EUROPEAN
COMMISSION

Brussels, XXX
[…](2012) XXX draft

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Commission Regulation implementing Directive 2009/125/EC of the European Parliament and of the Council

with regard to ecodesign requirements for directional lamps, light emitting diode lamps and related equipment

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Commission Regulation implementing Directive 2009/125/EC of the European Parliament and of the Council

with regard to ecodesign requirements for directional lamps, light emitting diode lamps and related equipment

Lead DG: ENER

Associated DG: ENTR

Other involved services: SG, ENV, CLIMA, COMP, ECFIN, CNECT, MARKT, SANCO, TRADE, RTD, JRC.

TABLE OF CONTENTS

1. PROCEDURAL ISSUES AND CONSULTATION

1.1 Organisation and Timing

These actions are priorities of the Action Plan on Energy Efficiency[1] and the Energy Efficiency Plan 2011[2] .

The proposed implementing measure on the ecodesign of directional light sources ('DLS') is based on Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the Commission, assisted by a regulatory committee to set ecodesign requirements for energy-related products[3]. An energy-related product, or a group of energy-related products, shall be covered by ecodesign implementing measures, or by self-regulation (cf. criteria in Article 17), if the products represent significant sales volumes, while having a significant environmental impact and significant improvement potential (Article 15). The structure and content of an ecodesign implementing measure shall follow the provisions of the Ecodesign Directive (Annex VII).

Article 16 of the Ecodesign Directive requires the Commission to introduce, as appropriate, implementing measures on lighting in both the domestic and tertiary sectors. Commission regulations 244/2009[4] and 245/2009[5] introduced such measures for non-directional lamps. The proposed implementing measure complements these regulations by introducing ecodesign requirements for directional light sources ('DLS') in both the domestic and tertiary sectors.

The consultation of stakeholders is based on the Ecodesign Consultation Forum as foreseen in Article 18 of the Directive (see next section for details), including the consultation of stakeholders during a preparatory technical study from 2006 till February 2009 in order to assist the Commission in analysing the likely impacts of the planned measures.

Article 19 of the Directive 2009/125/EC foresees a regulatory procedure with scrutiny for the adoption of implementing measures. Subject to qualified majority support in the regulatory committee and after scrutiny of the Council and of the European Parliament, the adoption of the measure by the Commission is planned by mid-2012.

Commission Directive 98/11/EC[6] set mandatory energy labelling requirements on household lamps (with the exclusion of directional lamps) under Directive 92/75/EEC on the energy labelling of household appliances[7] (now replaced by Directive 2010/30/EU on the energy labelling of energy-related products[8]).

Considering that the ecodesign implementing measures expand the scope of EU energy efficiency policy on lighting products to the tertiary sector and to directional lamps, and that

---

1 COM(2006)545 final.
2 COM(2011)109 final.
3 OJ L 285, 31.10.2009, p. 10.
4 Commission Regulation (EC) No 244/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for non-directional household lamps, OJ L 76, 24.3.2009, p. 3, amended by Commission Regulation (EC) No 859/2009, OJ L 247, 19.9.2009, p. 3
5 Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council, OJ 76, 24.3.2009, p. 17, amended by Commission Regulation (EU) No 347/2010, OJ L 104, 24.4.2010, p. 20
6 OJ L 71, 10.3.1998, p. 1
7 OJ L 297, 13.10.1992, p. 16
8 OJ L 153, 18.6.2010, p 1

they are also transforming the market by raising the minimum energy efficiency of lighting products, it is appropriate to replace Commission Directive 98/11/EC with a delegated act under Directive 2010/30/EU, which would introduce a larger scope and a revised scale for the energy labelling of lighting lamps.

The consultation of stakeholders and the adoption procedure are carried out in a delegated act procedure according to Articles 10 to 13 of Directive 2010/30/EU, to the extent possible in parallel and linked to the proposed ecodesign measure.

1.2 Incorporating comments from the Impact Assessment Board

A first draft of the IA report (IAR) was discussed by the IAB on 5 October 2011 by written procedure. In its opinion of 14 October 2011[9], the IAB recommended to provide a clearer explanation of the scope of the problem, in plain language. Section 2.2 on problem definition was amended accordingly, by adding a description of the main lamp types involved, and the market structure analysis in section 2.5.6. was complemented. The reaction to the suggestion to present a better justification for EU action was the addition of concrete data proving the fulfilment of the criteria for action under the Ecodesign Directive in section 2.3. The analysis of the baseline scenario was strenghtened according to the request in section 2.5.8. The alignment of the efficiency requirements to third country legislation and the impact on EU producers was further elaborated in section 5.2.12. It was clarified in Annex 2 what were the sources of data for the assumptions underlying the calculations for the scenario analysis. The impact of the proposed quality standards was analysed more in-depth in section 5.2.6. The indicators were designated in chapter 7 on monitoring and evaluation. Finally, where appropriate, the views of the stakeholders were integrated to the text of the impact assessment (in addition to being discussed in a separate section), for instance in section 5.2.13 on intellectual property rights.

