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Proposal of a solar photovoltaic energy system for charge electric vehicles

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Abstract: The growing energy demand, environmental problems and the depletion of fossil fuel sources make renewable energy sources an alternative to solve this problem. This paper presents a proposal for a system capable of supplying the electric power necessary for the operation of an electric vehicle type e-trike. The system is integrated by 4 photovoltaic panels, regulator, batteries and inverter. The electrical circuit of the photovoltaic installation was also designed with the Proteus program, which allowed to simulate the correct operation of the proposed system.

Keywords: Solar energy, photovoltaic system, electric vehicle.

I. Introduction

At present, the generation of electrical energy depends mainly on the available fossil resources and the possibility of access to the electricity network (Rosso & Kafarov, 2015). The development of the populations has depended strictly on the capacity to use fossil fuels to obtain energy, which has caused a great negative impact on the environment with respect to the emissions of carbon dioxide in the atmosphere (Ben & Ben, 2017; Ghasemi et al., 2016). From this environmental problem has arisen the Green Economy concept which has been gaining much importance among academics and policymakers regarding issues of energy production (Gasparatos, et al., 2017; Cao et al., 2017; Salamanca, 2017).

Solar energy is an option for the future of humanity because it is the most abundant resource of renewable energy (Kannan & Vakeesan, 2016). Solar energy reaches the earth in the form of light and heat. Most of this energy is lost due to scattering, reflection and absorption by clouds. Studies have shown that global energy demand can be provided by solar energy (Lewis, 2007; Lúcio et al., 2016). Another reason why solar energy is the energy of the future is that its use does not have any harmful impact on the environment and does not affect the balance of ecosystems, compared to the case of the exploitation of fossil resources that clearly cause a lot damage (Kannan & Vakeesan, 2016; Ghasemi et al., 2016; Lúcio et al., 2016; Salamanca, 2017).

Mexico ranks as the fourth most attractive country in the world to invest in photovoltaic solar energy projects, after Australia, Singapore and China, respectively. The average solar radiation that Mexico receives is 5.5 kWh / m², having its highest point in the northwestern zone of Mexico, receiving 5.78 kWh / m² on average in Ciudad Juarez. According to the National Inventory of Renewable Energies (INER), Mexico has the resources to generate renewable and clean energy, and has the proven potential to generate more than 16,161 GWh of electricity annually. The federal government aims to achieve that 35% of the country's energy comes from clean technologies by 2024 (Espinoza et al., 2015).

Photovoltaic solar energy is a source of energy that produces electricity from renewable sources obtained directly from solar radiation by means of a semiconductor device called a photovoltaic cell, or by deposition of metals on a substrate called a thin-film solar cell (Aguilar, Aledo, & Quiles, 2016; Salamanca, 2017). In recent decades, photovoltaic systems have become a form of effective electric power production, especially in places with good radiation (Yahyaoui et al., 2015), thanks to its easy installation and post-installation maintenance it is low cost, which allows photovoltaic systems to be used more frequently (Abella, 2016; Salamanca, 2017).

In research conducted by various authors (Olaya, Arango & Larsen, 2016, Islam et al., 2016, Salamanca, 2017), these focus on the development of photovoltaic technology works for the supply of energy; In addition, after the energy crisis of the 1970s, public interest in the application of photovoltaic solar energy as an alternative source of electricity increased. The automotive industry has changed its perspective towards energy efficiency and the use of renewable energy sources (Pinzón et al., 2016, Schoettle & Threin, 2000), due to the pollution caused by the use of fossil fuels. The new electric vehicle systems are driven by the need for fuel economy and the reduction of pollution. As well as the new conditions of improvements in: safety, comfort, reliability and autonomy (Monroy et al., 2017).

This paper presents a proposal for a system capable of supplying the electric power necessary for the operation of an electric vehicle type e-trike.

II. Methodology

The methodology followed for this project is based on the research proposed by several authors (Guacamene *et al.*, 2018, Pérez, 2018, Bugallo *et al.*, 2017, Espinoza *et al.*, 2015, López *et al.*, 2016; Fajardo & Osorio, 2014) in which the calculations are made for the month in which the system will have its worst performance, consisting essentially of the following points:

Estimation of consumption: In this step, the energy that will be needed daily by the station is determined. Since it is possible that alternating current and direct current devices are fed, an estimate of both cases must be made.

Calculation of the optimal angle of inclination of solar panels: Although a panel has the ability to generate electricity in the absence of direct sunlight, it is intended to be directly captured, which together with an appropriate orientation of the panel allows us to have a maximum use of the resource. It is recommended to orient the panel to the south if the location of the system is in the northern hemisphere and orient it to the north if it is located in the southern hemisphere. It is essential to calculate the optimum angle of inclination, to know which month presents the worst scenario regarding the amount of sunlight that can be captured, considering not only the low insolation, but a possible high energy demand, because it is for this worst possible scenario that the system is designed.

Dimensioning of the accumulation system: To dimension the accumulation system, the maximum depth of discharge must be considered, which is the maximum discharge level allowed for the battery before the regulator is disconnected; Days of autonomy (D), are the number of days that the system must be able to operate when there is no sunlight and the overall factor of installation performance (R).

Dimensioning of the photovoltaic generator: Due to the possible energy losses that may occur in the system, it is necessary to consider a generation higher than the estimated consumption. It is considered that up to 10% of the energy produced is lost when dissipating in the regulator, same energy that will not be converted into useful energy.

