Comparative Study to Identify the Energy Efficiency of Fluorescent Lamps and LEDs

Moura, Mariangela; Motta, A.L.T.S.; Noya, M.; Soares, Carlos Alberto Pereira

Abstract-- The current model of energy matrix produces strong impacts on the environment, such as the modification of ecosystems and the air pollution through greenhouse effect gas emissions like CO2, resulting from the burning of fossil fuels. Because of these and other negative human actions on the environment, the planet watches environmental disasters due to climate changes in progress. Thus, the use of alternative energies combined with the rationalization of energy consumption can be directly linked to reducing the emission of pollutants in the atmosphere reducing these negative effects on the environment.

The search for better energy performance of buildings must be a constant concern of professionals, through projects aimed at efficient technological solutions based on the full utilization of available natural resources in nature. This efficiency should be based on finding less energy to provide the same amount of energy value. Thus, the article presents a case study conducted at the headquarters of the Secretaria de Estado de Fazenda do Rio de Janeiro (State Department of Finance of Rio de Janeiro), between the current lighting system, consisting of fluorescent lamps compared to Light Emitting Diode - LED bulbs. The case study aimed at testing the efficiency and quality of the light emitted by the LED lamps, compared to fluorescent lamps, and verify by measuring the percentage of savings achieved between the two lighting systems, their performance and index brightness between fluorescent and LED lamps. The study presents a comparative record between the two types of bulbs and should serve as the basis of study for other researches related to energy efficiency, since it provides important data of use between traditional and widely used fluorescent and LED lamps, less used in function of high cost.

Index Term-- Energy efficiency, Sustainability, Environment

1. INTRODUCTION

Initiatives that prioritize energy efficiency in public buildings are a priority in many countries, since they aim at the economy of the system, besides contributing to the reduction of emissions of greenhouse effect gases, which cause negative environmental impacts.

A building is more energy efficient than others when it provides the same environmental conditions with a lower energy cost. In buildings, energy is used as electricity to operate equipment for the comfort of its occupants and users. Such equipment includes refrigeration systems, lighting, vertical transportation, operation of offices and other devices [18].

In Brazil, in 1985, by interministerial decree No. 1877, the Ministries of Mines and Energy and Industry and Commerce established the Program for Energy Conservation - PROCEL, coordinated by the MME - Ministry of Mines and Energy and operated by Eletrobras (Brazilian Electric Utility Company) with the aim of promoting the rationalization of energy consumption. The program consists of several sub-programs, particularly in the areas of public and industrial lighting, sanitation, education, public buildings, municipal energy management, information technology development and dissemination.

As a consequence of the crisis in energy supply in 2001, Brazil has several Laws and Decrees applicable to public buildings and various ministry initiatives that seek to rationalize the consumption of energy resources, which is why, the article presents a case study and draws an analogy between two different types of lighting: fluorescent T8 lamps - 16W, widely used in corporate environments and tubular lamps LED- Light Emitting Diode system. The initiative aimed to verify the quality of the light emitted by fluorescent lamps compared to LED bulbs, the brightness index and the percentage of savings between the two different types of lighting. The study aims at promoting interest in new sources of cheaper and cleaner energy, since energy is the driving force of socioeconomic development. The tests were conducted between December 2014 and January 2015 and proposes to minimize spending on electricity consumption, which has as a main objective, the preservation of the environment, since the current model of energy matrix adopted by most countries promotes the degradation of the environment, changes the ecosystem, emits gases that contribute to the increase in the greenhouse effect, resulting from the burning of fossil fuels, among other harmful factors to the environment.

The rational use of energy resources devoted to public buildings must be a constant topic of research due to the importance of the subject. Therefore, the study aims at meeting the economic requirements of the electrical system of the building. The proposed evaluation through tests, of the newly designed, current lighting system, in T8–16W fluorescent lamps and LED tube lamps provides important data to the lighting system with tube LED lamps and their application. For this reason, proving, through testing, items such as the percentage of savings between the two types of lamps is an important document, since relevant data reveals a little known technology less used by great part of the population.

