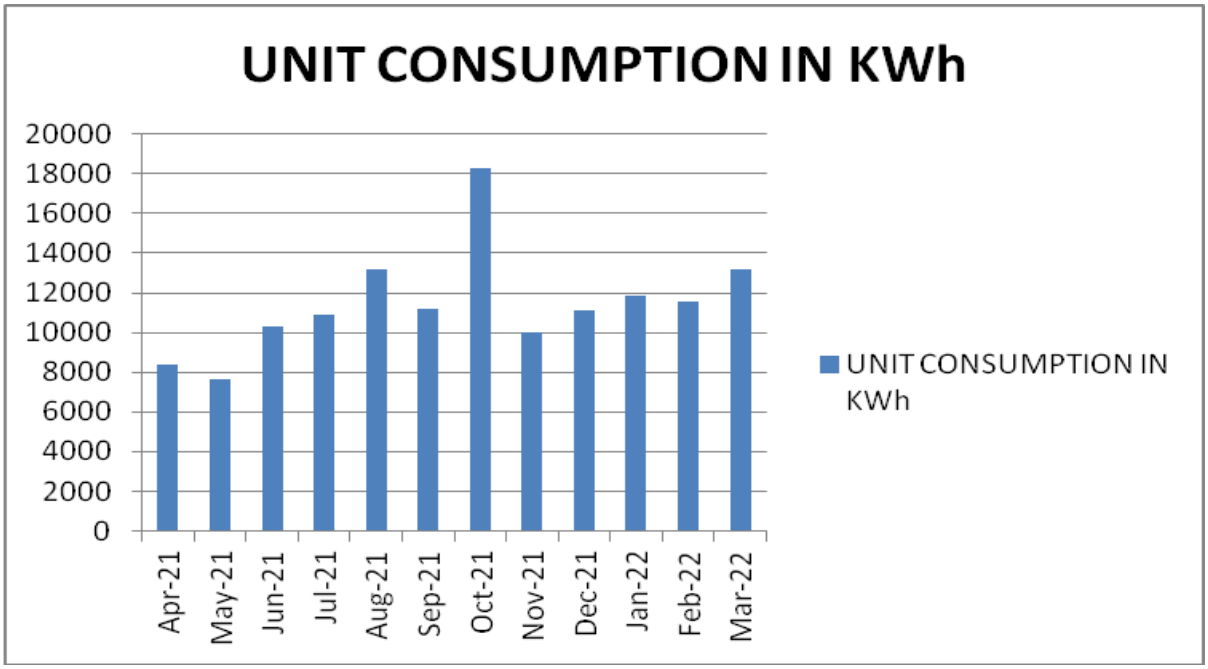


DEPARTMENT WISE COST FOR ENERGY PER MONTH

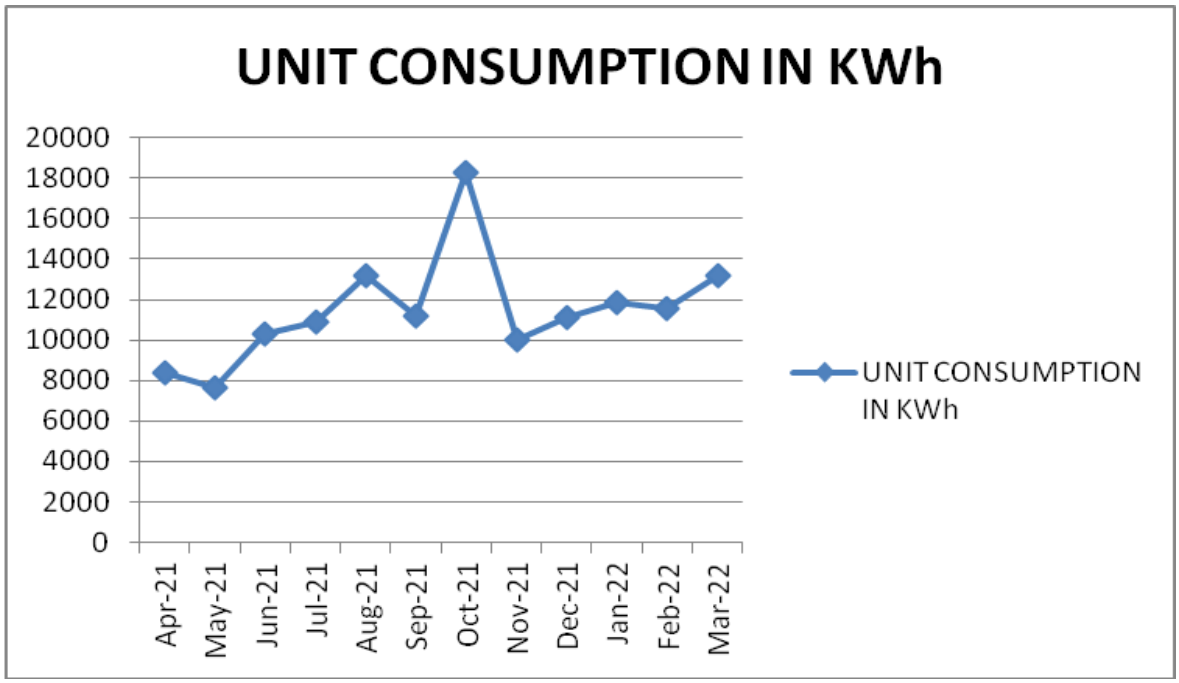


Average energy consumption per month: 178640.64 kWh.

