Topten Product Criteria Paper on

Domestic Lighting

Part I: Non-directional lighting
(CFL and standard halogen lamps)

Bernd Schäppi
Austrian Energy Agency

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The Project in brief

Topten is part of the international Euro-Topten Plus initiative supported by the European programme Intelligent Energy Europe and several national institutions (energy agencies, WWF, consumer associations, research institutes). On global level, Topten is coordinated by TIG, the Topten International Group. This association promotes to the Topten Charter, TIG statutes and Rules of Procedure (www.topten.info).

Topten is a service that supports the market for energy efficient products. It aims at making energy efficient products the first choice for consumers, by offering them a user-friendly tool for product comparison and selection. The key element is an online information platform for consumers presenting the most energy efficient appliances currently available in various product categories, including household appliances, office equipment, consumer electronics and cars. Information on energy consumption and performance of products as well as several other characteristics (i.e. brand, model, price, picture) is provided. Product data is based on labels and standardized declarations as well as tests from accepted well-known institutions. The service is independent of manufacturers and retailers.

Consortium

The Euro-Topten project is co-ordinated by the Agence de l'Environnement et de la Maitrise de l'Energie (ADEME, France). The other 19 project partners are:

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Contact

Therese Kreitz (project leader)
500, routes des Lucioles
F-06560 Valbonne
France
+33(0)493957984
therese.kreitz@ademe.fr

Sophie Attali
6 rue de Verdun
93450 Ile-Saint-Denis
France
+331 4922 0064
so-phie.attali@topten.info

Eric Bush
Rebweg 4
7012 Felsberg
Switzerland
+41 81 252 63 64
info@topten.info

Bernd Schäppi
Mariahilfer Strasse 136
1150 Vienna
Austria
T: +43 1 586 15 24 - 147
bernd.schaeppi@energyagency.at

Content

1 Introduction

The criteria presented in this paper cover part of the major lighting technologies currently used in households. The focus is on non-directional compact fluorescent lamps with integrated ballasts and standard halogen lamps. Halogen spots, CFL reflector lamps and LED lamps will be addressed in a separate document.

With the new EC regulation 244/2009/EC a stepwise phase-out of standard incandescent lamp technology has been defined. Starting in fall 2009 with 100W, lamps using incandescent technology shall disappear from the market by 2012. Based on the new regulation halogen lamps of efficiency class C will remain on the market until 2016. This class of products is about 30% more efficient than traditional incandescent but much less efficient compared to CFL and LED technology. Thus, it should be avoided that this type of products becomes the first choice of consumers for standard incandescent replacement. Thus, the primary challenge for initiatives like Euro-Topten in the next years will be to support the phase-out of standard incandescent lamps by concomitant measures guiding the consumer to the efficient technologies for replacement.

In some countries where consumers are very reluctant to buy CFL lamps (such as Austria) efficient halogen lamps can serve as a temporary replacement for conventional incandescent lamps until LED technology is ready for broad application. In other countries where consumers are more willing to buy CFL lamps (e.g. Italy), pushing for CFLs is more advisable as it allows tackling the whole saving potential available today.

Although cost-effective solutions for energy efficient non-directional household lamps exist for quite a while, market forces have resulted in a relatively strong market penetration of low efficiency products. The past market failure can largely be explained by the fact that purchasing costs for energy-efficient lighting equipment (compact fluorescent lamps or "CFL") are significantly higher, even if cost savings are achieved over the life cycle. The benefits are often unclear or irrelevant to the person making the purchasing decision. Another issue has been low quality of some CFLs causing disappointment of consumers.

The preparatory study for the EUP directive estimated that a total of 4.2 billion lighting points in the EU-27 equipped with incandescent lamps, halogens or CFLs had an annual electricity consumption of 112 TWh in 2007. This corresponds to an annual spending of 15.2 billion Euro and 48.3 million tons of CO_2 emissions per year.

Without taking countermeasures, the electricity consumption of non-directional household lamps would have been expected to rise to 135 TWh per year in 2020. The new EC regulation should now lead to energy savings of approximately 39 TWh of electricity consumption per year by 2020 in EU-27 and to a reduction of approximately 1.6 tons of the mercury content of the installed lamp base in 2020 (EUP preparatory study).

If consumers would primarily demand lamps of efficiency class A energy savings of 86TWh per year by 2020 could be achieved. Thus, energy savings could be more than

doubled compared to EUP measure if the consumer can be convinced soon to buy only A class lamp technology. Supporting the exploitation of this larger energy saving potential should be a major target for initiatives like Euro-Topten.

The purpose of this criteria paper is to provide a common basis for the selection of criteria for the specific product group as a basis for the national website. It is a clear goal to consider the same basic criteria for products throughout the Euro-Topten network. However, the range of products differs significantly in European member States in terms of price level, configuration, energy classes and energy consumption corresponding to levels of purchasing power and behavioural aspects (mentality, customs, etc.). Consequently specific quantitative thresholds for the individual criteria as a basis for the Topten lists may be different from country to country.

The paper starts with a short overview on the major lamp technologies currently used in households including some issues of efficiency and quality. It continues with a summary on current legislation and standards relevant for Euro-Topten as a basis and finally concludes with recommendations on product categorisation and criteria to be used within Euro-Topten.

