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Technical-economic analysis of a grid-connected photovoltaic system

Análisis técnico económico de un sistema fotovoltaico conectado a la red

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Abstract

This article presents the technical-economic feasibility of a distributed energy system connected to the grid or micro grid for the Recintos Zapallo, San Mateo parish, Esmeraldas Province. Having distributed generation seeks to minimize power losses by having generation from the load point. The work begins by collecting monthly data of the electrical loads of the Zapallo compound, climatic data and associated monetary data with the objective of investigating a feasibility study of the renewable energy supply system. Different scenarios are developed according to the needs of the project and the scenarios were modeled using HOMER software. The study concludes with a direct comparison of economic feasibility, renewable

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energy fraction and emission between all aspects of the system for a suitable sustainable solution. This study is useful for distribution companies to have an additional element of judgment to minimize power losses in the network, as well as to consider building island circuits to optimize distribution costs in rural locations.

Keywords: Distributed Energy System, Photovoltaic System, HOMER Software, Optimization

Resumen

Este articulo presenta la viabilidad técnico-económica de un sistema de energía distribuida conectado a la red o micro red para el Recintos Zapallo, la parroquia San Mateo, Provincia Esmeraldas. Al tener generación distribuida se busca minimizar pérdidas de potencia al contar con generación desde el punto de carga. El trabajo se inicia recopilando los datos mensuales de las cargas eléctrica del recinto Zapallo, los datos climáticos y los datos monetarios asociados con el objetivo de investigar un estudio de viabilidad del sistema de suministro de energía renovable. Se desarrollan diferentes escenarios de acuerdo con las necesidades del proyecto y los escenarios se modelaron mediante el software HOMER. El estudio concluye con una comparación directa de la viabilidad económica, la fracción de energía renovable y la emisión entre todos los aspectos del sistema para una solución sostenible adecuada. Este estudio que sirve para que las empresas distribuidoras tengan un elemento más de juicio para minimizar las pérdidas de potencia en la red, así como considerar construir circuitos en isla que permitan optimizar los costos de distribución en localidades rurales.

Palbras clave: Sistema de Energía Distribuida, Sistema Fotovoltaico, Software HOMER, Optimización

Introduction

In all parts of the world, reliable electricity supply is key to economic development. However, in many developing and less developed countries, access to a stable and uninterrupted electricity supply is considered a luxury (Ordóñez et al., 2017).. This project will allow us to analyze in a complex way a major problem in the rural sectors of our province we will carry it out with an energy that today is currently revolutionizing the whole world this is the Photovoltaic Solar Energy let's talk a little about it The photovoltaic effect was discovered by the Frenchman Alexandre Edmond Bequerel in 1838 when he was only 19 years old. Bequerel was experimenting with an electrolytic battery with platinum electrodes when he noticed that the current rose in one of the electrodes when it was exposed to the sun. We must take into account the concept of the aforementioned that indicates that it is that which we obtain through the conversion of sunlight into electricity under the use of technologies based on photoelectric effects (Israel et al., 2020). (Israel et al., 2020). Solar photovoltaic energy is one of the most efficient renewable sources at present, and it should be emphasized that it is one of the keys to the decarbonization of the planet. Everything is based on the photovoltaic cell, an electronic device with the ability to capture and transform light energy into electricity (Antonio et al., 2022).

This paper analyzes the technical-economic feasibility of incorporating new storage technologies in small renewable systems. For this purpose, a software simulation of a renewable system composed of photovoltaic panels, with their respective storage (Lead, Lithium and Flux batteries) and inverter is carried out. The analysis is carried out for when the system operates in island and when it is connected to the grid. The corresponding simulations were made to a case of consumption of a rural type house in the area: Zapallo, San Mateo parish, Esmeraldas Province, through this technical and economic analysis we will be able to determine the improvements and profitability of an active distribution system.

