

# The Measure of Performance

Key efficiency metrics in assessing LED lighting technology

July 30<sup>th</sup>, 2012



LEAPFROG  
LIGHTING

## EFFICIENCY VERSUS EFFICACY

Two commonly confused terms in lighting are efficiency and efficacy. They are similar, but with a few important differences.

The light output from a lamp can be defined in a number of ways. The simplest is the amount of radiant flux, or radiant power, measured in Watts. This is the total amount of emitted light energy, which can include parts of the optical spectrum the eye cannot see. Radiant power is used to measure efficiency—how much light energy came out for the amount of electrical energy that went into the lamp. Efficiency is expressed as a number, or percentage, as it is simply Watts in divided by Watts out.

The second output measure is the efficacy of the lamp—or how effectively it creates useful light. Efficacy is more commonly used in lighting because it takes into account the ability of the eye to see certain colors better than others. For example, although white light is made up of all the colors in the spectrum, we tend to see green best of all, so a lamp that produces more green would appear brighter to us than one that was more red or blue. The unit of measure for visible light is lumens, which corrects radiant flux output for the sensitivity of the eye. Efficacy is the number of lumens out divided by the electrical power supplied, so is stated as lumens per Watt (or lm/W).

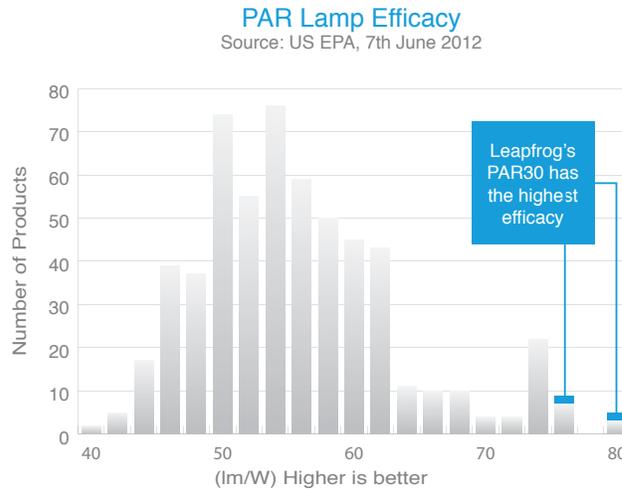
## Inefficiency = Obsolescence

High technology has sparked remarkable advances in virtually all sectors in the past few decades. The lighting industry is no exception. Widespread public concerns over the environment and skyrocketing energy demands—among other factors—have driven the industry to improve on the dismal inefficiency of traditional lighting technologies. For example, incandescent lamps, the mainstay for more than a century, produce a pleasing light yet waste 90 to 95 percent of the energy supplied to them. Although much more efficient than old incandescent technology, compact fluorescent lamps (CFLs)—touted over the past 10 or 15 years as the premier solution—still use two to three times the energy of light-emitting diode (LED) lamps.

The extraordinary long life of LED lamps is well documented, and lamp-life claims of 40,000 to 50,000 hours are not uncommon; however, their energy efficiency is of primary importance to many commercial and residential lighting buyers who want to reduce electricity consumption without sacrificing quality of light. LED lamps consume substantially less energy to produce the same amount of light as many competing types. As innovation continually increases LED energy-saving capabilities, older, inefficient technologies are steadily being rendered obsolete.

### LED LIGHTING TECHNOLOGY IS STILL IN ITS INFANCY AND TECHNICAL PERFORMANCE VARIES WIDELY AMONG MANUFACTURERS AND INDIVIDUAL BULB TYPES.

Yet the mere presence of an LED chip is no guarantee of peak performance. LED lighting technology is still in its infancy and technical performance varies widely among manufacturers and individual bulb types. These discrepancies are clear in recent statistics published by the US Environmental Protection Agency (EPA). Figure 1, for example, shows the extraordinary range of efficacy among PAR30 LED lamps on the market. Most of these lamps achieve efficacy readings of between only 40 and 60 lumens per Watt (lm/W), which means much of the technology's energy-saving potential is lost in poor design and not converted to light. Only a few LED lamps currently on the market achieve the efficacy performance and energy savings the market should expect from the technology.



