SENSE AND NON-SENSE OF LED LAMPS

LED lamps are not expensive! A lamp should not be seen as a product but a utility to produce light. When buying a lamp you are not buying a piece of hardware, your requirement is light- a combination of hardware and energy.

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"Introduction of LED for general lighting is not always presented with the right arguments and technological advantages or disadvantages. Also economy and geographic location will be of influence. In India the needs may be different than in Africa, the US or Europe.

Lemnis Lighting is worldwide active and recognized the difference in needs to reduce energy consumption with LED. Together with CG Ltd, Lemnis went on a search for the optimal specifications to meet consumer needs in the Indian market. These requirements may not always be in pace with current standards or regulations based on the 'old' mature lighting technology.

One should realize that regulations are based on incandescent or gas-discharge lamps and often do not match the characteristics of LED light. This could place the LED advantages into disadvantages when comparing with the 'old' lighting standards. For B2B applications the requirement is focused on a 75W incandescent replacement, mostly as a down lighter. For domestic lighting the needs may be quite different. Let's have a deeper look at some general understanding.

One lamp with high light output works best = Non-sense

The question is "How much light do I need?"

When we change from kerosene lamps to incandescent lamps nobody knows how much Watt lamp they should replace it with. Since the most popular lamp on the shelf in India is 60W, One will buy the 60W lamp for it. A 15 or 25W lamp produces less lumen per watt than a 60W lamp and does not give that much light. On top of that, buying 2 or 3 lamps is more expensive.

However, if we consider the efficiency of LED lamps then they become more

Fig. 1 Labors working in poor lighting of a kerosene lamp

efficient at low power levels. From energy saving and lighting comfort perspective it would be better to have 2 or 3 LED lamps of 2W than one LED lamp of 6W. One lamp in a room will cause spooky shadows on the walls and will affect visibility in a negative way due to less uniformity. Technically the heat management and light source problems of a 6 Watt LED lamp are exponentially bigger. Better to go cheap and certain with respect to life time. The domestic market is asking for a 60W replacement since that is what is known but shouldn't we look with a new view when innovating? There are different trends in popularity. In Scandinavia the most sold bulb is 25W, in the UK, Netherlands and Germany it's 40W (source Greenpeace). The US starts with 75W and up to 100W. It seems unpredictable and not only effected by geographic latitude. Economic conditions seem equally important. Example is the US car industry which swapped in the oil crisis almost overnight from huge inefficient limousines to small Japanese cars. A preferred lamp for rural India reflected on infrastructure, economics and need would be around 120 to 160 lumen at 2 Watt or 210 lumen at 3 Watt. Using more lamps simultaneously will be much more convenient. The trend in developed countries from 1950 to 2000 was from 1 lamp in the room to at least 5 lamps in the room. In 1950, a whole house had 3 lamps and nowadays the average is 42 (Central bureau of statistics Netherlands 2001). In a fast developing country like India such evolution does not need half a century anymore.

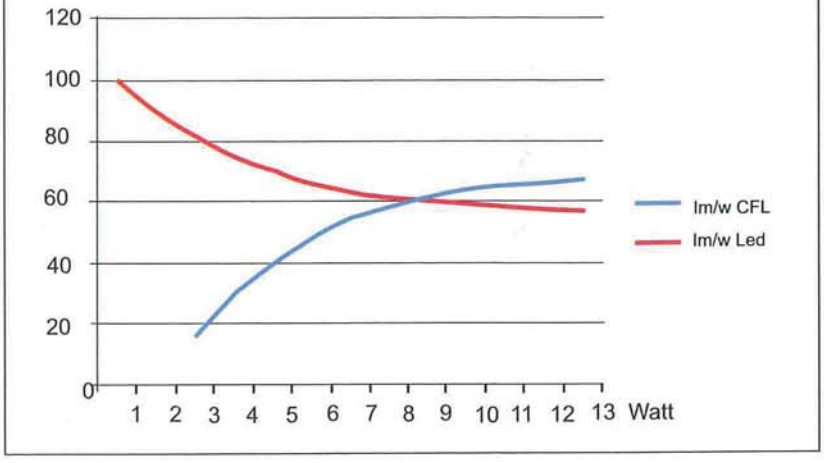
LED lamps are efficient = Sense

There is a major differencein physics between CFL and LED. CFL's require heat to work optimal.

A low power CFL does not heat-up easily and once it reaches its working temperature the lm/W output for small CFL's is limited. LED's work the other way around- the cooler the better. The output of a LED will drop substantially when they get hot. The characteristic efficacy of a CFL compared with a LED lamp is presented in fig. 2. It's evident that low Wattage LED lamps beat the CFL by far.

