Palestine Polytechnic University

College of Engineering

Design and Building of Electrical Energy Auditing System in Old Buildings

Project Team:

Jamal Zagharnah **Ahmad Juneidi**

Supervisor:

Dr.Raed Amro

Submitted to the College of Engineering

in partial fulfillment of the requirements for the degree of

Bachelor degree in Power Engineering

Hebron

2020/ 2021

الاهداء

الى شهداء فلسطين رحمهم الله

الى آبائنا وامهاتنا حفظهم الله تعالى

الذين كانوا عونا ودعما لنا في مسيرتنا

الى معلمينا الافاضل في جامعة بوليتكنك فلسطين

الى كل من علمنا حرفا في هذه الدنيا الفانية

الى الاهل والاصدقاء وزملائنا في الدراسة

نهدي اليكم هذا العمل المتواضع

شكر وتقدير

بعد شكرنا لله عز وجل ان اعاننا على انجاز هذا البحث المتواضع نتقدم بجزيل الشكر والامتنان للدكتور الفاضل رائد عمرو على تفضله بقبول الاشراف على بحثننا, وعلى كل النصائح والتوجيهات اللتي كانت بمثابة نبراس منير في كل خطوة.

وكذلك نود شكر كل من ساعدنا على اتمام هذا البحث وقدم لنا العون والمساعدة بتزودينا بالمعلومات الازمة لاتمام هذا البحث.

Abstract

This project studies the most important causes and factors that lead to waste of electrical energy in old buildings (such as schools, universities, and government institutions) and also studies the causes of the critical electricity situation in Palestine.

This project provides the most important tips, guidelines and ways to rationalize electricity consumption in these buildings.

This project provides a rationalization system for electrical energy in government buildings, schools and old universities that do not contain any rationalization system and are not prepared in their infrastructure to receive modern rationalization systems.

This project aims to conserve the limited electrical energy in Palestine and also to preserve public money by conserving energy in these buildings.

الملخص

يدرس هذا المشروع أهم الأسباب والعوامل التي تؤدي إلى هدر الطاقة الكهربائية في المباني القديمة (كالمدارس والجامعات والمؤسسات الحكومية) ، كما يدرس أسباب الوضع الحرج للكهرباء في فلسطين.

يقدم هذا المشروع أهم النصائح والإرشادات وطرق ترشيد استهلاك الكهرباء في هذه المباني.

يوفر هذا المشروع نظام ترشيد للطاقة الكهربائية في المباني الحكومية والمدارس والجامعات القديمة التي لا تحتوي على أي نظام ترشيد وغير مهيأة في بنيتها التحتية لاستقبال أنظمة ترشيد حديثة.

يهدف هذا المشروع إلى الحفاظ على الطاقة الكهربائية المحدودة في فلسطين وكذلك الحفاظ على المال العام من خلال الحفاظ على الطاقة في هذه المباني.

Table of contents

Table of picture

Tables table

Chapter1: Introduction

1.1 Overview

This project studies wasted energy in old government and government buildings (such as schools, universities and government institutions) in terms of the causes and factors that lead to waste, where we focus in this project on old buildings and the reason for this is that the old buildings are not prepared in their infrastructure to receive a modern rationalization system Therefore, we will work on designing a rationalization system commensurate with the infrastructure of these buildings, and suggest appropriate solutions available in the market to reduce as much as possible the energy wasted in these buildings.

This is to save public money and also to maintain the limited energy that is provided in small quantities that are not enough for the need during peak hours, especially in the winter when we suffer from power outages, and we also do not have companies to generate power, which makes the situation worse

1.2 Objective

1. Increasing the auditing of electrical energy in Palestine by reducing wasted energy in public buildings.
2. Conservation of electrical energy which is already limited
3. Save overhead costs by reducing your electricity bill, thus saving money.
4. Avoid cutting loads at peak times and in the period when the demand for energy increases.
5. Supporting the manufacture of energy-saving equipment, especially from local production, in a way that helps develop the national economy as a whole.

1.3 Motivation

The incentive of this project is to obtain the best possible quality of the received energy by rationalizing as much as possible in the wasted energy in government buildings and also reducing the public money wasted because of this wasted energy.

1.4 Methodology:

1. Statistics of energy consumed in public buildings (schools, universities and government buildings)
2. Obtaining official data on the consumption of electrical energy in these public buildings.
3. Estimate the monthly consumption of the buildings model.
4. Designing a rationalization system for electrical energy for these old buildings in proportion to their infrastructure.
5. The application of the proposed rationalization system on a wooden model that simulates the fifth floor of Building B.

1.5 Introduction

Electricity is the backbone of life, industry and development. It has become one of the requirements of production and what the current scientific revolution has reached thanks to the presence of electricity and its technologies. Preserving and rationalizing it is a societal and religious responsibility.

What do we mean by rationing?

