



ORIGINAL RESEARCH PAPER

Engineering

ENERGY AUDIT in college campus: A CASE STUDY

KEY WORDS: energy audit, solar system, energy conservation, data logger.

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ABSTRACT

Today saving energy is very important and necessary process for the entire consumers in this world. It just not provides information about cost and consumption but also provide various energy saving strategies. Our present work is based on energy audit of the Ganga Campus, Jhajar. This work provides a simple process of energy audit in small commercial buildings or shopping malls. In present work we have calculated total load of college equipment and total annual cost on power utilization including diesel-generator power system. During the energy audit work we have identified many sections which needs to be implemented for energy saving. Secondly our approach is to transfer the dependency of diesel-generator system to solar system and transforming the campus in green campus. Our main aim is proper utilization of all the resources available inside campus and saving environment by reducing CO² emission.

INTRODUCTION: Energy is the ability to do work and work is the transfer of energy from one form to another. Energy comes in different forms - heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy.^[1]

Energy audit: Energy audit is a systematic study or survey to identify how energy is being used in a building or plant, and identifies energy savings opportunities. An energy audit is an identification of energy uses for energy conservation in a building, industry or system to reduce the amount of energy input into the system without negatively affecting the outputs. An energy audit is the first step in identifying opportunities to reduce energy expense in commercial and industrial uses.^[2] Using proper audit methods and equipment, an energy audit provides the energy management with essential information on how much, where and how energy is used in an organization (industry or building).^[2]

Energy audits provides more help in both the field residential and commercial that how and where can be make their homes and building more efficient. An energy auditor does a room-by-room inspection and observes billing history, insulation leak, air leakage, heavy energy usage areas etc. A good energy auditor will help owners make more informed decisions on improved energy efficiency. An energy audit find the energy wastage area, causes of leakages of energy, insulation working and all factor for reducing energy input.^[4] Energy audit is the management of energy by optimal salutation. A optimal solution is provided by maintenance of electric power systems, to extent the operation, design, application and some important factor which is related to energy. Optimal in this case refers to the design or modification of a system to use minimum overall energy where the potential or real energy savings are justified on an economic or cost benefit basis. Optimization also involves factors such as comfort, healthful working conditions, the practical aspects of productivity, aesthetic acceptability of the space, and public relations

Types of energy audit :Energy Audit can be classified into the three types, Preliminary Energy Audit, Detailed Energy Audit, Investment-Grade Energy Audit.

Literature review: In IEEE International Conference 2009, "Energy Audit and Its Application in Coal-Fired Power Plant" by Yong Li; Jian-Jun Wang, et.al. International Conference 2009. This paper presents the addresses of many method of energy audit in coal-fired power plant. In this paper, by analyzing current utilization situation of energy in China's coal fired power plant, the significance of energy audit in coal-fired power plant to energy-saving and emission-reducing is introduced. Energy audit contents such as energy management audit, energy utilization audit and energy-saving potential analysis is given. According to energy audit practice in coal-fired power plant, the implementation step and a substantial case of energy audit are proposed.^[10]

"Electrical energy audit in a Malaysian university - a case study" by Singh, H., et.al. in IEEE International Conference 2012. In this

paper, the electrical energy audit performed for the development of the electrical energy efficiency measures EEMs in University Technology MARA (UiTM) Penang is discussed. To improve the electrical energy performance in buildings, an enhanced level of awareness to reduce energy waste, the use of efficient equipment and control systems is found to be the most effective energy efficiency measures strategy to improve the lighting and air conditioning system efficiency in the buildings. The benefits of implementing the energy efficiency measures in buildings are substantial both in terms of energy savings and cost savings.^[11]