The article presents a study on energy efficiency in a Public Building located in the State of Rio de Janeiro. This is an example of Modernist architecture in Brazil designed by the architect Affonso Eduardo Reidy in the 1950s. The
building, owned by the Government of the State of Rio de Janeiro has recently undergone a retrofit with a broad view of sustainability. At the time, fluorescent and reflective fixtures with high performance fins were used.

Present a comparative study between the current system of the newly designed Public Building consisting of 16W fluorescent lamps in high performance tracks of lighting, with systems of reflective fins, in contrast with the LED technology system. The proposal is to measure the energy efficiency, that is, the percentage of savings presented by the two systems, the quality of light emitted by the LED tubular lamps, compared to fluorescent lamps, their performance and brightness index between fluorescent and LED lamps. The study suggests an important record about energy efficiency and can serve as a reference scientific researches between traditional fluorescent for other lamps and LED lamps.

2. ENERGY STATISTICS IN BRAZIL

According to the National Electric Energy Agency - ANEEL, Brazil has 72,245 million units of electricity consumers [2]. These data correspond to April 2014, the month in which the consumption of electric energy in Brazil totaled 27,174,690 megawatt-hour (MWh), as reported in table 1.

The largest number of consumer units belongs to the residential sector, with 61,388 million, followed by the commercial sector, services and other activities with 5,256 million, 4,169 million rural connections, 572,904 industrial customers and government with 540,479, still according to table 1.

<table>
<thead>
<tr>
<th>Consumption Sector</th>
<th>Electrical energy consumption</th>
<th>Revenue from electrical energy supply</th>
<th>Number of consumer units</th>
<th>Average energy supply (MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>11,291,988,27</td>
<td>3,779,178,316</td>
<td>65,722,895</td>
<td>354,68</td>
</tr>
<tr>
<td>Industrial</td>
<td>2,344,735,66</td>
<td>1,455,287,125</td>
<td>275,351</td>
<td>277,47</td>
</tr>
<tr>
<td>Commercial service</td>
<td>7,284,314,71</td>
<td>2,346,876,149</td>
<td>5,535,010</td>
<td>322,17</td>
</tr>
<tr>
<td>Rural</td>
<td>1,453,923,45</td>
<td>338,658,893</td>
<td>4,322,068</td>
<td>232,61</td>
</tr>
<tr>
<td>Government</td>
<td>1,352,210,20</td>
<td>448,693,974</td>
<td>266,415</td>
<td>396,81</td>
</tr>
<tr>
<td>Public lighting</td>
<td>1,290,368,81</td>
<td>247,242,405</td>
<td>90,390</td>
<td>106,17</td>
</tr>
<tr>
<td>Public Service</td>
<td>1,002,324,82</td>
<td>244,942,594</td>
<td>75,485</td>
<td>289,39</td>
</tr>
<tr>
<td>Other consumption</td>
<td>46,103,14</td>
<td>16,035,399</td>
<td>9,487</td>
<td>345,28</td>
</tr>
<tr>
<td>Tapping</td>
<td>33,313</td>
<td>6,376,192</td>
<td>83,388</td>
<td>244,37</td>
</tr>
<tr>
<td>Rural Irrigation</td>
<td>409,765,18</td>
<td>75,614,370</td>
<td>87,827</td>
<td>187,17</td>
</tr>
<tr>
<td>Public Service</td>
<td>65,627,83</td>
<td>16,490,828</td>
<td>697</td>
<td>251,28</td>
</tr>
<tr>
<td>Total</td>
<td>29,416,543,31</td>
<td>8,973,772,390</td>
<td>77,043,276</td>
<td>305,96</td>
</tr>
</tbody>
</table>

2.1. Programs, Decrees and Energy Efficiency Laws in Brazil and in the world

The need for measures in order to hinder excessive spending on energy in public buildings has attracted the attention of many countries, which have introduced programs that encourage a policy of rational use of energy, to be adopted by managers aiming at sustainability and environmental and technological development. In Europe, since the early nineties, there has been a concern about the standardization of energy efficiency. In the U.S. and Japan, this practice occurs since the seventies. Energy efficiency labels and Minimum Standards are being deployed in more than 50 countries [10-11]. Their findings foster energy savings and convincing marketplace transformations [23].

In Germany, for example, Deutsche Energie Agentur - DENA, established in 2008, is responsible for all issues related to energy efficiency. Among the programs and activities under their responsibility, it is possible to highlight a program named Energy Performance Certificate for Buildings.

