

Incandescent light bulbs – Compact fluorescent lamps Questions and answers

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Why are 60W incandescent bulbs being withdrawn from the market from 1 September 2011?

Lighting uses nearly ten percent of the electricity consumed by the average two-person household in Germany – equivalent to the amount needed to run two refrigerators. Incandescent light bulbs are particularly inefficient, converting only five percent of the electricity they consume into light, while the remainder is lost as heat.

Achieving the EU's ambitious climate change mitigation targets involves reducing energy consumption by various means – including the use of more efficient products and technologies. European Regulation 244/2009 therefore sets efficiency standards for lamps that are being introduced in stages, commencing in 2009. This already means that incandescent bulbs of more than 60W and

inefficient halogen lamps can no longer be sold.¹ The next stage with even stricter standards will apply from 1 September 2011; this will prohibit putting clear 60W incandescent bulbs on the market:²

	Efficiency class F and G	Standard incandescent bulbs and conventional halogen lamps (efficiency class D and E)				Halogen lamps (efficiency class B and C)
		≥ 100 W	≥ 75 W	≥ 60 W	< 60 W	
Before 01.09.2009						
Before 01.09.2009						
Before 01.09.2010						
Before 01.09.2011						
Before 01.09.2012						

Source: [Leaflet for consumers on incandescent light bulb phase-out](#) (Umweltbundesamt, in German language)

The 60W incandescent bulb remains the “classic” lamp for domestic lighting. But hoarding them is environmentally counterproductive and also technically unnecessary – no one will need to put up with less satisfactory products after the cut-off date of 1 September 2011. There are now many alternatives to the classic incandescent light bulb: whatever the use, type of fitting, or light quality required, significantly more efficient compact fluorescent lamps, halogen lamps or LED lamps are available.

What different types of lamp are there?

Incandescent lamps are what are commonly known as (incandescent) light bulbs. They incorporate an electrical conductor, the metal filament, which is made of osmium and tungsten and enclosed in a gas-filled bulb. Electric current passing through the filament heats it and causes it to glow.

Compact fluorescent lamps (CFLs) have a fluorescent coating on the inside and are filled with gas. Electrical excitation of the gas molecules produces light. CFLs are therefore a type of gas discharge lamp. As well as CFLs there are also energy-efficient **fluorescent tubes** (colloquially known as neon tubes). These differ from CFLs only in their shape. While fluorescent tubes come in the shape of a long tube, compact fluorescent lamps are bent to make them compact and save space – hence the name.

Full-spectrum lamps are compact fluorescent lamps or fluorescent tubes that emit light that resembles daylight. The colours of objects seen in this light are rendered very effectively and are similar to how they would appear in daylight. The light from full-spectrum lamps includes a small amount of UV light. Full-spectrum lamps are often marketed using terms such as biolight, daylight or nature colour. They can be identified by the number 950 or 960, which always appears on the packaging.

Halogen lamps work on the same principle as incandescent lamps, but the glass bulb is filled with a special gas such as the halogens iodine or bromine. This lengthens the lamp’s life and means that the filament can be heated to a higher temperature, which increases the light output per watt, otherwise known as the luminous efficacy. For example, the luminous efficacy of a 50-watt halogen lamp is about 50 percent more than that of an equally bright incandescent bulb. Despite this, the luminous efficacy of a halogen lamp is still only roughly one-third that of a corresponding compact fluorescent lamp.

¹ Regulation (EC) No. 244/2009 of 18 March 2009 with regard to ecodesign requirements for non-directional household lamps lays down statutory standards for the energy efficiency and quality of lamps.

² Since 1 September 2009 frosted/pearl lamps have had to be of energy efficiency class A. Only some compact fluorescent lamps and LED lamps currently meet this standard. For clear lamps the energy efficiency class standards are being introduced gradually.

LED lamps (light emitting diodes) are electronic semi-conductor components. If current flows through the diode, it emits light. The most efficient white LED lamps available today (as at August 2011) have a luminous efficacy of between about 30 and 100 lumens per watt.³ They thus outperform incandescent and halogen lamps, whose light output is 17 and 30 lumens per watt, respectively, but are less good than some fluorescent tubes, which usually achieve between 60 and 110 lumens per watt.

