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International Journal of Science and Engineering Invention(IJESI)
Volume 02 Issue 02 April 2016, page no. 1 to 9
Available Online at - www.isij.in

Research Article e-ISSN 2455-4286 Open Access

Photovoltaic, a Choice, Quality to Electric Service Chone Canton

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Abstract: ***The change of energy mix is a fact today in Ecuador and 2017 the power generated from renewable energy sources is expected to exceed 50% of the existing conventional generation. The main load centers in the province of Manabí are far between 120 and 400 km from hydroelectric forming the basis of the generation system, consequently resulting in a significant amount of losses in transmission and distribution. Currently many settlements in rural areas of the province are affected by irregularities and poor quality of electricity service. The paper presents an analysis of the quality of electricity service in isolated areas of the municipality Chone and proposes solutions that can improve service quality, through sustainable energy planning at the expense of indigenous resources of the territory.***

Keywords: *Service quality, energy efficiency, rural electrification grid extension, photovoltaic systems.*

1. Introduction

One of the most used in industrial, commercial, services and that has allowed the development of technologies is electric power, which is one of the ways that more advantages and comfort bring human beings today, resources without But is a resource that must be generated on demand in coming to the load centers where the supply and quality can be controlled at the time being used sites.

Of all forms of perhaps the most polluting and degrading the environment human activity is on the management of fossil energy resources: extraction, production, transportation and consumption. Most of the energy used in the world comes from the so-called "fossil fuels", which constitute about 80% of primary energy consumption worldwide.

Efficiency and saving energy resources are one of the ways to achieve stable power supply and quality service. Now of a need that the power supply system are reliable and in some third world countries there are several factors that prevent energy reaches the user with the required quality.

According to the United Nations Program for Development (UNPD), currently 2 billion people lack access to electricity services, billion use uneconomical sources (dry cell batteries, candles,

kerosene) to stock up on some kind of energy vital needs such as lighting and cooking and 2 000 500 million people living in developing countries mainly in rural areas, have limited access to commercial energy services [1] access.

In Ecuador for thermal generation it is used in higher percentage bunker and diesel are more expensive than natural gas or coal. Therefore the cost of generation based on the use of oil is high in any of its variants due to high fuel prices, why for some industry representatives, the state should lower the cost of fuel, which would be equal to grant a subsidy for generators, which would reduce the price of electricity generated [2].

The probability that a computer or system meets its specific mission under certain conditions of use in a given period, is what has traditionally been called reliability [3]. The quality of electricity service needs the integral behavior of a large group of technical requirements, constituting a very complex task considering the growing population demanding this service, and the development of technologies and the use of fossil fuels, which cover more massive form 80% of global energy demand [4].

The current planetary model is highly polluting, inefficient, based on intensive use of sources of generation to extinction, socially unjust and growing demand. The use of energy sources from fossil fuels, is the cause of 75% of emissions of greenhouse gases. The current rate of exploitation of oil contributes to the rapid depletion of this resource, although recently new deposits have been discovered. About 40% of global CO2 emissions come from the electricity sector in Ecuador is around 9% [4].

In Latin America different actions are taken to improve the quality of energy in isolated areas using other energy alternatives. For example Colombia applied studies aimed at sustainable development of micro-networks along with several business models according to the social and economic conditions [5]. Another of the studies is related to the distribution networks [6], where even in Ecuador there are deficiencies that affect users, not fulfilling with the quality of service provided to the population, according to the provisions of the plan national good living 2013-2017 [12].

Development of Renewable Energy Sources (RES) has had a substantial increase in the last 20 years with two fundamental goals: to increase and improve the current generation system, and most importantly, ensure sustainable and clean the planet life. The potential of the RES available to Ecuador and especially the province of Manabí, is adequate to meet existing demand in rural areas and can be used to meet the current energy consumption and provide an environmentally cleaner alternative for the future.

For the provinces of the coastal area of Ecuador and especially to the province of Manabí, the RES more than an alternative, constitute a solution first hand to meet the energy demands and especially for rural areas, where technical requirements generation current system does not allow provide adequate quality of electricity service, can refer to the level of disruption and low voltage received by users who are away from the distribution network. According to [7] between June 2014 and June 2015, the 30% reduction in power disruptions was achieved, according to the Minister of Electric Power, specifying that they went from 25 to 17,000 cuts in the current year , as you can appreciate despite the efforts of the system it becomes unsustainable from the technical point of view.

