Implementation of 288 KWP Photovoltaic Solar System On-Grid in a Manaus Industrial Polo Company

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Abstract

The rational use of electricity is practically mandatory, due to the current moment in which the country crosses, mainly due to the reduced reservoir levels of the hydroelectric plants, and where there are high costs in the production of its fuel inputs. fossil fuels, and recent tariff adjustments that the government has been approving year after year, making conventional energy increasingly expensive in the country. Companies and households focus on looking for ways to dodge electricity inflation through clean and renewable energy sources, as is the case here, of photovoltaic solar energy. Aiming to supply about 70% of the electricity bill of a Company of the Manaus-AM Industrial Pole, this work proposes a 288 KWp photovoltaic solar system, consisting of 900 330 W photovoltaic panels, accompanied by 10 Inverters. 30 KW each, connected to the Amazonas Energia Distribution Network, featuring an On-grid solar system, and becoming the largest executed solar energy project in the Amazon and Northern Brazil. The implementation of the system seeks to make feasible and solve the high cost of the electric bill with the application of a solar system, and analyze its investment, financial return and clean energy generation for the next 25 years.

Keywords: Electricity; Solar energy; Photovoltaic panels; On-grid

1. Introduction

Over the years, humanity has become more dependent on electricity, both in terms of housing and work. It

is worth remembering that the use of polluting energy sources to meet the growing demand for energy directly impacts the environment, thus affecting the present and future generations [1]. In this scenario, we enter with renewable energy, reducing environmental impacts, using clean and sustainable energy, as is the case in Brazil, photovoltaic solar energy [2].

The sources of energy generation are mostly indirect forms of solar energy (hydro, biomass, wind, among others). Over the years, along with the development of industries and equipment, there has been an exponential growth in the application of photovoltaic energy, presenting itself as one of the best and most advantageous reliable alternatives for reducing electric energy inputs [3].

The conversion of solar energy generation in Brazil has high potential, where the average daily average irradiation varies between 4.2 and 6.0 Kwh / m² per day, thus, maintains that housing projects should be focused on finding solutions for avoid or minimize expenses with environmental conditioning, provide alternatives to the use of electric water-heated showers and reduce energy expenditure on equipment [4].

2. Theoretical Referential

Rationalizing energy use is an economic and environmental necessity. In the case of electricity in particular, the water crisis that has occurred in recent years reveals the fragility of the water supply system in some regions and also the risks of falling electricity supply or increasing tariffs with more intense energy injection. in carbon at SIN. Although many do not believe it, there is a finite horizon in the power generation capacity that needs to be respected as the environmental impacts of building hydroelectric reservoirs are high. Thermoelectric plants, which send energy to the grid in the country to complement the supply of hydroelectricity to the population, in most cases, employ fossil fuels that are intense in GHG emissions, although there are some that run on renewable sources [5].

2.1 Solar Energy

Photovoltaic solar energy is defined as the energy generated through the direct conversion of solar radiation into electricity. This is done by means of a device known as a photovoltaic cell that acts using the photoelectric or photovoltaic effect principle [6].

The photovoltaic effect is generated by the absorption of sunlight, which causes a potential difference in the structure of the semiconductor material. A photovoltaic cell does not store electrical energy, it only maintains a flow of electrons in an electrical circuit as long as light falls on it. This phenomenon is called “Photovoltaic Effect” [7].

2.2 Photovoltaic Solar Panel

Solar panels, or modules, are the main components of the photovoltaic power generation system. These are formed by a set of electrically associated photovoltaic cells in series and / or parallel, depending on the voltages and / or currents determined in the project. The set of these modules is called photovoltaic generator and constitute the first part of the system, that is, they are responsible for the process of capturing solar radiation and its transformation into electricity [8]. Figure 1 below represents an electrical diagram of an on-grid photovoltaic system.

