Management System for the Building of the Faculty of Engineering at PTUK

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***Abstract*— With the development of the electrical network and its tools, such as motors, lighting, and required efficiency, as well as the high cost and demand for energy, especially in institutions with high energy consumption. There is a great need to preserve that energy, initiate and audit it sufficiently to obtain a possible energy value at the lowest cost, and then identify the things that need to be replaced or improved. This paper explains a system to save the load of the building while injecting the excess energy into the network, and the building load is mainly provided through the solar cells. However, if the energy produced by the photovoltaic matrix and the battery cannot meet the required load, an additional generator covers the power deficit. In this research, a new improvement method was developed considering the maximum availability and minimum cost of system capital for the optimal size of the photovoltaic power generation system to evaluate the effectiveness and accuracy of the proposed optimization method. The results of this study is compared to the method used in the Homer program for better demonstration.**

Keywords— Energy management system, Homer, PTUK.

I. Introduction

A *management system* is a framework that helps organizations achieve their goals by coordinating their activities and resources. It can be used to manage a wide range of aspects, such as product quality, operational efficiency, environmental impact, and workplace safety [1], [2].

Implementing energy-efficient technologies, materials, and manufacturing processes can help companies improve productivity and product quality. New technologies can also be used to improve the efficiency of equipment and materials [3], [4], [16]. A management system can help organizations improve resource efficiency, financial performance, risk management, and protection of people and the environment [5].

A management system can also help organizations improve the consistency and quality of their products and services to increase the product value for customers and stakeholders. An energy audit is an excellent first step in developing an effective energy management system [6]. An energy audit is a detailed assessment of a facility's energy use and costs, followed by recommendations for changes that can save money on energy bills. Energy audits are essential for any cost control program [7]–[17].

The continuous interruption as a result of the source's inability to meet the necessary load affects the production of solar energy cells because this system is connected to the grid and it contains a protection system called Al-Jazeera system that separates the solar cell system from the grid; therefore, the production stops and solar cells become ineffective because these interruptions are in the peak period of the power outage which negatively affects the laboratories that demand energy significantly. Consequently, diesel engine is needed as an alternative energy source, which consumes a massive amount of fuel at a high cost. The emission is an unclean energy source that harms the environment.

This paper proposes an improvement to design a system that can provide a demand for building loads at the lowest cost and maximum compatibility, and mathematical models are used for the components of the system in addition to meteorological variables such as solar energy and temperature. The purpose of this paper is to achieve the following in the improved design:

- Reduce cost.
- Regulation of energy consumption
- Reduce burden on Grid.
- Provide a clean, environmentally friendly system and a secure source of energy.
- Get the optimal size and capacity of the system.

II. Methodology

The following software tools are used to design and optimize a solar photovoltaic (PV) system for the faculty of engineering:

- Homer: This software simulates the system and determines the optimal configuration of solar panels, batteries, and other components.
- SketchUp: This software creates a 3D model of the building and the solar PV system to visualize the layout and ensure the system fits within the available space.
- PVsyst: This software calculates the solar PV system energy output and determines the size of the system required to meet the energy needs of the building.
- Dialux evo: This software designs the lighting system for the building and estimates the energy savings that can be achieved by replacing the existing lighting with more efficient fixtures.

These software programs are valuable for designing a solar PV system that meets the specific needs of the faculty of engineering building and the available solar resources. The software programs are also used to optimize the system's design to minimize costs, maximize energy output, and reduce the energy consumption of the building. In addition to the design of the solar PV system, Dialux evo software is used to design a more efficient lighting system for the building, which helps to reduce the overall energy consumption of the building and save money on electricity bills.

III. Results

The College of Engineering at Palestine Technical University – Kadoorie (PTUK) contains a PV system consisting of 96 cells; the system production capacity is 31.2 kWh, producing 39.4 megawatts per year. When adding 104 additional PV to the previous system with the same capacity as the previous cells (325 kWh), the production capacity of the added cells is 34 kWh, producing 56.16 megawatts per year. The total system produces 104 megawatts per year. The results from PV system are shown in the following figure as the old system.

