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Supplying the Energy Demand with Photovoltaic Systems for Small and Medium-Sized Enterprıses

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Abstract **– Today, there are numerous small and medium-sized enterprises that continue their activities. These businesses, which want to increase profit margins, are going to reduce their costs every day by showing them wherever they operate. One way to reduce costs is to minimize the amount of electrical energy that machinery and equipment, which are among the basic costs of businesses, have spent. To reduce the amount of energy consumed, businesses often resort to ways of reducing the burden of businesses such as production, reducing the number of shifts, and shrinking. To reduce such problems to a minimum and to prevent businesses from resorting to different ways, the electricity needs that are among the basic costs of businesses need to be met with renewable energy sources. In this study, the average amount of energy required by photovoltaic systems and small and medium-sized enterprises was calculated and a photovoltaic system design for an ongoing operation was realized. In accordance with these calculations, the number of photovoltaic modules to meet the average energy requirement of the operator was calculated, and the appropriate battery, charging controller and inverter were selected. It has been determined that in order for an operator to spend an average of 55,000 watts a week to supply this energy, when the number of closed days is taken as 5 days, 10A-24V minimum capacity in the charge regulator, 27 batteries in 150Ah / 24V capacity, inverter with minimum 1kW power and a total of 38 (19 * 2) series connected panels are required on 2 parallel arms to be designed with an 80Wp polycrystalline silicon module.**

Keywords **– Photovoltaic, energy systems, SME.**

I. INTRODUCTION

Along with the increase in population, the energy demand also increases day by day. International energy politics is seeking to meet this energy need from different sources. The international energy agency states that energy demand will increase by 40% [1]. Reductions in energy resources and environmental pollution have made renewable energy sources compulsory [2]. The Kyoto protocol also aims to reduce dependence on fossil fuels [3]. States have accelerated their renewable energy work, taking into account these situations. Solar energy coming into the world plays a big role in eliminating this need. Various workings have been done in this area and various results have been achieved.

Fırat SALMANOĞLU and Numan ÇETİN have concluded that a hybrid system designed for the maritime province would be beneficial[4]. Emrah KIYANÇİÇEK, tried to reduce the installation cost of systems with PVS2 package program for dimensioning photovoltaic systems[5]. Dursun AYDÖNER designed a building model that produces its own energy in Istanbul region[6]. Huan-Liang and colleagues implemented PV cell, module and photovoltaic modeling in matlab program [7]. Reich and his colleagues simulated a photovoltaic model using CAD software[8]. Volkan KARACA and his colleagues examined the potential of sunbathing in Tokat province and implemented a photovoltaic system design according to a house energy requirement[9].

According to GEPA data, average annual sunshine duration in Tokat region is 6.75 hours[10]. In the context of data taken from GEPA of Tokat province, systematic system design has been realized for small and medium sized enterprises. Various calculations were used during the design process[11]. First, the average energy requirement of the business is calculated. In this direction, the required battery, inverter, charge regulator, PV panel was selected.

II. SYSTEM DESING

First, the average weekly energy requirement of the process is calculated. It was found that the business spent an average of 54950 watts of energy per week(Figure1).

Device	Average Power	Daily Working Time	Number	Energy Consumption	Weekly
Lighting	25	6	5	750	5250
Computer	100	12	1	1200	8400
Refrigerator	200	24	1	4800	33600
Microwave Owen	500	2	1	1000	7000
Other Devices	100	1	1	100	700
Total					54950

Fig. 1. The weekly energy used in workplace

Then then the average daily energy requirement is calculated.

Average Daily AC Load = 7850 Wh / day

Average Daily Energy Demand

E_L = 7850 / 0.58 = 13534 Wh / day

It was found that average of 13534 Wh of energy per day. When the system voltage is taken at 24 V, the average load current is found to be 23.49 A and PV size 83,54A.

I_L=13534/24.24=23,49A

I_{PV}= 24*23,49/6,75 = 83,54A

The multi-crystalline silicon module was used and the number of parallel modules was found to be 18.99.

I_{SC}= 4.5A OST80 multi-crystalline silicon module

V_{MP}= 15.5V multi-crystalline silicon mouüle

When we get 12V as nominal value, it was calculated that parallel modules are 2 pieces, total number of modules are 38 pieces, total module power is 3040 Wp.

The battery capacity account is shown below.

E_{bat}= E_L*Number of Closed Days/Battery Discharge Grade (DoD)

E_{bat}= 13534 * 5 / 0,7 = 96671 Wh.

Amper Hour Capacity = 4027 Ah.

When the 150Ah / 24V battery is selected, total battery capacity was calculated 4050kWh.

Parallel Number of batteries = 4027/150 = 26,8 => 27 pieces.

Serial Number of Batteries = 3 pieces.

Total Battery Capacity = 9 * 3 * 150 = 4050 kWh.

The total power of the devices operating at the same time was taken into consideration when the inverter was selected(Figure2).

Device	Average Power
Lighting	25
Computer	100
Refrigerator	200
Microwave Owen	500
Other Devices	100
Total	925

Fig. 2. Total power of devices

Since the total power of the devices running at the same time is 925 Watt, it meets the requirements of the 1kW inverter system. With I_{SC} = 4.5A and 19 parallel modules, the system can deliver a maximum of 85.5A. For this reason, charge regulator with the condition of voltage 24 V should be selected with minimum 10A with 3 parallel connected batteries in 9 parallel lines. It is possible to separate the PV modules into groups and use a charge regulator with lower power and the voltage does not change.

III. Conclusion

In this study, firstly the energy required by an operator was calculated. In this context, a grid-dependent photovoltaic system design has been realized. When the design was realized, the average sunshine data of Tokat region was used from GEPA. It is hoped that the work will be carried out in the future. As a result, a design for a company located in the province of Tokat has been realized. The system is designed to be installed in an operation that consumes 55 kWh energy. The number of days off was taken as 5 days. In this case, it is determined that a minimum capacity of 10A-24V is required for the charge controller and 27 batteries for 150Ah / 24V capacity. In addition, it has been determined that a total of 38 (19 * 2) series connected panels are required on 2 parallel arms to be designed with invertor that minimum 1kW power and 80Wp multi-crystalline silicon module.

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