Optimal use of electrical energy resources, which is a set of procedures or technologies that reduce energy consumption without compromising the comfort or productivity of individuals and using energy when it is really needed, as improving energy efficiency and rationalizing its consumption does not mean preventing energy consumption as much as it means using this energy in some way more Efficiency in a way that reduces waste.[1]

Everyone knows that the electric power situation in Palestine is going through difficult times and difficult circumstances, and there is a shortage of electrical energy and its interruption, especially in winter and in many areas, while Palestine mainly supplies its electrical energy needs from Israel. The West Bank is supplied entirely by the Israeli national grid, while the Gaza Strip is partly supplied by the Israeli grid and the Gaza Power Plant. The maximum recorded and estimated load for the entire West Bank and Gaza Strip is 675 MW, of which 435 are MW. Approximately 88% of this capacity is now withdrawn from the Israeli national grid (it is difficult to quantify precisely because electrical loads are scattered and not connected to a single electrical system), and the rest is generated locally.[2]

In addition, there is an amount of wasted energy, especially in public and government buildings such as (schools, universities, government institutions, etc.), as a result of forgetting or neglecting some of their workers and not being responsible for the wasted energy in them.

Therefore, in order not to increase the critical situation in energy in Palestine, we chose this project because we noticed a waste of electrical energy, and our goal of this project is to reduce and rationalize this waste in public and government buildings through the use of available technology.

1.6 Evidence of wasted energy in public buildings

1. The following pictures prove what we are talking about. They are pictures of some government institutions that remained illuminated after they were empty of employees and the end of official work in them (figuer 1.1).

Figure 3.1: Illuminated government buildings after working hours

2. Table 1.1 shows the group of loads present in one of the schools, and through our estimated calculations and comparison with the actual consumption of them through the annual consumption schedule for them from the **Southern Electricity Company (SELCO)** shown in Table 1.2, it was found that there is an excess consumption of what is estimated consumption.

Table 1.1: Loads in one of the government schools

Appliances	**Quantity**	**Power (watt)**	**Operation time (hrs)/Day**	**KW.hr/day**
Management computer	2	150	4	1.2
Computer lab	14	150	2	4.2
Photocopier	1	200	1.5	0.3
Heater devies	10	2400	4hr (winter)	96
Water heater 1 liter	1	600	0.5	0.3
cooler machine	1	350	6	2.1
Neon lamp 120 cm	84	35	6	17.64
projector	1	100	1	0.1
Display Screen	1	150	1	0.15
Wall fans	7	60	3	1.26
Router	1	6	24	0.144
Total (without Heater Devies)				**27.394**
Total				**123.394**

Notes:

- The visit to the school was in November and we excluded the heating loads from the calculations because the weather in this month is mild and there is no need to operate these devices.

- The school direction is towards the east, so there was no need to light the corridors, as they depend on natural daylight

Calculation :

According to our estimation of the loads in the school, it consumes approximately 27.394 kilowatt hours per day, according to the previous schedule.

The school operates on November 21 a school day, so its monthly consumption equals:

Monthly consumption = 27.394 * 21 = 575.27 KW/ month

The actual bill for that month, based on the electricity company data, as shown in Table 2, was **605 KWh**. In November 2019.

Table 1.2: The annual consumption schedule for the year 2019 for a group of schools affiliated with SELCO

	استهلاك المدارس KWH سنة 2019													
	12	11	10	9	8	7	6	5	4	3	2	1	اسم المدرسة	
12283	1138	1450	1502	1347	970	0	0	855	1457	1473	1553	538	وزارة التربية والتعليم / مدرسة بنات الظاهرية الثانوية	034203053
6793	746	1003	1034	684	163	0	0	384	720	755	1081	223	وزارة التربية والتعليم مدرسة الرافدين الاساسية المختلطة	034203055
4938	565	605	556	478	233	0	0	296	648	519	843	195	وزارة التربية والتعليم مدرسة بنات الرماضين الثانوية	034804424
2528	345	188	209	215	196	0	0	178	274	493	220	210	وزارة التربية والتعليم مدرسة بنات زهرة المدائن الاساسية	034203060
12203	1345	1462	1945	1437	269	0	0	706	1651	1254	1260	874	وزارة التربية والتعليم مدرسة دكور عثمان بن عفان	034203063
10829	1002	1003	1039	1004	841	0	0	476	1458	1552	1903	551	وزارة التربية والتعليم مدرسة بنات شهداء الظاهرية الثانوية	034203197
4904	463	486	304	319	130	0	0	254	692	821	1127	308	وزارة التربية والتعليم مدرسة بنات الظاهرية الاساسية	034200692

Based on our approximate calculations, we found a difference in consumption of about 30 Kwh/month, and this reflects wasted energy.

This is an example of one small school out of many schools. If we do the math for all schools, we will find a large amount of wasted energy.

Table 1.3 shows the distribution of loads belonging to the Southern Electricity Company (SELCO) - Dhahriya branch. Accordingly, the electrical load of government institutions including schools constitutes 2.22% of the total load of the company. Perhaps it is a small

number, but there is a large amount of energy wasted in these institutions and if they are neglected, the electrical situation in the country will worsen.

Table1.3 : The load division of the Southern Electricity Company (SELCO) - Dhahriya branch.

KW			2019
اجمالي KW الحكومي	اجمالي KW المدارس	اجمالي الاستهلاك الكليKW	شهر
72102	14436	3163507	**1**
99585	39712	2918442	**2**
44221	33775	2988296	**3**
40523	33826	2764419	**4**
147811	18526	3112297	**5**
55343	0	3260929	**6**
53738	0	3395234	**7**
72894	16579	3515048	**8**
65019	28674	3195879	**9**
57977	32064	3042295	**10**
57604	31325	2813565	**11**
60003	26669	3060436	**12**
826820	**275586**	**37230347**	**TOTAL**

$$\text{Loads of government institutions\%} = \frac{Loads\ of\ government\ institutions\ (KW)}{Total\ load\ (KW)}$$

$$= \frac{826820(\text{KW})}{37230347(\text{KW})} = 2.22\%$$

Some people may notice that there is a Building Management System (BMS) that can solve this problem, but this system cannot be applied to old and government buildings in which we work to save energy .

