

# Optimization Energy Audit for College Workshop

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**Abstract** — An essential tool for evaluating energy use trends and spotting potential for efficiency upgrades in buildings is an energy audit. This abstract gives a summary of an energy audit done on a college facility to assess energy use, pinpoint inefficient areas, and suggest long-term energy-saving solutions. The college building's energy systems, including lighting, heating, ventilation, and air conditioning (HVAC), electrical equipment, and insulation, were thoroughly assessed as part of the energy audit. We used a variety of data gathering techniques, including on-site measurements, equipment assessments, power bill analyses, and historical energy use data. The results of the energy audit showed several instances of inefficiency and energy waste. Excessive illumination was shown to be significantly impacted by out-of-date lighting fixtures. It was suggested to use energy-efficient lighting technology like LED bulbs and occupancy sensors when it was determined that outdated lighting fixtures were a key cause of excessive energy use. The investigation of the HVAC system revealed insufficient insulation and air leakage, which resulted in substantial heat loss and increased energy use. Improvements in insulation, air leak repairs, and HVAC control optimization were advised for greater effectiveness. Additionally, the audit found potential for energy reduction through tenant participation and behavioral adjustments. To encourage sustainable practices among students, professors, and staff, awareness campaigns and energy-saving recommendations were offered. The possible return on investment for installing energy-efficient measures was assessed using financial assessments, taking into account elements including energy cost reductions, equipment longevity, and readily available incentives and rebates. The audit study also highlighted the advantages of energy conservation for the environment, such as decreased greenhouse gas emissions and improved sustainability. The energy audit of the college building concluded with a list of various chances for energy savings and suggestions for doable actions to optimize energy use and lessen the institution's environmental impact. The college may gain significant energy savings, support sustainability objectives, and set an example for other educational institutions aiming for energy efficiency by putting the proposed methods into practise.

**Keywords:** Audit, Energy, HVAC, College

## I. INTRODUCTION

The audit study also highlighted the advantages of energy conservation for the environment, such as decreased greenhouse gas emissions and improved sustainability.

The energy audit of the college building concluded with a list of various chances for energy savings and suggestions for doable actions to optimize energy use and lessen the institution's environmental impact. The college may gain significant energy savings, support sustainability objectives, and set an example for other educational institutions aiming for energy efficiency by putting the

proposed methods into practice. The essential component and prerequisite in industrial facilities for progress, economic expansion, automation, and modernization (Saidure et al., 2007, Hasnuzzaman et al., 2011). International academics are concerned about how to meet the future energy demand because of the fast rising global energy consumption. According to projections made by Abdulaziz et al. (2011), global energy consumption would rise by 33% between 2010 and 2030. Energy is used for a variety of tasks in the industrial sector, including processing and assembly, air conditioning, and lighting. In total, the industrial sector consumes more energy than any other end-use sector, accounting for nearly 50% of all delivered energy globally (IEO, 2011).

Natural gas, petroleum, and coal account for roughly 28, 26, and a third of the primary energy consumed by industry, respectively. According to EIA (1995), 7%. There is significant room for cutting energy consumption and associated expenses because it is one of the major controllable expenditures in most organisations, particularly those in the manufacturing and processing sectors (Jekayinfa, 2006). The advantages are also immediately reflected in an organization's profitability while also improving the environment globally through energy saving. Shortly after the oil energy crisis in the early 1970s, the idea of energy auditing was born. Since there were several inefficient energy usage, it was rather simple for the auditor to find places where energy might be saved. The energy efficiency of industrial operations has substantially grown over time due to facility management's enhanced energy awareness (Mitrovic and Muller, 2002). A technical report that also includes recommendations for increasing energy efficiency, cost analyses, and a consumption reduction action plan. According to Ojo (1995), an energy audit identifies all the energy streams in a system, quantifies energy usages based on each stream's distinct purpose, and strives to strike a balance between the overall energy inputs and its use. Energy auditing often involves turning conservation concepts into reality by combining economically sound solutions with other organisational factors within a predetermined timeline (Umesh, 1998). The first and most important stage in putting any comprehensive energy management programme into place is an energy audit. It aims to address the how, where, and quantity of energy consumed in a system. Additionally, it offers a chance to examine how energy is used and makes recommendations for ways to reduce losses and raise system effectiveness. Improved maintainability, reliability features, together with a reduction in losses, are the immediate benefits received by energy audit. Long-term energy savings are possible with the adoption of energy-efficient machinery.

The alternate name for the preliminary audit the simplest and fastest sort of audit is a basic audit, often known as a screening audit or walk-through audit. A quick assessment of facility utility bills and other operating data, together with a walk-through of the facility to become familiar with building operation and identify obvious areas of

energy waste or inefficiency, are all that are required. Minimal interviews with site operating employees are also conducted. Typically, during this kind of audit, only the most serious issues will be found. Corrective actions are quickly discussed, and rapid estimations of installation costs, possible operational cost reductions, and straightforward. On the other hand, a detailed energy audit is a thorough audit that offers a detailed energy project execution since it assesses all significant energy-using systems. It is a reliable approach for energy audits and savings. Three phases—the pre-audit, the audit, and the post-audit—are included in this audit. The goal of an energy audit is to encourage energy conservation inside the organisation.

