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Assessment of the Photovoltaic Potential in a Single-Family Residence in the City of São Luís–MA

Márcio José Melo Santos
Universidade Ceuma, Brazil

Abstract: Brazil is known worldwide for its energy production, since it is basically from renewable sources. The Sun, as a source of clean, free and abundant energy, makes energy systems not only contribute to reducing greenhouse gas emissions, but also a great way to save money. In the middle of this scenario photovoltaic energy has been gaining prominence mainly in the north / northeast region of the country because it is located close to the equator line, with a higher intensity of solar rays. In this way, this work has the objective of evaluating the performance of solar panels installed in the coverage of a single-family residence located in the city of São Luis-MA, thus verifying the energy potential for the region and obtaining quite significant results for this type of energy production.

Key words: energy, solar, performance

1. Introduction

The use of solar energy, inexhaustible if taken into account the scale of terrestrial time, comes from the beginnings of the formation of the Earth. From the first microorganisms to today's evolved organisms, everyone needs sunlight to survive and evolve [1]. Having verified this, the need for a more in-depth study on the subject has led to the promotion of content research.

The sun is the source of energy and responsible for the origin of most renewable energy sources and even those that do not directly use solar radiation have their origin in this. One way of using its potential is to make use of photovoltaic solar energy, which is defined [2] as the energy generated by the direct conversion of solar radiation into electricity. This is done by means of a device known as photovoltaic cell that acts using the principle of the photoelectric or photovoltaic effect.

Photovoltaic solar energy is obtained through the direct conversion of light into electricity, called the photovoltaic effect, and is performed by photovoltaic (PV) devices. The development of photovoltaic technology was initially driven by companies in the telecommunications sector, which sought energy sources, since the photovoltaic cell is the most suitable medium to provide energy, because it has lower cost and weight [3].

The objective of this work was to evaluate the performance of 28 photovoltaic panels installed in the roof of a single family dwelling, occupying an area of 45,798 m², composed by 5 residents and 1 employee, located at Latitude: 02°29'25.71"S Longitude: 44°14'58.34" O in the city of São Luís-MA. In the study in question, the system used is the on-grid. They are those that work concurrently with the electricity grid of the energy distributor. Briefly, the photovoltaic panel generates electricity in direct current and, after converting it to alternating current, is injected into the electric power grid. This conversion is due to the use of the frequency inverter, which performs the interface between the panel and the electrical grid [4].

As for its operation, the solar module is positioned facing the sun, when it receives its rays, generated by the phenomenon called photoelectric effect, the electric

Corresponding author: Márcio José Melo Santos, Esp., Production Engineer; research areas/interests: production engineer, sustainability. E-mail: santosmarcio92@hotmail.com.

energy, which is conducted through cables and is stored in batteries similar to those of automobiles [5]. The conversion of solar energy occurs in a silent manner, without emission of gases and does not require an operator for the system.

After evaluating this, the research verified the solar energy production of the year 2017 after the installation of the panels, comparing it with the previous year to obtain the result of its performance. In this way, consider improving the quality of the environment and preserving the sources of energy and natural resources, thus contributing to sustainability.

Distributed generation of electricity through systems with photovoltaic panels consists of generation units, which in addition to consuming energy, begin to produce part of the energy required, and in some situations may shed the surplus energy to the electricity distribution network [6].

2. Material and Methods

The study aims to work with a bibliographical review of documentary research on photovoltaic systems for energy storage applying the practice, verified with the performance of the panels installed in the coverage of a single family dwelling.

The feasibility of the project was first made through an assessment of the available solar resource for the location. A very convenient way to express the accumulated value of solar energy over a day is through the number of hours of full sun. This magnitude reflects the number of hours in which solar radiation should remain constant and equal to 1 kW/m² so that the resulting energy is equivalent to the energy accumulated for the day and place in question [7].

In this way, data on solar radiation from Brazil were collected through the Brazilian Solarimmetric Map of 2017, based on 6 hours of radiation from the T Sundata program, developed by CRESESB, with a mean value of 5.36 kwh/m²day (Fig. 1).

