Annex 2

Working document on possible ecodesign requirements for general lighting equipment ("Domestic lighting part 1, including incandescent bulbs")

Table of contents

Executive summary

This paper is the main consultation document for possible ecodesign requirements on general lighting, outlining the principal issues at stake. It is complemented by a document containing the ecodesign requirements under consideration.

The main purpose of the ecodesign requirements under the planned implementing measure would be to set minimum energy efficiency requirements that any lamp for general lighting placed on the market in the EU would have to fulfil. The measure would also set performance and quality requirements for those lamps, so as to ensure that alternatives to incandescent lamps (such as compact fluorescent lamps with integrated ballast) provide an equivalent service to the users.

The setting of the efficiency requirements is proposed to be complemented with a subsequent update of the Energy Labelling of lamps directive (98/11/EC), once the levels specific to the reflector lamps (including LEDs) are established under a separate measure. As a result efficient lamps belonging to current top classes A and B would be better differentiated.

Minimum lamp efficiency requirements are proposed to be set with reference to the label levels.
Several options are presented for discussion in the Consultation Forum. Based on the discussions the Commission services will finalize an impact assessment before defining which option to propose for adoption. All the examined options lead to a total phase out of traditional incandescent bulbs (GLS) used for general lighting purposes. The phase out is achieved not via a ban on GLS as a technology, but through setting minimum energy efficiency requirements common to all lamp technologies.
The main questions for debate are the level of ambition beyond phasing out GLS and timing. 4 options are identified for the minimum levels:
1. Current class A: leaves only the most efficient compact fluorescent lamps (CFL) on the market (for which several concerns are raised such as lighting design issues, mercury content and to be verified health claims)
2. Current class A with exceptions: allows *efficient* clear glass halogen lamps to coexist with CFLs
4. Current class C: allows *average* halogen lamps to probably dominate the market (proposal of the lighting industry from June 2007)
There exist substantial differences in the saving potential of the different options, which ranges from 47 TWh to 74 TWh / year in EU-27.
On timing, the question is whether to implement quickly (such as 3 stages and 5 years, with total GLS phaseout after 3 years) or more cautiously (5 stages and 9 years, with total GLS phaseout after 7 years), as proposed by the lighting industry. The timing also raises the question of production capacity and closure of production lines in Europe.

Introduction

This document should be read as the main discussion document for the Consultation Forum on "domestic" lighting. As several options are still open, and the language of the proposed requirements could be perceived as rather technical by non-experts, it was considered appropriate to use the format and style of a discussion paper. The ecodesign requirements that could be part of a future implementing measure are formulated in a separate document.
This document and all the annexed documents are based on the recommendations of the preparatory study for potential ecodesign implementing measures on domestic lighting products.[1] You can learn more about the ongoing decision making process on the Ecodesign of Energy Using Products web page of the European Commission.[2]

Scope of the measure: general lighting versus "domestic" lighting

The original intention was to have two objectives in the working document:

1. Fixing basic minimum efficiency and performance requirements on all lamps used in general lighting, regardless of the technology. No lamp could be used for general lighting that does not respect these requirements. This would be done in order to close the net and not to leave loopholes for technologies not specifically covered in implementing measures.

[1] www.eup4light.net
[2] http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm

2. Fixing technology specific minimum efficiency and performance requirements on all lamp technologies typically used in domestic lighting, with voluntary indication of suitability for domestic lighting (the approach taken in the previous two working documents).

However, in practice technology or application specific requirements on domestic lighting products seem to be redundant for the following reasons:

1. The technologies typically used in domestic lighting are at the lower end of the efficiency range of lamp technologies (incandescent lamps, halogen lamps, and in the range of mercury-containing lamps, compact fluorescent lamps with integrated ballast). There is no reason to have requirements on them that would be separate from the basic minimum efficiency and performance requirements applicable to all lamps for general lighting. A differentiation between mercury-free and mercury containing lamps is included.

