



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 10, October 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569



Energy Efficiency Improvement and Cost Saving Opportunities for an Industrial Site

Anubhav Kumar Tiwary¹

B. Tech. Student, Department of Mechanical Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, India¹

ABSTRACT: Electricity is an essential part of life and important to the economic development of the country. It's rationally non-viable to evaluate the actual magnitude of the part that electrical energy has played in the building up of modern day civilization. Electrical Energy demand is increasing rapidly, because of population and economic growth. While accompanied by greater well-being, rising demand creates new challenges. Effective use of energy can control this electricity demand. Generally speaking, an energy audit set up the guideline for any improvement in the area of electrical energy utilization. Energy audit is a systematic, independent and documented process for obtaining audit authentication and it include a comprehensive way to decrease the amount of energy input into the system without negatively affecting the output. This paper shares the experience of energy conservation project carried out in a manufacturing industry situated in Pune city. Economic and systematic measures of energy conservation have been followed subject to budget constraints, and the results of such measure were realized through reduction in energy cost with the added benefit of environmental safety.

KEYWORDS: Energy Audit, Energy Management, Energy Conservation, Energy Efficiency.

I. INTRODUCTION

Every day, we are surrounded by one of the most important creations of all time, electricity. Electricity is essential for all processes that occur across the whole universe. Energy is a conserved quantity with a limited amount within the universe, though there is a near limitless supply. It can be measured and stored in various ways, but it is not a material substance, even though it can be transform directly into matter. Our energy decisions and choices impact Earth's natural systems in ways in which we have a tendency to might not bear in mind of, thus it's essential that we elect our energy sources rigorously. Energy management and related energy conservation in industry sector are well known issue as various legislative acts and standards have been adopted in recent years. Rising energy prices, stricter environmental law restrictions, new supply and demand policies as well as energy end use efficiency policy programs have created increased demand for reducing energy consumption and related energy costs in industrial companies.

Electrical Energy utilities are becoming more and more stressed since existing transmission and distribution system are facing their operation restriction with growing load. Now a day's human life cannot be imagined without electricity, saving energy means reducing the amount of energy used while achieving similar outcomes of end use, because we know we are having finite amount of energy resources in earth to generate electrical power. Energy demands and costs are increased over time. Increasing usage of energy-intensive products and services directly disturbs the greenhouse-gas emissions and climate change.

To prevent our living earth from global warming, it is extremely important to optimize the energy usage. To conserve electrical energy and resources for our future, energy audit is instigated. Energy audit is an inspection, review and study of energy flows, for energy conservation in a building which can help you determine how much energy is consumed, how much energy is losing and which area you should prioritize to make your building more efficient and comfortable. Energy audit helps to use energy efficiently rather than conserving energy. Both energy efficiency and conservation are basically reduction of energy.

This energy audit report describes how energy can be conserved and managed whilst keeping in mind the sustainable development of the society. The Audit Report is of CMR Control Systems India Pvt. Ltd., a manufacturing industry in Pune. Through this Audit we tried to educate the people who are working there about how they can play an essential role in energy conservation at ground level. The later part of the Audit carries the calculations done about how much energy and capital can be saved through switching to Solar Energy, Windmill, HVAC (Heating Ventilation and



Air Conditioning), and other energy efficient measures. With the help of energy efficient measures in different sectors like lighting and proper ventilation helps energy conservation.

II. ENERGY AUDIT

An energy audit is an inspection survey and an analysis of energy flows for the conservation of energy to an extent which is possible in any building. It identifies how and where energy is employed and suggests methods for energy savings. The scope of an energy audit, the complexity of research and also the level of economic estimations are parameters which will be considered differently by each individual auditor and should be defined prior to the start of any energy audit activities.

In order to carry out an energy audit and implement its recommendation, the corporate top management must be convinced of the requirement of implementing energy management at their company. The procedure adopted for this energy audit is split into three step process:

- 1) **Data Collection:** In data collection phase, comprehensive data collection was performed using different tools like observation and interviewing key persons.
- 2) **Data Analysis:** Exhaustive analysis of collected data was done from the database that was generated. This analysis forms the baseline for achieving any energy cost savings as results of recommended and implemented energy efficiency methods.
- 3) **Recommendation:** Then the last step is to give recommendation on the basis of results from the detailed data analysis and observations, several steps for reducing energy consumption were suggested without affecting the comfort and satisfaction of employees along with their cost analysis.

