All About LED Lighting

by Randall Ghent

Introduction – Did You Know?...

- 1/3 of lightbulb sales by Philips and Osram are now LED.
- 1/3 of UK households have LED lighting installed.
- Still, public awareness is very low. Case in point – as part of a display at Wilkinson designed to inform the public about LED lighting: "Watts are now measured in lumens." Wrong! …or… the widespread view that so-called 'energy-saving' bulbs are the most efficient.

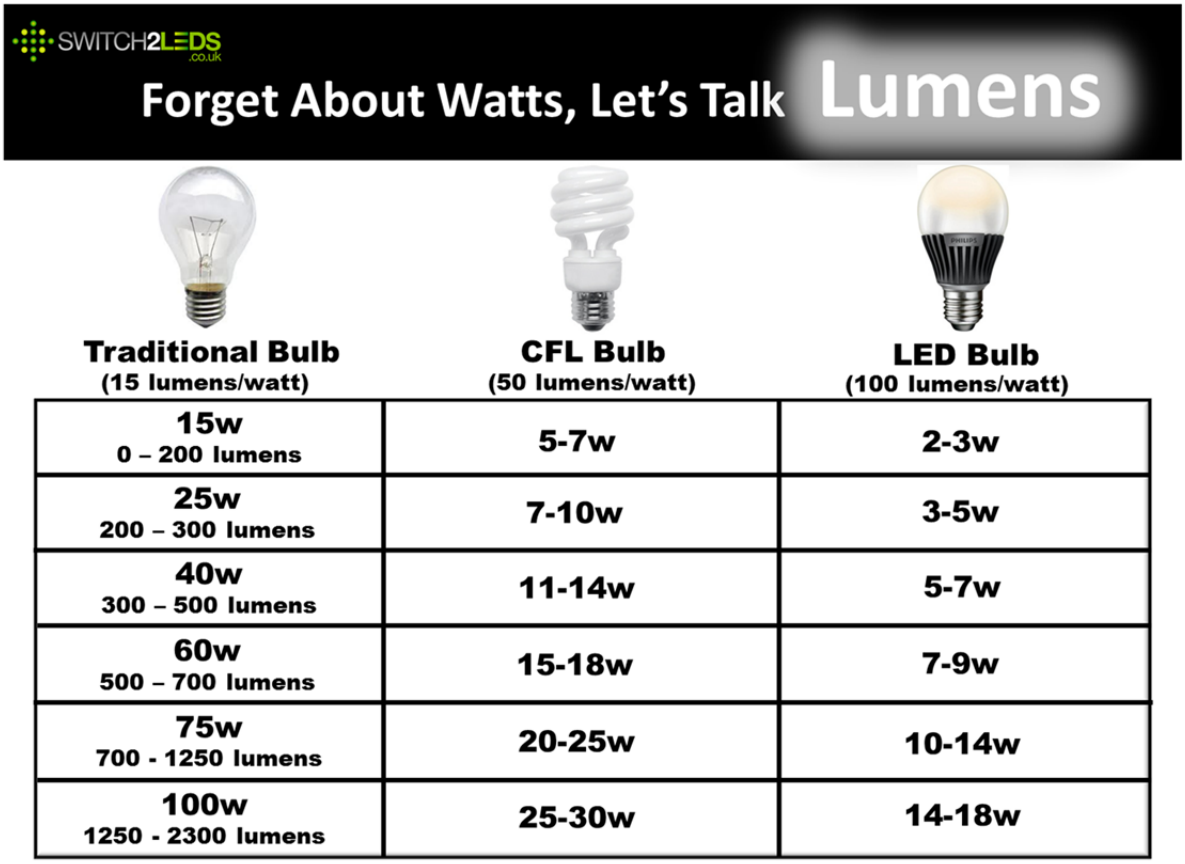
Why Switch to LED?