**Figure 1**  
*Compared to hundreds of other PAR30 LED lamps tested by the US EPA, the Leapfrog Lighting product delivers the highest efficacy (lm/W).*

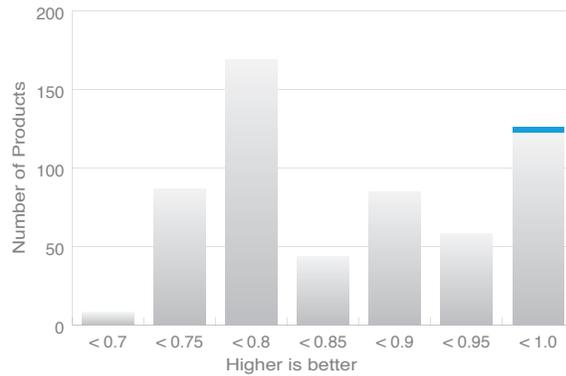
**MANY UTILITIES PENALIZE USERS THAT HAVE LOW POWER-FACTOR USE PATTERNS, SO THERE'S OBVIOUS BENEFIT TO SELECTING TOP PERFORMING LAMPS.**

Among these, the PAR30 dimmable lamps from Leapfrog Lighting deliver the greatest efficacy with ratings of 75 lm/W for the warm white and 80 lm/W for the cool white versions. In fact, compared to hundreds of PAR30s tested by the EPA's Energy Star program<sup>1</sup>, Leapfrog's lamps are among the top performers in virtually all major efficiency-performance categories, including power factor. Power factor is a measure—expressed as a ratio or percentage—of how well a lamp absorbs the power it's supplied. The closer this ratio is to one, the higher the power factor—and the greater the efficiency. Lamps with a low power factor draw more current than those with high power factors to produce an equivalent amount of light. The more current that's required, the more electricity must be generated. Understandably, this increased demand is a concern for utilities, which actively encourage high power factors, particularly among commercial and industrial users. Many utilities penalize users that have low power-factor use patterns, so there's obvious benefit to selecting top performing lamps.

Leapfrog Lighting's PAR30s have a power factor of 0.95 (Figure 2), meaning the lamps are 95-percent efficient in using the electricity that flows to them. Compare this to many LED lamps that waste as much as 30 percent of the energy they draw.

<sup>1</sup> Leapfrog Lighting's PAR30 lamps were not among those lamps tested by the EPA; however, the PAR30s' quoted performance figures have been verified in an NIST-traceable lab.

**PAR Lamp Power Factor**  
Source: US EPA, 7th June 2012

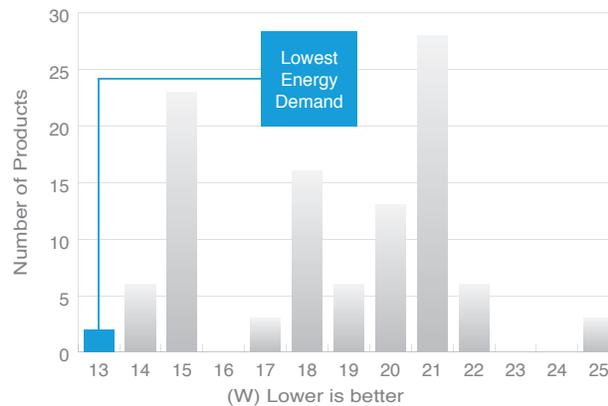


**Figure 2**  
At 95 percent, the Leapfrog Lighting PAR30s have one of highest power factors in the industry compared to lamps tested by the EPA.