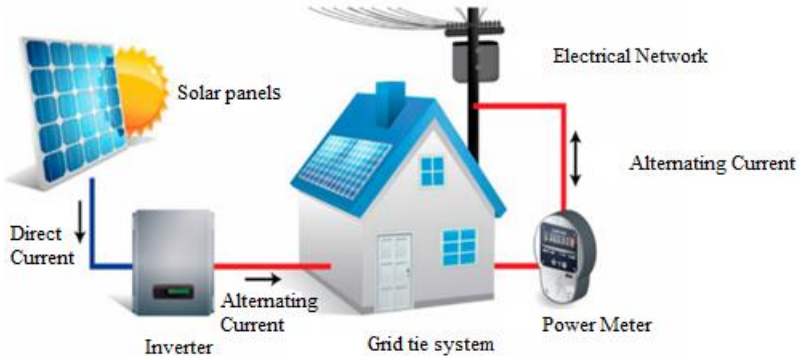

Figure 1. Photovoltaic electrical diagram, on-grid system
Source: http://www.ecomais.ind.br/energia-solar, 2019.

2.3 Systems connected to the utility grid (ON-GRID)

They are those who work concomitantly with the power grid of the power distribution company. Briefly, the photovoltaic panel generates electricity in direct current, after converting it to alternating current, is injected into the electricity grid [9]. Such conversion occurs by the use of the frequency inverter, which performs the interface between the panel and the power grid [10]. With these systems, which work from the array of solar panels installed on the roofs, the so-called solar panel, consumers are able to generate all the energy they consume and thus save up to 95% on their electricity bill [8].

3. Methodology

Data and technical information on design and installation are presented here; individuals and legal entities involved; component specification; commissioning tests.

The electricity projects of this project were prepared under the minimum acceptable technical and safety conditions, in compliance with ANEEL Normative Resolution No. 482/12, of April 17, 2012, and ANEEL Normative Resolution No. 517/12, of December 11th. 2012. NDEE-002 - Low Voltage Electricity Supply - Individual Buildings. Standard NBR-5410 - Low voltage electrical installations from ABNT. NR-10 - Regulatory Standard on Safety in Electricity Facilities and Services, and Ordinance no. 598 amending NR-10.

The connection point to the utility network will be at medium voltage, 13.8KV, through a 3.25mm² insulated copper cable underground branch from the S / N utility pole to the inbox where the meter installed in the sheltered substation measurement booth, giving full access to the utility.

Indirect type (kWh) metering for the consuming unit shall be bi-directional, as recommended by PRODIST - Module 3 - Section 3.7, ie measuring the active energy injected into the grid and the active energy consumed from the grid. EletrobrásDistribuidora will promote the replacement of the installed unidirectional meter by the appropriate bidirectional meter.

4. Analysis and Discussion of Results

In the months of June, July and August of 2018, that is, in the period when the photovoltaic solar system had not yet been installed, there was a large expense in the local electricity bill, totaling the three months, costing to the owner, a total of R $ 83,121.53 (eighty-three thousand, one hundred and twenty onereais and fifty-three cents). These amounts of the electricity bill are, respectively, R $ 27,017.71, R $ 26,491.40; R $ 29,612.42.

With the high values of the electric bill, the solution found to reduce expenses was the investment in the solar system. Looking at the customer's case, a system of 288 KWp was calculated, which would be enough to reduce 70% of its electricity expenses. This system has been implemented, with a total of 900 330 W solar panels, along with 10 power inverters that transform DC (DC) into AC (AC), which is used in corporate homes.

It can be observed the subsequent months of September, October, November and December 2018, and analyze the high amounts still paid on account of electricity, which are, respectively, R $ 24,141.79; R $ 27,465.79; R $ 22,718.96; R $ 21,867.24.

In December 2018, there was a reduction in the electricity bill, which, being a motorcycle production company, noted that in December the production was reduced, and consequently, the amount electricity and also, to compensate for the reduction in December, January had an increase in production and its energy expenses, returning to higher values. As usual, production increases or decreases according to demand, so the months of February and March had significant reductions due to low production of motorcycles. The values for January, February and March, respectively, are R $ 29,429.47; R $ 18,037.74; R $ 15,812.27.

The project for the execution of the work had a total duration of two months, which were April and May, a period that was still being calculated the electricity bill in a conventional way, ie, buying energy from the local electricity distributor. In Figure 2, we can see the site with the successfully installed solar system, ready to generate power in subsequent months. The months that began to generate their own energy were from June 2019.