"Energy Audit: A Case Study" by Mendis, et. Al. on International Conference ICIA 2006. This paper provides an overview of a general energy conservation measures (ECMs) that can be commonly recommended for an industrial facility. It should be noted that the ECMs presented in this paper does not pretend to be exhaustive nor comprehensive. It provides merely to indicate some of the options that energy auditor can consider when performing an analysis of an industry. This paper presents energy saving methods in a methodological approach, experienced during a detailed energy audit of a medium scale apparel industry in Sri Lanka. The energy consumption and savings assessed in term of equipment's used and functional areas occupied. Investing to improve the energy efficiency of a textile industry provides an immediate and relatively predictable cash flow resulting from lower energy bills.^[5]

"Bureau of Energy Efficiency Govt. of India" The Bureau of Energy Efficiency is an agency of the Government of India, under the Ministry of Power created in March 2002 under the provisions of the nation's 2001 Energy Conservation Act. The agency's function is to develop programs which will increase the conservation and efficient use of energy in India. The government has proposed to make it mandatory for all appliances in India to have ratings by the BEE starting in January 2010.^[9]

METHODOLOGY and DATA COLLECTION: All related electricity consumption and energy conservation data and information are gathered and compiled. The existing situation on the ground at the identified site is also evaluated and assessed in order to ensure effective and efficient procedures for subsequent energy conservation measurements. This also include a review of existing world-wide available technologies for energy saving schemes, which suit the nature and characteristics of the region under study. We use some general tools for energy audit like Fuel efficiency monitor, Combustion analyzer, Infrared thermometer, Water flow meter, Thermocouple sensor, Data logger, etc. Collection of Data of college CAMPUS, we collected the room wise details of electrical connected load, pervious two year's electricity bill and other power consumption information; Total Unit Consumed per Day/ per Month/ per Year, Identification of Week Points of Installation, Analysis of DG Data, CO₂ Emission due to Burning of Diesel, Calculation of Payback Period etc. we collected data from each and every room from all the 3 floors of academic building, girls hostel boys hostel management block, administration block,

library and labs. We have also considered month wise electricity bills of last two years; here we are providing a sample of that information.

GANGA INSTITUTE OF TECHNOLOGY & MANAGEMENT						
Total Amount Spend in 2015 (Diesel generator + Elec. Bill)						
Month 2015	Gen. 64kva cost	Gen. 140kva cost	Diesel Total (Rs.)	pump bill amount	Elec. Bill Amount	Total
Jan	0	49775	49775	5910	198104	253789
Feb	0	41525	41525	6150	130478	178153
Mar	0	64075	64075	7244	145994	217313
Apr	5500	157850	163350	10958	173998	348306
May	32725	287375	320100	11358	192791	524249
Jun	66550	28325	94875	3906	214823	313604
July	73975	62975	136950	4658	132549	274157
Aug	40425	91300	131725	6110	134545	272380
Sep	550	139700	140250	4478	214088	358816
Oct	0	85525	85525	4954	297763	388242
Nov	1375	30800	32175	5608	266802	304585
Dec	22000	0	22000	6694	177879	206573

RESULT and DISCUSSION:

After processing and analyzing the data of Ganga Campus we find following results which are shown in the form of graphs. These graphs show monthly consumption of electricity, diesel and total amount paid by college on electricity and diesel. These graphs provide us very important information about the energy consumption pattern of the college month and year wise. In the given graph below we have shown the cost consumed on the monthly basis.

In this graph we observe that during year 2015 in July and august our electricity demand was quite low but in month October and November our load goes on increasing due to heavy demand.

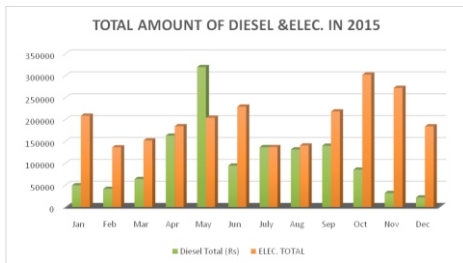


Fig. 1 Variations of Diesel cost and total electric bill amount per Month (2015)

The above graph shows the total amount spent on diesel and electricity in the year 2015. We observe that when diesel consumption is high, electricity consumption is low (in month May) and where electricity consumption is high diesel consumption is low (in month Jan, Feb, Nov, Dec).

