International Journal of Physical Sciences and Engineering
Available online at www.sciencescholar.us
Vol. 4 No. 2, August 2020, pages: 14-25
e-ISSN : 2550-6943, p-ISSN : 2550-6951
https://doi.org/10.29332/ijpse.v4n2.443

Sustainable Development and Renewable Energy Sources in Milagros Community

Jean Pierre Mera Bravo[a], **Guillermo Antonio Loor Castillo**[b], **Wilber Manuel Saltos**[c], **Lenin Agustín Cuenca Alava**[d]

Manuscript submitted: 18 June 2020, Manuscript revised: 27 July 2020, Accepted for publication: 09 August 2020

Corresponding Author [a]

Keywords

electricity;
energy;
photovoltaic;
solar energy;
sustainable;

Abstract

The exploitation and use of renewable energies have grown significantly, where the volatility of the prices of specific fuels, the fight against climate change, and the search for new business opportunities are many of the causes that have fueled this growth and development. The objective of this research was to carry out an evaluative study on renewable energies and the sustainable development of the inhabitants of rural areas in the province of Manabí. For this, it was necessary to carry out a study of the demand for electricity consumption in the El Milagro community, Riochico parish; Likewise, it was necessary to analyze and evaluate the different renewable energy alternatives, identifying if there are projects of this type implemented in that rural area, based on identifying the area where the system can be installed. The methodology to be applied was bibliographic and field, with techniques for collecting quantitative and qualitative information, textual theory, with exploratory, descriptive, analytical, and prepositive methods of observation, surveys, semi-structured interviews, bibliographic, and data tabulation. The survey was applied as research instruments. The results of the study allowed us to propose guidelines for the construction of a renewable energy system in the El Milagro community, Riochico parish, and thus contribute to the protection of biodiversity.

Contents

[a] Universidad Técnica de Manabí, Portoviejo, Ecuador
[b] Universidad Técnica de Manabí, Portoviejo, Ecuador
[c] Universidad Técnica de Manabí, Portoviejo, Ecuador
[d] Universidad Técnica de Manabí, Portoviejo, Ecuador

1 Introduction

Despite the extraordinary technological advances experienced in the field of electricity generation, according to AIE (2013), (Velez, 2018), its transmission and distribution, even at present times, worldwide more than 1.3 billion human beings do not have electricity services, Africa being one of the continents where nearly half is concentrated, since approximately one coexists in these territories A quarter of the 2.6 billion that continue to use the traditional use of biomass for cooking (Rader & Norgaard, 1996; Beeharry, 1996).

Renewable energies have been recognized by the European Union, which in 2007 acquired the commitment to transform this continent economically with high energy efficiency and low greenhouse gas emissions, acquired the commitment to reduce 20% of this type of emissions, by saving 20% of energy consumption, and achieving a target of 20% renewable energy in total EU energy consumption in 2020 (RTA, 2010). According to estimates, in 2015, installed capacity was reached for the generation of electricity from renewable energy, approximately 1,849 GW worldwide. Investments in this sector are trending upward; in 2015, it had an investment of 285,000 million dollars to maintain growth in the capacity to generate electricity from renewable energy (Carreño *et al.,* 2017; Lund, 2007; Hall & Bain, 2008).

Renewable energies are identified as sources that will have a progressive contribution in satisfying energy demand in the coming years, replacing non-renewable fossil fuels, partly imported. Thus, "at present, the contribution of renewable energies (about total consumption of primary energy), worldwide is around 8% and only in Europe, 6%; percentages corresponding almost exclusively to hydropower and biomass (Schallenberg & Otros, 2008).

Renewable energy has progressed in recent years due to improvements in technology, associated with cost reductions and mainly thanks to the interest expressed by different administrations in different countries, in the form of grants and donations. The international community is committed to adopting sustainable development models, where efficiency figures as a key paradigm to achieve the proposed goals and in this scenario the losses inherent to the centralized electricity generation models, coupled with its eminent oil character and in other cases With the use of nuclear fission, they question the ability of the system to achieve sustainability.

Concerning the Republic of Ecuador, economic and social growth has generated important changes in the use of energy, for this, it is already using some alternatives of supply of the same that comes from the use of renewable resources, replacing partially to hydrocarbon derivatives, whose reserve horizon is relatively short at the national level if no new reserves are found. In this country, some energy supply alternatives from the use of renewable resources are already being used to partially replace hydrocarbon derivatives, whose reserve horizon is comparatively short at the national level if no new reserves are found.

