



Energy efficiency of luminaires

by Mark Coles



For more than 100 years, the incandescent lamp has been used in dwellings as the main source of light but, as these lamps are extremely inefficient, they are now being phased out. As world leaders are committed to reducing the emission of greenhouse gases by curtailing energy consumption, incandescent lamps will be gradually replaced by suitable energy-efficient lamps.

This article looks at the UK's energy obligations and the energy efficiency of lamps.

The Kyoto Protocol

The Kyoto Protocol of The United Nations Framework Convention on Climate Change (UNFCCC) was endorsed by 186 countries in September 2008. The treaty is legally binding which commits industrialised countries to reduce their "collective" greenhouse gas emissions to 5.4% below 1990 levels by 2012.

There is slight flexibility within the agreement whereby, for example, a high polluting

country struggling to meet targets could finance a carbon-reducing project in another country to offset their own carbon production.

The European Union

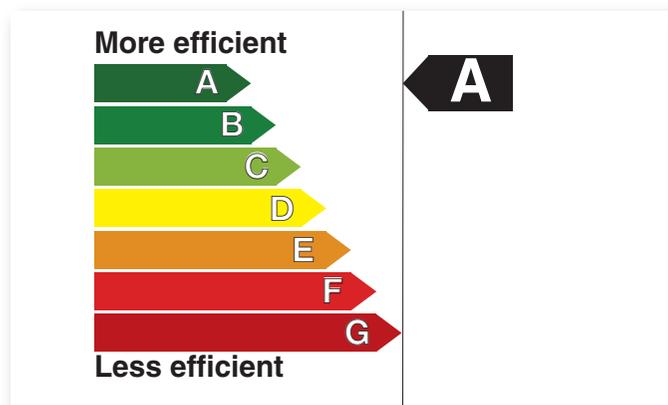
The European Union (EU) currently consists of 27 member states (the four countries of the UK and Northern Ireland count as one member-state). It is estimated that lighting accounts for 20% of a member state's energy usage, therefore, extensive work has gone in to developing and introducing directives which will reduce and control the energy consumption of lighting for commercial and residential/domestic applications. The EU has effectively agreed that inefficient lamps will be phased out gradually from the EU market starting in September 2009 and finishing in September 2012.

Energy Efficiency Label

The Energy Labelling Directive, (EEL) 98/11/EC & Eco-Label 2002/747/EC,

A	LED, FLUORESCENT AND CFL
B	HALOGEN ENERGY SAVERS
C	HALOGEN
D	
E	INCANDESCENT GLS
F	INCANDESCENT CANDLE
G	INCANDESCENT STRIPLIGHTS

Energy classification - typical lamp types



Energy efficiency label

acknowledges the growing energy consumption of household appliances, it shows the actual energy consumption of appliances and sets minimum standards

for household appliances. By law, the EU Energy Label must be displayed on all new household products of the following types displayed for sale or hire:



Image courtesy of LIF

- refrigerators, freezers and fridge-freezer combinations
- washing machines
- electric tumble dryers
- combined washer-dryers
- dishwashers
- lamps
- electric ovens
- air conditioning equipment

The Labelling Directive does not apply to:

- lamps with a light output in excess of 6500 lm
- lamps rated at less than 4 W
- reflector lamps - note that only non-directional lamps are currently considered as light is emitted equally in all directions, whereas directional/reflector lamps direct light to where it is needed, therefore, directional lamps are considered to be more efficient
- lamps operated from batteries
- lamps not primarily for illumination

Incandescent lamps offer a low efficacy as the majority of energy consumed is converted into heat. A typical range would be 8-14 lumens per watt (lm/W). Luminous efficacy is a figure of merit for light sources and is the ratio of luminous flux (in lumens) to power (usually measured in Watts). As most commonly

used, it is the ratio of luminous flux emitted from a light source to the electrical power consumed by the source and, therefore, describes how well the source provides visible light from a given amount of electrical power. This is also referred to as luminous efficacy of a source.

Table 1 shows general luminous efficacies and efficiencies of common lamp types.