In France, a Direction Generale de l’Energie et des matieres premieres – DGEMP, under the Ministry of Ecology, Energy, Sustainable Development and Land Use Planning is responsible for the formulation of energy policies, as well as for ensuring the supply of mineral sources. Among its duties, we can highlight the development of regulations aimed at increasing energy efficiency in buildings.

In the UK, the Energy Efficiency Accreditation Scheme - EEAS is a paid certification, which recognize the reduction of energy consumption not only in the private sector but also in the public organizations.

In the United States, the Federal Energy Management Program program - FEMP was created to accelerate the introduction of energy efficiency in the public sector. FEMP foster orientation to federal agencies and promotes the conservation and efficient consumption of energy and water, increasing the use of renewable energy sources.

In Portugal, the P3E Programme - National Programme for Energy Efficiency in Buildings, sponsored by the Directorate General for Geology and Energy (DGEG), an agency of the Portuguese Public Administration, aims at contributing to the promotion and evaluation of policies related to energy and geological resources. The program brings together a set of strategic activities designed to mitigate the short-term trend of growth in energy consumption in buildings, thus contributing to the decreased levels of Greenhouse Gas Emission (GHG).

Brazil has some legal mechanisms and related energy efficient institutions. The introduction of some devices aims at accelerating the inflow of technologies and energy efficiency measures. The institutions involved are the Ministry of Mines and Energy (MME); Eletrobras, electric utilities company through PROCEL Program; Petrobras, Brazilian multinational energy corporation through COMPET Program; the Brazilian electricity Regulatory Agency (ANEEL), through the Energy Efficiency Program for Dealers and Distributors of Electrical Energy (EEP), regulated by the ANEEL Agency; the distribution companies and the National Institute of Metrology, Standardization and Industrial Quality (INMETRO), through the Brazilian Labeling Program (PBE). The article highlights the National Electrical Energy Conservation Program - PROCEL established in 1985 by the Ministry of Mines and Energy and Industry and Commerce which currently accounts for approximately 98 % of the results obtained by PROCEL in 2008 [6]. The program holds
subprograms, including PROCEL EPP - Energy Efficiency in Public Buildings, which was established in 1997 in order to promote energy efficiency in public buildings within Federal, State and Municipal levels. The program also aims at obtaining the commitment of managers in a systematic fight in order to hinder electricity waste in public buildings by unifying policies and disseminating best practices, as well as successful experiences, encouraging states and municipalities to try changing habits combating waste of energy resources.

The article also draws attention to one of the main legal instruments related to energy efficiency - Act no. 10.295/2001 (Energy Efficiency Act) and Decree No.4.059/2001, which regulated the referred Act. This second instrument has created the Energy Efficiency Indicators Steering Committee (CGIEE), aiming at developing a program of targets showing the evolution of the levels to be achieved for each regulated equipment.

2.2. Energy efficiency and its importance as public policy for the environment

Reports written by Intergovernmental Panel on Climate Change - IPCC highlight the importance of energy efficiency as part of the actions for the stabilization of greenhouse gas emission [12]. Studies undertaken by the International Energy Agency, attribute to the energy efficiency actions approximately 50% of the contribution to stabilize carbon emissions by 2050, compared to 21% of renewable resources and 6% nuclear energy [13-8].

The developed economies have managed to decouple their energy demand from economic growth through encouraging more efficient technologies. However, the demand for energy continues to grow in developing countries, especially in Brazil, China and India, where there is still a gap when it comes to putting into practice more efficient technologies [25].

Energy efficiency (EE) can occur due to technological progress, either within cost reduction of the economic sectors, or even when compared to the consumer reaction. However, these factors have not been sufficient. Public policy and market regulation have been increasingly employed in the advancement of measures and technologies associated to a greater energy efficiency [14-17-24-22-15].

Several experiments of structural redesign on energy efficiency were introduced in some countries in the nineties including the privatization of energy companies in order to promote greater participation of private investment, and competitiveness. Meanwhile, in most of these countries, either the industrialized ones, or the developing ones, the movement underwent the insertion of public policies, which aimed not only at preservation, but also at increasing investments in order to ensure universal access to energy services, environmental preservation, energy efficiency and climate change [4-5-15-24-26].