In 2007, the State created a Ministry specialized in the renewable energy sector, the Ministry of Electricity and Renewable Energy (MEER), responsible for designing and executing policies and programs for the development of renewable sources in the country, through of the Under secretariat of Renewable Energies and Energy Efficiency. Additionally, the National Electricity Council (CONELEC) is in charge of regulating the electricity sector (including renewable energy). This institution approves concessions for the use of renewable energy resources and establishes the price of these energies. On the biofuels issue, the governing entity is the Ministry of Coordination of Production, Employment, and Competitiveness (MCPEC), which presides over the National Council for Biofuels, a multisectoral entity made up of several Ministries related to biofuels, by state companies and representatives' private sector (Piloso, 2017).

In the last decades, in the Republic of Ecuador, from the implementation of the new energy matrix, the energy from Biomass is the one that is used with the greatest quantity, followed by photovoltaic and wind energy. In such a way that "The unification of renewable sources in the energy scene of Ecuador and the practical application of technical concepts associated with distributed generation (DG), constitute a potential

generator of important social relations of production and reproduction of energy goods/services (Rodriguez, *et al.,* 2017; Rodríguez & Vázquez, 2018).

In the province of Manabí, specifically in the city of Portoviejo, solar radiation presents an annual relative variation, given the latitudinal location of the territory concerning the apparent movement of the Sun and the own climatic conditions that take place throughout the year. The level of the average annual solar radiation incident in the city of Portoviejo is above the average values registered for the province of Manabí, therefore any investment made in the study area guarantees higher energy levels than expected in the rest of the province (Vazquez *et al.,* 2018).

This work addresses the problem of demand for energy and the need to introduce renewable energy systems in rural areas that is why the need arises to propose a solution to this problem through a detailed analysis of the current situation of this type of energy, as a possible active solution in the institution that favors sustainable development. The interest in carrying out this research in the rural areas of the Manabí province, exclusively in the El Milagro community, Ríochico parish, is motivated by the demand for renewable energy in this sector and taking advantage of the solar potential that exists in that area.

2 Materials and Methods

A bibliographic review was carried out, the observation method was applied, interviews with community members, a survey was also applied to the residents to know different aspects related to energy and its efficiency, the quantitative and qualitative method was used to carry out the analysis of the behavior and use of energy in the community.

3 Results and Discussions

Renewable energies are practices to improve energy efficiency and achieve sustainability in the territories. In the Republic of Ecuador, investments in renewable energy are very few, since they have not been implemented for a long time. The lack of incentives presents a barrier to the implementation of this type of energy; however, with the support of foreign governments are new electrical projects, including the use of alternative renewable energies such as solar, biomass, and thermal.

Today Ecuador has 51.78% of renewable energy installed, this shows that the challenges of changing the energy matrix are already a reality and until 2015 they have replaced fossil fuel consumption with 51.78% in energy production. Renewable, which represents 13,638.89 gigawatt-hours (GWh) distributed for the benefit of Ecuadorian society. This historical milestone constitutes the footprint of the energy revolution aimed at strengthening the economy of all the country's inhabitants. Aiming to achieve 93% of clean and renewable energy, taking advantage of the potential of natural resources such as water, the solar, wind, and gradually discarding the production of polluting energy; also allowing an increase in installed generation capacity to 6,009.83 megawatts (MW) (ARCONEL, 2016).

Renewable energy sources and sustainable development

The dimensions of sustainability can be observed in the economic, environmental, and social fields, their interactions enhance sustainability, here the information systems can cover all of them (Rodríguez *et al.,* 2015). The electrical engineering career is developing a project to create conditions that allow achieving sustainability, from the introduction of renewable sources from the locality (Rodriguez *et al.,* 2019).

The system has been designed in such a way that it can be based on a web platform (Martinez *et al.,* 2019), it will incorporate all the cartography related to renewable energy sources in such a way that it can serve as an instrument for carrying out research and connection projects that enhance teaching at the university (Vázquez *et al.,* 2019). The proposal has among its strategies, linking environmental, and natural risks, because there are negative experiences related to drought, floods, and earthquakes (Hernandez *et al.,* 2018; Delgado *et al.,* 2017).