The goal of the energy audit is to pinpoint, categorise, and rank cost-saving strategies related to energy utilisation in the company's offices, workshops, and facilities. The work that qualifies for the Energy Audit Study should be focused on the following. Identifying the areas of energy wastage and estimation of energy saving potential in the company facilities. Additionally, assessing the expenditures and payback duration for cost-effective methods that would increase energy usage efficiency. Identifying the potential uses of co-generation and renewable sources of energy (such as solar energy and biogas plants) and suggestions for implementation, where practicable, with cost-benefit analysis, are among the other things that may be done. In the industrialised nations of the globe, energy efficiency is increasingly playing a role as a catalyst for sustainable economic growth (Davidson, 2006). The situation is different in Nigeria right now because industries there are still mostly oblivious to the enormous economic and social benefits that may be derived from adopting energy efficiency and conservation measures. This, together with a high incidence of power outages brought on by extensive usage of self-generated electricity and a lack of investment capital, have led to high specific energy content in the products made by Nigerian companies. Loss of competitive advantage in the global market by these industries and low after-tax profits are the cumulative effects. This is a significant barrier to investment and long-term industrial expansion. Industries in Nigeria could take advantage of possibilities in low-level, low-risk, but highly valuable energy-efficient solutions that minimise the botAs a result, a lead time will be generated to pursue high-tech driven manufacturing procedures that will be backed at maturity by an energy-efficient culture that is currently in place. The whole purpose of energy efficiency is to minimize the amount of energy used to get a desired effect.

The reduction of energy productivity can be achieved through the application of a number of principles, some of which include historical energy use reviews, energy audits (reviews of current practises), thorough analyses of energy use (engineering analysis, computer simulation, availability studies, etc.), aggregation of energy uses, and energy conservation, to name a few (Eastop and Croft, 1990; Payne, 1997). The goals of this study were to (i) evaluate the energy consumption patterns in the food processing industry and distillation and bottling company, and (ii) determine the energy sources used in the industry. This Is a Level 2 Heading

## II. LITERATURE REVIEW

The energy audit of a fume exhaust system blower utilised in a cold rolling mill was the main topic of Anupama Gupta, Pallavi Verma, and Richa Priyadarshani's study [1]. They discovered that, regardless of fume emission, the old system ran constantly at a consistent pace. They recommended a superior strategy that would involve installing an AC electronic speed variable drive, which would save energy and lengthen the life of the motor. The implementation cost was Rs. 1,50,000, and it was estimated that Rs. 3,60,000 would be saved annually.

A building housing a university underwent an energy audit by Manoj Kumar Lamba and Abhishek Sanghi [2]. They determined that lighting loads (36%) and personal computers (44%) were the biggest energy users. Their recommendations included switching from traditional to electronic ballast FTL and from CRT to LCD displays. Employing motion sensors to regulate lighting, building solar water heating systems, and monitoring. By putting these measures in place, they predicted a total annual energy savings of 311126.4 kWh and a monetary savings of Rs. 2,644,574.4.

An energy audit of a school was performed by Ramya.L.N and M.A.Femina [3], with a particular emphasis on the conventional lighting demand. To save energy and money, they advised switching to CFL or LED bulbs instead of standard tube lighting. The anticipated monthly energy savings from switching to CFL or LED lighting were 739.2 kWh and 308 kWh, respectively. The payback period for LED was estimated to be 8.1 months, compared to 5.2 months for CFL. Additional suggestions included utilising ceiling insulation, turning off superfluous electrical devices, and computer brightness optimisation and timers for air conditioners.

In Aurangabad, the "Kohler Power India" sector underwent an energy audit by Sachin P. Parthe and Santosh Kompeli [4]. They recommended utilising LED lights in place of sodium vapour lamps and variable frequency drives (VFD) to lessen blower power usage. By making these adjustments, they predicted yearly savings of Rs. 5832 for each light and 4069 kWh per month. They also suggested changing from standard to sophisticated breeze air blowers, which will save 78 kWh of electricity and Rs. 10653 in monthly costs.

An energy audit was carried out at Bangalore's Nandi Institute of Technology and Management Sciences (NIT&MS) by Gousia Sultana and Harsha.H.U [5]. They sought to cut electricity use anywhere from 20% to 60%. There The use of motion sensors, refraining from using photocopiers when they are idle, switching to LED lighting, switching from laser printers to ink-jet printers, and switching from CRT monitors to LCD monitors were among the recommendations made for replacing traditional chokes for tubular fluorescent lamps (TFL) with electronic chokes. These steps needed a total investment of Rs. 2,42,062. The analysis predicted a decrease in energy usage of around 41.66% and a decrease in costs of roughly 30.6%, with computed payback times for each item.

According to a recent UN estimate [6], around 1.3 billion people globally lack access to electricity. The Asia

Pacific area, which includes Pakistan, is home to many of these people. According to the paper, future initiatives to increase access to energy would concentrate on smaller power systems and off-grid connections, concentrating on the use of renewable energy sources.

Despite being a pioneer in the usage of renewable energy to produce power in 2010, the Asia Pacific area only made up a small fraction of the overall electricity utilised in the region. In comparison to other regions of the world, the average quantity of power consumed per person in the region's dwellings is likewise relatively low.

The study also highlights how many individuals cook their meals using solid fuels like coal or wood, which can lead to indoor air pollution. Pollution of this kind might be dangerous and can cause early demise. For these communities, it's crucial to identify healthier and safer cooking options.

This is obvious after reading the paper [7]. That a lot of tube lights are used. LED lights should be used in place of tube lights to increase energy efficiency. Compared to CFL and tube lights, LED lights have a two-year guarantee and use less units. It is evident from examining Fig. 3 that LED lights will be very successful in preserving electrical energy over the following five years.

