Palestine Polytechnic University

College of engineering

Introduction for a graduation project

Energy Management Analyzes of The Korean Building at Palestine Polytechnic University

By

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اهداء

بسم الله نبدأ وبسم الله نسير والى الله المنتهى والى الله المصير

الحمد لله ما هب نسيم البلاد وفاح نسيم الشهداء والحمد لله بهمة الاسيروالم الجريح وتعب اللاجيء وجمال البلاد

.ثم الصلاة والسلام على اشرف خلق الله سيدنا محمد صلى الله عليه وسلم

..اما بعد

نقف ها هنا امامكم وقفت المُوَدعِ المرحب

..مودعين من سنينَ عشناها في جامعة بوليتكنك فلسطين مودعين زملاء المقعد

الدراسي مودعين .اروقة جامعتنا التي لنا في كل زاوية ذكرى تذكرنا .بكم

.مُرحبين بالضيوف مرحبين للأهل الكرام فأهلا وسهلا بكم ... طبتم وطاب لقاءُكم

أُهدي تخرجي البهيِّ الماتعِ السّارِ هذا

إلى صاحبِ الفخامة والرجولة والصلابة

الذي علمني على القيم الفضلى والسّيرةِ الحُسنى العملاق الأول والقدوة المُثلى صاحبِ الحبِّ الأول ، الوارف ظله، الغني قلبه، الساعي لرفعتي وإخواني دوما أبي الغالي.

كما يعجز معجمي وتكثر تمتمتي وتحشرجت حروفي في كيفية تقديم هذا الإهداء لصاحبة المقام السامي التي أوصاني بها ربي خيرا ورسولنا الأكرم بِرا ...المعجزة الأولى ، والبداية والنهاية، وكل القصيدة، التي تحملت وتحملت وسهرت معي وسهرت فكأنها كانت تقرأ حروف كتبي معي فلا تنام حتى أنام ملكة الملكات وسيدة الأرض والمرأة الأولى في حياتي أمي...

لكما ولكم جميعا أهدي هذا التخرج

Abstract

Energy is one of the basic needs in human life. Energy is obtained from multiple sources such as fossil fuels and renewable sources. People seek to generate and use energy at the lowest costs, as the world is moving towards solutions and methods to conserve energy and not waste it, especially in facilities and factories, where energy conservation and management measures contribute to economic development in the world.

Building management systems are one of the methods used to find solutions and opportunities to reduce energy consumption in facilities and factories.

This study aims to use Building Management Systems (BMS) to find opportunities to reduce energy consumption in the Korean building at Palestine Polytechnic University - Hebron, and to develop plans that include modern methods and recommendations to rationalize the use of (HVAC) and normal loads and lighting in the building and to apply some mechanisms to the Korean building to reduce the value of The electricity bill in the building, for example, before applying the Building Management System (BMS) to the Korean building, the annual bill for the building was NIS 225932, and after applying the Building Management System (BMS) to the Korean building, the annual bill for the building was NIS 127,000. That is, the application of the Building Management System (BMS) The building saves approximately 99,000 shekels per year. Note that the costs of the (BMS) process do not exceed 265,000 shekels, and the amount can be recovered after 2-3 years. After that, a study was carried out for the project during 20 years, and it was found that it had reaped profits of more than 1,600,000 shekels during 20 years of implementing the project. Note that the application of building management systems saves money and human effort and saves time.

الملخص

الطاقة من الحاجات الأساسية في حياة الإنسان. يتم الحصول على الطاقة من مصادر متعددة مثل الوقود الأحفوري والمصادر المتجددة. يسعى الناس إلى توليد الطاقة واستخدامها بأقل التكاليف ، حيث يتجه العالم نحو حلول وأساليب للحفاظ على الطاقة وعدم إهدارها ، خاصة في المنشآت والمصانع ، حيث تساهم إجراءات حفظ الطاقة وإدارتها في التنمية الاقتصادية في العالم.

أنظمة إدارة المباني هي إحدى الطرق المستخدمة لإيجاد الحلول والفرص لتقليل استهلاك الطاقة في المنشآت والمصانع.

تهدف هذه الدراسة إلى استخدام أنظمة إدارة المباني (BMS) لإيجاد فرص لتقليل استهلاك الطاقة في المبنى الكوري في جامعة بوليتكنك فلسطين - الخليل ، ووضع خطط تتضمن أساليب وتوصيات حديثة لترشيد استخدام (HVAC) والأحمال العادية. والإضاءة في المبنى وتطبيق بعض الآليات على المبنى الكوري لتقليل قيمة فاتورة الكهرباء في المبنى ، على سبيل المثال ، قبل تطبيق نظام إدارة المباني (BMS) على المبنى الكوري ، كانت الفاتورة السنوية للمبنى ٢٢٥٩٣٢ شيكل ، وبعد تطبيق نظام إدارة المباني (BMS) على المبنى الكوري ، كانت الفاتورة السنوية للمبنى ١٢٧٠٠٠ شيكل. أي أن تطبيق نظام إدارة المباني (BMS) يوفر المبنى حوالي ٩٩ ألف شيكل سنويًا. علما أن تكاليف عملية (BMS) لا تتجاوز ٢٦٥٠٠٠ شيكل ويمكن استرداد المبلغ بعد ٢-٣ سنوات. بعد ذلك أجريت دراسة للمشروع على مدى عشرين عاما ، ووجدت أنه حقق أرباحا تجاوزت مليون و ٦٠٠ ألف شيكل خلال ٢٠ عاما من تنفيذ المشروع. علما أن تطبيق أنظمة إدارة المباني يوفر المال والجهد البشري ويوفر الوقت.

Contacts

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Chapter One: Introduction.

1.1 Introduction

The Energy and rationalization management of electricity consumption is very important, as it is considered a solution to many problems

Energy management is defined as the optimum use of electrical energy resources, which is a set of procedures or techniques that result in reduced energy consumption without compromising the comfort or productivity of individuals and the use of energy when it is truly needed. The objective of a Building Management System is to achieve optimal level of control of occupant comfort while minimizing energy use .

These control systems integrating component to luminescent, fans, pumps, heating/cooling equipment, dampers, mixing boxes, and thermostats.

Monitoring and optimizing to luminescent, temperature, pressure, humidity, and flow rates are key functions of modern building control systems.

And in this project, we will create a management and rationalization system for electrical energy consumption in the Korean building at Palestine Polytechnic University using the Building Management System (BMS).[1]

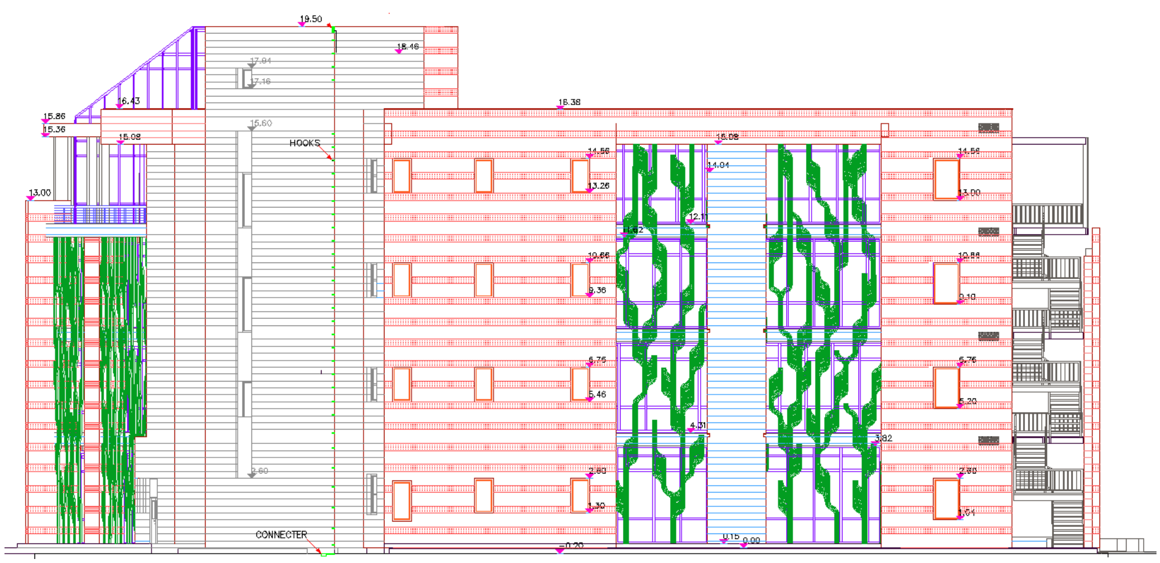


Figure (1. 1) : Korean Building at Palestine Polytechnic University

1.2 Background and Statement of The Problem (Motivation)

- **Problem definition**

1. Height energy consumption of light
2. Height energy consumption of HVAC
3. Height energy consumption of power
4. Lots of maintenance work and many breakdowns in the building
5. Difficulty in controlling the building and difficulty in measuring and monitoring the performance of the building
6. Lack of interaction with other building systems

- **Project motivation**

1. We work power saving, so we save on electricity bills in the building through the Functions that we apply in rooms, offices and laboratories (Room Management System)
2. Reducing the workforce and thus reducing the salaries paid
3. Monitor and control all loads
4. Reduce maintenance
5. Consumer convenience in easy control
6. Save a lot of time
7. Increasing the life span of devices and equipment, especially since this building is full of modern and expensive devices

1.3 Objectives

This project aims to monitor, control, operate and centralize all construction activities. It includes controlling and monitoring all electromechanical loads (such as ventilation, air conditioning, heating, lighting and elevators) and linking to weak current systems such as surveillance cameras, sound, theft alarm system, access control system and fire alarm system through one integrated system. As follows:

1. HVAC, electrical and ventilation control.
2. Lighting management.
3. Gates and elevators.
4. Fire alarm and fire extinguishing control systems.
5. Security and anti-theft systems.
6. CCTV cameras.
7. Access control to the building (fingerprint or card).

1.4 Importance (Energy Management)

1. Energy saving (fuel + electricity)

2. Savings on cables.

3. Maintaining indoor air quality at the lowest costs.

4. Increasing the operational life of HVAC equipment.

5. Increasing the service life of lighting devices through optimum operation.

6. The time schedule for starting and stopping the work of the systems to be controlled.

7. Determine the daily, weekly, monthly, annual work program.

8. Obtain real-time warnings and malfunction reports.

9. Economic work according to external air conditions.

1.5 Methodology

1) Survey of the energy consumed in the building

2) Obtaining official data on electrical energy consumption in this building

3) Designing new plans for the Korean building containing a BMS system.

4) Implementation of the BMS system on the Korean building in PPU.

1.6 Action Plan

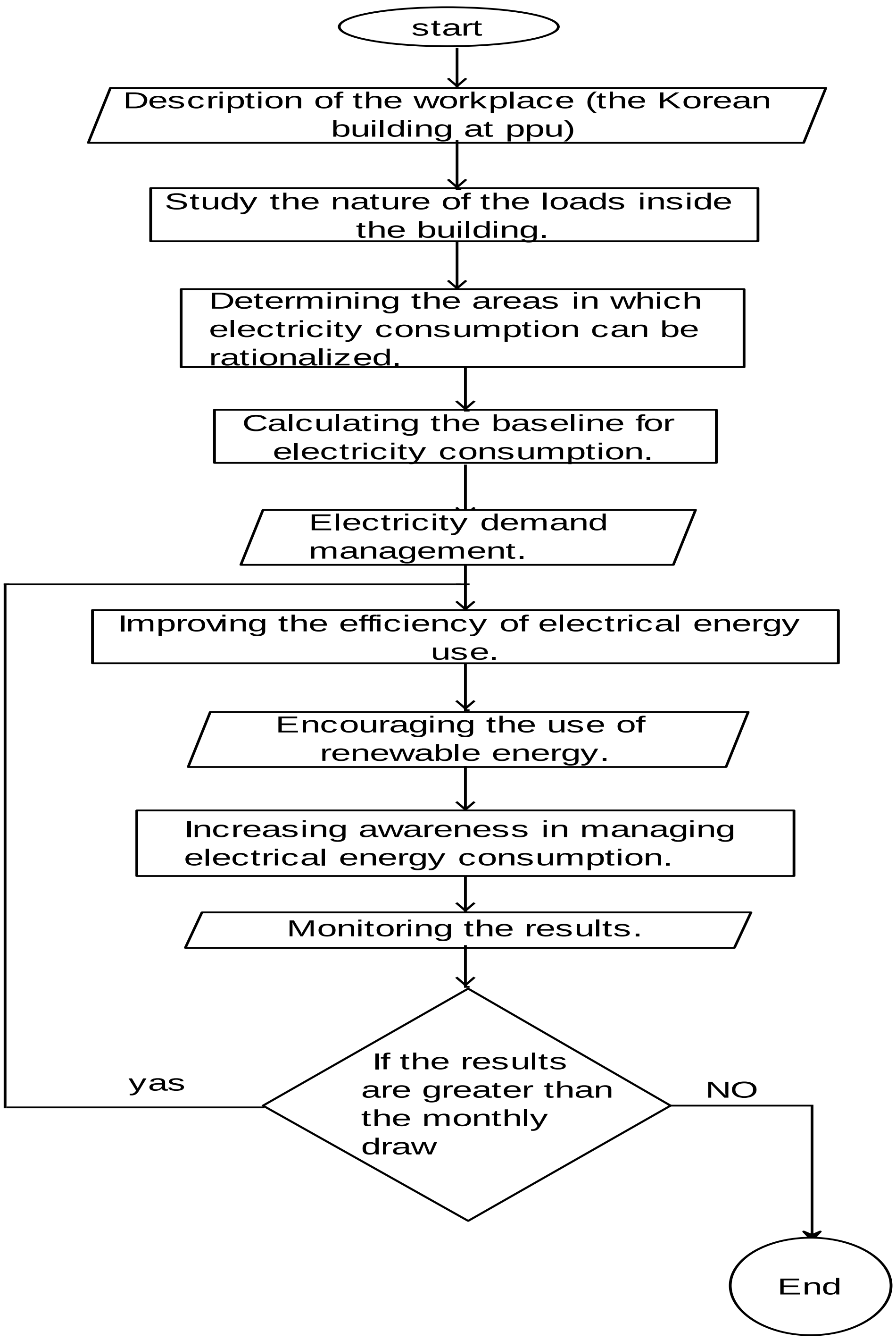


Figure (1. 2) : Action Plan

1.7 Time Schedule

Table (1. 1): This table illustrate the tasks that we did and how long it takes weekly for each task:

