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Energy efficiency analysis at Escola Santa Mônica Maternity in MACEIÓ - AL

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ABSTRACT
The use of electrical energy in public sectors may not be used in the best way, allowing energy costs to be high, since it is not used efficiently and with quality. These facts can be observed in indicators such as electricity bills, overheated conductors, frequent operation of protection devices and burning of hospital electronic devices. It is possible to check the state of an electrical system by measuring electrical current and voltage. The central objective of this work is to analyze the energy quality of the electrical system at the Santa Mônica Maternity School (MESM-AL), located in the city of Maceió- AL, with the aim of not only proposing a contingency plan for expenses, , as well as improving the electrical energy quality of the system as a whole, through precise measurements of the main electrical quantities of the system, as soon as energy efficiency problems are found.

Keywords: Power quality, Frequency, Voltage, Current.

INTRODUCTION

The various regulatory standards for electrical energy systems usually require equipment capable of carrying out sophisticated measurements to measure the various indices related to energy quality. However, one of the most common parameters is related to the power factor, in which Brazilian legislation determines that this must be between 0.92 and 1.00 inductive and 0.92 capacitive. The law provides for a monetary increase in the electricity bill if the power factor is outside these limits (ANEEL, 2021).

The low power factor causes a circulation of reactives in the electrical power system, which makes it inefficient, increasing conductor losses, damaging energy quality, affecting distribution system devices and, consequently, increasing construction costs. and maintenance.

Currently, conventional power theory is no longer valid for cases in which currents are not sinusoidal. In this situation, energy meters, both induction and electronic, may present a reading inaccuracy caused not only by the harmonic current content, but also by voltage and current imbalances and distortions.

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Therefore, such meters must be analyzed under non-sinusoidal conditions, together with imbalances in voltages and currents, through a theory whose power definitions are valid for the current scenario of the electrical system, and for all types of situations that the system may present.

For some time now, the scientific community has been striving to create a theory that encompasses all electrical phenomena that could be applied for any purpose, be it measurement or compensation for disturbances.

The increasing use of equipment based on power electronics (rectifiers, converters, among others) raises the importance of the relationship between this area of electrical engineering and the quality of electrical energy (QEE). Despite providing efficient control of the energy flow, these loads produce harmonic voltage and/or currents that lead to an increase in disturbances caused by harmonic distortion in electrical systems, resulting in a worsening of the quality of electrical energy (LUÍS, 2019). Therefore, it is necessary to measure the harmonic content of the system so that a way to mitigate harmonic distortion problems can be determined.

As harmonics (or harmonic components) cause power quality problems, their regulation is necessary through standards that ensure the maximum level of harmonics tolerated. To achieve this, indicators must be used to quantify and analyze the effects of harmonics (NASCIMENTO, 2007).

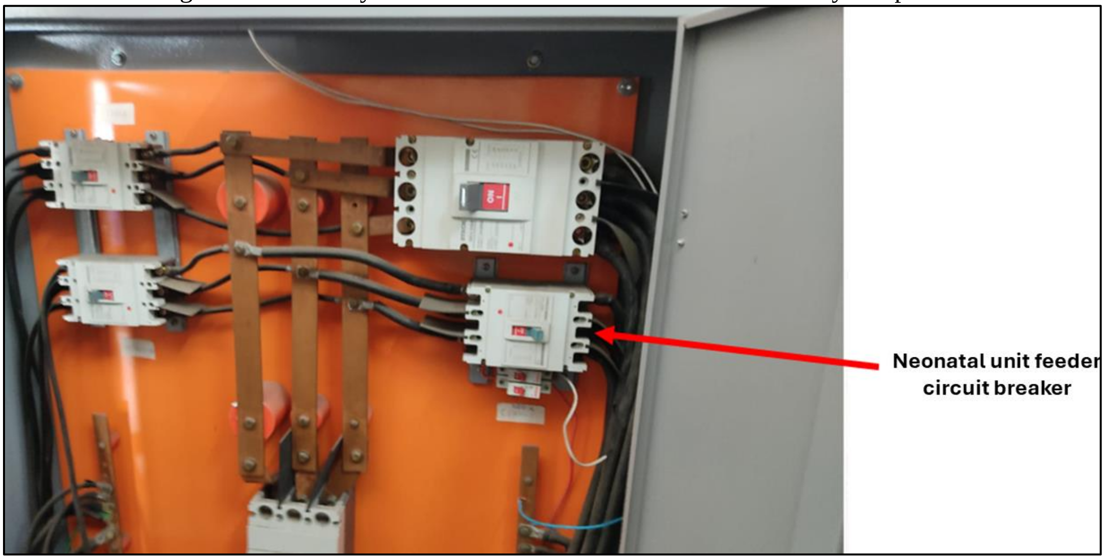
The analysis of electrical parameters will be carried out by measuring the main electrical parameters to check possible disturbances in the MESM's power quality, which may range from low associated power factor (excess reactives), harmonic components of voltage and current in the system, unbalance and voltage fluctuation, being the most important parameters in measurements. Measurements will be carried out with an electrical energy analyzer, of the electrical quantities in the MESM electrical energy distribution board(s), for the purpose of analyzing the energy quality of the MESM electrical system. If electrical characteristics that are harmful to the electrical system are detected, such as low power factor, harmonics, heating of conductors, among others, propose the MESM, an efficiency and quality plan for electrical energy.

