HIDDEN POWER

LIGHT BULBS

Which light bulbs are most efficient?

Question & Answer Fact Sheet

Type of Light Bulb	General Information	Advantages	Disadvantages
Incandescent 	• Produces light by passing electricity through a metal filament which becomes heated and glows • Efficiency = ~ 10% • Cost: ~ **$0.99/Type A bulb** (60 Watt ; 750 lumens; 2000 hours)	• Warm glow (aesthetically pleasing) • Readily available • Cheap initial cost	• Extremely inefficient; ~90% of input electricity is wasted as heat
Compact Fluorescent (CFL) 	• Produces light by passing electricity through a tube of mercury gas, creating invisible UV radiation which is then absorbed by a phosphor substance coating the tube, causing the phosphor to fluoresce (emit visible light) • Efficiency = ~ 85% • Originally thought to be the light bulb of the future, but has failed in doing so • Cost: ~ **$8.95/Type A bulb** (13 Watts; ~ 800 lumens; 15,000 hours)	• Efficient AND requires less electrical energy input overall • Can be long lasting* (Note: if and only if guidelines for usage are followed)	• Produces an aesthetically unappealing light color • Light gradually builds to full brightness; not immediate • *Unreliable longevity (fails quickly if not allowed to rest 15 minutes between uses) • *Tends to overheat and fail if used in recessed lighting canisters • Tends to flicker • Not usually dimmable • Fragile (difficult and expensive to manufacture) • Contains mercury (environmental hazard; requires special disposal)
Light Emitting Diode (LED) 	• Produces light by passing electricity through a diode which emits one particular color (wavelength) of light that is unique to the material within that diode • Efficiency = ~ 90% • Cost: ~ **$15.95/Type A bulb** (11 Watts; ~ 600 lumens; 25,000 hours)	• Efficient AND requires less electrical energy input overall • Likely the future of lighting • Uses solid state semiconductors which are quickly getting better, cheaper, and easier to make • Different diodes can potentially be combined to create an aesthetically pleasing warm glow • Bulb longevity	• Expensive; production not yet cheap enough to appeal to consumers • Not yet bright enough for standard, common, everyday uses • Cooling issues exist, causing premature diode failure and limiting brighter light production • The aesthetic, warm glow that consumers desire is not yet fully developed • Light shines in only one direction; bulb must be shaped to allow light to shine all around

Defining Light Bulb Efficiency

Total Energy IN = Total Energy OUT

Electricity = Light + Heat

Note: *A 100% efficient light bulb would convert ALL electrical energy into visible light, and there would be zero loss as heat. A 50% efficient light bulb would convert half of the electricity to light, and the rest would be generated as heat.*

$$\% \text{ Efficiency} = \frac{\text{Amount of Light Energy Produced}}{\text{Total Electrical Energy Input}} \times 100$$

Helpful Definitions:

Lumens = a measure of how much light reaches a surface at a given distance away from the light source (often thought of as the "brightness" of a light)

Wattage = a measure of how much electricity a light bulb uses each second (measured in Watts; a unit of power)

Kilowatt-Hour = the total amount of energy used by a 1000 Watt light bulb in 1 hour; directly purchased by consumers from their electric company provider (e.g. Allegheny Power's 2011 "price to compare" for residential customers is listed as *7.13 cents per kilo-watt hour*)

What are some other types of light sources, how do they work, and for what purposes are they used?

Halogen lamps are essentially an improved (longer lasting) version of the incandescent bulb. In addition to utilizing a tungsten filament, these light sources also contain an inert gas, and a halogen gas, such as iodine and bromine. During normal operation of an incandescent bulb, tungsten gradually evaporates over time (noticeably depositing itself upon the inside of the glass bulb), causing the filament to wear thin and break. Chemical reactions between a halogen gas and tungsten, however, make it possible for the tungsten to redeposit itself back onto the filament. This cycle increases the usable lifetime of the bulb; it also makes it possible to heat the filament to higher temperatures, increasing the bulb's potential light intensity. Halogen lamps are widely used in automobiles and stage lighting. (Efficiency = ~10%; similar to an incandescent bulb)

Metal-halide lamps are a type of high-intensity discharge lamp. In a highly-pressurized tube filled with a mixture of gases, an electric arc is created between two tungsten electrodes, thereby heating and vaporizing the enclosed gases and producing intense, efficient light in the process. The intense light, heat, and pressure that exist in these bulbs, compared to their relatively small size, require that these lights use unique fittings and wiring in order to function safely. Metal-halide lamps are commonly used in sports stadiums, parking areas, and other places where high intensity, higher efficiency lighting is desired. (Efficiency = ~24%)