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Energy Audit a step to effective Energy Management

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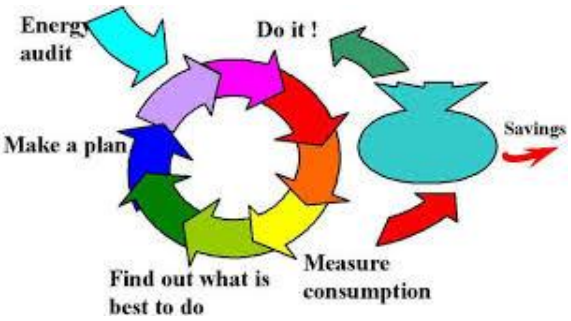
***Abstract*-**Regular energy consumption audits help to identify intentional and unintentional waste of electrical energy. It also helps identify opportunities for energy rationing and practices for rationalization of consumption. Every reduction in energy consumption helps reduce carbon emissions and makes working environments safer and more comfortable. The rationalization of consumption also ensures the health and safety of individuals. Rationalization of consumption and waste of energy can be achieved by meeting guidelines that improve communication between property management and people working in these buildings.

This study is designed to answer a number of questions about energy practices in a department of the University of Technology, the Department of Sports. Certainly some of these questions will be difficult to answer, but we tried our best to be as relevant to as many people as possible. Some questions are difficult to answer without the help of specialized bodies (for example, is there roof insulation?). Although it is difficult to answer some of the questions posed, these questions deserve to be asked to determine the imbalance through which waste and consumption of larger amounts of energy.

***Keywords*-** *Energy Conservation, Carbon Free Environment, Management.*

I. INTRODUCTION

The world today suffers from several dilemmas that cause great harm to all mankind. The most important of which is climate change, pollution of the environment and air [1]-[2]-[3]. These problems are resulted from the human activities of using fossil fuels to produce energy. The demand on these fuels has been increased globally because of the increase in the population and the need for comfort methods [4]. In contrast, the fluctuation of oil prices up and down during the last decade to hurt the entire world economy, whether exporters or suppliers [5]-[6]. Therefore, auditing and conversion of the energy consumption will reduce the burning of fossil fuels and in turn will reduce the harmful effects of these pollutants on the environment.



The energy audit process is a process of surveying, surveying and analyzing the electrical energy flow of the building to be inspected and designed to conserve the amount of energy consumed. This process will reduce the amount of energy entering the building without adversely affecting the work of his equipment and the comfort of the inhabitants [7]. In the field of commercial and industrial real estate, energy auditing is used to reduce energy expenditure consumed and the effects of carbon emitted into the atmosphere to produce this energy. The energy audit of the buildings is a service for the owner of the building and its occupants as the efficiency of the building's energy use is evaluated by the residents. This efficiency is determined by specialized equipment (such as bellows and infrared cameras). As a result of the study and evaluation, Energy in all magazines spent in lighting, heating, and cooling building [8]-[9].

The energy audit in the building means recording and analyzing all the characteristics of the building's envelope, including walls, floors, ceilings, doors, skylights, and windows. Heat-resistance and heat-resistance measurements are performed for each of these parts [10]. Because air leakage and the rate of leakage through the building envelope is a concern, it is highly dependent on the quality of building windows, doors. The energy audit aims to measure the overall thermal performance of the building [11]. The energy efficiency assessment and programming of mechanical systems available in construction, such as HVAC, heating and ventilation devices, and water heaters, are evaluated after review.

After energy is reviewed in buildings, a written report determines the amount of energy used and consumed compared to local climate standards, temperature settings, ceiling overruns, and solar orientation. Such a report reflects the use of energy for a period of time that may be one year and proposals are made to improve power consumption to be implemented for the next year [11]. The accuracy of the energy estimate is greatly improved when invoices are available showing the quantities of energy consumed such as electricity, natural gas, fuel oil or any other energy sources consumed during the evaluation period, which is one or two years [12].

