Energy Efficiency in the Rectory of the Federal University of CEARÁ

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Abstract

The present paper relates the activities in the field of energy efficiency in the Rectory of the Federal University of Ceará - UFC. The work is part of the Program of Efficiency in the Consumption of Electric Energy of the UFC - PROCEN. Parallel to that, a study on the use of grid -connected photovoltaic (PV) technology was developed. Based on the energy diagnosis, it was possible to identify energy economy and solutions that increase the efficiency of the systems such as climatization and lighting. This research has the support of ELETROBRÁS.

Keywords: Energy Efficiency, Grid-connected PV systems.

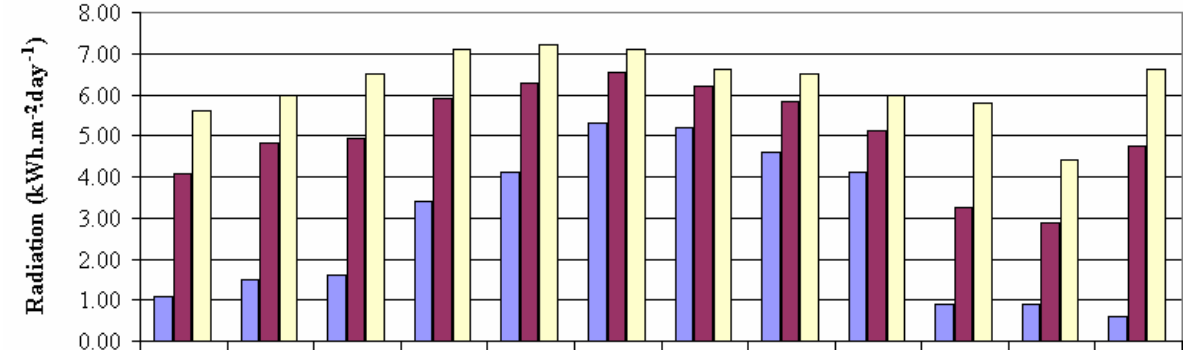
1. Introduction

Today Brazil invests heavily in energy, with great effort of the society, with waste between 20 - 30 % in several sectors, such as processes, installations and equipments [1].
The Energy Balance distributes the electrical energy consumption in the following sections: energy (3.6%), residential (22.6%), commercial (14.2%), public (8.8%), agricultural (4.1%), transport (0.4%) and industrial (46.2%). The public and commercial section show growth in the final energy consumption bigger than 600 % in 2002 in relation to the year of 1970.
From the total energy used by the public section, 77% is represented by electricity. The evolution of the electricity consumption in this section presents 55% of growth from 1987 to 2002 [2]. According to a research of the Brazilian Electricity Conservation Program (PROCEL), the energy consumed by the public buildings is bigger than 10 TWh / year. Potential of electricity saving is in order of 20%, what is equal to an annual economy of 2 TWh / year. [3].

The Rectory of UFC is a public building, that is subject to a time of use tariff (*tarifa horosazonal verde*) and consumption of ca. 284 MWh / year with an area of ca. 4,778 m^2 [5]. This consumption is equivalent to 2,370 middle class residences. In this context, it is important to promote an electricity rational use combined with renewable energy, producing a sustainable building.
Renewable energy combined with improvements in energy efficiency and a more rational approach to energy use, renewables can provide fossil fuels currently offer in terms of energy services - heating and cooling, electricity and transport fuels. [4].

The motivation for renewable energy sources comes of the recognition that conventional forms of energy currently in use are limited. For example, the solar energy is seen as a highly interesting alternative, because is a clean renewable energy source, limitless and available in all the globe.

The knowledge of the solar radiation is of basic importance for a project and performance of a grid-connected PV plant. Figure 1 shows solar data collected in Fortaleza, Ceará. As can be seen, the global radiation values (kWh.m-2.day-1) for the period April 2003 - March 2004 show no significant monthly variation.



	apr/03	may/03	jun/03	jul/03	aug/03	sep/03	oct/03	nov/03	dec/03	jan/04	feb/04	mar/04
Minimum	1.10	1.50	1.60	3.40	4.10	5.30	5.20	4.60	4.10	0.90	0.90	0.60
Average	4.07	4.84	4.95	5.92	6.28	6.56	6.22	5.84	5.13	3.25	2.87	4.73
Maximum	5.60	6.00	6.50	7.10	7.20	7.10	6.60	6.50	6.00	5.80	4.40	6.60

Fig. 1. Monthly values of global solar radiation for the period of April 2003 - March 2004 in Fortaleza

2. Energy Efficiency Actions

The energy efficiency actions are based on the energy diagnosis. With the use of this diagnosis was possible to identify energy saving and solutions that increase the efficiency of the systems such as climatization and lighting.