The program RES and especially photovoltaic technology can be widely applied in the province of Manabí, due to the incidence and scattering of solar radiation in the province, which allows implement comprehensive strategies for sustainable energy planning, not only for electrification of isolated houses, but can be deployed systems pumping water for irrigation,

community use and installations connected to the network, with possibilities of designing autonomous systems or small micro networks, achieving supply separate dwellings or small communities, where the distance of the system the houses is approximately a distance of one kilometer, so that there are no leaks and that can provide quality service to users. How are you their experiences in various parts of the world and in Cuba, where it was implemented about 15 years ago, a system with a micro isolated system in two communities [8]. There is a program of electrification in areas far from the grid using autonomous systems and microgrids, electric service to ensure social objectives [9].

Photovoltaic solar systems for its flexibility of application, provide a unique opportunity for the energy sector provide solutions of high quality services in remote rural areas, for example for health services, education, communications and electricity, as well as for the supply of water for human consumption, animals or agriculture.

The aim of this work is to propose the introduction of new sources of power generation from the use of solar potential in rural areas Chone Canton of the province of Manabí, which will improve the quality of electricity service provided in these areas and electrify communities and homes that do not yet have this service and to support the activities of water supply for human consumption, small industry and agriculture.

2. Materials and methods

For the study was based on the possibility of collecting information disclosed by different media and informative way on the electrical service in the province of Manabí, especially in the Chone Canton, on communities and homes are still without electrifying, interruptions They are caused in the distribution lines, besides the quality of energy that reaches users primarily in rural electrified by extending the grid.

The geographic information system (GIS) was used for the location of rural communities in the municipality of Chone and solar radiation impinging on it, in order to determine the possibility of introducing photovoltaic systems for different applications electrification between those they include: network connection, autonomous rural electrification systems and autonomous systems for pumping water.

Published was used for cartographic information on the website of regional scale of 1: 250,000 in January 2013.

Layers in version of Basic Geographic Information IGM open access [10]. (UTF-8, these layers have assisted in the course of the analysis concerning the areas which are close to the people and having a renewable potential that can be tapped.

For the study of solar potential information databases published on the website of the NASA [11] was used and information studies that have used the data published on this site was revised, to study the potential of the renewable sources, taking into account that satellite information may be unreliable if the analysis of climatological parameters of the sites where the study is conducted is not integrated. This analysis does not work with data measured on the ground, only the satellite data, which allows acquire a good approximate view on energy interpretation of measurements of solar radiation and wind, causing the performance of calculations and study for the implementation of investments in photovoltaic systems.

3. Results and discussion

3.1 Initial situation

The RES may provide sufficient electrical energy for sustainable, reliable and clean manner, with the aim of achieving a sustainable diversification of the current energy matrix supported by fossil

fuels. Especially photovoltaics in areas with good solar potential can be implemented by networked systems, such as support for centralized function to improve service quality, reduce losses, save fossil fuels and reduce the environmental impact of the generation system electricity.

Photovoltaic systems can also be implemented in order to provide support in meeting the demand resulting from the creation of new local businesses and services in areas with significant amount of population, while it can be used to reach the electricity to remote rural communities of the grid, where the extension of service by the conventional route is not justified from an economic point of view.

Photovoltaic solar energy also offers opportunities for solutions for access to water by installing alternative aqueducts and irrigation areas and watering holes for livestock in rural areas. Photovoltaic systems have also been used with good experiences to ensure electricity service in social facilities in rural areas.

Among the key constraints to the widespread application of technology can be noted, the high costs that in previous years came trading systems; but the photovoltaic market currently led by China, offering competitive prices with any generation technologies that have traditionally been used. The advantage from the economic point of view lies in the low operating costs, as they are able to generate electricity with zero virtual spending for fuel, lubricants and other inputs. Pollution levels are considered depreciable in facilities that are performed in the mode of distributed generation.

Planning good life (2013-2017) in Ecuador [12] part of a fundamental principle is to achieve the improvement of the living conditions of the city and countryside, offering quality energy services and promoting the diversification of the matrix energy from renewable use of existing potential in the territory.

One of the measures in favor of the research is political support for the introduction of technologies based on the use of the RES, which can be introduced quickly than any other technology way, as reflected in teacher Ecuador plan [13], thereby allowing preserve the current state of the ecosystem.

For the study of reliability we started from knowledge of disruptions now occurring in the province, but mainly the poor quality of service in rural areas, where for various technical reasons among which are the losses and the generation deficit, the energy that reaches users do not have the quality required in relation to the low voltage and mains frequency. On the other hand during the winter months accounting for 50% of the year, service interruptions occur frequently because power lines traverse wooded areas where winds cause cable breaks and falls Pole and work reset service have delay by the poor state of the roads at this time of year.