In Brazil, it was not different. When the electricity sector was privatized, the Government sought for political and financial support in order to improve energy efficiency. As an example, one can observe the requirement imposed upon the power distribution companies, that they must apply part of their annual net revenue to programs related to energy efficiency (Act 9.991/2000).

2.3. Economy and standardization through the Light Emitting Diode - LEDs

The public sector has an estimated potential savings of up to 40% of its electricity consumption. This percentage shows the extent of the impact that can be achieved in reducing public spending. The standardization has a potential for significant impacts to increase energy efficiency and establish a sustainable market for efficient technologies [16].

Due to its great capillarity (Federal, State and Municipal) the public sector should set an example of pilot projects to other consumption sectors, since energy is one of the most important expenditure in this sector and savings may release resources to other areas of greater social impact. In case 30 to 40% of the electrical energy costs were spared, the savings could add up to R$ 2 to 2.5 billion per year [21].

Some solutions and strategies have been adopted in several countries to accelerate the modernization of the sector. These solutions are directly linked to the reduction in consumption that aims at energy efficiency [20].

It is in such scenario that the article presents a study on energy efficiency and tests the efficiency of LED tube lamps as compared to traditional fluorescent lamps.

The light emitting diodes-LEDs, are electronic components which, when energized, emit visible light, once the emission happens through quantum effect. They represent a new paradigm [19]. A breakthrough in traditional artificial lighting. They are known as harbingers of a new era in lighting, thanks to their benefits and the various advantages that they present over sources of traditional lights [9].

Among the benefits and advantages, we can highlight: the innovative technology; the varied application and flexibility, thanks to the reduced dimensions and shapes; instant activation, durability and long working life, which allow lower costs of spare parts; high luminous efficiency, since they are punctual light sources with less loss in comparison with traditional lights; variety and color control; temperature variation; low heat dissipation and greater robustness, as well as better performance in relation to conventional lighting. With regard to environmental sustainability, they are energy-efficient, and are mercury-free, considered one of the most harmful metals to humans and the environment. Moreover, they guarantee low energy consumption, with savings of up to 80% in comparison to other technologies [3-19-7].

Some manufacturers guarantee a 50,000 (fifty thousand) hour durability to LEDs against 10,000 (ten thousand) hours of fluorescent lamps.

However, the literature presents some negative aspects in relation to LED lamps. It is estimated that their cost may be three times higher than the cost of traditional lamps. Nevertheless, their useful life and high yield make up for loss, creating compensation mechanisms [9-7].

The quality of the light emitted by LED lamps is questioned, because it tends to be diffuse, not providing
focused lighting, and loss of luminous flux [9]. Such statement meets the study performed in this research, for the object of the study, the working environment illuminated by LED tube lamps, had a significant improvement of lighting, as shown in the case study. As for the loss of luminous flux, it has not been possible to identify within the period tested.

3 METHODOLOGY AND CASE STUDY

The case study below presents an analogy between the consumption of fluorescent lamps opposed to LED lamps. The current lighting system in the working area of the building is composed of fluorescent tubes T8 4x16W on tracks composed by reflective fins. The lighting pagination design was done in accordance with illuminance criteria, determined by the standard NBR 5413/92 that fix recommended values for interior lighting [1].

The study aimed not only at measuring the consumption in Kwh between the two lighting systems, but also at demonstrating the efficiency and the quality of the light emitted by the two systems, in the case studied, fluorescent lamps, opposed to LED lamps and the brightness index between the two types of lamps. It is worth mentioning that the tests were carried out based on the existing fixtures, with no intention of replacing them.

3.1 Methodology

In order to obtain reliable results two independent circuits were created in the box breakers of one of the floors of the Public Building. For each circuit, a wattmeter was installed, as shown in Figure 1.

![Fig. 1. Record of the wattmeter installation in the circuits](image)

In the first circuit 12 62x62cm luminaries composed of reflective and fluorescent lamps 4 fins at each lighting fixture were installed, illuminating the first working area in operation according to figure 2. In the second circuit, the same quantities and types of luminaires with 4 LED lamps in each fixture were installed, lighting up the second working area in operation, according to figure 3. The wattmeter measured the kWh for each circuit during 34 (thirty-four) days.

