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The Role Of Lamps In Managing Household Electricity Consumption

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Abstract *In every country, the electricity industry is one of the most important foundations of economic activity. The investment and establishment of this vital industry requires a long time and significant resources. Electrical energy is used in various aspects of life, with household lighting being one of the most important. Different types of lamps, such as incandescent, fluorescent, and LED, are used for lighting, each with different power and consumption characteristics. The selection of the lamp type, considering the activity and application of automated sensors that are active and inactive at specific times, has a significant impact on energy consumption reduction. Since artificial lighting is expensive but essential, understanding and comparing the cost of lamps and the supply of electricity to residential units is an important issue addressed in this study. This research is practical and descriptive in terms of importance and examines the cost of supplying and energy consumption of incandescent and fluorescent lamps, considering their voltage, power, and lifespan. The selected lamps are analyzed and evaluated as samples. The research results show that using energy-efficient lamps instead of energy-consuming lamps can result in approximately 83.3% cost savings in electricity supply and energy consumption, according to the measurement criteria of the Afghan Power Supply Company. Finally, by comparing the lifespan of the studied lamps, there is an 88.9% reduction in the number of lamps used.*

Keywords: *Lamps, Electricity, Household Consumption, Comparison*

INTRODUCTION

Sunlight is essential for health and better living, but in the absence of sunlight and its warmth, the provision of artificial energy becomes one of the important and natural desires of humans[1]. Nowadays, the use of artificial light in various places, such as the working environment of industrial institutions and residential units, has become widespread[2]. The provision of artificial lighting requires foundational resources and infrastructure, which are capital-intensive and costly. On the other hand, the use of artificial energy for illuminating homes constitutes a significant part of household and government consumption. The increasing demand for artificial light in residential units has always been a problem for countries, especially Afghanistan, where it is thought necessary to devise cost-effective management strategies[3]. Due to the limited resources of energy and its vital importance in life affairs, humans have always strived to use the minimum resources for maximum benefit, which has led to rapid progress in lamp technology. The development of low-consumption lamp technology has become an economic alternative to high-consumption lamps, in addition

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to saving costs, convenience, and ease of use in a lighting system[4]. Current global ideas are strongly focused on reducing the use of high-consumption lighting lamps due to the reduction in energy consumption, the provision of fossil fuels, and the emission of greenhouse gases, which has economic savings benefits. To the extent that the use of high-consumption lamps is[5], it is essential to change the consumer pattern and find effective solutions for reducing energy consumption. Electricity energy, as a fundamental and key infrastructure in the national economy, has different short-term and long-term effects and plays a different role in developing and developed countries. Almost one of the significant concerns of policymakers in any government in Afghanistan is the provision of electrical energy. A better understanding of the behavior of domestic electricity consumers helps energy sector managers to adopt better strategies in this regard[6].

According to the resolution of the Economic Commission, "All government offices are obliged to refrain from excessive use of electricity."[7] Given that electricity consumption constitutes a significant part of the country's total consumption, the provision of funds for production and transmission, proper distribution of electric power, limitations of fossil and hydro resources, the gradual increase in the Earth's temperature are among the most important issues that have made the use of energy-saving lamps a vital necessity in the country[8]. Saving electricity is not only a necessity but also a divine guidance in this matter, "and do not be wasteful for He does not love the wasteful"[9]. Identifying solutions and formulating policies to reduce electricity consumption and how to finance it has always been the focus of artificial energy users, researchers, and policymakers. Therefore, studying this phenomenon can be effective not only for the users of residential units but also for the economic growth and development of the entire country[10].

Considering the key role of electricity in the national economy and its effects as an important infrastructure in the development of other sectors, and also the very high costs of production, distribution, and transmission of energy, especially in Afghanistan, understanding and recognizing the consumption process in the long and short term is of special

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[9] Holy Quran - Surah Al-A'raf and Al-An'am, aayat 31,141.
[10] https://civilica.com/doc/36415

importance[11]. Managing electricity consumption through guidelines, considering the potential that consumer loads have, and the use of automatic sensors change the consumption culture and prevent the waste of electricity[12].eghtesat+sanati in the winter season, the most significant increase in complaints from citizens is about the lack of electricity, especially the issue of how to use electrical energy.