The lone refrigerator in the home has a 1000 W rating and a load test efficiency of less than 50%. Replace this refrigerator with one that has earned a star. The yearly use of the existing refrigerator is 1642.5 units, costing Rs. 4927.50. However, by swapping it out with a refrigerator with a 3-star rating, the yearly electricity usage will drop to 636 units, equivalent to a cost of Rs. 1878. This substitution will result in an annual savings of 1016.5 units, or Rs 3050. Additionally, choosing a 5-star refrigerator would save you Rs 3727.50 year.

Similar to that, the air conditioner in use is an old model that did badly in the study of the load test. Replace it with a star-rated air conditioner, it is advised. The existing air conditioner costs Rs 60225 and uses 20075 units yearly. The yearly electricity usage would drop to 13466.1 units with the installation of a 5-star 1.5-ton split air conditioner, saving Rs 40398.30 annually. This substitution will result in annual savings of 6608.1 units, or Rs 19826.70.

Several studies[8] were out in EU nations looked at the energy energy use in schools and found great room for energy savings. For instance, schools in southern Finland use the most energy, with elementary schools and universities using an average of 214 and 229 kWh/m<sup>2</sup> annually. The average annual final energy usage for educational facilities in Slovenia is 192 kWh•m<sup>-2</sup>. Studies conducted in the United Kingdom and Luxembourg also provided data on school energy usage. There are over 51,000 educational buildings in Italy, and each one uses an average of 20 kWh•m<sup>-2</sup> of electricity and 130 kWh•m<sup>-2</sup> of thermal energy per year. By spotting problems and offering fixes, energy audits are essential for enhancing the energy efficiency of these structures.

For energy audits in educational facilities, several approaches have been developed, including the usage of regulations like EN ISO 13790 and EN 16247-2. These audits assist in determining potential energy efficiency measures and evaluating energy performance. Additionally, tools have

been created to aid administrators in evaluating energy performance and choosing cost-effective solutions.

This work's goal is to introduce a brand-new energy audit technique that adheres to EN 16247-2 standards. With the help of this technique, it should be possible to produce virtually Zero-Energy Buildings (nZ EBs) and discover realistic, affordable alternatives. The process entails developing a numerical model of the building, calibrating it, choosing energy-saving measures, figuring out the most affordable options, and making sure that nZEB standards are being met.

Overall, the goal of this study [9] is to develop a useful tool for diagnosing energy deficiencies in schools and putting in place affordable retrofit measures to make them into the second stage of energy auditing is a thorough analysis of a campus building's operational systems to determine its energy usage. Examining the building's functioning, HVAC and lighting systems, operational hours, and occupancy density are all part of this process. Architectural plans and drawings are used to gather pertinent data and requirements to start the audit. To categorise information like peak demand, climatic circumstances, and possible energy savings, the energy consumption patterns are examined.

According to an audit of a campus building in Rockhampton, the HVAC system accounts for 95% of the university's entire energy use. Natural gas and gasoline are two other energy sources that contribute 2.5% and 3.5%, respectively. Inside of Rockhampton the Academic Zone is the main energy user on campus, using 88% of the total electricity.

The HVAC system is the main factor in the fluctuating electrical energy consumption in Rockhampton throughout the year. The mean air temperature and electrical energy usage are significantly correlated. For the Rockhampton campus, the reference building load—which represents the minimal amount of energy used annually—was found to be about 57,000 kWh per month.

Between 2014 and 2016, CQ University's electrical energy consumption climbed by around 3% every year, while the consumption bill at the Rockhampton campus increased by about 9%. Climate conditions have an impact on changes in energy use. It is noteworthy that energy use is higher in the summer and lower in the winter.

The maximum energy Demand was typically highest in March, while demand was lowest in July. Due to extra sessions in December, overall energy use increased, although it fell over the holidays when schools were closed. A rough estimate of the cost of yearly electric energy use is 1,175,149 AUD.

Securing a sufficient and effective energy supply is crucial for the sustainable development [10] of contemporary civilization. The total installed capacity of power plants in India as of February 2018 was 334,146.31 MW. However, with India's energy consumption expected to increase by 4.2% year till 2035, renewable energy sources must be given top priority. Energy audits are essential in minimising waste and maximising energy use to meet this demand and lessen the impact on energy production. There is an urgent need to give renewable energy sources priority until 2035. Energy audits are essential in minimising waste and maximising

energy use to meet this demand and lessen the impact on energy production.

Energy conservation is using energy as effectively as possible while reducing waste. This essay focuses on an alternate strategy for conducting energy audits that explicitly aims to save power costs by swapping out inefficient appliances with more energy-efficient ones. This paper's technique focuses on integrating solar water heaters and biogas systems as a key means of energy conservation.

Solar water heaters use the sun's energy to heat water, minimising the need for gas or electric water heaters. Households may drastically reduce their energy use and costs by switching to solar water heaters. Similar to this, biogas systems provide an eco-friendly option by producing biogas from the breakdown of organic waste. This biogas may be used to generate power or as a green energy source for cooking.

This study outlines a thorough technique for energy efficiency and emphasises the advantages of using biogas and solar water heaters. Along with examining possible difficulties and factors for these solutions' effective adoption, it also discusses the merits of these solutions from an economic and environmental standpoint.

[11] Effective energy control requires an understanding of and management of building energy usage. Energy efficiency cannot be fully understood by looking only at total energy use. It's crucial to assess the unique energy usage habits of each institution separately. The Department of Facilities Management at CQUniversity is in charge of to manage the building's systems. Currently, a building's performance and any abnormalities in its operations are evaluated using maintenance profiles, energy consumption statistics, and systems efficiency reports. However, there are several ways to improve the structures' energy efficiency.