PER MONTH ENERGY CONSUMPTION PER MONTH

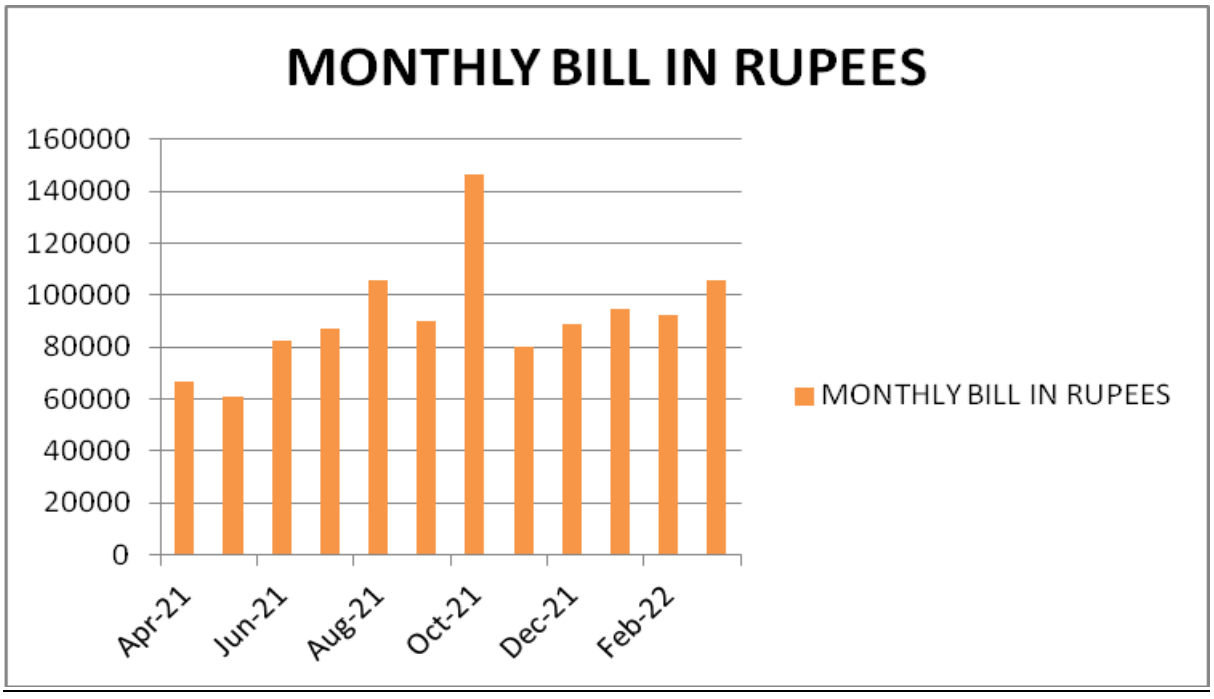


TOTAL POWER CONSUMPTION PER YEAR = 126468 KWh

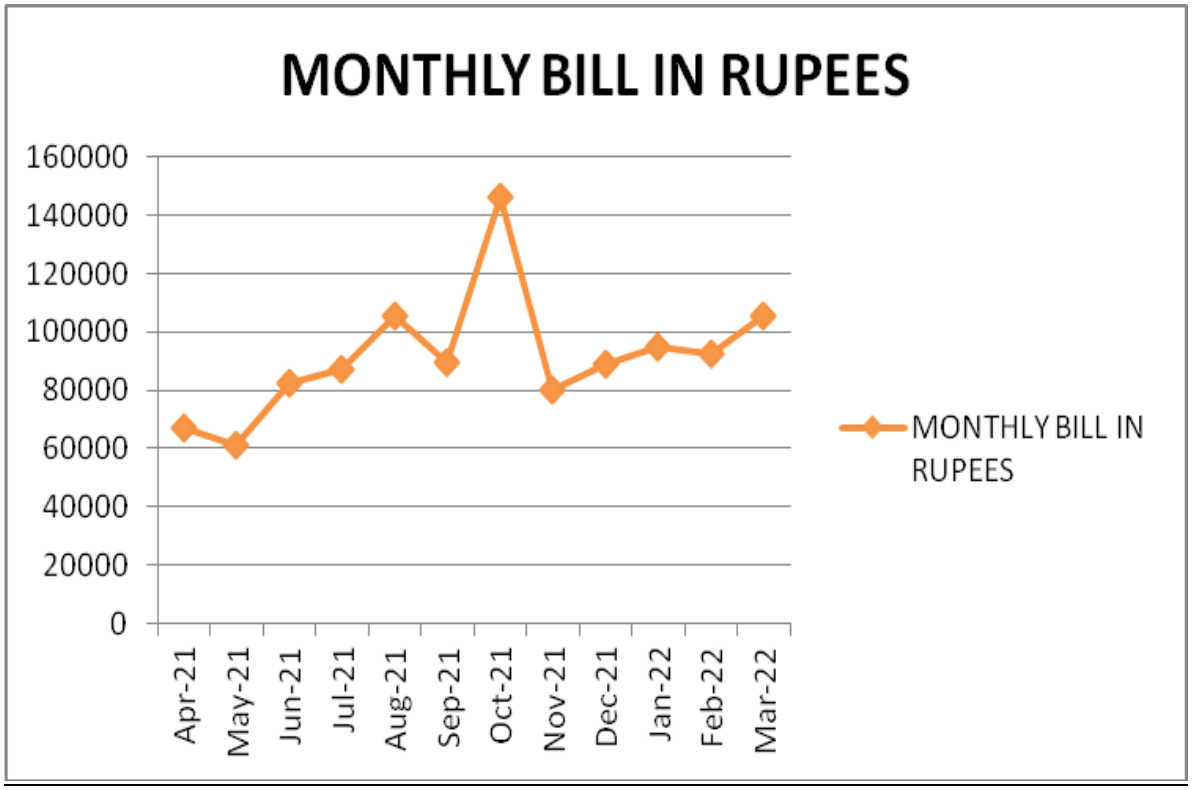


AVERAGE MONTLY CONSUMPTION OF COLLEGE – 20282 KWh

MONTHLY BILLING PATTERN IN RUPEES FOR FINANCNIAL YEAR 2021 - 2022

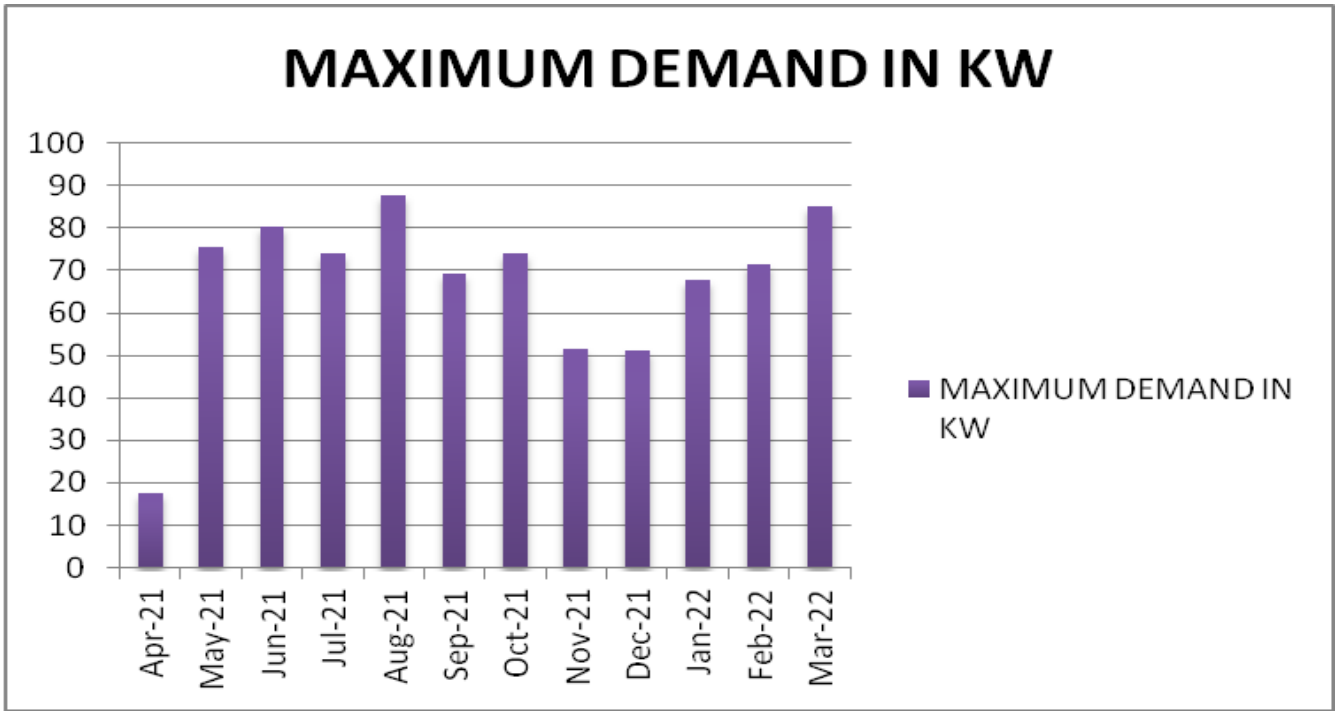


BILLING AMOUNT FOR FINANCIAL YEAR 2021 -2022 = 1100536/-

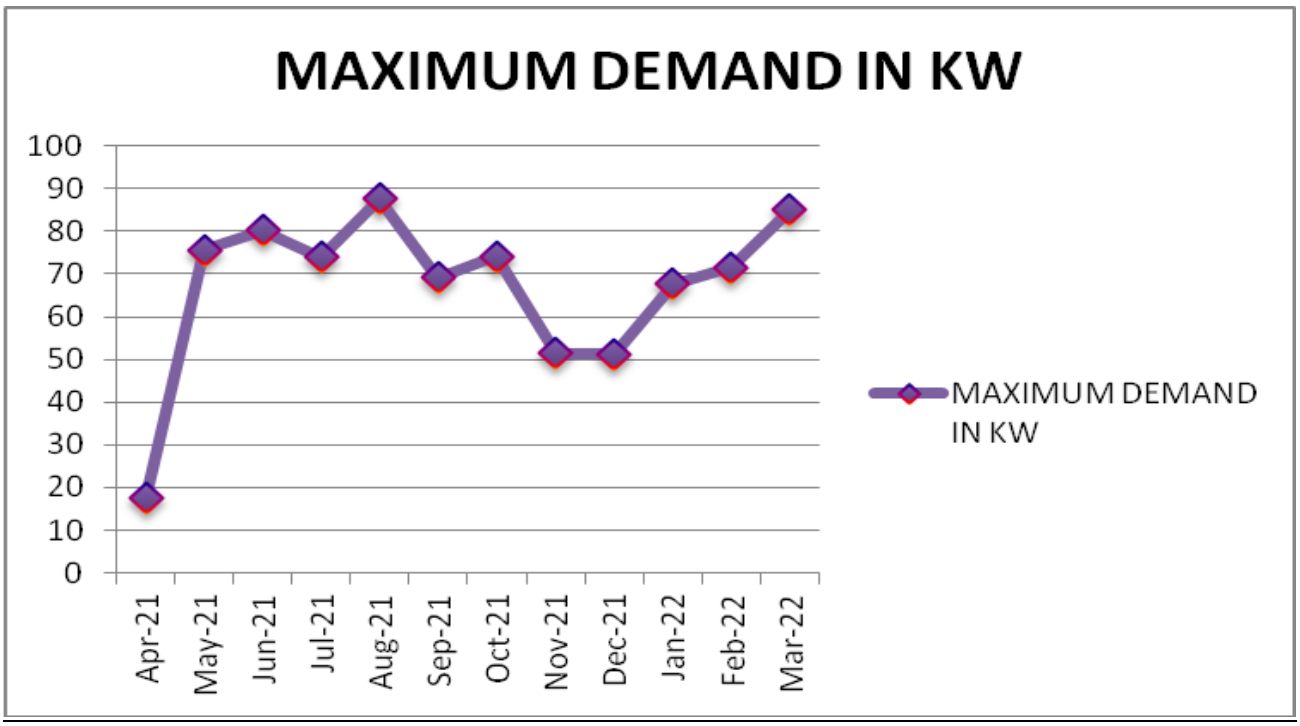


AVERAGE MONTHLY BILLING FOR FINANCIAL YEAR 2021 – 2022 = 91712/-

MAXIMUM DEMAND PROFILE FOR KRG AUTONOMOUS COLLEGE



SANCTIONED MAXIMUM DEMAND FOR KRG AUTONOMOUS COLLEGE - 71 KW



RECOMMENDATION - WHILE WALK THROUGH AUDIT IT IS BEEN OBSERVED THAT THERE IS A VAST VARIATION IN MAXIMUM DEMAND AGAINST SANCTIONED LOAD , COLLEGE HAS A SANCTIONED LOAD OF ONLY 71 KW WHILE MAXIMUM DEMAND REMAINS NEAR TO 85 KW IT CAME TO NOTICE IT EVEN SHOOTED UP TO 131 KW AT SOME TIME SO ITS PROFILE IS OBSERSED AND RECOMENDED TO HAVE HT CONNECTION DESPITE OF HAVING SEVERAL LT CONNECTIONS AS IT IS EVEN NOTIFIED IN MPERC (MADHYA PRADESH ELECTRICITY REGULATORY COMMISSION) TO HAVE HT CONNRECT ABOVE 50KW LOAD DEMAND (ATTATCHED IN ANNEXTURE)

