

LED Tubes for General Lighting

Replacement for Fluorescent Tubes



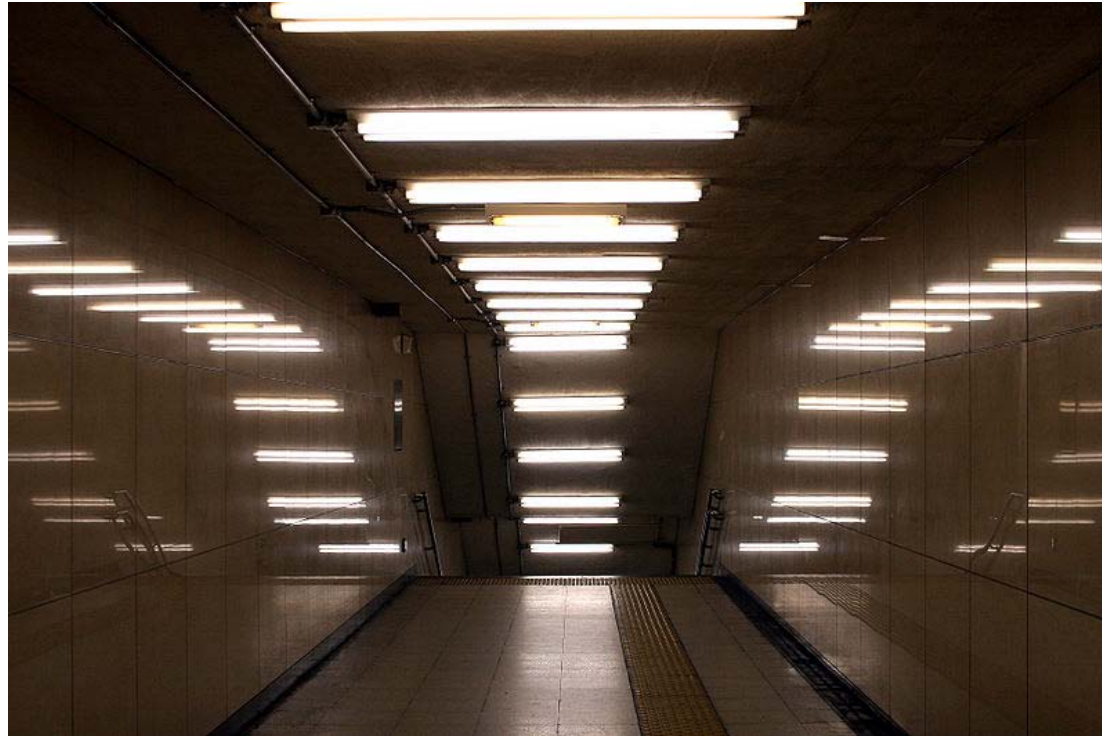
Green-Energy-Products.com, LLC

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Introduction

Fluorescent tubes carry the bulk of lighting in offices, factories and public buildings. Everyone knows them - and got adjusted to their disadvantages.



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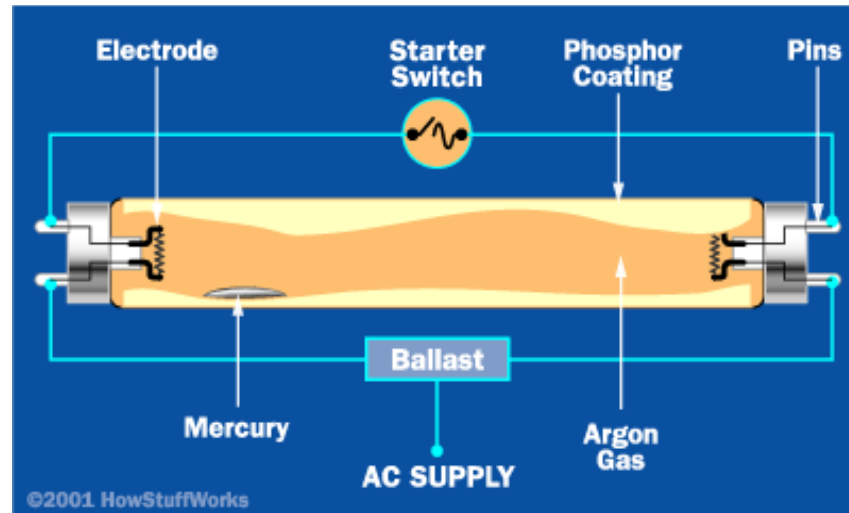
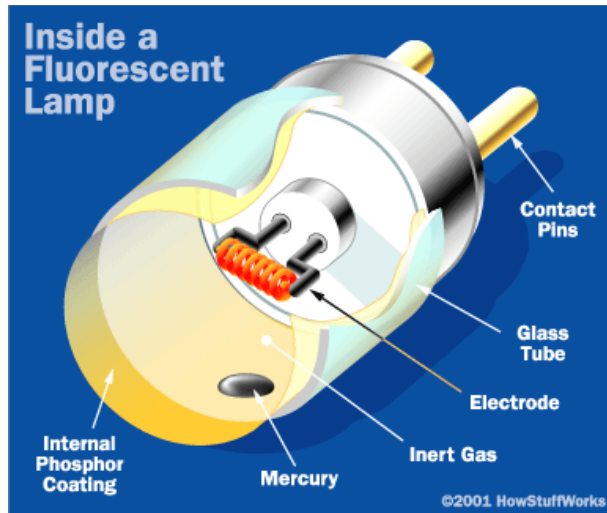
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Fluorescent Tubes – A little Background