The timetable

From September 2009, lamps equivalent in light output to 100 W incandescent lamps and above will have to be graded as C class, therefore, 100 W incandescent lamps, which are class E, will not meet this requirement. Running concurrently, lower wattage incandescent lamps of F and G classes will be phased out so that only E-class incandescent lamps will remain. By the end of 2012, the efficiency level will be made progressively better, moving to class C, effectively completely phasing-out clear incandescent lamps.

Halogen clear lamps (xenon-filled) which reach class C will remain on the market until 2016. Unless new technologies emerge, all remaining clear lamps will be extra-low voltage halogen,

	Type	Overall luminous efficacy (lm/W)	Overall luminous efficiency
Incandescent	5 W tungsten incandescent	5	0.7%
	40 W tungsten incandescent	12.6	1.9%
	100 W tungsten incandescent	13.8	2.0%
	200 W tungsten incandescent	15.2	2.2%
	100 W tungsten glass halogen	16.7	2.4%
	200 W tungsten glass halogen	17.6	2.6%
	500 W tungsten glass halogen	19.8	2.9%
	Tungsten quartz halogen	24	3.5%
	Photographic and projection lamps	35	5.1%
Light-emitting diode	White LED	10 - 150	1.5 - 2.2%
Arc lamp	Xenon arc lamp	30 - 50	4.4 - 7.3%
	Mercury-xenon arc lamp	50 - 55	7.3 - 8.0%
Fluorescent	9-26 W compact fluorescent	46 - 72	8 - 11%
	T12 tube with magnetic ballast	60	9%
	T5 tube	70 - 100	10 - 15%
	T8 tube with electronic ballast	80 - 100	12 - 15%
Gas discharge	Metal halide lamp	65 - 115	9.5 - 17%
	High pressure sodium lamp	85 - 150	12 - 22%
	Low pressure sodium lamp	100 - 200	15 - 29%

Table 1 - General luminous efficacies and efficiencies of common lamp

Clear Lamps			
Stage	Date	Phasing-out	Replacements
1	1 September 2009	All clear lamps > 950 lm (≈ 80 W GLS)	Energy class C
2	1 September 2010	All clear lamps > 725 lm (≈ 65 W GLS)	Energy class C
3	1 September 2011	All clear lamps > 450 lm (≈ 45 W GLS)	Energy class C
4	1 September 2012	All clear lamps > 60 lm (≈ 12 W GLS)	Energy class C
5	1 September 2013	Increased quality requirements	Energy class C
Review	2014	-	
6	1 September 2016	All clear lamps > 60 lm	Energy class B
Clear Lamps			
Stage	Date	Phasing-out	Replacements
1	1 September 2009	All non-clear lamps	Energy class A

Table 2 - Timetable showing the phasing out incandescent lamps

supplied by transformer, from 2016, reaching class B.

Under certain conditions, special purpose incandescent lamps, for example, those used in household appliances such as ovens or fridges, traffic lights, infrared lamps, tanning lamps and lamps used within the entertainment industry, are exempted from the current requirements of the directive.

Table 2, shows the timetable of phasing out incandescent lamps. Note that an energy efficient lamp is often only part of a luminaire - where a luminaire may comprise of a lamp, control gear, shade/reflector/diffuser, etc.

There is a strategy to deal with ballasts of luminaires, known as Tertiary Implementing Measures. Table 3, overleaf, shows the timetable of requirements for lamps/ballasts/luminaires in relation to the specific type of discharge lamp used.

There are more rigorous requirements for a Stage 3 to be implemented from 2017.

Building Regulations

Building Regulations set the minimum standards to which new or refurbished installations are to comply and, in terms of the requirements for lighting, the following information applies:

Building Regulations of Scotland

The Building Regulations (Scotland) 2004 - Guidance is available in Section 6, Energy, of the Technical Handbooks.

