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Design of A Photovoltaic Installation for A Maintenance Workshop, in Chone Canton, Ecuador

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Abstract

With the passing of the years and until today we are and continue to Dependent on fossil fuels, since electrical energy is the most used resource in the world, it becomes the main reason and the alternative to not depend on fossil resources. The importance of electricity could be considered of vital use, with it comes the development of society, the services that are provided lighting, food refrigeration and the use of some equipment that facilitate daily living are essential. For the development of the research, the desktop research method was applied where different types of bibliography and databases are consulted, in addition to the PvSyst 7.1 software, for the calculation and design of a photovoltaic solar installation for 5 kW, obtaining as results the design of a photovoltaic system to reduce demand during daytime hours.

Contents

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1 Introduction

In America we work to achieve energy sustainability, there are agreements between countries to improve energy efficiency. In Ecuador for the year 2020, the energy demand was 80% generated by hydroelectric plants, achieving with this that the majority of thermal power plants have gone out of operation, achieving reductions in COemissions2 (Society, 2021). In Ecuador, awareness is being raised about the need to venture into more extensive and efficient use of renewable energies available in the territory, knowing that it is in the solar belt, these are attractive regions for purposes of photovoltaic use (Interempresas, 2021). In America, many renewable technologies can be taken advantage of as they are countries that present all the potential of the FRE (Estrada, 2013), for which their territory is in both hemispheres, they are countries that are richer in renewable resources, depending on the geographical situation in the one found.

Ecuador, due to its location, is a country with an excellent solar resource. The daily irradiation (annual average) on a horizontal surface is greater than 4.0 kWh / m2day, throughout the national territory and in some places, it is greater than 5 kWh/m2 day (Rodriguez & Vázquez, 2018). Its geographical division due to its geographical diversity is divided into four regions The Coast, between the Pacific Ocean and the mountain range, the Sierra, the East, or Amazon, east of the mountain range, and the Insular Region or Galapagos, in all its regions there are various applications of the solar potential. Regarding the types of energies that have their technological advance within the country and that even though they are still depending on fossil energy sources, if there is a technological advance, it is hydroelectric plants that have been fundamentally introduced in the Sierra and Amazonia (Maruri, 2012).

The radiation from the sun can be divided into three, direct solar, diffuse and global, the latter is the amount of total radiation that reaches the horizontal surface of the earth at an angle of 180 degrees, the result of the vertical component of direct radiation plus diffuse radiation (Wid & Munkhammar, 2019). The application of renewable technologies is necessary for many of Ecuador's regions to maintain environmental quality, in such a way that this research proposes a self-consumption system that is as economical as possible, ensuring that the equipment has high efficiency, what is proposed is the selection of the different devices carefully to ensure that they are adequate to ensure a good operation of the installation. The evaluation and development of renewable energies must be carried out in a context of territorial ordering and planning, here the Geographic Information System (GIS) is a necessary tool for this purpose.

2 Materials and Methods

A bibliographic search was carried out to know the facilities that are currently operating that generate energy with renewable sources of energy, in addition to the desktop research, for the design of the photovoltaic system the PVSyst 7.1 software was used, where it was possible to determine the number of emissions that are no longer discharged into the atmosphere.

3 Results and Discussions

Manabí has renewable energy potentials, it has more than 11 rivers, many with high flows, others very small, but which can offer enough energy to be used in an isolated house. Currently, they maintain the reservoirs such as: La Esperanza, Poza Honda, Proyecto Multiple Chone, and Daule Peripa, in figure 1, the Poza Honda dam is shown.

Figure 1. Poza Honda Dam- Santa Ana- Manabí
Source: (Goraymi, 2021)

The Poza Honda dam represents an energy source for the Santa Ana canton and the development of the Manabí province, it provides the country with the potential of this energy, estimating the amount of 22,000 MW that can be technically and economically usable, currently, only 20.21% has been used. The main source of this renewable resource is the Andes Mountain range, where important water systems emerge with slopes towards the Pacific Ocean and towards the Amazon (Eichler & Stöhlker, 2007; Wang et al., 2020; Sarafianos et al., 2013). Photovoltaic solar energy is an inexhaustible source, obtained from the use of electromagnetic radiation from the Sun, in the province of Manabí, at the site "El Aromo" is a new electricity generation project that will be developed, it is a project that will take advantage of solar radiation through the use of photovoltaic technology as a grid-connected system to generate electricity (CELEC, 2021).

The plant will be in the El Aromo sector, 20 kilometers from Manta, on the land that was acquired for the construction of the Pacific refinery, for the development of this project investment of approximately 200 million dollars is expected, the same that will come from private capital. The energy of this plant will be connected to the National Interconnected System through the San Juan de Manta 230-thousand-volt substation, which is already under construction by the Electricity Corporation of Ecuador, through the trans electric business unit, with an investment of USD 40.7 million (CELEC, 2021). Figure 2 shows the area where the project will be developed.

Figure 2. El Aromo
Source: (CELEC, 2021)

As observed in the area, it will be the first of these characteristics in the country, it will have an installed capacity of 200 Megawatts, which is equivalent to 60.6 percent of the energy it consumes in the city of Manta or 23 percent of the province of Manabí.