The user behavior in energy consumption can be considered the most important factors affecting energy consumption, in addition to the climate and the age of the building. Therefore, energy review sometimes involves the need to interview residents of the building to understand their behavioral patterns associated with energy use during the year and by seasons. Also, the history of energy bills can be reviewed and compared to the utility company in terms of use of heating and cooling degree. Data obtained from local weather data can also be used to model the thermal power structure of a building. Thermodynamic modeling using a computer takes into account a large number of variables that can affect energy consumption whether increase or decrease [13]-[14].

The energy audit of buildings uses facilities to propose effective ways to reduce energy consumption and thus cost materially while improving the comfort of occupants and the efficiency of thermal buildings. In many countries of the world, buildings of this type are eligible for energy efficiency grants from the central government. In recent years, with the development and development of smart phone technology, homeowners can conduct energy audits in relatively sophisticated ways on their mobile phones. This technique is now considered one of the means of improving energy efficiency [15].

The type of energy audit is determined depending on:

1. Industry used: its function and type [16].
2. To what extent the penetration and the depth required for the final inspection are [17].
3. The size of the audit and the desired amount reached [18].

Thus, the energy review can be divided into two methods: preliminary, and detailed [19]. The preliminary energy review is a relatively rapid process [20-23]:

- Establish a review of energy consumption in the building.
- Assessment of energy saving potential and scope.
- Identification of the most likely ways to reduce consumption (and the easiest of interest)
- Identify immediate improvements / savings (special / low cost)
- Set a "reference point"
- Identify parts that need further detailed study and measurement to reach a better assessment.
- In the primary energy audits, available or readily available data are used.

A comprehensive audit provides a detailed plan to improve the energy expenditure of the building. After evaluating all the major energy systems in the building, a more accurate estimate of energy and cost savings can be made. The mutual effects of all projects must be considered, and the use of energy in all major building equipment is measured to ensure detailed calculations of optimal energy cost savings and thus the cost of the project. That comprehensive review is a key component of the energy balance. The comprehensive review relies on an inventory of energy systems assuming current operating conditions. After conducting energy calculations, the current use is compared to the estimated cost and the invoice for the facility [25].

Interest in energy audits has begun to rise, especially with increased emissions of carbon dioxide and other greenhouse gases. Pollution audits have become a prominent factor in all energy audits. The use of sustainable and renewable energy-efficient technologies helps reduce pollution from facilities [26].

The pollution and emissions calculators are available on the Internet, and can be used to help in measuring air polluting emissions as well as carbon dioxide. For general pollution review, we need energy and heating fuel invoices for two years. From this information, the amount of carbon dioxide emissions, volatile organic compounds, nitrous oxide, carbon monoxide, sulfur dioxide, mercury and its compounds, cadmium and its compounds, and lead and its compounds can be estimated [27-29].

Energy management as a term represents a number of meanings, and the main concern here is to provide energy in corporate buildings, the public sector, the private sector, and households [30]. Energy management is the use of energy through proactive and systematic coordination of procurement, conversion, and distribution with full attention to environmental and economic objectives. The approach to energy conservation is done using energy management as a monitoring and control process to maintain a certain level of energy expenditure in the building or organization. This process is usually done in the following sequence:

1. Measure the energy consumption of the building concerned and collect the necessary data [32].
2. Find outlets to save energy and use everything necessary to provide them. This process is based on the analysis of the building's measurement data to find and estimate the waste areas. The new energy savings can be verified after proposing several updates to the building, such as replacing lighting equipment or increasing insulation of the building [33]-[34].
3. Take measures to enable energy savings by addressing waste areas and replacing or improving energy-wasting equipment. This process is usually determined by the additional costs required [35].
4. Continue monitoring and recording to check progress using continuous data analysis to ensure success of energy conservation efforts [36].

To avoid confusion, many people use "energy management" as an expression of energy-saving efforts and usually focus on improving the use of available buildings and equipment. For the more precise meaning, the behavior of the occupants of the real estate and their energy-saving behavior fall within this sense and encourage people to use less energy by increasing energy awareness. Also, the use of cheap but effective control devices such as temporaryswitches can also be included in this definition [36]-[37]-[38].The process of the foursteps above can be applied in either way - consideration of energy saving measures involves the purchase of new equipment or the upgrading of fabric construction. The concept of energy management has gained popularity in large buildings for a long time and is now followed by homes [39]. Most homeowners do not know this term and are taking random measures to reduce the waste of energy. However, the method of monitoring and analysis of the results used by professional energy professionals has the effectiveness of reducing consumption no less than those available in large buildings [40]-[41].