III. IMPORTANCE OF ENERGY MANAGEMENT IN INDUSTRIAL COMPANIES

The industrial sector consumes about 50% of the total commercial energy available in India. The Indian energy sector is highly energy concentrated and efficiency is well below that of other industrialized countries. The consumption of energy in industry affects every individual of that country directly through the cost of goods and services, the quality of manufactured products, the strength of the economy and the availability of jobs. The industrial sector consumes energy in numerous ways. As a result, the number of industries addressing energy-related issues has risen in recent years and increasing activity concerning energy management can be determined in business practice. Industrial companies have seemed to notice that energy management can be a powerful tool for enhancing their production systems and operations towards improved energy efficiency and thereby reducing energy use and related energy costs. Any industrial, institutional, commercial or residential, has countless energy demands placed upon it. In industry, there are the usual loads such as lighting, heating, cooling, ventilation, data processing, etc. By identifying these by type, classification, use, quantity and more down to an appropriate level of detail, one can create an energy baseline. Industries must try to improve the existing systems of their equipment and increase efficiency. This can be done by energy audits.

The government should make it compulsory for every industrial site in the country to carry out energy audit. This would give every industry an opportunity to find out energy saving opportunities that can be implemented. If these energy saving opportunities are implemented it means a reduction in the production cost of their products and thus making their products competitive on the market. In some cases, it is possible for the government to give incentives to companies that have implemented energy saving technologies. This would help to reduce the initial capital required to buy the replacement products. For example, in South Africa, the government through the Department of Energy and the Power Utility they provide rebates for companies that are successfully implementing energy saving products. They also encourage competition among the industries by providing prizes for the most energy saving company during the year.

Energy management is very important as all well-organized actions can help reduce an industry energy bills and damage it does to the environment. Energy prices are rising and business can be at considerable risk if industries do not take the initiative of conduction of energy audit. Energy audits find out where business is wasting energy. An energy audit is an analysis of a facility, illustrating that a comprehensive approach is required in order to exploit the existing energy efficiency potential keeping in mind how and where that facility can decrease energy consumption and save

energy costs. Its insight to energy efficiency and conservation can lead to notable savings on the company's profitability bill.

IV. PROCEDURE FOR ENERGY AUDIT

Energy Audit Survey conducted in a manufacturing industry CMR Control Systems Pvt. Ltd., Katraj, Pune. The initial phase of energy audit starts with site inspection work. The procedure adopted is presented below:

- Collect all the load details with a maximum demand of the electrical equipment.
- Calculate the usage of load.
- Identify and calculate the unnecessary usage of power wastage.
- Calculate the daily utilization of power by all the equipment and make pie chart accordingly.
- Data collection of all the major equipment's and find out the performance.
- Interaction about the energy usage with suitable survey.
- Identify the energy saving and conservations opportunity.
- Report on suitable recommendation with existing and implementation suggestions.
- Provide awareness on electrical safety to the person there.
- Submission of suitable energy audit report.



Fig. 1.Site Picture

V. ELECTRICAL ENERGY AUDIT

- A visit was scheduled with the managing director of CMR Control Systems Pvt. Ltd, Katraj, Pune.
- Collected all the existing and available data of building about demographic and age of employees working in the company.
- Detailed load profile data was collected on site (all appliances and energy using devices).
- Consumption analysis of all energy sources.
- Characterized energy consumption into Cooling, Lighting, Work appliances and others.
- We calculated the total energy usage of all the major appliances per day.
- Survey conducted in month of August and energy usage per day was approximately 295 kWh.