1.7 Building Management System (BMS)

A building management system (BMS) is a computer based central control system which is installed within a building to manage the operation of its services – heating, cooling, ventilation, hot water and lighting, and in some cases the integration of these services with the building envelope through control of shading devices and windows.[3]

A BMS system comprises two key elements: controllers in the field, often in cabinets within plant rooms, and a computer 'head end'. Each controller sends and receives signals to / from the various items of building services equipment. The computer 'head end' provides an interface with the controllers, showing real-time temperatures and plant operating conditions, allowing the user to change and program system settings.[3]

1.2.1 Why we don't use BMS

There are several reasons for not using a building management system (BMS) in our project, the most prominent of which is that these buildings are old and not prepared to implement a new building automation system, and for these reasons our project aims to design a simple energy system that is compatible with the structure and the infrastructure installation system in it relatively.

1.2.2 Other reasons led to not using the building management system

1. **Data is Expensive to Acquire & Utilize**

The cost of sensors has dropped precipitously in recent years. In 2004, the average cost per sensor was $1.30. In 2020, the average cost per sensor is expected to be $0.38. Unfortunately, the cost reductions in sensors have not resulted in a significant decrease in the cost of a full BMS installation. As of 2014, the cost to deploy a basic BMS was at least $2.50 per square foot and could be as high as $7.00 per square foot. While the cost of sensors has plummeted, the cost of equipment controls has remained stubbornly high.

2. **Acquiring data is challenging**

Installing a dedicated data solution system for a task as trivial as controlling the lighting can foot a hefty bill.

3. **Requires extensive research**

There is quite a bit of research that goes into determining the right BMS vendor for the requirements of your organization. You do not want to pay for devices or peripherals that you will end up not using. You will require professional assistance, for deciding the features you need and also for the installation of hardware and software, which is costly to come by.

4. **Maintenance**

One of the disadvantages of this system is that the maintenance process requires high costs in addition to efficient engineers to implement the process.

Chaptre 2: The Causes of The Critical Electrical Situation in Palestine

The electrical situation in Palestine is going through critical situations and is getting worse with the increase in the population and the increase in demand for electricity. Among the main factors that increase the critical situation for electricity are the following:

2.1 The Israeli Occupation's Control of Electric Power in Palestine

The electricity crisis is as old as the occupation, and is represented in the Israeli control and control of energy resources and the materials that operate them (oil and gas).

This means that there are no stations to generate electricity in Palestine, and even if such stations are built, the cost of operating them will be very high.

Due to the import of gas or diesel for it from Israel, and buying electricity from abroad to distribute it through Palestinian transfer stations and manage them from public and private Palestinian parties may be less expensive than operating the power plants. For this reason, the Palestinian Authority has been slow in constructing generating stations to this day, and the topic is still under study and research by the Palestinian Energy Authority and the private sector. All this means that Israel is the ultimate controller over the electricity energy that supplies the Palestinian population, unless the Palestinians are allowed to use their resources and are given the freedom to import from neighboring countries for electric power and the materials and generators that operate them.

2.2 Waste and Irresponsibility

The other reason that makes the electrical energy situation in Palestine more dangerous and more dangerous is the excessive irresponsible use of this energy, especially in public buildings such as schools, universities, government buildings and others.We notice that electrical waste is present in many public and private buildings, including government buildings, as a result of neglect or forgetting of their employees, and many of these buildings remain lit after the end of the official working hours, which makes electricity and the energy situation deteriorate.

2.3 The Reasons for Wasting Electrical Energy in Buildings

Much energy is wasted on lighting, heating and cooling indoor spaces when there is no one or almost no one.

But did you know that up to 20% of this money goes to nothing? really. Waste energy is a real problem, and it is one that costs government institutions money. Below are the main causes of energy waste in commercial facilities.

2.3.1 Old and ineffective equipment.

In the event that the facility has very old equipment and has poor efficiency, it is possible that a newer model will be available on the market; More energy efficient. Upgrading requires an upfront investment, but these costs can be recovered quickly through the return on investment of these new equipment, and also through energy savings compared to old equipment.

2.3.2 Air conditioning accidents

Space heating and cooling are responsible for 40% of the energy costs of the office. Many facilities make matters worse by practicing poor heating and cooling habits. Some examples include leaving exterior doors and windows open, not changing the air filters, and operating heating and cooling equipment at the same time.

2.3.3 Ineffective lighting practices.

Experts estimate that lighting is responsible for 25% of electricity consumption worldwide. If the office still uses old incandescent bulbs, upgrading to LED or CFLs can cut your lighting costs by 80%! You should also have motion sensors installed so that the lights do not turn on when the building is uninhabited.

2.3.4 Running electronics in an empty office.

You should not operate any equipment when your office is empty unless it is absolutely necessary. Before you leave for the night or the weekend, turn off computers, turn off the lights, and turn off anything else that doesn't need to be turned on. Take a step further by disconnecting these devices from their ports, as they can still draw power even when turned off.