Light emitting diodes are already replacing incandescent bulbs in some special applications, such as torches. Before LEDs start to take over from incandescent bulbs for general lighting purposes, however, their light quality, luminous efficacy and energy efficiency need to be improved and their cost needs to fall.

How much electricity do the different types of lamp use?

Lamps are divided into energy efficiency classes⁴, which range from A to G. You may already be familiar with this system and the corresponding labelling from other household appliances, such as refrigerators and washing machines.

The most energy-efficient lamps – those that use the least electricity – are assigned to Class A, while the least energy-efficient ones are labelled G.

- Compact fluorescent lamps and fluorescent tubes: Class A and B
- Halogen incandescent lamps: Class B, C and D
- LED lamps: Class A
- Conventional incandescent lamps: Class D, E (before 1 September 2009 also F and G)

Why are some compact fluorescent lamps only in energy efficiency class B?

For aesthetic reasons some compact fluorescent lamps are enclosed in a second glass bulb that is designed to give them a different shape, such as that of a globe or candle.

Since the second glass bulb absorbs light, these lamps use slightly more electricity and this places them in Class B. However, they still use significantly less electricity than conventional incandescent bulbs, which fall into energy efficiency classes D and E.

Where can compact fluorescent lamps be used?

Compact fluorescent lamps are available for almost all uses, both inside and outside. There are large and small fittings (E27 and E14), large and small sizes, different shades of white, coloured lamps and even ones that are dimmable or incorporate sensor technology.

There are also many different shapes on the market in addition to the familiar long tubes: short spiral tubes, conventional light bulb shapes, candles, globes, lamps with reflectors and special shapes such as rings. There are now even compact fluorescent lamps with a plug-in base that are suitable for halogen lamp holders.

Of course not every lamp is intended or suitable for every purpose. When buying a lamp you should therefore bear in mind what shape and fitting size you need and whether other features, such as dimmability, are required. For example, there are quick-start lamps for lighting hallways and stairs, and lamps suitable for frequent on/off switching. Different levels of brightness can also be chosen to suit different uses: warm white lamps provide a pleasant light, similar to that from incandescent bulbs, for living areas, while for work areas a lamp with a colder light and hence better colour rendering may well be preferred. If your local electrical shop offers only a limited choice, you can find more information on manufacturers' websites and place an order online or through an electrical dealer.

³ See <http://www.topten.ch/>

⁴ This applies to domestic lamps (not reflector lamps) with an output of more than four watts and a luminous flux not exceeding 6,500 lumens (Directive 92/75/EEC).

Information on a lamp's properties can be found on the lamp packaging.

Was steckt in der Energiesparlampe?
 Ab September 2010 gelten neue Informationspflichten auf den Verpackungen von Energiesparlampen. Was die einzelnen Punkte bedeuten, sehen Sie hier:

		Ein Beispiel:
	Angabe von lm und W. Je höher der angegebene Lumenwert, desto heller das Licht (Watt gibt den Stromverbrauch an)	1400 lm 22 W
	Umrechnung von Lumen in Watt einer vergleichbar hellen Glühlampe	 100 W
	Lebensdauer in Stunden oder Jahren bei 3 h Betrieb pro Tag	8000 h 8 Jahre
	Anzahl der Schaltzyklen – wie häufig ist das An- und Ausschalten möglich?	 20.000
	Je niedriger der Wert in Kelvin, desto wärmer die Lichtfarbe	2700 K warmweiß / ww
	Anlaufzeit bis 60 % der Lichtleistung erreicht sind	15 s
	Angabe, ob die Lampe dimmbar ist	
	Länge und Durchmesser in mm	91 mm x 46 mm
Hg	Quecksilbergehalt in mg	2,5 mg

Der Hersteller ist verpflichtet, eine Web-Adresse anzugeben, auf der Hinweise zum Umgang mit zerbrochenen Lampen zu finden sind.
 Grafik: Initiative „Sauberes Licht, sauber recycelt.“

Source: [Lightcycle "Sauberes Licht, sauber recycelt."](#)

How long do compact fluorescent lamps last (burn time and number of on/off cycles)?