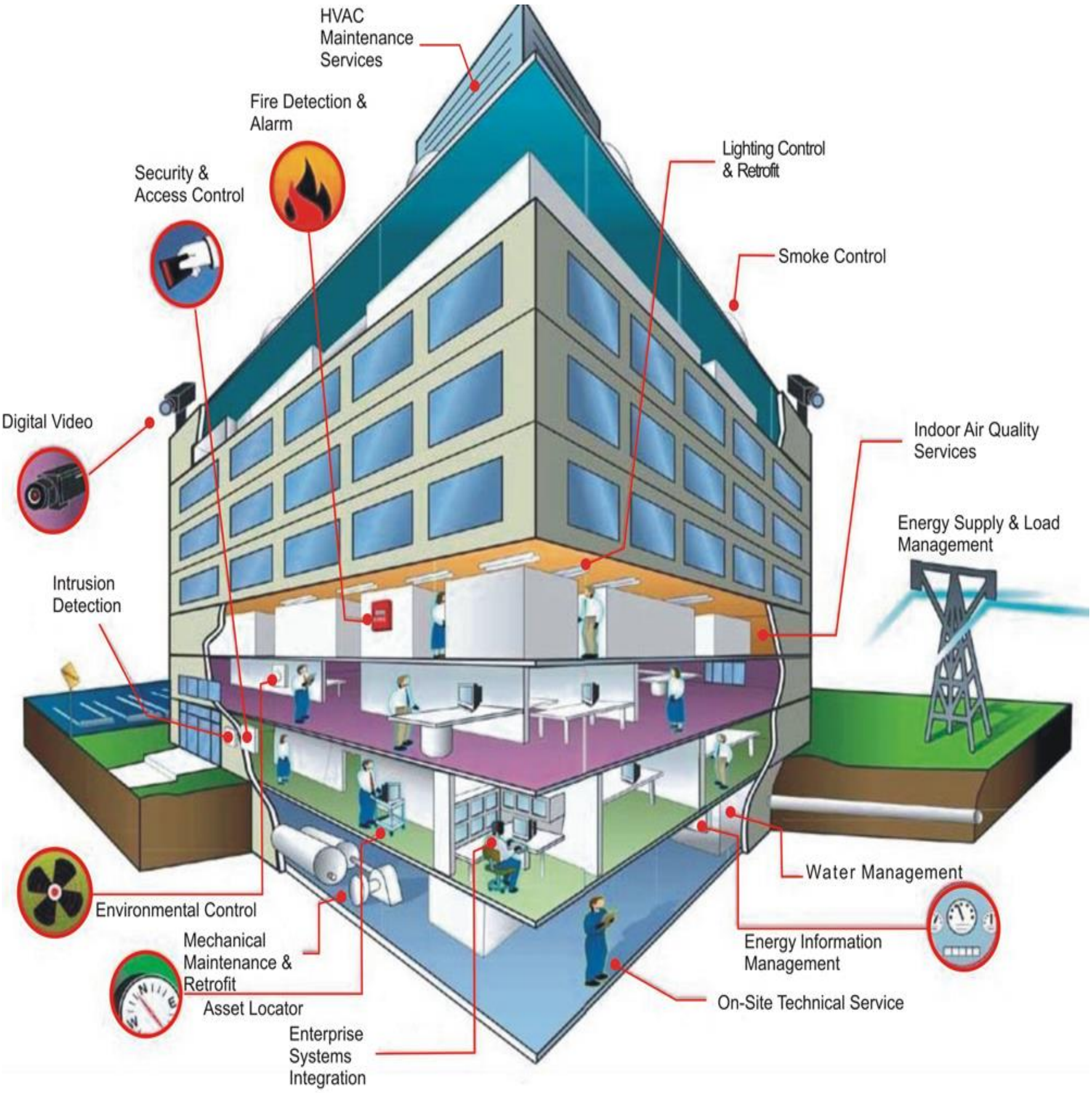
Table (1. 2) : From the twelfth week to the sixteenth week, and the project introduction will be completed, prepared and discussed.

week / task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Finding Project Idea															
Proposal															
Collecting data															
Documentation															
Preparing for presentation															
Print documentation															

2

Chapter Two: Building Management System (BMS):

Building Management System (BMS)



: Building Management System (BMS)

Figure (2 .1) : Building Management System (BMS)

A building management system (BMS) is a control system that can be used to monitor and manage the mechanical, electrical and electromechanical services in a facility. Such services can include power, heating, ventilation, air-conditioning, physical access control, pumping stations, elevators and lights. .[3]

A very basic BMS consists of software, a server with a database and smart sensors connected to an Internet-capable network. Smart sensors around the building gather data and send it to the BMS, where it is stored in a database. If a sensor reports data that falls outside pre-defined conditions, the BMS will trigger an alarm. In a data center, for example, the BMS might trigger an alarm when the temperature in a server rack exceeds acceptable limits. .[3]

2.2 Direct Benefits of BMS Application:

1. Energy saving (fuel + electricity)

2. Savings on cables.

3. Maintaining indoor air quality at the lowest costs.

4. Increasing the operational life of HVAC equipment.

5. Increasing the service life of lighting devices through optimum operation.

6. Reducing the number of operators required for management operations.

7. Hot and cold-water valves control.

8. Monitor conditions of air filters.

9. The time schedule for starting and stopping the work of the systems to be controlled.

10. Determine the daily, weekly, monthly, annual work program.

11. Obtain real-time warnings and malfunction reports.

12. Economic work according to external air conditions. [4][5]

2.3 What Activities Can We Monitor and Control Through the BMS?

1. HVAC, electrical and ventilation control.

2. Lighting management.

3. Gates and elevators.

4. The system of billing the water consumed (hot or cold) by investors such as restaurants.

5. Billing system for electricity consumed by investors.

6. Fire alarm and fire extinguishing control systems.

7. Security and anti-theft systems.

8. CCTV cameras.

9. Access control to the building (fingerprint or card). [6]

2.4 Methods

Control and BMS methods are described hereafter, The ATLAS Project. Building Management Systems & Controls – Introduction. [7]:

2.4.1 Time Control Methods (For Heating)

• Time switches turn on and off the heating (or water heating) system at preselected periods (of the day, of the week) [7]

• Optimizers: these controls start the heating system in a building at a variable time to ensure that, whatever the conditions, the building reaches the desired temperature when occupancy starts. [7]

2.4.2 Lighting Control Systems:

Different control systems exist, either based on time control or a required level of luminance or use of lighting. [7]

1. Zoning: Lights are switched on in zones corresponding to the use and layout of illuminated areas, in order to avoid lighting a large are if only a small part of it requires light
2. Timed control: to switch on and off automatically in each zone to match a prerequisite schedule for light use
3. Occupancy sensing: In areas which are occupied intermittently, occupancy sensors can be used to indicate whether or not anybody is present and switch the light on or off accordingly. Detection systems are based on ultrasonic movement and infrared sensing
4. Light level control: this consists of switching or dimming artificial lighting to maintain a light level measured by a photocell. It is particularly necessary to give value to ambient daylighting.

2.4.3 Temperature Control Methods:

1. Frost protection generally involves running heating system pumps and boilers when external temperature reaches a set level (0 C^o) or less in order to protect against freezing [7]
2. Compensated systems: which control flow temperatures in the heating circuit relative to external temperature thus allowing a rise in the circuit flow temperature when outside temperature drops [7]
3. Thermostatic radiator valves: these units sense space temperature in a room and throttle the flow accordingly through the emitter (radiator and converter) to which they are fitted [7]
4. Modulating control: can be applied to most types of heat emitters and is used to restrict the flow depending on the load demand and this controlling the temperature [7]
5. Proportioning control: involves switching equipment on and off automatically to regulate output[7]

2.4.4 Building Management Systems:

These technologies consist of both hardware and software.

The hardware is typically represented by one (or more) control and processing units and by a number of peripheral devices (which control the operation of say, heating or cooling systems, artificial light-sources or other appliances and which can be represented by sensors, thermostats, etc.,) connected to the control units. The control unit, based on the information supplied by some of the peripherals or based on pre-set instructions, runs the system. The control unit can be as simple as a relay or a timer switching on or off an electric water heater or as sophisticated as a microprocessor operating on “fuzzy logic”.

Commands can be sent from the central unit to the peripheral units through Ethernet cable, power-lines or telephone lines, fiber-optic cables or even using radio transmissions. The software is simply the program and the instructions that allow the control unit to manage the operations of the peripheral devices and of the appliances. [7]

2.5 Comparison of Companies Working on BMS

2.5.1 Schneider Company

Schneider Company features [8]

1-Best security

2-Capacity to support the newest cost- and time-saving applications and functions

3-Open and scalable integration platform

4-Ability to leverage cloud computing for analytics and AI-driven digital services

5-An architecture designed for mobile access to data and control to improve the Productivity of facility teams and enhances the experience for occupants

6- Features to address flexible building needs and new ways of working

7- There are the latest devices and software that support Internet Protocol

8- multi-protocol support KNX, Lon Works, BAC net, Modbus, M-bus, SNMP

9- Ease of maintenance

2.5.2 Schneider Disadvantages

1. Business growth cannot be achieved without a negative environmental impact
2. Sustainability data is expensive, complex and time-consuming to manag
3. Sustainability is a matter of reputation and not determining grow [9]

2.5.3 Schneider's Applications

1. room control HVAC control for optimum comfort and energy efficiency
2. lighting control Realizing comfort, performance and flexibility in using the interior space, helping to reduce operating costs
3. power control
4. pump control [10]

2.5.4 Abb Company

ABB Company features

1. Quick and simplified configuration of each system architecture
2. User-friendly HMI (Human-Machine Interface) and Visualization for the Internet of Buildings (IOB)
3. Decentralized IT architecture that ensures both interoperability and security
4. SCADA Global Server OPC, BACnet, Obit [11]

2.5.5 Abb Applications

1-KNX the global standard for building automation

The demand for building management systems is continuously increasing as well as the demand for comfort and versatility in the management of e.g. lighting, blinds, heating, air-conditioning, and energy savings. Thanks to ABB i-bus® KNX all the essential building applications can be easily controlled, monitored and signaled via a uniform system.[12]

2-Heating, Ventilation and Air Conditioning solution

ABB Clime ECO combines heating, ventilation and air conditioning in one holistic solution, a true ecosystem based on the worldwide standard for Home and Building Control, ABB i-bus® KNX. From central control and management of heating and cooling systems down to room-level automation, ABB ClimaECO simplifies the implementation of intelligent automation in modern buildings.[12]

3-Door entry system

With the ABB door entry systems, you won’t compromise impressive style for innovative technology. For the system is more than just a door video system – it is the future of smart building monitoring and security at your fingertips. Depending on your requirements for a smart building, you have the choice between the wire system or an IP system. [12]

Table (2. 1) : Comparison of Companies Working on BMS [13][14]

Number	control	Schneider company	ABB company
1	**lighting control**	Easily control the lighting Realizing comfort, performance and flexibility in using the interior space, helping to reduce operating costs	Lighting control is not very flexible or easy, but it works to save costs
2	**power**	There are easy-to-use online energy management applications Track and understand energy usage and report performance over time	Contains online energy management software and applications It has good efficiency, but it does not fit some things with the Korean building
3	**HVAC**	Maximizing profitability and energy efficiency by controlling scalable automation with HVAC logic controllers Main Benefits: Proven reliability and design flexibility Energy efficiency through customizable applications Simple, straightforward setup and configuration Integration with every essential HVAC communication protocol Local support and availability	ABB's solution for HVAC ensures the optimal indoor air environment for occupants.
4	**Efficiency**	Efficiency is high	Low efficiency compared to other companies

3

Chapter Three: Rationalizing The Consumption Of Electricity.

3.1 The Causes of the Critical Electrical Situation in Palestine.

3.2 Reasons for wasting electrical energy in buildings.

3.3 Rationalizing the consumption of electricity in lighting, heating and cooling devices.

3.1 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:

3.1.1 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.

3.1.2 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.

3.2 Reasons for Wasting Electrical Energy in Buildings

A lot of energy is wasted lighting, heating and cooling indoor spaces when there is no one or almost no one.Here are the main reasons for wasting energy in a building

3.2.1 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.[15]

3.2.2 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.[15]

3.2.3 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. .[15]

3.2.4 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. .[15]

3.2.5 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.[15]

3.3 Rationalizing the Consumption of Electricity in Lighting, Heating and Cooling Devices

There are several procedures that must be followed to rationalize electricity consumption in lighting, including the following:

3.3.1 Take Advantage of Natural Sunlight

Buildings that are still under construction or 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, energetic and in a good mood creates a comfortable and psychologically appropriate learning environment. On the other hand, turning off the lights after using the classroom is to make it cooler, especially in the summer. Among these designs are the following: [16]

- Adding curtains on the windows that allow natural light to enter the classroom, as this contributes to reducing the use of electric light and increasing reliance on natural light.
- Take advantage of the areas exposed to natural light by allowing the entry of light from above, as the presence of skylights or ceilings that transmit light in corridors, bathrooms and public places helps to reduce the consumption of electric light.

3.3.2 Use Energy-Saving Lamps

Lamps are considered one of the most high-energy tools because they work for long hours, which leads to high temperature and additional energy consumption for cooling as well, so it is recommended to replace ordinary lamps with energy-saving lamps such as: built-in fluorescent lamps or lamps, and this type of lamp is characterized by the following: [17]

- Provides strong lighting suitable for study.
- Assistance in rationalizing the consumption of electric current.
- Lasts longer than traditional bulbs.
- It has modern features such as color change and light intensity control.

3.3.3 Using Sensors to Turn Lights on and Off

To rationalize the consumption of electrical energy in the building, we need the participation of students and teachers by doing many practices and applying some methods that contribute to this. In the area where it is located, and turned off when there are no people around, these simple changes save money significantly at the end of the month or school year. [18]

3.3.4 Turn Off the Lights After Working Hours

Turning off the lights seems to be a given, but many students may forget to do so or not realize its importance, so they should always be reminded to turn off the lights in unused classrooms or homes; Because it consumes a lot of electricity every month. [19]

3.3.5 Rationalizing Electricity Consumption In Heating And Cooling Devices

There are a set of tips that must be followed to rationalize the consumption of electricity through heating and cooling devices, and they are as follows: [20]

•Close the classroom door when entering or exiting. 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.

•Use air fans instead of the air conditioner.