2.3.5 The role of architectural design in rationalizing energy consumption in buildings

Green buildings are known as high-efficiency buildings that reduce negative impacts on the environment and human health and are designed to be economical in energy and water consumption and natural resource consumption. This is achieved through efficient design, selection of appropriate materials, in construction, and in building operation and maintenance.

2.2.5.1 Architectural Strategies

The strategies that adopt include design solutions to achieve environmental requirements and reduce energy consumption away from the use of modern equipment and technologies, and include a set of strategies, the most important of which are:

1. **Directing the building**

   The orientation of the building greatly affects the thermal gain of the building during daylight hours, as a study found that directing the building towards the southeast - northwest achieves the lowest energy consumption, and when directing to the northeast - southwest direction, the energy consumption for air conditioning purposes will increase by 8% while changing it in the direction. (East - West) The amount of energy consumed increases by 15% and increases to 23% when changing the direction to (North - South)

2. **The architectural form of the building block**

   The clean rectangular shape and what is close to it are the best shapes in terms of minimizing the influence of thermal loads

In summer, and the most common in winter, by adopting the correct orientation, the greater the external surface area, the greater the area of heat exchange in gain or loss.

3. **Adoption of natural ventilation**

The adoption of natural ventilation has a great effect in purifying the atmosphere of the house and reducing the concentration of bacteria, in addition to cooling the building structure from the inside and cooling people in summer. The cooling by natural ventilation and the revival of the use of windshields greatly reduce the dependence on cooling devices, especially during the night periods in summer and during the whole day in the spring and autumn period.

Chapter 3: Rationalizing Electricity Consumption in School Lighting

There are many measures that must be followed to rationalize electricity consumption in the school, including the following:

3.1 Take Advantage of Natural Sunlight

Schools that are still under construction, or that are in the process of development or rehabilitation, can use and adopt modern designs that support the use of natural light, as many studies have shown that natural sunlight helps students to be more focused, alert and in a good mood. It creates a comfortable and psychologically appropriate learning environment. On the other hand, switching off the lighting after the use of classrooms is done in making them cooler, especially in the summer, and among these designs are the following: [1]

- Adding custom curtains to windows that allow natural light into the classroom, as this contributes to reducing the use of electric light and relying more on natural light.
- Take advantage of areas exposed to natural light by allowing light to enter from the top, as having skylight or light-permeable ceilings in corridors, bathrooms, and common areas helps reduce electrical light consumption.

3.2 Use Energy-Saving Lamps

Lamps are one of the most high-energy gadgets in schools. Because they work for long hours, which leads to their high temperatures and consumes additional energy for cooling as well, so it is advisable to replace the regular lamps with energy-saving lamps, such as: compact fluorescent lamps or LEDs, and this type of lamps is characterized by the following:[4]

- It provides strong lighting suitable for study.
- Help to rationalize electric current consumption.
- Lasts longer than conventional lamps.
- It has modern features such as color changing and light intensity control.

3.3 Using Sensors to Control Lights On and Off

To rationalize electrical energy consumption in schools, we need the participation of students and teachers by doing many practices and applying some methods that contribute to this. In the area in which it is located, and it turns off when there are no people present, and these simple changes greatly save money at the end of the month or the school year. [4]

3.4 Turn Off the Lights after Working Hours

The process of turning off the lights appears to be a clear and taken matter, but many students may forget to do this or that they do not realize its importance, so they must always be reminded to turn off the lights of unused classrooms or homes; Because it consumes a lot of electricity every month. [5]

3.5 Rationalization in Heating and Cooling Devices

There is a set of tips that must be followed to rationalize electricity consumption by heating and cooling devices, and they are as follows: [6]

- Close the classroom door when entering or leaving, as leaving the door open leads to a loss of heat or cold air, which increases the need for energy to heat or cool the room.
- Maintaining the regular maintenance of the air conditioning and heating system in schools, and in the event of a malfunction in the system, whatever it is, it will consume more and double electrical energy, and the presence of heating problems such as air leaks, filters and defective channels cost huge sums on the electricity bill, so you should not neglect the maintenance Systems and their continuous renewal. [7]
- Moderation in the use of cooling and heating systems, where the temperature can be set in the summer to 24-27 ° Celsius, which is suitable for cooling the classroom, but in winter the temperature must be set at 18-20 ° C so that it is sufficient to warm the place. [8]

- Ensure that the water faucets work in all parts of the school and are free of leaks, and replace the damaged ones immediately. Because dripping faucets require a lot of electricity to heat the water again. [8]
- Ensure that the ventilation and heating openings remain exposed and not covered by furniture, such as: study desks and cabinets. To avoid preventing the flow of hot or cold air into and out of classrooms, arranging and adjusting furniture is among the teacher's tasks and responsibilities that must be carried out under his supervision and direction.
- Avoid placing heating in corridors and uninhabited places, as students spend most of their time during work hours in classrooms only. [9]

3.6 Rationalizing Electricity Consumption in School Equipment

Electrical appliances are among the tools that have been used for long times in schools and need to be rationalized in consumption, and here are some tips that help with that:

- Directing students and requiring them to turn off electrical devices, such as computers, after they have finished using them, and not leave them open all the time; Because that drains electrical energy greatly. [10]
- Operating the timers in places where there are no people on a regular basis, as the timer is set so that the electricity works during specific hours, and after that it shuts off automatically, as this is a real saving step; This is due to the low prices of these timers compared to the savings they make. [5]
- Teachers direct students to turn off display screens and smart panels after they are finished using them, even if some devices do not require large amounts of electricity, but leaving them open leads to a drain on the electrical system. [5]
- Switching display screens, TV screens and computers in the school to flat screens and LCD screens, as these screens are used extensively during school hours and this will contribute to reducing electricity consumption. [4]
- Disconnecting the electrical power after the end of working hours and during the holidays, to devices and equipment that the blackout does not affect, such as vending machines spread throughout the school.