2 Product Specification – overview of most relevant product types and characteristics

2.1 General aspects

This chapter provides an overview of the lamp technologies covered in this criteria paper. It provides basic technical information on characteristics and energy efficiency of the major lamp types. Only non-directional lighting for domestic use as well as for use in other environments is addressed (e.g. service sector). The focus is on:

- CFL lamps with integrated ballasts and
- Standard halogen lamps (excluding spots)

The following technologies are addressed in separate papers:

- Tubular fluorescent lamps with external ballasts
- Lamps providing directional lighting (e.g. halogen spots). Directional lamps have at least 80 % light-output within a within a cone with angle of 120°.
- LED lamps
- High and low pressure discharge lamps (service sector)
- Metal halide lamps (service sector)

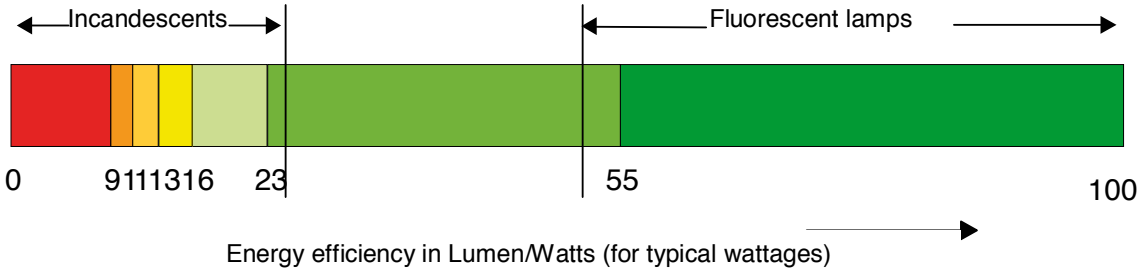
The following table shows the average efficiency of the different technologies currently available on the market. The efficiency is expressed in lumen per watt (lm/W). The label class information is given for the sake of providing orders of magnitude: LEDs are not yet covered by a regulation, but this technology is known to be very efficient and will most surely be classified as A (without considering quality issues).

Tab.1 Efficiency of lamp types currently available on the market

Label class (old scheme)	Minimum energy efficiency Lumen/Watt (700lm)	Lamp type
A	111	Low pressure sodium discharge lamps, best LEDs (not yet on the market)
A	71,9	LFL with external electonic ballast, High intensity discharge lamps
A	59,5	CFL with external ballast, LEDs
A	51,6	efficient CFL lamps with integrated ballast
B	30,4	inefficient CFL lamps with integrated ballast
B	20,3	efficient halogen lamps (available as retrofit)
C	15,2	average halogen lamps
D	12,8	inefficient halogen lamps
E	11,1	Incandescent lamps

100 lm/W can be taken as the current approximate maximum efficiency possible for indoor lighting with available technology (high efficiency LFL lamps). Thus the lm/W values indicated at the same time provide the relative efficiency in %.

Another typical way of showing this:



2.2 Basic issues regarding lamp selection criteria for consumers

The demand for certain lamp technologies in the domestic sector is determined by a few basic criteria, which are of central relevance for the consumer. Among the most relevant are price, design, colour rendering index, colour temperature and lifetime.

Purchasing price

Purchasing price for CFLs and for the advanced more efficient halogen technologies is higher than for standard incandescent and standard halogen lamps. However, during use phase net cost savings are achieved due to higher lifetime and efficiency. Thus,

total costs and savings should be highlighted in consumer information and promotion. Price range is 2-15€ depending on product type and quality (see further below).

Design

Design is a critical issue from the consumer perspective. Regarding this aspect especially older CFL technology was at a disadvantage since a design and size of products was not comparable with standard incandescent lamps. However there has been much improvement in recent years and different types of retro design lamps are available now for both CFL and halogen lamp technology. Information activities should emphasize that many design types are available already which can adequately replace standard incandescent lamps.

Colour rendering index

The colour rendering index (CRI) is a quantitative measure of the ability of a light source to reproduce the colours of various objects in comparison with an ideal light source. Light with a balanced continuous colour spectrum like sunlight or classic incandescent lamps allow an excellent colour reproduction respectively a high CRI of 100%. A lamp which emits light only in a very narrow segment of the colour spectrum (e.g. low pressure sodium lamp) has a poor CRI and does not allow a good colour distinction. CFLs which emit light in defined bands of the spectrum only, also show significantly lower CRI compared to incandescent lamps (CRI 60-90%). CRI is measured based on eight standard colours and a reference lamp (max. CRI 100%). CRI is independent of the so called colour temperature of the lamp (see below).

Colour temperature

The colour temperature of a light source is determined by a comparison with a heated ideal black-body radiator. The temperature (K) at which the heated black-body radiator matches the colour of the light source is the source's colour temperature. For incandescent lamps, the colour temperature is more or less equivalent to the emission temperature of the bulb as for this technology the light is produced by a thermal process. For other technologies like CFL the relationship is more complex.

Colour temperature is relevant for the human perception of light quality. Low colour temperatures between 2000 and 3500 K are perceived as “warm light quality”. This is also the typical range for standard incandescent and halogen lamps. Colour temperatures in the range of 4000-6500 K are perceived as “cool/cold light quality”. Examples are “cold white” tri-phosphor fluorescent lamps and metal halide lamps.

In the discussion on quality of CFLs it is often mentioned by consumers that the typical “cold light quality” is undesired. In this context, it has to be emphasised that also warm white CFL lamps are available at colour temperatures around 3000K. However, these

lamps show a lower CRI around 70-75%[1]. Thus against common criticism the consumer has the option to choose “warm white light” within CFL technology.

It is recommended to check the light quality of lamps in the retail shop already. Professional retailers normally offer this option. In supermarkets it is most often not done but the European Regulation 244/2009 asks for quality checks for all lamps put on the market after the 1 sept. 2010

Lamp lifetime

Lamp lifetime is an important criterion which finally also determines the energy efficiency and eco-efficiency of products. Average lamp lifetime is about 1000h for standard incandescent lamps, 2000-3000h for modern halogen lamps, about 10000h for CFLs and may be 50000h and more for LEDs. However, lamp lifetime is also dependant on the number of switching cycles. In the early days of CFL technology, lamp lifetime was strongly affected by switching. However today's quality products with pre-heating function do not show significant problems in this respect. Many products theoretically can be turned on and off many times per day over a period of 20-30 years. However, there are also cheap products of lower quality on the market which do not allow a very high number of switching cycles.