Fluorescent tubes are low-pressure Mercury vapor discharge lamps which produce UV light.

The UV light hits the wall of a glass tube which is covered with Phosphor. The Phosphor absorbs the UV light and transforms it to visible white light. The lamp needs high voltage to start the discharge, and a device that limits the current during operation. Most FL lamps have therefore a ballast and a starter, in newer lamps these functions can be performed by electronic circuits (more expensive).



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Fluorescent Tubes – Main Disadvantages

- ▶ **Mercury is poisonous**

If an FL tube or CFL breaks, the whole building and its A/C ducts need to be cleaned (recommendation by EPA).

- ▶ **The light is not comfortable**

Only some of the energy is transformed to light. The rest is heat, UV and an unnatural light spectrum. The light is pulsing with the mains frequency (50/60Hz). Especially when many tubes are connected to only one power line, the light feels uncomfortable and can cause health problems.

- ▶ **Low power factor**

In buildings where many tubes are installed the capacitive and inductive electricity waves will be unsynchronized. For more than 500 tubes, a special power control unit is needed to correct this problem.

- ▶ **Defect rate of new fluorescent tubes and CFL's**

Due to glass breakage and leakage problems 5%-10% of defective new fluorescent tubes are considered to be acceptable.

- ▶ **Questionable energy savings and lifetime**

An inductive kick from the ballast provides a high voltage pulse to start the lamp. If the lamp is frequently switched on and off, the energy savings of FL tubes and CFL's are very limited. On top of it, the tubes will age rapidly.



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The Alternative: LED Tubes

A real alternative to fluorescent lighting are LED tubes. They contain absolutely no mercury, do not emit UV radiation and are truly energy saving, lasting four times as long as fluorescent bulbs.



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Characteristics of LED light vs. FL light

LED Light

- ▶ Directional
the light comes out in an angle of 120°
- ▶ Light color spectrum is easily adjusted
through the Phosphor mix
- ▶ Natural Colors
color rendering depends on Phosphor mix
- ▶ Instant start
also in cold temperatures
- ▶ Not for hot environments
operates best below 40°C
needs open air for cooling

Fluorescent Light

- ▶ Not directional
FL light radiates all around, 360°
- ▶ Cold light
warmer tones only with high effort (expensive)
- ▶ Colors appear not natural
better color rendering only possible at
significantly higher manufacturing costs
- ▶ Start with delay and flickering
especially in cold environments
- ▶ Can operate in environments
up to 60°C (at less light output)



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Environmental Advantages of LED Tubes

- ▶ Less power consumption
An LED tube consumes only about 30% of the power an FL tube needs to produce an equivalent illumination
- ▶ No poisonous substances in LED tubes
FL tubes and CFL lamps contain Mercury
- ▶ Recycling of LED tubes is possible
FL tubes and CFL lamps are hazardous waste, cannot be recycled;
LED tubes contain valuable raw material which can be re-used, e.g., Aluminum, PC, etc.
- ▶ Carbon Dioxide
Led tubes save about 2/3 of the greenhouse gas an FL tube would create.
- ▶ Long life
LED tubes live about 4 times as long as FL tubes, 50,000 hours instead of 10 to 15,000.



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LED Light is Directional

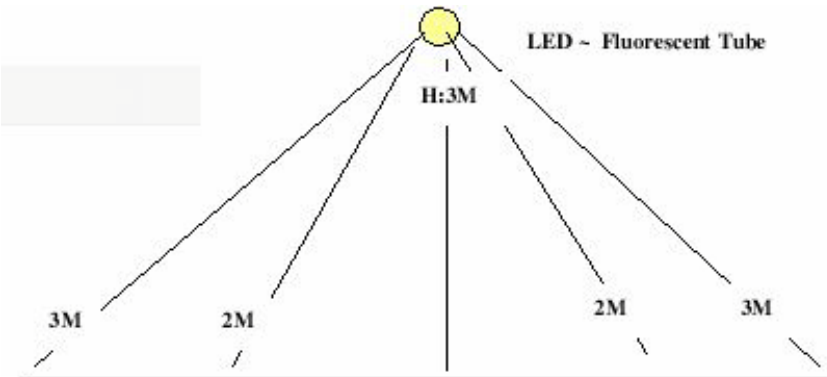
While FL tubes and conventional light bulbs distribute their light all around, LED light is directed to an angle of 120°. Luminaries are designed to shade off the non-useful portions.