3.7 Other Tips for Rationalizing Electricity Consumption in School

There are many methods and tips to save electricity, which are still under development and innovation every day, and here are other tips that can be applied:

- The school buildings will be covered with special and insulating materials that prevent the outside heat from entering the interior, although the insulation project will be costly, but it will greatly save the use of cooling and heating systems, and thus reduce the use of electrical current. [12]
- Applying the rules of rationalizing electricity consumption to all school facilities without exception, specifically student housing, as it should not be neglected as it constitutes a large percentage of electricity consumption, and the most important focus on housing is the installation of sensors, and educating students well about how to deal with electrical devices. [12]
- Start using solar panels, generate energy from them, and truly and completely rely on them. [13]
- Create a new and useful study atmosphere at the same time, as some classes can be taken in the outdoor school grounds, when the outside weather is warmer, and thus dispensing with heating systems for good periods. [3]

3.8 Awareness of Rationalizing Electricity Consumption in the School

There are many other tips that can be used to rationalize electricity consumption in the school, including the following: [14]

- Hold student meetings every week or two; To discuss ways to conserve electricity in school.
- Forming a student club and encouraging its members to establish a group of projects aimed at preserving electricity within the school, such as awareness and education campaigns for all school students on how to preserve the environment by saving electricity consumption.

- Spreading students' efforts such as awareness campaigns and other activities in the various media.
- Create posters that symbolize the conservation of electricity, and clarify it through drawing, such as a drawing of a light switch with the word (Off) written on the poster.
- Educating students about the importance of renewable energy sources and their benefits, and comparing them with non-renewable energy sources and the extent of the damage they cause to the whole environment and not only to the school, and when the student understands the damage, he will become aware and eager to save electricity consumption, and he will transfer those actions and information to his home as well. [7]
- Spreading competition among students to come up with ideas that help rationalize electricity consumption, choose the best ones, and apply it in all school areas. [15]
- Encouraging students to rationalize energy consumption through teachers. Because the teacher is the primary influence on students, as the teacher must be careful to remind students to turn off the lights or computers before leaving the classroom, or to ask them to calculate the amount of energy saved after applying the instructions for rationalizing electricity consumption.

.

Chapter 4 : The Proposed Rationalization System in Old Buildings

In this chapter, we will design a rationalization system that will be used in government buildings, universities and schools that are old-fashioned and do not contain any modern rationalization system and are not also equipped in the infrastructure to receive modern rationalization systems. Therefore, we have designed a rationalization system that suits these buildings and works to rationalize a lot of wasted electric power, especially in lighting because it accounts for the largest percentage of electrical load in these buildings.

This system is designed based on the division of the building in terms of use into three sections:

1) Regular places to use
2) Frequently used places
3) Rarely used places

Based on this division, we chose the right solution for each department.

4.1 Solutions Used in Regular Places

They are the areas that are regularly used for certain periods during the daily work time such as classrooms and teachers 'offices.

1) Wall-mounted push-button countdown timer switch with screw-ins.

Easily replace your old wall switch or spring wound timer with the Defiant Pressure Wall Countdown Timer. With a simple push of a button, the lights will be on and off at your leisure, keeping energy costs low. The countdown timer can be set at intervals of 5, 10, or 30 minutes, and 1, 2 or 4 hours and fits with any single or multi-group wall art decor style. The timer has screw tips, making it easy to install and works with CFL, LED, and incandescent bulbs. The LED indicator lights can be turned on or off to meet your needs and preferences.[16]

figure 4.1: Wall-mounted push-button countdown timer switch with screw-ins.

2) Timer Electric Switch for Countdown

This timer socket is widely used to control your light, water pump and home appliances, it can control the required time and help save a lot of energy. Easy to install and easy to operate. And it has a large time scale to set up and read the time quickly and clearly, Has a bright red power switch and a rotating timer for tuning, can remind you whether the electrical equipment is working. The shell is made of high quality plastic material, so it is really a kind of perfect household staple.

figure 4.2: Timer Electric Switch for Countdown

Features:

The shell is made of high quality PC material, which makes it eco-friendly, safe and durable to use. The shortest set time is 1 minute and the longest set time is 2 hour, and the timing is very accurate. The lighting, water pump and the energy-saving appliances will run for the time you specify and you don't need some maintenance. It is very easy to install with a wire connection type, has a common wall, also convenient for replacement. They can be widely used to control water pump and household appliances, such as sensitive area, air conditioners, electric fan, warm fan, rice cookers, aquarium, router, phone charger, electric bicycle etc.