11.4. Power supply Equipment and Major Loads

Sanctioned MD : 71 KW
Demanded MD : 132 KW
Transformer : NIL – All LT Connections
Generator : 3 X 15 KVA

Table 1. Major Equipment related to Electrical energy utilization

FANS

Sr. No.	Place of Installation	Ceiling Fan				Wall Fan		COOLER	
		No.	Watt@75	No.	Watt @100w	No.	Watt @70w	No.	Watt @250w
1	ACADMIC BLOCK	15	1125	4	400			6	1500
2	POLITICAL SCIENCE DEPT.	20	1500	8	800			2	500
3	COMPUTER DEPT.	12	900	7	700			3	750
4	MUSIC DEPT.	32	2400	11	1100			1	250
5	PSYCHOLOGY DEPT.	40	3000	34	3400			1	250
6	BIO TECH DEPT.	7	525	0	0			3	750
7	CHEMISTRY DEPT.	15	1125	8	800			2	500
8	PHYSICS DEPT.	8	600	6	600			2	500
9	SMART CLASS	20	1500	5	500			1	250
10	ZOOLOGY DEPT.	30	2250	13	1300	1	70	1	250
11	ECONOMICS DEPT.	18	1350	10	1000				
12	COMMERCE DEPT.	20	1500	15	1500				
13	HISTORY DEPT.	14	1050	10	1000				
14	MATHS DEPT.	8	600	4	400			1	250
15	GEOGRAPHY DEPT.	7	525	6	600	2	140	2	500
16	PRINCIPAL OFFICE	12	900	7	700				
17	HINDI DEPT.	6	450	11	1100	2	140	2	500
18	HOME SCIENCE DEPT.	20	1500	17	1700	8	560		
19	PHILOSOPHY DEPT.	0	0	4	400				
20	FINE ART DEPT.	0	0	9	900	2	140	2	500
21	LIBRARY	18	1350	11	1100	8	560	6	1500
22	GIRLS HOSTEL Ist FLOOR	50	3750	18	1800			4	1000
23	GIRLS HOSTEL 2nd FLOOR	10	750	3	300			4	1000
24	GIRLS HOSTEL 3rd FLOR	10	750	3	300			4	1000
25	GIRLS HOSTEL 2(Ist FLOOR)	10	750	3	300	1	70	4	1000
26	GIRLS HOSTEL 2(2nd FLOOR)	30	2250	13	1300			4	1000
Total		**432**	**32400**	**240**	**24000**	**24**	**1680**	**55**	**13750**

GRAND TOTAL 94590 SAY 94.590 KW

AS per Rating Provided Total Tonnage of Acs installed is 24.5 Ton.

Sr. No.	Tonnage	Numbers			@ WATT	Total Watt
	2 Ton without star	10			3500	35000
	1.5 Ton 3 star	3			1500	4500
	1.5 Ton 5 star	12			840	10080
Total		**25**			**4500**	**49580**
	SAY 49.5 kw OR 50 KW					

OTHER EQUIPMENTS

A. GEYSER @3000 Watt			
Sr. No.	Place of Installation	No.	Watt
GirlsHostel 1st			
1	First Floor	2	6000
2	Second Floor	2	6000
3	Third Floor	1	3000
GirlsHostel 2nd			
1	First Floor	4	12000
2	Second Floor	3	9000
Total		**12**	**36000**
B. EXHAUST FAN			
1	18" Fan @200W	12	2400
2	14" Fan @100 W	8	800
Total		**20**	**3200**
C. WATER COOLER 150 LTR.@1780 W			
Total		**8**	**14240**
D. COMPUTERS			
1	Desktop @180 W	81	14580
2	Laptop @ 30 W	9	270
3	Server	1	1000
Total		**91**	**15850**
E. Heavy Duty Printers/Copiers @ 1 KW			
		15	15000
Total		**15**	**15000**
F. SUBMERSIBLE PUMP			
1	@ 7.5HP	3	5500
	@ 1.5HP	2	2000
Total		**5**	**7500**
G. DEEP FREEZE/FREEZE @ 276 W			
		15	4140
Total		**15**	**4140**
GRAND TOTAL		**95930 Kw SAY 96 KW**	

CEILING FANS

1) There are Total 772 ceiling fans installed in campus all of them are fitted with rheostat regulators and almost all the fans are regular fans . Energy Saving ceiling fans can be achieved in two ways

(a) **By replacing all rheostat regulators by electronic regulators.**

All in total 772 fans approximately are operating rheostat regulators or regulators are not working. There is considerable loss due to use of rheostat regulators. Further using fan without regulators causes' energy loss as power drawn by fan various with speed.

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

Regulator Position	With Rheostat Regulator		With Electronic Regulator		Relative Energy Saving
	Watt	Energy Saving %	Watt	Energy Saving %	
1	66.66	32	37.8	61.4	43%
2	72	26.5	51	49	30.50%
3	86.6	17.7	64.6	35.4	21.50%
4	88	11.1	78	22	12.20%
5	100	0	100	0	0%

12. SAVING ECONOMICS:

(a) By replacing all rheostat regulators by electronic regulators.

Assuming that ceiling fan is operated for 12hrs/day 200 days per year and saving achieved is 27% in every consumption

= Annual Energy consumed by one ceiling fan without regulator

=Annual cost of energy consumed by one ceiling fan without regulator

=100x12x200x8.0 (Taking unit cost Rs. 8/unit) =1920/-

=Annual cost of energy saved for one ceiling fan =1920x0.27 = 518.5/per year

=Total saving in a year by replacing all 772 rheostat regulator /no regulators with electronic regulators

=518.5x772 =400282/-

--Cost of providing regulators @ 200/regulator

=200x772= 154400/-

Pay Back Period = cost of energy efficient fan /saving per year

=154400/400282=0.38 year = 5 Months only

B) By replacing old ceiling fans with energy efficiant (EESL) fans.