2. Under the street and the office lighting working documents a voluntary indication of suitability of lighting products for those particular application areas was proposed[3], as the specific needs of those application areas could be clearly defined. Such an indication of suitability is not possible for domestic lighting, where uses are extremely diverse and unpredictable. Consequently, the working document proposes no provisions that would be specific to equipment installed for domestic lighting only.

This should lead to the following coverage of the currently planned implementing measures on lighting products:

	General lighting			
	GLS, HL, CFLi[4]	CFLni, LFL[5]	HID[6]	Other lamps
Basic requirements		–	–	
Technology specific requirements	–			–

Defining "general lighting"

(Annex I of the Possible Ecodesign Requirements)

General lighting is "substantially uniform lighting of an area without provision for special local requirements" (EN 12665). This notion is opposed to more localised types of lighting such as decorative or task lighting, and also to special purpose lighting where providing visible light is not the (main) purpose of the lamp (e.g. infrared or disinfection lamps). General lighting includes all applications (street, office, domestic, industry, commercial etc). According to the findings of the preparatory study, general lighting lamps can be defined based on the following technical parameters. If a lamp emits light in a given quantity (at least 150 lm) and with a given colour quality (corresponding to the definition of "white light"[7]), it

[3] See the relevant Working Documents on http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm
[4] GLS = incandescent lamp, HL = halogen lamp, CFLi = compact fluorescent lamps with integrated ballast
[5] CFLni = compact fluorescent lamps without integrated ballast, LFL = linear fluorescent lamp
[6] HID = high-intensity discharge lamp
[7] The SI unit for luminous flux (lumen) is related to the sensitivity of the human eye. The human eye is much more sensitive to green light than to blue light and as a consequence it could seem energy efficient to use green

can be used in general lighting. The definition can be reinforced by providing a list of the lamp caps used in general lighting.

Future requirements on reflector lamps, LEDs, luminaires with incorporated lamps

The lamp types grouped under the category "directional light sources" should also be covered by efficacy requirements, as they can fall within the definition of general lighting lamps. However, as the measurement of their efficacy is more complex and cannot be tackled separately from the luminaires' efficiency measurement, more work needs to be done. A separate implementing measure will be proposed later on these lamps once the recommendations of the preparatory study become available.

Revision of the energy label for lamps

It is proposed to adapt Directive 98/11/EC on the energy labelling of lamps so as to replace current class levels with those indicated in Annex III.2 of the working document and to include low voltage lamps that are currently exempted. The on-going discussions on the layout of the energy label will determine the codes assigned to each level (e.g. "A" or "9"). The working codes and colours attributed to the different proposed levels in this working document should not be considered as a proposal for codes and colours to be used in the revised lamp energy label. They were selected for the sole purpose of enabling the simplest comparison with current energy classes in the framework of this discussion paper.
A comparison of the new levels with the current classes, together with an indication of the classes to which currently available lamp technologies typically belong to is given below. More detailed information on the limit values can be found in the Excel workbook annexed to this document (sheets "Label – values" and "Label – types"). Please note that the energy class of directional lamps (reflector lamps, LEDs etc) will be determined later based on the conclusions of the second half of the preparatory study.
In all examined scenarios further in this paper, current energy classes D-G would be phased out ultimately, so the lowest class of the label would be set accordingly, and the highest would be A+++.

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light for illumination. But if a light source for illumination is only monochromatic, the appearance of all objects that have any other colour changes into an undefined grey. Only 'white light' can be used for general illumination, as it contains all the colours of the visible light spectrum and gives a natural appearance to all the different colours in the environment.
Defining general lighting by 'white light' is also important because it allows the exclusion of many special purpose lamps (eg. infrared lamps and ultraviolet disinfection lamps), where the generation of visible light is only a side-effect. This is typical of the transition zone between visible and non visible long wave length light (red - infrared light) or of the transition zone between visible and non visible short wave length light (violet - ultraviolet light).