1. **Energy efficiency (lumens/watt) – 50% savings over fluorescent, 90% over halogen or incandescent *today* and improving rapidly. This translates into energy cost savings.**
2. Longer bulb life – e.g. halogen 1,500 hours to LED 30,000-50,000 hours, which also equates to a lower maintenance cost in commercial/industrial environments.
3. LED bulb costs coming down whilst energy costs are going up.
4. Many LED bulbs are dimmable, unlike fluorescents.
5. Colour temperature – LEDs available in a range of 'warm' to 'cold' light versions as well as a range of colours for specialist uses (e.g. night lighting of Millennium Bridge in York).
6. Flexibility– not only available in bulbs but bendable strips and sheets, range of beam angles, fitting types, frosted vs unfrosted, etc.
7. Excellent for off-grid installations – because (a) limited power is available and the cost per watt of energy delivered is high, and (b) LED is widely available in 12V DC.
8. No start-up delay when switching on, unlike many fluorescents.
9. Works better in cold environments than fluorescents.
10. Less heat output than other technologies – especially important in hot climates, in refrigeration lighting, and to reduce electrical fire danger.

Reason 1: Energy Efficiency

There's no point replacing bulbs to reduce watts, if you're reducing the light output to below your needs. So you need to look at lumens (light output) together with watts (power consumption).

Energy efficiency is measured in lumens per watt. That's how much light output you're getting for a given amount of power. It's important to calculate lumens/watt because even among LED bulbs, there's quite a range of efficiencies. Curiously, you won't find lumens/watt figures on product packaging. So you'll have to calculate it yourself. Fortunately, it's not hard. For example, if you see a 3W bulb emitting 300 lumens, that's 100 lumens/watt. You'll want to strive for 100+ lumens/watt, which is usually possible if you look around. Prototype Cree LED bulbs have surpassed 300 lumens/watt, so it's just a matter of time before the bar is raised once again.



Reason 2: Longer Bulb Life

This is a massive issue for companies employing facilities management contractors high hourly rates to change light bulbs – even more so when the bulbs are out of reach and require hiring in a scissor lift. With halogen GU10 bulbs, which last 1,500 hours, it's a no-brainer to replace them with LEDs, which last 25,000+ hours. In such a situation, even when the LED bulbs cost at least twice as much as halogen bulbs, you can easily develop a 'business case' for switching – based on bulb life alone.

For everyone else, bulb life is the second factor to include in cost savings calculations, even if it's a quick and rough mental calculation.

Payback and Return on Investment (ROI)

Payback is the point in time when you've recouped the costs you've outlaid by replacing your bulb(s). That is, when you 'break even'. To achieve the quickest payback, you will need to replace your higher-wattage bulbs, and those that are used most often. If you need to calculate which bulbs will be cost-effective to replace, you can use a simple cost calculate as below.

The first step is to convert the bulb wattage to kW – because that is the format used to calculate energy costs. Just divide by 1,000. The rest of the calculation determines the kilowatt-hours per year of your bulb, based on the average hours/day and days/year of usage. The last steps are to multiply by your utility costs per kilowatt-hour, and then add in the cost of the bulb (and any installation costs).

Halogen > LED payback calculation:

35W halogen GU10: 0.035 kW x 12 h x 365 d x £0.15 util = £23.00 energy costs/year + £1.50 bulb

3W LED GU10: 0.003 kW x 12 h x 365 d x £0.15 util = £1.97 energy costs/year + £4.03 bulb

Year 1 savings: £24.50 - £6.00 = £18.50 Year 2 savings: £24.50 - £1.97 = £22.53

Simple payback = difference in bulb cost / electricity savings per year:
£2.53/£21.03=0.12 years = **payback in 1.44 months**

Bulb Lifetime Return on Investment: The LEDs gain from investment is the £21.03 saved in electricity per year times **20 years** (the lifetime of the bulb), or £420.60. Then, we must add the cost of the halogen bulb replacements over the LEDs lifetime, which is 20 times, or £30 (20 x £1.50). Therefore, the ROI = (£420.60 +£30 -£4.03)/£4.03 x 100 = **11,081%**

Year 1 ROI: (£21.03 + 1.50 - £4.03)/£4.03 x 100 = **459%**

Fluorescent > LED payback calculation:

12W CFL: 0.012 kW x 4 h x 365 d x £0.15 util = £2.63 energy costs/year + £3.00 bulb