•Maintaining periodic maintenance of the air conditioning and heating system in the building, and in the event of a system failure, whatever it is, it will consume more and double electrical energy, and heating problems such as air leaks and filters and the cost of defective air ducts huge sums on the electricity bill, so do not neglect maintenance systems and their continuous renewal. [21]

•Moderation in the use of cooling and heating systems, where the temperature in summer can be set to 27 degrees Celsius, which is suitable for cooling the season, but in winter the temperature must be set to 18 degrees Celsius so that it is sufficient to heat the place. [22][23]

•Ensure that water taps throughout the building are working and free of leaks, and replace them immediately. Because drip faucets require a lot of electricity to heat the water again. [24][25]

•Make sure that the ventilation and heating openings remain open and not covered with furniture, such as: study desks and cupboards. To avoid blocking the flow of hot or cold air in and out of the classroom, arrangement and adjustment of furniture are among the tasks and responsibilities of a teacher to be performed under his supervision and direction. [26]

•Avoid placing heating in corridors and uninhabited places, as students spend most of their time during working hours in classrooms only. [27]

4

Chapter Four: Information About the Korean Building at Palestine Polytechnic University

The Korean Building at Palestine Polytechnic University

Figure (4 .1) : The Korean Building at Palestine Polytechnic University

4.1 Components of The Korean Building

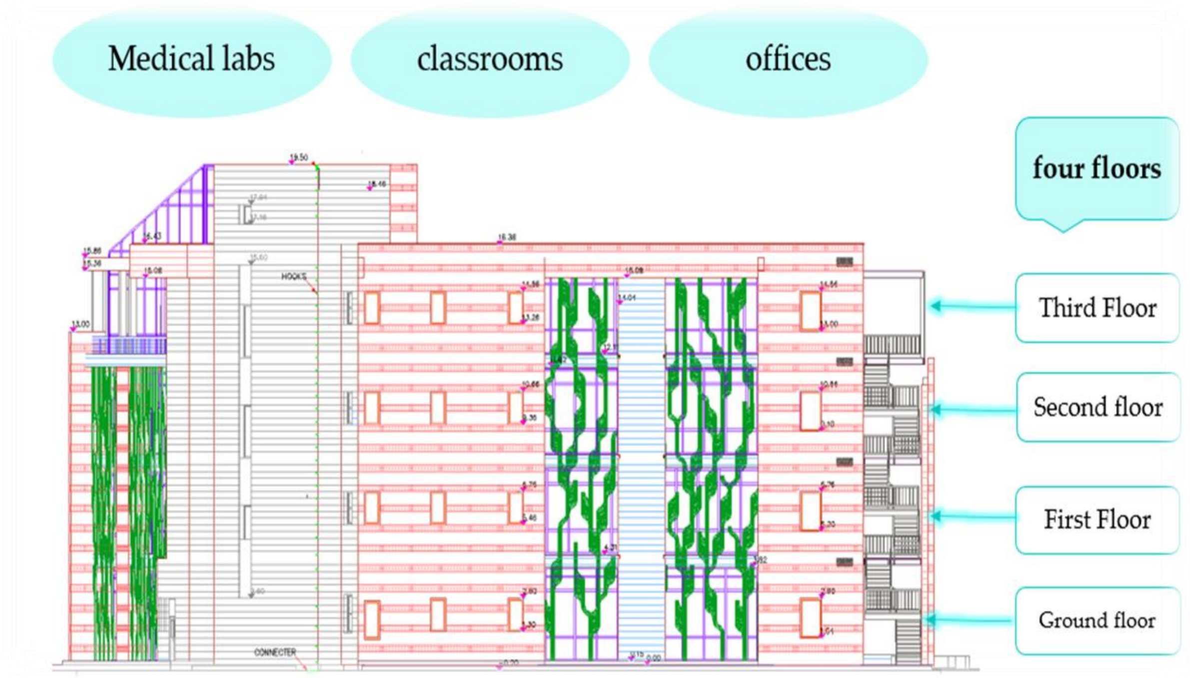


Figure (4. 2) :Components of The Korean Building

The area of this building ( ) consists of four floors :

a) Ground Floor.
b) First Floor.
c) Second Floor.
d) Third Floor.

Each floor contains many rooms classified into :

a) Medical laboratories
b) Classrooms
c) Offices.

4.2 Electrical Loads in The Korean Building

The electrical loads in the building were divided into four sections:

Electrical Loads for The Ground Floor

Table (4.١) : Load of Ground Floor

GROUND FLOOR			
AC/W	LIGHTING /W	POWER/W	ROOM
2570	336	1000	R1
1600	224	1000	R2
1600	112	1000	R3
2020	336	2250	R4
0	108	250	R5
0	108	250	R6
0	36	250	R7
0	144	500	R8
0	36	250	R9
0	216	500	R10
0	36	500	R11
0	144	250	R12
1000	112	750	R13
1000	112	750	R14
1000	112	750	R15
1600	224	750	R16
1600	336	750	R17
1280	224	750	R18
2570	343	2500	R19
1280	352	3250	R20
1280	224	750	R21
0	168	1000	R22
1000	224	750	R23
0	2370	1000	Corridor
21400	6637	21750	TOTAL

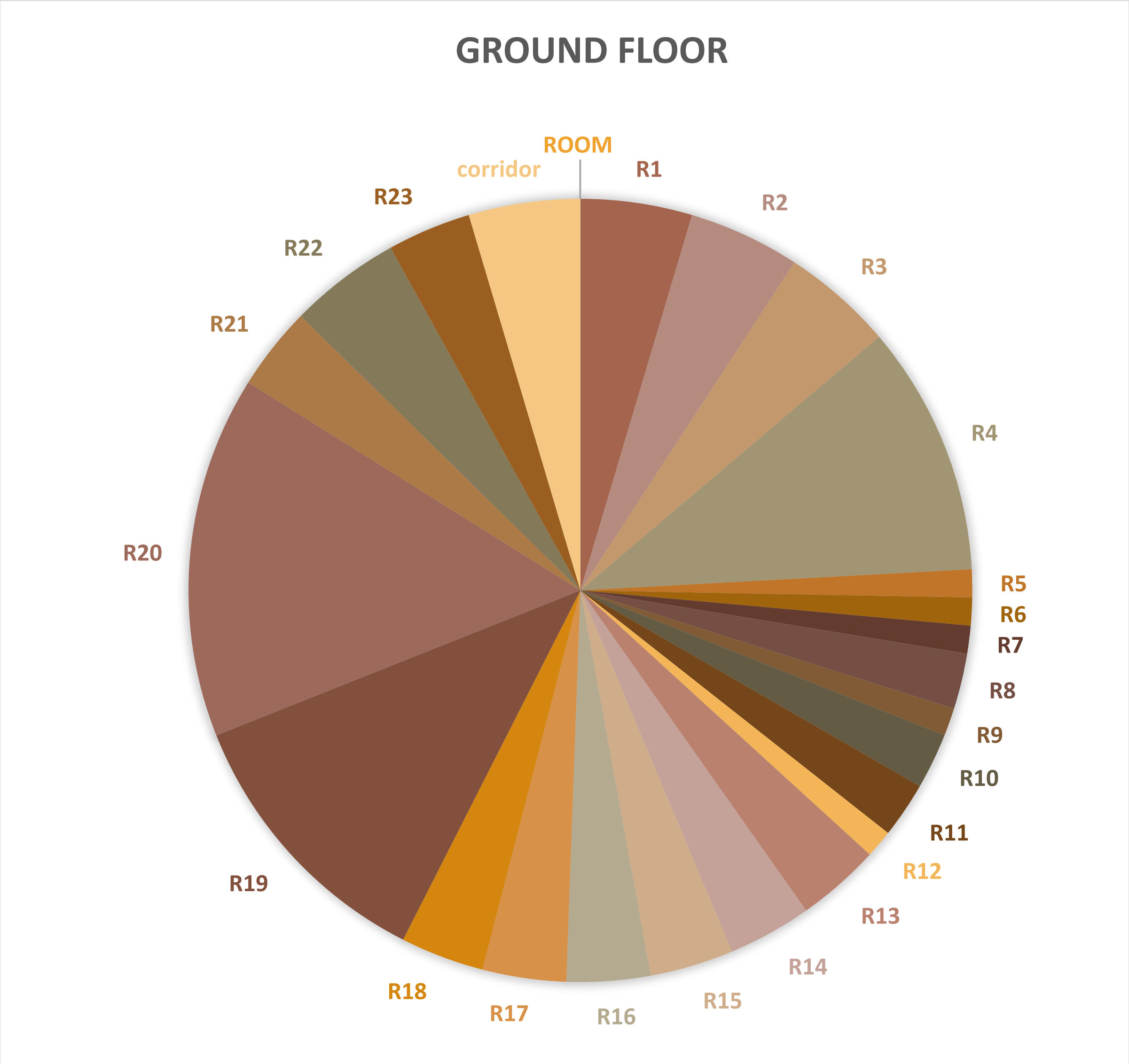


Figure (4. 3) : Ground Floor

The ground floor consists of 23 rooms and a corridor. The loads for each room were calculated as follows, the calculation of power, lighting and AC.

Table (4.2) : Highest Load / Wat

HIGHEST LOAD / WAT	ROOM
POWER	R 20
LIGHTING	R 20
AC	R 1 + R19

Table (4.٣) : Load of First Floor

FIRST FLOOR			
AC/W	LIGHTING /W	POWER/W	ROOM
2570	336	500	R1
2850	240	9000	R2
2020	72	1500	R3
0	144	1000	R4
0	144	500	R5
0	36	0	R6
0	216	1000	R7
3657	504	1350	R8
8110	1183	3000	R9
0	1414	1500	R10
2020	336	1750	R11
2050	336	1750	R12
0	226	750	R13
28787	5187	23600	TOTAL

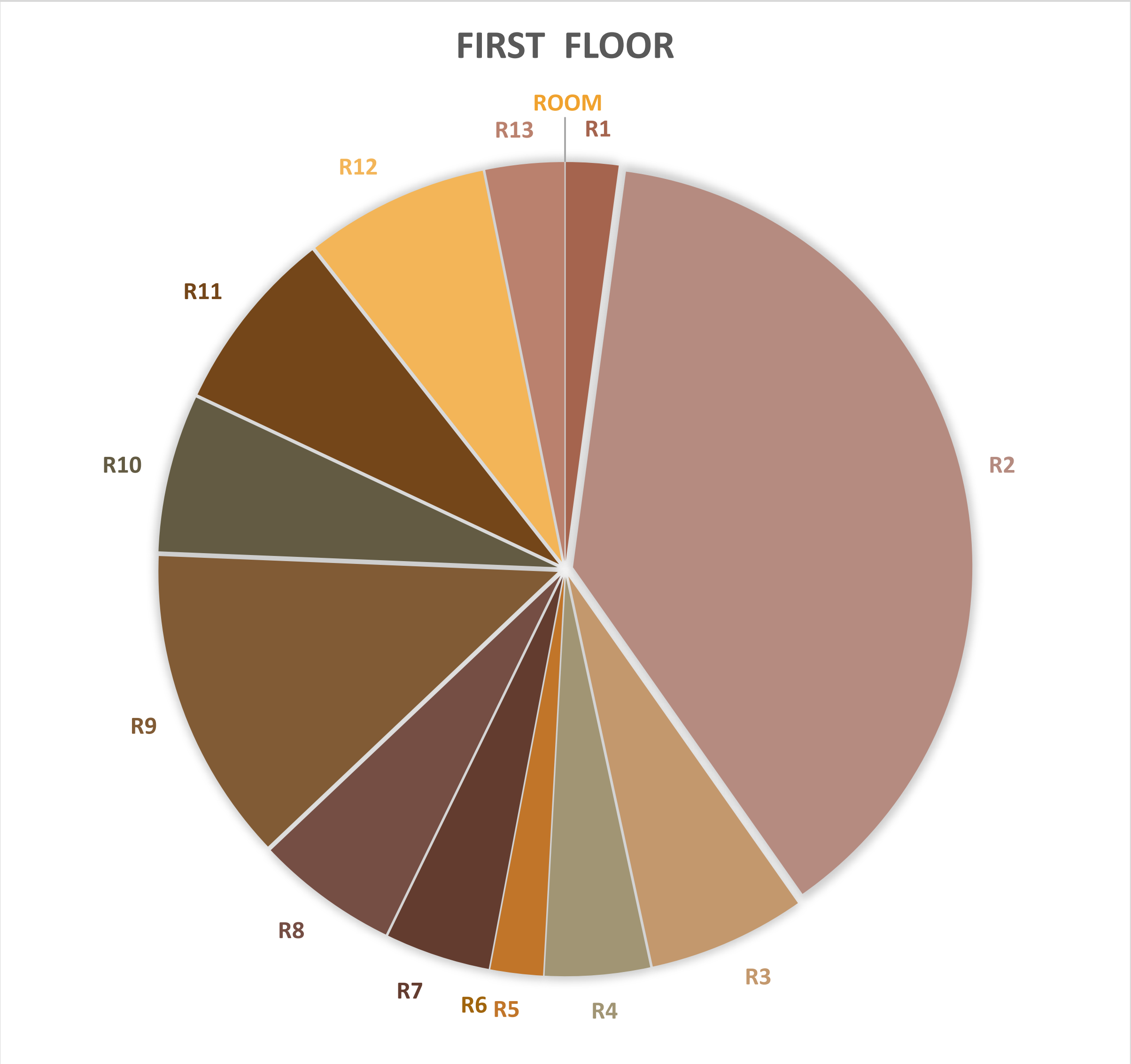


Figure (4. 4) : First Floor

The ground floor consists of 13 rooms and a corridor. The loads for each room were calculated as follows, the calculation of power, lighting and AC.