This vision requires diverse instruments that transform attitudes, lifestyles, and patterns of social participation, where it is known, which territories are the most suitable for making investments and which ones have renewable potentials to be exploited. The objective of the chapter focuses on characterizing the El Milagro community, Riochico parish in the province of Manabí, the possibility of implanting renewable sources for the sustainable development of this rural area was analyzed. In this way what is intended to achieve the objective by associating the analysis of the environment.

According to the diagnosis made in the community "El Milagro", Riochico parish, there is no renewable energy or a photovoltaic system connected to the network that helps to reduce the high consumption of electrical energy and to cover energy needs at a better cost (Briskman, 1992; Herberholz *et al.,*1997). Until today, the traditional electrical system continues, which generates greater consumption of economic resources for its use. The El Milagro community, Riochico parish belonging to the Portoviejo canton, in the province of Manabí, is considered the economic capital for its commercial development, import, and export of products, 5 km away. from the capital the city of Portoviejo and 17 km from the international sea and airport of Manta.

The parish population is 11,757 inhabitants, being 52.35 male and 47.65% female. Table 1 shows the potential risks and threats.

Table 1
Potential problems include the following threats.

Type	Variable	Priority	Description
Problem	Natural threats	2 high	Presence of floods on productive land
	Natural threats	3 medium	The risks of soil erosion in the area have moderate and high rates, this reflects the potential degree of susceptibility to erosion
	Climate / water	2 high	pollution of surface waters by poor management of solid and liquid wastes
	Natural plant coverage	2 high	Los mountains or hills are being cleared for crops of short cycle
	Ecosystems and Conservation Priorities	2. high	the fauna and flora has been diminished due to the transformation of native vegetation into crops, grasslands, and populated areas
	Renewable natural resources	3 medium	The use and abuse of fertilizers destroy the soil and to the detriment of the health of the population
	Relief/soil	2 high	Land use is developed in two categories, agricultural and livestock (grassland), which is overused
Potential	Climate / water	2 high	Pleasant climate suitable for developing productive activities such as tourism
	Natural plant cover	2 high	Existence of a collection car for the collection of waste in the parish capital
	Ecosystems and Conservation Priorities	2 high	Existence of afforestation and reforestation programs on the part of the State
	Land use and coverage	1. Very high	Lands suitable for developing agricultural, livestock, and tourism activities

Source: Technical and Participatory Diagnosis 2015
Elaboration**:** GADP Riochico - A. Ponce

Renewable energy technologies in currently, they are already recognized and mature, mainly in developing countries where the market has grown. In the case of the Republic of Ecuador, this is an initial market unlike other Latin American countries, where the inclusion of renewable energy has allowed them to develop better. This research work is essential to carry out an evaluative study on renewable energy and sustainable development for the inhabitants of rural areas in the province of Manabí.

The electricity grid of the future requires a qualitative leap, not a quantitative one, taking into account the need to better manage energy resources that favor environmental protection and respond to the increasingly demanding quality requirements of services and products. The project seeks the maximum integration of the facilities in the chosen location so that their possible impact on any phenomenon is minimal. At a technical level, the different elements that make up your installation are exposed and analyzed to ensure its correct operation. Likewise, a study is made of those elements that may negatively affect performance and the environment in the studied community.

Characterization of the electrical system

According to the mapping carried out as part of the diagnosis, it is known that the power supply for the Riochico parish, starts from the Portoviejo 2 substation, with a 12.5MVA power transformer, Voltage 69 KV/ 13.8KV, located by the Colegio 12 de Marzo, is done through the feeder PT035, Portoviejo- Riochico, Playa Prieta 569´550.9139 Electric Substation, with a three-phase network at a voltage level of 13.8 KV. In turn, a branch is derived from this feeder to provide electrical energy to the educational center. Table 2 shows the characteristics of the system.

Table 2
Characteristics of the electrical system

Quantity	Equipment
1	SF6 switch
1	Vacuum switch
9	TC
3	TP
3	Feeder

Source: Machuca (2016)

The behavior of solar radiation

The Portoviejo canton belongs to the Province of Manabí and is its capital. The coordinates are 1 ° 0´ - 1 ° 10´ south latitude and 80 ° 15´ - 80 ° 30´ west longitude. Studies reveal that it has one of the highest levels of solar radiation relative to the rest of the country. Its climate is subtropical dry to tropical, it oscillates an annual average temperature of 26 ° C, with a rainfall of 491 mm a-1, and 76.2% of relative humidity. The seasons: winter, generally starts in January and April, and the dry season or summer between May and December. Table 3 describes the statistical data of the average solar potential on a monthly and annual basis.