Figure 2. Factory with solar system installed.

With the project completed and ready to generate electricity, the electricity bill data for June, July and August 2019 were collected, and there is a large positive impact on the reduction of the electricity bill of the site, as we can see in Table 1.

Table 1. Electricity bills from June to August 2019.

Month	Invoice Total
June	**R$ 13.686,71**
July	**R$ 15.220,91**
August	**R$ 7.765,43**

* Values in Brazilian Real

With the use of the solar system, there is a huge difference in the electricity bill. We can make the comparative of the year 2018 from June, July and August 2018 and Table 1, which show values from June, July and August 2019. At the same time of the year, with the same values of factory production. This difference is best explained visually in Figure 3, comparing economic expenditures without the solar power system and the photovoltaic solar power system.

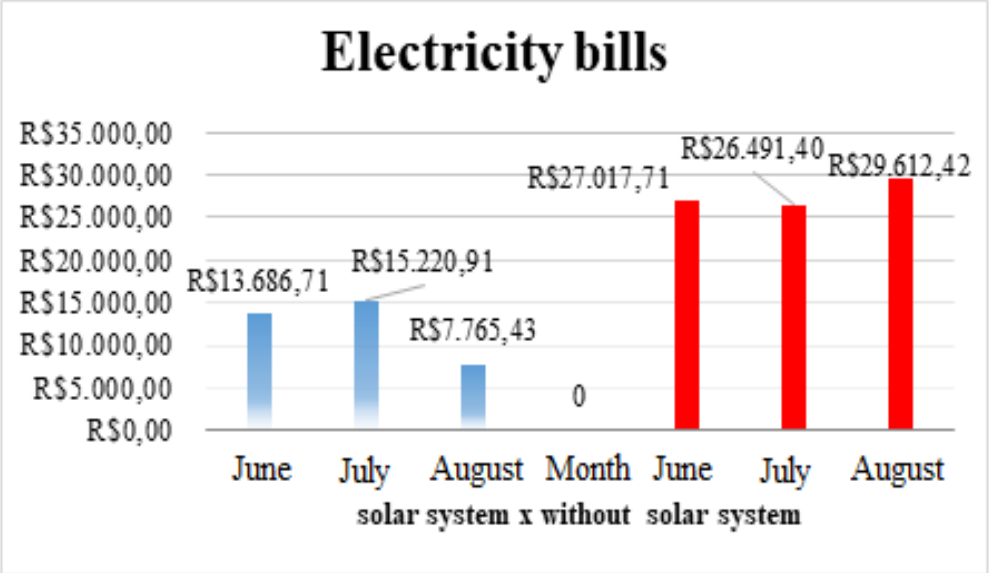

Figure 3. Comparison of solar and non-solar expenses.

* Values in Brazilian Real

Figure 3 shows the amount of electricity spent on the site, significantly reduced after the use of the solar system, generating its own electricity and, comparing the months of August 2018 and the month of August 2019, there is a difference of R $ 21,846.99 (twenty one thousand, eight hundred and forty-six reais, and ninety-nine cents), which in terms of percentage, means an economic reduction of approximately 73.7%, reaching the expected results. , which were calculated to reduce 70% of the values of the electric energy bills.

To obtain this photovoltaic system, there was an investment of R $ 800,000.00 (eight hundred thousand reais), which will have its financial return, PayBack, according to the values reduced by more than 70%, estimated in approximately 3 years. as shown in Figure 4, estimates.

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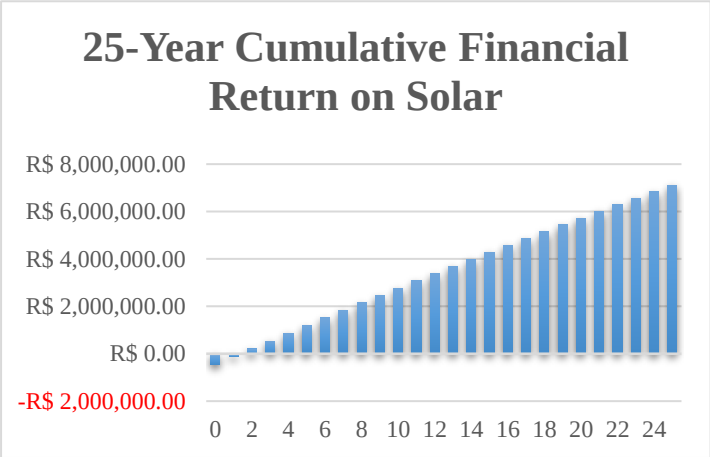

Figure 4. Estimates of financial return.