METHODOLOGY

In the hospital, inside the transformation station, there is a main panel with the main bus and another secondary panel with 04 secondary feeders.

Initially, the electrical energy analyzer would be installed on the MESM main board. However, as the maximum electrical current of the energy analyzer available for the project is 200 A, the analyzer was therefore installed on the power supply of the hospital's neonatal unit, which falls within the limitations of the instrument for measuring electrical quantities (voltage and electric current). The reference for the electrical energy analyzer used is the DMI P1000R v2. In fig. 1, the place where the power supply for the neonatal unit is located can be seen.

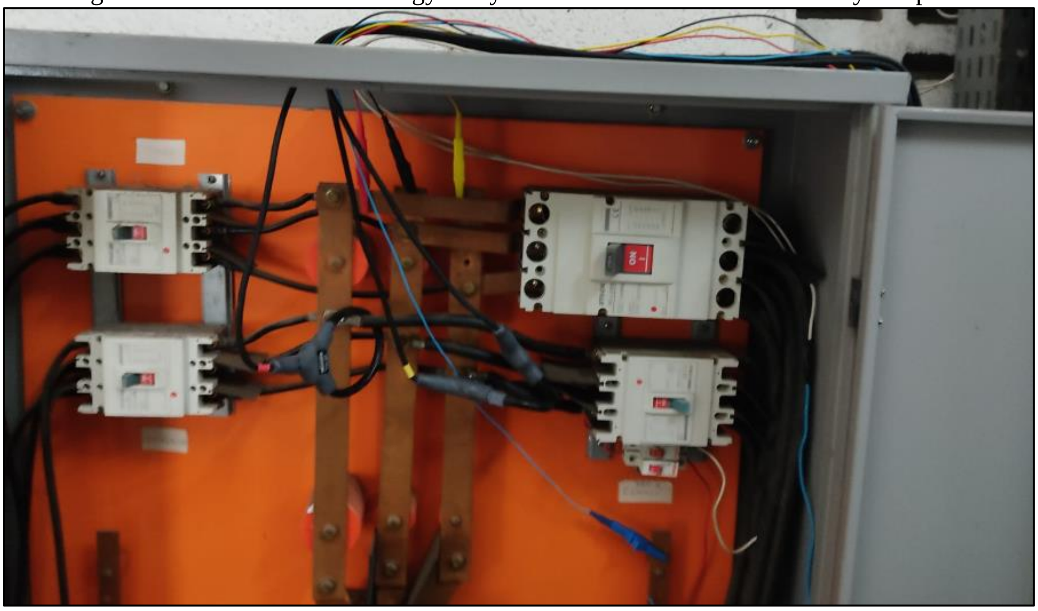
Figure 1. Secondary feeder board at the Santa Mônica Maternity Hospital.



Source: The author, 2024

And in fig.2 you can see the installation of the energy analyzer that was connected to the electrical network on 01/10/2024.

Figure 2. Installation of the energy analyzer at the Santa Mônica Maternity Hospital.