- The following data represents Electricity usage of each equipment:

TABLE 1. DATA COLLECTED

EQUIPMENT	CAPACITY (in Watt)	QUANTITY	CONSUMPTION	DAILY USAGE (in Hour)	UNITS CONSUMED PER DAY (in kWh)	UNITS CONSUMED PER MONTH (in kWh)
AC 1 TON	3500	6	21	8	168	5040
Cassette AC 3 TON	7000	2	14	1	14	420
Cassette AC 2 TON	10500	1	10.5	8	84	2520
Ceiling fans	70	11	770	8	6.16	184.8
Standing almonard fans	180	2	360	8	2.88	86.4
Wall mounted almonard fans	180	6	1080	8	8.64	259.2
Wall mounted small fans	100	4	400	8	3.2	96
LEDs office	18	55	990	8	7.92	237.6
Halogen lamps outside	25	4	100	1	0.1	3

- Went through the energy bills for last 12 months.
- A charge of electrical energy is 5.43 rupees/unit.
- Monthly Units consumed pie chart is given below:

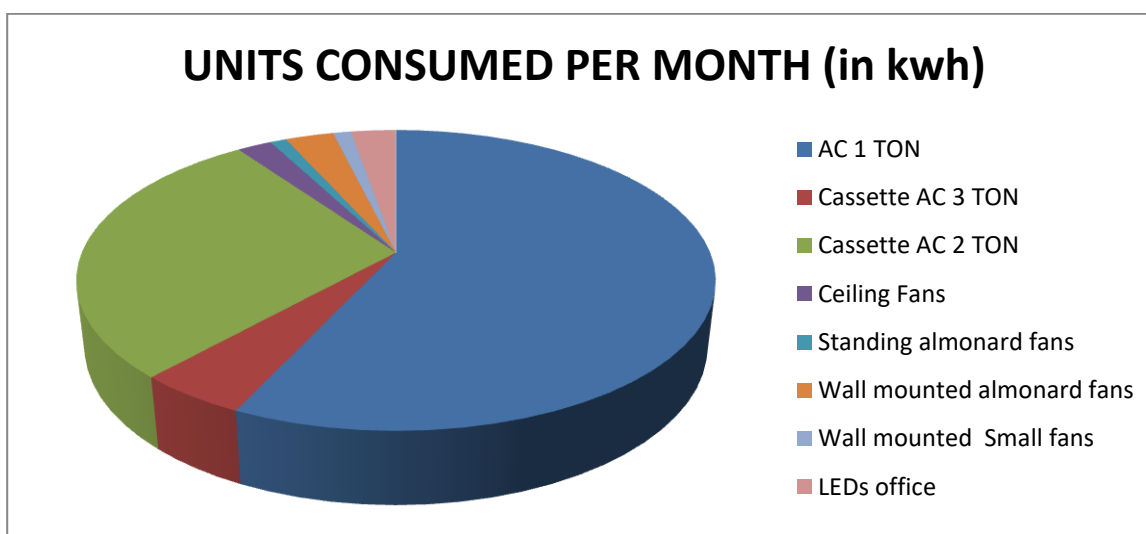


Fig. 2. Monthly Unit Consumption

VI. RECOMMENDATION

- Solar Energy:** Solar energy is energy that comes from the sun. Solar energy is unlimited renewable energy source that doesn't produce CO₂ emissions or other gases, because it doesn't consume fuel or need other resources, such as water or wind. Therefore, its maintenance and energy production costs are practically zero. The biggest advantage is that the energy production coincides with the times of maximum demand in industries. The periods with the highest energy demand are concentrated in the time slots between 11:00 AM to 4:00 PM and to a lesser extent, from 8:00 PM to 11:00 PM. Solar panels can be used to charge batteries and perform smaller electrical tasks.

Calculating no. of solar panel needed in this manufacturing industry,

Total monthly power consumption = 295 kWh * 30 = 8850 kWh

1 Solar panel = 330 Watt

Total kW of solar panels needed for this building = $8850 \text{ kWh} / 120 = 73.73 \text{ kW} = 73750 \text{ Watt}$ of solar panel

Since we are using 330 Watt solar panels,

Total number of solar panels needed to power = $73750 \text{ Watt} / 330 \text{ Watt} = 224$ solar panels.

Cost of 1 Solar Panel (330Watt) = Rs. 9000 (Approx.)

Cost of 224 Solar Panels = Rs. $(224 * 9000) = \text{Rs. } 20,16,000$.

Size of a 330 Watt solar panel with 72 cell configuration = $3.25 \text{ ft.} * 6.42 \text{ ft.} = 20.86$ square ft.

