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Study for the Economical Factibility in the Implementation of the Renewable Energy Technologies for the Electrification of the Rural Community of Media Luna in Salamanca, Gto.

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Abstract. The present work aims at studying the economical factibility of the electrification of the rural community of Media Luna in Salamanca Guanajuato by means of eitherextension of the distribution electrical networkor renewable energy such as photovoltaic or wind power. The study is accomplished by carrying out an accounting of the potential of these energies in the rural community; thisstudy should be used for the electrificationplanning of the rest of the communities.

Keywords: Economical factibility, renewable energy, rural community.

1 Introduction

Currently there exist some rural communities in the City of Salamanca, Guanajuato which lack of the electricity commodity; hence the present work aims at fostering the development of more efficient technology for generation and use of energy as well as strengthening the technological development in the field of renewable energies.

It is worth highlighting that the outcomes can be applied to another rural communities and municipalities having similar features as the one regarded herein, such as socio-economical structure, size, distribution and meteorological conditions.

On account of the research development nature, several studies to evaluate the economic impact that may have the installation of new medium-tension electric grid on costs are carried out. Besides, these studies imply the posts arrangement, wiring and accessories. With the study it will be seen that the CFE negotiation costs can be avoided in contrast to the installation of renewable energy systems.

It is well known that in order to have a general perspective, in the long term, of a project it is necessary to carry out a financial analysis which allows to assess parameters as initial investment and net present value over a certain period of time (for this particular case the time was 20 years). In so doing, the analysis must allow for maintenance costs, overhauling costs and useful life. As well, in order to know if the project is worth in a time- discount calculation, the analysis must take into account a

Fig. 1. Top sight of Media Luna

Minimum Attractive Rate of Return (MARR) which considers the annual inflation rate of the country where the study is carried out. In this particular case, the inflation rate was 3.92% for 2006, and the MARR was 5 %. Finally, however, in order that the most feasible solution can be implemented, socio- economical factors are considered, too.

It is worthwhile stressing that the main beneficiaries of this study are the rural community inhabitants, one of the fundamental aspects to be reviewed is the renewable energy potential in the rural zone, which may be used as base for the electrification planning of the rest of the rural communities.

2 Methodology

The community of Medial Luna is located at the north part of Salamanca bordering with the cities of San Miguel Allende and Juventino Rosas, at 25 kilometers roughly from the urban zone of Salamanca, that is a time travel of 1:40 hours, the number of houses is 10 and the total number of inhabitants is 60.

2.1 Extension of the Distribution Electric Grid

The closest community to Media Luna with electric service is the Joyita de Villafaña; a bi-phase grid line extends 1.5 km from a school located therein, nearby to Media Luna at the northeast side.

The economical proposal delivered by the CFE Company for extending the distribution electric grid up to 1.5 km was $348,422.00. It included the annual consumption costs for thewhole community ($3,835.24) as well as the maintenance costs. Then all these figures are brought to the present value by considering a period of 20 years, which comes to be $535,011.25.

Table 1 shows the value of the initial investment and the net present value over a period of 20 years for extending the electric grid line.

Table 1. Economic effects of photovoltaic system.

Inversión Inicial	$ 398,422.00
VPN 20 años	$ 535,011.25

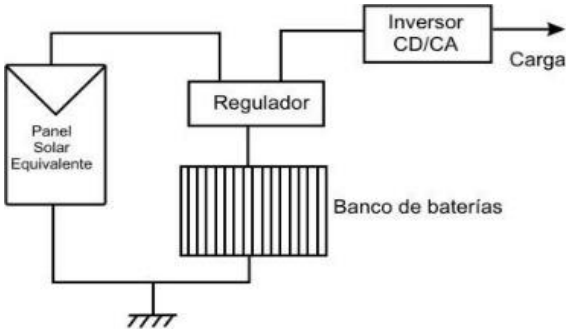

Fig. 2. Main Elements of the Photovoltaic System.

Table 2.

Inversión Inicial	$ 1’421,429.50
VPN 20 años	$ 1’671,906.49

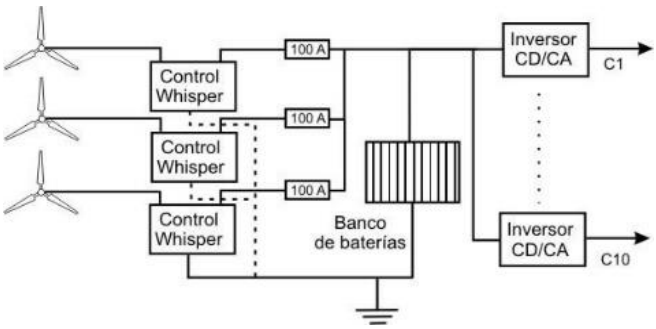

Fig. 3. Wind Energy System Main Elements.

2.2 Photovoltaic Energy

The sizing of the photovoltaic system for eachhouse was carried out by considering a solar irradiance of 4.4 kWh/m^2-day. The mainelements of the system are shown in Figure 2.

The total cost of the photovoltaic systems for 10 houses was $ 1’421,429.50, and calculating by means of the life cycle analysis of the components and maintenance, the annual costs are yielded over a period of 20 years in accordance to the net present value.

Table 2 shows the values for the initial investment and the net present value at 20 years for the whole photovoltaic system.