3.2 Analysis of possible solutions

It is proposed as a result of work a model of planning that allows the energy study of the area as a preliminary stage in the process of planning and decision-making for solving the technical problems associated with the low quality of electric service, increased demand and rural electrification.

The methodological versatility of the proposed model allows its use for studies and evaluations on sites with difficulties and of the negative impact that involves the low quality of electricity service with failures interrupt and low voltage network, leading to damages in electrical equipment that in some cases become damaged, with a negative economic impact for users who do not see their living conditions improved. In other cases increased demand in remote areas of power generation, can lead to the gradual increase in losses and deterioration of the quality of the technical parameters of the network, although it

can be taken based solutions application of technical machinery to ensure the tension and stability of the network, in some cases the ultimate solution can be achieved by introducing a source of generation to support the centralized system.

It includes integrated modeling of different variables analysis techniques among which are: selection of the study area; analysis of energy demand with the study and evaluation of the load; evaluation of the quality of service and technical condition of the networks; study of the economic feasibility analysis of the cost of electrification by different sources; evaluation of the technical condition of access roads; assessment of the socio-economic importance of the study area; study and evaluation of the potential of the RES; Analysis of the cultural traditions of the area under study and; assessment of the financial capacity to undertake investments; among other issues. In Figure 1 shows the proposed sustainable energy planning for areas with low quality of electricity service and rural electrification model.

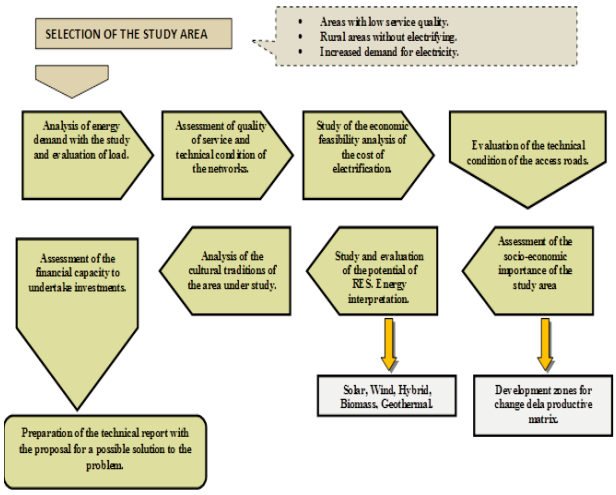

Figure 1: Model for sustainable energy planning

The development model begins with the selection of the study area, which should result from the analysis of the areas that have difficulties with the quality of electric service, rural communities or homes isolated that do not have electrical service or result of new or increased demand this; After selecting the study area is analyzed in demand for energy that exists in this area and the study and evaluation of the load, which is particularized and the study deepens in major consuming centers of electricity is done, defining the weight they represent for the service. The study should be conducted particularizing the electricity consumption data at different times, but especially during the hours of the day when solar energy is being harnessed in availability. a general diagnosis on electricity consumption and energy efficiency is realized; an assessment of the technical condition of the networks, transformers and insulators if any, and the quality of service is performed. This requires the measurement of voltage and frequency at the point of energy consumption is carried out for a reasonable time at different times; the technical and economic feasibility study on investment that can be made for the solution of the problem is made. It examines whether it is required to introduce a new generation source or if you can only solve the problem by adding a technical device enabling improved reliability and quality parameters of the network; the assessment of the technical condition of the access roads to the site is required to attend technologically is performed, resulting information necessary for the development of technological maintenance plan. Consider that during winter climate stage with the occurrence of rains, some sites in rural areas practically uncommunicate; The model provides for the assessment of the socio-economic importance of the area under study, as this is to reconcile the priorities set in the plans of the state, according to energize the development of certain areas or sector of the country, although the central purpose it focuses on ensuring the improvement of living conditions of the population, as envisaged in the National Plan for Good living 2013-2017 [14].; The study and evaluation of the potential of RES (Solar, Wind, Water, Biomass, Geothermal) is one of the jobs that can offer a high level of technical input in terms of possible solutions. This is about