1.3 Transparency of the consultation process

Starting in 2006, the Commission commissioned a study of domestic lighting products, called "Lot 19: Domestic Lighting; Preparatory Studies for Eco-design Requirements of EuP." (in the following called "preparatory study"), carried out by external consultants[10] on behalf of the Commission's Directorate General for Energy and Transport (DG TREN, now DG ENER).

Soon after initiating the Lot 19 study, the Commission made a policy decision to accelerate the analysis of non-directional, general service domestic lamps, which resulted in Lot 19 being split into two parts: part 1 on non-directional household lamps (NDLS) and part 2 on directional lamps (DLS) and household luminaires.

In October 2008, part 1 of the Preparatory Study was finalised, and in March 2009, the Commission adopted Regulation 244/2009. In October 2009, part 2 of the Preparatory Study was finalised, and the Commission started working on developing a proposal regarding energy efficiency requirements for directional lamps.

The preparatory study followed the structure of the "MEEuP" ecodesign methodology[11] developed for the Commission's Directorate General for Enterprise and Industry (DG ENTR). MEEuP has been endorsed by stakeholders and is used by all ecodesign preparatory studies.

---

[9] Ares (2011)1094863 of 14 October 2011.

[10] Tichelen, P. van (VITO) et al., Preparatory study Lot 19: Domestic lighting - Part 2 Directional Lampas and household luminaires, 2009; documentation available on www.eup4light.net

[11] "Methodology for the Ecodesign of Energy Using Products", Methodology Report, final of 28 November 2005, VHK, available on DG TREN and DG ENTR ecodesign websites: http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm

External expertise on directional light sources (DLS) was gathered in particular in the framework of the preparatory study[12], which was developed in an open process, taking into account input from relevant stakeholders including manufacturers and their associations, environmental NGOs, consumer organisations, and EU Member State experts. The consultants provided a dedicated website[13] where interim results and further relevant materials were published regularly for timely stakeholder consultation and input. The study website was promoted on the ecodesign-specific websites of DG ENER and DG ENTR. Open consultation meetings for directly affected stakeholders were organised at the Commission's premises in Brussels on several occasions.

In line with Directive 2009/125/EC[14], formal consultation of stakeholders was carried out through the Ecodesign Consultation Forum, which met in Brussels, 5th of July 2011. The Commission services sent out Commission Staff Working Documents (2 draft measures accompanied by an explanatory note) for ecodesign requirements for DLS and labelling requirements for NDLS/DLS[15]. More details are given in Annex 1.

1.4 Preliminary results of stakeholder consultation

The following summarizes the opinions of the stakeholders at the Consultation Forum. More detailed meeting notes are given in Annex I.

The general approach to set mandatory minimum requirements in the framework of ecodesign and to issue an (updated) energy label for DLS/NDLS was supported unanimously by all stakeholders.

Also the Commission proposal on timing of the minimum requirements in 3 tiers (2013-'14-'16) was generally supported.

There was broad consensus, explicitly by Member States, green NGOs and professional lighting designers and with no contrasting view from industry, that the label and the minimum requirements should be as far as possible technology-neutral.

As regards the ambition level of the COM proposal for minimum requirements, there was a comment from industry, who did not want to include explicit Stage 3 requirements. Some Member States, however, disagreed and wanted to take a clear long-term vision on the ambition level.

No stakeholder – except initially the industry who could eventually agree to the alternative— supported the initial COM proposal to apply a form of the lamp label to household luminaires. The language-free label was indeed too complex and incomprehensible to the users. However, a warning to the users about luminaires that are not compatible with energy efficient lamps was still considered appropriate.

Stakeholders were supportive to include light emitting diode (LED) lamps in the ecodesign measure, but with functional performance requirements to avoid the mistakes from the past with poor-quality compact fluorescent lamps (CFLs). Industry stressed that these requirements should be in line with global legislative practice in order not to have a negative

---

http://ec.europa.eu/enterprise/eco_design/index_en.htm.