For example:

For a lamp that illuminates a working area from above, only the fraction of the light that hits the working area is useful. All other light is lost – radiated in other directions.

When comparing the lumen, an FL tube needs to produce much more light to achieve the same illumination on a flat surface.

Since in most cases 2/3 of the light of an FL tube is lost that way, an LED tube only needs 1/3 of the lumens to achieve the same illumination.



Typical Illumination Characteristics					
120cm Tube mounted in 3 m height, illumination measured at the ground					
	nominal	actual	distance from center		
	power	power	3 m	2 m	0 m
LED tube	16 W	16 W	24 lux	39 lux	55 lux
Discount FL tube	36 W	55 W	18 lux	24 lux	34 lux
Philips FL tube	36 W	50 W	20 lux	29 lux	42 lux



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Economy and ROI

LED tubes are expensive, more than 10 times the price of FL tubes

Aside of the environmental advantages, LED tubes return profit in the following cases:

- ▶ Long operation hours
where the power savings justify the higher price
e.g., Wal-mart is replacing all FL tubes in cooled areas with LED tubes, ROI in half a year
- ▶ Frequent light switching
FL tubes do not like switching, their lifetime declines sharply with frequent switching
e.g., automatic staircase lights, elevator lights
- ▶ Difficult locations
where the costs of exchange are substantial
e.g., high ceilings, factory lighting, outdoor advertising light boxes / billboards



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Sample ROI Calculation

	Conventional 36W T8 FL Tube	LED T8 Tube
Power Consumption (W)	50	16
Life Expectancy (hours)	10,000	50,000
Prices (USD)	Tube	3.00 \$
	Ballast	10.00 \$
	Starter	1.00 \$
# of replacements	Tubes	5
	Ballasts	3
	Starters	5
Material costs (USD)	50.00 \$	73.80 \$
Exchange costs (5 USD/time)	25.00 \$	5.00 \$
Total cost of ownership (USD)	75.00 \$	55.00 \$
Total Power Consumption (KWH)	2500	800
Total Electricity Fee (USD 0.13/KWH)	325.00 \$	80.00 \$
Total (USD) in 50,000h	400.00 \$	135.00 \$
LED tube saves (USD)	265.00 \$	

Notes:

The LED tube would save 1.3 tons of CO2 as compared to the FL tube.

This sample calculation does not take into account:

- The light quality:
FL tubes with comparable quality light are about 3 times as expensive
- Energy savings when the tube is operated in A/C cooled areas
- Costs of financing



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LED Lighting Examples



Airport (directional illumination)



Hospital (noise reduction, comfortable light)



School (energy saving, comfortable light)



Hotel (energy saving, comfortable light)



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LED Tubes - Prices

(approximate fob prices as of July 2009)



2ft, 60cm 8W, AC 190V..240V or 100..140V	Aluminium Body, Transparent Cover - White 6000-7000K, 900 Lm - Commercial White 4000-5000K, 900 Lm - Warm White 3000-4000K, 850 Lm	37.80USD
3ft, 90cm 12W, AC 190V..240V or 100..140V	Aluminium Body, Transparent Cover, - White 6000-7000K, 1350 Lm - Commercial White 4000-5000K, 1350 Lm - Warm White 3000-4000K, 1270 Lm	58.05USD
4ft, 120cm 16W, AC 190V..240V or 100..140V	Aluminium Body, Transparent Cover, - White 6000-7000K, 1800 Lm - Commercial White 4000-5000K, 1800 Lm - Warm White 3000-4000K, 1700 Lm	65.25USD
5ft, 150cm 20W, AC 190V..240V or 100..140V	Aluminium Body, Transparent Cover, - White 6000-7000K, 2250 Lm - Commercial White 4000-5000K, 2250 Lm - Warm White 3000-4000K, 2120 Lm	88.80 USD
5ft, 150cm 24W, AC 190V..240V or 100..140V	Aluminium Body, Transparent Cover, - White 6000-7000K, 2436 Lm - Commercial White 4000-5000K, 2360 Lm - Warm White 3000-4000K, 2315 Lm	88.80 USD

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