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identifying the availability of use of existing renewable sources in the study area and to define the possible introduction of technologies generating electricity. At the same time energy interpretation of satellite data and other meteorological information that are available it is done. At the end of the study must obtain an estimate of the energy that can be generated from the use of renewable sources; Is planned parallel analysis of the cultural traditions of the area under study, since any energy intervention is made, should maintain utmost respect for cultural and ancestral traditions of communities; In many cases any of the solutions to energy problems, goes through a process is limited by lack of funding, so that implementation of the proposed model is planned evaluating the financial capacity to undertake investments. The results of these studies can analyze the different alternatives of seeking funding, for carrying the necessary investments to solve the problems; At the end of the development work of the technical report is expected with the proposal of possible solutions, properly argued and signed by the specialist blamed the execution of the work; The development and implementation of the model will implement a set of concepts associated with sustainable energy planning, which is considered with special attention to the possibility of solving the problems posed from the use of indigenous resources of the territory and also allow implementing measures reducing the environmental impact of energy services

3.3 Special features of the area chosen for the study

Chone Canton is the first territory where there has been partial implementation of the proposed model, so that you can validate an important part of the feasibility of the proposed new model of planning. In this area a preliminary study for the economic analysis of the feasibility of the extension of the grid was made, being shown that for distances of 5 km in rural areas not extending the power grid is justified [15] for various reasons , among which are: the high cost of network expansion in rural areas; The increase in losses with the potential to worsen the quality of electricity service in the technical parameters of voltage and frequency of the network; The difficulties encountered to ensure the maintenance of the network and solving interruptions by the poor condition of roads communications in these areas; among others. Reason leading to the search for renewable alternatives to solve the problems.

In Figure 2 shows the area where grid extension is feasible, both economically and technically, as well as communities that are at a distance of 5 km of the network where the service is It becomes unstable, since it was found that above this distance is not the reliability and quality of service is guaranteed to be very costly an investment for the electrification of these territories.

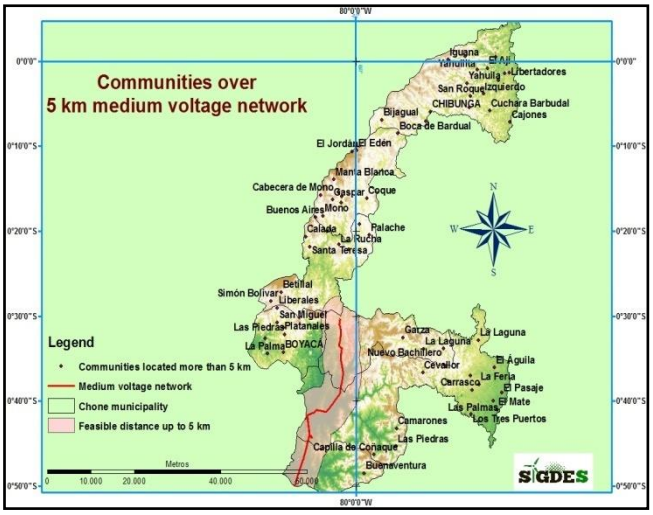

Figure 2: Communities more than 5 km from the network

In Figure 3 you can see a map color scale study results related to the distance of the communities to the electricity grid. It can be seen that most of them are more than 5 kilometers of the network, even some are located 80 kilometers, where it is not economically or technically justifiable extend the service.

International Journal of Science and Engineering Invention(IJESI)
Volume 02 Issue 02 April 2016, page no. 1 to 9
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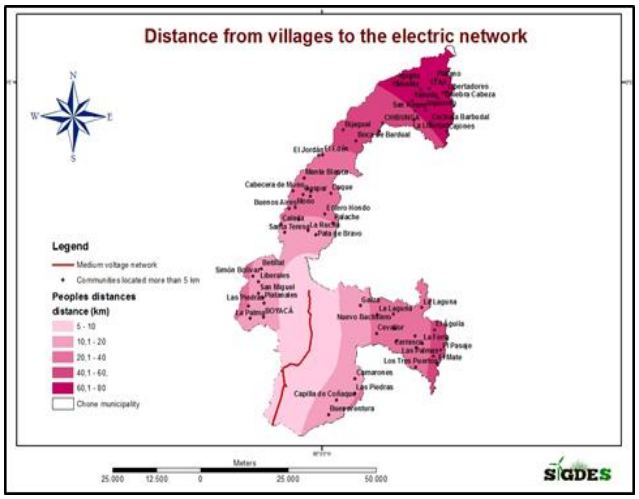

Figure 3: Distance of the communities to the electricity grid

In the graph of Figure 4 the number of communities shown by distance from the power supply above 20 kilometers to 80 kilometers, some of them are electrified and others are still not electrified. All these communities which total 63, are a potential for the study based on management measures for sustainable energy planning based on the use of RES and especially value the photovoltaic technology in order to support the improvement of quality of service communities that are already electrified, and perform electrification in cases that do not have the service, giving compliance with the provisions of the National plan for good living 2013-2017 [14], [13].