12 Tichelen, P. van (VITO) et al., Preparatory study Lot 19: Domestic lighting - Part 2 Directional Lampas and household luminaires, 2009; documentation available on www.eup4light.net

13 www.eup4light.net

14 Further to Article 18 of the 2009/125/EC Directive, formal consultation of stakeholders is to be carried out through the Ecodesign Consultation Forum consisting of a "balanced participation of Member States' representatives and all interested parties concerned with the product group in question".

15 Available on DG ENER's ecodesign website: http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm#consultation_forum.

effect on competitiveness. On the 'if' and 'how' of including LED (integrated) modules the opinions were diverging.

Some Member States raised the issues of a possible health risk of ultraviolet (UV) emissions from certain light sources. It was concluded that the opinion of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) would be taken into account.

On the subject of the regulation of halogen converters, it was concluded that there was in principle no problem, but that the detailed requirements and the test method should be reviewed.

Finally, although there was consensus that the lamp label should be understandable and useful to consumers, there were widely differing opinions on how this was to be achieved. The consumer association advocated a simple 'lm/W' yardstick and additional standardized product information. The light source manufacturers were not supportive, claiming that a simple label would be more effective and standard icons would have a negative impact on the manufacturer's corporate identity. The luminaire manufacturers complained that a label on a luminaire is detrimental to the product's presentation in a showroom and they demanded more options for the dealer. Member States appeared to be more supportive of more information on the energy label and some advocated the use of 'lm/W'.

2. PROBLEM DEFINITION

2.1 Problem

There are two types of lamps on the market: non-directional lamps (e.g. light bulbs) and directional light sources (DLS), which are called in popular terminology **reflector lamps** or **spot lights,** and which direct most of their light (at least 80%) in an angle of 120° or smaller.[16]

Non-directional lamps are already covered by ecodesign regulations 244/2009 and 245/2009. The planned ecodesign regulation covers directional lamps. These are divided into different types based on shape. Table 1 at the end of this section shows examples of the most popular reflector lamp shapes falling within the scope of the planned ecodesign regulation.

Directional Light Sources and related products constitute a significant and fast growing environmental impact and sales volume. There is a wide disparity of environmental performance for functionally comparable products and the preparatory study indicated a significant improvement potential without excessive costs, but - due to market failure and regulatory failure - this potential is insufficiently realised.

The EU-27 annual electricity consumption of DLS in 2007 is around 30 TWh/year, which is comparable to the electricity end-use of a country like Denmark. It is projected to grow to over 50 TWh/year in 2020. This is five times more than the electricity use of DLS lamps in the policy reference year 1990. Over the same period, the related carbon emissions will grow by a factor of 4, i.e. from around 5 Mt CO_2 eq./year to close to 20 Mt CO_2 eq./year.[17].

The main driver for growth is a change in consumer preference (fashion, interior design). Bright 'spot-lights' are increasingly used not only in living room ceilings, wall and desktop fixtures, but also more and more in all sorts of furniture like kitchen-cupboards, clothes closets, bathroom-fixtures, etc. This growth – although for a small part due to displacement of

16 Most available directional lamp technologies (incandescent, halogen, compact fluorescent and light emitting diode) direct their light with the help of a built-in reflector. Some light emitting diode (LED) lamps do not require a separate reflector, as the diodes already provide light in a given direction.

17 Based on 0,5 kg CO_2/kWh in 1990 and 0,4 kg CO_2 eq./kWh in 2020.

non-directional light sources (NDLS) - is primarily expansion-growth, i.e. leading to more light sources per household.

As such the current trend is detrimental to the EU's policy goals on resource efficiency, security of supply and abatement of carbon emissions. It also results in an increase of other pollutants emitted to air, water and soil, linked to electricity production, that have a negative effect on related policy goals.

The preparatory study for this product group identified a saving potential of up to 45% at lowest Life Cycle Costs, minimal payback times and without negative impact on functionality. Consumers could save equally on running costs: the saving could be as much as 4 billion euros in 2020.[18]

In part, these savings will be offset by a higher purchase price, but even when doubling the current 1.3 billion Euro consumer spending on the purchase of DLS, the scenario is still economical. On the business-side the extra consumer spending would mean double revenues and more jobs for the industrial, wholesale and retail sector that invest in energy-saving lamps.

18 In 2010 prices, but at an annual electricity price rise of 2,5% above inflation and an increase from 30 to 50 TWh/year of business as usual consumption between 2010 and 2020.