Table (4.4) : Highest load / WAT

HIGHEST LOAD / WAT	ROOM
POWER	R 2
LIGHTING	R 10
AC	R 8

Table (4.٥) : Load of Second Floor

SECOND FLOOR			
AC/W	LIGHTING /W	POWER/W	ROOM
1000	254	1500	R1
1000	112	750	R2
1000	122	750	R3
1000	112	500	R4
1280	224	500	R5
1280	168	1500	R6
2020	336	1500	R7
800	112	750	R8
800	122	750	R9
800	112	750	R10
800	48	250	R11
1000	48	750	R12
1280	96	1750	R13
4050	240	3250	R14
4050	192	3625	R15
0	252	500	R16
0	180	500	R17
0	108	1000	R18
0	24	500	R19
4050	192	6750	R20
1000	24	1250	R21
800	24	500	R22
0	24	0	R23
1280	72	1250	R24
800	24	1000	R25
800	24	1500	R26
0	336	0	corridor
30890	3582	33625	TOTAL

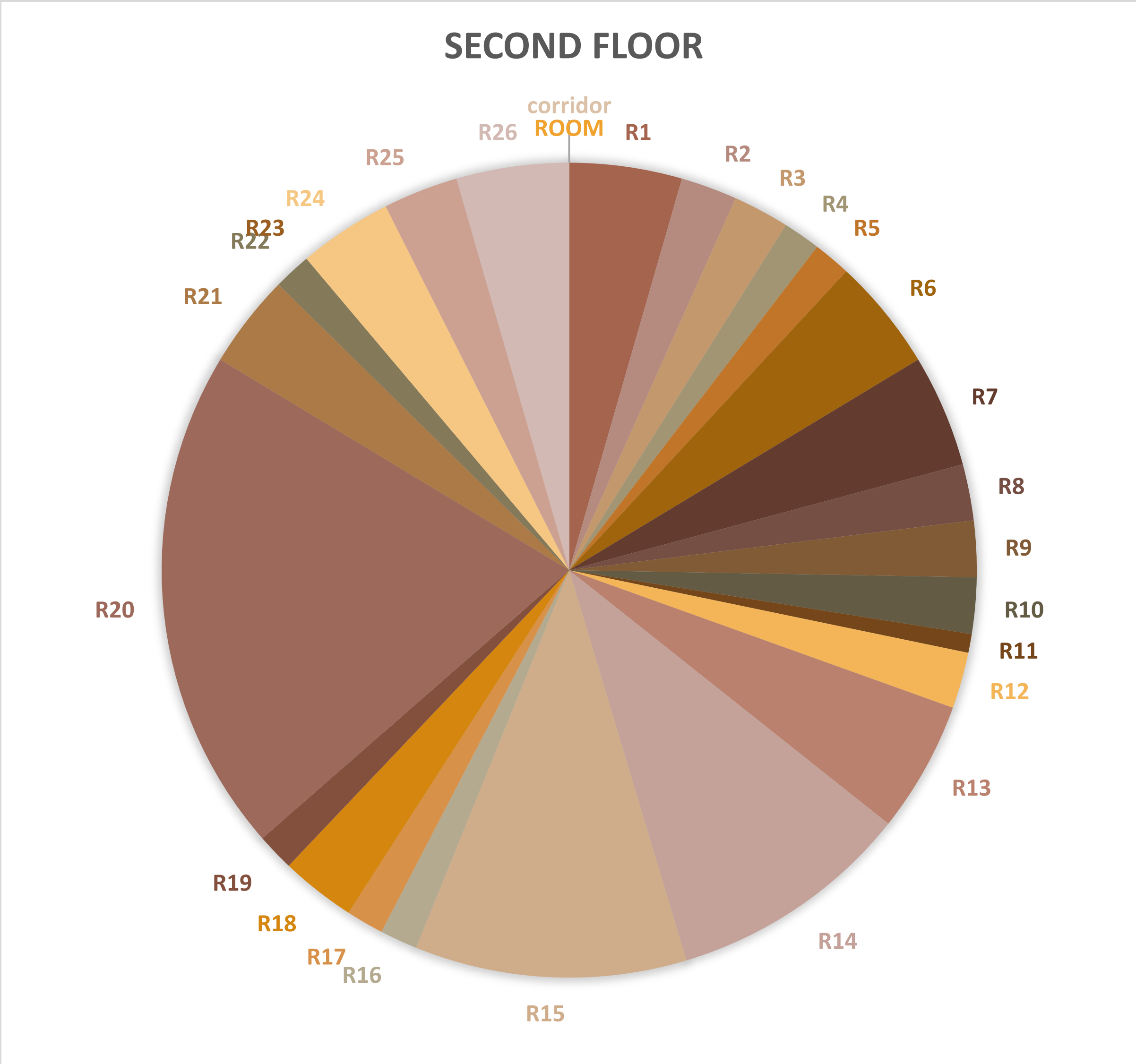


Figure (4. 5) : Second Floor

The ground floor consists of 26 rooms and a corridor. The loads for each room were calculated as follows, the calculation of power, lighting and AC.

Table (4.6) : Highest load / WAT

HIGHEST LOAD / WAT	ROOM
POWER	R 20
LIGHTING	R 16
AC	R 14 + R15 + R20

Table (4.٧) : Load of Third Floor

	THIRD FLOOR		
AC/W	LIGHTING /W	POWER/W	ROOM
800	24	1000	R1
800	24	1000	R2
800	24	1000	R3
0	120	1000	R4
1000	24	750	R5
1000	96	1000	R6
4050	216	8000	R7
0	144	500	R8
0	174	500	R9
0	840	1250	R10
0	252	2500	R11
1280	48	1750	R12
1000	72	2750	R13
1280	72	1000	R14
1280	112	500	R15
1280	144	3500	R16
0	1324	1500	R17
14570	3710	29500	TOTAL

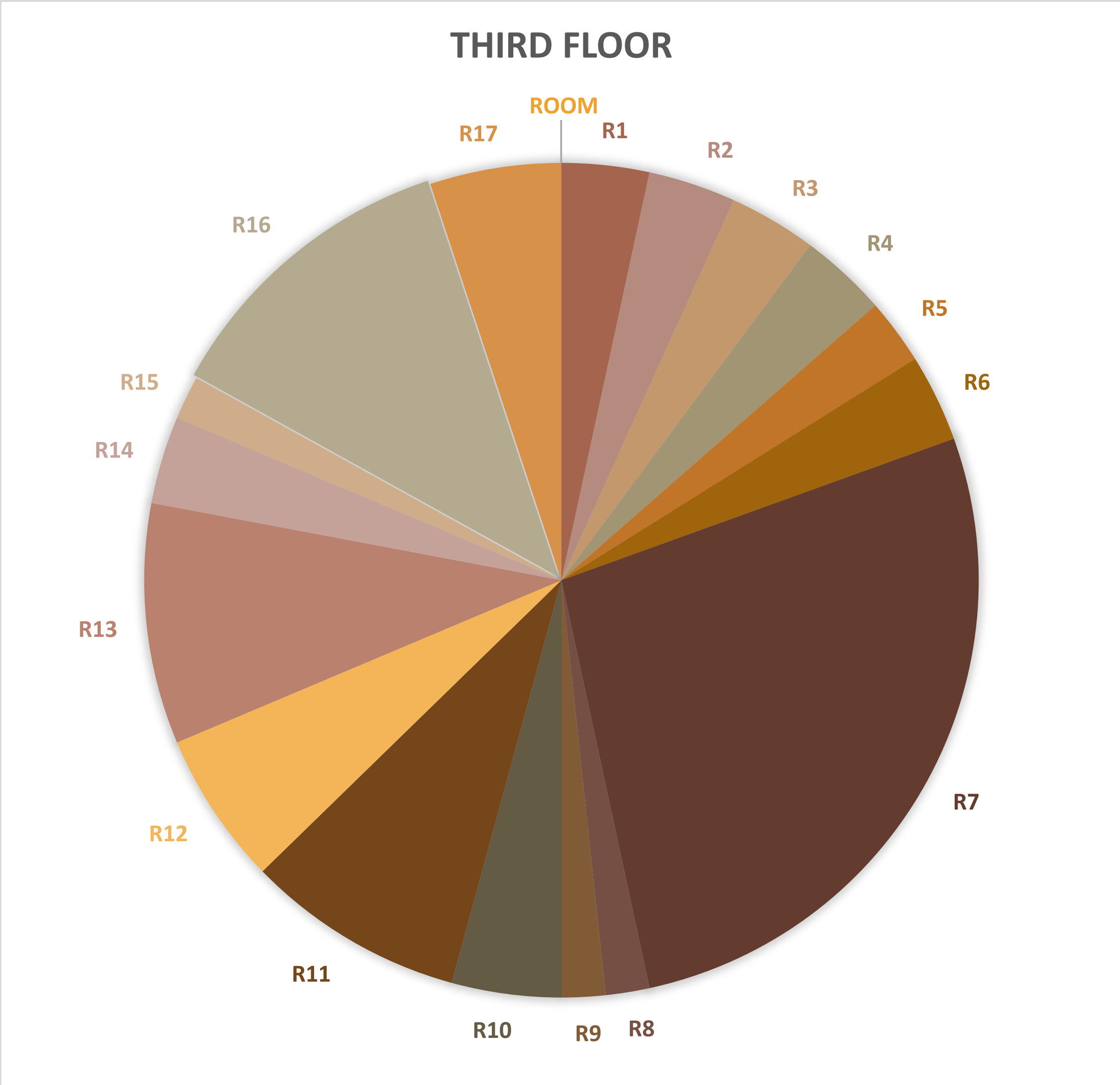


Figure (4. 6) : Third Floor

The ground floor consists of 17 rooms and a corridor. The loads for each room were calculated as follows, the calculation of power, lighting and AC.

Table (4.8) : Highest load / WAT

HIGHEST LOAD / WAT	ROOM
POWER	R 7
LIGHTING	R 17
AC	R 7

5

Chapter FIVE: Accounts and Bills of Quantities

5.1 : Annual electricity consumption in the building

The electrical devices were sorted from each other, by separating the capacity of the lamps from the capacity of the air conditioning, and so on with the rest of the electrical devices. The capacity of each electrical device in the building was determined in watts. The consumption of each floor of the currents was determined. The building's consumption was determined in kilowatt-hours, and the value of the consumption output was multiplied by the price Kilowatt hour

Table (5 .1) : Approximate load OF GROUND FLOOR

working hours…h/d	Approximate load/W	GROUND FLOOR
8	21750	**power**
8	21400	**AC**
8	6637	**Lighting**

$P = V \times I \qquad W = V \times A \qquad I = \frac{P}{V}$

$$current\ of\ power = \frac{power}{volt}$$

$$= \frac{21750\ w}{220\ v} = 98.86\ A$$

$$current\ of\ lighting = \frac{power\ of\ lighting}{volt}$$

$$= \frac{6637\ w}{220\ v} = 30.16A$$

$$current\ of AC = \frac{power\ of\ AC}{volt}$$

$$= \frac{21400\ w}{220\ v} = 97.27\ A$$

$$\sum \text{current of this floor} = 98.86 + 30.16 + 7.27 = 226.29\ \text{A}$$

Table (5. 2) Approximate load OF FIRST FLOOR

working hours…h/d	Approximate load/W	FIRST FLOOR
8	23600	**power**
8	28787	**AC**
8	5187	**Lighting**

$$P = V \times I$$

$$W = V \times A$$

$$I = \frac{P}{V}$$

$$current\ of\ power = \frac{power}{volt}$$

$$= \frac{23600\ w}{220\ v} = 107.27\ A$$

$$current\ of\ lighting = \frac{power\ of\ lighting}{volt}$$

$$= \frac{5187\ w}{220\ v} = 23.57 A$$

$$current\ of AC = \frac{power\ of\ AC}{volt}$$

$$= \frac{28787\ w}{220\ v} = 130.85\ A$$

$$\sum \text{current of this floor} = 107.27 + 23.57 + 130.85 = 261.69\ \text{A}$$

Table (5. 3) Approximate load OF SECOND FLOOR

working hours…h/d	Approximate load/W	SECOND FLOOR
8	33625	**power**
8	30890	**AC**
8	3582	**Lighting**

$$P = V \times I$$

$$W = V \times A$$

$$I = \frac{P}{V}$$

$$current\ of\ power = \frac{power}{volt}$$

$$= \frac{33625\ w}{220\ v} = 152.84\ A$$

$$current\ of\ lighting = \frac{power\ of\ lighting}{volt}$$

$$= \frac{3582\ w}{220\ v} = 16.28A$$

$$current\ of AC = \frac{power\ of\ AC}{volt}$$

$$= \frac{30890\ w}{220\ v} = 140.409\ A$$

$$\sum \text{current of this floor} = 152.84 + 16.28 + 140.409 = 309.529\text{A}$$

Table (5. 4) Approximate load OF THIRD FLOOR

working hours…h/d	Approximate load/W	THIRD FLOOR
8	29500	**power**
8	14570	**AC**
8	3710	**Lighting**

$$P = V \times I$$

$$W = V \times A$$

$$I = \frac{P}{V}$$

$$current\ of\ power = \frac{power}{volt}$$

$$= \frac{29500\ w}{220\ v} = 134.09\ A$$

$$current\ of\ lighting = \frac{power\ of\ lighting}{volt}$$

$$= \frac{3710\ w}{220\ v} = 16.8\ A$$

$$current\ of AC = \frac{power\ of\ AC}{volt}$$

$$= \frac{14570\ w}{220\ v} = 66.22A$$

$$\sum \text{current of this floor} = 134.09 + 16.8 + 66.22 = 217.11\ \text{A}$$

$$current\ of\ the\ puilding$$
$$= \sum\ current\ of\ the\ graund\ floor\ + \sum\ current\ of\ the\ first\ floor$$
$$+ \sum\ current\ of\ the\ second\ floor\ \ + \sum\ current\ of\ the\ third\ floor$$

$$\sum current\ of\ the\ puilding\ = 226.29 + 261.69 + 309.529 + 217.11 = 1014.619\ \text{A}$$

$$total\ power\ of\ the\ puilding = V \times I = 220\ \times 1014.619 = 223216.18\ V/A$$

$$actual\ power\ of\ the\ puilding\ =\ total\ power\ of\ the\ puilding\ \times PF(power\ factor)$$
$$= 223216.18\ \times 0.9 = 200894.562\ W$$

$$power\ load\ \ =\ actual\ power\ \times (load\ factor) = 200894.562\ \ \times 0.75$$
$$= 150670.9215\ W\ = 150.67\ kw$$

$$KWh\ \ =\ KW\ \times (operating\ hours)$$

The building operates from 8 am to 4 pm , which is approximately 8 hours per day during 22 days per month .

$$operating\ h\ /m$$
$$=\ numberof\ operating\ hours\ per\ day$$
$$\times number\ of\ operating\ day\ in\ a\ month$$

$$= 8 \times 22 = 176\ (hours\ /m)$$

$$operating \frac{h}{y} =\ operating \frac{h}{m} \times number\ of\ operating\ months\ per\ year$$

$$= 176\ \times 12 = 2112 (h\ /y)$$

$$KWh\ /y\ \ =\ KW\ \times (operating\ hours) = 150.67\ kw\ \times 2112 (h\ /y)$$

$$= 318215.04\ \ KWh/y$$

The price of a kilowatt-hour in Palestine according to standard = .71اغورة

Energy charge = .71اغورة

$energy\ cost\ \ =\ KWh\ /y \times$ Energy charge $= 318215.04 \times 0.71 = 225932.67$ شيكل $/y$

5.2 : CASE STUDY

Samples are taken from offices, teaching halls and laboratories, in addition to the corridors. A study was conducted on them to determine the number of operating hours during the day, in order to find out the percentage of building operation during the day.