Wind energy

Subsection should be written without a bold type. The result and analysis are presented in the present form. Please avoid too many paragraphs in this section. The movement of air masses induced by the heating of the masses by solar radiation is used to generate electrical energy, for this, wind turbines are used, which move a turbine and manage to transform the kinetic energy of the wind into mechanical energy (Chen et al., 2009; Luo et al., 2015; Azadeh et al., 2007). In the country, the commitment to change the energy matrix stands out. In October 2007, the Galapagos Islands wind farm was inaugurated on San Cristóbal Island, with installed wind power of 2.4 MW and estimated annual production of 3.2 GWh (Reve, 2010).

In Ecuador, the Villonaco Wind Power Plant, operated by the Corporación Eléctrica del Ecuador –CELEC EP, through the CELEC EP - GENSUR Business Unit, is the power plant located in the continental territory with the highest power that has contributed to the National Interconnected System (SIN) with 525,849.50 megawatt-hours (MWh) of energy, this represents the decrease in the emission of 337,647.96 tons of CO2 to the environment (Soto, 2021). Figure 3 shows the location of the Villonaco wind power plant, is located between the cantonal limits of Loja and Catamayo and it is precisely the difference between the height and temperature of these two towns, which generates air recirculation at the local level and hence the high wind speeds at the site.

Figure 3. Villonaco Wind Power Plant Source: (Celec Ep)

According to data from the SCADA system of the Villonaco Power Plant, this June 15, 2020, the winds reached speeds of 16 meters per second (57.6 km/h), which allowed the plant to generate at its maximum capacity, that is, 16.5 MW of power (CELEC, 2020).

Biomass

Energy from biomass is relevant, it is based on components and organic waste that can be found in any part of the territory, two groups are defined within it, those that go through a process to obtain fuel and those that are used as caloric energy in a job. In the country, it is very abundant, but due to being a developing country it is not yet exploited as it should, fundamentally the biomass of agricultural residues such as bananas, coffee, cocoa, flowers, corn, rice husks, potatoes (Roldan et al., 2015).

In an agreement between the different Ecuadorian ministries such as production, pre-investment, and electricity, they promote through the Bioenergy Atlas of Ecuador, which classifies and takes into account the updated information on production concerning biomass. Figure 4 details the location and amount of residual biomass available by canton and its respective energy potential for 10 crops (banana, rice, cocoa, sugar cane, corn, African palm, pineapple, coffee, hearts of palm, and plantain). 3 livestock activities (poultry, swine, and cattle) and forestry. Studies of this type have been carried out in some areas of the province of Manabí (Carreño et al., 2020).

Figure 4. Ecuador Bioenergy Atlas
Source: (Morquecho, 2018)

The country's bioenergy atlas is observed, the main current use of biomass being biofuel, which the government is implementing at the national level. Since 2010, biofuels called Ecopaís have been produced, this fuel has been replacing the conventional one, covering 45% of the gasoline demand of the entire territory (Morquecho, 2018).

Design of a photovoltaic system for self-self-

Photovoltaic consumption without batteries connected to the grid is an economical solution to save on your monthly electricity bill, these solar kits are designed to cover office areas and other applications where it is required to reduce demand in the daytime, these in many cases improve the power factor (Perzon et al., 2005; Pillai & Green, 2010; De Blas et al., 2002). The technical, economic, environmental, and social studies determined that the Bay Pass sector of the Chone canton, Manabí province, is the most suitable place to develop this project. The software was PVsystused. 7.1 (PVsyst, 2021), through this the meteorological characteristics and geographical location of the site in which the design was carried out were obtained, through the study the solar kit can be adapted and implemented. Within the general data of location, limits, and territorial division. The Chone canton is located in the northern part of the Manabí province. The climate is hot and dry in summer, from June to November, and warm rainy in winter, from December to May. The temperature has high variations during the year that can go from a minimum of 22.8 ° C to a maximum of 33.7 ° C, this is due to the geography and location of the canton.

The hydrographic network of the canton is made up of rivers whose lands are subject to flooding due to the presence of intermittent estuaries, ponds, and lakes. The location, topography, and physical structure of the canton determine the natural hazards that can affect it, particularly in Chone it is exposed to natural events such as floods, earthquakes, and landslides (Molerio, 2018). These data indicate that for the design of the systems, the risks that could affect the implementation of FRE were evaluated in the same way, it is added to the information of threat of natural origin so that if it is not affected it should be prevented according to the requirements within the risk zone (Florent & D'ercole, 2001). The design project was developed in a fast mechanics workshop that has state-of-the-art technology to vehicle maintenance, a task that goes from alignment to repair, replacement, and counterbalance of tires, in its first stage only the part is considered lighting and force applied to computer equipment since it is based on a power of 7 kWp.