Current label class	Proposed levels	Minimum Efficacy (lumen / Watt) for a 700 lm lamp [8]	Typical lamp types [9]
A	A+++	111	low pressure sodium lamps (≥36 W), best available LEDs in low power
A	A++	71,9	linear fluorescent lamps with electronic ballast, high-intensity discharge lamps
A	A+	59,5	compact fluorescent lamps with separate electronic ballast
A	A	51,6	efficient CFLs with integrated ballast
B	B+	30,4	inefficient CFLs with integrated ballast
B	B	20,3	efficient halogens
C	C	15,2	average halogens
D	D	12,8	poor halogens
E	E	11,1	incandescents
F	F	9,4	
G	G	< 9,4	
The working codes and colours attributed to the different proposed levels in this working document should not be considered as a proposal for codes and colours to be used in the revised lamp energy label.			

Discussion on the level of ambition of minimum lamp efficacy requirements

The proposed ecodesign requirements are set out in the Possible Ecodesign Requirements document based on the recommendations of the preparatory study. However, in Annex III.3. of the Possible Ecodesign Requirements, the minimum lamp efficacy requirements are indicated as optional at this stage, awaiting the discussion in the Consultation Forum. This section is meant to present some options for this discussion.

All the options examined below lead to a total phase out of traditional incandescent bulbs (GLS) used for general lighting purposes.
The phase out is achieved not via a ban on GLS as a technology, but through setting minimum energy efficiency requirements common to all lamp technologies.

[8] This value expresses how much light (in lumens) each watt powering the lamp has to produce, in the case of a lamp having a light output of 700 lumens. The value varies with the light output of the lamp, high light output lamps being more efficient than their low light output counterparts. In the Energy labelling of lamps Directive a formula is used to calculate the required efficacy of the lamp based on its light output.
[9] For simplicity, only typical lamps are indicated for a given class. The same lamp technology could be present in other classes as well.

The questions relate to the level of ambition when phasing out incandescent bulbs, in terms of minimum levels and timing.

A. Alternative lamp technologies

The two major currently available alternative lamp technologies to GLS are compact fluorescent lamps with integrated ballast (CFLs) and halogen lamps:

1. Halogens are full alternatives to GLS; they are 1,3 - 2 times more efficient than GLS and last twice longer (2 years).
2. CFLs are 3-5 times more efficient than GLS, they last 6-10 times longer (6-10 years). They can replace frosted (non-transparent) incandescent bulbs, but cannot provide a bright point-like light source like clear glass transparent lamps.

Bright point-like light sources give a different light distribution from the diffuse light of frosted bulbs and cause decorative shiny reflections on glossy surfaces. This is mainly an issue for lighting design.
Here is a comparison of the efficacy of lamp technologies (compared to GLS)[10]:

Lamp technology	**Efficacy**	**Energy class**
Average conventional GLS	1	E
Average halogen lamps (ELC proposal)	1,4	C
Very efficient halogen lamps (best available)	1,8	B
CFLs with bulb-shaped cover and low light output	2,7	B+
CFLs with bare tubes or high light output	4,6	A

B. Levels of ambition of the options

In this section different options are presented as regards the level of the requirements. The levels are expressed according to the table above comparing proposed levels to existing classes.
A first estimate of the likely impact on energy efficiency is also given for each option. In the section following the options, other impact factors (such as on industry) are briefly addressed. This gives a rough idea of the order of magnitude of the difference between the options and of the type of impact they could have on different stakeholders. The assumptions will be further analysed in the impact assessment.

Relation with luminaire requirements:

In options 1 and 2 below, luminaires compatible only with inefficient lamps (C-level or worse halogen lamps) would be phased out already at the first stage of implementation (unless

[10] The relative efficacies in the table were obtained by averaging for each lamp type the efficacies of their typical energy class at different light outputs from 100 to 1000 lumen, with steps of 100 lumen. The result looks similar to simply comparing the efficacies of typical lamps at 700 lumen (typical light output of a 60W E-class GLS lamp).

coming with integrated presence detection), so that fewer users would have to replace installed luminaires in further stages when C-level lamps are phased out.
Please note that in the discussion of options it is not taken into account that consumers can also buy new luminaires with reflector lamps that are currently exempted but should be covered in another measure soon.