The main energy-consuming equipment on the CQUniversity campus in Rockhampton, according to an energy assessment, comprises lighting systems, HVAC systems, and office and educational amenities. According to a 2012 research, lighting systems are responsible for 30% of the campus' overall energy use. The majority of rooms come with power factor correctors and fluorescent lighting. Electric lighting systems are mostly used to enhance natural lighting and offer sufficient interior illumination.

One significant problem identified during the Electric illumination in empty rooms should always be on, according to an audit. Additionally, as students frequently use university buildings and offices outside of regular business hours, lights are frequently left on after they leave. The outdoor lighting fixtures are also dirty and badly maintained, which reduces their efficacy and wastes energy because of the inadequate illumination. The fluid-tilt installation in the parking lot runs from 5:00 pm to 5:30 am every day, indicating the necessity to modify its operating hours in accordance with seasonal differences between summer and winter.

HVAC systems, which account for an estimated 45–50% of the building's energy use and include chillers, air handling units (AHUs), and fan coil units (FCUs), were found to be the biggest energy consumers. overall energy use. It was discovered that the HVAC system operated using continuous control schemes rather than adapting for real demand.

Openings like doors and windows were regularly left open in classrooms, labs, and offices, and many FCUs were seen to be left on in empty places. Academic personnel, office workers, and students had access to air-conditioned areas outside regular business hours, which led to the HVAC system continuing to run unnecessarily, similar to the lighting energy audit. The fact that all AHUs delivering conditioned air worked as constant air volume (CAV) providers, disregarding the interior temperature, was another important discovery.

Based on the results of the energy audit, a number of recommendations may be made to increase energy efficiency. Utilising timers or occupancy sensors to regulate lights can minimise energy waste in places that aren't used. To maximise their effectiveness and reduce energy inefficiencies, outdoor lighting fixtures should be prioritised for maintenance and cleaning. Additionally, employing stricter control methods for the HVAC system, such as implementing temperature sensors for demand-based operation and using variable air volume (VAV) systems, can dramatically lower energy use. These actions will lessen the campus' carbon footprint, which will help to save money while simultaneously promoting environmental sustainability.

[12] The Department of Facilities Management may pinpoint particular areas for improvement and execute focused energy-saving initiatives by carrying out extensive energy audits and analyses on a facility-by-facility basis. An improved campus environment, lower operating costs, and more energy efficiency will result from this proactive approach to energy management. The availability of sufficient and suitable energy sources is crucial for the sustained development of human society. It is essential that we take the required actions to close the gap between energy supply and demand as the need for energy keeps rising. In particular, the hostel and mess of the Maharaja Surajmal Institute of Technology in Janakpuri, New Delhi, are the subject of this study's energy audit. The goal is to pinpoint areas where energy utilisation may be optimised and offer solutions for more cost-effective energy use.

The research seeks to increase awareness of energy usage and encourage energy conservation practises by undertaking a complete examination of energy use and wastage through various equipment. The thorough analysis offers insightful conclusions. Into the institution's energy use practises. It assists in identifying particular locations where energy saving measures may be put into place, resulting in cost reduction, less environmental pollution, and improved demand-supply gap management.

The study paper's findings add to the academic institution's general grasp of energy conservation. They stress the necessity of sustainable practises and the significance of energy awareness. The article offers doable solutions that may be used to maximise energy efficiency and lessen energy waste. The institution can help create a more sustainable and ecologically friendly atmosphere by putting these steps into practise.

This study article emphasises the importance of energy conservation and the demand for sustainable energy practises in its conclusion. Performing an energy audit at the hostel the mess of Maharaja Surajmal Institute of Technology

illuminates the institution's energy usage trends and waste. The proposed actions resulting from the study offer important insights for cost containment, pollution abatement, and bridging the demand-supply imbalance. The goal of the article is to increase awareness and promote the use of energy-saving techniques, ultimately promoting a more sustainable future.

The amount of energy used affects a building's operational expenses significantly. Buildings today are constructed with an emphasis on energy efficiency and lowering carbon footprints. However, there is always opportunity for improvement in older structures that may be retrofitted in a proper way to reduce energy use and carbon footprints. An energy audit of an academic institution was performed in a case study in northern India. Several potential for considerable energy savings were found by the university.

[13] The case study focuses on the National Institute of Technical Teachers Training & Research in Chandigarh, India, and suggests actions that might reduce energy use by 35% and carbon emissions by around 177 tonnes. The study's suggestions are doable and call for small expenditures with manageable return times.

The use of the institution building's rooftops for solar photovoltaic (PV) power plant installation is one of the analysis's important points. Currently, a solar PV power plant constructed on the building's rooftop provides 7% of the structure's energy needs. Up to 25% of energy might be saved by increasing the number of solar power plants that are installed on roofs. Solar energy sources can supply all of the building's energy requirements.

It is possible to drastically cut energy use and carbon emissions by integrating solar power generation with retrofitting techniques. The structure may become more ecologically friendly and sustainable by utilising renewable energy sources like solar electricity.

The results of this case study highlight the potential for retrofitting techniques and the use of solar power generation to reduce energy use and carbon footprint in existing structures. For building owners, managers, and politicians looking to encourage energy efficiency and sustainable building practises, these insights are helpful.

[14] The United Arab Emirates (UAE) have a built environment where the focus is on sustainability because of the country's hot temperature and rapid urban and population expansion. has focused on the quantity of building rather than its energy efficiency. The delayed development of energy-efficient construction rules and the subsidised price of power have made the problem even worse. As a result, the UAE frequently appears among the nations with the most environmental impact, with a large share of emissions coming from the power needed to produce building cooling.