There are all in Total 772 fans are present in KRG College campus those all are old type non energy efficient fans without star rating so these fans should be replaced with star rated energy efficient fans which will result in saving as follows.

Total fans in campus = 772

Wattage of each old fan= 75W

Time of usage for round the year = 12hrs @200days/year

--Yearly consumption of fan per year

=75x12x200 = 240 KWH (units)

--Electricity Bill for each fan @ 8/- per unit will be 240x8 = Rs. 1920/-

--If these fans are replaced with star rated energy efficient fans having wattage of 50 watt each

--Yearly consumption of energy efficient fan per year

=50x12x200=240 KWH

--Electricity Bill for each fan @ 8/- per unit will save in on its -->240-120 =120 unit per year

--Saving per fan = 1920-960=960/- per year

--Cost of replacement with 50 watt Energy Efficient fan @1360/- per fan (cost of fan ass per EESL)

--Per fan cost = 1360/-

--Pay Back Period = cost of energy efficient fan /saving per year

= 1360/960 =1.41 = 1.5 years (18 Months)

The payback period for changing existing fans with energy efficient fans taking faulty and repaired fans primarily will be 1.5 years so it recommended converting 50% of fans per year.

2) COOLERS

Assuming that coolers are operated for 12 hrs/day 200 days per year and saving achieved by electronic regulator is 27% in every consumption.

--Annual cost of energy consumed by one cooler without regulator

= 250x12x200x8.0 (Taking unit cost @ 8.0/-) = 4800/-

= Annual cost of energy saved for one cooler =4800x0.27 = 1296/per year

--Total saving in a year by connecting all 41 coolers with electronic regulators

= 1296x41=53,136

= Cost of providing regulators @400/regulator =400x41 = 16400/-

-- Pay Back Period = cost of energy efficient fan /saving per year

= 16400/53136 =.3 year (4 Months)

By replacing old coolers with energy efficient coolers

Assuming that coolers are operated for 12 hrs/day 200 days per year

- Total coolers in campus = 55
- Wattage of Each Old Cooler = 250 watt
- Yearly consumption of cooler per year = 250x12x200 = 600 units
- Electricity bill of each cooler per year = 600x 8/- = 4800
- If these coolers are replaced with energy efficient coolers of wattage 125 Watt
- Yearly consumption of Energy efficient cooler per year
- 120x12x200 = 300 Kwh units
- Electricity bill for each cooler @8/- per unit will save
- 600 -300 = 300KWh units
- 300x8/- = 2400 /- per year
- Cost of replacement with 125 watt Energy efficient cooler fan and pump @ 6600/- per fan and pump cost as per EESL
- Per fan and pump set cost = Rs6600/-
- Payback period = cost of fan and pump set /saving per year
- 6600/2400 = 2.75 years only

The payback period for converting existing coolers with energy efficient coolers taking same cooler structure will be 2.7 years so it recommended converting 50% of coolers per year.

3) Air Conditioners

As per reports available from maintenance staff out of total 25 AC 10 are very old type and needs replacement which will increase cooling efficiency as well as considerable saving in electricity consumption.

Calculations and Pay Back period by replacing one old and without star rating AC is given below. It has been assumed AC running hours daily as 8 hrs and period from March to September around 200 days.

--Electricity consumed by one AC in a year

=2500x8x200/1000= 4000 kwh

--Electricity consumed by 3 stars AC in a year

=15600x8x200/1000= 2400 kwh

= Savings in Unit = 1600 kwh

= Saving in Rupees = 1600x8/- per unit

= 13600 rs /-

Cost of one 3 star 1.5 ton AC = 27000 for window and 35000 for split

Payback period = investment/saving

Window AC = 27000/13600

= 2 years

Split AC = 35000/13600

= 2.5 Years

i.e, 2 years for window AC and 2.5 years for split AC.

Keeping in view heavy capital involved in replacing all AC at a time following 13 recommended.

(a) In physical manner AC should be replaced, first of all faculty AC to be replaced i.e., 5 Air conditioners a year which will result in saving of 68000 rupees/year and the replacing investment will be 150000 assuming average cost 30000/ Rs. AC.

(b) Similarly Next year remains 05 no's to be replaced saving of Rs. 68000/- that year also.

4) Other Best Practices to save Energy in ACs:

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

1. Insulation of room should be properly maintained by keeping all doors/windows of AC rooms and check for any broken window glasses/ door closure malfunctioning to prevent cold air to go out and hot air to go in.

2. AC should be switched on only 15 min before actual use and switched off while going out.

3. Normal air conditioning temperature should be kept not less than 24 degrees present BEE mandate. By thumb rule, increase in 1 degree in indoor air temperatures can save 6% of electricity.

4. Room should have curtain on windows preferably dark colors.

5. If you are spending long hours in an air-conditioned room, try this tip. Keep it on for a couple of hours and then switch off for another one or two hours.

6. Keep the ceiling/wall fan switched on when the AC is running. Together, they keep the room ventilated and circulate the cool air in all corners. Also, you will not have to keep decreasing the temperature.

7. All the dirt which gets accumulated in the ducts/filter and vents of the AC just make it work extra hard to ensure the cool air reached your room. Regular cleaning of filters can lower an AC's energy consumption by 5-15 per cent. Plus, it saves the device from breaking down or in need of repair.

8. Most found defects leading to poor efficiency and consuming extra power are dirty air filters, thermostat not working, ice formation, water leakage, fan and swing not working. Ensure fort nightly checking of these points.

4) GEYSERS

In walk through audit of GOVT.KAMLA RAJA GIRLS POST GRADUATE AUTONOMOUS COLLEGE GWALIOR has been observed that total 12 nos. 3000 watt electric geysers have been installed for providing hot water in hostel (Ganga Hostel and Saraswati Hostel) bathrooms. Its operation cannot be considered as same is required by students in hostel. It is proposed that 750 Ltrs. capacity solar water heater be provided as detailed below. To ensure hot water supply even during cloud or on no bright sun light day hybrid type solar geysers with auto cut facility is proposed.

It has been assumed that geyser being used from October to March i.e. 6 months around 200 days in a year for 8 hrs per day.