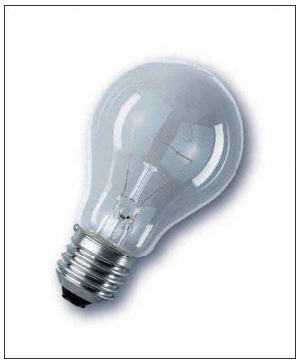
2.3 Lamp types

2.3.1 Incandescent lamps

Standard incandescent lamps show high lighting quality and performance but low energy efficiency and are therefore phased out from the market (see EU regulation further below). Different types of halogen lamps and fluorescent lamps are available for replacement (see below). Incandescent lamps work by heat-driven light emission. An electric current passes through a thin filament, heating it until it produces light. The glass bulb prevents that oxygen reaches the filament, which otherwise would be destroyed by oxidation. In former days light bulbs were evacuated, today they are filled with an inert gas. Incandescent lamps have a typical colour temperature of 2300-2900K which provides the typical warm white colour. They show a continuous light spectrum and a high colour rendering index (100%). Due to this light characteristics the technology was often preferred for lighting in domestic environment compared to CFL-lamps. This technology will be phased out due to the EUP directive by 2012.

[1] CRI can be higher at 2700K, which is already considered as "warm white".

Fig 2.1 Standard incandescent lamp



2.3.2 Standard halogen lamps

Standard halogen lamps are also incandescent lamps with a tungsten filament in a small transparent compartment filled with an inert gas and small amounts of halogen (iodine, bromine). Standard halogen lamps are actually more or less advanced incandescent lamps. Halogen lamps can operate at a higher temperature than a standard gas filled lamp which allows a higher efficacy (10-30 lm/W). Color temperature is higher compared to a non-halogen incandescent lamp. There is normally a trade-off between life-time and efficacy of lamps thus products with higher lifetime show significantly lower efficacy. Standard (low efficiency) halogen lamps are not much more efficient than standard incandescents (<15%). Only C-class and B-class halogen lamps are significantly more efficient however relatively inefficient compared to CFLs (see below).

Fig.2.2 Standard halogen lamps (G and R7S socket types)

2.3.3 Halogen lamps with Xenon filling and infrared coating

New halogen lamp technology with xenon or krypton gas filling allows 25-30% higher efficiency compared to incandescent lamps at same light output. Lamps are available in conventional halogen lamp design or in glass bulbs shaped like incandescent lamps with traditional socket, which makes it compatible with all luminaires using incandescent lamps (sold as retrofit “energy saver lamps”, Halo retro C).

Fig. 2.3 Retro C-class halogen lamp and infrared coated halogen lamp (class B)

In the newest halogen technology infrared reflective coating is applied to the halogen lamp capsules which allows 45% less energy consumption for the same light output compared to incandescent lamps. Based on this technology class B efficiency can be reached with halogen technology. However, for technical reasons, this is currently only possible with low voltage lamps. This lamp type is available both with standard halogen lamp socket and as high voltage incandescent retrofit design. For the retro design lamps (see Fig.2.3 on the right) a transformer is placed in the socket of the lamps. Due to technical restrictions, the technology currently is only available for lamps up to the equivalent of a 60W incandescent bulb (20-30W lamps equivalent to classic 40-60W incandescents). Prices for B-class lamps currently are around 7 €, C-class lamps cost about 2 €. The lamps show a higher lifetime of 2000-3000h compared to incandescents (1000h). Due to the higher life time and efficiency a pay-off respectively net savings during are achieved despite the higher purchasing price.

2.3.4 Compact fluorescent lamps with integrated ballast (CFLs)

CFL lamps typically consist of a gas-filled tube and an electronic ballast. Ballasts are required for fluorescent lamp technology to limit the current in the lamp and stabilise it.

The electrical current from the ballast flows through the gas, causing it to emit ultraviolet light. The ultraviolet light excites a phosphor coating on the inside of the tube which emits the visible light. Mercury vapour is used as gas filling. A plasma is created and the current can flow; Gases are Hg and Ar.

Compact fluorescent lamps are 60-80% more energy efficient compared to standard incandescent lamps. The average life of a CFL is between 8 and 20 times that of incandescents which is 6,000 to 20,000 hours compared to 750-1,000 hours for incandescent lamps.

Fig. 2.4 Standard CFL lamp

Good quality consumer CFLs reach a colour rendering index of >80%. CFLs can be dimmable, but rather for expensive models and it must be explicitly stated.

In contrast to recent debates, CFL technology does not pose significant health risks if typical usage is considered. The only potential impact is due to the UV-radiation. However, effects have only been detected for long-term exposure at distances of less than 20cm. Electro magnetism is also an issue often discussed for fluorescent lamps. Electromagnetic waves are emitted from the ballast in the socket of the lamp. So far there has been no evidence that the typical electromagnetic emissions observed for CFL lamps have any effect in terms of health[2]. Electromagnetic emissions also have been significantly reduced during the last few years. Very sensitive persons could also avoid the risk of any interference by keeping a minimum distance to the light source (e.g.> 30cm).

Overall the only significant environmental impact of CFL to date is due to non adequate disposal. A large quantity of CFLs is still disposed via residual waste. However CFLs must be disposed as hazardous waste due to the significant mercury content. In the European Union, CFLs are one of many products subject to the WEEE recycling scheme. The retail price includes an amount to pay for recycling, and manufacturers and importers have an obligation to collect and recycle CFLs. This aspect requires further consideration in promotion measures for CFLs.

[2] Serious studies, for example by done by SCENHIR in preparation to the EU regulation, have concluded on no effect on high sensitive people.

3 Legislation and standards

The following section gives a short summary on legislation instruments and standards at EU-level which serve as a relevant basis for the information provided in the Euro-Topten initiative.

3.1 The EUP regulation

The most important basis for the definition of Euro-Topten product criteria in the future is the EU Ecodesign directive 2005/32/EC which within the next few years will define energy efficiency criteria for more than 30 product groups. These criteria are implemented in specific EU regulations. For non-directional domestic lighting the *COMMISSION REGULATION (EC) No 244/2009* has already been published in March 2009.

