Original Research

Economic viability analysis of the implementation of a photovoltaic energy production in a small health business

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ABSTRACT

This article analyzed the tradeoff between cost and benefits related to the implementation of a photovoltaic system in a health business company, based on the electrical energy's consumption. Beyond the financial return, this study estimated the CO2 emissions reduction. By the end of the study, is concluded that the discovery and progress of new technologies brings opportunities to transforming costs that were considered inevitable on evitable. It aroused the interest on making a new search find wastes, as well as the most common ones.

Keywords: Photovoltaic energy. CO2 emission. Sustainability. Solar energy. Alternative energy.

1. INTRODUCTION

The present study has the objective of evaluating the possible benefits of implementing a photovoltaic energy generation system in a small health company located in the city of Macaé. The photovoltaic power system consists of silicon plates and an inverter, which operates generating electricity and powering the grid. This energy is stored in the form of a balance that can be used in up to 60 months. The study basically consists of a comparison between the pre-installation measures and the estimates of generation of the system, accompanied by the respective monetary units.

1.1 Photovoltaic System Sizing

Method

From the energy consumption analysis of the last twelve months, the system was scaled according to the procedure described below. Table 1 shows the consumption

Table 1. Consumption History of each month values of the months considered for the calculation.

Month	Consumption History
January	3.579,00
February	3.082,00
March	3.799,00
April	3.559,00
May	3.517,00
June	3.282,00
July	2.826,00
August	3.137,00
September	3.117,00
October	2.989,00
November	2.956,00
December	2.850,00
Total	38.693,00

First, the average daily consumption of each month (ADCM) was calculated in the following way:

$$ADCM\ (kWh) = \frac{(Monthly\ Consumption - \ Minimal\ Rate)}{Amount\ of\ days\ of\ the\ month} \quad (1)$$

The average daily consumption of each year (ADCY) was calculated using the result above:

$$ADCY\ (kWh)\ = \frac{\sum_{1}^{12} ADCM}{12} \quad (2)$$

The Total Potency Required was calculated this:

$$Potency\ (kWp) = \frac{\left(\frac{ADCY}{Solar\ Radiation}\right)}{Yield} \quad (3)$$

The number of panels was calculated using the following equation:

$$Number\ of\ solar\ panels = \frac{Potency}{Potency\ of\ each\ panel} \quad (4)$$

The total space required was calculated as follows:

$$System's\ Total\ Size(m^2) = Number\ of\ Panels\ x\ Panels'size \quad (5)$$

The following constants were used for the calculations:

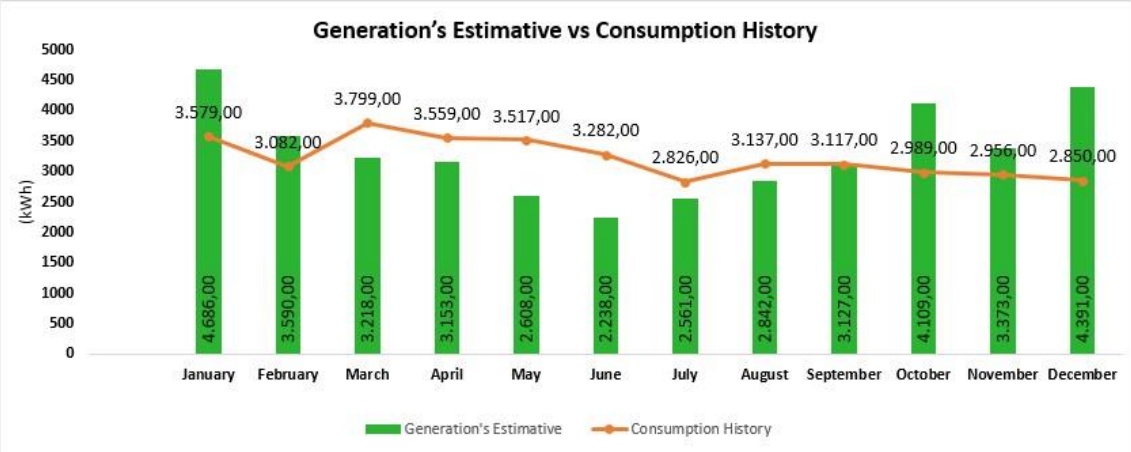
$$Constants \begin{cases} Minimal\ Rate = 50\ kWh \\ Solar\ Radiation = 5\ \frac{kWh}{m^2} \\ Yield = 80\% \\ Solar\ Panels' Potency = 265\ W \\ Panel\ Size = (1\ x\ 1{,}80) m^2 \end{cases}$$