Dimensioning of the voltage regulator: The dimensioning of the regulator is intended to obtain the maximum current that will flow through the station safely. The current intensity that the generator produces is the sum of the intensities produced by each of the modules when operating fully.

Dimensioning of the inverter: It is important to consider that the input voltage in the inverter will not always be constant, therefore, to counteract variations in voltage in the inverter, it has a range of 15% tolerance. The investor will be defined taking into account the power that the system demands.

Dimensioning the wiring: In the dimensioning of the wiring it is important to consider the length of the cables, this due to the losses that may be suffered by the Joule Effect, always looking for the shortest possible lengths, in order to improve the voltage drop and that the resistance of the wiring is minimal. The relationship between the section and the length of the cable.

For the simulation of the proposal system we used the Design Suite, an electronic design automation software, developed by Lab Center Electronics Ltd., which consists of the two main programs: Ares and Isis, and the VSM and Electra modules.

III. Results

The main properties of the vehicle were identified for later with the necessary information to select the appropriate system. The solar energy system consists of photovoltaic panels, regulator, batteries and inverter, as can be seen in Figure 1. These elements are briefly described below.

Photovoltaic panel: It captures the solar radiation to later convert it into electrical current through photovoltaic modules.

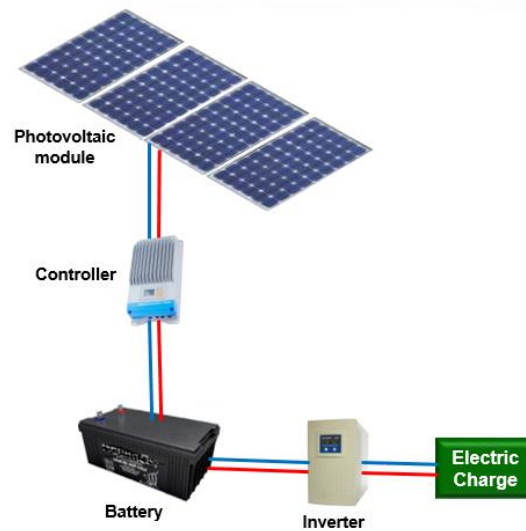
Batteries: They store the electrical energy generated to be later used in periods when the demand exceeds the capacity of the photovoltaic generator.

Controller: The charge controller automatically reduces, stops, or diverts power when the batteries are fully charged.

Inverter: Responsible for transforming the direct current produced by the photovoltaic generator into alternating current.

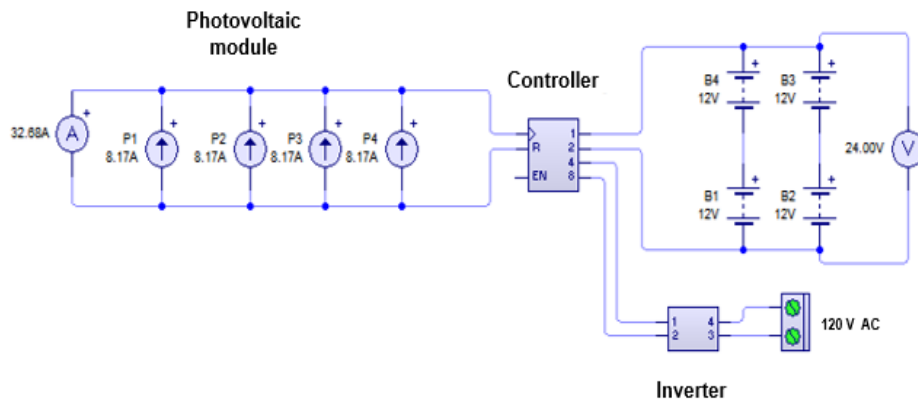
Although the charge will be made directly from the controller, the inverter is included to be able to take advantage of the energy at some time that is necessary. The calculation of the number of panels needed for this system allowed to determine that there are 4 of 250 W, poly-crystals of 30.6 V and 8.17 A. To meet the needs of the vehicle whose power consumption is 1000 W an array of 2 is required. batteries connected in series 89 Ah 12V that provides 89 Ah to 24v, and from this arrangement is generated another equal but connected in parallel, it throws as a result a battery bank of 24v and 178 Ah. This allows determining that the maximum discharge time of the battery bank will be 2.1 hours using the vehicle at its maximum speed.

Figure 1: Proposal for a photovoltaic system.



The load controller was calculated with the same number of panels and the comparison was made to select the best option. Therefore, a 40 A controller was selected, in this case the 40 A MPPT40 with a load time of 5.44 hours. For the structure a fixed structure was determined, which allows positioning it on the roof of a building. The electrical circuit of the photovoltaic installation was also designed with the Proteus program (Figure 2), which allowed to simulate the operation of the system with the solar panels, battery bank, controller and inverter.

Figure 2: Simulated system with Proteus software.



IV. Conclusion

A proposal was generated for a system capable of supplying the electric power necessary to charge the batteries of a solar vehicle, for which a solar cell sizing methodology was selected.

The simulated results with Proteus, allow observing that it is possible to implement a system of solar panels with sufficient capacity to supply the total energy demand of the electric vehicle in question.

The selection of each element of the system was made, being composed of 4 poly crystalline panels of 250 W of 30.6 V and 8.17 A., a controller of 40 A and the batteries of 89 Ah.

V. References

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