Currently, electrical systems generate a considerable cost in network repowering projects, so that modifications have been proposed in these systems to compensate the demand for supply at peak hours, this is done in search of mitigating the instability of the system during the period of time with higher consumption. The use of renewable energy is increasingly on the rise, so new projects are being implemented with environmental care in mind, so from a theoretical point of view, photovoltaic solar panel systems are considered as a source of renewable energy, since it makes the transformation of solar radiation into electricity, this process is done through its photovoltaic cells.

The reason why this project was chosen is to present an environmentally friendly energy system option, where it is also proposed to optimize the cost of investment in repowering and technical improvements of the distribution system, where it is intended to benefit the population of the parish "El Zapallo" both for its future population growth and to meet the current demand for electricity distribution at peak hours. Likewise, a methodological benefit will be obtained through this project, so that an existing study model will be available for future projects of implementation or integration of photovoltaic systems to the active network system in this sector, contributing in turn to the study and contribution to the use of renewable energies.

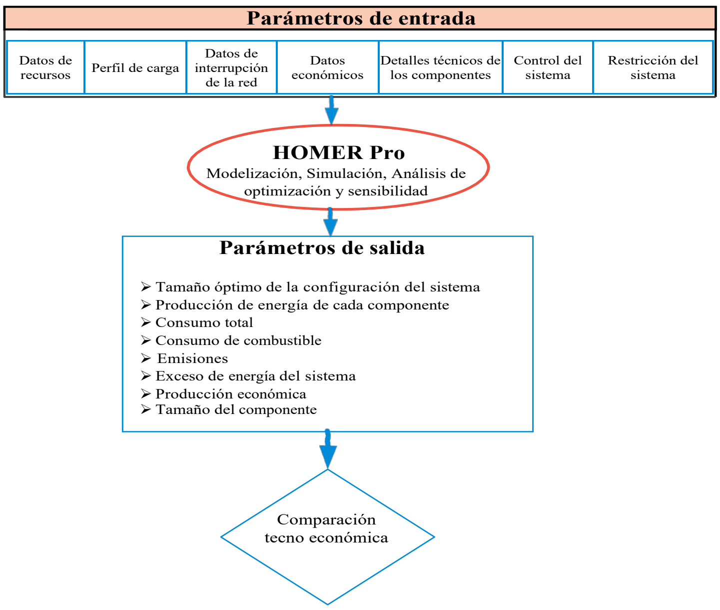
The scope of this project is to study the optimization of the electrical distribution network in the "El Zapallo" parish. This study will be developed based on a point of the distribution network where the peak demand is evidenced according to the dimensioning of the network, so the study is limited to check the load flows at the reference point in order to contribute to the reduction of consumption by using a photovoltaic system connected to the network. This will be verified through the design and simulation of the grid-connected photovoltaic system using HOMER Pro software.

Methodology

To identify Recinto Zapallo, San Mateo parish, Esmeraldas Province, as a good site for grid electricity generation, we first used data from the National Aeronautics and Space Administration (NASA) on solar potential and temperature. As a result of this analysis, the research area offers great solar potential. It is considered a model for grid electrification. From August to December 2022, primary data were collected from end-user surveys and questionnaires. The administrative officer also assisted in data collection. Secondary data were collected primarily through annual reports, publications, literature, and online searches of relevant organizations. All of this data was fed into the HOMER energy model, which determined that a grid-connected solar PV system could meet primary energy needs while reducing overall system and energy costs. The theoretical formalism of the proposed system components is described below.

Techno-economic, optimization and sensitivity analysis of grid-connected PV systems for the selected locations is carried out using HOMER Pro, with weather, load, grid outage and economic data as input data, as shown in Figure 1.

Figure 1. Methodological Process of the Research.



Source: (Das et al., 2018)

Results

HOMER Pro is a microgrid software and HOMER Energy is the international standard for optimizing the design of microgrids in all areas, from community energy and the benefits of grid-connected Recinto Zapallo, San Mateo Parish, Esmeraldas Province. This system can be improved and distributed through HOMER Energy. HOMER (Hybrid Optimization Model for Multiple Energy Resources) adds 3 control tools in a single software product, so that production and financials work side by side. Simulation

HOMER is a simulation program, it strives to simulate a feasible method for all possible arrangements of the tools you want to study. Depending on the complexity of the problem, HOMER software can simulate hundreds or even thousands of methods. HOMER simulates the process of a hybrid microgrid for an entire year, in time periods ranging from one minute to one hour.