- Annual consumption of electricity by one geyser =3000x8x200 = 48000 KWH

- Let with solar geyser, electric geyser consumption is reduced by 90%.
- Unit saved by each geyser = 0.9x4800 =4320 KWH
- In Rupees @ 8/- per unit= 4320x8 = 34560/-
- Cost of 750 Ltrs. Solar Geyser = 135000+ 15000(Pipe Fitting) 150000/- per unit
  - Both Ganga and Saraswati Hostel has total inmates of 110 Girls in total.
  - Maximum total requirement of hot water@ 25Ltr./student use per day = 25x110 =2750 Ltr/day
  - Investment = 04x150000 = 600,000/-
  - Energy saving by installing solar geyser in hostels.
  - Saving by each geyser x No. of geyser
  - 34560x12 = 414,720/-
  - Payback period = Investment/Saving 600,000/414,720
    - i.e. 3 years

It May please be noted that :

Hot water produced by the solar heating system during the day is stored in an insulated tank. The insulation of the tank is such that water should be remaining hot without significant drop in temperature for around 24 hrs. Thus water heated during the previous day should be available for use in the next morning.

5) COMPUTERS :

Computers and monitors account for 30%-40% 0f the energy used by office equipments their energy consumption is seemed only to office lighting. It is estimated that a power managed computer consumes less than half the energy of a computer without power management

There are 81 desktop computers, 09 laptop and 1 server installed in campus. Apart from this there are 15 heavy duty printers.

Desktop on average consumes 200 watt along with UPS and CRT (Cathode Ray Tube) Screen.

Saving can be attained by following measures :

- Replacing Desktop Computers by laptop

A lot it depends on the type of screen. A CRT (Cathode Ray Tube) screen consumes more than LCD (Liquid Crystal Display) screens. LCD screens can save up to 75% electricity over a CRT screen. A desktop also requires a UPS (Uninterruptible Power Supply) to keep it running during power losses which can eat significant amount of electricity. Laptop also have various other power management feature.70%-80% of power consumption in a laptop is by CPU and rest of the components consume very less electricity. Laptop typically consumes 20-50 watts of electricity that can be trimmed down in power saver mode. Desktop along with UPS normally consumes 200 watt with CRT monitor and with LCD monitor it comes down to approx 100 w where laptop power consumption is around 30 w.

If desktop is replaced with laptop then assuming average use of 10 hrs/day for 300 days in a year. Saving calculations are as given below:

- Power consumed by one desktop = 200x300x10/1000 = 600KWh
- Power consumed by one laptop = 30x300x10/1000 = 90KWh
- Annual saving by replacing one desktop = 600-90 kwh = 510 KWH
- If 50% i.e. 40 desktops are replaced every year than saving/year=510x40=20400 unit/year
- Yearly saving in Rupees = 20400x8/- @unit = 163200/-
- Cost of 40 laptops adjusting 10000/salvage value of desktop = 25000x40 =10,00,000/-
- So pay back = Investment/Saving = 1000000/163200 = 6 years

However it is long period, so it is recommended that whenever there is replacement/new purchase is required always go for laptop. Switching to a laptop may be a smart decision for someone who is concerned about how much energy a computer uses.

Other Measures :

Apart from above following measures by which considerable saving can be achieved.

- Laptops are an additional 20% more power efficient when running on AC adaptor power over battery power. So always use laptops with AC adaptor on.
- On standby the power consumption of both a desktop and a laptop computer falls about one third.
- If the monitor is switched off completely then of course it does not use power.
- Switch off the speakers if you are not using them.
- Switch off the printer when it's not used.
- Switch off the screen if you are not working on the PC just now.
- Switch off your computer or put it on standby mode if you are not going to work on your PC for more than 30 minutes. A multiple socket makes it easy to switch off all your computing equipments.
- Switch off modem at night.
- One common misconception is that using a screen saver saves power, but it is not true.

6) Harnessing Solar Power for Energy Source Substitution :-

In our view there is a huge scope for solar power in Govt. KRG college asc quite big chunks of energy consumption is only during day ours (about 70 percent) when sun shine is available an lot of space is vacant on every department roof so roof top type of solar power plants with grid connectivity can easily be installed at every buildings roofs .though there are very huge variation in monthly energy consumption over period under study let us take (AVG Demand /Power Factor = KVAH rating = 20280/0.8) 25350 KVAH monthly consumption and assuming 70 % ie 17750 KVAH is consumed during day hours . It will come 590 units per day.

- For Generating 600 units per day 150KVA solar power plant is required , cost benefit analysis of same is as follows :
- Units generated per year (10 months avg/year) = 600x10x30 = 180000KWH
- Saving due to generated units = 180000x8/- = 1440000/-
- Monthly saving 120000/- i.e 1.2 lacs

- Investment required @40000per KVA = 150 x 40000/- = 6000000/-
- Payback period = investment/saving = **4.5 years approximately**

LIGHTING ARRENGEMENT:

Tube Lights as per table there are 851 no. of Tube Lights with magnetic choke . These tube lights should be replaced with LED tube lights which will result in saving as follows :-

- Tube Lights with magnetic choke = 851
- Wattage of each (including choke wattage)=60 watt
- Time of usage @ 8hrs/day
- Total per day electricity consumption=851x60x8 = 408.48 KWH
- Yearly electricity consumption-->408.48x365 = 149,095.2 KWH
- Since all tube lights are not always in use taking diversity factor of 0.8
- Annual unit consumed =149,095x.8 = 119276 KWH

Replacement With 18 w LED Tube Lights

- Per day consumption (Taking 0.8 diversity factor)=851x18x8x0.8-->98.035 KWh
- Yearly electricity consumption = 98.035x365 = 34687.775 KWh
- Total saving units in an year =119276-34687.775 = 84588.225 KWh
- Yearly saving=84588.225x8 = 676708.8 /-
- Cost of Replacement @ 300/LED TL
- 300x851 = 255300/-
- **Pay Back period= 255300/676708.8 = 0.377 years = 4.5 months**

Replacement of Sodium Vapor Lamps with 45 W LED Fixtures:

As per table 23 No's Sodium Vapor Lamps with magnetic choke are present in whole campus of K.R.G. College .These Sodium Vapor Lamps should be replaced with 45 LED fixtures which will result in saving to be as follows:-