2.1 Artificial Lightining System

The artificial lighting in the UFC Rectory is composed by lamps of 20W, 40W, 100W and incandescent, totaling 33 kW of installed power. The lighting total density corresponds to the value of 7.89 W / m^2. Analyzing the lightining system of Table 01, it is observed significant opportunities of saving that can be reached through appropriate measures of electricity rational use as:

- Replacement of fluorescent lamps of 20 W, 40 W and incandescent, by 16 W, 32 W and fluorescent compact lamps respectively;
- Replacement of the incandescent lamps for fluorescent compact lamps;
- Replacement of the luminaires for others of high performance;
- Replacement of eletromagnetics ballast with low factor of power, for electronic ballast with high factor power and high frequency.

The adopted lamps have a bigger perfomance than conventional lamps. These have the same luminous flow and smaller power than the conventional ones; besides this advantage they produce light with temperature of 4,000K, allowing better reproduction of colors, so more visual comfort. The use of modern luminaires can produce a significant reduction in the amount of conventional luminaires, being obtained the same result of the conventional system.

In the project, the ballasts are dispositive necessary in any types of fluorescent lamps, it is chosen the electronic of high perfomance. These have small losses, with that energy is saved besides eliminating the heat emission for the environment.
Simulations in a lighting software were made for each environment of the Rectory. Based on the ones, the replacement of the old illumination systems for others of high efficiency, an economy of 50% is verified in the lighting load and an increase of 39% of the lighting level. The project implementation decreases the energy indicator, ligthing total density, for 3.92 W / m^2, presenting a system more efficiency.

2.2 Artificial Climatization System

The current artificial climatization system consists in majority air-conditioning of the type window, presenting a climatization total density corresponds to the high value 33.83 W / m^2. From replacement of the existent equipments in end of useful life, for ones technologically more advanced, it was obtained a reduction of the thermal load estimated in ca. 32%. The equipments proposed should have certification PROCEL.

2.3 Financial technique attractiveness

It was used for the evaluation of the relationships of benefits and costs (RBC), a calculation method considered by the National Agency of Electric Power - ANEEL - in the Manual for Calculation of the Program of Energy Efficiency [6].
In the lighting system, RBC calculated was 1. This value shows that the benefits are reached with the implantation of the project are equivalent at the costs, during the useful life of the equipments. In the climatization system, the value of RBC calculated was 1.49, so larger than 1. This value shows that the benefits to be reached with the implantation of the project are larger than the related costs, during the useful life of the equipments.
With the study of the viability of replacement of the artificial lightning and climatization systems for other more modern and efficient, the system would make about 43% of total consumption saving and power reduction of 42 % (Table 01).

Table 01. Efficient lighting and climatization upgrades - summary.

Item	Amount	Current power (kW)	Propose power (kW)
Fluoresc lamp	578	22.2*	14.1*
Fluorescent Compact	27	0.5	3
Incandescent	151	5.9	-
Ar-conditioning - type window	58	186.3	107.9
Total		**214.9**	**124.9**
Load Reduction (kW)			**90.0**
Load Reduction (lightining + climatization)			**42%**

*Lamps and ballasts power.

4. Grid-Connected PV System

4.1. Proposed PV system

The proposed PV system for use in the UFC Rectory is an initial study of a grid-connected PV technology in the university for giving an energy autonomy, making use of the available

solar energy through PV technology during the all year [5]. The proposed plant has 25.35 kWp and a 26 kW inverter, obtained through the combination of inverters of 1 kW.
It was chosen to cover part of the Rectory parking with PV modules because no change in the building is allowed. In this way, the structure has the benefit of the electricity and shadow for the cars. The parking has a total area of 826 m^2. The project involves the equivalent of ¼ of the total parking area, without bringing any damage to the green area or the architectural structure of the Rectory (Figure 2).

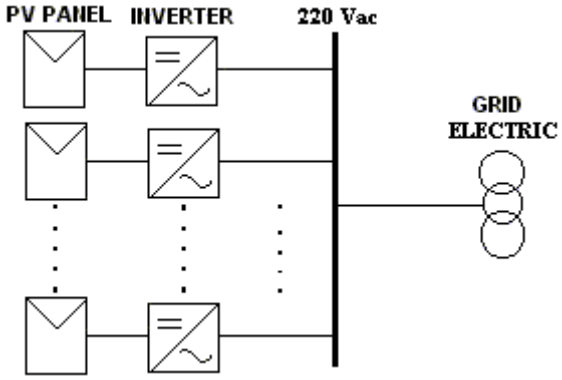


Figure 2 – PV proposed connection

4.2 Estimate of PV electricity production

The implementation of the PV plant can contribute with a medium quota of 13% of the electricity demand. The installation operating in an annual base can produce 36 MWh. The output solar is estimated from the data global solar radiation available (Fig.1) and area of the PV array installed, considering a efficiency factor of 10%.
The PV plant of 25.35 kWp grid-connected can produce the equivalent the total load of artificial lightining of the Rectory of UFC. Combining the energy efficiency with renewable energy in the Rectory, the PV plant can give a more significant contribution according with Fig. 3. and Fig. 4.