This study focuses on analysing data, particularly from the UAE, that looks at how well passive building-envelope methods may cut down on energy use. As the need for energy laws grows, a number of solutions have been devised to deal with the unique problems the UAE is currently facing. These solutions include alternatives for retrofitting as well as planning methods for the building exterior. They target heat transfer via walls, windows, and roofs that is radiative, convective, or conductive. Techniques

for energy-effective natural ventilation have also been investigated.

The geographic scope of this assessment is restricted to the United Arab Emirates (UAE), a country with a distinctive economic growth pattern and laws that specifically encourage energy efficiency. The review's conclusions highlight the importance of a number of elements in producing energy-efficient architecture. The management of excessive light levels and glare, the use of natural ventilation, and proper selection and placement of glazing in highly glazed office buildings are some of these factors. Thermal insulation has demonstrated energy savings of over 20% in residential contexts. Techniques for natural ventilation have shown to be particularly promising. Employing mixed-mode ventilation, high-rise office buildings have the potential to save up to 79% on energy, compared to up to 30% in villas.

The UAE may significantly cut its energy use and lessen its environmental effect by putting these steps into place. The study highlights the need of taking into account regional variables and creating personalised methods to improve energy efficiency within the particular setting of the UAE. The UAE may move towards a more sustainable and ecologically aware built environment by implementing energy-efficient practises and passive building-envelope solutions.

[15] Energy audits are a practical and economical approach to closing the energy supply-demand imbalance. These audits assist in locating areas of energy loss and offer suggestions for advancement. In a current research, a thorough examination of building energy audits was carried out on a number of Dhaka-area commercial structures. In order to streamline the energy audit procedure, the research also created a programme named "EnergyWise" using Microsoft Visual Basic Application. research, a thorough examination of building energy audits was carried out on a number of Dhaka-area commercial structures. In order to streamline the energy audit procedure, the research also created a programme named "EnergyWise" using Microsoft Visual Basic Application.

Data processing, summary, and transfer to Excel spreadsheets are all automated using the "EnergyWise" programme. Users may easily analyse and pinpoint regions of electrical load consumption, expressed as a percentage of the overall load, by entering data. Understanding patterns of energy consumption and setting priorities for energy-saving initiatives are made possible by this information.

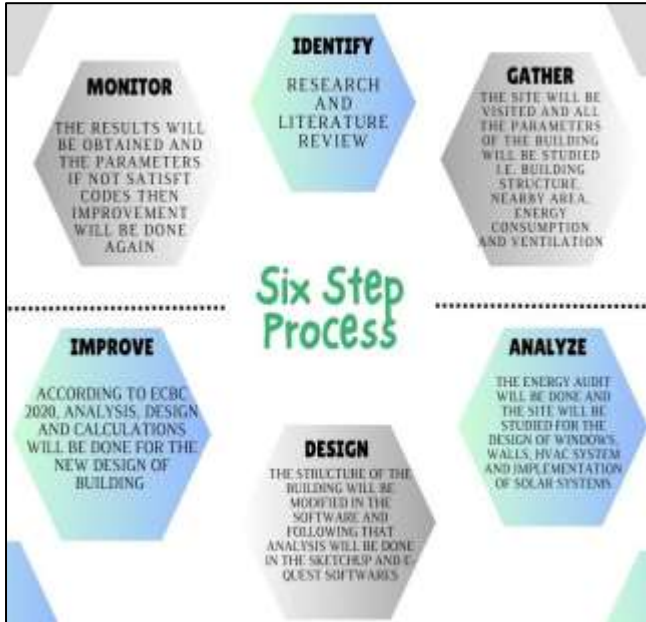
The study's findings show that Dhaka's business buildings consume electrical energy inefficiently. However, considerable energy savings may be made by replacing outdated machinery and lighting fixtures with ones that use less energy. According to the study, electrical systems might save 8%–15% on energy.

: Equations should be typed in either Times New Roman or Symbol font, or, if the equation is multileveled, inserted into your text as a graphic instead. On the far right of the line containing the equation, number it in parentheses, and use this number to refer to it in the text (1).

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### III. METHODOLOGY

This is another level 3 heading: The body text is divided into two columns on each page, written in 10 pt. Times New Roman, and justified (meaning that the text is spaced in a way that makes the right edge line up neatly). All the appropriate formatting is automatically applied in this template. If anything goes wrong, you can reapply it using the “styles” section in Word.



The first step in an energy audit is a survey. Survey refers to information on the academic area, its physical attributes, the tools utilised inside, the amount of energy used, etc. Three sections of the survey might be made:

- 1) A first survey: The auditor might need to be familiar with the building and how it is utilised before doing the walk-through survey. The following sources of information can be used to identify more ECOs for evaluation: architectural blueprints, air-conditioning blueprints, electrical lighting and power blueprints, utility bills and operation logs for the year prior to the audit, air-conditioning manuals and system data, and building and plant operation schedules. However, in order to take advantage of these opportunities, a larger capital investment will be required.
- 2) Walk-Through: If the blueprints and other available preparatory material adequately depict the building and its operation, the walk-through procedure could be carried out after we were familiar with the structure. A trip around the structure to examine the building envelope might be the first step in the procedure. A building must be separated into analysis zones if a model analysis is part of the investigation. It would be confirmed during the interior assessment that the air conditioning system is functioning as it should. Changes and additions would be recorded in the International Journal of Engineering Research and General Science. The windows' kind and state, window seal efficiency, normal lighting and power consumption, occupancy, and space utilisation are all indicated. This data might be contrasted with the suggestions in the relevant code of practices.

