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Use of Small Wind Turbines in Isolated Areas Social Impact

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Abstract

Local development is aimed at achieving sustainability and energy independence with the use of indigenous resources, in this environment technologies that take advantage of wind energy is one of the most propitious in low wind speed. Since very remote times have been solving different problems in the isolated and rural areas, in the province of Manabí there are no high wind speeds these are maintained between 2.5 and 3.5 m / s. In the research carried out, it was possible to demonstrate the feasibility of implementing small wind turbines in most of the territory of the Chone canton of the province of Manabí, visualizing that the implementation of small-scale technology can provide adequate solutions to the use of the resource since there is potentiality Energy to introduce the technology with the use of micro-wind turbines that its starting speed is in the range of 1-3 m / s, knowing that these only require small technical maintenance, besides being viable technologies to support the change of Energy matrix, generation of jobs and promises to achieve energy independence in isolated rural areas, improving the living conditions of the population and enhancing social development.

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1. Introduction

Wind energy is dependent on the heating of the earth's surface. In the equatorial zones, a great absorption of solar radiation takes place, in comparison with other regions; Hot air rises in the tropics and is replaced by masses of cold surface air that comes from colder regions. This cycle closes with the air movement in the upper atmosphere, in addition to the incidence of the rotation of the earth linked to the seasonal changes where the incident solar radiation fluctuates and influences the variations in the magnitude and direction of the prevailing winds in the earth's crust (AIE, 2015).

Wind energy presents positive environmental aspects, first that it is renewable and sustainable characteristics that make it propitious to be used in almost all regions where the renewable resource exists since at present there are technologies for small powers, it also offers one of the energy options Renewable sources in terms of reducing CO2 emissions. Its implementation generates savings in the use of fossil fuel reserves. For many poor countries, it contributes to security and diversity in energy supply, empowering local economies to create a new vision for the use of renewable energy.

The wind energy that reaches the rotor of a wind machine is initially transformed into mechanical energy available in a rotating movement; this can be used to drive devices that transform it into other forms of energy: mechanical, electrical, thermal or potential. The most effective applications will be those in which the final use of energy with the least number of transformations is reached (Quiroz *et al.,* 2016).

This research assesses the social and environmental impact of wind turbines that can work at low wind speeds and can be used in areas where wind densities are not high and serve to benefit independent rural housing in areas difficult to access as Is the canton of Chone in the province of Manabí.

2. Materials and Methods

In order to develop the research work, we reviewed information on wind turbine applications operating at low wind speeds, their technical characteristics and the impact of their introduction in isolated areas. The Chone canton of the province of Manabí was taken as an example because it has two characteristics that make it competitive, first because it has low wind densities in most of its territory and second because there are still scattered houses without electrification and in some things the service Electric comes with difficulty.

Through the deductive research it was possible to verify that the conditions of the indigenous energy resource, the techniques for its use, the isolated areas without energy service or of poor quality and the social necessity, elements that are essential for the decision-making in local programs for The improvement of social conditions and the development of isolated áreas.

3. Results and Discussions

3.1 Use of wind turbines in isolated areas

In isolated areas it is difficult and expensive to carry energy, but if the local renewable resource is used, energy independence can be achieved and costs reduced, renewable sources of energy are distributed, wind to a greater or lesser degree can be harnessed depending Of the climatic conditions and relief of the area, the cost of the technologies that provide the potential for the wind at the present time for isolated zones are competitive with the extension of the network and more even when they are combined with other energies like solar. In the scheme of Figure 1, it is possible to observe the elements necessary to achieve energy independence and improve social conditions.