The following values were obtained:

$$Obtained\ Values: \begin{cases} Average\ Daily\ Consumption\ of\ Each\ Year\ (kWh) = 104{,}10 \\ Potency(kWp) = 26{,}02 \\ Number\ of\ Solar\ Panels = 99 \\ System's\ Total\ Size = 178{,}20\ m^2 \end{cases}$$

Graph 1 shows the history of consume versus the generation's estimative, both in months. As in Brazil the exceeding produced of energy can be consumed on the subsequent two months, the extra credits will complement the gap left by the months when the energy production is not enough to meet all the demand.

The general balance of energy quantity generated and consumed is shown on Table number 2.

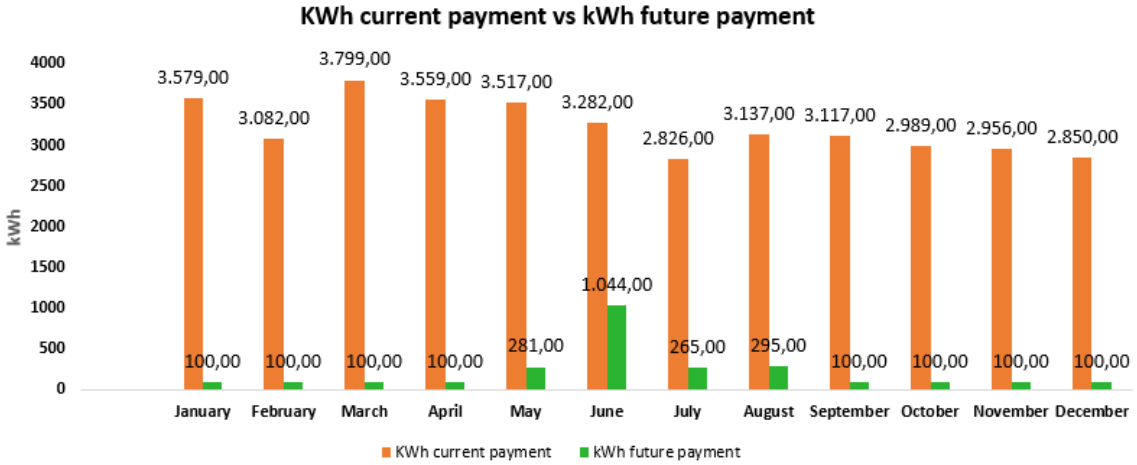


Graph 1. Generation's Estimative vs Consumption History

Table 2. Comparison of consumption measures and generation estimates

Month	Consumption History	Generation's Estimative	Electricity supplied by the grid	Credits generated
January	3.579,00	4.686,00	0,00	1.107,00
February	3.082,00	3.590,00	0,00	508,00
March	3.799,00	3.218,00	581,00	0,00
April	3.559,00	3.153,00	406,00	0,00
May	3.517,00	2.608,00	909,00	0,00
June	3.282,00	2.238,00	1.044,00	0,00
July	2.826,00	2.561,00	265,00	0,00
August	3.137,00	2.842,00	295,00	0,00
September	3.117,00	3.127,00	0,00	10,00
October	2.989,00	4.109,00	0,00	1.120,00
November	2.956,00	3.373,00	0,00	417,00
December	2.850,00	4.391,00	0,00	1.541,00
Total	**38.693,00**	**39.896,00**	**3.500,00**	**4.703,00**