* Values in Brazilian Real

Figure 5 provides a comparison of how much would be spent on conventional energy for 25 years, and how much it is estimated to spend during these 25 years (warranty time of solar panels) with the solar system.

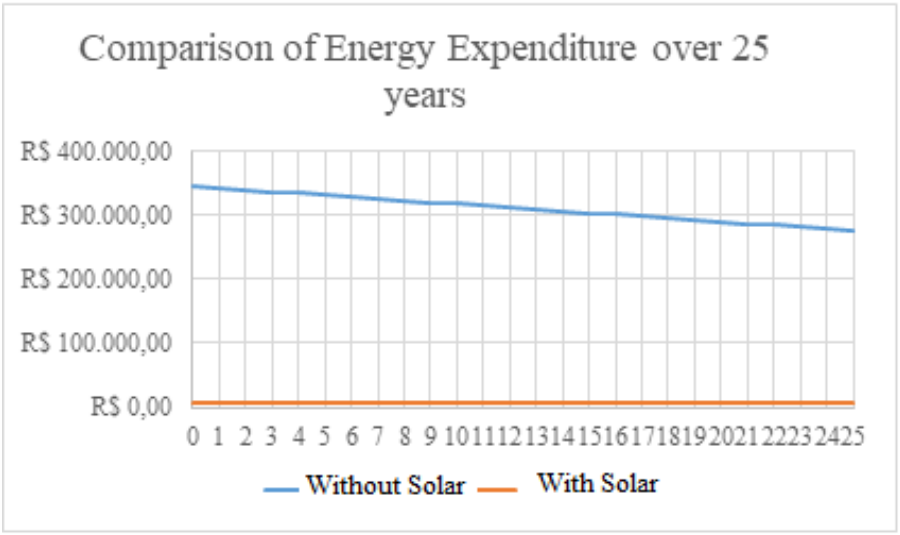

Figure 5. Comparison of expenses with electricity.

* Values in Brazilian Real

Thus, by analyzing the estimates, the electricity bills will be reduced to less than 10,000 reais per month, causing profit, generating electricity and, being self-sustaining, ceasing to emit CO2 in the atmosphere and generating credits in the power utility distribution network. local electricity.

5. Conclusion

Alternative sources of renewable energy, such as solar energy, demonstrate more efficient electricity generation processes compared to fossil fuel-generated energy distributed by the country's electric utilities. In the solar energy system, its use and generation of electricity in a distributed way, have great advantages in terms of reduction of the electric bill compared to the expenses of the conventional transmission and distribution system, besides allowing generation credits to the owners. , which are obtained by the surplus

energy generated by the solar system, thus, lowering values in future electric bills that will be calculated by the utilities, because even with the solar system, even reaching the maximum generation efficiency, the fee is still paid dealership minimum, which varies prices, if speaking of homes and businesses. The investment for a solar power system is high, but considering its cost-effectiveness, it is clearly noted that the financial return is huge, calculating the lifetime of the equipment, which lasts 25 years.

Therefore, analyzing the results, it can be seen that the values obtained are satisfactory, just compare August 2018 and the same month 2019, when the solar system was already generating its own energy, with an economic reduction of over 70% of the value. paid when you did not have the solar system in question. By analyzing the electricity bills before and after the project, we clearly see the advantages of solar energy, but even to obtain such a system, whether residential or industrial, the values for acquisition are still very high, however, withthe advancement of technology that is increasingly developing, the values for acquisition become more accessible to consumers of electricity in general.

6. Acknowledgment

To MSc. Livia da Silva Oliveira, for supporting the development of this article.

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