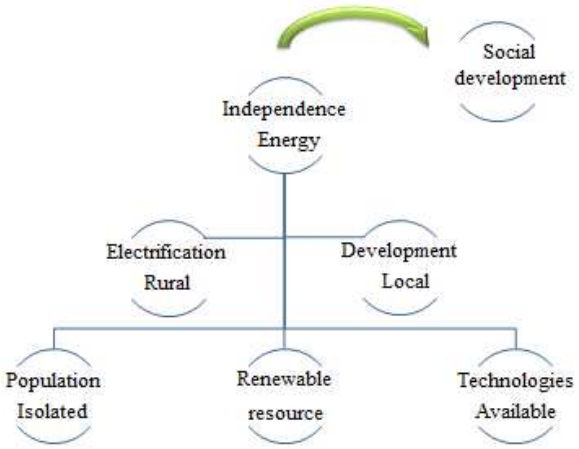

Figure 1. Schematic for achieving social development

There are small wind turbines that can provide solutions to isolated homes, for rural electrification where the energy service does not arrive or arrives with very poor quality. According to studies carried out, these do not require strong winds to start harnessing their energy. The development of this technology has succeeded in starting to generate electricity with start speeds of 1 m/s (AIE, 2015).

There are different models that can be used to generate at low speeds and that do not impact the medium as they are: the American multi-blade, the Savonius among others that today are used for water pumping, power generation, grinding of grains, etc.

According to the International Energy Agency (IEA) there are 17% of the world's people without electricity, or 2.7 billion people (Quiroz *et al.,* 2016), where the province of Manabí accounts for one percent, is one of the provinces of Ecuador that has 5% without electrification according to data of SENPLADES and the Chone canton with 9,072 houses without electrification (Maldonado & De Jeronimo, 2008).

3.2 Analysis of the wind in rural areas of the province of Manabí

The study has developed in the province of Manabí, especially the municipality of Chone, where there are adequate renewable resources (wind) that can give a solution to problems of rural electrification if the use of small wind turbines is used. Figure 2 shows the wind potential of the municipality of Chone, this information was processed using satellite information published by the National Aeronautics and Space Administration (NASA) (Maldonado & De Jeronimo, 2008), in addition to using information from the population settlements published on the Military Geographic Institute (MGI) (Energía eólica, 2003), as can be seen in almost all the canton the available resource to be used, in addition to the isolated populations of the electric distribution lines.

As you can see the most intense colorations are those with the highest wind speed measured at 10 meters in height, are not very high but to meet the energy needs of independent homes and use the small wind turbines or technologies that generate energy from Small wind speeds, which as shown in the greater areas of the territory is greater than 3 m/s (meters per second).

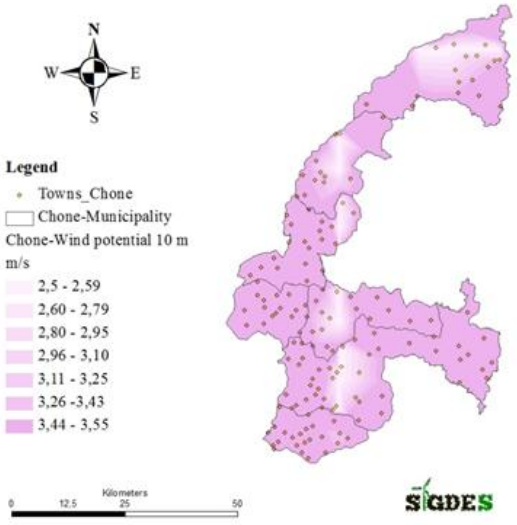

Figure 2. Chone wind potential and its towns

In order to decide the type of wind turbine to be used, it is necessary to know the energy demand and to measure the wind speed in a timely manner.
To know the energy that can be generated applies equation (1).

$$Ce = \frac{1}{2} mV^2 \qquad (1)$$

Where:
Ce → Kinetic energy (Joule/s)
M → Airflow (kg/s)
V → Wind Speed (m/s)

From this analysis, the area swept by the shovel is the area of catchment where the wind will strike perpendicular to it and the density of the air, as shown in equation (2).

$$m = \delta A V \qquad (2)$$

Where:
δ → air density (kg / m3)
A → catchment area (m^2)

It is possible to state that the theoretical power (Pm) that can be obtained in the unit of time is calculated with Eq. (3), for A = 1 (Quiroz *et al.,* 2016).

