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Evaluation of Alternative Disposal and Replacement of Fluorescent Lamps

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Abstract. This paper presents a evaluation of the disposal alternatives and substitution of the flourescent lights, in order to contribute with the correct recycling of this product. Initially presents a projection of how much eletricity can be saved by changing the most used lamps by the brazilian for LED lamps (Light-emitting diode). After, a economic viability evaluation also is presented in this study. Also a description of the reciclyng methodologies and disposal of the flourescent lamps and the danger who may be caused for health, are presented with the final conclusions of this research.

Key words

Energy Efficiency, Electrical Engineering, Lighting Environment, Recycling.

1. Introduction

The consumption of electricity in Brazil tends to grow every year, prompting the lighting spent in the residential, commercial and industrial areas be higher. The economic stability associate with the population income growth allows more people to have access to new technologies, adding to this the high urbanization rate with the expansion of housing credit. According with [1], the residential sector is the most lacking for energy efficiency, where lighting is responsible for 24% of the eletricity consume of a residence, so a study about replacing current technologies viability is necessary, as well a environmental impact analisys.

This research aims to demonstrate the main technologies of disposal/recycling of flourescent lamps who not harm the environment and aren't risk to human helth. Also a comparison with LED bulbs is performed showing the most economically viable technologies and greater sustainability and presenting the energy savings that they offer.

2. Residential Lighting Industry in Brazil

A. Sector Analysis

According with some studies maded by the Ministry of mines and energy (National energy plan) with collaboration of EPE (Energy Research Company), we know that the total energy consumed in a home 24% is lighting spent. A study by EPE in 2011 found a energy consume of 112.590 GWh in the residential sector. So comes the conclusion that a year spent on lighting in Brazil is approximately 27.045,6 GWh, However it is a sector that consumes a lot of energy due to innefficiency in the lamps system currently used in Brazilian homes.

B. Replacement Proposal

According to data of [2], in Brazil are selled almost three hundred million light bulbs followed by a hundred million of fluorescent lamps. We can see a domination of

fluorescent lamps and bulb lights in Brazilian market. But the use of fluorescent lamps tend to gain more space in the market due to the Brazilian government is encouraging the purchase, making some laws and given a deadline for the end of the light bulbs. New technologies of lamps mutch more efficient and sustainable than incandescent bulbs and fluorescent have called the attention. It's the case of LED technology, which can repace light bulbs and flourescent lamps with the advantage of being more efficient, having a lifespan 5 times longer and not harming the eviroment with the remains after they burned out. So was researched what type and modelo of LED lamp would be the ideal to replace the most used lamps in Brazil. The table I shows the chosen replacement lamps for the flourescent and bulb lamps longer used.

Table I. – LED lamps proposed to substitution.

Most used lamps in Brazil	Equivalent LED lamps
Light Bulb 25W	Vision LED A55 Philips 5W
Light Bulb 40W	Incandescente 40W Pharathom A40 classic Osram 8W
Light Bulb 60W	Pharatom A60 classic Osram 12W
Light Bulb 100W	Master LED par 38 Phlips 18W
Fluorescent lamp 20W	Master LEDtube Philips 11W
Fluorescent lamp 40W	Master LEDtube Philips 22W
Compact Fluorescent 15W	Parathom A60 classic Osram 12W
Compact Fluorescent 23W	Master LED pas38 philips 18W

3. Saving Electricity

In Brazil the is still a culture of short-term results that justifies the fact that 50% of residential lighting still be done by light bulbs, motivated by this type of lamp are cheaper [1]. But what seems cheaper at time of purchase is not the best option for saving energy and consequently for the families economy, just as seen in Table I, the LED bulbs need far less power for the same function.

A. Comparison between the lamps

For this comparison of energy savings between the lamps, was considered based on data detailed on [3], the total spent on residential lighting in Brazil with lamps currently used in Brazilian homes. As previously mentioned, Brazil spends 27.045,6 GWh with the current lighting situation used by residences. To obtain as would be saved using the LED lamps of Table I, we can just calculate using the proportion of the Power values of both types of lamps. For example according to Table I the lamp "master LED tube de 11W" is equivalent to the fluorescent lamp of 20W, so we can conclude that the LED lamp is 45% more economical in electricity savings than the Flourescent lamp. Proceeding with this calculation for the other and knowing through data in Table II the percentage of use of each lamp in Brazil, we can reach the conclusion of saving electricity generated in a year by the subtitutions.