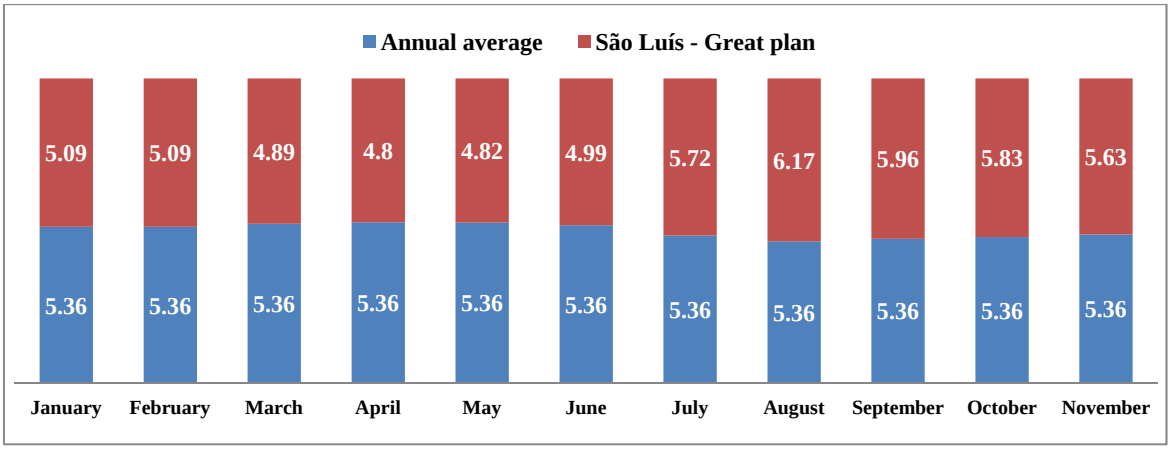

Fig. 1 Estimation of solar radiation during the year and annual average.

Using the data in fig.1 and the calculation memory described below, predict that the monthly average solar energy produced in Brazil will perform satisfactorily.

$$AP = Rad * Área$$

$$Ap = 5{,}36 * 45{,}798$$

$$AP = 245{,}48 \frac{kWh}{mês}$$

Being:

AP - Energy use; Rad - mean value of solar radiation; Area-area occupied by photovoltaic panels.

For this, the work is based on data collected in the city of São Luís, which were obtained using the Aurora Plant Viewer system.

Subsequently, a historical survey of the energy consumption of the residence of the year 2016 was made with Companhia Energética do Maranhão (CEMAR) to build on the results of 2017.

In addition to the survey, a descriptive of loads was

present in the studied environment to verify the energy demand of the residence being demonstrated by Table 1.

Once these analyzes were carried out, it was verified that the electronic equipment was kept the same, without acquisition of new ones in the studied period. Verifying based on the above information, a high monthly energy consumption of the residence, making possible the project's need to reduce energy supplied by the energy company, thus, an economic reduction.

A total of 28 solar panels were installed on the residence's roof, and its performance over the months was verified using the Aurora Plant Viewer software. The monthly graphs of its performance can be obtained by demonstrating the potential amount of pollution that can be avoided by generating electricity through of photovoltaic panels.

3. Results

The use of the solar source to generate electricity offers several benefits, both from an electric, environmental and socioeconomic point of view [8].

After analyzing the parameter prior to the installation of the photovoltaic panels (year 2016), it is possible to observe a very efficient performance of the energy company (year 2017) supplied by the energy company, as shown in Figs. 2 and 3.

Table 1 Description of loads of the consumer unit.

Equipment	Average power (W)	Quantity	Charge (w)
DVD player	30	2	60
Air conditioning 9,000	1300	2	2600
Air conditioning 12,000	1600	1	1600
Electric shower	4500	3	13500
Computer	180	4	720
Cooker hood	300	1	300
Automatic electric iron	1000	1	10000
Cooker hoods	60	1	60
Microwave	1200	1	1200
2 door refrigerator	110	1	220
Printer	180	1	180
11w Fluorescent Lamp	11	40	440
Washing machine	500	1	500
Blender	270	1	270
Internet Modem	12	1	12
Notebook	30	2	60
Router	10	1	10
TV	100	5	500
Overall			**23232**

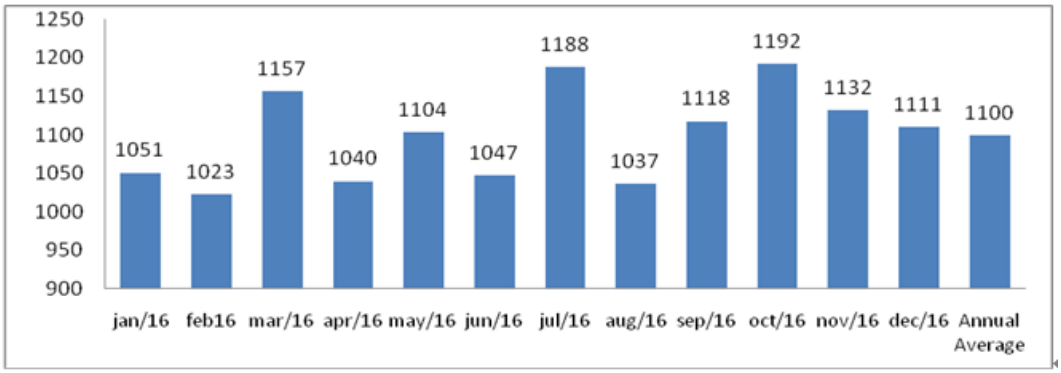

Fig. 2 Survey of monthly energy consumption (2016).