The technology of lamps has recently advanced so rapidly that any explanation concerning this subject will become obsolete immediately. The first inventor of the lasting lamp was Khalid Faris in 1896[13]. In the contemporary world, this technology is produced by various countries and multinational companies[14]. The ever-increasing expansion of electronic devices for providing artificial lighting sources in military, space, and administrative sectors around the world has led to the development of numerous infrastructures for the production, usage, and distribution of electrical energy. In military and space sectors, high-powered microwave lamps such as relativistic magnetrons, relativistic klystrons, magnetic insulator oscillators, backward wave oscillators, victors, gyrations, and free electron lasers are used[15].

Spiral traveling wave tube amplifiers are utilized in radar technology in ships like the ASP-147 and in some missiles, and commercially in communication satellites[16]. Magnetron lamps are also applied in various industries, the most important of which is the use of microwave ovens in the food industry[17]. Similarly, considering the temperature of the lamp and X-rays, which can reach around 2000°C, it has applications in the medical and engineering fields[18]. In the space industry, high-powered microwave lamps are used due to their high power, i.e., several hundred megawatts, for applications such as high-powered radars, high-powered transmitters, and plasma furnaces. These types of lamps include relativistic magnetrons, relativistic klystrons, magnetic insulator oscillators, backward wave oscillators, victors, and gyrations[19]. Ultraviolet (UV) lamps are used in various disinfection or

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microbe-killing operations[20]. The lamps used in vehicles are divided into three categories based on the type of application and energy consumption, which include main lighting lamps, warning lamps, and miniature lamps[21]. The lamps that are used in residential units are generally categorized into eight types, which include (incandescent, halogen incandescent, standard fluorescent, compact fluorescent, mercury vapor, metal halide, high-pressure sodium vapor, and low-pressure sodium vapor)[22]. Recently, in most countries around the world, the use of low-consumption fluorescent lamps has become widespread due to their high brightness, long lifespan, suitable light quality, and reduced environmental impact compared to incandescent bulbs and other high-consumption lamps, making them a suitable light source in homes, stores, etc.[23].

In the field of lamp technology, extensive studies have been conducted on the use of lamps in different sectors and how they are utilized. Briefly, some of these studies will be mentioned in the future. The amount of light emitted by a lamp is measured in lumens[24].The effectiveness, electrical performance, light efficiency, and brightness intensity of mercury and fluorescent lamps were compared by Yasum (2011), showing that the brightness intensity at a distance of 2 meters for three low-consumption lamps with powers of 23, 24, and 48 watts was 67, 67, and 43 lumens, respectively. This means that the illumination of low-consumption lamps is greater than that of high-consumption (mercury) lamps. An important feature of lamps is reaching maximum brightness in a short amount of time. In this case, Daff (2012) has proven that Compact Fluorescent Lamps (CFL) take less time to reach their maximum brightness compared to high-consumption lamps, which is significant for residential unit users[25].Intensity, temperature, color, and other manifestation indices are among the energy consumers' needs for providing adequate lighting, which can vary in each location. An incomplete light spectrum may cause a change in the apparent color of a visible object, or a low color temperature of sources may reduce people's alertness. However,

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[25] Golmohammadi, Rostam and Mahtab Azizi, The study of electromagnetic spectrum radiation in conventional compact fluorescent lamps, Journal of Occupational Medicine, No. 3, Volume 5, Page 47, Iran fall, 7/14/1695.

artificial lighting sources with a CRI (Color Rendering Index) of ≥60% are suitable for most manufacturing jobs, and a CRI of ≥80% is appropriate for most office and residential tasks[26].

The brightness of a lamp is one of the defining factors for lighting quality. Similarly, the light and brightness of LED lamps with higher color temperatures can be beneficial in improving user performance, according to the research findings of Elahe Amoozadeh. It is recommended for users in residential units to use energy-saving lamps. Energy-saving lamps are available in different sizes and shapes and are of the compact fluorescent type. These lamps have a useful life of 4,000 to 15,000 hours and approximately 10 times the lifespan of incandescent lamps, and produce about 4 times the light of incandescent lamps. These lamps contain ultraviolet light and the toxic substance mercury, which can be harmful to human skin and eyes. Research on the use of these types of lamps has shown that if the standard radiation exposure limits are not observed, it can be damaging[27]. Research results indicate that in the year 2000, from 1.3 billion low-consumption lamps using 20,000 megawatts of electricity, the same number of high-consumption lamps would have used 80,000 megawatts of electricity. In fact, the energy savings of these lamps is equivalent to the energy of 28 thermal power plants[28].