B. Energy Savings in Numbers

We can know what would be saved by replacing approximately 14.348,31 GWh per year. To get an idea according to the media secretary of the state of Paraná, was spent in 2010 about 25,083 GWh, the energy savings would be equivalent to supply nearly 60% of the entire state of Paraná.

Not only in energy savings for the Brazilian system that is a viable substitution, economically to the consumer's pocket is worth also thinking in the long term. According to the 2011 statistical yearbook of electricity published by EPE the average consume by home is about 154 KWh/Month and total 58.006 million households located in Brazil [3].

Table II. – Consume lighting participation [1]

Tipo	Participation [%]
Light Bulb 25W	1,28
Light Bulb 40W	4,88
Light Bulb 60W	37,07
Light Bulb 100W	5,95
Fluorescent lamp 20W	6,35
Fluorescent lamp 40W	9,31
Compact Fluorescent 15W	14,53
Compact Fluorescent bigger than 15W	17,41
Other	3,24

C. Simulation of Energy Savings

For an analysis of the financial savings that woulb be generated if the consumer swapped the lamps it uses currently, just simulate a house with tem points are used 60W light bulbs compared to their equivalent flourescent and. Table III shows the values achieved considering a period of seven years.

Table III. – Estimate Cost

Lamp Type	Initial Cost with Purchase of Lamps	Exchange spent seven years	Cost of Electric Power	Total Cost
Light Bulb	R$ 18,00	R$ 756,00	R$ 6040,80	R$ 6814,80
Fluorescent lamp	R$ 215,20	R$ 430,40	R$ 2772,00	R$ 3417,60
LED Lamp	R$ 1240,00	R$ 0,00	R$ 1209,60	R$ 2449,60

Thus, we observe that it is economically viable to replace the LED lamps, recalling that were not considered losses generated in flourescent lamps due to the number of drives, was also not considered to the low power factor with which they operate.

Therefore according to the figures in Table III concludes that the economics of LED lamps over light bulbs would be 66% and for the compact fluorescent economy reaches 27%.

D. Saving Energy Paradox

When you buy a flourescent light buys thinking of two basic factors, the lamp price and the economy generated over time, but it should take care to arrive as such economy conclusion. According [4], shows that the numbers of actuations influence the life of a flourescent lamp, to have na idea, a fluorescent lamp who is turned on every hour has its each life reduced in 30%.
Another aspect that should be noted is the power factor is such that fluorescent lamps work [4]. Usually this type of lamp operates with power factor between 0.4 and 0.6. For example: if a person exchange an incandescent 60W (power factor = 1) by a fluorescent 15W (power factor 0.4) will have on energy bill savings, But is consuming almost the same as a light bulb somewhere around 37.5 VA.
Nowadays the companies do not charge the reactive power of the residential consumer, but this scenario may soon change with the trend of increased supervision and with the incentive for energy efficiency will not take long for the residential consumer also pays its share of reactive.

4. Dispose of Flourescent Lamps

Linked to population growth, fluorescent lamps are increasingly gaining ground in the market, so you cannot ignore that the destination has to be given to this type of material.
In Brazil only 6% of the bulbs are recycled properly and there are 10 companies that can provide the right destination to such lamps [5]. This low rate of recycling should be because of the high cost involved in recycling and transport, as well as the disinformation of the danger a broken fluorescent bulb or in inappropriate places can cause the health of living beings.

A. Environmental Danger and Health

The mercury is a toxic metal and is present in greater quantities in fluorescent lamps, so we discover how much of this material is exposed in between the population. Considering that in Brazil are discarded annually forty million fluorescent lamps and the average amount of mercury is 20mg per lamp comes to scary 800.000g of mercury are released into landfills or dumped in common thrash[6]. According to the secretary of the environment of São Paulo the amount of 3g to 30g are already considered fatal to humans, due to this and other factors the authorities are very concerned about proper disposal. Even when not infect humans directly, mercury tends to go against groundwater or even springs, polluting rivers, contaminated fish and consequently the human being.
According to a report by Ban Mercury Working Group for the overall rates of mercury, the load currently equivalent to less than 1/50 of a tablespoon of mercury (one drop) deposited in a lake of 20,000 liters is enough to make fish this lake unsuitable for human consumption. Once ingested by people, methyl-mercury is rapidly absorbed through the gastrointestinal tract and readily penetrates the blood-brain barrier and the placental allowing the passage of mercury from a pregnant woman to her fetus.