### IV. DESIGN OF EXPERIMENTAL SETUP:

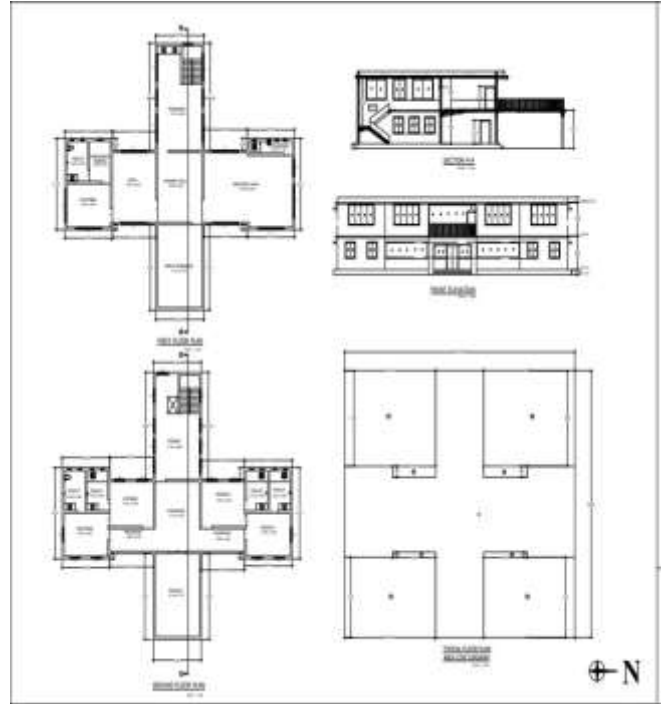
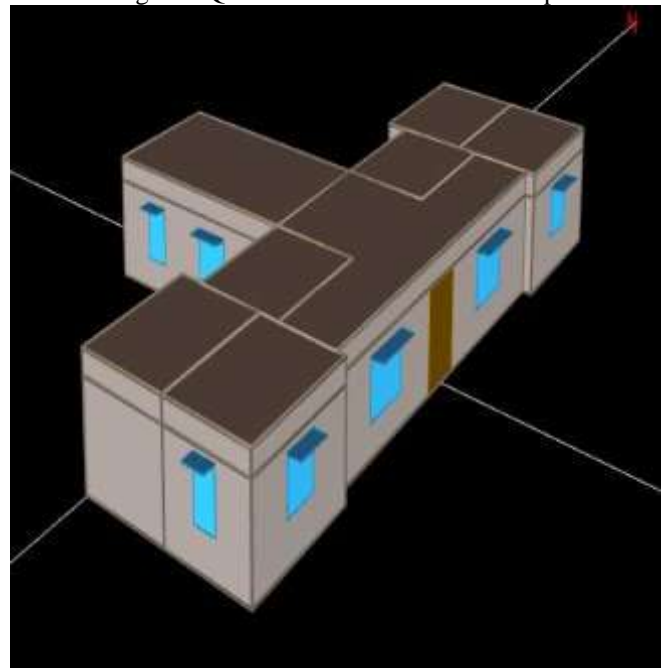


Fig. 1: Layout of College Workshop

| <b>BUILT UP AREA SUMMARY</b>    |            |               |                      |               |
|---------------------------------|------------|---------------|----------------------|---------------|
| FLOOR                           | COMM. AREA | RESI. AREA    | excess. balc.        | TOTAL AREA    |
| GR. FLOOR                       | ---        | 287.42        | ---                  | 287.42        |
| 1 ST FLOOR                      | ---        | 287.42        | ---                  | 287.42        |
| <b>TOTAL</b>                    | ---        | <b>574.84</b> | ---                  | <b>574.84</b> |
| <b>TOTAL RESIDENTIAL AREA =</b> |            |               | <b>574.84 SQ.MT.</b> |               |

Fig. 2: EQuest Model of Basic Workshop



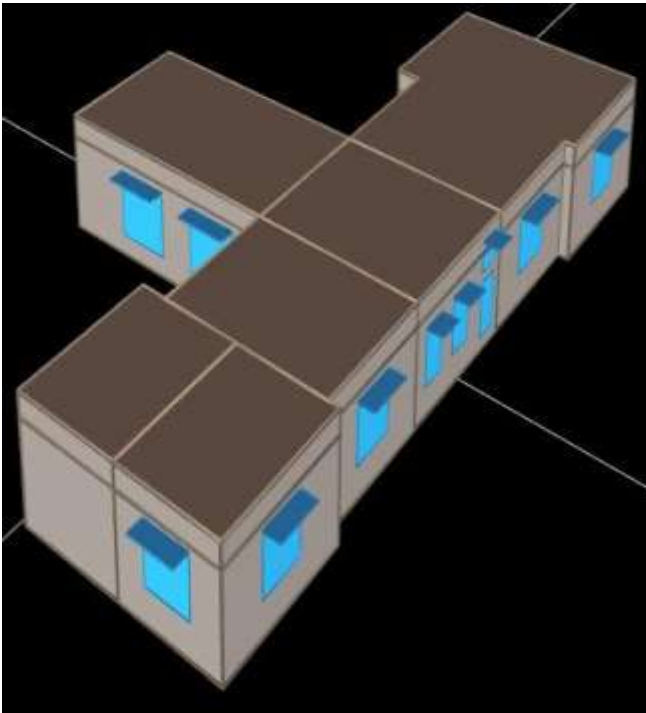


Fig. 3: EQuest Model of Machine Shop

**A. Lathe Machines:**

Monthly Energy Consumption (kWh) = Rated Power (kW) x Daily Operating Hours x Number of Operating Days in a Month

Here's now calculate it:

Rated Power (kW) = 1.5 kW

Daily Operating Hours = 2 hours

Number of Operating Days in a Month (an average of 20 operating days per month) = 20 days

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 1.5 kW x 2 hours/day x 20 days/month = 60 kWh/month

So, the lathe machine would consume approximately 60 kilowatt-hours of energy per month when operated for 2 hours a day, 5 days a week, assuming 20 operating days in a month.