Optimization

HOMER studies all conceivable combinations of array types in a single run, and then groups the systems according to the flexible optimum. HOMER Pro programs the original optimization process that greatly simplifies the strategy procedure for ranking the lowest-priced possibilities for microgrids or other distributed generation of electric power systems. HOMER is a patented "derivative-free" optimization process that was calculated specifically for the HOMER effort.

HOMER allows you to ask as many "What if?" questions as you wish, since you cannot control all the characteristics of a system, nor can you identify the importance of an exact variable or option without consecutively running hundreds or thousands of simulations and equating the results. HOMER makes it very easy to match thousands of possibilities in a single run. HOMER allows you to understand the control of variables that are beyond your control, such as fuel cost, wind speed, etc., and recognize how the optimal system changes with these differences.

The output of photovoltaic generators depends mainly on the size of the generator, the reduction factor, solar radiation and temperature. To calculate this output, HOMER uses the following equation:

$P_{PV} = C_{PV} f_{PV} \, (I_T / I_{T,STC})[1 + \beta_P \, (I_C - I_{C,STC})]$

Where:

C_{PV}photovoltaic system capacity (kW),

f_{PV} reduction factor of the photovoltaic panel [%],

I_TThe current time step, the solar energy is incident on the whole in kW per m2,

$I_{T,STC}$ under conventional test conditions, incident radiation in kW/m2,

β_P energy heat coefficient in %/ °C.

$I_C$cell temperature at the current time step in degrees Celsius,

$I_{C,STC}$: temperature of cells under typical test circumstances [25].

HOMER's Cost Analysis Procedure

The sum of the costs of C_{PV} and of the converter C_{CONV} is the system cost.

$C_{SYSTEM} = C_{PV} + C_{CONV}$

Net present cost: The total costs of installation and operation over its useful life are determined as follows:

NPC = $\frac{A_C}{R_F}$ (i, P_L)

where, A_C, R_F , i, and P_L represent the annualized total cost, the capital recovery factor, the interest rate in and the useful life of the system in years, respectively.

Annualized cost: The sum of all annualized equipment costs, including capital, operating and maintenance costs, including replacement and gasoline costs.

$C_{ANUAL} = (CCR_F + CO)$

Capital recovery factor: Capital recovery factor is a coefficient that calculates the present value of equivalent annual cash flows.

R_F = (i X (1 X i)^n / (1 X i)$^{n-1}$

where n indicates the duration and i the real annual interest rate.

Cost of energy: The average cost per kilowatt-hour of usable electricity produced per system.

$$\text{COE} = A_C / (\mathrm{D}_{\mathrm{Pr,(AC)}} + \mathrm{D}_{\mathrm{Pr,(DC)}})$$

here, $\mathrm{D}_{\mathrm{Pr,(AC)}}$ denotes AC primary load and $\mathrm{D}_{\mathrm{Pr,(DC)}}$ is DC primary load.

Place of Study and Illustration of the Area

These case studies were developed to test the capacity of the multilevel optimization method to analyze remote communities with different climatic conditions. For this purpose, we considered 18 residences (houses) located at Recintos Zapallo, the parish of San Mateo, Esmeraldas Province. Recintos Zapallo has been selected because it presents different climatic conditions in terms of solar energy availability. Table 2 shows the average horizontal insolation (Figure 5). As we are interested in analyzing the influence of climatic conditions, we set the load profile for the campus.