5.2.1 : Case study ONE :

Teacher's office :

Teacher 1 :

The day	Operating hours
Sunday	10-11
Monday	12-1
Tuesday	9-1
Wednesday	12-1
Thursday	9-1

Teacher 2 :

The day	Operating hours
Sunday	11-3
Monday	12-1
Tuesday	12-1
Wednesday	-
Thursday	2-3

Teacher 3 :

The day	Operating hours
Sunday	11-1
Monday	12-2
Tuesday	12-1
Wednesday	-
Thursday	10-12

The day	Number of Operating hours per day
Sunday	5 hours =(5/ 8)×100% ≈ 63%
Monday	2 hours=(2/ 8)×100% ≈ 25%
Tuesday	4 hours=(4/ 8)×100% ≈ 50%
Wednesday	1 hours=(1/ 8)×100% ≈ 13%
Thursday	4 hours=(4/ 8)×100% ≈ 50%

$$average\ time = \frac{63\% + 25\% + 50\% + 13\% + 50\%}{5} \approx 40\%$$

5.2.2 : Case study TWO :

Teaching room and lap :

The day	Operating hours
Sunday	8-9 , 10-11 , 11-12 , 12-1 , 2-3
Monday	8-9.15 , 9.30-10.45 ,12.30-1.45 ,2-3.15
Tuesday	8-9 , 10-11 , 11-12 , 12,1 , 2-3
Wednesday	8-9.15 , 9.30-10.45 ,12.30-1.45 ,2-3.15
Thursday	8-9 , 10-11 , 11-12 , 12,1 , 2-3

The day	Number of Operating hours per day
Sunday	5 hours $=(5/8)\times100\% \approx 63\%$
Monday	5 hours $=(5/8)\times100\% \approx 63\%$
Tuesday	5 hours $=(5/8)\times100\% \approx 63\%$
Wednesday	5 hours $=(5/8)\times100\% \approx 63\%$
Thursday	5 hours $=(5/8)\times100\% \approx 63\%$

$$average\ time\ = \frac{63\% + 63\% + 63\% + 63\% + 63\%}{5} \approx 65\%$$

5.2.3 :Case study THREE :

Arcade :

$average\ time\ \approx 30\%$

$$\text{Average time for 3 cases } = \frac{40\% + 63\% + 30\%}{3} \approx 45\%$$

$\text{saving time } = 45\% \times 8 = 3.5\ hours$

5.2.4 : *total operating cost saving*

After applying the BMS process to a building, it works 4.5 hours instead of 8 hours per day

$KWh\ = KW\ \times (operating\ hours)$

The building operates from 8 a.m. to 4 p.m., approximately 4.5 hours a day, 22 days a month.

$$operating\ h\ /m = number of\ operating\ hours\ per\ day \times number\ of\ operating\ day\ in\ a\ month$$

$$= 4.5 \times 22 = 99\ hours$$

$$operating \frac{h}{y} = operating \frac{h}{m} \times number\ of\ operating\ months\ per\ year$$

$$= 99 \times 12 = 1188\ (h\ /y)$$

$$KWh\ /y = KW \times (operating\ hours) = 150.67\ kw \times 1188 (h\ /y)$$

$$= 178995.96\ KWh/y$$

$energy\ cost = KWh\ /y \times$ Energy charge $= 178995.96 \times 0.71 = 127087.13$ شيكل $/y$

$$total\ operating\ cost\ saving = existing\ operating\ cost - new\ operating\ cost$$

$= 225932.67 - 127087.13 = 98845.54$ شيكل $/y$

5.3 : Quantities and cost

Table (5. 5) QUANTITIES AND COST Ground floor

total price	price	Quantity	The name	#
90×26=2340$	90$	26	Motion sensor	-1
20×2=40$	20$	2	Bush button	-2
100×26=2600$	100$	26	light fixture	-3
30×15=450$	30$	15	Power socket	-4
100×18=1800$	100$	18	Smoke sensor	-5
24×1=24$	24$	1	Alarm buzzer with alarm button	-6
20×1=20$	20$	1	Phone socket	-7
20×11=220$	20$	11	CB 10A	-8
30×33=990$	30$	33	CB 16A	-9
260×1=260$	260$	1	Knx power supply 640A	-10
30×2=60$	30$	2	3×32A MCB	-11
20×1=20$	20$	1	1×10 MCB	-12
12×1=12$	12$	1	Fuse 6A	-13
300×1=300$	300$	1	Line coupler	-14
35×1=35$	35$	1	4×40A RCCB	-15
315×1=315$	315$	1	Knx -lighting actuator 24 channel	-16
375*3.5=1313$	3.5$/m	375m	Wires	-17
7350$			Labor wages	-18
18149$=61525₪			Total	

Table (5. 6) QUANTITIES AND COST FIRST floor

total price	price	Quantity	The name	#
90×14=104$	90$	14	Motion sensor	-1
20×2=40$	20$	2	Bush button	-2
100×14=1400$	100$	14	light fixture	-3
30×15=450$	30$	15	Power socket	-4
100×26=2600$	100$	26	Smoke sensor	-5
24×1=24$	24$	1	Alarm buzzer with alarm button	-6
20×1=20$	20$	1	Phone socket	-7
20×8=160$	20$	8	CB 10A	-8
30×15=450$	30$	15	CB 16A	-9
260×1=260$	260$	1	Knx power supply 640A	-10
30×2=60$	30$	2	3×32A MCB	-11
20×1=20$	20$	1	1×10 MCB	-12
12×1=12$	12$	1	Fuse 6A	-13
300×1=300$	300$	1	Line coupler	-14
300×1=300$	300$	1	Knx - lighting actuator 16 channel	-15
35×1=35$	35$	1	4×40A RCCB	-16
360*3.5=1260$	3.5$/m	360m	Wires	-17
7350$			Labor wages	-18
14845$=50324₪			Total	

Table (5. 7) QUANTITIES AND COST SECOND floor

total price	price	Quantity	The name	#
90×30=120$	90$	30	Motion sensor	-1
20×2=40$	20$	2	Bush button	-2
100×30=3000$	100$	30	light fixture	-3
30×24=720$	30$	24	Power socket	-4
100×30=3000$	100$	30	Smoke sensor	-5
24×1=24$	24$	1	Alarm buzzer with alarm button	-6
20×1=20$	20$	1	Phone socket	-7
20×13=260$	20$	13	CB 10A	-8
30×24=720$	30$	24	CB 16A	-9
260×1=260$	260$	1	Knx power supply 640A	-10
30×2=60$	30$	2	3×32A MCB	-11
20×1=20$	20$	1	1×10 MCB	-12
12×1=12$	12$	1	Fuse 6A	-13
300×1=300$	300$	1	Line coupler	-14
300×1=300$	300$	1	Knx -2 lighting actuator 8 channal	-15
35×1=35$	35$	1	4×40A RCCB	-16
315×1=315$	315$	1	Knx -1shutter&lighting actuator 24 channal	-17
490*3.5=1715$	3.5$/m	490m	Wires	-18
7350$			Labor wages	-19
18271$=61938₪			Total	

Table (5. 8) QUANTITIES AND COST THIRD floor

total price	price	Quantity	The name	#
17*90=1530$	90$	17	Motion sensor	-1
2*20=40$	20$	2	Bush button	-2
17*100=1700$	100$	17	light fixture	-3
7*30=210$	30$	7	Power socket	-4
14*100=1400$	100$	14	Smoke sensor	-5
24*1=24$	24$	1	Alarm buzzer with alarm button	-6
20*1=20$	20$	1	Phone socket	-7
160$ 20*8=	20$	8	CB 10A	-8
30*7=210$	30$	7	CB 16A	-9
260*1=260$	260$	1	Knx power supply 640A	-10
2*30=60$	30$	2	3×32A MCB	-11
20*1=20$	20$	1	1×10 MCB	-12
12*1=12$	12$	1	Fuse 6A	-13
300*1=300$	300$	1	Line coupler	-14
300*1=300$	300$	1	Knx -2 lighting actuator 16 channels	-15
35*1=35$	35$	1	4×40A RCCB	-16
285*3.5=998$	3.5$/m	285m	Wires	-17
7350$			Labor wages	-18
14629$=49592₪			Total	

Table (5. 9) QUANTITIES AND COST TO MDB(main distribution bored)

total price	price	Quantity	The name	#
2700*1=2700$	2700$	1	Automation Server	-1
1300*5=6500$	1300$	5	DL-16	-2
900*1=900$	900$	1	PS-24V	-3
650*2=1300$	650$	2	DO-FA-12	
400*2=800$	400$	2	UL-8/AO-4	
12200$=41358₪			Total	

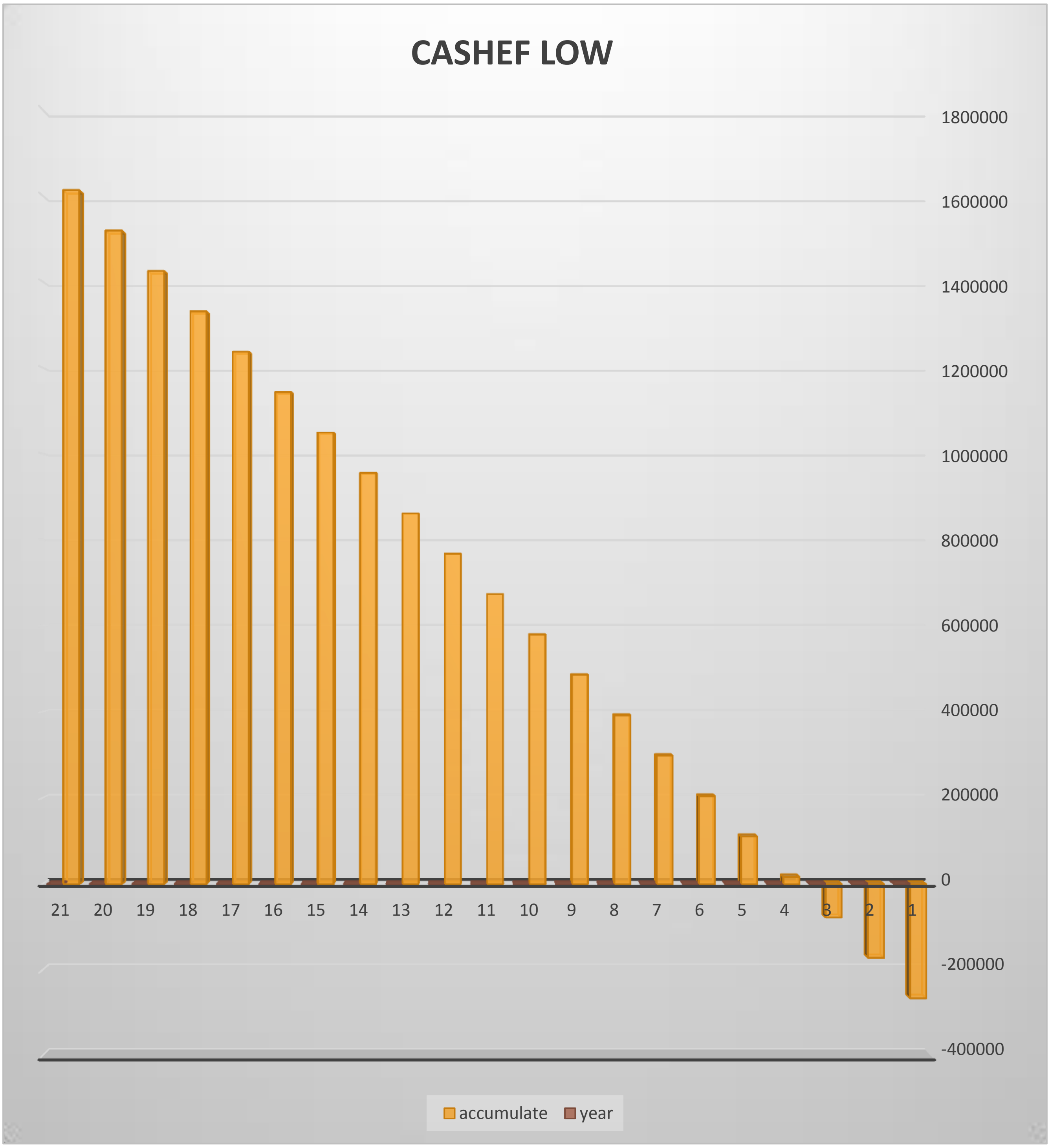
$$\text{capital cost} = \text{Ground floor cost} + \text{fist floor cost} + \text{second floor cost} + \text{thied floor cost} + \text{main distribution board cost}$$
$$= 61525 + 50324 + 61938 + 49592 + 41358 \approx 265000₪$$

