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Photovoltaic System Implementation in Baltra and Puerto Ayora Islands: Socioeconomic and Environmental Impact

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Abstract

In the research, an analysis of the impact of the photovoltaic systems installed in two islands of the Galápagos archipelago is made. In this sense, a series of calculations has been used to find the significant values that have allowed us to choose the specific devices for this project. A modeling study was analyzed to quantify the total energy of the system, the number of possible modules to be installed, the amount of energy to be stored according to the type of batteries and the ampere-hour (Ah) that the regulation set must support of the electric current. The socio-economic and environmental impact of the system on Baltra Island was assessed with an example and estimations to make it explicit, the results of the surveys used are shown through which the most significant results were exposed, exposing that the photovoltaic systems in stage of implantation do not affect the environment, flora and fauna, its greatest impact is in the use of land.

Contents

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1. Introduction

Energy has always been a fundamental element in the development of human society, after the industrial revolution, humanity focused on oil, but nowadays pollution, the greenhouse effect, climate change, forces us to look for new sources clean energy to meet our needs. Today in the day, photovoltaic solar energy makes the object of great interest. While the production of electricity with the photovoltaic system is progressing due to the decrease in the cost of purchase and manufacturing of solar panels (Rubio, 2016).

In this sense, solar energy developed in the 1950s and is now one of the most widely used sources in the world. Its technology was discovered in 1839 by members of a family of French scientists, Alexandre Edmond Becquerel son of Antoine César (who collaborated with Ampere and Biot in the study of electricity), discovered the photovoltaic effect in 1939 (Oviedo-Salazar, 2015). And it is his son the physicist Antoine Henri Becquerel who presented him publicly to the academy of sciences at the end of the year 1939 (Mauguit, 2015). His story continued with Albert Einstein's work on the photoelectric effect, published in 1905, and the development of a Jan Czochralski process to produce monocrystalline silicon purified in 1918 (Sánchez, *et al*., 2018). It is in 1954 that the American researchers Gerald Pearson, Darryl Chapin and Calvin Fuller working for the Bell laboratories managed to develop a solar panel that presented a performance of 6%. These cells were composed of "doped" silicon whose interest was discovered in 1939 by Russell Ohl (Jiménez, 20).

The photovoltaic industry finally took its flight thanks to the space search and the explorations carried out by the way to improve the power supply of the satellites (Yveth, 2011). Since the 1990s the production of solar panels for private (domestic) or industrial use has been made exponentially due to the increase in energy demand, climate change and the level of COincrease2 in the atmosphere. In recent years scientists and politicians presented solar panels as an ideal, ecological source of electricity production. From this fact, many countries such as Ecuador with the impulse of their government are implementing projects to take advantage of this technology ("Renewable energy and community tourism: a joint commitment to the sustainable human development of rural communities," 2014). The Ecuadorian state concerned about the ecological, economic and social viability of the activities in the Galapagos archipelago Islands has expressed the need to adopt measures and implement actions to prevent habitat degradation and the ecological impact on the delicate balance of the species that They coexist in the Galapagos National Park and the Galapagos Marine Reserve.

The project achieved the reduction of carbon emissions, replacing the energy that came from fossil fuels with renewable energy, mainly wind, integrated with other alternative systems such as solar and biofuels. The conceptual development of the initiative "Zero Fossil Fuels for Galápagos (was also supported (Zorrilla, 2016). In this way a real and effective commitment to the sustainable development and conservation of Galapagos is assumed, it was decided to start the Zero Fossil Fuel program in Galapagos, under the objective of eradicating the use of petroleum-derived fuels from the Archipelago (MEER, 2016). The project consists of the implementation of a 200 kWp photovoltaic system for the Baltra island and 1.5 MWp for the Puerto Ayora island. The study in this document will focus on the implementation of the socio-ecological and environmental impact of the photovoltaic system on Baltra Island and Puerto Ayora.

A similar study was carried out at the Loja wind farm (Hernández, 2018) and other investments made in that province were taken into account, which is developing a strategy of diversification of renewable energy sources as a policy of the provincial government.

2. Materials and Methods

The objective of this research work is to study the data prior to the implementation of photovoltaic plants in the Baltra and Puerto Ayora islands of the Galapagos archipelago. In order to know what is happening, the solar GIS program (Solargis, 2018) was used to have geographic data, some books, a computer and the internet connection that helped us to search, to read, to see documentaries about manufacturing companies. the solar panels, to download the theses (masters and doctorate) related to the subject to enrich our database and take advantage of the laboratory experiments already done. As a statistical methodology, the quantitative technique was applied to quantify the data found during the investigation. Work surveys were used to collect precise data on the subject of the research study. The students and professors of the physical and mathematical department of the Technical University of Manabí were chosen as a population and as 21 sample people composed of 5 teachers and 16 students.