Table 3
Statistical data of the annual average daily solar radiation of the province of Manabí

Concept	Annual average	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Potential solar power (kWh / m2 day)	4,601	4,982	4,977	5,526	5,409	4,867	3.93	3,753	4,056	4,312	4,269	4,367	4,758

Source: (Cedeno & Chavez, 2015)

In the city of Portoviejo, solar radiation presents a relative variation during the year, given the latitudinal location of the territory concerning the apparent movement of the Sun and its climatic conditions that take place throughout the year. Table 4 shows the statistical data on the average annual and monthly solar radiation that affects the city of Portoviejo (Cedeño & Chávez, 2015).

Table 4
Average annual solar radiation incident in the city of Portoviejo

Concept	Anual average	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Portoviejo (kWh/m² día)	4,850	5,385	5,270	5,865	5,775	5,235	4,085	3,830	4,115	4,430	4,470	4,610	5,135

Source: (Cedeno & Chavez, 2015)

The analysis of the data reflected in tables 3 and 4 allows us to define that the level of the average annual solar radiation incident in the city of Portoviejo, is above the average values registered for the province of Manabí, therefore any investment made in the study area to take advantage of the incident solar potential guarantees higher energy levels than expected in the rest of the province. The incident solar radiation in the city of Portoviejo guarantees that for each kWp of photovoltaic installed, between 31, 5 MWh and 31.9 MWh of electricity can be generated in the life cycle of the technology, with an estimated average cost between 8 and 10 cents per kWh generated

According to the analysis Rodriguez *et al.,* (2017), in tables 3 and 4 the level of the average annual solar radiation incident in the city of Portoviejo shown, is above of the average values registered for the province of Manabí, therefore any investment made in the study area guarantees higher energy levels than expected in the rest of the province.

For the Riochico parish, the incident solar radiation in the city of Portoviejo can be considered, which guarantees that for each kWp of photovoltaic installed, between 31.5 MWh and 31.9 MWh of electricity can be generated during the technology life, with an estimated average cost between 8 and 10 cents per kWh generated, which represents a very competitive price with any of the energy sources available in the territory. Figure 1 graphically shows the relationship between the average annual solar radiation of the province of Manabí and that which affects the city of Portoviejo.

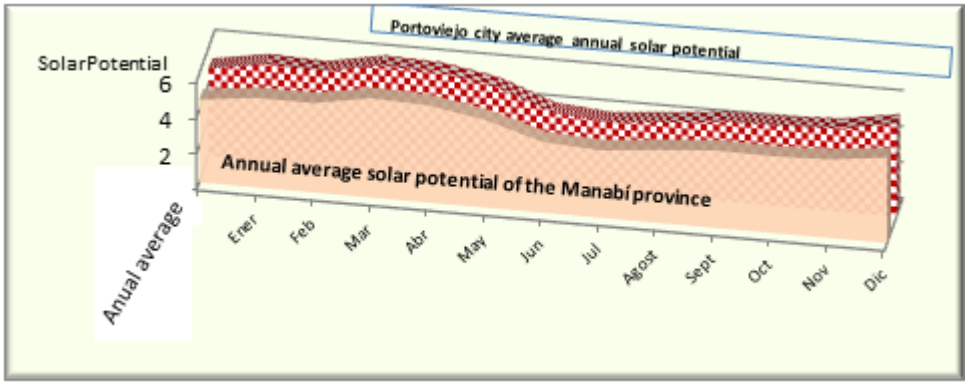

Figure 1. Average annual solar potential of the city of Portoviejo
Source: (Rodríguez *et al.,* 2017)

Comportamiento de la red en la comunidad "El Milagro" de parroquia Riochico

Respect for the function of the community "El Milagro" of the Riochico parish, it requires precision a quality electrical service, with stability, efficiency, and effectiveness, for each of the activities that are carried out and that control the electrical energy and to support this study, it was necessary to monitor the quality parameters of the electrical service having as indicators the power, current, voltage and power factor.

This measurement can be carried out with the help of the Sentron PAC 3,200 energy measurement equipment, an instrument with which the most relevant network parameters in the community can be viewed or displayed. Through this equipment, the measurement values are shown through a large 72 x 54 mm screen, with a resolution of 128 x 96 pixels. Apart from measuring the values of electrical quantities such as voltages and currents, they affected measuring the apparent, reactive, effective power and energy values.