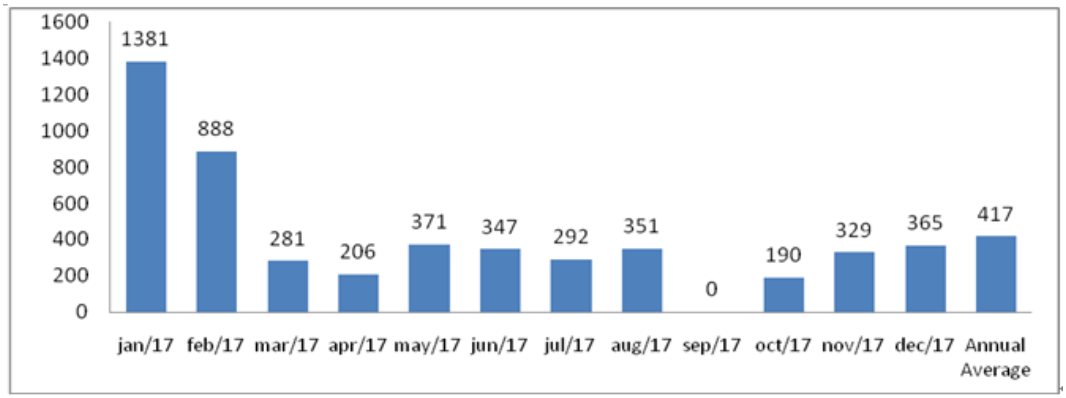

Fig. 3 Survey of monthly energy consumption (2017).

Having said these results, it is observed that they are quite satisfactory in view of the fact that the panels became self-sufficient. The system showed a reduction in the energy consumption provided by the energy company on average of 38% per year. The decrease in the supply by the company was due to the reduction of energy supplied — panel production — directly into the energy account by the photovoltaic system, result shown by the chart below.

The photovoltaic panels presented an annual energy production of 6672 kWh (Fig. 4) and an annual savings of R $ 3490.86 (amount written off directly from the account), resulting in a significant reduction in costs on a monthly basis.

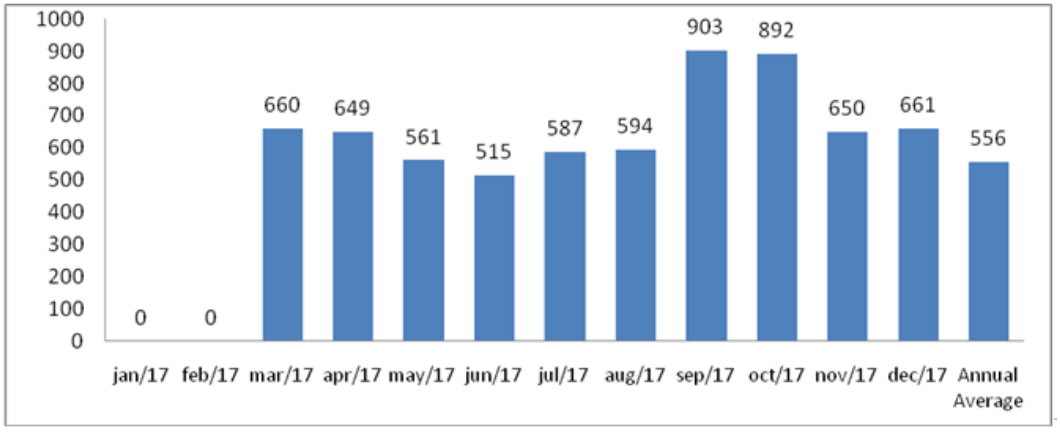

Fig. 4 Production of energy by photovoltaic panels (KWh).

4. Conclusion

Of the renewable energies available on the planet, sun is undoubtedly the most abundant. Solar energy has a safe, clean, renewable and autonomous character, since it does not use life-threatening means, it does not generate waste in its process and allows an independent use since it can be used individually or in community [9].

Converting solar energy into electricity using photovoltaic cells has become a very viable alternative due to increased electricity consumption and environmental problems, mainly caused by the burning of fossil fuels, in addition to using an inexhaustible source of energy. By using only sunlight to generate electricity, photovoltaic modules do not generate noise during the conversion process and can be coupled in homes, buildings and so on.

Based on the methodology proposed in the above work, it was possible to achieve the general objective of this work, where it can be concluded that the results are quite satisfactory, since the system presented a

reduction in energy consumption provided by the energy company on average of 38% year (2016-2017) and presenting an annual energy production of 6672 kWh, resulting in a significant cost reduction on a monthly basis.

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