3. Results and Discussions

It was obtained as a result of the surveys that 85% of the survey population knows that the production of photovoltaic panels and their implementation help to improve the ecological problems caused by the generation of energy with other sources. We inquired about the aspects that cause damage to fauna and flora in the manufacturing process of solar panels (from the extraction of its components to use), in figure 1, a graph is shown where it is observed that the 70 % of the sample responded that the solar panels in the manufacturing process cause a small impact on the emissions, 20% consider that it impacts less and 10% responded that the impact is high.

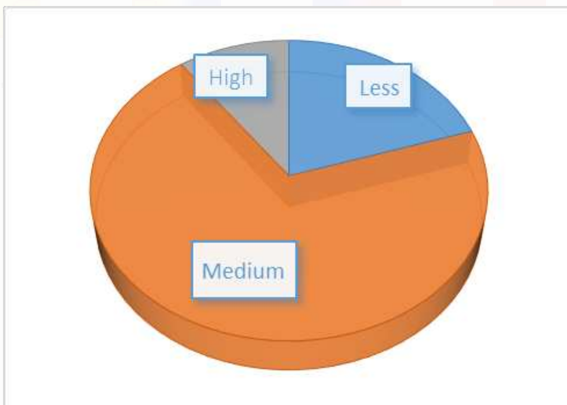

Figure 1. Impact on the manufacture of photovoltaic panels questionnaires

A question was asked about Energy the type of energy that would guarantee a better balance in the environment without affecting the flora and fauna. Figure 2 shows the results obtained showing that the 55 % of respondents agree that solar energy is the one that achieves greater balance in the environment and therefore less impact on flora and fauna.

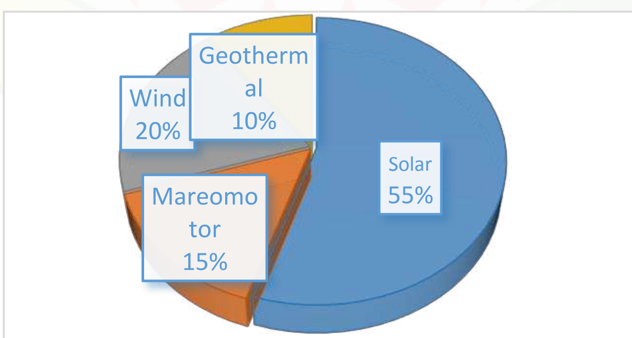

Figure 2. Type of energy that achieves more balance with the environment

Solar energy is derived from the sun and can be exploited by transforming it in two ways: in the form of heat it is called solar thermal energy and to produce electricity it is called photovoltaic solar energy, in figure 3 it is observed isolated here the energy that comes from the sun is transformed by the photovoltaic cells and stored to be used for water pumping, telecommunications repeaters, public lighting and lighting inside homes, light bulbs, use devices such as radios and televisions, and take advantage of low-energy appliances (Jain, *et al*., 2017). In addition, different power stations can be designed and land studies evaluated (Arafet, 2014) and feasibility to make different investments.

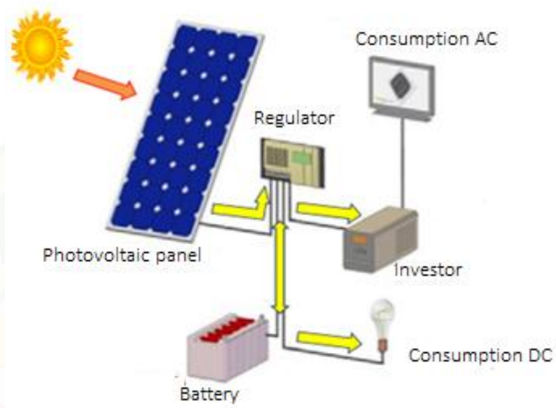

Figure 3. Isolated photovoltaic solar

The system that is installed in the Baltra Islands and Puerto Ayora is a larger system installed by the Ecuadorian state concerned about the ecological, economic and social viability of the activities in the Galapagos Islands, with the objective of adopting measures and carrying out actions to prevent habitat degradation and the ecological impact on the delicate balance of the species that coexist in the Galapagos National Park and the Galapagos Marine Reserve.