3.2. Items analyzed:

I. The luminance efficiency and the quality of the light emitted by the LED bulbs.

II. The percentage of economy between the two types of lamps.

3.3. The luminance efficiency and the quality of the light emitted by the LED lamps

In order to perform the comparative study, parameters referred to interior luminance determined by NBR 5413/92 were considered.

The reference floor plans of the building have an average 475 m² of useful carpet area with of 2.50m headroom. The floor is composed of carpet tiles, bottom to top window glass frames in the entire length of the front façade. The side façade, although made up of the same type of window frame, has the protection of original brises soleils, from the time of the property construction. The furniture consists of workstation tables, as well as high, medium and low cabinets coated in textured melamine in white color, configuring a "landscape" layout.

The illumination of working areas of flooring type is composed of 62x62cm lighting tracks with reflective fins with 4x16W fluorescent lamps and also 2x16W reactors. There is no intention to replace current lighting tracks. The same will be done concerning the environments, in other words, all the layouts will be kept with the same characteristics previously projected.

The first testing step was to measure with a lux meter the illuminance level achieved by a finned reflective track,
composed of 4-T8-16W fluorescent lamps, in an environment without interference from any other type of exterior lighting. Subsequently, the same procedure was adopted, under the same conditions, to measure the illuminance of 9W LED tubular lamps. The test was conducted in room with the same characteristics of the type floors of the building, in other words, with the same type of existing furniture, the same ceiling height of 2.50m and floor type formed by carpet tile room. The illuminance between the ceiling and the work surface was measured according to the results presented in Table II.

**TABLE II**

<table>
<thead>
<tr>
<th>Types of Lamps</th>
<th>Fluorescent</th>
<th>LEDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured average of illuminance level</td>
<td>460 luxes</td>
<td>575 luxes</td>
</tr>
</tbody>
</table>

As for the quality of the light emitted by the lamps, this was checked during the evaluation period in which the lamps remained on the work place number 2. It was unanimous the report of employees who observed a considerable improvement of lighting in the work environment illuminated by LED tube lamps, which had a higher illumination light quality and more vibrant colors on the work surface and the other objects in the room, compared to fluorescent lamps.

3.4. The percentage of consumption between the two types of lamps

The tests took place between December 29 2014 and January 31 2015 as shown in Table 3 comprising a period of 34 days of sampling. Two wattmeter gears (equipment that measures kWh) were installed on both circuits of lighting: fluorescent and LEDs, which supplied during the period kWh / day kWh of the LED lamps and the fluorescent lamps circuit. The equipment also provides the value of consumption for each circuit measured by day. It only requires the user to add the power rate, which is charged by the utility power supply. In the case of the Rio de Janeiro City, a company named LIGHT holds the concession supply and displays the value of the power rate of R$ 0.562333 to January 2015.

Among the measured values in Table 3, it was possible to notice, within the results of the research, a percentage of 52.02% of savings concerning the circuit of the LED lamps over the circuit for fluorescent lamps, which allows stating, accurately, the efficiency of the former type of lighting.