B. Recycling and Handling

Although it is very important to properly dispose of fluorescent lamp, according with portal São Francisco, there are few companies accredited to do this type of service. In cities where there is this kind of service the lamps should be placed in separate containers flagged with warnings to the toxic content and shock proof. According portal São Francisco, it is estimated that each fluorescent lamp recycled costing somewhere between R$0.60 to R$0.70, this value may increase considerably due to the transport of such lamps must be done by specialized companies, a fact that more expensive and further complicates recycling.
There are several technologies for proper recycling / treatment of fluorescent technologies which will be exemplified below.

C. Simple Crush

According to [7], this process aims to grind the lamp to subsequently through an exhaust system to remove part of the mercury in the lamp. This technology does not separate the components of the lamps with a focus on reducing the mercury content contained in them. Studies made by manufacturers of equipment attest to 98% reduction of the mercury which was previously in the lamp. The great advantage of this system is the possibility of being mobile, the system can be moved to distant cities where there are no recycling companies around.

D. Heat Treatment Crush

According to the study presented in [7], is seen as the most efficient process in the recycling of fluorescent lamps, basically it is made in two parts, Part grinding part and distillation of mercury, at the beginning stage of grinding all materials who compose the lamp are separated: aluminum, glass, metallic iron phosphorus mixed with mercury and isolation . The separation starts with crushing the lamp through crusher or mill, then through an exhaust system separated the materials mentioned above by different gravimetric separation and electrostatics.
The phosphorous dust with mercury is collected by a filter inside the machine. In the second stage this dust is removed from the filter and sent to a distillation process for treating mercury. The glass is clean turn and sent to companies specializing in recycled for later use in the manufacture of non-food origin. At the stage of distillation of mercury is obtained by the process of reporting where the metal is heated at a temperature above its boiling point. The vaporized material is condensed and absorbed by special collectors, after this process if necessary mercury may still have to undergo a further treatment, such as bubbling in nitric acid to remove impurities.

E. Chemical Treatment Crush

The chemical treatment also takes place in two stages, Crushing and Containment of mercury, the difference is

that grinding is done through a curtain of water, so that mercury cannot escape. Metals and glasses are washed and sent for recycling, the water used for washing the mercury is filtered and then precipitated for separating mercury from phosphor powder, liquid subsequently undergoes a chemical treatment with sodium sulfide, sodium sulfite or sodium bisulfate. With this process the mercury is converted into mercury supplied. A water-insoluble solid element. Now with mercury precipitate the water can be filtered, removing the phosphor powder and mercury which can be distilled and reused. [7]

F. *Blowing Treatment*

For this type of treatment, the priority is to recycle the glass of fluorescent tubes. The main objective is to preserve the glass in its natural form so it can be resold for the same purpose for which it was created.
The process consists in removing the aluminum in the edges of the lamps through a system that heats and cools the metal, subsequently with a open tube apply blowing air to remove the phosphor powder with mercury inside the lamp, leading them through a system of cyclones until activated carbon filters [7].
Note here that this process just as simple crush only minimizes the concentration of mercury dumped in the environment because the filters that retract mercury are discarded in landfills.

5. Final Considerations

This studies the viability of replace and proper disposal for fluorescent lamps, addressing some information on light bulbs. Was verified that the technology of LED bulbs has incredible potential for growth, driven by its high efficiency combined with their construction because the materials used in its manufacture does not harm the environment or the human health.
However the same cannot be said about the fluorescents, because they are dangerous to the human health. Even with proper handling, the mercury for being a material extremely toxic and bioaccumulative becomes an imminent danger, given that all processes studied fail to recycle 100% of mercury, because of this metal chemical characteristic tends to get stuck with the materials that are contact, furthermore, some processes use a lot of electricity and water for treatment, something not advisable in times of shortage and energy saving.
Although the crushing with heat treatment has proven the most efficient technology is foreign, which generates much cost to be applied in Brazil, and even being aplied, the mercury contaminates the equipment through which pass during recycling that after a while they go to landfills.
On the other hand if you did a study on the savins of electric energy and the financial impact caused if the lamps most used by Brazilians were replaced for LEDs proposals. Was verified that the replacement would generate savings of up to 53% on electricity spent on lighting in Brazil, would be saved 14,348.31 GWh per year, the equivalent of three Itaipu turbines working throughout the year.
Economically the financial savings compared to fluorescent lamps would be 27% against 66% compared to light bulbs.
Thus was observed that a proper disposal is essential for the future of public health, and that replacement is extremely viable for society, whether in the environmental, financial, energy savings and most importantly, would be the best option for population health, which is the most precious the human being.

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