### High output, low power demand

At 950 lumens (warm white) and 1000 lumens (cool white), Leapfrog Lighting PAR30 lamps deliver some of the highest light outputs available. Yet these lamps produce this output with the lowest power demand of any on the market. As the EPA figures show (Figure 3), some LED lamps draw as much as 25 Watts to produce 1000 lumens. The Leapfrog PAR30s almost halve this figure, delivering the same output while using less than 13 Watts each. This efficiency is critical for buyers who want to achieve optimum energy and cost savings without sacrificing light output.

**Power Used - PAR Lamps > 1000 Lumens**  
Source: US EPA, 7th June 2012

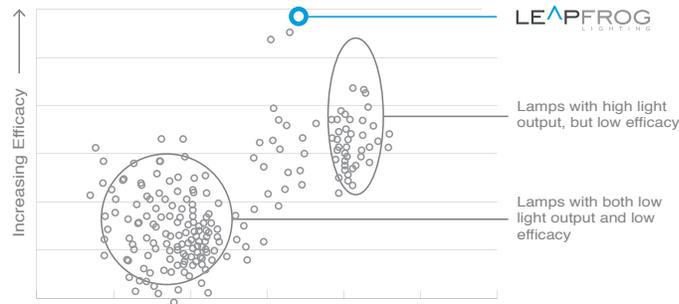


**Figure 3**  
Among PAR30 lamps that produce more than 1000 lumens, Leapfrog Lighting's LEDs draw the least electricity—less than 13 Watts.

### Coupling efficacy with high output

Figure 4 maps Leapfrog Lighting's PAR30s as well as lamps tested by the EPA according to efficacy and light output. Note that most lamps

deliver relatively low light output and low efficacy. Those to the extreme right deliver high light output but sacrifice efficacy. Leapfrog Lighting's PAR30s are among the few lamps that provide relatively high output coupled with high efficacy.



**Figure 4**  
*Leapfrog Lighting's PAR30s are among the few LED lamps in their class to deliver both high light output and high efficacy.*

## Better quality through testing

Leapfrog Lighting attributes the high performance of its PAR30s to a rigorous and ongoing product sourcing and testing regimen. The company sets precise specifications for each lamp according to its application. The PAR30s, for example, are intended for common area down-lighting applications where demand for energy efficiency is high and quality of light is critical.

**A COMPREHENSIVE BATTERY OF SIX TESTS ASSESSES LIGHT OUTPUT, ENERGY EFFICIENCY, COLOR QUALITY (BOTH COLOR TEMPERATURE AND COLOR RENDITION), AND OVERALL STRUCTURAL INTEGRITY.**

With specifications in hand, Leapfrog's technical experts travel to meet manufacturers around the world, inspecting their operations, evaluating product designs and assessing quality-control procedures. Although these manufacturers have some of the most stringent product testing facilities in the industry, Leapfrog maintains its own laboratory to verify the performance of every lamp prior to shipping. A comprehensive battery of six tests assesses light output, energy efficiency, color quality (both color temperature and color rendition), and overall structural integrity. The company also regularly verifies the rate of lumen depreciation to help affirm the projected lifetime of each product line. To ensure testing accuracy, Leapfrog Lighting regularly cross-calibrates its laboratory to an independent NIST-traceable test facility.



## Peak performance for peak energy savings

In three of the most critical technical measures—efficacy, power factor and light output—Leapfrog Lighting’s LED PAR30s are among the industry’s top performers. For the lighting buyer, the Leapfrog PAR30s deliver peak efficiency for the highest possible energy savings, particularly among high-output lamps of their type.

## About Leapfrog Lighting

Leapfrog Lighting is a North American-based supplier of high-quality LED lighting products. The company is dedicated to helping consumers and lighting professionals experience the extraordinary benefits of LED lighting: its remarkable energy efficiency, long life, and low environmental impact.

To inspire the confidence buyers need to choose LED lighting technology, Leapfrog LED lamps optimize performance across all key categories, including energy efficiency, total light output, color quality, construction, lamp life, and price. The result is a unique balance of quality, performance, reliability and value—the best LED lamps at the lowest cost of ownership. [Tested. Inspected. Guaranteed.](#)