Building Regulations of Northern Ireland

Building Regulations (Northern Ireland) 1994 Guidance is available in Technical Booklet F: Conservation of Fuel and Power (Dec 2008, revised 2006)

Building Regulations of England and Wales

Part L (Conservation of fuel and power) April 2006

- L1A Conservation of fuel and power in new dwellings
- L1B Conservation of fuel and power in existing dwellings
- L2A Conservation of fuel and power in new buildings other than dwellings
- L2B Conservation of fuel and power in existing

buildings other than dwellings

Guidance is available to Part L (Conservation of fuel and power) in four Approved Documents. The Building Regulations of England and Wales applies to dwellings and buildings other than dwellings.

As an aside, there are proposed changes to Part L and Part F (Means of Ventilation) of the Building Regulations. The UK Government is currently considering transferring responsibility for Building Regulations in Wales to the Welsh Assembly, in which case, these proposals will only apply in England. A consultation paper was published on 18 June 2009, with a closing date of 17 September 2009.

The consultation sets out the proposed changes to Part L and Part F of the Building Regulations that are planned to come into force in 2010, these include a range of

measures, such as, a strategy for training and dissemination designed to further improve the levels of compliance and performance in buildings.

In its Building a Greener Future - Policy Statement (July 2007), the Government set out that new homes will be net zero carbon from 2016. As steps to achieving this target, energy efficiency standards for new homes are to be improved by 25 % in 2010 and 44 % in 2013 relative to the then current 2006 standards.

The Government also wants to introduce improved energy efficiency standards for new non-domestic buildings, and in its 2008 Budget announced an ambition for all new non-domestic development to be net zero carbon from 2019.

Proposals for a similarly phased improvement beginning with 25 % in 2010 and plan to consult on the further trajectory towards zero carbon new non-domestic buildings.

The UK Government is also committed to addressing the energy efficiency of existing buildings and the consultation therefore proposes appropriate changes to the requirements when people elect to carry out building work to existing buildings.

When the proposed energy efficiency standards in Part L are strengthened in 2010 there is likely to be a tendency to more airtight buildings. It is therefore necessary to propose changes to Part F of the Building Regulations at the same time to ensure that adequate means of ventilation is provided.

More information at can be found at www.communities.gov.uk/publications/planningandbuilding/partlf2010consultation

Thanks

The Lighting Industry Federation (LIF) www.lif.co.uk
The Lighting Association www.lightingassociation.com/

		IM fluorescent lamps	IM high-pressure lamps
Stage 1 from 2010	Lamp	Phasing out of T5/T8 with RA < 80	Obligation to provide technical information on websites and in documentation
		Phasing out of T8 "halophosphate" lamps	
		Phasing out of CFL-2 pin lamps (magnetic control gear operation)	
		Obligation to provide technical information on websites and in documentation	
	Ballasts	Ballast EEI = min B2	No special requirements
		Dimmable EBs: EEI = min A1	
$P_{58} \leq 1 \text{ W}$			
For new lamps: EEI = min A3			
Luminaire	Luminaire energy limit values = sum of ballast limit values (number of ballasts installed)	Technical information must be provided on websites and in documentation for luminaires > 2000 lm	
	After Sept 2010: Technical information must be provided on websites and in documentation for luminaires > 2000 lm		
Stage 2 from 2012	Lamp	Phasing out of T10 and T12 lamps	Phasing out of inefficient HS and HI lamps (E27, E40 and PGZ12 base)
			Phasing out of HPM lamps from 2015
	Ballast	$P_{58} \leq 0.5 \text{ W}$	Introduction of efficiency limit values for HID EBs
	Luminaire	Luminaire energy limit values = sum of ballast limit values (number of ballasts installed)	The energy efficiency of all HID EBs must be indicated e.g. $\eta = 78 \%$
Luminaires must be compatible with stage 3 ballasts, except for luminaires $\geq \text{IP4X}$		Technical information must be provided on websites and in documentation for luminaires > 2000 lm	

There are more rigorous requirements for a Stage 3 to be implemented from 2017.

Table 3 - Timetable of requirements for lamps/ballasts/luminaires in relation to the specific type of discharge lamp used