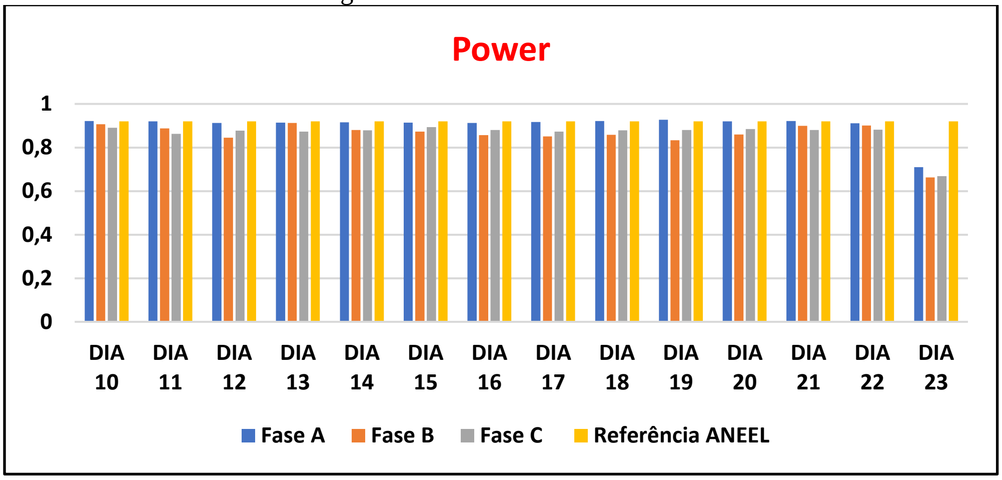
Source: The author, 2024

The energy analyzer was connected to the electrical network for approximately 2 weeks. It was disconnected from the network on 01/23/2024. The data storage capacity is 20 days. At the end, a spreadsheet was generated with the data measured and calculated over the 2 weeks. The parameters were measured over 24 hours a day, uninterruptedly, with 12 records every 1 min, that is, one record every 5 seconds.

RESULTS AND DISCUSSIONS

The parameter graphs were generated by considering the arithmetic mean over 1 day of analysis. In fig.3 the evolution of the power factor over the 2 weeks can be seen.

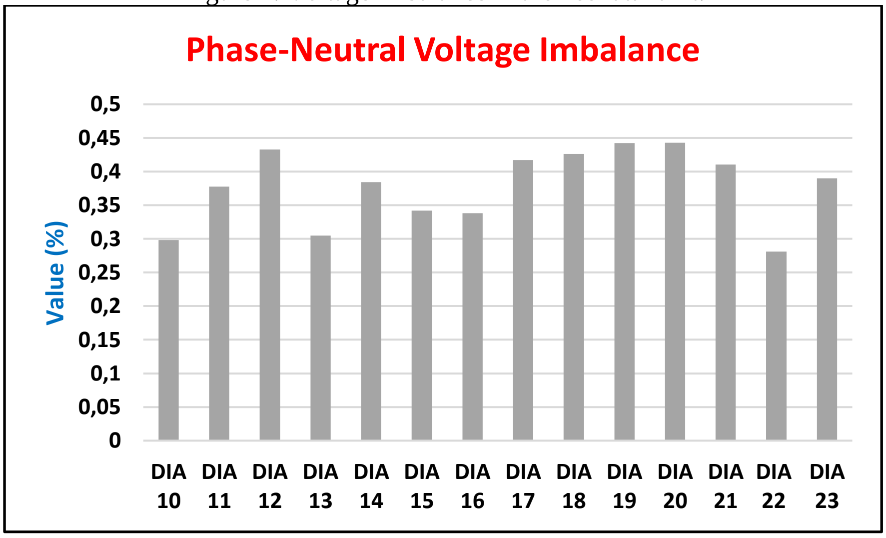
Figure 3. Power factor of the neonatal unit.



Source: The author, 2024

In fig.3 it can be seen that practically throughout the 02 weeks the power factor remained close to the ANEEL reference, that is, 0.92, except on 02/23/2024. This indicates that the load of the neonatal unit does not have a considerable reactive characteristic. Voltage and current imbalances can be seen in figs. 4 and 5.

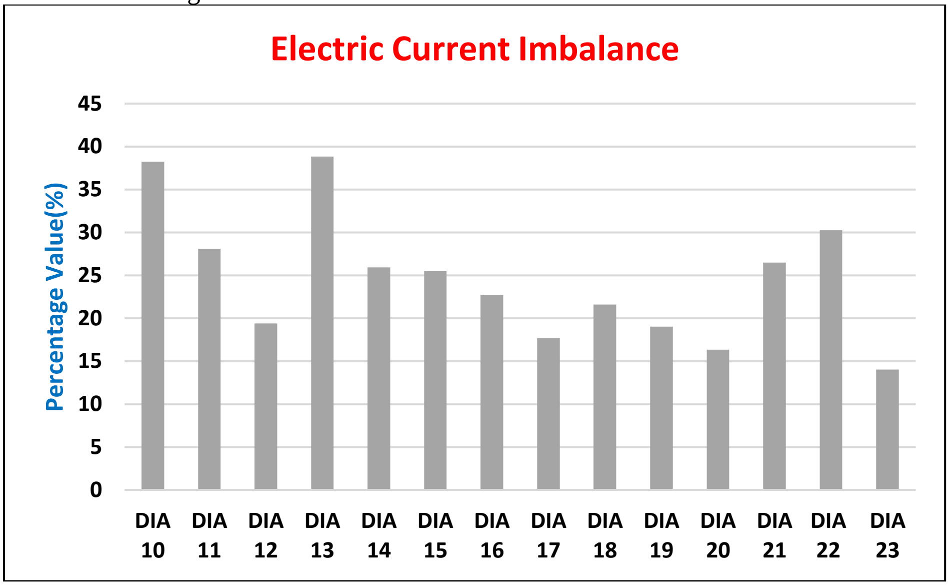
Figure 4. Voltage imbalance in the neonatal unit.