Therefore, every homeowner has to be concerned with the provision of energy and not to see that this concept applies more to non-residential buildings. Most energy saving principles that apply to corporate buildings and organizations can be applied to homes. The above four steps can be applied successfully to household energy management [42].

Most of the measures to rationalize energy consumption are simple household management measures and can be applied immediately. Additional low-cost measures can be used such as timers, isolation of pipes, or thermal insulation of the building. These measures will include additional expenditures but will increase the value of the property [43]-[44].

This study provides a list of important energy audit inquiries designed to stimulate interest in energy saving practices. Many of the questions listed may not be applicable in this building or institution. The form is designed to be relevant to as many applications as possible. Some of the questions listed will be difficult to answer without the help of specialists (for example, is there roof insulation?). Despite all this, questions must be asked because they deserve to be presented and analyzed. The study was conducted in the Department of Sports Building and Supplementary Stadiums at the Iraqi University of Technology, to determine the possibility of reducing energy expenditure and improving electricity consumption.

II. RESEARCH METHODOLOGY

The study conducted an application form with a list of questions that need answers. The questions were focused on four main electricity consuming parameters in any department or buildings. These parameters were lighting, heating, cooling

and ventilation, and electrical equipment. Appendix A represents the application form and the questions used in the study.

III.RESULTS AND DISCUSSION

Table 1 represents the lights description and distribution in the sport department and its playgrounds. There are football ground lights, basketball ground lights, sports hall lights, and tennis playground lights. In that every location we found "emission" lights in the field. In the football field there are four tower poles available and each tower having 104 lights with a total of 416 lights. In the basketball field there are four tower poles available and each tower having 56 lights fittings, so the total is 224 lights. In indoor sports (A) hall there are 35 lights available, and in the in indoor sports hall (B) there are 112 lights available.

As it is seen from the above description and Table 1, the total energy utilization and the cost for maintenance are very high and expensive. Also, the heat for emission type light will be more and it will reduce life of enclosure and lamp. Besides, it is harmful in the closed spaces. So; these lights should be replaced with other types of lights that are useful and saving energy. One of the most important methods proposed to reduce the lights, especially within the building, is by giving more areas lit by sunlight. The number of lights in these areas is reduced depending on the sun's rays. This solution can be considered a renewable and sustainable solution.

Table 1, the lighting distribution and power in the studied Department

No.	Light Description	Location	Total Power in kW
1	2000W, metal halide Liner tube double end fitting	Football ground	832 KW (416X2000W)
2	2000W, metal halide E40 discharge lamp	basketball field	448 kW (224X2000W)
3	1000W, metal halide E40 discharge lamp	hall Sport (A)	35kW
4	400W, metal halide E40 discharge lamp	hall Sport (B)	44.8 kW
5	40 W fluorescent tube	Administration office	4 kW

Table 2 lists the water heaters used to worm water for the students and staff washing, and the pumps used to raise water to the tanks above the building.

Table 2, the heaters and pump distributions in the studied Department

No.	Description	Quantity	**Location**	Total Power in kW
1	Heaters	2	Kitchen and bathroom	96
2	pump	3	Swimming pool	11

The measures of the above table indicate that the total energy used is very high and expensive. New types of heater and pumps must be used to reduce this energy consumed. The proposed solution is to replace the electrical heater by solar thermal heaters which introduce a renewable and sustainable solution.

Table 3 illustrates the cooling units used in the studied department and its power consumed. These cooling units include the AC package units and the spilt units used in the offices of the Departments and in the closed halls.

Table 3, the air conditioning units used in the studied Department

No.	Description	rebmuN	noitacoL	Total Power in kW
1	Split Unit AC	40	First floor admin building	60
2	Package units	2	Offices	48
3	Package units	8	Sports Hall A	200
4	Package units	6	Sports Hall B	144

The total energy consumed by AC units is very high and expensive. So, to reduce consumed energy, a programmable thermostat that lets the building environment to be wormer or cooler during periods when it is empty can be used. This procedure reduces the temperature difference between the exterior and interior of the building, which in turn reduces energy loss. If the programmable thermostat is difficult to be prepared, manual adjustment can be used.