6W LED: 0.006 kW x 4 h x 365 d x £0.15 util = £1.31 energy costs/year + £6.00 bulb

Year 1 loss: £7.31 - £5.63 = -£1.68 Year 2 savings: £2.63-£1.31 = £1.32

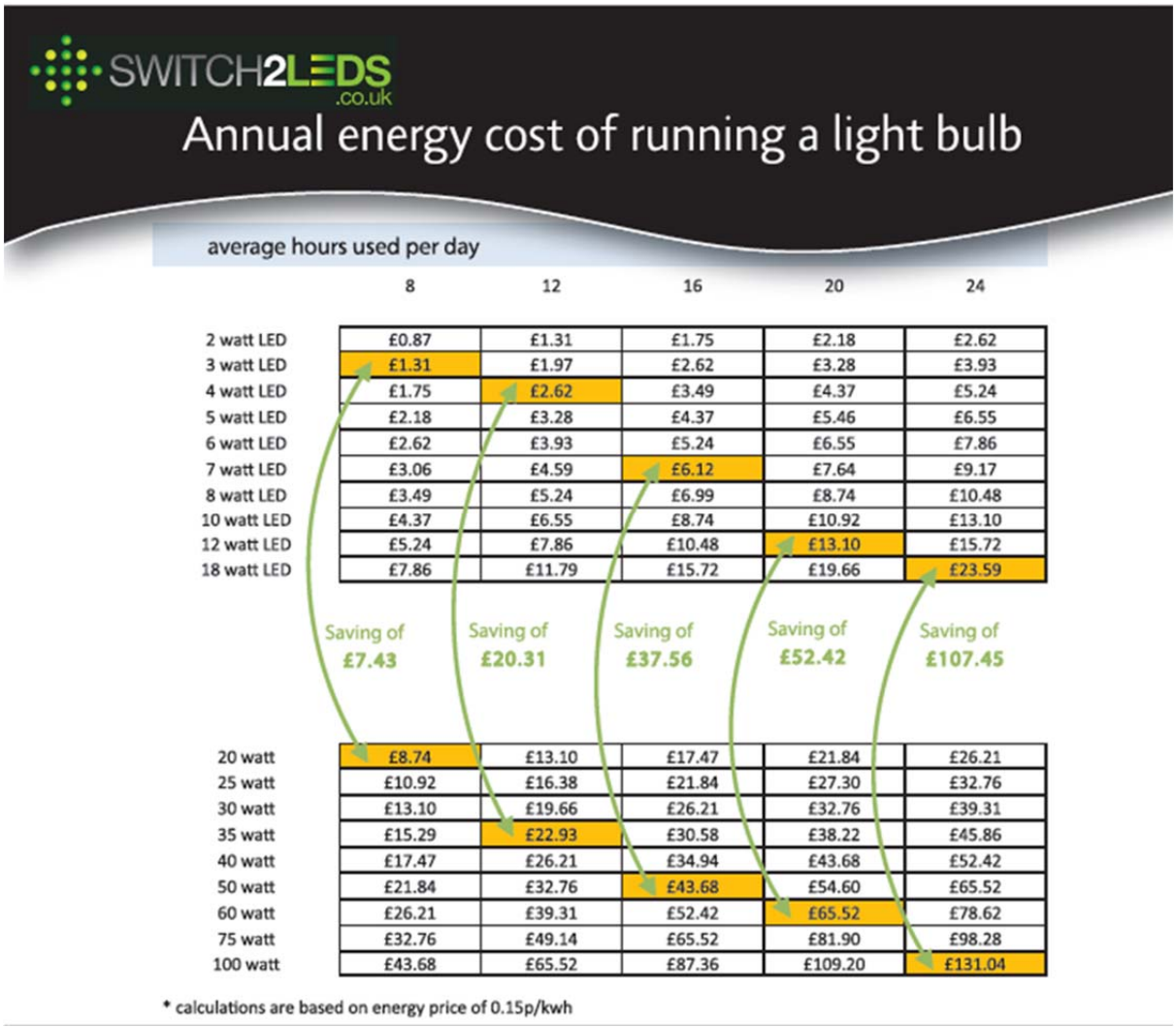
Simple payback = difference in bulb cost / electricity savings per year:
£3.00/£1.32=2.27 years = **payback in 27.27 months**