This regulation provides the framework for a stepwise phase-out of standard incandescent lamps and halogen lamps (lower than C class efficiency) from the market. The regulation specifies different phase-out schedules for lamp types, requiring

- A complete phase out of non-clear lamps (both standard incandescent and halogen) for September 2009. In the past both standard and incandescent lamps have been sold as clear lamps (lamp type with clear glass and visible filament) and non-clear lamps (lamp type with opaque glass, internal filament not visible).

- For clear lamps (both standard incandescent and halogen) a stepwise phase-out is foreseen starting with lamps >100W in September 2009 followed by 75W in 2010, 60W in 2011 and all other wattages in 2012. Thus in theory all standard incandescent lamps should disappear from the market by 2012.

- C class halogen lamps will be allowed until 2016. From 2016 onwards, only B-class halogen will be allowed except for special socket lamps where C-class will remain on the market.

Current market practise in some countries is likely to lead to a delayed phase-out since many retailers tend to increase their stocks for standard incandescent lamps to be able to serve the market beyond the official date of the phase-out. This unfortunately is possible as the regulations only affect the primary introduction of products to the market (by manufacturers and importers) but not the sales of already existing stocks by retailers. It is therefore also an important task of the Euro-Topten network to prevent customers from buying the old inefficient technology still remaining on the market for some time. However, Topten teams should check the situation in their country, e.g. in France retailers seem to "play the game".

Tab. 3.1 Phase-out of standard incandescent and halogen lamps according to EU regulation 244/2009

	Non clear lamps		Clear lamps	
Date	Requirement		Requirement	
Sept. 2009	Class A	Phase-out of all incandescent, halogen CFL lamps below class A in September 2009	Class C for >100W	stepwise phase out of incandescent and halogen lamps of less than class C
Sept. 2010	Class A		Class C for >75W	
Sept. 2011	Class A		Class C for >60W	
Sept. 2012	Class A		Class C for all other W	
Sept. 2013	Class A	introduction of second level functional criteria in addition to the ones introduced in 2009		
Sept. 2014		Review of criteria		
Sept. 2015				
Sept. 2016	Class A		Class B for all lamps except for special cap halogens	Phase out of class C halogen lamps

The following tables 3.2 and 3.3 show the further requirements regarding functional and quality aspects. Table 3.2 is addressing fluorescent lamps and table 3.3 basically covers halogen lamps. Criteria for LED so far have not been defined.

The functional criteria are also essential for Euro-Topten product lists as they cover important quality features of lamps. Aspects like lamp survival factor, lumen maintenance factor, switching cycles before failure, colour rendering index, colour temperature and lamp warm-up time are critical for the consumer. Especially the latter three criteria often caused disappointment of consumers as there have been many low quality products on the market. It is therefore essential to promote CFLs not only on the basis of efficacy but to set clear minimum criteria for other essential quality parameters as well.

The EU-regulation furthermore defines comprehensive criteria regarding mandatory product information which has to be provided for consumers on product packaging as well as on websites of manufacturers (see table 3.4).

Tab.3.2 Functional requirements for fluorescent lamps (EUP-regulation 2009)

Functionality parameter	Stage 1 (2009)	Stage 5 (2013)
Lamp survival factor at 6 000 h	>0,50	>0,70
Lumen maintenance	At 2 000 h: >85 % (>80 % for lamps with second lamp envelope)	At 2 000 h: >88 % (>83 % for lamps with second lamp envelope) At 6 000 h: >70 %
Number of switching cycles before failure	>half the lamp lifetime expressed in hours >10 000 if lamp starting time >0,3 s	>lamp lifetime expressed in hours >30 000 if lamp starting time > 0,3 s
Starting time	< 2,0 s	< 1,5 s if P < 10 W < 1,0 s if P ? 10 W
Lamp warm-up time to 60 % Φ	< 60 s or < 120 s for lamps containing mercury in amalgam form	< 40 s or < 100 s for lamps containing mercury in amalgam form
Premature failure rate	<2,0 % at 200 h	<2,0 % at 400 h
UVA + UVB radiation	<2,0 mW/klm	<2,0 mW/klm
UVC radiation	<0,01 mW/klm	<0,01 mW/klm
Lamp power factor	>0,50 if P < 25 W >0,90 if P ? 25 W	>0,55 if P < 25 W >0,90 if P > 25 W
Colour rendering (Ra)	>80	>80

'Lamp survival factor' (LSF): is the defined fraction of the total number of lamps that continue to operate at a given time under defined conditions and switching frequency;

'Lamp lumen maintenance factor' (LLMF): which is the ratio of the luminous flux emitted by the lamp at a given time in its life to the initial (100 hour) luminous flux;

'Lamp start time': time needed after the supply voltage is switched on, for the lamp to start fully and remain alight;

'Lamp warm-up time': which is the time needed for the lamp after start-up to emit a defined proportion of its stabilized luminous flux;

'Premature failure': is when a lamp reaches its end of life after a period in operation which is less than the rated life time stated in the technical documentation;

'Switching cycle' is the sequence of switching on and switching off the lamp with defined intervals;

'Lamp lifetime': is the period of operation time after which the fraction of the total number of lamps which continue to operate corresponds to the lamp survival factor of the lamp, under defined conditions and switching frequency;

Tab. 3.3 Functional requirements for non fluorescent lamps excluding LEDs (i.e. halogen)

Functionality parameter	Stage 1 (2009)	Stage 5 (2013)
Rated lamp lifetime	>1 000 h	>2 000 h
Lumen maintenance	>85 % at 75 % of rated average lifetime	>85 % at 75 % of rated average lifetime
Number of switching cycles	>four times the rated lamp life expressed in hours	>four times the rated lamp life expressed in hours
Starting time	< 0,2 s	< 0,2 s
Lamp warm-up time to 60 % Φ	<1,0 s	<1,0 s
Premature failure rate	<5,0 % at 100 h	<5,0 % at 200 h
UVA + UVB radiation	<2,0 mW/klm	<2,0 mW/klm
UVC radiation	<0,01 mW/klm	<0,01 mW/klm
Lamp power factor	>0,95	>0,95

The mandatory information requirements shown in table 3.4 provide a valuable basis for the Euro-Topten project. Since essential data has to be provided on manufacturers websites, data retrieval for Topten will be strongly facilitated. Manufacturers are required to make all specified product data available starting in September 2009.