Compact fluorescent lamps (CFLs) have a very long service life of up to 15,000 hours – far longer than the 1,000 hours which is all that the good old light bulb can manage.

The **life** quoted on the packaging is always the “average” burn time of the lamp, i.e. a statistical figure. In tests, half the lamps had failed after burning for this number of hours. The actual life of your CFL may be longer or shorter than this.

Note: The light output of CFLs diminishes with time. Towards the end of the life quoted on the packaging they usually emit only 80 percent or even less of their original output. At this point they should be replaced, put in a different light fitting, or used somewhere where less light is needed.

As well as the lamp's overall life, its ability to **withstand on/off cycles** is also important for some uses. The CFLs that perform best in this respect can be turned on and off more than 200,000 times and are thus suitable for locations such as stairs.

Are there compact fluorescent lamps that emit light whose colour temperature is similar to that of incandescent bulbs?

Yes, most of the compact fluorescent lamps on sale these days now have a light quality similar to that of an incandescent bulb. However, the choice ranges from “daylight white” to “warm white”, with

“warm white” corresponding roughly to the light quality of incandescent bulbs. If you want to be quite sure, look for a colour temperature rating of 2,700 Kelvin, or go to a specialist shop and ask for the lamp to be demonstrated.

The table below shows what quality of light corresponds to different colour temperature ratings.

Light quality	Colour temperature in Kelvin [K]
Daylight white	5,000 – 6,000
Neutral white	4,000
Warm white	3,000
Warm white (resembling incandescent bulb)	2,700

How do I find the right compact fluorescent lamp to replace my old light bulb?

The basic principle is that the brighter the light that you want, the higher the power consumption or wattage of the lamp needs to be. But to make the right choice you now need to consider the luminous flux of the lamp and no longer simply the number of watts.⁵ This is because the new lamp technologies have different wattages that cannot be directly compared with the wattage of incandescent lamps. The luminous flux is a measure of the amount of light that a lamp gives off. The higher the figure, the brighter the lamp. The luminous flux is given on the packaging in lumens (lm). The lumens of the old incandescent lamps should therefore be compared with those of the more efficient ones.

The table below summarises the power consumption of incandescent and compact fluorescent lamps of the same brightness.*

Lamp power	Luminous flux	Typical power consumption of a similarly bright CFL
15 Watt	90 Lumen	3-5 Watt
40 Watt	400 Lumen	7-9 Watt
60 Watt	700 Lumen	11-13 Watt
75 Watt	900 Lumen	15-18 Watt
100 Watt	1.400 Lumen	20 Watt

Source: [adapted from Energy Agency NRW, “Viel Licht mit wenig Geld. Energiespar- und Leuchtstofflampen.” Wuppertal, no year.](#)

A 11-watt compact fluorescent lamp with a luminous flux of around 660 lumens is roughly equivalent to a conventional 60-watt light bulb. You should therefore note the figure for the lamp’s luminous flux given on the packaging and check that it is what you need.

Other considerations are factors such as the fitting, location (e.g. staircase, hallway, toilet, work area), dimmability, colour rendering, the colour of light needed and the appearance of the lamp. If the lamp is visible a globe or candle model can be used. Otherwise you can choose the classic bent tube or spiral shape, since these are even more efficient (no outer casing that absorbs light).

Because of the greater complexity of the issues involved, you may need to seek advice. Most of the information you need will be found on the lamp packaging, but quality should also be taken into account since – in contrast to conventional incandescent bulbs – there are wide differences in the quality of compact fluorescent lamps. Unfortunately there are not at present any lamps that carry a quality label such as the Blue Angel. This means that the only guidance currently available is that provided by independent market surveys such as [EcoTopTen](#) or by tests.

⁵ For example, the luminous flux of a standard 60-watt light bulb can be between 550 and 710 lumens.

How long do compact fluorescent lamps take to reach full brightness after switching on?