- Total Sodium Vapor Lamps in campus = 23 Nos.
- Wattage of Each (Including choke) = 500W
- Time of usages @ 11 hrs/day
- Total per day electricity consumption=23x500x11 = 126.5 KWh
- Yearly Electricity consumption = 126.5x365 = 46172.5 KWh
- If these Sodium Vapor Lamps are replaced with same lumen capacity LED fixtures i.e. of 45 w LED fixtures
- Total per day electricity consumption of 45w LED fixtures=23x45x11 = 11.385 KWh
- Total saving units in an year =46172.5-4155.5 = 42016.975 = 42017 KWh
- In Rupees = 42017x8/- = 3,36,136/-
- Cost of Replacement @ 5600/Fixture
- 5600x23 = 128800/-
- **Pay Back period= 128800/336136 = 0.38 years = 5 months**

13. Recommendation for Energy Conservation

After analysis the data and equipments installed, we proposed here with following Energy Efficiency improvement measures

Sr. No.	Recommendation	Monthly Saving	Yearly Saving	Estimated Investment	Pay Back Period	Remark
1	Replacing Tube lights with choke by LED Tube Lights	56392/-	676708/-	255300/-	4.5 Months	Should be done immediately
2	By replacing the Rheostat Regulators by Electronic Regulators	31974	383690	148000	5 Months	Should be done immediately
3	By Replacing 50% old and repaired fans with Energy Efficient fans every year	30880	370560	524960	1.5 Years	Medium Investment Short Payback
4	By providing solar water geysers in Hostels	69120	414720	600,000	3 Years	Medium Investment Medium Payback
5	Replace old and repaired AC by 5 star rated AC	22666	136000	350,000	3 Years	Medium Investment Medium Payback
6	By installing 33 KV HT connection in place of LT connection	30% Reduction electricity bill	30% Reduction electricity bill	60 Lakhs	10 Years	High Investment Medium Payback
7	By replacing Sodium vapor lamps street light with 40 watt LED street light	28011	336136	128800	5 Months	Low Investment should be done immediately
8	By replacing induction cook top with LPG Gas Stove	1200	14400	11000	9 Months	Low Investment should be done immediately
9	By Replacing 50% of old and repaired coolers with Energy Efficient coolers in hostel	5% of electricity bill	5% of electricity bill	250,000	2 Years	Medium Investment Medium Payback
10	By Providing Electronic Regulators for coolers	7590	53136	16400	4 Months	Low Investment frequent payback

14 Quantitative and Qualitative Measurement

S.No.	Requirements and checklists of the audit	Conformity		
		Yes	No	NA
1.	Have internal Energy audit procedures been developed And implemented in the Organization?		✓	
2.	Have programmes for the achievement of energy efficiency and conservation objectives beenestablished and implemented as on today in the Campus?	✓		
3.	Has a Management Representative, Electrical Engineer, Staff in charge been assigned for energy Savings on power consumptions?	✓		
4.	Have programmes for the achievement of prescribedfinancial outlay for current bills for each building in The campus towards power consumptions?	✓		
5.	Has the organization ensured that personnel performing environmental specific tasks have the Required knowledge on energy audit (e.g. education,training programme, seminar, workshop, camp, etc.)?	✓		
6.	Are objectives and targets documented towards energy Audit periodically and any Register are made?		✓	
7.	Any analysis of energy flows for energy conservation in terms of the amount of energy input into the systemwithout negatively affecting the output in buildings	✓		
8.	Implications of alternative energy efficiency measures sufficient to satisfy the financial criteria of sophisticated investors		✓	
9.	Identification of the most efficient and cost-effective Energy Conservation Opportunities (ECOs) or Measures (ECMs) taken by the Management		✓	
10.	Are the following energy efficiency and conservation Aspects considered in sufficient detail?		✓	
	a. Fluorescent (tube) lights, Incandescent lamp and sodium vapour lights are replaced with CFL / LED	✓		
	b. Number of Uninterruptible power supply (UPS) andPower generators for power back-up to alternative current supply facility in each building	✓		
	c. Number of solar panels, solar lights, solar water heaters, electric water heater installed		✓	
	d. Automatic sprinkler system used for irrigation purpose		✓	
	e. Ultra-violet lights and any other harmful lights used with safety precautions		✓	
	f. Attempt in reducing the energy expense and carbon footprint	✓		

	g. Disposal facility for hazardous arise from electrical gadgets, equipment and installation		✓	
	h. Renewable energy utilization (solar panel, wind mill)		✓	
	i. Natural / Mechanical air ventilation at Indoor / Outdoor auditorium, stadium, seminar halls, etc.	✓		
	j. Sign boards indicating Switch OFF / ON, Danger at Electrical equipment and Power transformers in the campus	✓		
11.	Signing of MoU with Govt. and NGOs to ensure aboutthe energy conservation and efficiency in the campus		✓	
12.	Conduction of awareness programmes and outreach programmes on the energy conservation and efficiency	✓		
13.	The details of public transport, battery operated / electric vehicles, biofuel use, exhaust fans, boiling water system, chillers and geysers on energy savings mode		✓	
14.	Projects and Dissertation works on the energy conservation and efficiency carried out by students and staff members	✓		
15.	Steps taken to take care of day lighting, AC machines heat emission and ecofriendly Refrigerators, etc.	✓		
16.	Use of water metering, **IoT** based energy efficiency practices, remote waterlines, automation of electrical fittings and gadgets to save energy		✓	
17.	Are all monitoring electrical equipment appropriately Maintained and calibrated?	✓		
18.	Are any energy conservation technologies and retrofitfor energy conservation equipment being Implemented?	✓		
19.	Skylight roof ratio, fenestration plan and Daylight luminance in building construction towards energy efficiency*			✓
20.	Any Automatic Lighting Shutoff with occupancy Sensors and Timers, Exterior / Interior lighting control facility*			✓
21.	Have any rooms and guest suites a master control device at the main room entry that controls all permanently installed luminaries and switched receptacles*			✓
22.	Total electricity usage divided by total campus' population (kWh per person)			✓
23.	The ratio of renewable energy production divided by 1/3 total energy usage per year			✓
24.	Total carbon footprint divided by total campus' population (metric tons per person)			✓
25.	Elements of green building implementation as reflected in all construction and renovation policies		✓	
26.	Greenhouse gas emission reduction awareness programme to the stakeholders	✓		