Table 1. *Monthly Average Global Horizontal Solar Irradiance.*

Months	Clarity index	Daily radiation Kwh/m2/day
January	0.479	4.766
February	0.545	5.627
March	0.552	5.794
April	0.618	6.330
May	0.613	5.971
June	0.611	5.749
July	0.524	4.992
August	0.497	4.955
September	0.467	4.827
October	0.531	5.478
November	0.498	4.982
December	0.468	4.585

The raw solar resource data input to the software is the average global horizontal radiation measured at 10-minute time intervals over the two years. In addition to the solar resource data, the latitude and longitude of this zone will also be used as input data. The time zone is another parameter to be adjusted. Recintos Zapallo is located at latitude: 0°29.6'N, longitude: 78°59.8'E, and with time zone of GMT +5:00 . The annual solar radiation available at the study site is 5.34 Kwh/m2/year using HOMER.

HOMER evaluates the power of the photovoltaic system during the year by hours and uses the latitude value to calculate the average daily radiation from the brightness index and vice versa. The annual average daily solar insolation in this area is 6330 Kwh/m2/day. The efficiency of the PV system is not a HOMER data, because the program does not designate the size of the PV system in m2, but in kW of rated capacity. The rated capacity is the amount of energy that the PV module obtains under STC conditions and takes into account the efficiency of the panel. When handling rated capacity, HOMER does not have to deal with efficiency, since two modules with different efficiencies (and the same surface area) would have different sizes.

Solar resource data was downloaded on 12/15/2022 14:42:40 from the National Renewable Energy Lab National Solar Radiation Data base:

- Cell number: 314081
- Cell dimensions:40km*40km
- Latitude of cell midpoint:17.012
- Length of cell midpoint:81.859
- Average annual radiation: 5.34 Kwh/m2/year

Site Loading Profile

The total load profiles for the site were obtained from the respective recinto Zapallo , canton Quinindé in Esmeraldas for the year 2022. According to the load data collected, the daily electricity consumption , which were 18 houses as shown in Figure 6. The remaining loads were supplied only from an unreliable grid. The proposed grid-connected PV systems were also modeled considering only the critical load of the sites. of the sites.

Table 2. *Estimated Average Daily Electricity Consumption*

Consumption year 2022	January (kwh)	February (kwh)	March (kwh)	April (kwh)	May (kwh)	June (kwh)	July (kwh)	August (kwh)	September (kwh)	October (kwh)
House 1	114	114	116	113	113	115	116	112	114	116
House 2	119	118	115	116	115	116	118	117	118	115
House 3	116	114	118	115	118	114	118	116	114	118
House 4	120	118	115	119	115	115	119	116	118	119
House 5	114	115	117	116	117	116	115	115	115	115
House 6	115	117	114	113	114	113	113	114	117	117
House 7	120	115	118	118	120	117	120	118	115	120
House 8	116	113	116	116	113	114	116	116	115	116
House 9	114	116	113	115	114	115	114	115	114	115
House 10	111	115	112	112	115	113	112	113	115	113

House 11	119	114	116	114	116	116	115	115	116	116
House 12	122	119	117	121	117	122	117	117	118	119
House 13	113	116	114	115	113	114	115	115	113	114
House 14	110	112	114	113	114	110	110	114	110	110
House 15	111	114	115	116	115	114	116	116	116	115
House 16	118	117	113	118	117	118	117	118	113	117
House 17	114	117	116	117	116	114	116	117	114	116
House 18	115	118	114	118	115	118	115	118	115	114
TOTAL	**1612**	**1618**	**1957**	**1972**	**1.964**	**1614**	**1611**	**1621**	**1606**	**2085**

Peak demand was between 8:00 a.m. and 5:00 p.m. that day. This was mainly due to the fact that the entire industrial park had started its manufacturing process.

Electricity Rates in Ecuador

The Board of Directors of the Agency for Regulation and Control of Energy and Non-Renewable Natural Resources (ARCERNNR), by means of resolution ARCERNNR-009/2022 of April 14, determined that the national average tariff for electricity service will remain at 9.2 cents per kilowatt-hour (¢USD/kWh). In other words, there will be no variation in the final price of the service for the consumer.

The Agency carried out the technical-economic studies, in coordination with the sector's governing body, the Ministry of Energy and Mines, for the implementation of this resolution. Since 2020, the price of 9.2 ¢USD/kW has been maintained for more than 5′ 505,033 energy service users.