Size of 224 Solar Panel = $(224 * 20.86) \text{ square ft.} = 4672.64$ square ft.

2. **Windmill:** It is one of the oldest energy sources utilized by humans and today is the most established and efficient renewable source of energy. Windmill converts the energy produced by the movement of wind turbine blades driven by the wind into electrical energy. It does not finish, it is inexhaustible and reduces the use of fossil fuels, which are the origin of greenhouse gases that cause global warming. Today, windmills can be used in various situations, even if we require a small amount of power. They can be used in most places because they can be made in any size.
3. **Air Conditioners:**
 - For air conditioners, the lower you go, the more money you blow. So, if possible, set the thermostat to the high temperature that will still keep you feeling cool. Maintaining a temperature 10 to 15 degrees higher than the one you require for 8 hours should save you up to 10% on your cooling bills every year.
 - Over time, the air filters on our air conditioners collect dust and eventually interrupt air flow. When air flow is restricted, your AC unit will strain to keep your home cool, and that will make it use more energy. Do not wait for your air filters to become obstructed. Cleaning and changing them every 30 to 60 days should keep the air flowing smoothly through your unit.
 - Keep the ceiling fan switched on when the AC is running. Since together, they keep the room ventilated and circulate the cool air in all corners of the room.
 - AC can be replaced by 5 star rating AC.
 - Regular servicing and Cleaning saves electricity.
 - Use ceiling or table fan as first line of defence against summer heat instead of air conditioners.
4. **Fan:**
 - While buying fans one should consider the energy ratings and if possible also listen to it while in operation.
 - Clean the fans regularly as heavy coat of dust in fan blades reduces motor efficiency and output.
 - The size of fan blades should be increased and no. of fans should be reduced to save more electricity.
 - Switch off the fans when not in use.
5. **Lighting:** A good supply of light does not necessarily mean the consumption of a great deal of energy. If the right lamp is selected for the right type of function, it is possible to save energy like incandescent lighting, fluorescent lamp, high intensity discharge lamp and low pressure sodium lamp. LEDs, etc.
 - Unnecessary lights should turn off when not in use. This may help them save a lot of energy as well money. Around 5% of the electricity saved by doing so.
 - There is need for the responsible personnel to remind personnel or office occupants to switch OFF office lights and utilize daylight. This can be done by putting posters at the doors of each office. This energy conservation strategy can save a lot of electricity as some employees even forget to switch OFF their office lights when they go home.
 - It was found that in some places during day time the illumination levels with natural light is sufficient so the power consumption can be reduced.



6. **Upgrade your HVAC system:** An HVAC system is made up of heating, ventilation, and air conditioning equipment. Heating alone is responsible for more than 40% of energy consumption. Upgrades to the third component of an HVAC system, ventilation, can also improve its energy efficiency.
7. **Install a programmable or smart thermostat:** A programmable thermostat can be set to automatically shut down or cut back heating and air conditioning during times when you are away from the cabin. When you install a programmable thermostat, you eliminate wasted heating and cooling energy while not upgrading your HVAC system.
8. **Adjust your daily behavior:** Conserving energy can be as easy as turning off lights or appliances when you don't need them.
9. Unplug and switch off all the electrical device or appliances that are not in use to reduce load losses.
10. Use the heavy load appliances in the non-peak load condition.

VII.CONCLUSION

Energy audit is a powerful tool in identifying energy wastage and to achieve interesting energy savings. This energy audit demonstrates the consumption of electricity by various appliances used in manufacturing industry. A careful audit will give the industry a plan with which it can effectively manage the industrial energy system at minimum energy price. Norms should be set and continuously reviewed during the course of operation, just as any other financial or production or commercial parameters. This approach could be useful for an industry in tackling essential energy cost and also hits several other benefits like improved production, better quality, higher profit and most important satisfaction of heading towards conducive in world energy saving. By implementing small, simple and systematic energy usage applications, we can achieve more sustainable energy consumption environment. Based on the results of this work, it is clear that the reduction in electricity usage if done at a larger scale will reduce the strain on the scarcity of electricity resources and the electricity production cost.

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**Impact Factor:
7.569**



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