In comparisons with CFL's the LED is often presented as "not yet" a good replacement. If we would compare a 4W CFL with a LED lamp then the LED may show 4W x 70 lm/W =280 lm whereas the CFL meets 35 lm/W x 4 = 140 lm. The LED lamp is 2x more efficient.

fig. 2. Led lamps at low energy are much more efficient than CFL



Dimming LED lamps save energy = Sense

There is a big misunderstanding about dimming lamps. Dimming a 60W incandescent lamp to 30W of its energy consumption results in a light reduction to 1/5 of the nominal light output. So here's no saving! Incandescent lamps produce light because the filament is white hot. Reducing energy through the filament will change the color of the filament from yellow/orange to orange/red and finally deep red with almost no photopic light output. Dimmable CFL's also get less efficient when they are cold. See a CFL just switched on. It may take up to a minute before the lamp is at its full light output. When a CFL is dimmed the lamp gets colder and therefore produces less light. This is also the case with gas discharge lamps in public lighting. Dimming a LED lamp will make the LED less hot and therefore more efficient. The LED lamp may therefore become more efficient than at full power when dimmed.

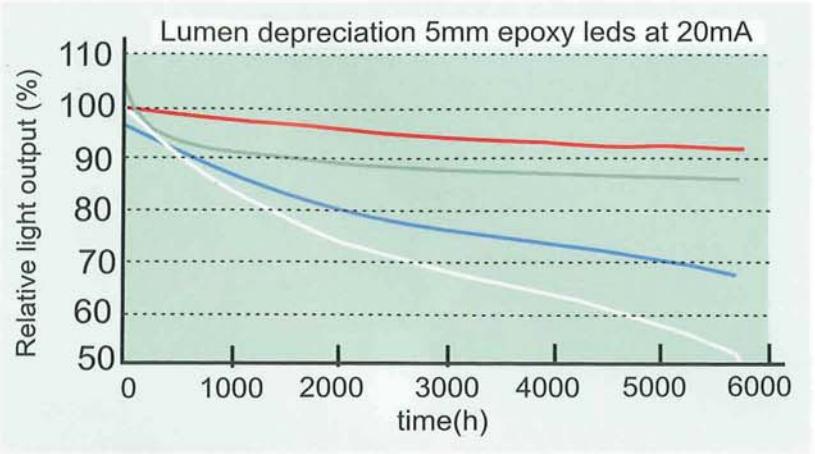
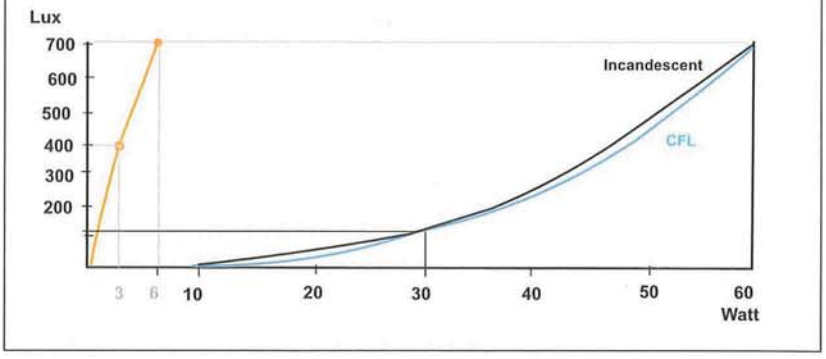


fig. 4. Led lamps become much more efficient than CFL or incandescent lamps when dimmed



LED lamps don't get hot = Non-sense

We learned before that LED lamps currently convert up to 10% of the electric energy in light. Expectation is that 220 lm/W will be the future technical maximum. It means that now still 90% of the energy is turned into heat. Since the power consumption is much lower than from incandescent lamps the amount of heat is less but the generated heat contributes to the ageing of the lamp. Especially the phosphors which convert blue chip light into visible white light will suffer from heat and will turn the light blue with a lot of light loss. The average behavior of 5mm white LEDs under equal conditions is shown in fig.2

The LED chips in the 5mm LED are not cooled since they are packed in epoxy. The only way to get rid of the heat is through the connection pins.

Well designed LED lamps will have a heat sink to get rid of the produced heat. When the lamp is not producing any heat it means that the energy is absorbed internally and there will be spots in the lamp which cannot be felt but which are extremely hot. It's bad for the lifetime of the lamp.

LED lamps are almost 100% efficient = Non-sense

Incandescent lamps produce 98.5% heat and 1.5% light. This can be calculated from 1W = 683lm.

At 10 lm/W the efficiency is 10/683 = 0.0146. For a LED the efficacy is 70 lm/W which results in 0.102 = 10.2%. Still 90% of all energy provided to the lamp is lost in heat. The absolute amount of heat is less than from an incandescent lamp since its 90% of 6W instead of 98.5% of 60 Watt.

LED light is expensive = Non-Sense

This is a major misperception. LED lamps are not expensive! A lamp should not be seen as a product but a utility to produce light. When buying a lamp you are not buying a piece of hardware, your requirement is light- a combination of hardware and energy.

Buying light by using kerosene or a candle is technically and economically one of the most inefficient lighting methods of all. Electric lighting is also not always efficient. Incandescent lamps convert only 1.5% of their consumed energy in light.

CFL's meet 5 to 6% but some LED lamps can nowadays reach a lumen efficiency of up to 12%. On top of that, the LED light can often be directed and spectrally modified to be more efficient for its task.