Tab.3.4 Information requirements to be provided on lamp packages as well as on web sites of manufacturers (this will be useful for national Topten teams to find information)

Information to be provided on product packaging	Information to be available on free access websites
# Nominal flux of the lamp (lm)	
# Nominal life time of the lamp (hours)	
# Number of switiching cycles before premature lamp failure	
# Colour temperature (in Kelvin)	
# Warm-up-time up to 60% of the full light output (seconds)	
# Warning if lamp can not be dimmed or only by means of specific dimmers	
# Claim of equivalence with incandescent lamp has to follow the specifications in the regulation	
# Term "Energy saving lamp" or any similar promotional statement may only be sued if the complies with efficacy criteria for non-clear lamps in stage 1	
	#Rated wattage (0,1 W precision)
	#Rated luminous flux (lm)
	#Rated lamp life time (hours)
	#Lamp power factor
	#Lumen maintenance factor at the end of the nominal life
	#Starting time (seconds)
	#Colour rendering (Ra)
	For lamps containing mercury
	#Instructions on disposal of lamps
	#Instruction on disposal in case of lamp breakage

3.1.1 Other relevant legislation at EU-level

- ***Directive 2002/95/EC on Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS)***

The RoHS Directive stands for "the restriction of the use of certain hazardous substances in electrical and electronic equipment". This Directive bans the placing on the EU market of new electrical and electronic equipment containing lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants.

Exemptions:

Exemptions from these requirements are for example:

- mercury in compact fluorescent lamps not exceeding 5mg per lamp
- mercury in straight fluorescent lamps for general purposes not exceeding halophosphate 10mg
- tri-phosphate with normal lifetime 5mg
- tri-phosphate with long lifetime 8mg
- mercury in straight fluorescent lamps for special purposes
- mercury in other lamps not specifically mentioned in this annex
- lead in glass of fluorescent tubes.

There are no exemptions for luminaires and ballasts.

- ***Directive 2002/96/EC on waste electrical and electronic equipment (WEEE)***

The WEEE Directive aims at:

- reducing waste arising from electrical and electronic equipment (EEE);
- making producers of EEE responsible for the environmental impact of their products, especially when they become waste.
- encouraging separate collection and subsequent treatment, reuse, recovery, recycling and sound environmental disposal of EEE .
- improving the environmental performance of all those involved during the lifecycle of EEE.

Exemptions: In the subcategory of luminaires for fluorescent lamps, an exception is made for luminaires in households. Also filament bulbs (incandescent and halogen lamps) are exempted from this directive.

- ***Directive 2000/55/EC on energy efficiency requirements for ballasts for fluorescent lighting***

The purpose of this Directive is to improve the efficiency of the systems by limiting the ballast losses. For this purpose, CELMA developed a classification system that takes both parts of the system into account, the lamp and the ballast and that is compliant with the directive. It constitutes an implementing measure within the meaning of article 15 of Directive 2005/32/EC.

- ***Directive 98/11/EC of 27 January 1998 implementing Council Directive 92/75/EEC with regard to energy labelling of household lamps***

This Directive applies the energy labelling requirements for household electric lamps supplied directly from the mains (filament and integral compact fluorescent lamps) and to household fluorescent lamps (including linear and non-integral compact fluorescent lamps), even when marketed for non-household use. The requirements will be updated in the revision of the labelling directive and its regulations in parallel to the implementation of the EUP regulation.

- ***Commission Decision of 9 September 2002 establishing revised ecological criteria for the award of the Community eco-label to light bulbs and amending Decision 1999/568/EC (http://ec.europa.eu/environment/ecolabel/)***

This Decision amends the Decision 1999/568/EC for the award of the Community eco-label. It sets specific criteria for light bulbs that aim in particular at promoting

  - the reduction of environmental damage or risks related to the use of energy by reducing energy consumption,
  - the reduction of environmental damage or risks related to the use of resources in both the manufacture and treatment/disposal of a light bulb by increasing its average lifetime,
  - the reduction of environmental damage or risks related to the use of mercury by reducing the total emissions of mercury during the lifetime of a light bulb.

The EU-Eco-Label is currently under revision (see also http://ec.europa.eu/environment/ecolabel/about_ecolabel/pdf/ep_proposal.pdf). In this revision process also new criteria for lighting are discussed. A proposal has been made to include criteria for LED lighting. Further information on the revision process and new criteria will be available during fall 2009.

- ***Electromagnetic Compatibility (EMC) Directive 2004/108/EEC***

The Council Directive 2004/108/EEC of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive) governs on the one hand the electromagnetic emissions of this equipment in order to ensure that, in its intended use, such equipment does not disturb radio and telecommunication as well as other equipment. In the other the Directive also governs the immunity of such equipment to interference and seeks to ensure that this equipment is not disturbed by radio emissions normally present used as intended.

- ***Low Voltage Directive (LVD) 73/23/EEC***

The Low Voltage Directive (LVD) 73/23/EEC seeks to ensure that electrical equipment within certain voltage limits both provides a high level of protection for European citizens and enjoys a Single Market in the European Union. The Directive covers electrical equipment designed for use with a voltage rating of between 50 and 1000 V for alternating current and between 75 and

1500 V for direct current. It should be noted that these voltage ratings refer to the voltage of the electrical input or output, not to voltages that may appear inside the equipment.

3.2 Relevant testing standards

This chapter shortly lists some relevant 'test standards or guidelines' related to the relevant lamp types. A “test standard or guideline” is defined as a procedure that sets out a test method. For detailed information the specific EN publications shall be considered.