The results obtained are aimed at proposing a design of the photovoltaic system for the community under study, to verify the reduction of energy costs according to consumption. The development of this study shows adequate electrical service in the homes of the El Milagro community of the Riochico parish, although certain problems are shown at night, also, it was possible to see the lack of photovoltaic systems that help expense mitigates and improve the electricity service in this group; therefore, it is necessary to set out the results of the required energy, economic, environmental and social feasibility studies and assessments, taking account that at present, the energy role is one of the main priorities of the scientific, political, economic and social agenda of countries, taking into account the many impacts it has on the planet because fossil-based resources and climate change are expected to weaken, all due to greenhouse emissions, creating a series of challenges that transcends individual actors and national areas and calls for the search for rapid common solutions for the benefit of the population

According to the World Energy Council (FAO, 1999), lack of energy has been shown to correlate very closely with many indicators of poverty" (p. 35). In the light of the above, it should be noted that people residing in rural areas are usually very low resources, many of them have no possibility of having electricity services, or where the electricity service has not arrived, they lead a difficult life with many limitations to carry out their social order activities, mainly at night, where they do not have access to the media and during the middle of the 24 hours of the day prevail silence and darkness for his social life (Rodríguez, 2015). A study of the cargo was made to a representative group of 10 community dwellings the "Miracle" is a village of the parish Riochico, being necessary to carry out an inventory of consumer equipment and appliances to obtain an estimate of the daily consumption shown in the table 5.

Table 5
Summary of the study on the cost of consumption in the community the "Miracle" is a village of the parish Riochico

Housing	Number of equipment (u)	Installed Power (W)	Daytime Consumption (Wh)	Night Consumption (Wh)	Consumo total (kWh)
1	26	5530	6929	7949	14.88
2	14	2280	5580	5730	11.31
3	24	14342	13686	14488	28.17
4	34	18045	15540	34565	50.10
5	18	4390	6390	7300	13.69
6	16	3490	6549	6959	13.51
7	14	3050	6504	6744	13.25
8	11	2040	2020	2775	4.80
9	12	2780	2020	2775	4.80
10	13	2220	7096	7746	14.84
Total	182	58167	72314	97031	169.35
Average	18.2	5816.7	7231.4	9703.1	16.94

Source: Residents of the "El Milagro" community, Riochico parish

The calculation for the table showing the installed power (W) was considered the inventory of the equipment according to its rated unit power, in addition to the number of energy-consuming devices that exist, applying equation (1) for this process.

$$Pe = Ce.Pnu \quad (1)$$

Where:
P→ power (W)
Ce→ Amount of equipment (U)
Pnu→ nominal unit power (W)

In the case of the estimate of energy to be consumed estimated in one day, the calculation of hours of daily operation was performed for each electrically consuming equipment or device, using equation (2).

$$Ec = P.\frac{h}{d} \qquad (2)$$

Where:
Ec → Estimated energy consumed (Wh/day)
h → working hours (X hours)
d → day (1 day)

According to the study, an average per-home is estimated to 18 installed equipment and devices that consume electricity with an average installed power per home is 5.9 kW and total daily consumption on average 17 kWh, of which about 7 kWh are consumed during the hours of the day for 41% and 9 kWh are consumed at night time for 59%. The average kWh is 16.94 per day, a value reflected in the electricity payment corresponds to $0.68, considering the price set by the electric company for a subsidized dignity rate equivalent to $0.04 per kWh.

Of the energy demand is of particular interest to the research, that of day and night hours can be covered with photovoltaic technology and therefore constitutes the basis for the size of the system that is required. Table 6 shows the result of the cargo inventory with the estimated kW/h energy consumption in the "El Milagro" community of the Riochico parish, for 24 hours

Table 6
Quality of electrical service at home

Alternatives	Number of people	Percentage (%)
Excelente	201	83.74
Bueno	124	33.16
Regular	38	10.16
Malo	11	2.94

Source: Habitantes de la comunidad “El Milagro”, parroquia Riochico

To determine their perception of the quality of the electricity service at home, the inhabitants of the “El Milagro” community, Riochico parish, through the survey it was found that: 84% of 201 people rate it as excellent; With 33% whose frequency is 124, there are the inhabitants who say the quality of the electricity service is good; 10% corresponding to 38, classify it as a regular service; and, with almost 3% whose frequency is 11, the inhabitants say it is a poor quality service. Most of the samples taken for the study receive good service from the electricity company. It has been shown that it is in hours of darkness that most of the problems occur in the electric power service of the sector where the surveyed sample passes.