Applying the software PVsyst. 7.1, are directly detailed and their application for an adequate and required design under the specifications and construction standards to arrive as shown in figure 5 for the autonomous type of model for the corresponding land area. This software does not allow us to choose and select the required inverter, using the calculations it executes, it shows us the alternative for the indicated power, the configuration of the design of the number of modules in series, and the number of the chain in which the modules are grouped (Sarzynski et al., 2012; Velilla et al., 2019; Santosa & Yusuf, 2017). The simplified connection scheme, such as the formation of the photovoltaic assembly, the same device that changes or transforms an input voltage of direct current to asymmetrical output voltage of alternating current, with the magnitude and frequency desired by the user or the designer. Once the desired voltage is obtained, which is

the load in which the user can use according to the configuration he has, in this case, it is self-consumption as shown in the simplified diagram of the figure.

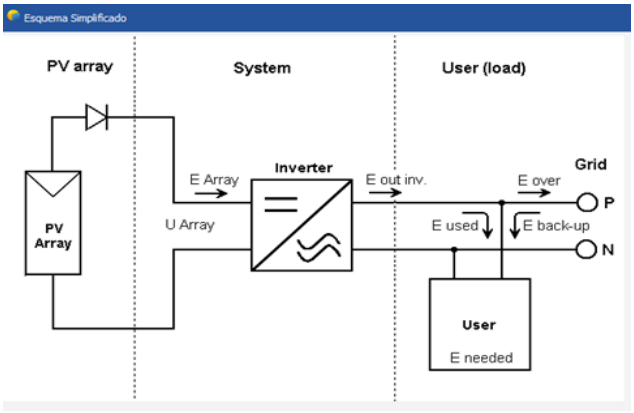

Figure 5. Simplified diagram of the photovoltaic system
Source: (PVsyst, 2021)

Within this software, it is possible to see the simulation parameters, such as the daily input and output concerning the available solar energy given globally in the receiving plane according to the inclination given in kWh/m^2/day. The proportion of the performance index programmed for each month of the year, it is also possible to observe the power output distribution of the system, that is, the energy injected into the network (van Noortwijk & Frangopol, 2004; Bokrantz et al., 2017). It is also obtained how the temperature is found or behaves vs effective irradiation, during its operation, it is also illustrated by its flow diagrams the losses concerning the system, this to keep in mind if this system despite its investment is It would be profitable, in addition to the amount of energy injected into the grid. But the most outstanding thing of all is to know-how by applying a design applying the FRE, it is the environmental part how much the balance of CO_2 emission is made of the total that is in the environment vs the reduction when implementing a design. See figure 6.

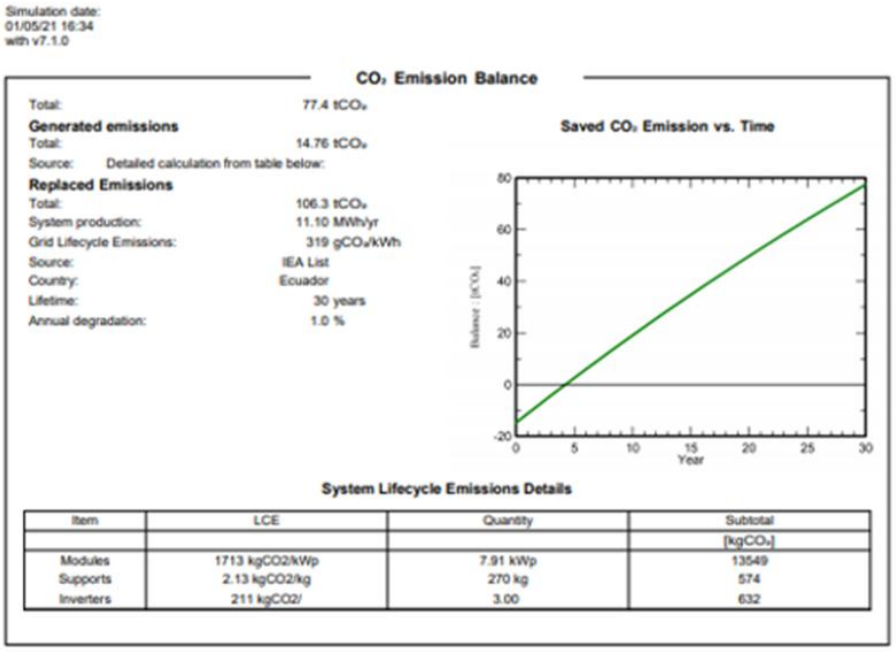

Figure 6. CO_2 emission balance of$_2$ the photovoltaic system
Source: (PVsyst, 2021)

In economic terms, a more in-depth analysis must be carried out, considering the cost of energy produced by a photovoltaic system in Ecuador is USD / kWh 0.1342 with the discount rate of 7%, the CF (capacity factor) = 15%, while with the discount rate of 10%, CF = 20% the cost of energy reaches USD / kWh 0.1229. The initial investment is high due to the high costs of these systems in Ecuador, and the profitability of the project changes completely between a solutions only for self-consumption, versus the option of self-consumption plus energy sales.

4 Conclusion

A photovoltaic system for self-consumption was designed in a maintenance workshop with the fundamental objective of reducing demand during daytime hours, in addition to taking into account the natural risk factors of the area, in addition to obtaining the amount of CO_2 emissions that they are stopped broadcasting with the system running.

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