Bulb Lifetime ROI: The LEDs gain from investment is the £1.32 saved in electricity per year times 20 years (the lifetime of the bulb), or £26.40. Then, we must add the cost of the CFL bulb replacements over the LEDs lifetime, which is 2 times, or £6 (2 x £3). Therefore, the ROI = (£26.40 +£3 -£6)/£6 x 100 = **390%**

Year 1 ROI: (£1.32 +£3 - £6)/£6 x 100 = **-28%**

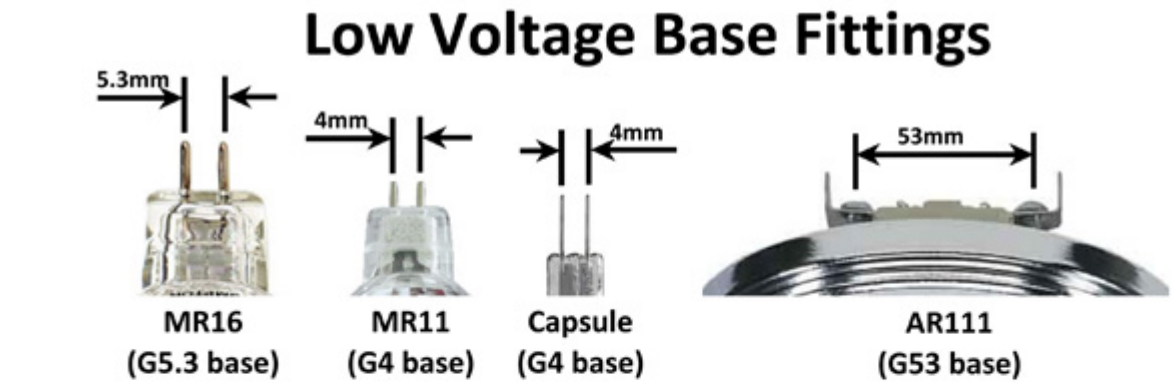
Why Avoid Switching?

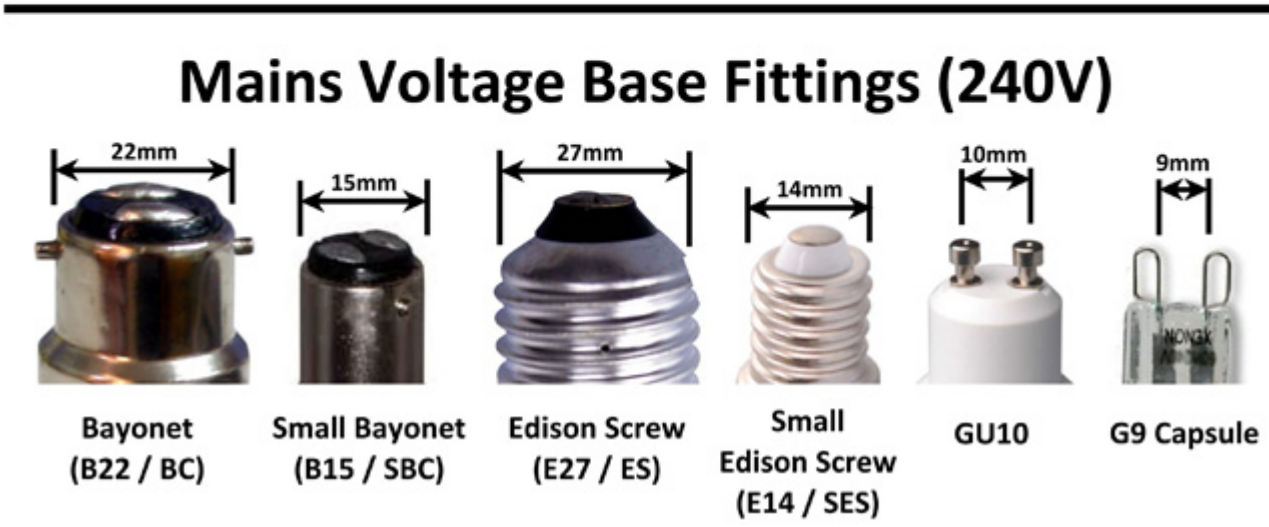
1. **My light fixture isn't used very often, so it wouldn't pay to switch (often true; see above).**
2. The bulb type for my fixture isn't available in LED version (less and less true; have a search!).
3. The quality of LED lighting is inferior to other technologies for my particular installation (usually untrue, but sometimes true in certain applications, so stay open-minded).
4. I've been burned by bad experiences with low-quality LED lighting (legitimate, but the answer is to avoid low quality).
5. The range of products is confusing and variable even within one bulb type (legitimate, but this guide will help you!).