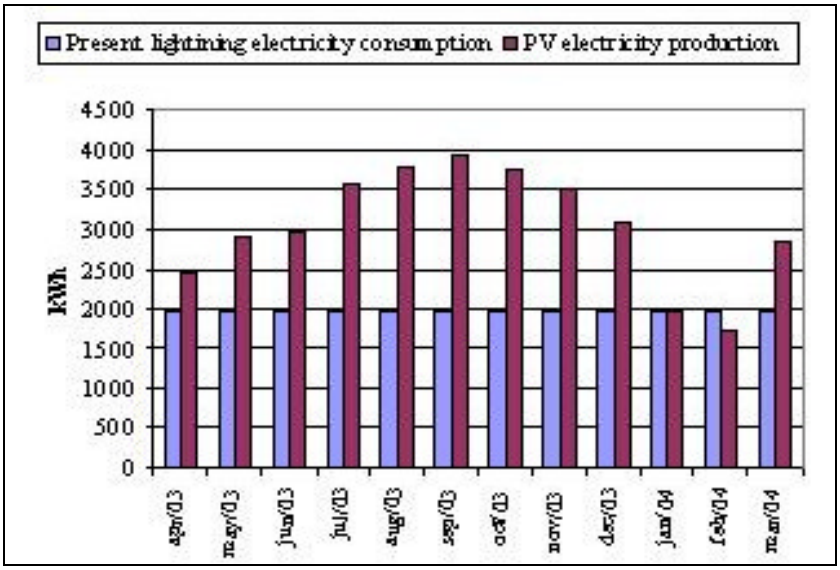


Fig. 3. PV electricity production versus present lightining electricity consumption (kWh) of the Rectory.

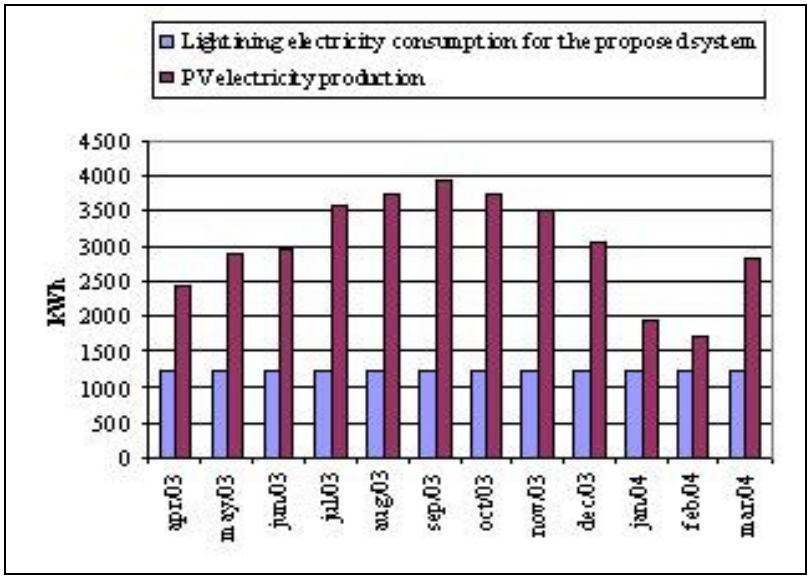


Fig. 4. PV electricity production versus lightining electricity consumption (kWh) of the Rectory for the proposed system.

5. Conclusion

The study shows that public buildings, with electric system installed with a traditional structure, offer significant opportunities of energy saving through replacement of the lightining and climatization components. The replacement of these components in the UFC Rectory contributes to the reduction of the consumption and installed power, making the use of the electricity more efficient. The relation of benefits and cost calculation, made from the optics of the consumer, showed that the benefits to be reached with the implantation of the energy efficiency actions are bigger than the costs involved.

To combine renewable energy with energy efficiency is a form of creating a sustainable building, without damages to the structure or green areas. The electrical energy being generated close to the consumption reduces transmission and distribution losses, and can still contribute to the autonomy of the UFC Rectory.

Acknowledgements

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