15. General Recommendations:-

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

- All class rooms, hostels, labs and common places to have Display Messages regarding optimum use of electrical appliances in the room like light, fans, computers, projectors, etc.
- MESSAGE
  - ❖ " SWITCH OFF APPLIANCES WHILE LEAVING"
    "DO WHAT'S RIGHT, TURN OFF THE LIGHTS"
    "बिजली बचाएं समृद् ध पायें।
- Most of the time, all the tube lights in a class room are kept ON, even though, there is sufficient light level near the window opening. In such cases, the light row near the window may be kept OFF
- All appliances to be kept off or in idle mode if there will not be used for at least next one hour.
- All computers to have power saving settings to turn off monitors and hard disks ay after 10 minute/30 minutes.
- The comfort air conditioning temperature to be set between 24 C to 26 C
- Lights in toilet area may be kept OFF During day time
- Lighting photo sensors to be installed in central library to utilize optimum day lighting.

- Street lights be fitted with day light sensors to minimize losses due to human error
- Split switching system to be adopted in inside corridors of hostels and college building by clubbing alternate tube/bulbs
- The heating load can also be reduced by reducing the consumption by other sources like lights, computers etc. and the occupancy needs to be considered. Explore the possibility of occupancy sensors.

Walk-through Audit conducted in various locations at Govt Kamla Raja P.G Autonomous College Campus and the Energy Equipment were inspected

16. Recommendations for improving the energy efficiency and energy conservation in the Organization

The energy audit included suggestions for energy cost reduction, preventive maintenance and quality control activities, all of which are critical for utility operation in the audit sites.

- Procurement of equipment with energy efficiency (4-5 star rated equipment) during replacement may be considered.
- Sub meters in all the buildings for energy monitoring are recommended so that energy load required and energy consumption in each building may be noted.
- Optimal water usage and temperature settings may be used which are coming under automatic process towards energy savings.
- Continuous monitoring and analysis of energy consumption by dedicated team may be planned within the campus.
- Promoting ECON awareness and practice among the stakeholders may be conducted periodical through Association, Clubs, Forums and Chapters.
- Turn off electrical equipment when not in use
- Maintain appliances and replace old appliances in all laboratories.
- Use computers and electronic equipment in power saving mode.
- Installation of Biogas plant for hostel kitchen as well canteen.
- Automatic switches with occupancy sensors in common areas
- Monthly use of electricity in the College is very high which may be reducing to a greater extent by means of undertaking a periodical energy audit.
- There are fans of older generation and non-energy efficient which can be phase out by replacing with new energy efficient fans.
- Regular monitoring of equipment in all laboratories and immediate rectification of any problems.
- Value added / Non-formal / Certificate / Diploma course on ‘Energy and Environment Management Audits’ may be conducted for the benefit of students and research scholars to become a certified Lead Auditor.

- Other Low Investment saving options:
- Providing Master switch outside every room will make it very easy for a person to switch off all appliances if someone forgets to switch few appliances of room while leaving. This will save a lot of energy.
- 2. Providing motion sensors in toilets has big energy saving potential. Motion sensor will automatically switch on lights when there is any movement and switch off when no movement for few minutes. Two of three motion sensors are installed in each toilet as per size. In view of very low price of motion sensors it is highly recommended.
- 3. Regular Cleaning of fiber sheet provided in roof shed of workshop/labs be ensured and few more opening in shed be provided, which will save considerable electricity being spent on lighting.
- 4. Regular cleaning of fans and exhaust fan blades be ensured otherwise efficiency will be compromised.

17. Steps undertaken to amend the suggestions given in the previous Energy AuditReport

S.No	Suggestions made during the previous Energy Audit Report	Steps taken to amend the suggestionsof the previous Energy Audit Report
1.	Suggested to install Roof top solar power plants and Solar water heaters	Installed Roof top solar power plants almost all buildings and Solar water heaters at both Men and Women Hostels which are functioning well
2.	Recommended to fit HVLS Fans and Exhaust fans in the auditorium and Indoor stadium for proper ventilation	HVLS Fans and Exhaust fans are fitted in the auditorium and Indoor stadium for proper ventilation to the stakeholders for maintaining a proper ecosystem and energy conservation strategies
3.	Suggested to protect all Transformer, Generators and UPS with fencing and keep the awareness boards and safety signs on 'Dangers' and 'Warnings, etc.	Transformer, Generators and UPS are protected properly with fencing and kept awareness boards and safety signs on 'Dangers' and 'Warnings for safety purpose and to draw the attention about Safety intervention.
4.	Advised to cover Electrical wires, switch boxes, inverters, and stabilizers not to cause any problem to the staff and student members	Electrical wires, switch boxes, inverters, and stabilizers are properly covered without any damage not to cause any problem to the staff and student Members in the campus.
5.	Advised to replace old generation computers and TVs with LED monitors and old incandescent (tungsten) bulbs with LED lights and install automatic street solar lights.	Replaced old generation computers and TVs with LED monitors, most of the places, old incandescent (tungsten) bulb uses with LED lights and installed automatic street solar lights in the campus which indicated the positive Indication on energy savings.
6.	Instructed to replace Overhead Projectors with LCD projectors to Reduce the power consumption.	Replaced Overhead Projectors with LCD projectors for the effective power Consumption and management.

18. Conclusions

Considering the fact that the organization is a well-established, long time run establishment with good reputation, there is significant scope for conserving energy and make the campus as self-sustained in it. The energy conservation initiatives taken up by the institution are substantial. Energy efficient lighting schemes, awareness created among stakeholders and necessary power backups are being practiced by the institution. There are some best Practices followed on Energy Audit in the Organization like Transformers, Generators and UPS are protected properly with fencing and kept awareness boards on 'Dangers' and 'Warnings'. It is observed that the most of places, sign board of 'Switch ON' and 'Switch OFF' are kept towards saving energy measures to the stakeholders. Electrical wires, switch boxes and stabilizers are properly covered without any damage which will cause any problems to the staff and student members.. Few recommendations, in addition, can further improve the energy savings of the Organization. This may lead to the prosperous future in context of Energy Efficiency Campus and thus sustainable environment and community development to the stakeholders in coming years to come.

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