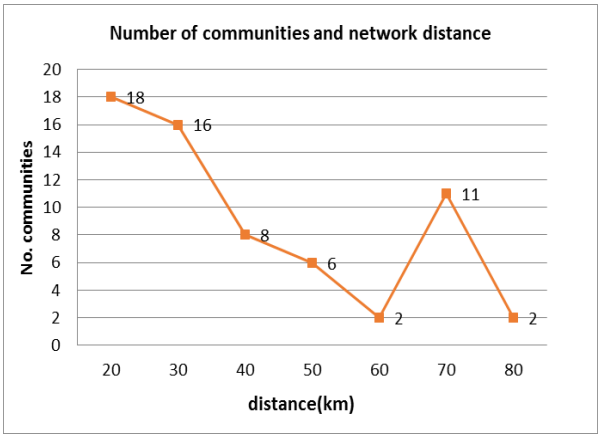

Figure 4: Number of communities by distance network

During the previous study it was accomplished the first assessment of the solar potential in the territory of the province and it was known that Manabí is one that at the country level more solar radiation per m2 has on average in the year. It can be stated that the monthly averages of the incident radiation in the Canton Chone, allow the development of large-scale photovoltaic technology, ensuring adequate energy results.

Table 1 shows the database of the annual and monthly average solar radiation is shown over a period of 11 years and its behavior in the different parishes of Chone Canton.

Table 1: Database of the annual average solar radiation

Parishes	*Daily average annual* (kWh/m^{2}day)
Boyacá	4,880
Canuto	4,880
Canuto	4,010
Chibunga	4,010
Chibunga	4,200
Chone	4,880
Chone	4,010
Convento	4,880
Convento	4,010
Eloy Alfaro	4,880
Eloy Alfaro	4,010
Ricaurte	**4,880**
Ricaurte	**4,010**

The Figure 5 shows the map shown chromatic scale annual average solar radiation especially the values shown in the parishes of the municipality Chone.

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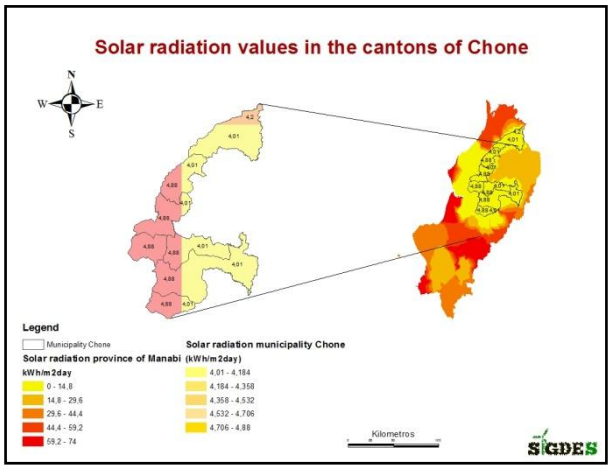

Figure 5. Map of solar radiation annual average of the province of Manabi and Chone municipality

The study results allow to verify that annual average solar radiation in Canton Chone behaves between 4,010 kWh/m2 day and 4,880 kWh/m2 day, this potential is appropriate to think about any of the variants of technological application aimed at taking advantage of the sun's energy, either through the electrification of rural communities with the implementation of microgrids, or electrification of isolated dwellings and systems connected to the network with the aim of improving service quality and reduce losses, plus other applications in water pumping systems.

All technological variants properly applied as a result of the application of the proposed model can improve the technical conditions under which currently provides electric service in these areas, reducing complaints from users by nonconformity relating to the service. The results can promote real alternative solutions to the management of quality, efficiency and energy savings, mainly in isolated areas.

Conclusions

The particular analysis in relation to the rural communities of Chone Canton, where the distance to the power grid could be a serious problem to ensure the quality of electricity service through the extension of the network, in addition to the high cost of such projects nature, and the results of the evaluation of solar potential in the province of Manabí and especially in the area of study, we demonstrate the feasibility of the introduction of photovoltaic technology in any of its applications. Tell yourself in: the autonomous systems for electrification of isolated dwellings; water pumping systems; articulation of micro-networks in rural communities; connected to the network to support the increased quality of service and reducing losses of centralized systems.

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