5.4 : Study the project's recovery over twenty years

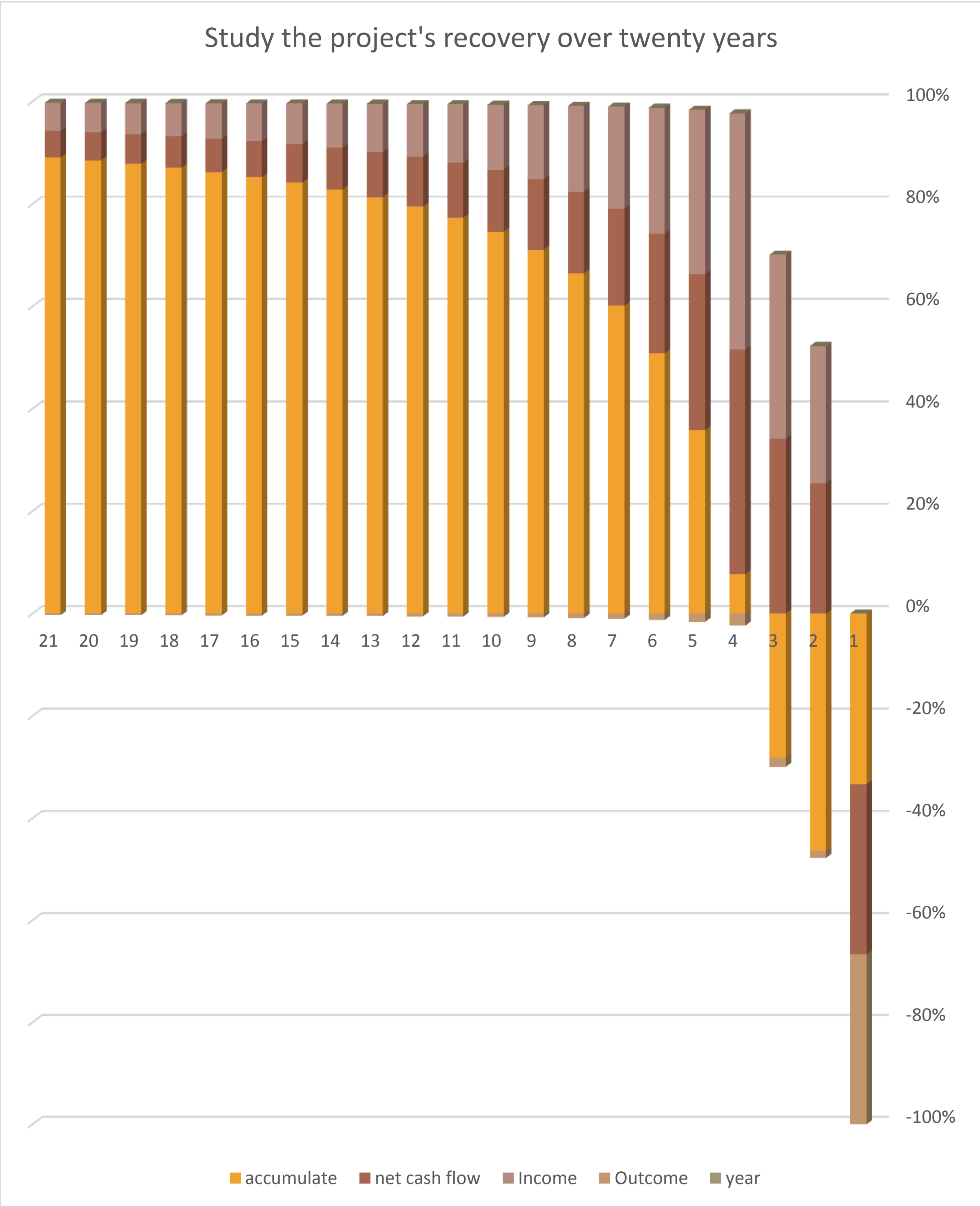
Table (5. 10) CASHEF LOW

year	Outcome	Income	net cash flow	accumulate
0	-265000	0	-265000	**-265000**
1	-5000	98845.54	93845.54	**-171154.46**
2	-5000	98845.54	93845.54	**-77308.92**
3	-5000	98845.54	93845.54	**16536.6**
4	-5000	98845.54	93845.54	**110382.14**
5	-5000	98845.54	93845.54	**204227.68**
6	-5000	98845.54	93845.54	**298073.22**
7	-5000	98845.54	93845.54	**391918.76**
8	-5000	98845.54	93845.54	**485764.3**
9	-5000	98845.54	93845.54	**579609.84**
10	-5000	98845.54	93845.54	**673455.38**
11	-5000	98845.54	93845.54	**767300.92**
12	-5000	98845.54	93845.54	**861146.46**
13	-5000	98845.54	93845.54	**954992**
14	-5000	98845.54	93845.54	**1048837.54**
15	-5000	98845.54	93845.54	**1142683.08**
16	-5000	98845.54	93845.54	**1236528.62**
17	-5000	98845.54	93845.54	**1330374.16**
18	-5000	98845.54	93845.54	**1424219.7**
19	-5000	98845.54	93845.54	**1518065.24**
20	-5000	98845.54	93845.54	**1611910.78**

$$\text{Simple payback} = \frac{first\ cost}{annual\ energy\ saving} = \frac{265000}{98845.54} = 2.6\ yaer$$



CASHEF LOW
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
-200000
-400000
21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
accumulate
year



Study the project's recovery over twenty years
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
accumulate
net cash flow
Income
Outcome
year

6

Chapter SIX : APPENDIX

6.1 BMS System Diagrams
6.2 DATA SHET

6.1 : BMS System Diagrams

6.2 : DATA SHET

6.2.1Automation server

Automation Server

Introduction

A SmartStruxure solution server is the core of the system and performs key functionality, such as control logic, trend logging, and alarm supervision. The Automation Server software is pre-loaded on Schneider Electric supplied hardware that supports communication and connectivity to the I/O and field busses. The distributed intelligence of the Automation Servers ensures fault tolerance in the system and provides a fully featured user interface through WorkStation and WebStation.

Features

The Automation Server is a powerful device that can act as a standalone server and also control I/O modules and monitor and manage field bus devices. In a small installation, the embedded Automation Server acts as a stand-alone server, mounted with its I/O modules in a small footprint. In medium and large installations, functionality is distributed over multiple Automation Servers that communicate over TCP/IP.

Communications hub

Capable of coordinating traffic from above and below its location, the Automation Server can deliver data directly to you or to other servers throughout the site. The Automation Server can run multiple control programs, manage local I/O, alarms, and users, handle scheduling and logging, and communicate using a variety of protocols. Because of this, most parts of the system function autonomously and continue to run as a whole even if communication fails or individual servers or devices go offline.

Variety of connectivity options

The Automation Server has numerous ports that enable it to communicate with a wide range of protocols, devices, and servers.

The Automation Server has the following ports:

- One 10/100 Ethernet port
- Two RS-485 ports
- One built-in I/O bus port
- Two USB host ports
- One USB device port

  The USB device port allows you to upgrade and interact with the Automation Server using the Device Administrator.

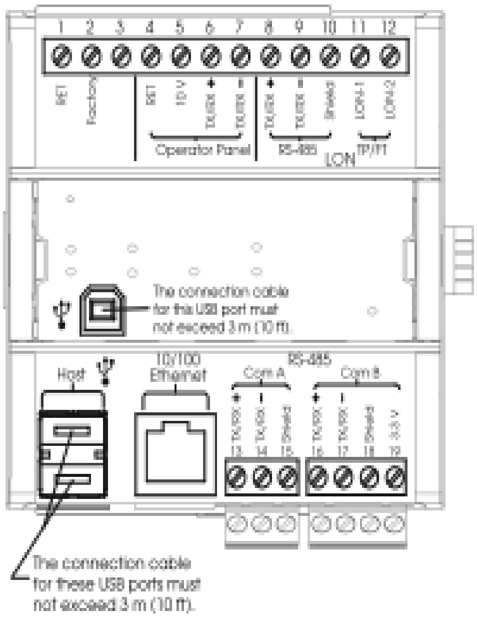
Authentication and permissions

SmartStruxure provides a powerful permission system that is easy to mange, flexible, and adapts to all kinds of system sizes. The permission system provides a security level to the highest standards. Authentication is done against the built-in user account management system or against Windows Active Directory Domains. The built-in account management system provides password policies that meet the toughest requirements. When Windows Active Directory is used, the administration costs are lower because users do not have to be managed in multiple directories.

WorkStation/WebStation interface

Through any client, the user experience is similar regardless of which SmartStruxure solution server the user is logged on to. The user can log directly on to an Automation Server to engineer.

Terminals



LNS

LNS version...OpenLNS
Installed on WorkStation PC

LonMark

Resource files version 14.00

CPU

Frequency ....160 MHz

SDRAM ....128 MB

Flash memory ....4 GB

Part numbers

Automation Server SXWAUTSVR10001
TB-AS-W1, Terminal Base for Automation Server
(Required for each Automation Server) SXWTBASW110001

Add-on options

SW-EWS-1, EcoStruxure Web Services (run-time) option
Consume only for one Automation Server, no maintenance SXWSWEWSX00001

SW-EWS-2, EcoStruxure Web Services (run-time) option
Serve & Consume for one Automation Server, no maintenance SXWSWEWSX00002

SW-EWS-3, EcoStruxure Web Services (run-time) option
Serve & Consume, plus Historical trend log data for one Automation Server, no maintenance
....SXWSWEWSX00003

SW-GWS-1, Web Services (Generic Consume) option
For one Automation Server, no maintenance SXWSWGWSX00001

6.2.2 Circuit breaker

Product data sheet
Characteristics

4CB232/10
Miniature circuit breaker, MAX4, 2P, 32 A, C curve, 10000 A, 415 V

Main

Product brand	Clipsal

Complementary

Curve code	C
Number of poles	2
[In] rated current	32 A
Number of modules	2
[Ue] rated operational voltage	415 V
Breaking capacity	10 kA conforming to EN 60898
Network type	AC
Network frequency	50/60 Hz
[Ui] rated insulation voltage	500 V
Mechanical durability	20000 cycles
Electrical durability	10000 cycles
Connections - terminals	Screw terminal for 1 cable(s) 0.5…35 mm² rigid Screw terminal for 1 cable(s) 0.5…25 mm² flexible Screw terminal for 1 cable(s) 0.5…25 mm² flexible with ferrule
Wire stripping length	13 mm
Tightening torque	3.5 N.m

Environment

IP degree of protection	IP20 conforming to IEC 60529 IP40 (modular enclosure) conforming to IEC 60529
Ambient air temperature for operation	-25…70 °C
Ambient air temperature for storage	-40…70 °C
Standards	AS/NZS 60898
Tropicalisation	2 conforming to IEC 60068-1
Relative humidity	95 % at 55 °C
Height	81 mm
Width	36 mm
Depth	78.5 mm
Net weight	215 g

Packing Units

Package 1 Weight	236.000 g
Package 1 Height	76.000 mm
Package 1 width	87.000 mm
Package 1 Length	38.000 mm

Offer Sustainability

Sustainable offer status	Green Premium product
EU RoHS Directive	Compliant EU RoHS Declaration
Mercury free	Yes
RoHS exemption information	Yes
China RoHS Regulation	China RoHS Declaration
Environmental Disclosure	Product Environmental Profile

6.2.3 UL-8/AO-4

Product datasheet

Specifications

SpaceLogic Controller I/O module, 8 universal inputs, 4 analog outputs

SXWUI8A4X10001

Main

Device short name	UI-8/AO-4
Product certifications	ICES-003 FCC part 15 class B CE RCM UL
Width	90 mm
Product or component type	I/O module
Net weight	152 g
Depth	64 mm
Ambient air temperature for operation	0...50 °C
IP degree of protection	IP20
Flame retardance	UL94V0-5VB
Height	114 mm
Ambient air temperature for storage	-20...70 °C
Power consumption in W	3.2 W
Input/Output type	universal input
Relative humidity	0...95 % non-condensing
Number of outputs	4 analog output
[Us] rated supply voltage	24 V DC
Product name	I/O Modules
Product brand	Schneider Electric
Range	EcoStruxure Building Operation

Complementary

Control type	Without
Product compatibility	Johnson Control Xenta Balco Continuum Honeywell I/NET Satchwell

Electrical connection	Plug-in sub-base
Switching frequency	25 Hz
Discrete input number	8
Mounting support	DIN rail Wall
Analogue input type	Configurable voltage, current or probe 0...20 mA Configurable voltage, current or probe 0...10 V input voltage Configurable voltage, current or probe 20 kOhm connection of probes Configurable voltage, current or probe 10 kOhm connection of probes Configurable voltage, current or probe 2.2 kOhm connection of probes Configurable voltage, current or probe 1.8 kOhm connection of probes Configurable voltage, current or probe 1 kOhm connection of probes Configurable voltage, current or probe 10 kOhm with shunt
Local signalling	LED (green/red) for high signal level LED (green/red) for low signal level
Range compatibility	EcoStruxure Building Operation TB-IO-W1 terminal base
Standards	UL 864 UL 916 FCC CFR47 part 15
Material	ABS + PC

Packing Units

Unit Type of Package 1	PCE
Number of Units in Package 1	1
Package 1 Weight	170.0 g
Package 1 Height	5.6 cm
Package 1 width	11.7 cm
Package 1 Length	9.1 cm

Offer Sustainability

Sustainable offer status	Green Premium product
REACh Regulation	REACh Declaration
EU RoHS Directive	Compliant EU RoHS Declaration
Mercury free	Yes
RoHS exemption information	Yes
China RoHS Regulation	China RoHS declaration
Environmental Disclosure	Product Environmental Profile
Circularity Profile	End of Life Information
WEEE	The product must be disposed on European Union markets following specific waste collection and never end up in rubbish bins
PVC free	Yes
Halogen content performance	Halogen free plastic parts & cables product

6.2.4 DO-FA-12

I/O Modules DO-FA-12 and DO-FA-12-H

12 channel Form A digital output

Introduction

The DO-FA-12 and DO-FA-12-H are digital output 12 channel I/O modules.

The digital outputs support digital Form A point types. The Form A relays are designed for direct load applications.

Function

Modular and scalable system

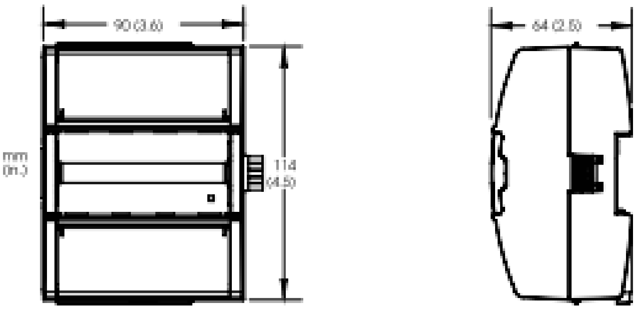
The modules are part of a modular system that delivers power and communications on a common bus. Connecting modules is a one-step process: just slide the modules together using the built-in connectors.

Patented two-piece design

Each module can be separated from its terminal base to allow the site to be wired prior to the installation of the electronics. The patented locking mechanism serves as handles for removing the module from its base. All critical components have a protective cover that permits convection cooling to occur.

Mechanical

Dimensions including terminal base ....90 W x 114 H x 64 D mm (3.6 W x 4.5 H x 2.5 D in.)



Weight including terminal base ....0.317 kg (0.70 lb)

Weight excluding terminal base ....0.194 kg (0.43 lb)

Terminal base TB-IO-W1

Part numbers

DO-FA-12, I/O module
12 Form A digital outputs SXWDOA12X10001

DO-FA-12-H, I/O module with HOA switches
12 Form A digital outputs with Hand/Off/Auto override switches SXWDOA12H10001

TB-IO-W1, terminal base for I/O module
(Required for each I/O module)..............................SXWTBIOW110001

Accessory part numbers

DIN-RAIL-CLIP, DIN-rail end clip
package of 25 pieces..............................SXWDINEND10001

PRINTOUT-A4-W1, printout sheets for terminal labels
A4 sheet size, 100 sheets, 18 labels per sheet..............................SXWTERLBL10011

PRINTOUT-LTR-W1, printout sheets for terminal labels
Letter sheet size, 100 sheets, 16 labels per sheet SXWTERLBL10012

S-CABLE-L, S-cable extension cord for Automation Server I/O bus L shaped connectors
1.5 m..............................SXWSCABLE10002

S-CABLE-L, S-cable extension cord for Automation Server I/O bus L shaped connectors
0.75 m..............................SXWSCABLE10003

Digital outputs

The Form A digital outputs of the DO-FA-12 and DO-FA-12-H I/O modules are closing contacts with one common terminal (C) and one normally open terminal (NO). The terminals are isolated from signal ground.