Steps to Take

1. Prioritise replacement of high wattage bulbs and those with the most usage (in hours/day).
2. Check your existing bulb wattage and bulb type (e.g. 56 W T8 fluorescent tube, 1200 mm).
3. Determine the equivalent LED wattage needed (approx 50% for fluorescent; approx 10% for halogen or incandescent) and adjust this up or down if more/less light needed. Alternatively and more simply, you could choose the equivalent lumens of your existing bulb.
4. Determine the colour temperature needed (on range from 2700 K to 6500 K – warm to cold).
5. Determine whether to go with frosted or unfrosted (frosted is usually best, to avoid glare) and dimmable or non-dimmable (dimmable requires LED-specific or low-voltage dimmer switch).
6. Determine the bulb shape and size you'd like, based on the fitting, shade and beam angle.
7. Hunt for appropriate bulb based on your choices, looking at lumens, lumens/watt and cost.
8. Avoid unbranded and suspicious suppliers, and those on eBay sold direct from China. Stick to trusted brands in the industry, but note that many of these may be unfamiliar to you (e.g. CREE, Kosnic, Aurora, Megaman… in addition to the 'big three': Philips, Osram and GE).
9. Compare multiple brands and sources for cost (Internet is easiest for this), but avoid choosing based on cost alone, as this is often a false economy.
10. Buy and test one bulb before committing to a larger order.