- **Note:** In practice, we used (Timer Electric Switch for Countdown) because (Wall-mounted push-button countdown timer switch with screw-ins.) is not available in the Palestinian markets.

4.2 Solutions Used in Frequently Used Places

They are the frequently used areas of the building that remain in use throughout the daily work

Like corridors as well as stairs, because they are areas of great use in this building and are always full of students (especially in universities).

- **Weekly Programmable Timer Digital**

  This timer switch could automatic turn on / off all kinds of electric equipment according to the time user set. It has a built-in 1.2V / 40mA rechargeable battery and a industrial grade chip. With high precision and strong anti-interference ability. It is widely used in 7 days programmable control of street lamps, neon lamps, production equipment, radio and television and many other home appliances.

figure 4.3: Weekly Programmable Timer Digital

This timer (figure 4.3) contains a new feature compared to the regular timer 24 (figure 4.4), which is that it is programmable for a week, unlike the regular timer, which is only programmed for 24 hours. It is a wonderful feature that made us use this type of timer in

order to exclude from it the official holidays at the end of the week and to adjust only the official working days.

figure 4.4: Timer 24 Hour

4.3 Solutions Used in Rarely Used Places

These places are in areas where people are less used or have short-term presence, such as kitchens and bathrooms.

The right solution to rationalize energy in these places is:

- **Motion Sensor Light Bulbs**

These motion sensor lights are an excellent choice in rarely used areas such as bathrooms and kitchens. Since it installs into a standard light socket, it is easy to install. These lights are an affordable way to obtain motion detection lighting.[17]

Figure 4.5: Motion Sensor Light Bulbs

This motion sensor light bulb will keep lighting for 60s per first installedI without detecting any motion in sensor area ,If there is any object moving, the bulb will always keep lighting until without any detecting motion - only for first installation , after the bulb turns off automatically. it enter into normal mode, it turns on when motion is detected. This design increases the life span which is more than traditional motion sensor lamp. .[17]

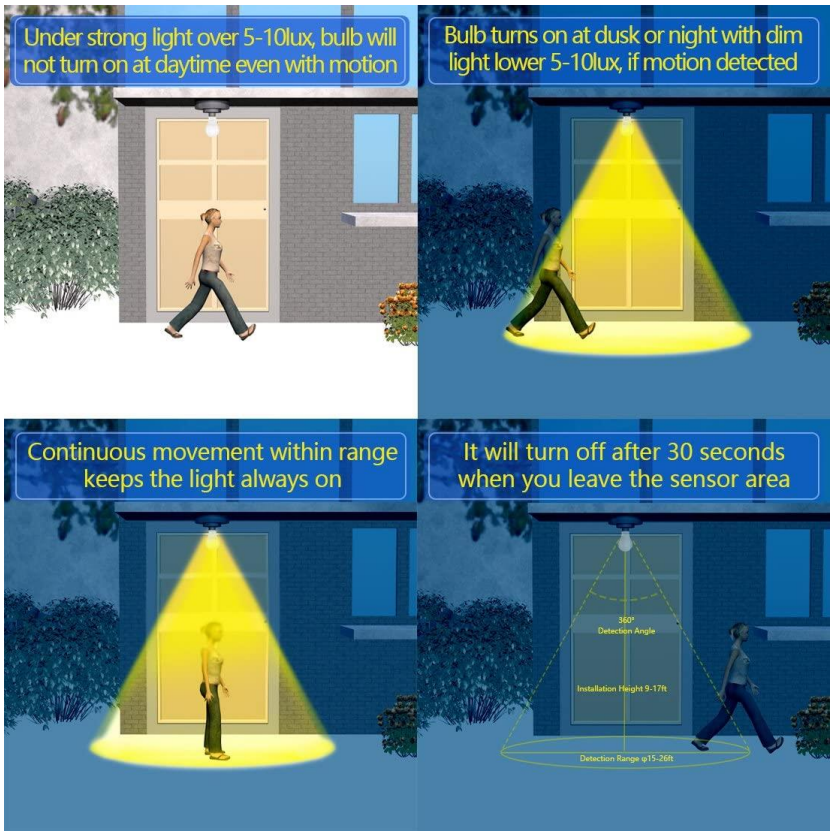

figure 4.5: Motion sensor lamp working principle

The motion sensor lamp can penetrate glass, veneer and walls to detect movement in the range of 13-19 feet, and the LED sensor lamp can also detect pets, so the radar sensor lamp will turn on when it detects any moving object, It works without a motion sensor light switch. .[17]

indoor radar motion sensor lamp 5W (equivalent to 50W), enough to see clearly, the motion sensor light can be applied in bathroom, stairs, corridor, hospital office stairs, hotel, coffee shop, shopping mall, garage, all inside . It can be installed outdoors as an outdoor motion sensor lamp. .[17]

figure 4.7: Motion sensor lamp work sites

Motion-sensing lighting system is one of the requirements of a sustainable building that an electrical engineer needs to consider. Let's dive into the disadvantages and advantages of this device in an office environment.[18]

- ✓ **Advantages**

Energy Savings - This system is very efficient as it automatically switches off the luminaires when there is no presence detected (for a predefine time). As a result, the end-user saves on electricity consumption.

Convenience - Turning on the lights will be as easy as walking inside the room. No need to search for the switch on the wall. The lighting system will automatically turn off the lights when it does not sense any movement for a certain period of time.