Monthly Energy Consumption (kWh) for 20 Machines = Rated Power per Machine (kW) x Daily Operating Hours x Number of Operating Days in a Month x Number of Machines

Monthly Energy Consumption (kWh) = 1.5 kW x 2 hours/day x 20 days/month x 20 machines = 1,200 kWh/month

**B. Horizontal Surface Grinder:**

Here are the values:

Rated Power (kW) = 0.75 kW

Daily Operating Hours = 2 hours per day

Number of Operating Days in a Month (assuming an average of 20 operating days per month) = 20 days

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 0.75 kW x 2 hours/day x 20 days/month = 30 kWh/month

**C. Power Hacksaw Machine:**

Rated Power (kW) = 0.75 kW

Daily Operating Hours = 2 hours per day

Number of Operating Days in a Month (assuming an average of 20 operating days per month) = 20 days

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 0.75 kW x 2 hours/day x 20 days/month = 30 kWh/month

**D. Bench Grinder Machine:**

Rated Power (kW) = 0.75 kW

Daily Operating Hours = 3 hours per day

Number of Operating Days in a Month (assuming an average of 20 operating days per month) = 20 days

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 0.75 kW x 3 hours/day x 20 days/month = 45 kWh/month

**E. Milling Machine**

Rated Power (kW) = 1.5 kW

Daily Operating Hours = 2 hours

Number of Operating Days in a Month (an average of 20 operating days per month) = 20 days

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 1.5 kW x 2 hours/day x 20 days/month = 60 kWh/month

**F. Shaper Machine**

Rated Power (kW) = 1.5 kW

Daily Operating Hours = 1.5 hours

Number of Operating Days in a Month (an average of 20 operating days per month) = 20 days

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 1.5 kW x 1.5 hours/day x 20 days/month = 35 kWh/month

**G. Centerless Grinder:**

Rated Power (kW) = 0.75 kW

Daily Operating Hours = 0.10 hours per day

Number of Operating Days in a Month (assuming an average of 20 operating days per month) = 20 days

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 0.75 kW x 0.10 hours/day x 20 days/month = 1.5 kWh/month

Rated Power (kW) = 1.5 kW

Daily Operating Hours = 1.5 hours

Now, plug these values into the formula:

Monthly Energy Consumption (kWh) = 1.5 kW x 1.5 hours/day x 20 days/month = 35 kWh/month

Number of Operating Days in a Month (an average of 20 operating days per month) = 20 days