Source: The author, 2024

The voltage unbalance observed over the 2 weeks in fig.4 remained below 3.0%, as recommended by PRODIST, for nominal phase voltages lower than 1.0 kV, as is the case with the phase voltage in the hospital unit, which is 220 V.

Figure 5. Electrical current imbalance in the neonatal unit.



Source: The author, 2024

The imbalance observed in fig.5 occurs due to the fact that the electrical current request per phase is neither uniform nor balanced, causing this imbalance to be high. However, there is no standard that indicates a real problem in PRODIST, regarding electrical current imbalance, however a high imbalance indicates that possibly one or more phases are underutilized, that is, there may not be a uniform distribution of loads. between the 03 phases.

In relation to the moments in which the power factor was recorded below that defined by ANEEL, i.e. 0.92, an analysis of the economic viability of installing a capacitor bank to correct the problem was carried out. According to the reality of the hospital unit in relation to the neonatal sector, due to its characteristic of variable demand throughout the recorded days, it is not viable to install a fixed capacitor bank, as it would compromise the power factor at different times. of the installation, when the reactive power is lower than that defined by ANEEL, that is, for every 1 kWh, it has a registered reactive power of less than 0.425 kVArh, disregarding holidays, Saturdays and Sundays. With the power bank fixed, it would increase the reactive power of the system, causing a decrease in the power factor.

The analysis was carried out observing what the power of the bank would be per phase, considering that the consumption profile in this neonatal unit is uniform. After observing the powers over the 2 weeks, observing the evolution of the power factor, the following characteristic was observed in table 1.

Table 1. Estimated capacitor bank for power factor correction.

Average bank power for phase A(kVAr)	Average bank power for phase B (kVAr)	Average bank power for phase C(kVAr)	Average power of the bank for the 03 phases (kVAr)
0.31	2.34	1.36	3.1

In table 1, the average value of the three-phase bank required for the correction was obtained, taking into account the feasibility of obtaining commercial three-phase automatic banks. At this level of reactive power, it is quite difficult to find three-phase automatic banks on the market. This makes possible correction of the power factor using this method unfeasible. Due to the low amount paid in fines for excess reactives, it is less expensive to pay this fine than investing in the acquisition of an automatic capacitor bank. What can be concluded about the neonatal unit is that in terms of low power factor, the recorded levels are irrelevant for possible correction.

The harmonic measurements observed over the 2 weeks were analyzed and their maximum levels can be seen in table 2.

Table 2. Maximum THD recorded in the hospital unit.

Voltage THD (maximum)	Electric current THD (maximum)
2.49%	5.54%

The levels observed in tab.1 were recorded over the 2 weeks, where the highest THD was sought, in one of the 03 phases of the neonatal unit feeder. Although in Brazil there are no standards that establish the limit of harmonics in electrical installations, only the IEEE 519-2 reference, not adopted in the country, the effects of harmonic distortion are well knThe author, such as; excessive heating of conductors, tripping of protection devices, conducted electromagnetic interference through conductors, among others (CAPELLI, 2013). However, in three-phase circuits with neutral, which is characteristic of the building, according to NBR 5410:2004, it provides for the possibility of increasing the nominal section when sizing the neutral conductor, in relation to the phase conductors, when the third harmonic rate and its multiples is higher than 33%. However, this rate was not observed in harmonics of multiples of three. The highest value found did not even exceed 6.0%. And also in dialogue with the person responsible for the electrical part of the hospital unit, no signs were found that the neonatal unit sector presented problems related to excess harmonics.

CONCLUSIONS

The measurement results exposed in the work, on the neonatal unit in the hospital unit, found that in relation to the power factor the system is efficient, being detected in a punctual manner, moments in which the power factor was below that which delimits the ANEEL. Therefore, it is not necessary to adopt strategies to correct the factor, as the costs would be high and the return would be unfeasible, as there are no commercial parameters for the correction. In relation to harmonics, the levels found do not present risks to the neonatal unit, nor were there any reports of possible symptoms that the harmonics found were harmful to the neonatal unit. The voltage unbalance is within acceptable limits according to PRODIST. And finally, the current imbalance observed is significant, although there is no standard that requires balance between the phases, it is recommended that the distribution of loads between the phases of the system be as uniform as possible, to avoid possible overloads or underutilization in one or more phases.

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