The research conducted by Hasan Rangriz in 1393 (2014) shows that the demand for electricity relative to price and income in the short term is inelastic. Incentive policies have been more effective in reducing electricity consumption than price policies[29]. Similarly, researchers like Hosseini Nejad, Koushki in 1372 (1993), Alkaei in 1376 (1997), Safaripour Esfahani in 1378 (1999), Sadatifar in 1380 (2001), Eshgari in 1380 (2001), Aminifar in 1381 (2002), Derjad in 2008, Bianco and Nardini in 2009, and Deng in 2010 have conducted research on household electricity consumption, and their findings confirm that the use of low-consumption lamps not only affects residential units but also has a significant impact on the country's economy[30]. According to researchers' studies, while low-consumption lamps are effective in reducing electricity costs, their use can have effects on human health and the environment, and taking note of several established remarks on this matter is not without

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substance.Fluorescent lamps have a magnetic field that, if not used properly, can cause changes in endocrine hormones and perceptual issues like reduced concentration and depression. According to the findings of Mahshid Azizi's research, it is advised to use high-quality lamps as much as possible[31]. Compact fluorescent lamps have varying levels of ultraviolet radiation and electromagnetic fields, and the researcher recommends avoiding using these lamps as a light source at close distances, namely less than one meter, as much as possible. Using fluorescent lamps for reading at close distances can cause various skin problems[32].

The ultraviolet rays of fluorescent lamps seem to pose the risk of developing skin cancer such as melanoma, cataract formation, effects on the immune system, and other complications[33]. Fluorescent lamps flicker at low frequencies of up to 160 hertz, causing eye fatigue and potentially exacerbating autism[34]. The amount of mercury in fluorescent lamps naturally contains 40-40 milligrams per lamp, which in case of breakage and release into the environment can lead to nerve damage, paralysis, and blindness[35].

RESEARCH METHODOLOGY AND FINDING:

In a general classification, the structure of the electricity network includes generation, transmission, and distribution. The costs of electric energy are reflected in two ways: direct (individual) and indirect (environment)[36]. In the world, energy-efficient lamps are of strategic importance for two reasons: reducing electricity consumption and the cost of its supply. By comparing lamps, one can find a suitable solution and help in reducing costs and contributing to economic growth[37]. This research is descriptive and applied and aims to increase the information regarding the use of consumer lamps in residential units to reduce consumption[38]. The information studied in this research includes the lifespan, brightness

[31] Azizi, Mahtab et al., Investigation of the intensity of electromagnetic fields emitted by conventional compact fluorescent lamps, Journal of Agronomy, Quarterly Journal of the Iranian Society of Ergonomics and Human Factors Engineering, No. 2, Volume 3, Page 44, Iran, Summer, 2015/6 / 1.
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[35] Alidadi, Hossein et al., The effect of heterotrophic bacteria in urban wastewater of Mashhad in removing mercury from fluorescent lamps, journal, Quarterly Journal of Research in Environmental Health, No. 3, Volume 6, Page 222, Mashhad, Fall, 1397/7/20.
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level, power, and price of the lamps used in residential units, which has been acquired from reputable domestic and international scientific sources www.afkarnews.com. To estimate electricity consumption, the cost of electricity supply, and the number of lamps used by residential unit consumers for lighting over four years and to stabilize it each year, percentages are presented. Also, considering the information studied, the following points are taken into account:

A – Among the high-consumption filament lamps, the 100-watt incandescent light bulb and the 20-watt compact fluorescent light, which are types of energy-efficient lamps, are chosen as samples since their lumens are the same, and the purchase prices are compared. It is clear that watt is always multiplied by hours, meaning that if the lamp is used for 10 hours for illumination in 24 hours, the calculation would be 10*20=200→w*h[39].