It should also be noted that the Board of Directors approved the Tariff Schedule for the Energy Charging Service for electric vehicles through Resolution ARCERNNR-011/2022, in accordance with the government policy set forth in Executive Decree No. 238, which establishes the promotion of a development model for the electric sector with the participation of public, mixed capital and private companies. With this planning, the load service providers will know the maximum values they will be able to charge to the end user (ARCERNNR, 2022).

Description of the Grid Connected Photovoltaic System

The proposed energy system is expected to meet the community's electricity demand. The renewable energy sources considered here are mainly solar, the photovoltaic panels produce direct current. A bi-directional converter is inserted into this configuration. It is used to switch the battery power from AC to DC voltage. It returns the AC power from the battery to the AC load for the consumers. All consumers need alternating current, so part of the software input values are based on size and quantity. The components are the solar PV and the converter, which also vary in size. This chapter is intended to illustrate the input variables that will help to optimize and model the system. Some values evaluated at their inputs will be summarized. We have already explained in detail in the previous chapters the components of the power generation system and their electrical loads. The schematic representation of the HOMER simulated model of the hybrid architecture considered in this project.

The effect of temperature is taken into account in this project. The specifications of the PV panel selected in this study are given in Table 4. The capital cost of solar PV at the current local price in the country.

Table 3. Technical and Economic Data of the Photovoltaic Solar Modules.

Parameter	Specification
Panel type	Flat plate
Operating temperature	47 °C
Power temperature coefficient	-0.40°C
Nominal operating cell temperature	17.02%
Reduction factor	0.85
Cost of capital	800 $/kW
Operating and maintenance cost	9.2 $/kW/yr.
Life	25 years

Source:(Authors)

System Economics

Once the resource and component data have been entered, HOMER Pro ranks all optimization results according to their total net present costs (NPC). The NPC is analyzed with the help of the following equation. (Suresh et al., 2020):

$$NPC = \frac{C_T}{CRF\ (i, N)}$$

Where C_T is the annualized total cost ($/year), i is the real annual interest rate (%), N is the useful life of the project (years), and CRF is the capital invested, which in this study is 25 years of capital. The CRF is calculated by the following equation (Suresh et al., 2020):

$$CRF\ (i, N) = \frac{i(1+i)^N}{(1+i)^N - 1}$$

The annual real interest rate is calculated from the nominal interest rate and the inflation rate using the following equation:

$$i = \frac{i_n - f}{1+f}$$

Where

I: is the nominal interest rate (%), and

F: is the annual inflation rate (%).

In this study, a nominal interest rate of 12.75% and an annual inflation rate of 10.84% are taken. With the above equation the real interest rate is 1.72%. (Podder et al., 2018).

The stabilized cost of energy (COE) is the cost per kWh of the power plant over an assumed duty cycle and is calculated as follows:

$$COE = \frac{C^T}{E_P + E_d + E_{gs}}$$

Where:

$E_P$is the total amount of primary load served by the system per year (kWh/year),

$E_d$is the total amount of deferrable load that the system serves per year (kWh/year), and

E_{gs}: is the amount of energy sold to the grid per year (kWh/year) of energy sold to the grid per year (kWh/year). (Podder et al., 2018).

Economic Study

The objective of making an investment in a solar photovoltaic installation is to consume less energy from the grid and use own energy, so it is essential to know the profitability of the installation and check that the investment will be profitable. The first thing to do is to draw up a budget to know how much money has been allocated to the installation and then a profitability study will be carried out using the NPV (Net Present Value) and IRR (Internal Rate of Return) methods.

Size and Cost Optimization

Immediately after selecting the component technology from the HOMER software library, we must enter the electrical load into the modeling tool. The primary load input is entered on the basis of 24-hour data, and then the software models a peak load. It also synthesizes the monthly load from a 24-hour data input.