The given graph below shows the total amount spent on diesel and electricity in year 2016. We observe when the diesel consumption is low electricity consumption is higher and vice-versa.

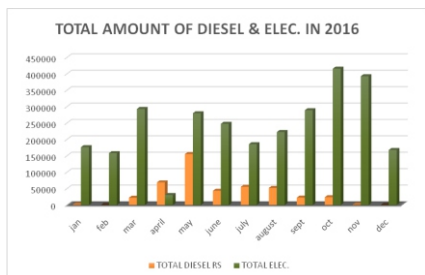


Fig 6 Variation of total amount of diesel & electric bill in 2016

Suggestions for Reducing Power Consumption: There are following suggestions for reducing power consumption cost, wiring defects, human hazards, Removing Wiring Defects, Proper Lighting, Proper Earthing, solar power plant, ground solar power plant etc. It has been found that the building of all Ganga Campus has some wiring defects, due to losses and some disturbance in continuous electric supply. So some changes in connection of wiring can bring effective benefits in the supply and help in bringing down the losses. Electric circuits in Campus do not have proper earthing, which may lead to great loss in terms of equipment's and can be fatal also. So it may be suggested that a proper wiring of earth can be done to reduce the risk of electric shock and power fluctuations.

We are well known that the rapidly growth of business and population are putting more and more pressure on world power resources. Photovoltaic Solar Power plant price will play a vital role in the larger development of solar power generation. We should grasp the opportunity to build the most suitable environmental friendly PV power plant. Solar PV system includes different components depended on your system type, site location and applications. The major components for solar PV system are solar charge controller, inverter, battery bank, auxiliary energy sources and loads (appliances).

Calculation of Cost of 20 KW Solar Power Plant for: Daily Average Demand of campus is 18 KW; for equalizing the demand of 18 KW we required to set up a 20 KW Solar Power Plant. Following are the details of a 20 KW Solar Power Plant. No. of Solar Panel required for 20 KW Plant of 250 watt Capacity is 80, Cost of Solar Cell per Watt with Installation is Rs.100; So the Cost of a 20 KW Solar Power Plant comes out Rs.2000000 (20 lakhs). The payback period is calculated on the basis of cost and saving. Total Amount Paid for DG and Electricity/ Year is equal to Rs.1925244 (19.25 lakhs) and calculated Cost of 20 KW Solar Power Plant is Rs.2000000 (20 lakhs); so the Payback Period would be almost 1.04 years. Since we can compare that the annual cost of power consumption is almost equal to solar plant installation. So we can say that installing solar plant is a good and beneficial step to save power, money and environment.

CONCLUSION AND FUTURE SCOPE: Energy audit provide the information that energy managers need to identify energy consumption patterns and components of a facility and document existing conditions, energy conservation opportunities can be identified and prioritized. By taking a methodical approach to the audit process, it is possible to identify and avoid unnecessary expenditures in industries while improving operation and comfort. A comprehensive study in Ganga Campus, Jhajjar was carried out to identify the pattern of energy consumption, estimate energy losses and suggest recommendations to reduce these energy losses. The study first includes the electrical layout of Ganga Campus, load details and input data collection of various electrical & mechanical parameters using measuring instruments. This work presents a simple method to calculate the total load of the Ganga Campus and total demand variation with season. We identify the faults in the present wiring system and area of improvement. Secondly we calculate the total fuel consumption in the DG set for eighteen months. We also calculate the total CO2 emission due to DG set operation and last we analyze the total power consumption cost and various factors which are important for saving energy.

In this audit process we find that the DG operation cost is very high due to non-availability of power from grid. For reducing this cost and saving environment we proposed a roof mounted solar power plant which can fulfil all the demand of college. The payback period of the solar power plant is very attractive and efficient. This work can be extended further in installing 1 MW solar power plant in the campus yard. So we can produce our total required power and remaining power can be given to the local grid. So by using this way we can improve the energy efficiency and saving money and environment.

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