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Solid-state lighting: the only solution for the developing world

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About two billion people around the world still have no access to electricity, and thus rely on poor-quality fuel-based lighting for home illumination. Solid-state lighting using white light-emitting diodes (LEDs), combined with renewable energy sources, may be the only sustainable option to provide home lighting to this section of humanity.

Lighting is a basic human need like clean water, food, sanitation and shelter. In this new era of information and market globalization, appropriate lighting should be considered a human right, directly linked as it is to literacy and therefore education. A well-educated population desires and tends to create healthier, safer, more democratic and peaceful communities. Thus, lighting is a key component in human development.

Two billion people, one third of humanity, still has no access to electricity, and thus relies on fuel-based lighting, a dangerous alternative that is unhealthy, expensive, and offers very poor levels of illumination[1]. This lack of light makes it difficult to perform most evening activities including studies by children and adults alike and therefore represents a significant barrier to human development.[2] Since 1999, the Light Up The World foundation (LUTW) has pioneered the use of white light-emitting diodes (WLEDs) as an appropriate home lighting solution, bringing safe, healthy and affordable light to approximately 10,000 homes around the world.[3]

It is estimated that 25 to 30 percent of the world's total electricity production is consumed by lighting. It is therefore imperative that we use the most energy-frugal forms available, particularly in the developing world, where demand is growing at an accelerating rate as a product of economic development. The fewer power stations constructed to meet the needs of lighting, the fewer emissions and waste generated, and the more capital available for other investment.

As part of the commitment to procure the best quality products, LUTW continuously tests, develops, and evaluates technology in the fields of solid-state lighting (SSL), renewable energy and energy storage at the University of Calgary Solid State Lighting Laboratory (UCSSLL). Ongoing research work performed at UCSSLL includes white-LED lumen-output-degradation testing, SSL system performance analysis, and the design of efficient driver circuits for dimming WLEDs.

Under ideal conditions, LEDs have the longest lifetime of all artificial sources. However, all LEDs present gradual luminous decay that is related to the driving current and the junction temperature, and different LED designs present their own characteristic degradation rates. As shown in Figure 1, high-flux LEDs (i.e. 1W devices) exhibit a dramatically slower rate of decay of luminous output than arrays of devices in conventional 5mm packages. The data in Figure 1 were collected at constant ambient temperature and with constant drive currents of 20mA and 350mA for the 5mm and high-flux LEDs respectively.

LUTW's experiments in rural Nepali, Indian, and Sri Lankan villages using flashlights containing three WLEDs and powered with D-cell batteries have shown conclusively that the WLED flashlights provide a very useful level of light for well in excess of 500 hours, compared to an absolute maximum of 50 hours for the incandescent version. Also, the WLED "bulb" is virtually indestructible and lasts for decades. This means the economic benefits to both villagers and to the environment can be simply immense.

The transfer and application of environmentally sound technologies is central to sustainable development and poverty alleviation.[4] However, despite major international, national and local initiatives to promote renewable energy technologies in developing countries, the uptake of these technologies has been disappointingly slow. SSL technologies are environmentally friendly, economically viable, socially appropriate, and have significant advantages over conventional lighting sources, thus be-

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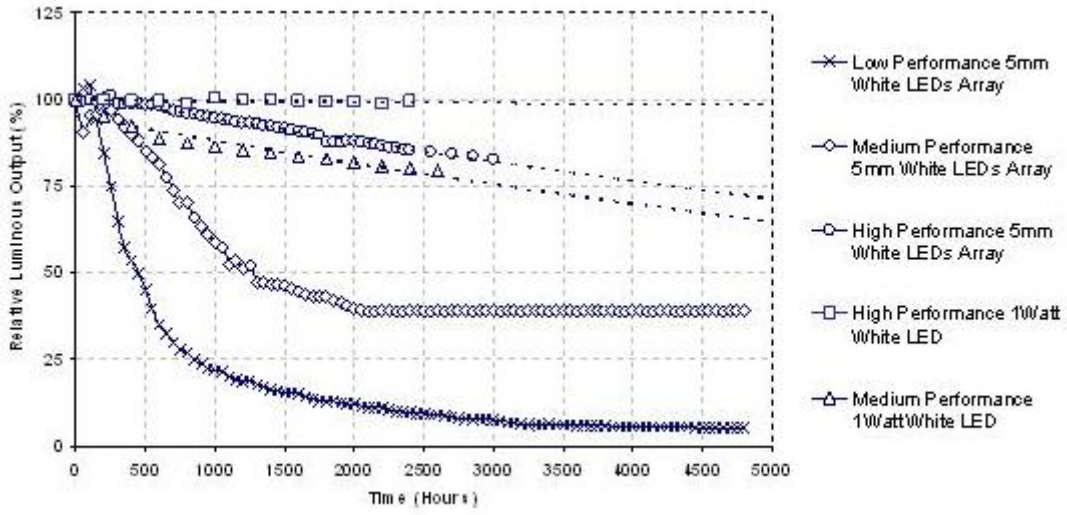

Figure 1. *The luminous output degradation of white LEDs under continuous operation shows that high-flux devices provide superior performance to arrays of devices in 5mm packages.*

ing an appropriate lighting solution for non-electrified communities in the developing world.[4]

Studies clearly show that the rural populations spend significant amounts of money to buy kerosene and candles for home illumination. These amounts vary widely from region to region, typically in the range of approximately $20 to $120 per year. A life-cycle costing over 10 years has been performed for an LUTW home-lighting system, consisting of a 5W solar panel, two 1W WLED lamps, and a 12V 7A hour maintenance-free lead-acid battery. This shows that the annualized cost is about $18 at 10% discounting rate, which is clearly affordable for even the lowest spending groups.

To accomplish the transition to SSL requires only the establishment of basic micro credit facilities, whereby villagers provide a percentage of the initial price and pay for the remainder on a monthly basis, substituting the payment for earlier expenditures on kerosene. Various leasing and similar arrangements can be made to facilitate access to lighting for those lacking sufficient financial resources or collateral.

We believe it is a fundamental obligation—and also a privilege—for those in the developed world to assist those in the developing world to raise their standard and quality of living, by their own efforts and in a manner which they choose. Let us together, in this new millennium, light up the world.

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