- ***EN 60064: ‘Tungsten filament lamps for domestic and similar general lighting purposes - Performance requirements’.***

This standard applies to tungsten filament incandescent lamps for general lighting services (GLS) which comply with the safety requirements in EN 60432-1.

- ***EN 60357: ‘Tungsten halogen lamps (non-vehicle) - Performance specifications’.***

This standard specifies the performance requirements for single-capped and double capped tungsten halogen lamps, having rated voltages of up to 250 V, used for projection, photographic, floodlighting, special purpose, general purpose, stage lighting.

- ***EN 60969 : ‘Self-ballasted lamps for general lighting services – Performance requirements’.***

This Standard specifies the performance requirements, together with the test methods and conditions, required to show compliance of tubular fluorescent and other gas discharge lamps with integral means for controlling starting and stable operation (self ballasted lamps) intended for domestic and similar general lighting purposes.

- ***EN 60081 : ‘Double-capped fluorescent lamps - Performance specifications’.***

This International Standard specifies the performance requirements for double-capped fluorescent lamps for general lighting service. The requirements of this standard relate only to type testing. Conditions of compliance, including methods of statistical assessment, are under consideration.

- ***EN 60901: ‘Single-capped fluorescent lamps – Performance specifications’.***

This International Standard specifies the performance requirements for single-capped fluorescent lamps for general lighting service. The requirements of this standard relate only to type testing. Conditions of compliance, including methods of statistical assessment, are under consideration.

- ***EN 50285: ‘Energy efficiency of electric lamps for household use – Measurement methods’.***

Specifies the test conditions and method of measurement of luminous flux, lamp wattage and lamp life as given on a label on the lamp packaging, together with a procedure for verification of the declared values. Only those parameters that are specific to Directive 92/75/EEC are included in this standard, all other parameters are defined in the relevant lamp performance standards.

- ***EN 60921: ‘Ballasts for tubular fluorescent lamps – Performance requirements’.***

This standard specifies performance requirements for ballasts, excluding resistance types, for use on a.c. supplies up to 1 000 V at 50 Hz or 60 Hz, associated with tubular fluorescent lamps with pre-heated cathodes operated with or without a starter or starting device and having rated wattages, dimensions and characteristics as specified in IEC 60081 and 60901. It applies to complete ballasts and their component parts such as resistors, transformers and capacitors. (It only applies to ferromagnetic ballasts; electronic ballasts are covered under IEC60929.)

- ***EN 60929 : 'AC-supplied electronic ballasts for tubular fluorescent lamps – Performance requirements'.***

This International Standard specifies performance requirements for electronic ballasts for use on a.c. supplies up to 1 000 V at 50 Hz or 60 Hz with operating frequencies deviating from the supply frequency, associated with tubular fluorescent lamps as specified in IEC 60081 and IEC 60901 and other tubular fluorescent lamps for high frequency operation. (It only applies to electronic ballasts; ferromagnetic ballasts are covered under IEC60921.)

4 Market data

4.1 Supplier market in Europe

The main European suppliers of the lamp types covered in this criteria are OSRAM and PHILIPS. However, both manufacturers produce a large part of their products in Eastern European countries.

Several retail chains like IKEA, ALDI, BAUHAUS and others operating at national level sell products under their own brand name which are often from Chinese production. Some of these “no-name” products are significantly cheaper but also may show lower quality for example regarding maximum switching cycles etc. However, there is no general rule to this. For example, different lamps from IKEA and ALDI have been tested showing partly good and partly bad performance and quality. Products on the very low cost side (e.g. < 4€) mostly seem to be of lower quality regarding one or the other criterion.

4.2 Sales data

Annual lamp sales in EU-27 are shown in Table 4.1. The figure shows sales for standard incandescent lamps, halogen lamps and fluorescent lamps from 2004-2006. The data indicates that

- sales of incandescent lamps (GLS) have been decreasing but represented still more than half of the total sales volume in 2006,
- sales of halogen lamps and compact fluorescent lamps are significantly increasing
- Sales of linear fluorescent lamps (LFLs) amounted to roughly 20% of total sales in 2006 whereas total halogen lamp sales amounted to 10%.Sales volume of CFLs was only 5% of total sales.

Tab.4.1 Sales in EU-27 between 2004 and 2006 (EUP preparatory study)

lamp type	2004	2005	2006	% change 2004-2006	estimated 2006
GLS-F, GLS-C	1231	1121	1096	-11%	1350
GLS-R	164	145	138	-16%	
HL-LV	53	58	60	14%	300
HL-R-LV	67	71	73	9%	
HL-MV	37	40	44	18%	330
HL-R-MV, HL-R-MV colour	29	30	32	10%	
LFL	378	395	386	2%	390
CFLi	73	93	97	33%	316
Others	50	43	44	-11%	
TOTAL	2081	1996	1971	-5%	

GLS… Incandescent lamp

HL…… Halogen lamp

LFL….. Linear fluorescent lamp

CFL…. Compact fluorescent lamp

C, F, R……..Clear lamp, frosted lamp, reflector lamp

LV……..Low voltage lamp

4.3 Stock Data

Table 4.2 shows the stocks of lamps in households in 2007. Data show significant variation between countries and differences regarding number of lighting points per household. The ratio of installed lamps is 54% for standard incandescent lamps, 24% for halogen lamps, 7,5% for LFIs and 14,6% for CFIs. While the percentage of incandescent lamps will decrease during the next years due to the new EUP regulation, an increasing trend to halogen lamps has to be avoided.

In this context Topten provides an important information platform for the promotion of fluorescent lamps and LEDs. LEDs have not been covered in the specific market studies. Products belonging to this upcoming technology have been of limited quality in previous years due to problems with colour and efficacy. However recently high quality products have become available on the market. Current remaining problems are high prices and limited availability of high quality lamps. LEDs are not addressed in this document but will be covered in a separate criteria paper available in fall 2009. LEDs are only partly covered in the current regulation on domestic lighting. They will also be part of the following regulation covering spots reflector lamps etc.