Most compact fluorescent lamps take between 25 seconds and two minutes to reach 80 percent of their full brightness. The reason for this delay is the preheating phase. This ensures that the lamp has a warm start, which prolongs the life of the electrodes in the lamp and increases the number of on/off cycles that the lamp can withstand. Cold-start lamps that dispense with this preheating phase start faster but have a significantly shorter life.

Compact fluorescent lamps are considerably more expensive than comparable incandescent bulbs. Why are the total annual costs so much lower despite this?

Compact fluorescent lamps (CFLs) cost somewhere between one and 30 euros, while conventional incandescent bulbs typically cost about 50 cents. Despite this, the total annual costs of CFLs are significantly lower than those of their incandescent counterparts. While the total annual costs of a 60-watt light bulb – calculated as the annual electricity costs and a proportion of the purchase price – amount to around 15 euros, the total annual costs of a comparable CFL are only about three euros.⁶

This is mainly because CFLs last between six and 15 times longer (depending on the specific model) than incandescent bulbs, so that the higher purchasing costs are spread over this longer lifetime. In addition, CFLs usually use only one-fifth of the electricity needed by a comparable light bulb, so that the annual electricity costs are significantly lower.

So the investment is worth while: the higher price of the CFL usually pays back in less than a year.

Compact fluorescent lamps and radiation – what do I need to know?

The standard compact fluorescent lamps (CFLs) on the market have an integrated electronic ballast that produces alternating electromagnetic fields. However, there are as yet no special limits or standards for the electromagnetic fields of lamps.

The German consumer organisation Stiftung Warentest measured the electromagnetic radiation of CFLs as part of the tests carried out for the March 2008 issue of its magazine. It concludes that even though fluorescent tubes have been in use for many years there is no scientific evidence for the health problems that are frequently ascribed to them. The German Federal Office for Radiation Protection (BfS), in its comments on the electromagnetic emissions of CFLs published in August 2009, states that “the use of compact fluorescent lamps for general lighting purposes in households is of no concern from a radiation protection point of view”. (“Radiation protection” in this context refers to electromagnetic radiation.)

The Swiss Federal Office for the Environment* recommends taking precautions against radiation from CFLs where necessary, maintaining a minimum distance from such lamps and not using them in, for example, desk or bedside lights⁷.

Compact fluorescent lamps and pollutants

Stiftung Warentest has for some years tested the emissions of volatile organic compounds (VOCs) from compact fluorescent lamps and has not identified any health hazards.

Unlike conventional incandescent bulbs, compact fluorescent lamps contain a small amount of **mercury** (typically between 1.4 and 5 mg), without which the lamp would not be able to function. Although incandescent bulbs contain no mercury, their mercury balance is in fact worse. This is because mercury is released during electricity generation in conventional power plants, and incandescent bulbs use five times as much electricity as compact fluorescent lamps of comparable brightness. Because compact fluorescent lamps consume significantly less electricity, their use reduces overall mercury emissions.

⁶ Own calculation based on the assumption that the lamps are used for three hours a day, the average electricity price in Germany is 22 cents / kWh and the power consumption of the compact fluorescent lamp is 11W.

⁷ Source: Bundesamt für Umwelt, Wald und Landschaft (BUWAL): “Elektrosmog in der Umwelt”. Bern, 2005

Why are mercury emissions higher for incandescent bulbs than compact fluorescent lamps?

A sample calculation: A 60-watt light bulb is equivalent to an 11-watt compact fluorescent lamp (CFL). If both lamps are on for three hours a day for a year, the light bulb uses 66 kilowatt-hours of electricity while the CFL uses only 12. The corresponding mercury emissions are 0.54 milligrams for the light bulb and 0.10 milligrams for the CFL.

To this must be added the mercury content of the CFL itself. If the mercury content of the lamp is two milligrams and the lamp has a life of 15,000 hours, the average mercury emissions attributable to the lamp itself are 0.15 milligrams per year. The CFL's total annual emissions are therefore 0.25 milligrams – significantly better than the light bulb's figure of 0.54 milligrams.⁸

Tip: The better performance of CFLs with regard to mercury emissions can be even further enhanced by using particularly long-life lamps, since the emissions are then spread over a correspondingly longer service life. The CFL's performance on this front becomes outstanding if the lamp is recycled after use and the mercury is recovered.