Option 1

Minimum energy efficiency requirement: level A

Phases out:

- All GLS
- All halogen lamps
- B+ level CFLs (currently with bulb-shaped cover and low light output)

Remain on the market:

- High light output CFLs
- CFLs without cover (bare tubes)

To be noted that this option leaves no more lamps offering a bright point-like light source and many existing luminaires for halogen lamps will have to be replaced by the users.

Efficiency: this option results in a situation which is **4,6 times more efficient** than using only average (E level) GLS.

Option 2

Minimum energy efficiency requirement: level A (with some exemptions in level B+ and B)

Phases out:

- All GLS
- All frosted halogen lamps
- All high light output halogen lamps
- Average and poor (level C and D) clear halogen lamps
- B+ level CFLs if they do not have excellent colour rendering

Remain on the market:

- All CFLs except B+ level with average or poor colour rendering
- Efficient (Level B) clear halogen lamps (not if high light output)

This option leaves the most efficient bright point-like light sources on the market.
It is explained in more detail in Annex III.3 of the Possible Ecodesign Requirements (the fact that it is there does not mean it would be the preferred option among those listed here). Its consequences in terms of values and lamp types is modelled in the annexed Excel workbook on sheets "Option 2 – values" and "Option 2 – types".
Efficiency: assuming that one fourth of the market will be clear halogen (level B), one fourth B+ level CFLs and the remaining half A level CFLs, this option results in a situation which is about **3,5 times more efficient** than using only average (E level) GLS.

Option 3

Minimum energy efficiency requirement: level C

Phases out:

- All GLS
- Poor halogen lamps (level D)

Remain on the market:

- All CFLs
- Efficient and average (Level B and C) halogen lamps both frosted and clear.

In this option average and efficient halogen lamps remain on the market as full alternatives (both clear and frosted) to GLS lamps.
When replacing GLS in existing luminaires, the low voltage B level halogens lamps come with integrated transformer, and are therefore as expensive as CFLs. It is therefore safe to assume that when replacing GLS in existing luminaries, the public will rather shift to the cheaper C level halogen lamps. Low voltage B level halogens are only likely in new installations where they can be fitted with external transformers.

Efficiency: assuming that two thirds of the market will be C-level halogen, and the remaining third divided equally between B level halogens, B+ level CFL and A level CFL, this option results in a situation which is about **1,9 times more efficient** than using only average (E-level) GLS.

This option corresponds to the last stage of the proposal of the lighting industry.[11] Its consequences in terms of values and lamp types is modelled in the annexed Excel workbook on sheets "Option 3 – values" and "Option 3 – types".

C. Comparison of options as to their energy and CO2 emission saving potential

The preparatory study has not come up yet with detailed scenario calculations, thus only a preliminary estimate is included hereafter.

Options are calculated proportionally according to the estimates under the section B, using a baseline of 100 TWh annual energy consumption of the EU-27 stock of affected lamp types, as in the ELC proposal.

Option	Efficiency if all GLS = 1	Estimated saving potential TWh / year, EU-27	Estimated saving potential Mt of CO2 / year, EU-27
1.	4,6	78	34
2.	3,5	71	31
3.	1,9 [12]	47	20

11

http://roms.elcfed.org/uploads/fmanager/070605_background_paper__the_elcs_proposal_for_domestic_lighting.pdf

Assumption: 1 kWh of electricity means 0,43 kg of CO2 emissions (used also in the preparatory studies).

Please note that these forecasts do not take into account growth rates in general lighting in terms of total light output, neither that consumers can also switch to newly installed luminaires with reflector lamps.

D. Other proposed provisions of the planned implementing measure

The Possible Ecodesign Requirements document contains also other provisions than those affecting lamp efficacy.