Table 4 show the electrical equipment used in the studied department and its consumed energy. In this table the electrical equipment evaluated were the computers, printers, and water coolers.Electrical heaters are not included on the basis that they are high electricity consumption devices and should not be used in official offices and must be replaced by gas or solar cookers.

Table 4, the electrical equipment used in the studied Department

No.	Description	Quantity	Location	Total Power in kW
1	computers	58	Admin. building	6
2	Printer	12	Admin. building	2.5
3	Water cooler	12	Kitchen, outside, and office	10

The table declares that the electricity consumed is very high. The building must be equipped with new appliances with lower power consumption, in addition to self-extinguishing equipment or the use of lower operating power when the device is in sleep mode. These power-saving devices can use laptops with lower power than desktop computers. Computers, printers, scanners, and other office equipment must have an automatic switch off when not in use. The savings that will be achieved from the electricity bill will benefit the university and

the environment. The Department can launch an advertising campaign by putting up posters encouraging energy saving, explaining the concept of rationalizing electricity consumption, optimizing the use of electrical appliances in the office and encouraging employees to extinguish lighting and legalize them upon the end of working hours.

CONCLUSIONS

Energy management can be considered the key to save energy in any building or institution. The interest in energy audit comes from the need to reduce energy consumption and reduce the burning of fossil fuels produced thereby improving environmental conditions. The continued burning of fossil fuels and the control of specific parties the oil and gas pricing made this issue a danger to all the governments of the world because of its impact on the national economic security of their countries. Reducing dependence on fossil fuels for energy production and developing legislation that sets pollution and emissions rates will need to begin with the concept of energy conservation in any management, building or home. The study showed that there are many methods to provide electricity consumption in the university's sports department, which is consumed for lighting, heating, cooling and electrical equipment.

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APPENDIX A

Lighting

- Are any tungsten lights present? Can they be replaced with another equipment which (energy saving)?
- Can lights be switched off to make use of daylight (e.g. lights parallel to windows or in corridors)?
- If space is intermittently occupied (e.g. store rooms, toilets, kitchen areas, copying rooms, corridors) is there scope for automatic lighting controls?
- Are any external lights on during daylight hours?
- Can main lighting ever be switched off?

Heating

- What is the actual temperature in the space?
- Does the temperature vary much during the day?
- Do occupants complain it is too hot or too cold?
- If there are Thermostatic Radiator Valves (TRVs), are they set correctly? Do they actually work or are they broken?
- Are radiators effective and giving consistent heat? They may need bleeding of air or maintenance to remove dust and sediment.
- If there is a room thermostat, is it correctly set?
- If the room tends to overheat, is there any bare pipework that could be insulated?
- Are radiators blocked by boxes and furniture restricting air circulation?
- Are portable electric heaters in use? If so, why is the heating system not adequate?
- If there are permanent electric heaters with individual temperature and time control, are they set correctly?
- Are external doors and windows closed when heating is on?
- Are any window panes cracked or broken?
- Is there evidence of problems with double glazing (e.g. moisture between panes).
- Is there adequate draught proofing on windows and external doors?
- If there is a roof space, is it insulated?

Cooling and Ventilation

- If there is air conditioning with local controls, make sure it is only on when necessary. Is it obvious how to control it? What temperature is it set to?
- Is air conditioning running at the same time as heating?
- Could the building reduce heat by closing blinds or fitting reflective film to windows which reduce solar gain? Remember, unnecessary lights and electrical equipment also produces heat.
- Are all external doors and windows closed when air conditioning is on?
- Are you making the most of natural ventilation? Opening windows overnight in the summer, where it doesn't present a security risk, will help cool the building down and reduce the need for air conditioning.
- Are you making the most of natural ventilation? Opening windows overnight in the summer, where it doesn't present a security risk, will help cool the building down and reduce the need for air conditioning.
- Is heating or air conditioning on in unused spaces, such as cupboards, corridors?