To determine if they have knowledge about the benefits of renewable energy, and which is the most abundant, the results shown in Table 7 were obtained, obtaining that 60 people indicate that the sun is the most abundant energy source, coinciding with the criteria that photovoltaic installations would help reduce your electricity bill expenses.

Table 7
Type of renewable energy

Alternatives	Number of people
Sol	60
Agua	1
Biomasa	0
Viento	41
Otras	0
Total	374

Source: Habitantes de la comunidad “El Milagro”, parroquia Riochico

As you can see, most of the inhabitants know the alternatives that are available in the territory, this allows you to make investments in the field of solar energy (Thekaekara, 1973). While strategies must be developed to meet the challenge of driving procurement policies that promote the inclusion and diversity of energies to ensure that each region or territory is energy-sustainable and thereby improve quality of life, reducing economic and environmental impacts with efficient management of natural resources.

4 Conclusion

The Riochico parish, although the inhabitants indicate good quality of electricity, there are still vulnerabilities, because when they have power outages, this causes losses; in addition to being vulnerable to risks. The inhabitants consider that one way to reduce the economic impacts of the electricity tariff is through the use of renewable energies, among which are the solar that could supply the cost of electricity and reduce the cost of the electricity bill, improving its living conditions, reducing environmental impacts.

Acknowledgments
The inhabitants of the Riochico parish are thanked for their contributions to the research.

References

ARCONEL. (2016). Ecuador posee un 51,78% de energía renovable. Recuperado el 24 de Enero de 2020, de https://www.regulacionelectrica.gob.ec/ecuador-posee-un-5155-de-energia-renovable/.

Beeharry, R. P. (1996). Extended sugarcane biomass utilisation for exportable electricity production in Mauritius. *Biomass and bioenergy*, *11*(6), 441-449. https://doi.org/10.1016/S0961-9534(96)00050-5

Briskman, R. N. (1992). A study of electrodeposited cuprous oxide photovoltaic cells. *Solar Energy Materials and Solar Cells*, *27*(4), 361-368. https://doi.org/10.1016/0927-0248(92)90097-9

Carreño, P., Espinosa, M., Esteves, C., Fragozo, C., & Fragozo, E. (2017). La industria solar fotovoltaica y térmica. Obtenido de

Cedeño, G., & Chávez, S. (2015). Implementación de tecnologias fotovoltáica conectada a la red para suministrar energia electrica al segundo y tercer piso del edicicio N° 3 de Docentes de tiempo completo de la Universicdad Técnica de Manabí, el ahorro y la eficiencia energética. . Portoviejo: Universidad Técnica de Manabí.

Delgado, A., Saltos, W., Rodríguez, M., & Cuenca, L. (2017). Photovoltaic Energy to Face an Earthquake. International Journal of Physical Sciences and Engineering, *1*(3), 19~30. Obtenido de https://sciencescholar.us/journal/index.php/ijpse/article/view/61.

FAO. (1999). The Challenge of Rural Energy Poverty in Developing Countries.

Hall, P. J., & Bain, E. J. (2008). Energy-storage technologies and electricity generation. *Energy policy*, *36*(12), 4352-4355. https://doi.org/10.1016/j.enpol.2008.09.037

Herberholz, R., Nadenau, V., Rühle, U., Köble, C., Schock, H. W., & Dimmler, B. (1997). Prospects of wide-gap chalcopyrites for thin film photovoltaic modules. *Solar energy materials and solar cells*, *49*(1-4), 227-237. https://doi.org/10.1016/S0927-0248(97)00199-2

Hernandez, A., Vera, D., & Rodriguez, M. (2018). Susceptibility to Flooding in Abdon Calderon of Canton Portoviejo Parish. International Journal of Life Sciences, *2*(3), 111~120. Obtenido de https://www.sciencescholar.us/journal/index.php/ijls/article/view/220.

Lund, H. (2007). Renewable energy strategies for sustainable development. *Energy*, *32*(6), 912-919. https://doi.org/10.1016/j.energy.2006.10.017

Martinez, V., Rodríguez, M., Bazurto, J., Vázquez, A., & Valencia, J. (2019). Implementation of a Geographic Information System for Sustainable Development, at the Universidad Técnica de Manabí. Revista Espacios, *40*(39), 26.