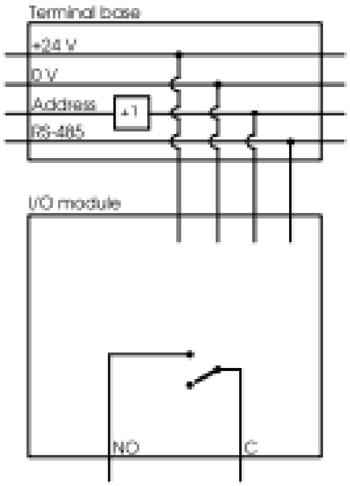


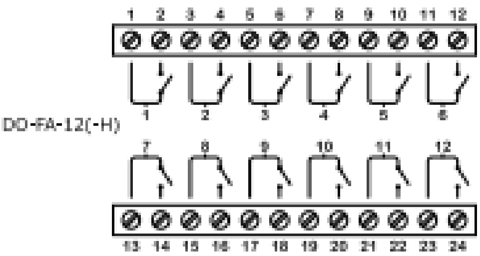
Figure: Form A digital output internal configuration

The I/O bus in the terminal base provides the I/O module with power and an address.

The address value in the I/O bus is increased by one for each terminal base. The I/O bus also enables RS-485 communication between the I/O module and the Automation Server.

Specifications

Digital outputs



Contact rating ....250 VAC/30 VDC, 2 A
Switch type ....Form A Relay
....Single Pole Single Throw
....Normally Open
Isolation contact to system ground ....3000 VAC
Cycle life ....At least 100,000 cycles
Minimum pulse width ....100 ms
LED polarity energized relay ....On
LED polarity non-energized relay ....Off
LED color ....Green

For protection from excess current that could be produced by field wiring, see Automation Server Family Hardware Guide.

6.2.5 POWER SUPPLY PS-24v

Power Supply PS-24V

Introduction

The PS-24V power supply module is designed to accommodate the specific power requirements of the Automation Server and its connected I/O modules.

Features

The PS-24V is a power supply module that accommodates 24 VAC or 24 VDC input power.

Reliable consistent output power

Each power supply module delivers reliable and consistent output power of 24 VDC to the terminal base.

30 W rating

This power supply module can supply power for loads up to 30 W. The consumption of downstream modules can vary. A PS-24V can deliver power to one Automation Server and a number of I/O modules calculated from the Power Budget table. If more I/O modules are needed, another power supply can be added to the bus. The output power delivered by the previous power supply on the bus is interrupted in the terminal base of the next power supply while also providing communication and ground pass-through.

Table: Power Budget

Module	DC input supply power
Automation Server	7 W
DI-16	1.6 W
UI-16	1.8 W
RTD-DI-16	1.6 W
DO-FA-12(-H)	1.8 W
DO-FC-8(-H)	2.2 W
AO-8(-H)	4.9 W
AO-V-8(-H)	0.7 W
UI-8/DO-FC-4(-H)	1.9 W
UI-8/AO-4	3.2 W
UI-8/AO-V-4(-H)	1.0 W

Modular and scalable system

The modules are part of a modular system that delivers power and communications on a common bus. Connecting modules is a one-step process: just slide the modules together using the built-in connectors.

Polarity independent

The main AC/DC input (L/+ and N/-) is galvanically isolated from the DC output (to the I/O bus). This removes the risk of damage due to earth currents and permits the input power to be wired without concern for polarity matching.

Overload protection

When a power supply module's load (total load of Automation Server, I/O modules, communication modules) exceeds its rating, the power supply module will protect itself from being damaged.

Terminals

PS-24V

Environment

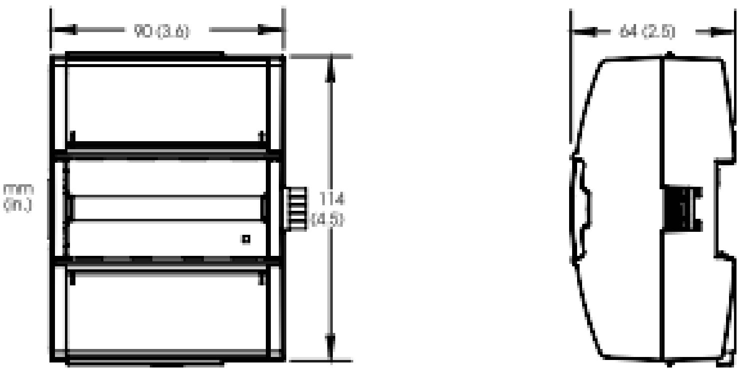
Ambient temperature, operating .... 0 to 50 °C (32 to 122 °F)
Ambient temperature, storage .... -20 to +70 °C (-4 to +158 °F)
Maximum humidity .... 95 % RH non-condensing

Material

Plastic rating UL94-5VB
Enclosure .... Eco Friendly ABS/PC
Enclosure rating .... IP 20

Mechanical

Dimensions including terminal base .... 90 W x 114 H x 64 D mm (3.6 W x 4.5 H x 2.5 D in.)



Weight including terminal base .... 0.285 kg (0.63 lb)
Weight excluding terminal base .... 0.186 kg (0.41 lb)

Agency compliances

Emission .... C-Tick; EN 61000-6-3; FCC Part 15, Sub-part B, Class B
Immunity .... EN 61000-6-2
Safety .... UL 916 C-UL US Listed

Part numbers

PS-24V Power Supply 24 VAC/VDC SXWPS24VX10001
TB-PS-W1, Terminal Base for Power Supply
(Required for each power supply) SXWTBPSW110001

Internal Configuration

The PS-24V power supply module does not connect to the address and communication busses in the terminal base. The AC/DC converter terminals L/+ and N/- are isolated from the circuits on the secondary side of the converter. You can wire these terminals without concern for polarity matching, but it is good practice to connect the positive supply voltage to L/+ and the negative supply voltage to N/- in order to prevent confusion.

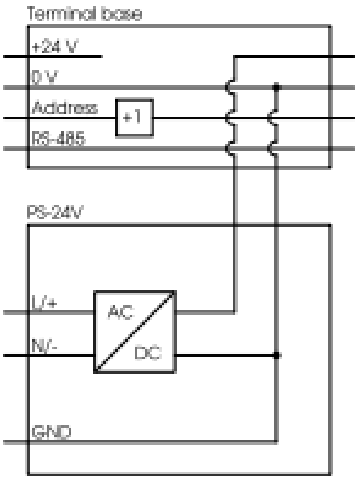


Figure: PS-24V internal configuration

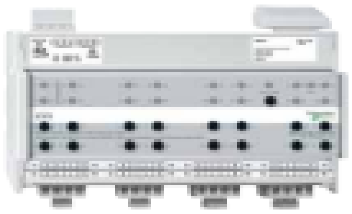
The ground terminal (GND) on the PS-24V power supply is connected to signal ground, which is the same as the negative output from the power supply. The purpose of this connection is to comply with EMC directives.

The address value in the I/O bus is increased by one for each terminal base. The I/O bus also enables RS-485 communication between the I/O module and the Automation Server.

6.2.6 KNX -2 lighting actuator 24 channel

Product data sheet
Characteristics

MTN649908
Blind/switch actuator REG-K/8x/16x/10 with manual mode, light grey



Main

For independent control of up to 8 blind/roller shutter drives or for switching up to 16 loads via make contacts. The function of the blind or switching channels is freely configurable. All blind/switch outputs can be operated manually using push-buttons. With integrated bus coupling unit. For installation on DIN rails EN 50022.

Complementary

The bus is connected using a bus connecting terminal; a data rail is not necessary. Channel status display via LEDs. A green LED indicates readiness for operation.

KNX software functions:
Blind functions: Blind type. Running time. Idle time. Step interval. Weather alarm. 8-bit positioning for height and slats. Scenes. Status and feedback function.
Switch actuator functions: Operation as break contact/make contact. Programmable behaviour for download. Delay functions for each channel. Staircase lighting function with/without manual OFF function. Cut-out warning for staircase lighting function. Scenes. Central function. Disable function. Logic operation or priority control. Status feedback function for each channel.

Power supply:
Nominal voltage: AC 230 V, 50 - 60 Hz
External auxiliary voltage (optional): AC 110 - 240 V, 50 - 60 Hz, max. 2 VA
For each blind output:
Nominal current: 10 A, cosφ = 0.6
Motor load: AC 230 V, max. 1000 W
For each switch output:
Nominal current: 10 A, cosφ = 1; 10 A, cosφ = 0.6
Incandescent lamps: AC 230 V, max. 2000 W
Halogen lamps: AC 230 V, max. 1700 W
Fluorescent lamps:
AC 230 V, max. 1800 W, uncompensated
AC 230 V, max. 1000 W parallel-compensated
Capacitive load: AC 230 V, max. 105 µF
Device width: 8 modules = approx. 144 mm

6.2.7 KNX power supply 640A data sheet

SpaceLogic KNX Power Supply 640 mA
SpaceLogic KNX Power Supply 320 mA

Product Information

This document follows on from the installation instruction and provides further product information. You will find information about e.g. the functions or the different operating states, etc.

MTN6513-1201 | MTN6513-1202 | MTN6513-1203

03/2020

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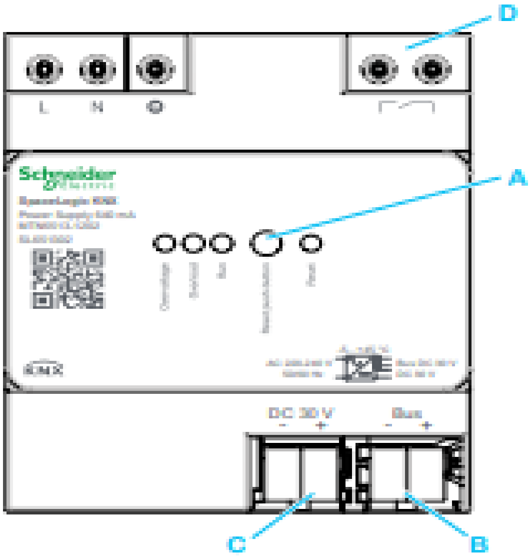
Schneider Electric

2 Getting to know SpaceLogic KNX Power Supply 640 mA

SpaceLogic KNX Power Supply 640 mA generates the KNX system voltage (SELV). It guarantees the supply of electrical energy to the KNX devices and data communication via the bus line.



The bus line can be connected to the KNX power supply at connection **B** "Bus". Due to the integrated choke, the use of an external KNX choke is not necessary.

In addition, the KNX power supply has a DC voltage output **C** "DC 30 V" (SELV), which has no choke. This connection is used, for example, to supply a further line (e.g. main line) via a separately installed KNX choke.

Alternatively, the DC voltage output can be used to supply other functional devices.

To increase the rated current, you can connect a maximum of two SpaceLogic KNX Power Supply 640 mA in parallel in one bus line. It is not necessary to connect 200 m bus line between the power supplies.

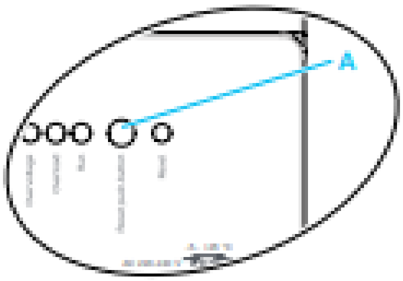
The electrical load can be divided between the "BUS" and "DC 30 V" outputs as required, but the device's nominal current of 640 mA must not be exceeded.

If the permissible nominal current of the device is exceeded, the device indicates overload (Overload LED lights up). This is independent of whether the voltage supply is operated individually or in parallel with a second one, or whether the "DC 30 V" output is also used.

The outputs have a common overload and short-circuit protection and an open-circuit proof. The bus line is connected via a KNX connection terminal.

4 Functions at a glance

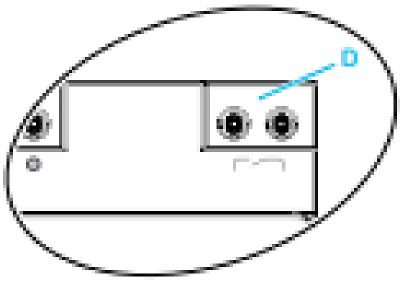
4.1 Display and operating elements



The power supply has a reset button **A**, which, when pressed, shorts the bus line for a defined time or permanently, thus resetting the connected bus devices. It is also possible to acknowledge a fault message via the reset button. Reset the device --> 10

You can read off the operating status of the power supply via a LED display on the front of the device.

4.2 Signalling contact



The KNX power supply has a potential-free relay output **D** as a signalling contact for operating or diagnostic messages. This contact is closed in normal operation and open in faulty operation of the devices (overload, overvoltage, KNX voltage failure).Function of the signalling contact --> 12

4.3 Operation with emergency power systems

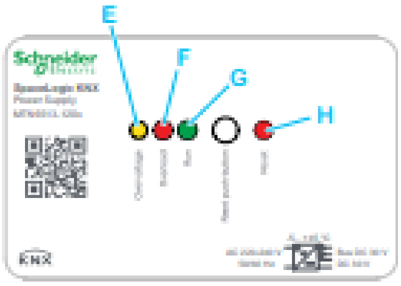
The KNX power supply can be used in combination with centrally supplied emergency power systems. In this way, the function of the KNX system and the operation of the most important functions can be guaranteed in emergency operation.

Statutory and standard specifications for emergency power and emergency lighting systems vary from country to country. In any case, check whether the specific requirements are observed.

5 Operation

5.1 LED display

You can read operating status of the power supply via a LED display on the front of the device.