- Detailed product information requirements describe what should be indicated to the consumer, so that he/she can make informed choices and proper use of the lamps (Annex III.1). In addition to the content proposed in the Working Document, the location of this product information is to be debated.
- A set of requirements ensure that all lamps (including CFLs) entering the EU market offer the performance that can be expected from general lighting lamps (Annex III.3). These requirements address aspects already tackled by existing voluntary quality charters such as the EU CFL Quality Charter, the United Kingdom's Energy Saving Trust's scheme, the U.S. Energy Star, the international Efficient Lighting Initiative or the Ecoprofiles of the European Lamp Companies Federation.
- A benchmark is recommended on the mercury content of mercury-containing lamps (Annex III.4).
- Luminaires that can only operate with inefficient lamp types (such as certain main voltage halogen lamps) are phased out (Annex III.5).
- The compatibility of wall-mounted dimmers with all general lighting lamps is also ensured via a requirement (Annex III.6).
- Finally a generic requirement is set to reduce the amount of non-recyclable waste originating from general lighting (Annex III.6).

E. Levels of ambition in timing

The so-called ambitious and cautious timing as hereunder have in common that they start with the higher light output lamps which also consume more energy.
The impact on industry and users should be assessed in more detail.

1. Ambitious

(proposal from preparatory study)

Implements a phase-out in **3 stages and 5 years** (with a one year transition period before first tier)

[12] The lighting industry claimed that Option 3 was about 3 times more efficient, not 1,9. This cannot be the result of their proposed ecodesign requirements alone, but probably assumes further soft measures in favour of CFLs, not within the scope of this analysis.

Stage 1 – year 1 after entry into force
Phases out:

- all GLS except level E low light output (under 40W)
- all high light output halogens
- level D medium light output halogens

Stage 2 – year 3
Phases out:

- All remaining GLS
- level C medium light output halogens
- level B+ inefficient high light output CFLs (some exceptions)

Stage 3 – year 5
Phases out:

- Level C and D low light output halogens
- Level B+ inefficient lower light output CFLs (some exceptions)

2. Cautious

(proposal from lighting industry)

Implement a phase-out in **5 stages and 9 years** (counting one year transition period before first tier).

Lamp Category	Phase 1 2009	Phase 2 2011	Phase 3 2013	Phase 4 2015	Phase 4+ 2017
>100W	ABCD ~~EFG~~	ABC ~~DEFG~~			
75W+		ABCD ~~EFG~~	ABC ~~DEFG~~		
60W+			ABCD ~~EFG~~	ABC ~~DEFG~~	
25W+				ABCD ~~EFG~~	ABC ~~DEFG~~

According to this proposal, a major category of GLS, the 60 W would be phased out in phase 3 (year 5), and another important category, the 40 W GLS in phase 4 (year 7). A total phase out of GLS would be effective as from phase 4.

F. Main potential problems with the options

I. Problems common to all options

a. Production capacity

The European lighting industry have reported in their comments to the preparatory study's recommendations that there could be serious capacity problems with the more ambitious timing of the phase out: "In 2007, the global demand for GLS is estimated to have been at least six times global CFL capacity, following the sudden upsurge in public interest in CFLs (12bn GLS versus 2bn CFLs). Investments in new production capacity to keep up with this have been and continue to be made, but even so there is a lag involved that must be recognised in any timetable. The ambitious timing requires that all GLS lamps above 40W, representing approximately 70% of the GLS market, are to be phased out in the EU from year 1. To achieve this replacement capacity 4 to 5 years is required given the large volume & supply chain consequences involved."

The consequences according to industry could be:

- A shortage of adequate light sources for a large range of applications and luminaires in the EU;
- Reduced availability or choice for consumers faced with empty shelves in retail outlets;
- A higher proportion of sub-standard products entering the market, with the risks and disadvantages associated with that
- Public discontent with the supply chain and the EU policy decisions that have led to that set of circumstances. Given the iconic status that measures on lighting has assumed in the efforts to mitigate climate change, this could have implications well beyond this product category.

The preparatory study has come up with the following analysis:

"The annual sales of CFLi after Stage 3 will be on the long run much lower compared to the current annual sales of GLS as CFLi lamps have about 6 times longer life time. Therefore the demand for alternative more efficient light sources will increase from the current 300 M CFLi and 1350 M GLS per year towards 500 M CFLi per year with a possible temporary over shoot in CFLi demand between Stage 1 and Stage 3. The EC production of CFLi is about 90 M CFLi lamps (the rest is imported) and cannot cover this demand. China produces about 2400 M CFLi (2006). Hence it is likely that China will fill up the newly created demand for CFLi lamp without a significant influence on its production capacity."