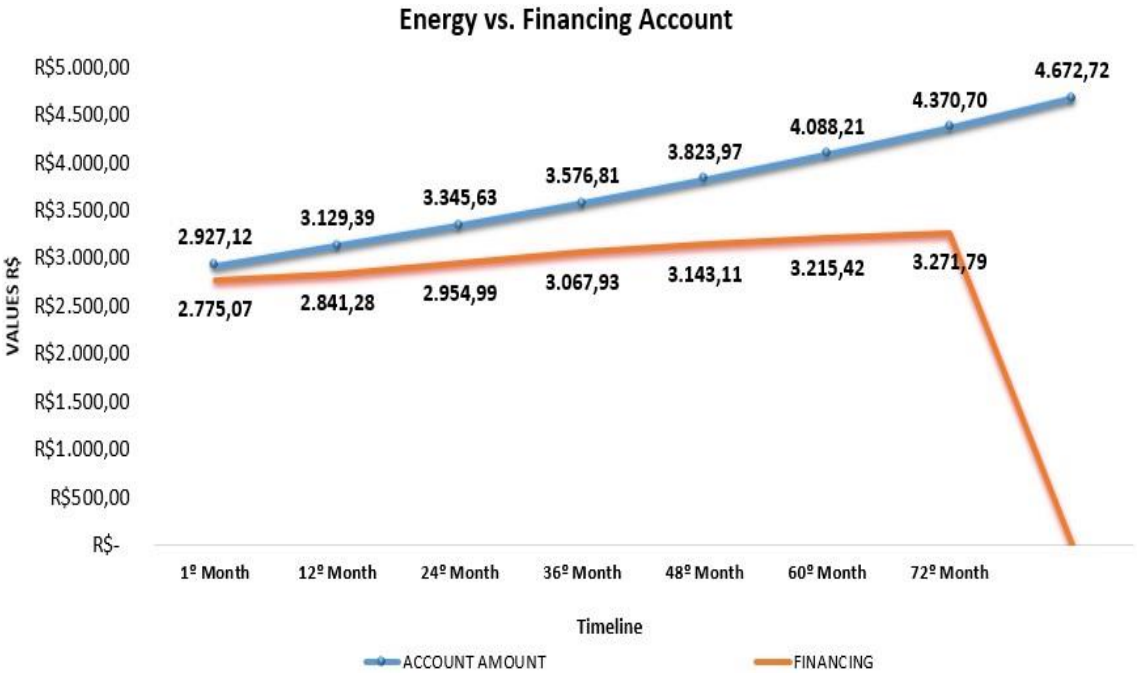
For the study of costs versus benefits, comparisons between energy's system generation and the monthly consume were made. For that, was considered how much kWh the companies pay without using the system and how much it would pay after implementing the system, as can be observed on graph 2.



Graph 2. kWh current payment vs kWh future payment

1.2 Comparison between energy bill versus investment

For the acquisition of the system, was considered a credit line with an interest rate of 12% per year on total investment, divided on seventy-two months (this is the reference value used). From these data, the curves of the amounts of the financing installments and the estimated amounts of the invoices for the same period were plotted, as can be seen in graph 3, below.



Graph 3. Energy vs. Financing Account

According to the budget the total value of the investment was R$148.189,30. Financed in seventy-two months it turns into R$220.243,44. By the end of the finance was observed that the difference between the estimated amount of the invoice and the financials' total was R$43.212,32. This information can be seen below, on table 3.

Table 3. Summary of values

FINANCED VALUE:	R$ 148.189,30
TOTAL FINANCING (72M):	R$ 220.243,44
EXPENSES WITH MAINTENANCE (72M):	R$ 0,00
TOTAL INVESTMENT (72M):	R$ 220.243,44
COST OF THE ENERGY ACCOUNT ACCUMULATED (72M):	R$ 263.455,76
ACCUMULATED ECONOMY (72M):	R$ 43.212,32
ACCUMULATED 25 YEARS:	R$ 2.206.817,45

1.3 CO2 emissions

Besides monetary gain, the implementation of photovoltaic system helps minimizing CO2 emission. Is estimated that using the system reduces this emission in 3.18 tons/year. Although the company does not directly emit CO2, the utility emits a certain amount of this gas in way to attend the demand.

2. CONCLUSION

After the study presented in this article we can come to some interesting conclusions about Lean Six Sigma and the constant search for wastes.

With the advance of technology around the world all current concepts must go through constant reformulations, thus it is possible to perceive that seemingly unavoidable wastes / costs can be eliminated from the matrix of costs of companies, just be aware of the knowledge required to do so.

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