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Residential Lighting: History, Energy Efficiency, And Health Effects

Review Article

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Introduction

In 2001, lighting accounted for 8.8% of domestic electricity consumption, constituting the fifth largest use of electricity in U.S. homes (Latta, 2007). By the mid-twentieth century residential lighting had become so reliable and commonplace it had begun to be taken for granted, seldom thought of unless it was not working. Today, however, in a climate of high energy prices and energy insecurity, lighting has become a critical element in any residential energy saving strategy. To get a glimpse of where domestic lighting technology may be going, or perhaps where it should go, reviewing its beginnings and development will be useful.

Historical Context

Historically, the technology of domestic lighting ranges from the simple burning stick, first used domestically around 1 to 1.5 million years ago [1], to today's sophisticated light emitting diodes. Propelling lighting development along this path have been various factors, including greater light output, increased efficiency and convenience, less maintenance, lower initial and operating costs, and safety. For most of the time artificial illumination has been used, it has been obtained directly through combustion. The first period of progress in domestic lighting began when a primitive human noticed that grease from cooking meat burned brightly when it dripped into the fire, perhaps in the Paleolithic period [2]. This simple observation led to the first oil lamp, probably nothing more than an overturned sea shell filled with grease and a wick of dried grass [3] The rushlight followed, and in turn, the candle [4].

Despite drawbacks, gaslight was such a leap forward in convenience, and so widely accepted, that it became a fixture in the 19th century, so much so it popularly symbolizes the period itself, often referred to as "The Gaslight Era" [5]. For those who had gaslight, there were no more smoky candles to snuff or lamp wicks to trim and replace and no need for constantly bringing candles or lamp oil home. Electric lighting was the greatest innovation in residential lighting since the domestication of fire. For the first time in history, artificial illumination did not depend on flame. The cleanest, most convenient, and safest light yet developed, the electric light revolutionized home life and society at large [6]. And for the first time, the energy efficiency of lighting was of paramount importance: Edison realized that his light would not succeed unless it could compete economically with gas [7].

Although other forms of electric light were introduced after Edison's original lamp, incandescents dominated lighting in the home for nearly a century because of their simplicity and cheapness [8]. By the late 1920s, the incandescent lamp had been essentially perfected and has remained largely unchanged since. Lighting research in Europe and America began around 1900 and culminated in 1939 when the General Electric company introduced the Lumiline® fluorescent lamp [9]. Although substantially more energy efficient and longer lived than incandescent lamps, early fluorescents produced a harsh, cold light. They were also more complicated to use, because they required special fixtures and a bulky electromagnetic ballast to operate.

In 1945, General Electric introduced the Circline® fluorescent lamp [9]. With its shorter tube formed into a small circle, this lamp was more convenient to use in the domestic environment, and was the first form of fluorescent lamp to be used to any significant degree at home. It was not until the 1990s and the introduction of the compact fluorescent lamp that fluorescent lighting could begin to rival the incandescent lamp in domestic lighting.

Lighting and Energy Efficiency

In the compact fluorescent lamp (CFL), improvements in phosphors have resulted in lamps that produce more pleasant light. Small electronic ballasts, a compact tube arrangement, and incorporation of a screw base allow CFLs to be used in ordinary fixtures. CFLs are now in a position to outnumber incandescent lamps in residential lighting uses.

The search for increasingly efficient lighting continues. The latest technology is that of the Light Emitting Diode (LED). Although the phenomenon on which the LED is based was reported as early as 1907 [10], it was not until 1962 that General Electric developed the first

practical LED [11]. Made commercially available shortly after, LEDs initially were available only in red and were just bright enough for use as indicator lights and instrumentation displays. The more recent development of white light emitting LEDs of higher power has enabled the technology to be adapted for interior lighting. Although LEDs use ¼ of the electricity used by CFLs, and their life span is 10 times that of a CFL, the initial high purchase cost is preventing widespread use at this time. CFLs represent only 20% of light bulb purchases in the U.S. [12].

Lighting and Human Health

Human responses to lighting have been the subject of substantial research. Zilber [13] noted that changing lighting conditions between spaces in a home should be gradual. He speculates that trips and falls by the elderly in halls and stairways may be partially due to inadequate lighting of those areas. As one moves from a brightly lit room to a darker space, that person can be essentially blinded. Zilber [13] also reported that light influences people in ways other than making vision possible. One such influence is Seasonal Affective Disorder (SAD), a condition brought on by shortening periods of daylight during the fall and winter. One treatment of SAD involves exposure to full-spectrum fluorescent light. On this topic, though, Tonello [14] cautioned that psychological conditions are affected by mood, motivation, and behavior, which are shaped by factors other than lighting. For this reason Tonello [14] recommends that relationships between lighting and human health be studied in a holistic context, with a view that includes numerous environmental variables in addition to lighting. Overall, however, research generally supports the views that lighting affects mood, work performance, well-being, and alertness [15].

Nuzum-Keim and Sontheimer [16] discussed concerns about ultraviolet light exposure from people with certain photosensitive dermatalogic and systemic diseases. These authors measured ultraviolet A (UVA) and ultraviolet B (UVB) leakage from incandescent bulbs and CFLs. They found that UVA leaks were higher from incandescent bulbs and UVB leaks were higher from CFLs, but the lower leaks of combined UVA and UVB were from shielded CFLs. They concluded that minimizing exposure to UVA and UVB by photosensitive people would have a small but measurable effect in minimizing risks of developing some illnesses.

Conclusion

In addition to consumers of lighting products, students and practitioners of interior design can benefit from knowledge of lighting in its historical context because this enriches perspectives on the topic. The importance of energy efficiency and healthy housing issues makes the connection between lighting and these topics critical to understand.

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