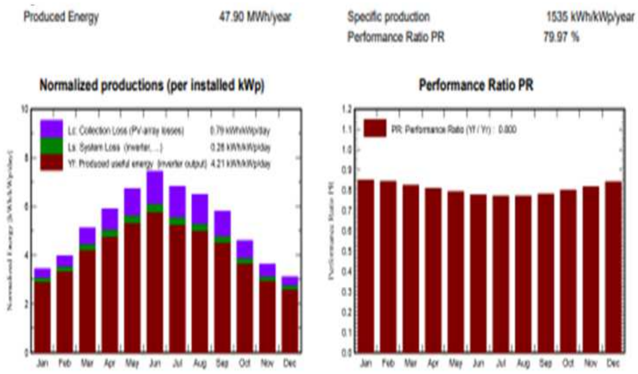

Fig. 1. Results from PVsyst for the previous old system.

Adding 89 PV panels with a capacity of 500 watts each to the old system is preferable to increase the annual energy production by 72 megawatts.

Adding the new 500-watt cells with an annual production of 72 megawatts to the old 30.8-kilowatt system with an annual production of 48 megawatts results in a total system with an annual production of 120 megawatts.

The floor plan of the College of Engineering building is uploaded in the SketchUp software to design a model with the actual dimensions on the ground, and the cells are distributed on the roof of the building according to the current plan and as shown in Fig. 3.

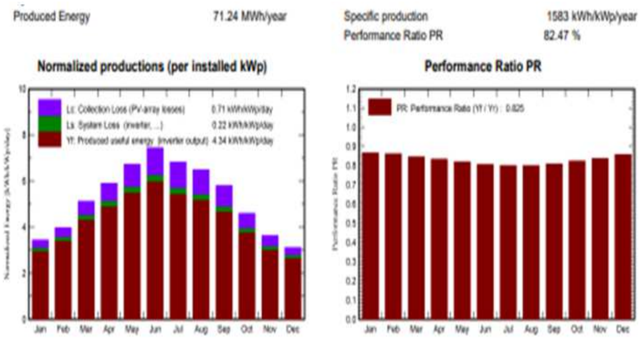

Fig. 2. Results from PVsyst for the proposed system.

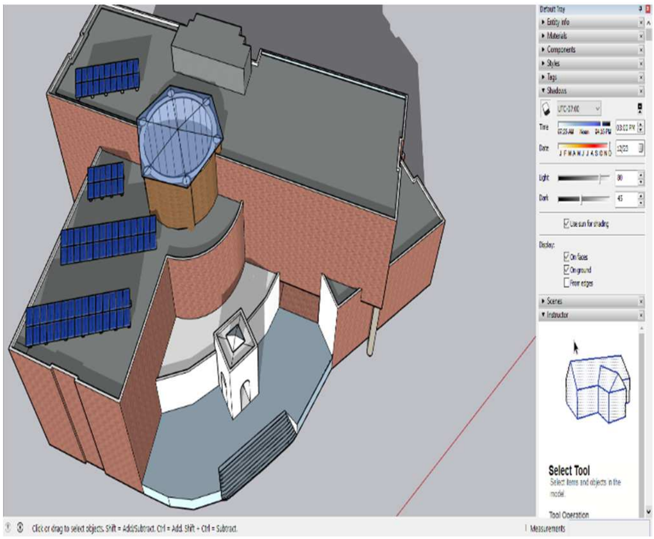

Fig. 3. Design of the old PV system on the roof of the college of engineering.

In the first stage, PV modules are added to the space on the roof of the college building, which seems possible to install an additional capacity of up to 32.5 kilowatts, with 100 modules with a capacity of 325 watts per cell as shown in Fig. 4 that is twice as the current project on the building. As a result, the proposed new project reached a capacity of 64.05 kW with 194 modules, achieving more building capacity with less electricity consumption.