B – The cost of electricity for residential units is considered at 2.5 Afghanis per kilowatt according to the estimate of the Breshna Company, which is up to a hundred kilowatts[40]. To stabilize the proportion and percentage of electricity costs, energy consumption, and the number of usable lamps according to the amount of lumens and power, the following formulas have been used according to the questions raised[41]

$$\frac{a}{b} = \frac{c}{d} \rightarrow a \times d = b \times c$$

$$\frac{p}{b} = \frac{r}{100} \rightarrow = p\frac{b \times r}{100}, b = \frac{p \times 100}{r}, r = \frac{p \times 100}{b}$$

[39] www.namatek.com

[40] Hazheer, Abdul Wali, the role of solar energy in reducing the cost of residential users, Journal, International Journal of politakhnin, No. 2, Year 1, p. 188, Kabul Spring, 2022/3 / 30

[41] Stanekzai, Homayoun and Abdul sami Nourzad, Mathematics Reviewer, Saeed Publications, p. 30, Kabul, spring, 2012

DISCUSSION

Table(1): comparison of the cost of supplying power and preparation of low and high lamps

no	Type of Lamp	Sample	Lumens	Lamp Power	Price per unit	Lamp life/hours	Number of lamp	Whole life of lamp	Power consumption/kw	Costs			Percent
										Electricity come/per kw	Electricity cost/4y	Cost 1 years+ Price lamp	
			lm	W	AF	H	N	T-H	KWH	AF	AF	AF	
1	High consumption	ILB	1600	100	20	1000	8	8000	800	2.5	2000	505	**79.6**
2	Low consumption	CFL	1600	20	120	8000	1	8000	160	2.5	400	130	**20.4**

RESOURCE[42]

(Table 1 explanation): The lamps under study were selected with different wattages and the same lumens so that, as observed in the table, energy-saving lamps with 1600 lumens, a power of 20 watts, a supply cost of 120 Afghanis, and a lifespan of 8000 hours are compared to a 100-watt lamp with the same lumens, a supply cost of 20 Afghanis, and a lifespan of 1000 hours. Considering the consumption, the high-wattage lamp's energy expenditure over four years amounts to 2000 Afghanis, and for one year, it is 500 Afghanis, which in reality, with the purchase of the lamp, totals to 505 Afghanis (p=800kwh*2.5Af=2000/4=500+5=505). Similarly, the energy cost of the energy-saving lamp over four years amounts to 400 Afghanis, and for one year, it is 100 Afghanis, which with the lamp supply cost, totals to 130 Afghanis (p=160kwh*2.5Af=400/4=100+30). Nevertheless, considering the raised question, it can be said that the use of energy-saving lamps leads to a reduction of up to 79 percent in the household's electricity supply cost.

[42] www.leelam.com – www.afkarnews.com – www.namatek.com
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Table(2): comparison of energy consumption of low of low and high consuming lamps										
no	Type of Lamp	Sample	Lumens	Lamp Power	Price per unit	Lamp life/hours	Number of lamp	Whole life of lamp	costs	
			lm	W	AF	H	N	T-H	KWH	Percent
1	High consumption	ILB	1600	100	20	1000	8	8000	800	**83.3**
2	Low consumption	CFL	1600	20	120	1000	8	8000	160	**16.6**

RESOURCE[43]

(Explanation of Table 2): The use of energy-saving bulbs, in addition to reducing the cost of electricity supply, is also effective in reducing electricity consumption. Considering the above table, if we assume the lifespan of the studied bulbs to be the same (1000/h), with different powers of 100 watts and 20 watts and with the same number of lumens that they have, the consumption of the high-consumption bulb under study becomes (800kwh), which means (kw=8L*100w=800kwh), and the consumption of the energy-saving bulb (160kwh) means (kw=8L*20w=160kwh). In fact, it is said that the use of an energy-saving bulb brings about an 83 percent reduction in electricity energy consumption.