In this way, a real and effective commitment to the sustainable development and conservation of the Galapagos Archipelago is assumed as a protected area, where a strategy on zero fossil fuels was implemented with the objective of achieving the objective of eradicating the use of derived fuels from the archipelago. of the oil. The project consists of the implementation of a 200 kWp photovoltaic system for the Baltra island and 1.5 MWp for the Puerto Ayora island (Billaiya, *et. al*., & Jain, *et al*., 2017).

Modeling of the Baltra plant

The data was used on the SolarGIS and the Galapagos archipelago. On the island of Baltra, 200 kWp is installed with an energy input of 0.85 GWh / year.

Socio-economic impact

The demand for each dwelling was assessed, if a house contains: 6 60 W spotlights (12 hours a day), 1 70 W television (12 hours a day), a 300 W refrigerator (12 hours a day), 1 1500 W washing machine (running 0.125h daily), 2 computers of 60 W each (running 6 hours a day), 900 W air conditioning (running 6 hours a day), 1 1500 W oven (running 3 hours a day). The total energy will be:

$$E_T = \frac{C_T}{Kp} = \frac{2.33*10^6 wh/dia}{0.75} = 3.11 * 10^6 wh/dia$$

The total energy consumed in the luminaires (ETL) was calculated) and taking into account that the ET is generated, the total available energy was calculated using equation (1).

With the Baltra plant you can feed:

$$E_{TD} = E_{TBaltra} - E_{Tluminaria} \quad (1)$$

Obtaining as a result that the available energy is 2188400Wh / day

For the calculation was used for the number of dwellings connected to the plant the equation (2)

$$Nv = \frac{E_{TD}}{E_{Tv}} \quad (2)$$

Obtaining as a result that the plant can power 103 dwellings with 300 daily public luminaires autonomously with a 7-day autonomy. But the only problem is the cost of the infrastructure knowing that one panel costs 295 euros for 2819 panels = 831605 euro = 969901 dollars only for the panels without taking into account the price of the batteries that are more expensive, the supports (of the modules), the system of protection, control, transport of energy and distribution. This system is expensive but during its transformation process, the energy does not pollute the environment.

Environmental

The impact of a photovoltaic plant as such is found in the process of extracting and transporting primary materials, transforming and producing the elements and appliances, and the quality tests that the devices must comply with. For the example studied of the environmental impact, it is analyzed in the imports of the equipment and tools, the transport to the place of installation, the energy consumed during the process of assembling the photovoltaic plant (Zorrilla, 2016). Especially in the Baltra plant, the most significant impact is the surface of the ground where it was installed, because it was necessary to cut the trees and transform the vegetation of the installation site.

This study is presented in the context of a desire to bring a more clear, reliable photovoltaic sector that grows rapidly and already represents a more or less considerable part of electricity on a world scale, its main objective is to study, the implementation of the photovoltaic plants in Galapagos in order to reduce the environmental impact and offer the energy autonomy to the archipelago due to its location and the importance of the site as an ecological reserve. This technology installed in Baltra can stop emitting to the atmosphere a 1516.9 t CO2. Amount of carbon in a year of operation calculated using the method proposed in (Gámez & Pérez, 2018) using equation (3).

$$ECO_2e = Epg + Pev \cdot IECO_2 \quad (3)$$

Where:

Epg → Possible energy to be generated daily with the estimated photovoltaic capacity kWhday
IECO2 → Index of CO emissions2 in the generation of electricity.

4. Conclusion

These results show that the environmental impact can be assessed by having different aspects in the proposed technology. The latter can contribute to the reduction of the global warming process of the planet, the experience can be replicated not only in the Galapagos Islands; but in all the places where there is the presence of solar energy.

To take into account the socio-economic impact of investments, it can be stated that there are benefits on the island when generating electricity without polluting its environment, without noise, above all it offers energy autonomy. The Baltra plant has the capacity to power energetically 300 public luminaires and 103 homes every day 24h / 24h and in the day the energy available for the luminaires will be available a total of E_T = 921600wh / day that can be used to power an energy health center or some schools.

Instead, its environmental impact is related to the manufacturing process that consumes too much energy and there are toxic gas formations and the greenhouse effect. But a plant already installed does not produce any dangerous health effects, only when the plant is being built must the trees be cut on the surface of the ground where the plant will be installed.

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