Please note the third country producers would also be bound by the quality requirements under the planned implementing measure.

Further capacity issues can be identified:

- It is likely that also in other parts of the world GLS will be phased out in the coming years, which could aggravate the capacity problem.

- After the first wave of CFLs are sold after the GLS phase out, the newly installed production lines may have to slow down, as the lifetime of CFLs is much longer than GLS lifetimes.

However, both of these issues may well be tempered by the following factors:
- Consumers are likely to stock up on GLS lamps
- It can last years before a GLS is broken when installed in applications with low annual operational hours
- Diversification in lamp technology (e.g. consumers are already now switching to halogen lamps luminaires)

b. Impact on jobs and costs for the industry

Both CFLs and halogens are mostly produced outside the EU (in the Far East). The bulk of the EU production (in terms of numbers) is still GLS lamps. Electronic ballasts for CFLs are cheaper to produce in third countries, and halogen bulbs are usually small enough to be transported cost-efficiently around the World. It is therefore likely that the technology shift, especially if implemented quickly, could affect production based in the EU in first place. In the European lighting industry's words:

"The ambitious timeline may result in manufacturers looking at every available short term option to access further capacities required. This could imply that access to increased capacity for energy efficient lamps could be sought outside the European Union rather than by investing in additional production facilities in Europe. The risks are such that the numbers of jobs affected and amount of finance involved would be very considerable – as indicated below:

Social Costs	Amount
Potential Jobs Affected	10,000
Assets Written Off (excluding buildings and infrastructure)	€250.000.000
Employee Termination Costs	€175.000.000
Sales Losses Material Suppliers	€200.000.000

It is probably more likely that GLS production lines can be converted to halogen lamp production than to CFLs. Both GLS and halogen lamps are filament lamps, CFLs are a completely different technology.

II. Problems specific to options resulting in a majority of CFLs on the market

a. Mercury content

Even if the quantity of mercury in CFLs is small and it is proposed to lower the limits further (currently 200 CFLs contain 1 g of mercury, according to the Working Document it would be 500 CFLs), the large amount of lamps involved still raise the question of disposal. Indeed

Stakeholders report that EU legislation on recycling of Waste Electronic and Electric Equipment (WEEE) is implemented unevenly as regards CFLs[13] and part of the mercury content of CFLs still ends up polluting the environment in the EU.
The content of mercury in lamps for general lighting is regulated by Directive 2002/95/EC currently under revision; in particular the tolerated concentration limits are specified in the annex to this Directive. These limits, together with all the other exempted applications mentioned in the annex are at present the subject of a dedicated study and extensive stakeholder consultation.[14]

b. Health issues

Some associations of patients suffering from various diseases have reported to the preparatory study consultants that their symptoms are aggravated in the presence of CFLs and also sometimes of other energy saving lamps such as LEDs. These statements have not yet been substantiated by scientific evidence, although they do quote a few UK researchers and doctors who support their arguments. The products in question have already been widely used for decades and comply with health and safety standards set under the Low Voltage Directive (2006/65/EC) and Council Recommendation 1999/519/EC on Electromagnetic Fields. However should those health claims prove to be significant, an option leaving space for an alternative to CFLs might be needed.

[13] The WEEE (Waste Electronic and Electric Equipment) directive (2002/96/EC) requires the Member States and manufacturers to ensure proper recycling facilities and product information on the end of life, however the directive's implementation is reportedly uneven across Europe. Also, people are still largely unaware that CFLs should be recycled at the end of life and that in case of accidental breakage how they should be cleaned up. If CFLs are not recycled they go to the communal waste and are either incinerated or end up in landfills. We can note that waste incineration facilities in the EU are increasingly equipped with filters stopping mercury pollution through the air, and EU legislation on landfills also provides for prevention of mercury leakage to the ground.
[14] http://ec.europa.eu/environment/waste/weee/studies_rohs2_en.htm