Piloso, J. (2017). Diagnóstico y análisis de generación de energías renovables no convencionales en el Sistema Electrico del Ecuado. Manta, República del Ecuador : Universidad Laica eloy alfaro de Manabí. (pág. 97).

Rader, N. A., & Norgaard, R. B. (1996). Efficiency and sustainability in restructured electricity markets: the renewables portfolio standard. *The Electricity Journal*, *9*(6), 37-49. https://doi.org/10.1016/S1040-6190(96)80262-4

Rodríguez, M. (2015). Factibilidad económica de la extención de la red eléctrica (Comunidades rurales de Chone). XXX Seminario de Sector Eléctrico ECUACIER 2015.

Rodríguez, M., Domínguez, J., Quijano, R., & Rodríguez, C. (2015). Los sig y la integración iberoamericana a partir del uso de las fuentes renovables de energía. XV ENCUENTRO DE GEOGRÁFOS DE AMERICA LATINA.

Rodriguez, M., Vásquez, A., Saltos, W., & Josnier, R. (2017). El Potencial Solar y la Generación Distribuida en la Provincia de Manabí en el Ecuador. Rev. Riemat, *2*(2), 1-5.

Rodriguez, M., Vázquez, A., Martinez, V., & Bravo, J. (2019). The Geoportal as Strategy for Sustainable Development. Engineering, International Journal of Physical Sciences and, *3*(1), 10-21. Obtenido de https://sciencescholar.us/journal/index.php/ijpse/article/view/239.

Rodriguez, M.; Vazquez, A. (2018). La energia fotovoltaica en la provincia de Manabí. Ediciones UTM-Universidad Técnica de Manabí, ISBN: 978-9942-948-20-5.

RTA. (2010). Desarrollo de las energías renovables marinas : condiciones de éxito en las regiones de la RTA del arco Atlántico. Red Nacional Transnacional Atlántica).

Schallenberg, J., & Otros, y. (2008). Energías renovables y eficiencia energética.

Thekaekara, M. P. (1973). Solar energy outside the earth's atmosphere. *Solar energy*, *14*(2), 109-127. https://doi.org/10.1016/0038-092X(73)90028-5

Vazquez, A., Rodríguez, M., Saltos, W., Rodríguez, C., & Cuenca, L. (2018). Rendimiento energético, económico y ambiental de una Central Fotovoltaica de 3,4 KWp en el modo de la generación distribuida (GD). Revista Espacios.

Vázquez, A., Rodríguez, M., Villacreses, C., & Velez, A. (2019). Local Energy Development and Sustainability: The Ecuadorian University. Journal of Advanced Research in Dynamical and Control Systems, *11*(05-Special Issue), 451-458.

Velez, M. (2018). Estudio de la eficiencia de los sistemas fotovoltaicos y su impacto socio económico en la zona rural del Cantón Chone. Revista Riemat, *3*(1), 23-29.

Biography of Authors

Jean Pierre,
Egresado de la carrera de ingeniería eléctrica de la facultad de Ciencias Matemáticas, físicas y Qui¿ímicas de laUnvresidad Técnica de Manabí.
Email: jeanmera_@hotmail.com

Gullermo Antonio,
A graduate of Electrical Engineering at the Universidad Técnica de Manabí (UTM), Portoviejo, Ecuador. Master of Educational Management. Assistant Department of Electrical and deputy dean of Electrical Engineering at the Faculty of Mathematics Chemistry, Physical in the UTM, Portoviejo, Ecuador. Professor, currently she is working on her doctoral work on the topic of smart grids for efficient application to university facilities.
Email: galoor@utm.edu.ec

Aspiring Doctor of Technical Sciences, Electrical Engineer, Has worked in various research primarily directed to the use of microgrids with renewable energy sources, it has participated in scientific events as the author of several currently working on the issue of the use of renewable sources in form of distributed generation through microgrids that enhance power quality and decrease environmental impacts.
Email: wsatos@utm.edu.ec

Graduate of Electrical Engineering at the Universidad Técnica de Manabí (UTM), Portoviejo, Ecuador. Master in Educational Management. Assistant Department of Electrical and coordinator of the School of Electrical Engineering at the Faculty of Mathematics Chemistry, Physical in the UTM, Portoviejo, Ecuador. Professor currently working on his doctoral work on the topic of artificial intelligence for efficient application to university facilities.
Email: lcuenca@utm.edu.ec.