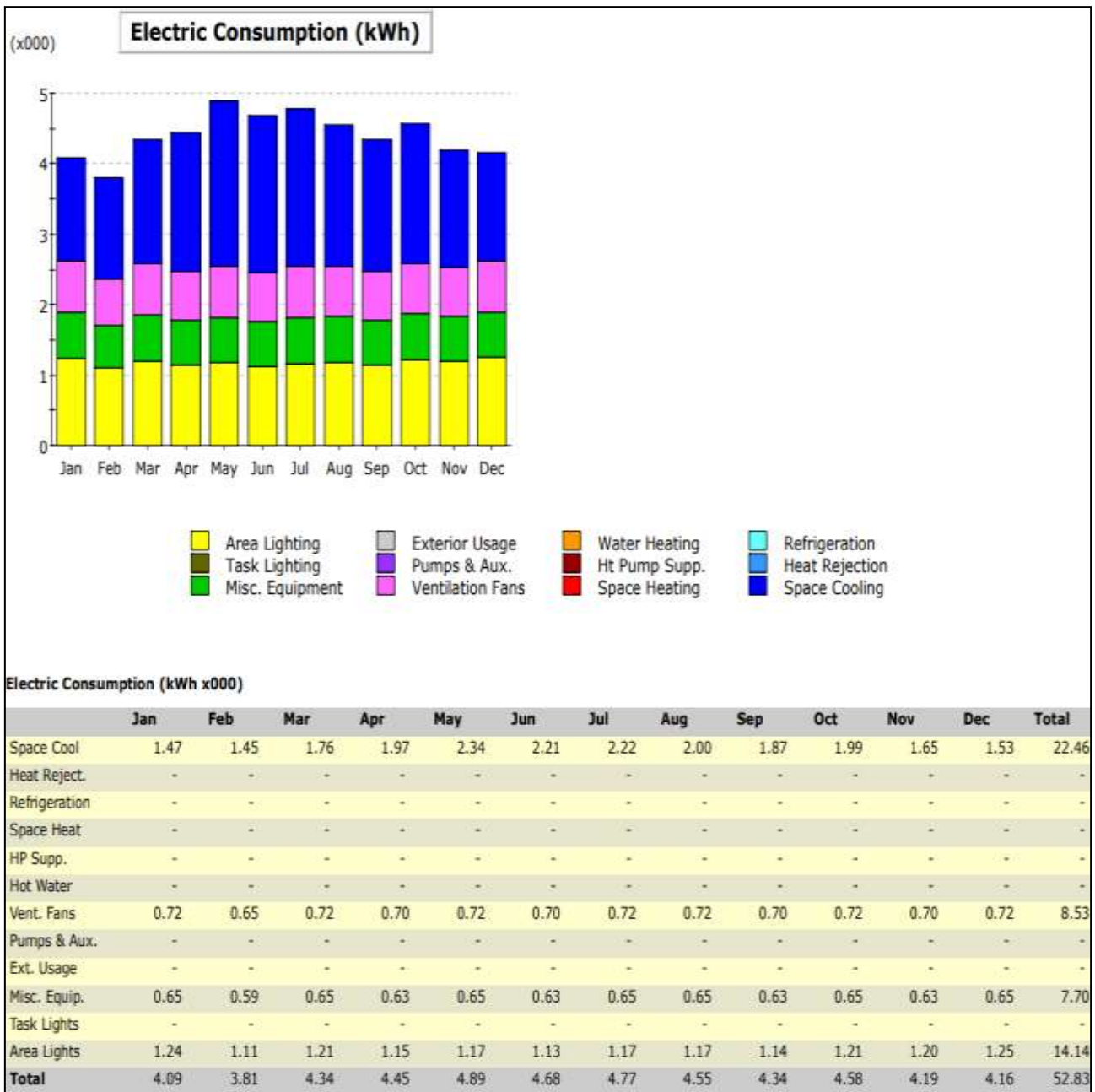


Fig. 4: Analysis of Basic Workshop

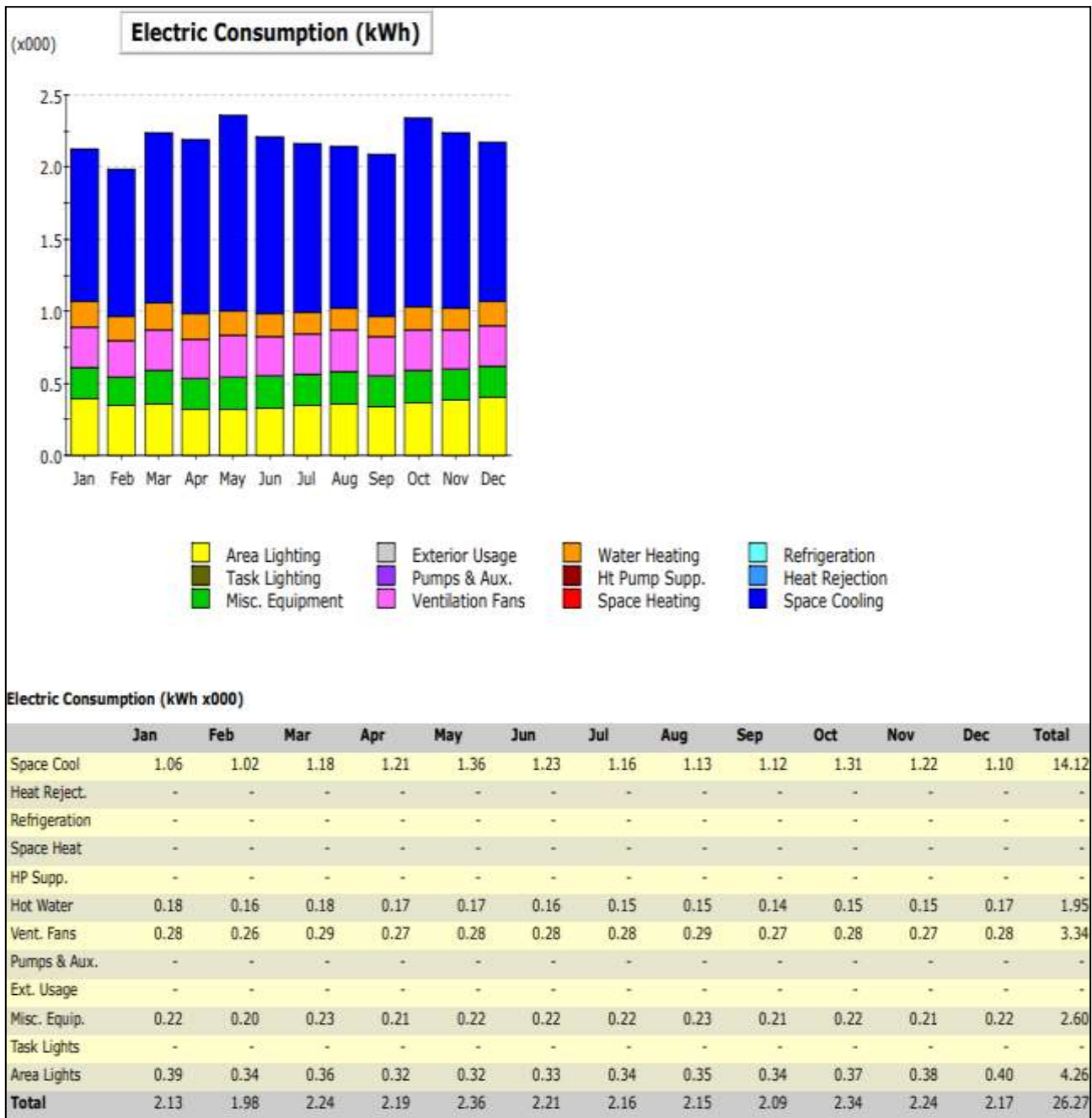


Fig. 5: Analysis Of Basic Machine shop

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