Acts as a Deterent - This device also acts as a deterent from intruders as it will be harder to do unlawful activities after business hours. The security team or people in the community will be able to pinpoint areas that may have unusual activities.[18]

- ✓ **Disadvantages**

The sensors of the motion-sensored lighting system need to detect presence or movement in order to activate. If there are only a few occupants in an area, this device will require them to periodically activate the sensor (subject to the hold on time set) by moving within the detection zone.

There is a possibility that the luminaires' lifespan can be shortened due to the frequency of the switching. This will occur if the motion detectors are located in areas of high activity. Strategic placement of the sensor and appropriate selection of the model for the area can mitigate this problem. [18]

The disadvantages mentioned can easily be mitigated by careful product selection and design of the lighting control system by the Electrical Engineer. Given this information, a motion controlled lighting system will provide significant advantages to an office setting. [18]

4.4 Soluion of Heavy loads:

We noticed that the university has a central heating system, but there are a large number of electric heating devices in teachers' offices, and there are cases that happen that the two systems work together, so we decided to use special sockets for electrical heating devices and these sockets are connected to each other on separate feed lines from the rest of the electrical loads. In this case, if the central heating system is switched on, it is possible to disconnect the line extending to the electrical heating appliance sockets, in this way we have only operated one heating system instead of both.

We will use the Italy socket system as in (Fig.4.8) or whatever type of socket differs from what it was previously in the building.

These sockets are connected to electrical lines that are separate from the rest of the loads in the building. Its electrical plug is attached to the end of the heater cable.

This method is so that the heating devices are not turned on during the operation of central heating by disconnecting the breaker for the special sockets of the electric heating devices.

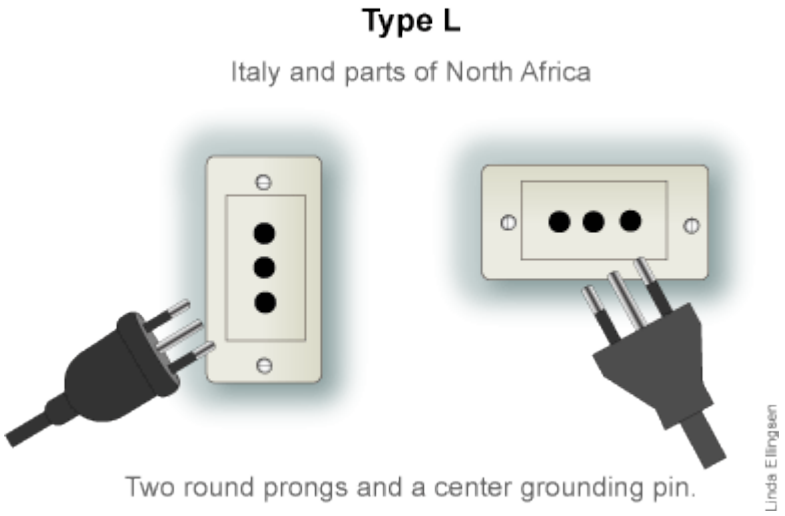

figure 4.8: Type L socket

Chapter 5: Practical Application, Recommendations and Conclusion

5.1 Practical Application

We made a wooden prototype simulating the fifth floor in Building B at Palestine Polytechnic University and applied this system to this prototype (see figure 5.1). The most important points in the practical part are:

1) Total reliance on LED energy-saving lamps and replacing all ordinary lamps in the building.
2) We Installed a countdown timer in places of regular use.
3) We Installed a 24 hour digital timer in frequently used places.
4) We Installed energy-saving lamps that contain motion sensors in places rarely used.
5) We Installed a special socket in places that contain two heating systems: the heating system with electrical appliances and the central heating system in the building. With switching the power outlet in the heating appliance cable to match the special socket.
6) This system supports between automatic mode conversion (timers) and manual mode (normal mode) through a selection switch. In order to transform the manual situation in unusual or off-duty events such as (seminars tonight, scientific exhibitions, university parties and many other events).
7) We have implemented a complete protection system for this model, including RCD and Circuit Breaker.

figure 5.1: The model simulates the fifth floor of the B-building in ppu with the application of the proposed system to it.

Figure 5.2 explains the mechanism of implementing the system in practice, depending on the solutions used in this project (electrical circuit).

Circuit:

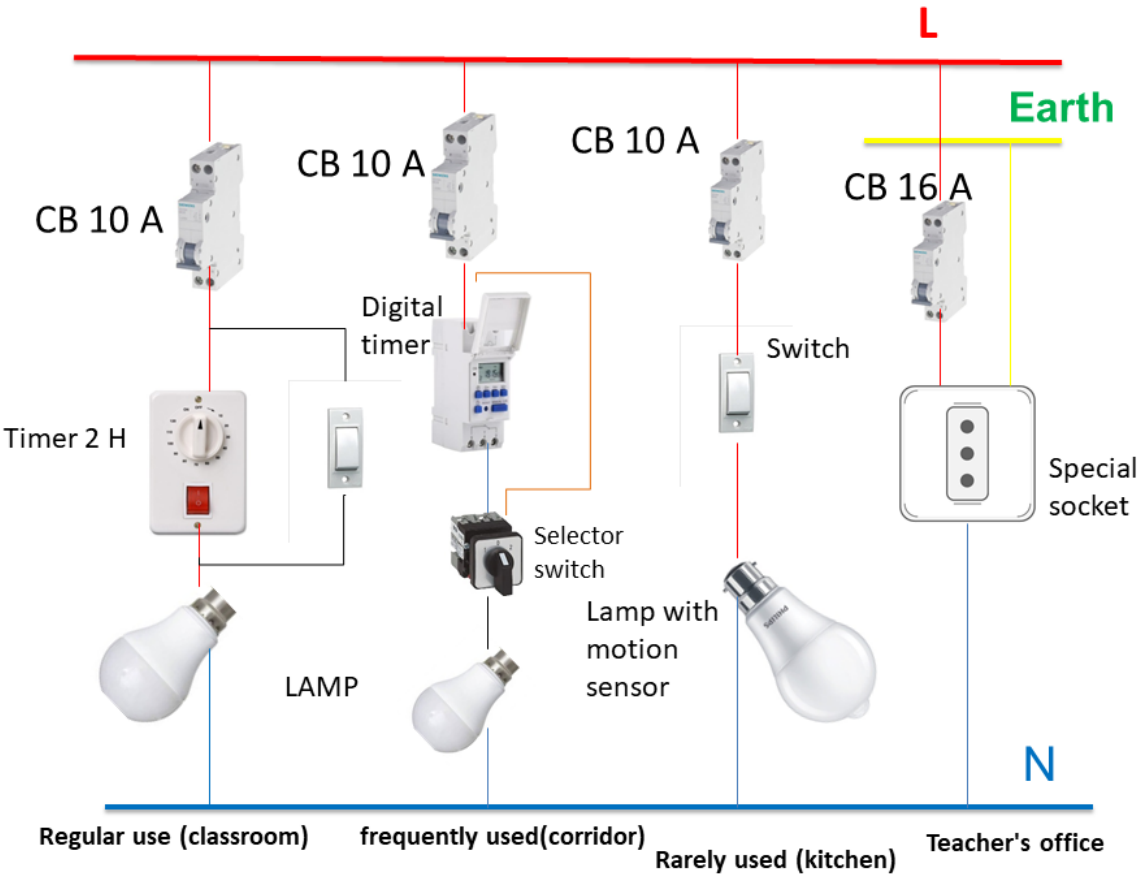

figure 5.2: The electrical circuit of the proposed rationalization system

5.2 Conclusion

1. This system aims to save wasted electrical energy in government buildings, universities and schools.
2. This system reduces the phenomenon of forgetting the lights working after the end of working hours and also on official holidays.
3. This system rationalizes wasted electrical energy in heating, especially in buildings that contain two heating systems, and prevents the operation of the two systems together.
4. This system is based on saving public money by saving electrical energy in public government buildings.

5.3 Recommendations

We recommend the competent authorities responsible for the following buildings: (government buildings, universities, schools, and public institutions) and any old buildings that are not prepared to receive modern rationalization systems to implement this system in order to preserve public money and preserve waste electric energy in these buildings.

Reference

[1] North Electricity Distribution Company (NEDCO)

[2] Hebron Electricity Company (HEPCO)

[3] AIRAH Guide DA28 Building Management and Control Systems

[4] "HERE ARE 14 THINGS YOU CAN DO TO SAVE ENERGY AT SCHOOL", www.paylesspower,5-9-2017 ،Retrieved 12-5-2020. Edited.

[5] The SOE Team (7-10-2017), "Five Ways to Save Energy in the Classroom" ،www.saveonenergy, Retrieved 11-5-2020. Edited.

[6] "How to Save Energy at School", www.wikihow.com, Retrieved 10-1-2019. Edited.

[7] "How to Save Electricity at School?", www.trvst.world, Retrieved 27-5-2020. Edited.

[8] Lauren (14-2-2017), "Top tips to save energy in schools" ،www.extremelowenergy.com, Retrieved 27-5-2020. Edited.

[9] "How to Save Electricity at School – 25 Energy Saving Tips", www.seniorled.com,23-2-2018 ، Retrieved 27-5-2020. Edited.

[10] BETH SPENCE, "5 EASY WAYS TO SAVE ENERGY AT SCHOOL" ،www.zenecosystems, Retrieved 27-5-2020. Edited.

[11] "Schools Could Save up to $33,690 Every Year by Reducing Energy Use", www.business.directenergy.com,5-8-2018 ،Retrieved 28-5-2020. Edited.

[12] Dwayne Kula (12-4-2019), "15 Actionable Ways to Save Energy At School" ، www.myledlightingguide, Retrieved 28-5-2020. Edited.

[13] "5 Ways To Save Energy At School", www.gmk.com.sg, Retrieved 28-5-2020. Edited.

[14] "How to Save Electricity at School", www.classroom.synonym.com, Retrieved 10-1-2019. Edited..

[15] "Simple ways for schools to save electricity", www.edexec.co.uk,14-11-2018 ،Retrieved 28-5-2020. Edited.

[16] The Home Depot is a US-based home improvement retailer https://www.homedepot.com/

[17] Amazon E-Commerce Company https://www.amazon.com/ref=nav_logo

[18] WalkerBai Consulting - Consulting engineer in Brisbane, Victoria

http://blog.walkerbai.com/advantages-and-disadvantages-of-motion-sensored-lighting-systems-