Table 3. Economic effects of wind energy system

Initial investment	$ 735,386.22
VPN 20 years	$1'048,260.27

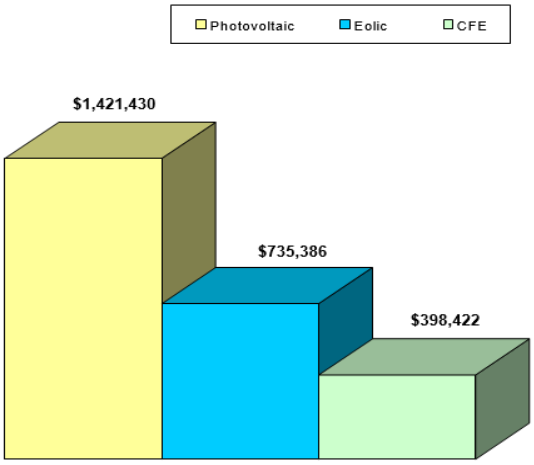

Fig. 4. Initial Investment Figures.

2.3 Wind Energy

As to the wind energy system, an annual windspeed average of 5 m/s was considered, so the whole system for 10 houses is shown in Figure 3.

The total initial investment for the wind energysystem came out to be $ $ 735,386.22. In order to assess the net present value of the project over the period of 20 years, the annualmaintenance costs and the life cycle of the components were included.

Table 3 shows the values for the initial investment and the net present value at 20 years for the wind energy system.

3 Obtained Results

The results yielded by the financial analysis tofind the more feasible solution are shown in Table 1, 2 and 3, with such values the studyof economical factibility is carried out then.

3.1 Initial investment

The minor initial investment is represented by the proposal of extending the distribution grid line by the CFE. The difference between projects is, on the one hand, 1 million pesosin comparison with the photovoltaic systemand, on the other hand, 350 thousand

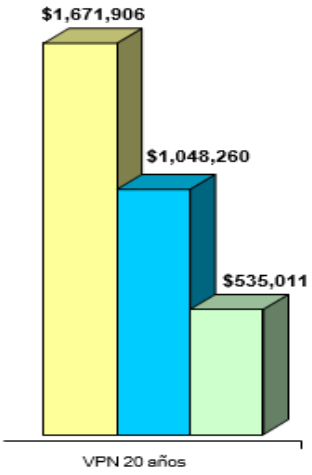

Fig. 5 NPV over 20 years.

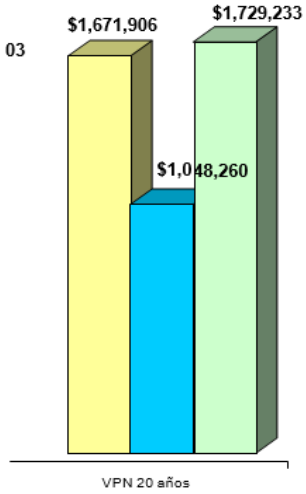

Fig. 6. NPV over 20 years by considering an electricgrid line of 6.5 km long.

if compared with the wind energy system,hence, from the economical point of view, the best option is to extend the electric grid in comparison with the renewable energies, this is two or four times the cost of the initial investment to extend the electric grid line. Figure 4 shows the economical difference among the possible alternatives.

3.2 Net Present Value over 20 years

The net present value points out the value ofthe money at present by discounting all the future outgoings at an appropriate rate of interest, i. e. it resolves the

equivalence in thezero time of the future cash-flows originated by a system.

For this particular case where the assessmentis carried out on a cost basis, the system showing the minor NPV will be the more economical feasible. Comparison of the alternatives is shown in Figure 5.

Clearly the results shown in Figure 5 points out that the CFE has the smallest NPV; the reason is that the costs generated by the consumption of energy are smaller than the costs presented by the renewable energies in maintenance and replacement of parts through the lifetime of the system. Thus, according to the NPV analysis, the project concerning the extension of the distributiongrid line is more cost-effective than the renewable energies.

3.3 Electric Grid Line Distance Factor

In order to have the same costs in the projects in the NPV, and if the construction cost of the electric grid line was 260,000 pesos, then the grid line would have to be **6.5 km** long, what indicates that to have a gridline equal or longer, the NPV would surpass the current installation costs of the renewable energies (Figure 6).

However if the distance of the electric grid lineis longer than 6.5 km, then the more cost- effective option is the renewable energies.

3.4 Socio-Economical Factor of the Rural Community

Being the extension of the electric grid line the more cost-effective alternative, it is worthwhile mentioning that, from the socio- economical point of view of the rural community, most of the similar rural communities have to cancel the electricservice because of the high costs in the bill. Estimation indicate that the community of Media Luna would have to pay 60 pesos each two months, which is an amount quite considerable for the inhabitants to the point that they opt for calling off the electric service.

This is a factor that is not considered in the renewable energies insofar as, from the very first time the energy is consumed, the user is completely independent of the generation costs, which is a great advantage in the renewable energies what leads to opt for this type of installations.

References

1. Mukund, R.: Wind and Solar Power Systems. CRC Press (1999)
2. Messenger R.A., Ventre J.: Photovoltaic System Engineering. CRC Press (2004)
3. Banda Navarro J.G.: Estudio de la Generación Eólica Empleando un Generador de Inducción. FIMEE (2007)
4. IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications. IEEE Std., pp. 485–1997 doi: 10.1109/IEEESTD.1997.83812.
5. Comisión Federal de Electricidad: Programa de Obras e Inversiones del Sector Eléctrico (2005-2014)
6. Secretaria de Energía: Acciones de la Secretaria de Energía Para la Promoción de las Energías Renovables para Electrificación Rural en Zonas Aisladas (2004)