This project describes a primary electrical load and its inputs. It groups a weekend load and for August, January and the rest of the months generated by HOMER after inserting the 24-hour load data represents the daily variation of the primary load profile of the 18 residence (houses) that are located in Recintos Zapallo Figure. 6 indicates the primary load demand and shows that the load profile changes during the day. The load is almost zero from midnight to 6:00 am. Load is about to increase in demand from 6:00 to 9:00 o'clock. Around lunch time, i.e. 12:00 to 14:00, there is a higher demand around dinner time, however, the peak time is from 6:00 PM to 10:00PM midnight.

Contribution of Resources

The raw sunlight-based information input to the program is the usual worldwide horizontal radiation measured in 10-minute time intervals over the two years. On the information from sun-facing assets the range and longitude of this territory would also be used as information, and another parameter was the time zone.

In the Zapallo area, where there are 18 residences (houses), it is located at latitude: 0°29.6'N, longitude: 78°59.8'E, and time zone: GMT +5:00. To obtain the energy generated by the photovoltaic system powered by the sun, it is necessary to enter in the HOMER program the estimated information about the solar resources in units of Kwh/m2.

Size and Cost of Solar PV

The following panel was chosen. The reason for the choice after considering different products in relation to the cost provided them 78 modules this product was chosen from the indicated company due to its low cost. The VarioTrack family consists of 2 models of MPPT solar charge controllers for systems with PV capacity from 1 to 75 kWp (with 15 in parallel), PV input voltage up to 150 Vdc and 12, 24 or 48 V battery banks.

Main Product Features

Efficient: A VarioTrack charge controller uses a sophisticated algorithm that ensures that the maximum available power from the PV modules is supplied to the batteries.

Robust: The device meets the highest industry standards and, thanks to its high degree of ingress protection (IP54), is particularly robust and suitable for harsh environments. In addition, it is fully protected against polarity reversal.

Flexible: The VarioTrack is designed to be used in all types of solar systems, and the combination of VarioTrack + Xtender results in a highly efficient system. Communication between the devices allows synchronization of the battery charging cycle regardless of the technology (lead-acid, lithium, nickel, etc.). Unlike other all-in-one hybrid solutions, the VarioTrack + Xtender allows independent selection of the appropriate solar PV and inverter-charger capacity, resulting in a more finely tuned system design.

Features and Benefits

Guarantees optimum energy production.

Follow-up efficiency: >99%.

Conversion efficiency: >99%.

4-step charger to extend battery life.

8 pre-defined battery charging curves as standard.

Free programming of the battery charge curve with the RCC-02/-03.

Low self-consumption: <1W in night mode.

Protection against incorrect wiring.

Reverse polarity protection.

Fully configurable.

IP54 enclosure.

Complete visualization, programming and data logging with the RCC-02/-03.

Up to 15 VarioTracks in parallel on the same communication bus.

Communication sets with Xcom-LAN, Xcom-GSM, Xcom-SMS (opt.).

Compatible with all photovoltaic systems.

Optimal use in an Xtender system with synchronized battery management.

Table 4. *Photovoltaic Panel Size and Cost .*

PV size (KW)	Cost of capital ($)	O&M cost ($ / year)	PV service life (year)	Considered Sizes (kW)
68	800	250	25	0,100,200

Power Converter Size and Cost

- A large generic free-standing converter is required to maintain power flow between AC and DC power system components.
- The standard power of the converter must be equal to or greater than the peak load, even if it is installed below the peak capacity.
- The cost of operation and maintenance in this case is not retained Converters of size 1,100,150,200,300 kw.
- The capital cost of the converter is taken as $300.
- The replacement cost is $300.

Table 6 shows the efficiency of the converter, which is 90%, and its useful life of 15 years.

Table 5. *Power Converter Size and Cost .*

Costs ($)			Useful life (years)	Quantity considered (KW)
Capital	Replacement	O&M		
300	200	50	15	50&100

DC-AC and AC-DC converters of 5.67 kW capacity are used in the system. The average inverter output power is 1.58 kW, the capacity factor is 27.9% and the maximum output power is 3.80 kW. A graph showing the variation of the inverter and rectifier output power over time is presented in Figure 16.