The average lifetime of incandescent lamps is 1000 hours. With only one lamp in the house the average use can be up to 6 hours per day for 365 days per year. That is (2190 hr/yr) and with a 60W lamp a power consumption of 131.4 kWh.

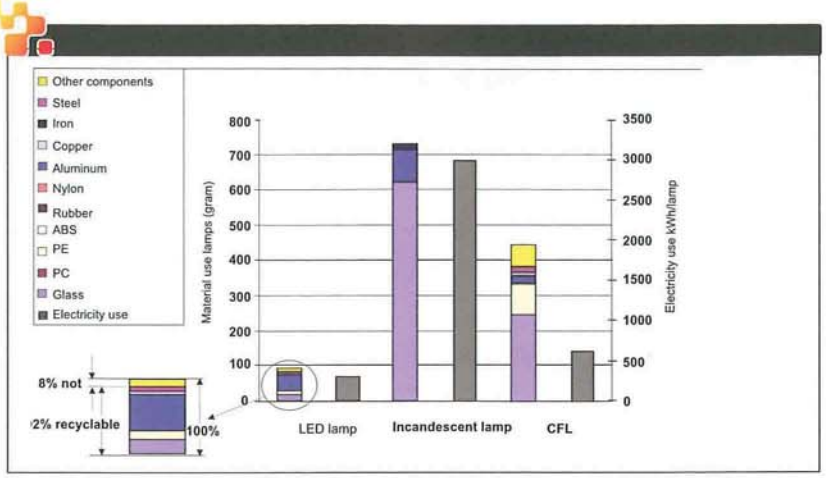
A good 6 Watt LED lamp can replace a 60W incandescent lamp and will have a lifetime of at least 25.000 hours. The energy consumption per year is than 13.14 kWh; a saving of 118.26 kWh. Based on an energy price of Rs.5/kWh a lamp of Rs.600 is earned back in a year.

LED lamps require a high power factor = Non-Sense

Power Factor is current in the grid which is not in phase with the voltage. Utility companies prefer a PF of 1. General utility regulations allow users a minimum PF of 0.85 to 0.9. The European standard IEC-555-2 and EN 60555 state that lamps under 25W require no Power Factor correction. The UK Energy Saving Trust requires a PF of 0.75 to 0.9 for LED in business applications. India is following that requirement. In the US, Energy Star requirements demand a power factor of 0.75 or higher for LED lamps of more than 5W.

What are we talking about with LED lamps with a 'bad' Power Factor of 0.57 ?

A Pharox 5W ECO shows a current of 36mA, which results in a cable loss in the grid of 1 mW per Ohm from the source (in this case the power plant). A simple test with a vacuum cleaner shows a voltage drop of 2.7V after switching 'on' and a current of 6.3A.



This calculates a grid resistance of 0.52 Ohm. At 36 mA lamp current, this is a total power-line loss of 0.68mW. That's only 0.0135% of the total lamp power. The 40W incandescent lamp which it replaces is causing in the same grid a loss of 15.7mW. That's 23 times more than with a LED lamp with a 'bad' Power Factor of 0.57. Only electric engineers will realize the ridiculous magnitude of the figures. They realize that P_loss=R_source*(i1+i2+i3+i4+....) . This causes that the power consumption of larger loads always dominates and the effect of the small load can be neglected.

For some perspective, a microwave or airco causes a 40.000 times higher grid loss than the LED lamp of 5 Watt with a 'bad' Power Factor. Lemnis introduced since 2004 capacitive PF on their lamps, reducing the inductive grid PF and cable losses. The Power Factor discussion is a non-discussion at such low power consumption. Billions of CFL's in the world have generally no better Power Factor than 0.5. Reason to mention this PF aspect is that equipping low power LED lamps with active PF correction makes led lamps unnecessary expensive. Additional components cause additional size, electronic waste and affects the lm/W ratio in a negative way. A high PF demand for low power lamps has a highly negative effect on sustainability!

LED lamps are sustainable = Sense

From energy efficiency point of view that's true. There are however many other variables which determine the sense of that statement. Many lamps are built from casted aluminum which results in more weight and more energy consumption in production. The CO2 footprint of the product is important.

The choices of materials, precious, rare earth, recyclable are also part of the Carbon footprint.

Environmental pollution in production, during use and after lifetime is another important element to consider for the future of our earth. An often forgotten danger is that CFL lamps contain mercury which cumulates in the food chain with catastrophic effects on life and health.

Last but not least, life time determines the real sustainability. This life time should not be outrageous. A lifetime of 50.00 hours results in 25 year lifetime. The technological development in LED is so fast that within 5 years the specifications will have improved to more than double of the current output. Independent laboratories investigated the sustainability of the Lemnis Pharox 300 lamp compared with incandescent and CFL lamps (fig.5.).

CG/Lemnis are taking all above considerations into account to produce lamps for a best fit to market. Only when recognizing and learning from the sense and nonsense of LED lighting will India be enabled to progress in modernization. ■