### TABLE III

<table>
<thead>
<tr>
<th>Month/Day</th>
<th>LED Lamp</th>
<th>Fluorescent Lamp</th>
<th>Consumes Fluorescent</th>
<th>Consumes LEDs</th>
<th>Value in Brilliant Effic (W/B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC 29</td>
<td>34.0</td>
<td>18.6</td>
<td>300</td>
<td>78</td>
<td>3.29</td>
</tr>
<tr>
<td>DEC 30</td>
<td>18.8</td>
<td>37.0</td>
<td>300</td>
<td>78</td>
<td>10.57</td>
</tr>
<tr>
<td>JAN 01</td>
<td>29.2</td>
<td>35.0</td>
<td>300</td>
<td>78</td>
<td>17.86</td>
</tr>
<tr>
<td>JAN 02</td>
<td>37.5</td>
<td>39.0</td>
<td>300</td>
<td>78</td>
<td>31.44</td>
</tr>
<tr>
<td>JAN 03</td>
<td>47.0</td>
<td>39.0</td>
<td>300</td>
<td>78</td>
<td>32.43</td>
</tr>
<tr>
<td>JAN 04</td>
<td>56.5</td>
<td>12.0</td>
<td>300</td>
<td>78</td>
<td>32.72</td>
</tr>
<tr>
<td>JAN 05</td>
<td>72.0</td>
<td>8.0</td>
<td>300</td>
<td>78</td>
<td>32.08</td>
</tr>
<tr>
<td>JAN 06</td>
<td>81.0</td>
<td>17.4</td>
<td>300</td>
<td>78</td>
<td>35.27</td>
</tr>
<tr>
<td>JAN 07</td>
<td>92.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>35.87</td>
</tr>
<tr>
<td>JAN 08</td>
<td>103.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>35.72</td>
</tr>
<tr>
<td>JAN 09</td>
<td>114.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>35.52</td>
</tr>
<tr>
<td>JAN 10</td>
<td>125.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>35.33</td>
</tr>
<tr>
<td>JAN 11</td>
<td>136.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>35.14</td>
</tr>
<tr>
<td>JAN 12</td>
<td>147.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>34.95</td>
</tr>
<tr>
<td>JAN 13</td>
<td>158.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>34.77</td>
</tr>
<tr>
<td>JAN 14</td>
<td>169.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>34.59</td>
</tr>
<tr>
<td>JAN 15</td>
<td>180.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>34.42</td>
</tr>
<tr>
<td>JAN 16</td>
<td>191.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>34.25</td>
</tr>
<tr>
<td>JAN 17</td>
<td>202.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>34.08</td>
</tr>
<tr>
<td>JAN 18</td>
<td>213.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>33.92</td>
</tr>
<tr>
<td>JAN 19</td>
<td>224.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>33.76</td>
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<tr>
<td>JAN 20</td>
<td>235.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>33.60</td>
</tr>
<tr>
<td>JAN 21</td>
<td>246.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>33.44</td>
</tr>
<tr>
<td>JAN 22</td>
<td>257.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>33.28</td>
</tr>
<tr>
<td>JAN 23</td>
<td>268.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>33.12</td>
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<td>JAN 24</td>
<td>279.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>32.96</td>
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<td>JAN 25</td>
<td>290.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>32.80</td>
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<tr>
<td>JAN 26</td>
<td>301.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>32.64</td>
</tr>
<tr>
<td>JAN 27</td>
<td>312.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>32.48</td>
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<tr>
<td>JAN 28</td>
<td>323.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>32.32</td>
</tr>
<tr>
<td>JAN 29</td>
<td>334.0</td>
<td>40.0</td>
<td>300</td>
<td>78</td>
<td>32.16</td>
</tr>
<tr>
<td>JAN 30</td>
<td>345.0</td>
<td>45.0</td>
<td>300</td>
<td>78</td>
<td>32.00</td>
</tr>
</tbody>
</table>

4. CONCLUSIONS

The theme of energy efficiency has been considered important over the past decades. The use of alternative energy sources should not be directly connected only to the need to manage the high cost of electricity in these public properties, but it should aim at balancing the negative effects of man over the environment, and also preserve users’ health.

About this issue, the article quoted some countries that seek to balance these negative effects through energy efficiency programs. Without a doubt, there is still a long way to go. The pursuit of energy efficiency in public buildings plays a key role as a public policy for the inductive effect of the market. The manager must have a fundamental role in this process; it should not behave like a mere energy consumer. It is the one, which must be aware of the need in order to promote best practices and incentive programs for energy efficiency models creating techniques and practices that promote the rational use of energy, reducing costs for the development and sustainable balance.

The article presented a comparative record between the two types of bulbs and should serve as the basis of study for other research related to energy efficiency. The study, carried out in a Public Building was accomplished to test the efficiency and quality of light emitted by the LED lamps, as opposed to fluorescent lamps. It was also noticed the percentage of savings in kWh between the two lighting systems, besides the brightness index between fluorescent and LED lamps.

As meant, the research has confirmed the tendency of energy saving of the LED tube lamps for the use in corporate environments since they have showed the highest amount of lux, better level of luminance with higher quality light.
emitted. As for energy efficiency, this research has shown that LED tube lamps represent a savings of 52.02% over the traditional fluorescent lamps, which allows us to accurately state the efficiency of this type of lighting.

REFERENCES