My compact fluorescent lamp is broken – what should I do?

If a compact fluorescent lamp breaks, the mercury it contains may be released. However, unlike in mercury thermometers, the amount of mercury in compact fluorescent lamps is very small.

Studies⁹ have shown that the relevant health-hazard threshold values are not exceeded when a lamp breaks and that the concentration of mercury can be quickly and substantially reduced by means of a few simple measures.

Sweep up the remains of the broken compact fluorescent lamp with a broom, place them in a screw-top jar and dispose of the jar as toxic waste. Leave the room and ventilate it thoroughly by opening the windows wide while keeping the door closed.

Even without these measures, the maximum possible exposure to mercury is much smaller than the exposure that results from eating fish¹⁰ or handling a broken thermometer.

However, some manufacturers produce shatter-proof lamps, so that the mercury cannot escape even if the lamp breaks.

How should compact fluorescent lamps be disposed of?

Because of the mercury they contain, discarded compact fluorescent lamps (CFLs) should not be placed in "normal" waste: they should be disposed of as toxic waste or returned to the dealer. Dealers must dispose of these lamps through a recycling company.

In contrast to the situation with used batteries, shops are not obliged to take back CFLs. Instead, local authorities have sole responsibility for collecting them. Often, however, the relevant facilities are a long way from where the consumer lives or open only at inconvenient times. As a result, only around thirty percent of CFLs from private households are properly disposed of.¹¹ The German environmental organisation Deutsche Umwelthilfe is therefore campaigning for it to be compulsory for the trade to take back end-of-life CFLs.¹² The dm drugstore chain has already set up collection points in its stores voluntarily, so that you can easily leave your old CFLs next time you shop there.

The scheme "Sauberes Licht, sauber recycelt" (Clean Light, Cleanly Recycled) [publishes tips on the proper disposal of lamps on its website](#).

⁸ Own calculation based on the assumption that in Germany in 2010 0.0082 mg of mercury are emitted per kWh of electricity generated (Source: GEMIS 4.6, <http://www.oeko.de/service/gemis/de/index.htm>). This assumption applies only to Germany and may need to be adapted for other countries (depending on the composition of electricity generation).

⁹ e.g. Katrin Süring: Gesundheitliche Gefahr durch Quecksilber in Energiesparlampen? In: UMID 1 2010, or Scientific Committee on Health and Environmental Risks: Opinion on Mercury in Certain Energy-Saving Light Bulbs, 2010

¹⁰ Fish for human consumption must not contain more than 1 mg of mercury per kilo. The mercury accumulated over a lifetime as a result of eating fish can therefore be more than the exposure caused by a broken compact fluorescent lamp. (<http://userpage.chemie.fu-berlin.de/~tlehmann/sonderab/quecksilber-zu-hause.html>)

¹¹ http://www.duh.de/uploads/media/Infoblatt_Energiesparlampen_2010.pdf

¹² [http://www.duh.de/pressemitteilung.html?&no_cache=1&tx_ttnews\[tt_news\]=2660&cHash=322e56a36e](http://www.duh.de/pressemitteilung.html?&no_cache=1&tx_ttnews[tt_news]=2660&cHash=322e56a36e)

Are LED lamps better than compact fluorescent lamps?

It is true that LED lamps do not need mercury to produce light. However, they do contain electronic components that, while not in themselves hazardous, do consume some valuable and rare resources. LED lamps have an even greater efficiency potential than compact fluorescent lamps; when used correctly they have a particularly long life and can provide light with accurate colour rendering. But the technology is not yet sufficiently advanced for general domestic lighting, and there are major quality differences in the products on offer. Moreover, at present only very few products come close to compact fluorescent lamps in terms of quality and energy efficiency. LED lamps also remain very expensive, so that their purchase does not pay back quickly enough. If you are looking for a high-quality product and would like to give LED lamps a try, make sure that you buy lamps that have been tested by [Stiftung Warentest or a similar organisation](#).

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