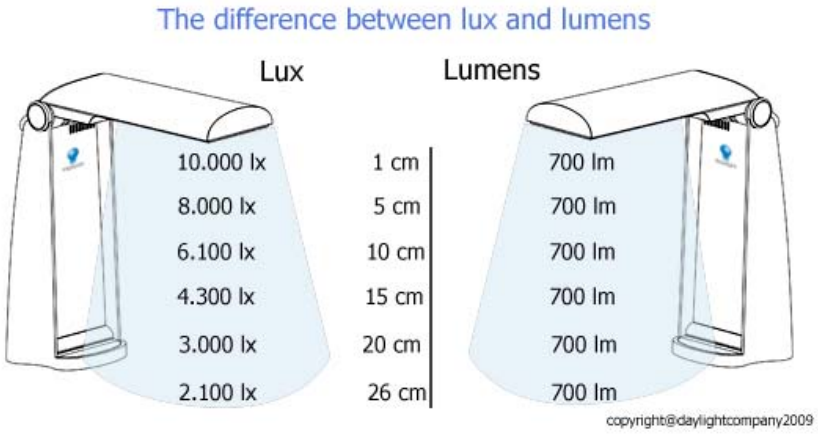


Sources

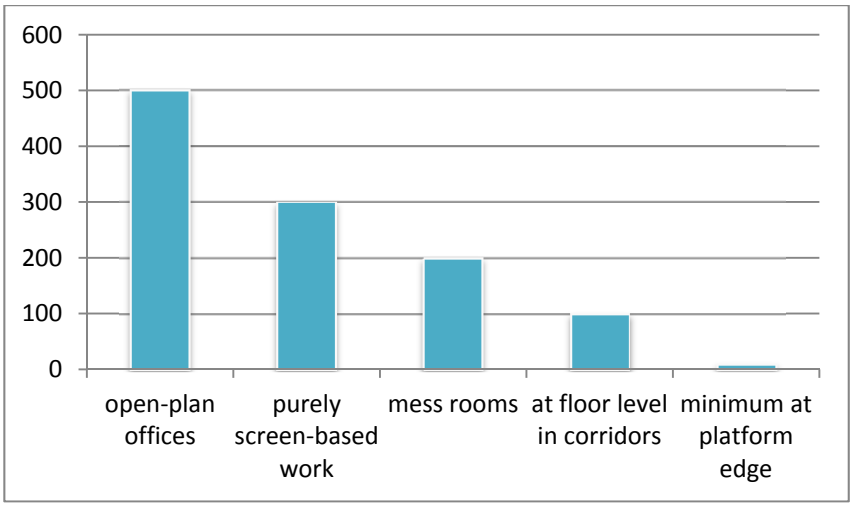
- **Ebay and Amazon** – e.g. MiniSun, Ledlam
- **Specialist websites** – www.energybulb.co.uk, www.ledbulb.co.uk, www.switch2leds.co.uk and many more, or you can start with a 'Google Shopping' search – e.g. type in 'Philips 4W MASTER Dimmable Candle LED'
- **B&Q** –sells Philips and full range of Diall (own brand) LED bulbs
- **Local hardware shops or Wilko** – usually more expensive but keep checking

Terms

- **Colour rendering** – the ability for lighting to reveal the colour of objects faithfully, measured on a Colour Rendering Index (CRI) score of up to 100. Fluorescents score 50 to 90. LEDs score 80 to 98. Incandescents score 100 (full marks).
- **Lumen** – a unit of light output (or 'luminous flux')
- **Lumens per watt** – a measure of the energy efficiency of lighting
- **Lux** – a unit of illuminance on a surface (1 lumen per m2)
- **Kelvin** – measure of colour temperature, from warm to cold, typically 2700K to 6500K.
- **Kilowatt hour** – 1,000 watts consumed over the course of one hour (useful in energy cost calculations and billing)
- **Watt** – a unit of power, or energy use



Lux level requirements by location (for rail industry use)



source: The Society of Light and Lighting, Railway Group Standard GI/RT 7010

About 12V MR16 Bulbs

- If you replace halogen MR16s with LED equivalents, you'll need to replace the transformer with what's called an LED driver to the back end of each bulb to avoid flicker. Alternatively, Philips MASTER LED MR16 bulbs have something internal that overcomes the need for this. A third alternative is to replace MR16s (12V) with GU10s (mains voltage).

About LED Tubes

- LED tubes will halve your energy use over fluorescent tubes. Osram SubstiTUBE is one of the most efficient types. If you replace fluorescent tubes with LED tubes, you'll need to check that the fitting has a magnetic ballast rather than an electronic ballast. Electronic ballasts are more efficient for fluorescent lighting but are not compatible with LED tubes. If you have an electronic ballast, the wiring to allow for LED tubes is quite complicated and may be dangerous. Better to avoid switching, as replacing the entire fitting with an LED fitting will not be cost-effective in the residential context.

About Automatic Controls

- Changing your lighting to LED isn't the only way to save energy. There are also automatic controls such as motion sensors (PIRs – passive infrared sensors) and light sensors with timers and sometimes dimming capability. For example, at the more technical end of the spectrum, the One Lux sensor turns on the lights when presence is detected, drop the lighting down to a certain dimmer level after a certain number of minutes have passed (customisable), and then turns off the lights entirely after a further number of minutes. It also takes into account natural light levels. The advantage is for public safety/security in that you're not turning off the lights entirely right away. PIRs are normally more appropriate for businesses than residences, with the exception of outdoor security lighting.

About SMD LEDs

- SMD stands for Surface Mounted Diode. It's a light-emitting diode that is mounted onto and soldered onto a circuit board. SMD LEDs are quite small since it has no leads or surrounding packaging that comes with standard LEDs. They are better, because they're simpler, cheaper and about 20% more efficient. An SMD LED also has a wide viewing angle, thanks to the fact that it does not have the standard LED's epoxy enclosure that focuses the beam (and creates more glare). The beam angle is 120 degrees rather than 60 or 30. The SMD LED life span can reach 100,000 hours.