Tab. 3.2 Stock of lamps in households in EU-27 from Remodece and JRC survey

			REMODECE survey						JRC questionnaire		
EU region	Coun-try	Number of house holds	GLS	Halogen LV	Halogen MV	LFL	CFLi	Lamp per HH	Lighting points	% of HH with CFLi's	CFLs/HH incl. HH without CFLi
		millions	no/HH	no/HH	no/HH	no/HH	no/HH	No/HH	no/HH	%	no/HH
Central and Eastern	BG	3,7	9,10	4,11	0,24	0,55	1,73	15,7	10,0	7	0,20
	CZ	4,40	8,85	3,50	0,38	1,60	4,80	19,1	10,0	70	2,90
	CY	0,32							16,0	79	2,00
	EE	0,60							6,0	20	0,25
	HU	4,10	8,30	1,40	0,00	0,30	3,20	13,2	18,0	60	1,00
	LV	0,97							20,0	19	0,42
	LT	1,30							6,0	20	0,25
	MT	0,13							15,0	50	1,00
	PL	13,3							20,0	50	0,50
	RO	8,13	8,37	0,80	0,27	0,75	1,05	11,2	10,0	20	0,20
	SK	2,1							15,0	60	1,00
	SI	0,69							19,0	50	1,00
Middle	AT	3,3							26,0	70	4,00
	BE1	4,3	9,3	10,0	1,10	3,0	7,2	30,7	26,0	71	2,50
	FR	32,2	12,80	2,10	0,80	1,50	3,20	20,4	18,9	52	2,26
	DE	39,1	12,50	7,10	0,70	1,90	3,10	25,3	32,0	70	6,50
	EI	1,44							18,0	38	1,50
	LU	0,20							20,0	70	2,00
	NL	7,0							40,0	60	4,00
	UK	26,20	15,6	2	3,80	1	2,3	25,0	20,0	50	2,00
Northern	DK	2,5	14,10	9,10	1,70	2,40	5,40	32,7	25,4	65	4,90
	FIN	2,5							23,5	50	1,00
	SE	4,5	21,0	4,0	1,0	4,8	4,0	34,8	22,0	55	2,20
Southern	GR	3,7	11,3	2,6	0,5	1,4	3,0	18,8	7,0	50	1,00
	IT	22,5	15,4	7,0	2,0	3,2	5,8	33,4	18,0	60	0,80
	PT	4,2	11,84	3,51	0,79	1,80	3,39	21,3	11,4	54	1,70
	ES	17,2							25,0	15	2,00

EU region	House-holds	GLS	Halogen LV	Halogen MV	LFL	CFLi	Lamps in survey	Lighting points by Remodece +JRC (rest)	Percentage of HH with CFLi's (JRC)	CFLs/HH incl. HH without CFLi, JRC
	millions	millions	millions	millions	mio.	mio.	mio.	millions	%	No/HH
Central+Eastern	39,73	386	95	10	36	109	288	636	42	0,8
Middle	113,74	1569	525	183	185	367	2433	2829	59	3,8
Northern	9,50	162	51	11	34	39	238	297	56	2,6
Southern	47,60	653	269	73	130	239	934	1364	42	1,3
EU-27	210,57	2770	939	277	385	753	3893	5125	52	2,6
	No/hh	13,15	4,46	1,32	1,83	3,58		**24,34**		

5 Concept and Criteria proposed for Euro-Topten

This chapter does not define specific target values to be met by Topten products in all Euro-Topten partner countries. According to the Topten concept, each country has to develop its specific Topten lists which depend on the products available on the national market. Thus, the specific thresholds for Topten lists depend on the products offered at national level and will be more or less stringent depending on the number of efficient products available.

The intention is rather to provide some recommendations regarding the criteria to be considered in Topten product listings and to give an idea of the efficiency of products currently offered on the market.

5.1 Lamp categorisation

Lamp categorisation for Topten lists should consider the typical different lamp types offered on the market respectively requested by the consumers.

Typical designs for compact fluorescent lamps are standard or spiral tubes and double capped lamps for retrofit of classic incandescent lamps. A further distinction is the E14 and E27 design with different sockets. For halogen lamps, the most common designs are the linear lamp types (R7S lamps) and the G-type lamps. An additional rather recent design type are retrofit halogen lamps fitting to standard E14 and E27 sockets used as a replacement for standard incandescent lamps.

Lamp categorisation for fluorescent lamps for the convenience of consumers should at least separate the following categories:

- E-14 socket
    - Tubular
    - Double capped (classic retrofit)
- E-27 socket
    - Tubular
    - Double capped (classic retrofit)

Examples on current categorization can be found on several Topten-websites already providing information on lighting products (see www.topten.info)

For halogen lamps, a B-class category may be included in the Topten lists (as selected products or in the "recommendation page") to guide consumers searching for halogen lamps to the most efficient alternative.

Due to the current phase-out of standard incandescent lamps consumers will search for alternatives especially regarding clear lamps with specific lighting characteristics. Apart from the currently still quite expensive LED lamps for which only few high quality products are available on the market but not easy to spot, halogen lamps may still be, depending on countries, the primary option of choice.

The new EUP regulation defines a stepwise phase-out of halogen lamps below class C efficiency by 2012 and a phase-out of class C by 2016. This means that C class lamps with Xenon gas filling will remain on the market until 2016. Nevertheless, class B halogen lamps are already on the market today however currently limited to a maximum wattage of 60W. If consumers in your country are really reluctant to CFL lamps, this specific halogen technology may be supported by additional product lists although

- it will hamper the whole energy saving potential to be reached
- it should be seen as a transition technology just temporarily closing a gap until more efficient high quality LED technology becomes more abundant.

LED lamp types will be considered in a separate lighting paper together with halogen spots and reflector lamps. The reason is that also for these product groups, new criteria defined in the EUP-regulation (expected for late 2009) need to be considered and because there is no international standard to measure LEDs' efficacy.