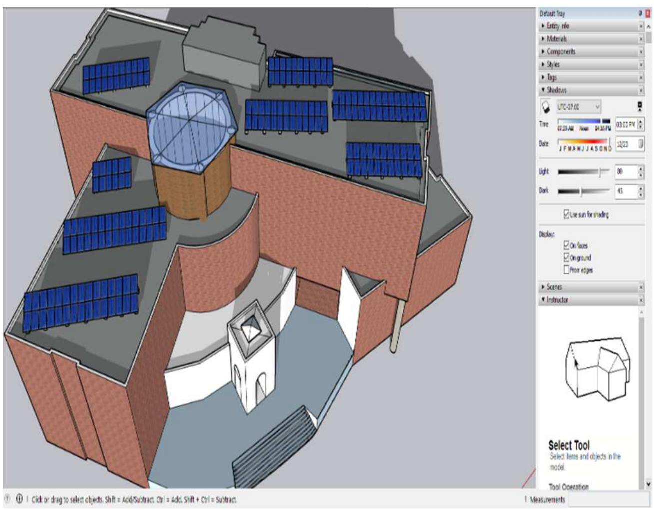

Fig. 4. The new PV system on the roof of the college of engineering.

In the second phase, PV modules are added to the space on the roof of the college building, which seems possible at this time to install an additional capacity of up to 40 kilowatts, with 80 modules with a capacity of 500 watts per cell as shown in Fig. 5. This proposal reached a capacity of 70.55 kilowatts with 174 modules.

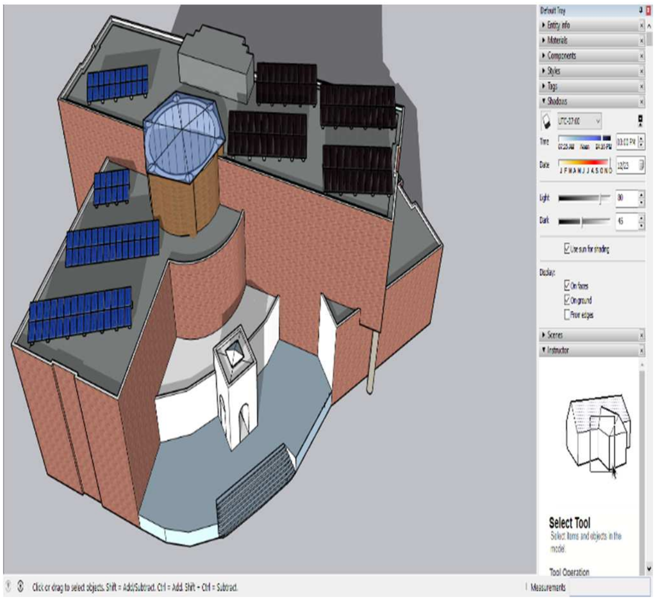

Fig. 5. The new PV system on the roof of the college of engineering (second phase).

IV. Conclusions and Recommendations

This paper proposes a new improvement method for designing and optimizing a solar PV system for the faculty of engineering at Palestine Technical University – Kadoorie. The method considers the maximum availability and minimum cost of system capital to achieve the optimal size of the photovoltaic (PV) power generation system. Various software programs are used to design and simulate the proposed system, such as Homer, to determine the optimal configuration of solar panels, batteries, and other components. SketchUp software: creates a 3D model of the building and the solar PV system to visualize the layout and ensure the system conforms to the available space. PVsyst: calculates the solar PV system's energy output and determines the system's size required to meet the energy needs of the building. The results show that the proposed system can significantly increase the annual energy production of the solar PV system at PTUK. Adding 89 PV panels with a capacity of 500 watts each to the old system increased the annual energy production by 72 megawatts, resulting in a total annual energy production of 120 megawatts. In addition to the increased energy production, the proposed system can also help reduce the cost of electricity bills for PTUK because the solar PV system can generate more electricity than needed to meet the building's load, and the excess electricity can be sold to the grid. Overall, the proposed system is a viable and cost-effective way to increase energy production and reduce the electricity costs of the solar PV system at PTUK.

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