Table(3): comparison of the application of low and high consumption energy and lamps									
no	Type of Lamp	Sample	Lumens	Lamp Power	Price per unit	Lamp life/hours	Number of lamp	Whole life of lamp	Percent of
			lm	W	AF	H	N	T-H	
1	High consumption	ILB	1600	100	20	1000	8	8000	**11.1**
2	Low consumption	CFL	1600	20	120	8000	8	64000	**88.9**

[43] www.leelam.com – www.afkarnews.com – www.namatek.com
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RESOURCE:[44]

(Explanation of Table 3): It is known that the lifespan of energy-efficient bulbs is longer compared to high-consumption bulbs, and this technology is evolving. As observed in the first table, against 8 high-consumption bulbs with a lifespan of (1000/h), one can use an energy-efficient bulb with a lifespan of (8000/h), provided that the lumens of the bulbs under study are the same. Considering Table number three, and with the note that an equal number of high-consumption and energy-efficient bulbs are considered, given the useful life of the bulbs over four years, the lifespan of 8 high-consumption bulbs becomes 8000/h and from the energy-efficient bulb 64000/h. Nevertheless, it can be said that 8 energy-efficient bulbs can be used for eight years, and the use of 64 high-consumption bulbs is prevented (p=8000/72000×100=11.1%) → (p=64000/72000×100=88.9%). In other words, if 8 high-consumption bulbs are used for 8000 hours of electricity, which is needed for a year and costs are incurred, with 8 energy-efficient bulbs, 64000 hours of lighting is created, which will realistically be usable over eight years. This matter illustrates the reduction in consumption of energy provision devices, environmental protection, and household consumption.

CONCLUSION

Given the vital importance of electric energy in the production process and the course of life, it is clear that better management and use of it is considered necessary. It is assumed that the technology of lamps is evolving every day. The use of energy-efficient lamps with new technology leads to savings in the production process, distribution, and consumption of energy. In this study, high-consumption and low-consumption lamps with the same lumen output have been examined and compared from three aspects. Looking at the results of GollMohammadi's research in the year 2000, it shows that by managing energy-efficient lamps, energy savings equivalent to 28 thermal power plants have been achieved, and the use of 1300 million high-consumption lamps has been prevented[45]. However, the current study in terms of the application of energy-efficient lamps with the same lumen output shows that there is about a 79.6 percent reduction in household electricity consumption (statistical community). Likewise, researchers like Hosseini Nejad Koushki (1993), Alkaei (1997), Saffar Y Pourasfahani (1999), Sadatifar (2001), Ashgari (2001),

[44] www.leelam.com – www.afkarnews.com – www.namatek.com
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Aminifar (2002), Derjyads (2008), Bianco and Nardini (2009), and Deng (2010), in relation to the management of electricity consumption, have concluded that the use of energy-efficient lamps in households not only aids in the management of household resources but also has a significant impact on the country's economy[46]. However, the results of the current study regarding better management of energy resources and the use of energy-efficient lamps show that there is an 83.3 percent reduction in general electricity consumption (statistical community) when using energy-efficient lamps, which has a considerable impact on the economy of the society, especially when electric energy is imported. Finally, in terms of using energy-efficient lamps, there is about an 88.9 percent reduction in the number of consumable lamps in residential units. Since the production and processing of lamps do not take place domestically, managing savings in lamps leads to a reduction in imports and dependency on them. Nevertheless, this research indicates that the management of energy-efficient lamps has significant effects.Efficient management, such as reducing environmental pollution, increasing economic growth, saving electricity resources, and reducing the level of use of production resources ("sustainable development"), has a significant impact on the economy and society. Overall, this research on the use of energy-saving light bulbs shows a three-dimensional reduction (79.6 percent in the cost of electricity supply and bulb procurement, 83.3 percent savings in the cost of electricity consumed by the residential sector, and an 88.9 percent reduction in environmental pollution). However, it is said that observing the evolution and diversity of light bulb technology will have a considerable impact not only on household consumption but also on environmental pollution.

RECOMMENDATION

- ✓ Users can employ energy-efficient light bulbs to reduce the consumption of electrical energy supply.
- ✓ One of the important characteristics of energy-efficient bulbs is their long service life, which significantly reduces the cost of maintenance and repair of the lighting system. However, one should continually be aware of the technological developments in this area.
- ✓ There are a variety of energy-efficient light bulbs available; users should strive to use higher quality energy-efficient bulbs to minimize potential risks.
- ✓ Researchers in this field can study other aspects of energy-efficient light bulbs, especially the use of automatic sensors in bulbs, to make better use of resources.

[46] Rangpour, Hassan and Hooman Pashotanizadah, The effect of subsidy targeting on electricity consumption of household subscribers in Tehran using genetic algorithm, Quarterly, Journal of Economic Modeling Research, No. 17, p. 130, Iran, Fall, 2014/06/15.

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