5.2 Topten Lamp Information

The following information should be shown on the Topten websites (in the tables) to ensure that the consumer gets sufficient information also on quality criteria other than energy efficiency:

Energy information:

- Rated wattage (W)
- Rated luminous flux (lm)
- Rated wattage per rated luminous flux (i.e. primary efficiency criterion) (W/lm resp lm/W)
- Energy consumption and energy costs over expected life time of lamp

Other functional information:

- Lamp dimensions (mm)
- Nominal life time (hours)
- Nominal switching cycles until premature lamp failure
- Warm-up time up to 60% full light output (s)
- Colour temperature (Kelvin)
- Colour rendering index
- Mercury content of lamps
- Indication of option for dimming
- Correct comparison with luminous flux of standard incandescent lamps (comparison is helpful but needs to be correct, see requirements in EUP regulation)

5.3 Topten Lamp selection criteria

The following section provides some recommendations regarding requirements for Topten lamps. It is not the intention to indicate precise mandatory requirements since real requirements for toplists will differ from market to market according to the country.

The following table provides the data for the most efficient products currently available on the market. These values will be too stringent for Euro-Topten as there may not be enough products on the certain national market to develop reasonable product lists. Thus, the values are provided to give an orientation about the maximum efficiency currently achieved - also independent of prices.

Tab. 5.1 Indicative values for most efficient products currently on the market

Criterion	value
Lamp efficacy	69 lm/W
Rated lamp lifetime	20000h
Lumen maintenance	90% at rated lamp lifetime
Number of switching cycles	1000000
Starting time	0,1s
Lamp warm up time to 80%	15s
Lamp power factor	0,95
Mercury content	<1,23 mg

Energy efficiency

As a general rule, only products equal or better than A class for fluorescent lamps and equal or better than B class for halogen lamps shall be considered. Topten lists should cover the 10-15 most efficient products per lamp type available on the local market. It is proposed that lamps are listed in a descending order starting with products of highest energy efficiency. However all lamps shall meet minimum functional or quality criteria as listed below.

Functional criteria

All products on the Topten lists should meet the following functional criteria. It is critical for the further success of energy efficient lamp technology that lamps are not only energy efficient but also provide high quality (regarding lifetime, colour etc.). Consequently, it makes no sense to promote most energy efficient products if they do not meet essential functional criteria. A set of recommended mandatory functional minimum criteria for Topten lists is given below.

Tab. 5.2 Functional minimum criteria for fluorescent lamps

Criterion	Mandatory level
Rated lamp lifetime	>10000h (if not possible 8000h, i.e. more than the mandatory 6000h)
Lumen maintenance	>80% at end of lifetime
Number of switching cycles before failure	>30000h
Lamp warm up time to 60%	<60s for classic shaped lamps and <30s for others
Colour rendering index	>80

Tab. 5.3 Functional minimum criteria for halogen lamps

Criterion	Mandatory level
Rated lamp lifetime	>2000h
Lumen maintenance	>80% at end of lifetime
Number of switching cycles before failure	>four times the lamp life time expressed in hours
Premature failure	<2% at 100h
Colour rendering index	>80
Lamp power factor	>0,95 I would take out this one, since we don't have it for the others

5.4 Further information on lighting and EUP regulations

Websites providing useful information

- www.eup-network.de: General information on EUP regulations
- www.toplicht.ch: broad overview on different lighting issues
- www.topten.info: link to already existing Topten categorization and listings

6 A few hints regarding communication on CFL lamps

Potential health effects

Common assumption: Lamps show negative effects on health due to UV and electromagnetic emissions.

CFL lamps have no negative impact on health under normal use conditions. Potential irritations of particularly sensitive people have been observed under long-term exposure at low distances (e.g. <20-30cm). According to EU studies, there are about 200000 people in the EU who may react sensitive to CFL lighting due to specific diseases. The effects are primarily due to UV radiation and partly due to electromagnetism (emitted by the ballast in the lamp socket). However, electromagnetic emissions also have been reduced dramatically during the last few years.

Overall healthy people not suffering from some specific disease which makes them more sensitive to the emissions mentioned will not experience negative health effects unless being permanently exposed at extremely low distance.

Environmental effects

Common assumption: Lamps have a strong negative effect on the environment primarily due to mercury content.

CFLs show no specific negative environmental effects if they are disposed as required. CFL lamps are covered by the WEEE directive and thus should be disposed like electronic waste. Lamps shall be returned to the retailer or disposed in specific locations responsible for the collection of electronic waste. Following this standard waste management any environmental pollution by mercury can be avoided. Lamps must not be disposed with normal household waste.

Lamp life time

Common assumption: Lamps are strongly affected by switching and thus lamp life time is much shorter than often declared.

For current high quality products lamp life time is not strongly affected by frequent switching anymore. According to current testing good lamps could be switched many times a day for 20-30 years. Based on the EUP directive the expected number of switching cycles has to be declared by the manufacturers. Thus, more information is available for the consumer now to support the right buying decision.

However low price products (2-3€) can show significantly shorter life time. A critical comparison and selection of products is relevant (see criteria explained earlier).

Light quality

Common assumption: CFL light is unpleasant and "cold"

CFL is basically the same technology used in office lighting for decades already (tubes). There has been no discussion about low lighting quality so far. Against common assumption also "warm white" CFL with lower colour temperature are available on the market. So the consumer can choose light qualities which may be more pleasant for specific domestic application. Light quality should be tested whenever possible to be sure to buy the desired product. Checking and comparing lamps normally is possible in professional retail shops.

No alternatives to CFL

Common assumption: Due to the phase out of the incandescent lamp there are no alternatives to CFL now. Consequently large stocks of incandescent lamps need to be bought to have enough spare lamps for several years.

For applications where CFL seems inappropriate due to different lighting quality new generation halogen lamps can be used instead of classic incandescent lamps. The new generation retrofit lamps can be used for direct replacement of standard incandescent lamps (high voltage, E-24 sockets etc.) and have the same design as classic light bulbs (also candle design available). Lamps are 30-50% more efficient than classic light bulbs. Thus hoarding of old technology incandescent lamps is inappropriate.