E	Overvoltage	On: Overvoltage on the KNX bus line and at the DC 30 V output
F	Overload	On: Overload or short circuit on the KNX bus line and at the DC 30 V output
G	RUN LED	On: Normal operation Off: No KNX voltage / DC 30 V or internal error Flashing: Overload or overvoltage
H	Reset	Flashing rapidly (approx. 2.5 Hz): Reset with a duration of 20 seconds Flashing slowly (approx. 0.25 Hz): Permanent reset

6.2.8 MOION SENSOR

Product data sheet
Characteristics

752IR2RC
Motion Sensor 752 series - Passive infrared - Indoor - Two-channel - 15m detection radius - 240 V

Main

Range of product	ARGUS standard movement detector
Range	ARGUS
Product or component type	Presence detector with IR receiver
Load type	LED lighting: : 100 W Incandescent lamps: : 2000 W - 230 V Halogen lamp: : 1000 W - 230 V Fluorescent tube: 900 VA Compact fluorescent lamp: : 100 W Motor: : 100 W Relay: : 5 A - 250 V
Colour tint	White

Complementary

Network frequency	50/60 Hz
Input function	Switch External trigger
Output voltage	220...250 V
Output current	10 A
Number of channels	2
Control type	Movement sensor
Function available	Switching, toggling, dimming
Light intensity adjustment	10...2000 lux
Horizontal detection angle	360 °
Detection range	Radius: 14000 mm
Device mounting	Surface Flush
Mounting height	2.5 m

Environment

IP degree of protection	IP52 IP40

Packing Units

Unit Type of Package 1	PCE
Number of Units in Package 1	1
Package 1 Weight	433.1 g
Package 1 Height	13.6 cm
Package 1 width	12.1 cm
Package 1 Length	17.8 cm

Offer Sustainability

Sustainable offer status	Green Premium product
REACh Regulation	REACh Declaration
REACh free of SVHC	Yes
EU RoHS Directive	Compliant EU RoHS Declaration
Toxic heavy metal free	Yes
Mercury free	Yes
RoHS exemption information	Yes
China RoHS Regulation	China RoHS Declaration
Environmental Disclosure	Product Environmental Profile
WEEE	The product must be disposed on European Union markets following specific waste collection and never end up in rubbish bins

Tech Data Sheet D01661GB3 Fire Detection 11/2014

AP200 SERIES DETECTORS

AP200 series detectors for FX NET Fire Detection Systems with FX-SLC protocol

AP200 series detectors are compatible with the FX-SLC loop controller (159+159 addresses per loop).

The new FX-SLC protocol delivers more devices on the loop and gives greater control, configurability and device management whilst enabling the overall system to optimised to the location.

AP200 series detectors are mechanically and electrically backwards compatible with Series 200 devices.

All detectors are environmentally friendly and meet the WEEE and RoHS legislative requirements, minimising end of life disposal costs.

The AP200 series detectors (except ESMI2251CTLE-W) have two integral tri-colour LEDs that provide 360° local visual indication of the device status. The LED colours are red for alarm, amber for fault and green for normal condition. The ESMI2251CTLE-W LED colour is red.

The detectors are available with or without single pole short circuit isolation.

ESMI 22051E Optical Smoke Detector

The ESMI 22051E photoelectric smoke detector has a completely new detection chamber design. This delivers improved responsiveness; reduced sensitivity changes caused by settling dust and reduced false alarms resulting from insect ingress and other debris. The plug-in unit uses sophisticated processing circuitry that incorporates smoothing filters to help eliminate transient environmental noise conditions that can be the cause of unwanted alarms.

The devices are managed by embedded software running complex algorithms that further improve resilience to false alarms and improve detection speed.

ESMI 22051TE Photo-Thermal Detector

The multi-criteria detector ESMI 22051TE photo-thermal detector uses thermal assistance to the core photoelectric smoke detector to give enhanced false alarm immunity and faster response to a wide range of incipient fires. The plug-in unit combines two separate sensing elements that are managed by embedded software to act as a single unit. The ESMI 22051TE conforms to EN54-7, a 58°C fixed temperature and rate of rise thermal assistance conforming to EN54-5. In areas where the normal daytime activities may potentially create unwanted alarms, the detector can be programmed to operate in a "heat only" mode, automatically reverting to full photo-thermal operation during unoccupied periods.

Schneider Electric

ESMI 22051TLE 3-element Multi-Criteria Detector

The ESMI 22051TLE multi-criteria, Photo Thermal Infra Red (PTIR), detector is the environmentally friendly alternative to the ionisation detector. The "PTIR" offers comparable speed of response to the ionisation technology for a fast flaming fire and is less susceptible to false alarms. It can be deployed with confidence in locations where the main risk is from fast-developing flaming fires. In addition to being an effective alternative to ionisation units, "PTIR" offers better performance over the alternative technologies of dual angle or dual wavelength optical detectors and photo-thermal detectors.

The integration of continual monitoring for all three major elements of a fire enables the ESMI 22051TLE respond far more quickly to an actual fire and has the highest immunity to nuisances. Based upon the sensor signals, the program is dynamically changing sensor thresholds, sensor gain, time delays, combination, sampling rates, averaging rates and, if any sensor fails, changing sensitivity of the remaining sensors as well as indicating a fault condition.

ESMI 2251CTLE-W 4-element Multi-Criteria Detector

The ESMI 2251CTLE-W plug-in fire detector combines 4 separate sensing elements to act as a single unit. CO sensing for monitoring CO products from a smouldering fire, IR sensing for measuring ambient light levels and flame signatures, optical smoke detection and heat detection.

The 2251CTLE detector has been designed for indoor use. It responds far more quickly to an actual fire and has the highest immunity to nuisances. The operating philosophy behind the 2251CTLE detector was to configure it so that it normally operates at a high immunity level, changing to become very sensitive to fires when fire characteristics are sensed. In this way transient nuisances are monitored and ignored, reducing the false alarm rate.

In areas where the normal daytime activities are likely to create unwanted alarms, the detector can be programmed to operate in a "Heat only" mode, automatically reverting to optical-thermal operation during the unoccupied period. The 2251CTLE is thus able to offer exceptional false alarm immunity and excellent fire detection.
Note: The LED colour is red.
Note: Direct sun light (such as mirror reflection) or strong IR light sources directed towards the detectors might saturate the IR sensor.

Temperature Sensors
ESMI 52051E, ESMI 52051RE and ESMI 52051HTE

The ESMI 52051E and ESMI 52051HTE are fixed temperature analogue addressable sensors employing low mass thermistors and microprocessor technology for fast response and linear temperature sensing. Their linear response allows these sensors to be used to signal temperatures over the range of 58°C (Class A1S) to 78°C (Class BS).

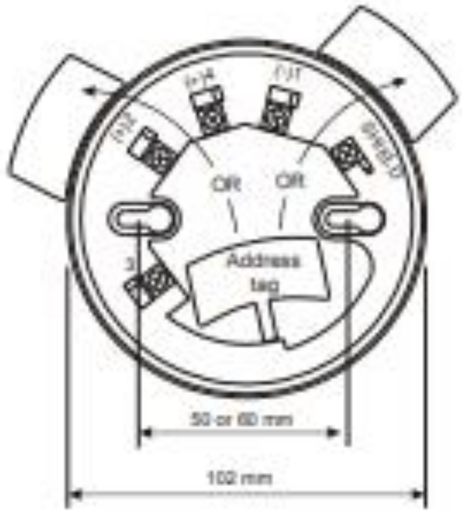
The ESMI 52051RE uses the same thermistor and microprocessor technology to provide an alarm when the rate of rise in temperature exceeds 10°C/minute (typical) or if the temperature exceeds a threshold of 58°C (Response Class A1R).

Address setting

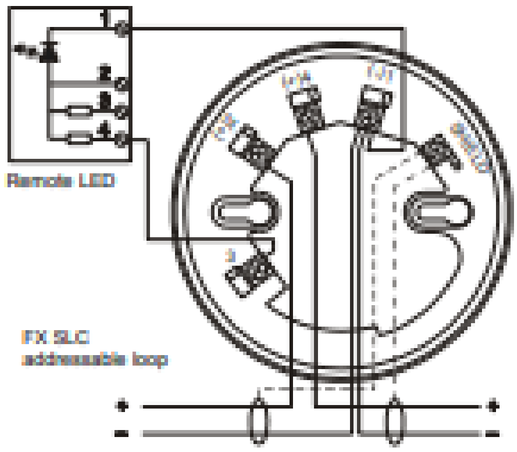
The individual address of detectors is set using the rotary switches.

Detector base B501AP

Mechanical installation



Electrical connections



Technical data

	Detectors			
	ESMI 22051EI ESMI 22051E	ESMI 22051TEI ESMI 22051TE	ESMI 22051TLEI ESMI 22051TLE	ESMI 52051EI ESMI 52051E ESMI 52051REI ESMI 52051RE ESMI 52051HTEI ESMI 52051HTE
Operating voltage range with isolation	15…32 VDC 15…28,5 VDC			
Maximum standby current	200 µA@24 VDC (no communication) 300 µA@24 VDC (LED blinking enabled, every 5 s)			
Led Current	3,5 mA@24 VDC			
Remote output voltage	22,5 V@24 VDC			
Remote output current	10,8 mA@24 VDC			
Temperature range	-30…+70°C			
Humidity	10…93% relative humidity (non condensing)			
Height installed in base B501AP	52 mm	61 mm	63 mm	61 mm
Diameter installed in base B501AP	102 mm	102 mm	102 mm	102 mm
Weight incl. base	97 g	99 g	102 g	88 g
Colour	White			
Material	PC/ABC			
Compatible bases	B501, B501DG, B524RTE-W, B524HTR-W, B501AP			
Max. wire gauge for terminals/base	2,5 mm^2			

Detector ESMI 2251CTLE-W LED colour: red	
Operating voltage	15...32 VDC
Maximum standby current	200 μA at 24VDC (no communications)
Maximum average standby current	300 μA at 24VDC (one communication every 5 sec. with LED blink enabled)
Maximum alarm current	7 mA at 24 VDC
Humidity	15 to 90% RH (non-condensing)
Application temperature range	-20°C to +55°C
IR range	0-450 μW/cm^2
CO range	0-500 PPM
Temperature range	+58°C
Dimensions installed in B501 base height diameter	 66 mm 102 mm
Weight with base without base	 176 g 111 g
Materials	Bayblend FR110
Colour	White
Max. wire gauge for terminals	2,5 mm^2
Tested	EN54-5 EN54-7 LPS 1279 (CO, Photo, Thermal) CEA 402 (Photo, Thermal)
Compatible bases	B501AP, B500 Series (B501, B501DG, B524HTR-W, B524RTE-W, B524EFT-1)

Electrical specifications - Isolator version

Isolation current	15 mA@24 VDC
Maximum continuous current	1 A (switch closed)
Additional loop resistance	20 mΩ typical (max. 30 mΩ)

Thermal sensor performance

Thermal sensor	Performance
52051RE	Class A1R, 58°C Fixed temperature and Rate of Rise
52051E	Class A1S, 58°C Fixed temperature
52051HTE	Class BS, 78°C Fixed temperature

Conclusion

Building Management System (BMS) provides greater visibility and control over energy use. A fully integrated solution can have up to 84% of the energy consuming appliances in a building directly under its control. The data they produce allows facility managers to better analyze, understand, reconfigure and optimize their site energy use and costs, by presenting it in an organized and informative manner.

Also, dealing with the Building Management System (BMS) is very easy and flexible. It also has many benefits, including extending the life span of the devices, and the most important benefits are reducing the value of the electricity bill. Before applying the Building Management System (BMS) to the Korean building, the annual bill for the building was NIS 225932 and after The application of the Building Management System (BMS) to the Korean building, the annual bill for the building was 127,000 shekels. That is, the application of the Building Management System (BMS) to the building saves approximately 99,000 shekels per year. Note that the costs of the (BMS) process do not exceed 265,000 shekels The amount can be refunded after 2-3 years.

It also has other benefits:

1. This system aims to save wasted electrical energy
2. This system reduces the phenomenon of forgetting to turn on the lights after working hours and also on official holidays.
3. This system is based on saving public money by saving electrical energy in buildings
4. The BMS system provides ease and flexibility in controlling the electrical equipment located in the building

RECOMMENDATIONS:

Some tips aimed at educating citizens in general on ways to optimally use electricity. There are many behaviors that most citizens do that cause an increase in electricity consumption and an increase in the value of the electricity bill. Citizens must adhere to the following advice.

1. Not leaving electronic devices connected to electricity, which causes the consumption of electrical energy even when the devices are turned off, so all devices, whether computer or others, must be disconnected from electricity after they are used
2. Turning off the lights and relying on natural lighting when available.
3. Relying on the university's energy-saving LED lighting
4. Turn on the lighting only as needed and turn off all lights when leaving the halls and rooms or when not needed
5. Regular maintenance and cleaning of lighting fixtures from dust, which leads to raising the efficiency of lighting
6. Not to operate air conditioners (in places where there are air conditioners) and rely on natural air unless necessary.
7. Close all doors and windows when the air conditioners are turned on (in places where there are air conditioners)
8. Disconnect all electrical appliances when not needed.
9. Make sure to close the office doors and windows when using the air conditioner, especially during the summer, and the temperature is preferably at 24 degrees.
10. Use motion sensors in offices, classrooms, and corridors, if possible.
11. When you leave the office, all computers, laptops, printers or copiers must be disconnected, in order to save electricity.
12. Educating office workers about the importance of rationalizing electricity by placing banners bearing the most important tips.
13. Choosing energy-efficient appliances can help save electricity, by reading the Energy Electricity Card that comes with the device.

الشكر والتقدير

و أخيراً وليسَ آخراً ، بالعلم نرقى و بالعلم نحيى و بالعلم تزدهر الأُمم

هنا تجمعنا مشاعر الفرح و الحزن في الوقت ذاته

الفرح على رؤية نتيجة التعب و الجهد و السهر ،

نتيجة سنوات قضيناها رفقة زملائنا و ومعلمينا ،

والحزن على فراق عائلتنا الثانية ، عائلة بوليتكنك فلسطين التي احتضنتنا طوال هذه السنين فأصبح لنا عند كل زاويةٍ منها ذكرى و حكاية

إلى مَن كانوا لنا عوناً و مرشداً ، وبوصلتنا التي اهتدينا بها في مسيرتنا الجامعية ، الى من وقفوا معنا في كل الظروف حلوها و مرّها ، الى من أثبتوا أنَّ المعلمَّ كادَ أن يكون رسولا ، معلمينا و معلماتنا الكرام.

إلى أصحاب الفضل الأول ، والحب الأول ، إلى نور عيوننا و ضياءِ حياتنا ، إلى سندنا و عوننا ، إلى أعمدة بيوتنا و أساسها و قدوتنا في هذه الحياة

إلى من سهروا على راحتنا و غمروا حياتنا بكل معاني الحبِّ و الإخلاص ، أهلنا ، آباءنا و أمهاتنا الكرام، تعجز الكلمات عن وصف مدى حبنا و امتناننا لكم ،

لكم منا جزيل الشكر و التقدير.

وفي الختام نشكركم كلٌ باسمه ولقبه لتلبية دعوتنا لكم لحضور هذه المناقشة

وحضوركم هو تشريفٌ لنا ودعم لمسيرتنا التعليمية

سنكون يوما ما نريد

لا الرحلة ابتدئت ولا الدرب انتهى

والسلام عليكم

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