The optimization results are presented in a global and ranked form, showing the most feasible and suitable power system structure for a load and input constraints set by the modeler. The feasible solutions are shown in ascending order of net present cost in descending order, while the overall optimization results present all affordable system combinations based on our NPC. The net present cost was the basis for selecting the distribution systems. The low excess electricity generation and high renewable fraction, are used to compare the power generation schemes in order to test their technical feasibility. The proposed system configuration. The HOMER results show that the PV, grid and converter configuration, in which the PV array capacity is 285 kilowatts and the converter capacity is 5.67 kilowatts with a cyclic load strategy, is the most cost-effective. It has a total NPC of $66,753 USD and a COE of 0.170 USD/kWh, with a renewable energy integration of 27.7%. Not only is it less costly, but it also emits less CO_2 (22,937 tons/year) into the atmosphere. The payback period of the system is only 6.4 years, which is approximately 13.5 years of pure revenue over the 25-year life of the system. As a result, it can be considered the most reliable, cost-effective and environmentally friendly system configuration.

The existing grid-only configuration has an NPC of $86,208 USD and a COE of $0.220 USD/kWh (shown in Figures 13). From an economic and environmental point of view, this system is less practical because the overall NPC and COE are somewhat higher and because it emits 1144 tons of CO_2 per year with 0% renewables penetration. of CO_2 per year with 0% renewable penetration.

The PV system produces considerably less surplus electricity than PV-only systems.

The environmental analysis focuses primarily on carbon oxide (CO_2) related to the operation of power systems. Considering the respective aspects together, the financial aspects stand out. Since the difference between the systems is significant, while the impact or effect of the environment is positive in all system configurations. Although the photovoltaic-wind system is the most advantageous, from the point of view of all these perspectives, such as economic, electrical and emissions analysis.

Electricity Production

The total electricity generation of the proposed grid-connected solar PV system comes from both PV and grid, where the PV system and the grid provide 28.7% and 71.3%, respectively, with no capacity shortage and 38.3% surplus electricity. Figure 14 shows the average monthly electricity generation of the grid-connected solar PV system.

The HOMER simulation software allows the environmental impact to be analyzed by generating the amount of GHG (in kg/year) emitted by the modeled system. In this study, the amount of GHG emitted by the PV system was compared to determine which system was more environmentally friendly.

The energy cost of the proposed system is $0.170 USD/kWh, its net present cost is $66,753 USD and its initial capital cost is $3,859 USD. With a renewable fraction of 27.7%, the system has a surplus electricity of 343,401 kWh/year. The payback period for the 20-year system lifetime is only 6.4 years. The proposed grid-connected solar PV system also emits less greenhouse gases: CO_2 of 22,937 kg, SO_2 of 99.4 kg and 2 kg of NOX to the atmosphere per year.

Conclusions

This paper presents the optimization and cost-benefit analysis through HOMER Pro simulation of a grid-connected solar photovoltaic system for 18 residences (houses) located in Recintos Zapallo, San Mateo parish, Esmeraldas Province. The location chosen for the study is a good option for the implementation of a grid-connected solar system, since it receives significant solar radiation on an annual basis of 5.34 Kwh/m2/year, with a daily energy demand of 6330 Kwh/m2/day.

The simulation and sensitivity results show that the system with a PV capacity of 285 kW, a capacitive converter of 5.67 kW, a grid power price of 0.220 USD/kWh, an average solar radiation of 4.65 Kwh/m2/year and a PV derating factor of 88% is the most environmentally and economically viable system than the current grid-connected system.The analysis also shows that in almost all areas of Recintos Zapallo there is a suitable candidate for the deployment of one of the grid-connected solar PV systems, due to the favorable solar radiation throughout the country.

This study also indicates that future use of the proposed system or similar types would decrease pressure on the grid and increase production from renewable sources, which would reduce the use of fossil fuels and improve energy security by mitigating greenhouse gas emissions. Although grid-connected solar PV systems have considerable installation costs, they are very cost-effective and environmentally friendly in the long term. With their increased reliability and quality of service, grid-connected solar PV systems can play an important role in the electrification of Zapallo Precincts, as well as the rest of the world.

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