$$Pm = \frac{1}{2} \delta V^3 \qquad (3)$$

Taking into account studies carried out at the University San Francisco de Quito, where an analysis is made for the location of wind farms on the Ecuadorian coast and comparing the values of the wind speed in the Chone cotton that ranges between 2.5-3.5 m/s (Cartografía, 2016), it can be said that it is feasible in these isolated rural regions to use wind technologies to generate electricity in the province of Manabí

3.2 Social, economic, technical and environmental impacts of the use of wind turbines in isolated areas.

The social impacts come hand in hand with energy development; if you manage to energize the isolated areas of Chone canton could have positive impacts on the population living in those regions, playing a basic role in eradicating poverty, guarantee quality Of life, the development of the region, creating new jobs and improving the conditions that favor gender equality.

Specifically, the most used option in the province of Manabí in the rural electrification plans that have been developed have been promoting the extension of the electrical infrastructure network, connecting settlements in increasing order according to the investment cost.

That the quality of the energy decreases when the distance increases the distance, but in addition as it is extended it becomes more expensive (Cartografía, 2016), making the connection to the network less viable.

Small wind generation systems are reliable technologies for sites that are far from generation centers and meet small energy demands, where homes are scattered one from the other In the studied region the dwellings are located at distances between 500 meters and one kilometer between them and also distant from the low voltage network, in many cases by mountainous areas, as shown in figure 3, the electric line is far from Many settlements where small wind turbines could be installed to provide specific and distributed solutions to homes, solving a social problem and applying the concepts of distributed generation with small generation sources and where users can self-supply and control their consumption.

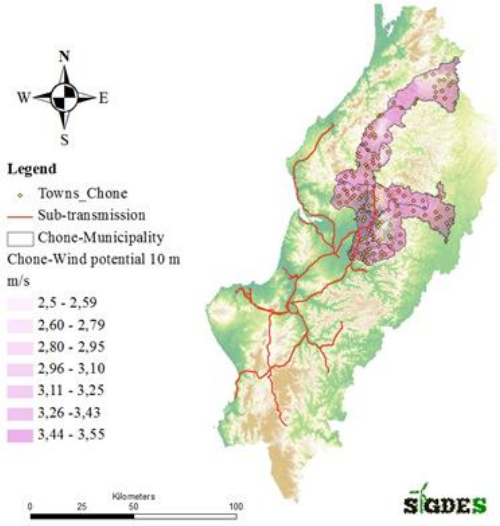

Figure 3. Remote mountain ranges and wind potentials

When it is valued economically the installation can be considered that it is competitive with the extension of the network for sites like the one studied, by the dispersion of the houses. With the introduction of technology, users can become energetically independent and sustainable, promoting local development, creating a new approach to development that improves their living conditions, creates new jobs and creates an awareness of the use of clean energy.

Being small the format of the wind turbines can be instantiated in places near the dwelling taking into account technically that the noise levels do not affect the residents. They are also combined with other types of renewable energy such as solar (María Rodríguez Gámez, 2016). The study results allow verifying that annual average solar radiation in Chone canton behaves between 4,010 kWh/m2 day and 4,880 kWh/m2 day (NASA, 2016).

For these types of installations, the environmental impact is minimal because they do not contaminate in the middle, in their maintenance stage they do not affect the ground, the noise levels are not high. They are economically viable, maintenance can be done by the user and if they are necessary because they help to improve social conditions and development opportunities in isolated areas.

The qualities and the results that can be obtained are necessary to socialize with the people of the community explaining the benefits that the project will generate in a way that assimilates the technology creating the conditions

and commitment to support the whole process of installation and maintenance to last during The life cycle and achieve their sustainability in the places where they are installed.

4. Conclusion

Renewable energy sources are the sustenance and guarantee for the sustainable development of the isolated rural regions that today are not electrified or where the service of energy arrives with poor quality these allows to be used in combination with other energies to diminish the processes of interference of the wind. It has been demonstrated that it is viable in Chone canton of the province of Manabí its introduction to gather the energy characteristics and the social necessity to implement a program of energy development with small wind turbines and with that, it achieves energy sustainability in isolated rural areas And supporting local development.

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Statement of authorship
The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

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