Table 1: Efficacy levels of popular reflector lamp shapes					
Lamp type		Energy Class			
Voltage	Shape	G-D	D-C	B	A, A+, A++
Mains voltage (230V)	R80	 Incandescent	 Xenon-filled halogen [19]	—	 Compact fluorescent lamp
	NR63	 Incandescent	 Xenon-filled halogen	—	 Light emitting diode lamp (LED)
	MR16	 Conventional halogen	 Xenon-filled halogen	—	 Compact fluo.lamp, LED
Extra low voltage (12V)	MR11	—	 Conventional halogen [20]	 Infrared coated (IRC) halogen [21]	 LED lamp
	MR16	—	 Conventional halogen	 IRC halogen	 LED lamp
Energy saving compared to E class:			10-25%	50%	70-90 %

[19] A halogen capsule filled with heat-retaining xenon gas replaces the simple filament of incandescent bulbs or the conventional halogen capsule. As in reflector lamps, the filament or capsule is usually not visible, the change goes unnoticed even when the filament is replaced by a capsule.

[20] Extra low voltage makes these lamps relatively efficient even without any further improvement.

[21] Invisible special coating ("infrared coating") is applied to the glass of the halogen capsule, which reflects heat back to the filament, further increasing efficiency. The coating can only be applied to capsules with filaments designed for extra low voltage, so IR coated mains voltage lamps would have to be equipped with an integrated transformer that delivers extra low voltage to the filament. Such lamps exist but are very rare.

2.2 Market and regulatory failures

The main market and regulatory failures hampering a larger market penetration of energy efficient DLS were identified in the preparatory study and are as follows:

1. Recent character of new technologies (lack of information, awareness)

In recent years several efficiency improvements and new reflector-lamp types have been introduced on the market and the consumer is not yet familiar with them. Most people are unaware of the difference between the standard type and extra energy saving types with special (IRC) coating or Xenon gas.

This confusion will continue as also non-incandescent technologies such as reflector compact fluorescent lamps with integrated ballast (CFLi-R), reflector high intensity discharge lamps with integrated ballast (HIDi-R) and the first versions of reflector light emitting diode lamps with integrated ballast (LEDi-R) are being offered on the market. These technologies have important energy saving potentials, but may have (still) some functional drawbacks in certain applications that can lead to a bad consumer experience. If these new energy saving technologies are 'pushed' prematurely, it may well have a detrimental effect on their long-term success.

Examples:

- Few people may realize that CFLi-R lamps are only suitable for wide-beam, general lighting applications, but are less or not appropriate as a typical 'spot' (narrow beam).
- The choice of colour temperature – which is currently available in 'cold' (e.g. around 5000 K) or 'warm' (3000K) - is an important feature for customer-satisfaction but often not well understood;
- For HIDi-R lamps in residential applications, the starting time and restrike time of several minutes and the lack of dimmable models are features that not many customers will realize.
- With LEDs, quite apart from the fact that efficiency-improvements and price-reductions are still ahead, there are important issues regarding low light output, 'glare' and colour temperature that may jeopardize the commercial success of this new technology when promoted prematurely as a general incandescent reflector lamp (GLS-R)[22] replacement.

It seems therefore even more important than with Regulation 244/2009 on NDLS that product information requirements should not only address the strict energy efficiency or environmental information[23], but also provide precise information regarding colour temperature, colour rendering, beam angle, equivalence with existing reflector lamp categories and other aspects.

2. Lack of specific policy measures (regulatory failure)

DLS have thus far been an underestimated group of lighting products. The rapid growth and the availability of alternative technologies are of recent date and have thus far largely escaped the attention of policy makers at national, European and global level.

DLS are exempt from the 1998 Lamp labelling directive, nor are they directly addressed in any other current EU legislation relating to energy efficiency.

22 Incandescent bulbs are also called "general lighting service" bulbs, hence the abbreviation "GLS".
23 See current energy label for lamps

The 2010 Recast of the Energy Performance of Buildings Directive (EPBD, 2010/31/EU)[24] mentions lighting as one of the applications to be included in minimum energy performance for new buildings and major renovations and the energy certification of existing buildings. However, requirements are not lighting-specific and it is left to the Member States, who again do not formulate requirements that specifically address DLS.

Similarly, the Energy Services Directive (2006/32/EC)[25] required Member States to adopt national energy efficiency plans and public procurement rules, but lighting is a recommended but not mandatory area of action.

The mercury content of fluorescent lamps is tackled in the RoHS Directive (2011/65/EU)[26], but compact fluorescent (reflector) lamps are an exemption, with mercury tolerated up to 2.5 mg per lamp (5 mg before 2012). Given the current limited market share of CFLi-R (2%), this affects only a small part of sales and –at current technology- all CFLi-R lamps comply.

This cannot be said about compliance with the WEEE Directive (2012/19/EU) [27], set up to handle recovery/recycling of –amongst others - discharge lamps (DLS: CFLi-R and HID-R). Schemes for recycling these products are fairly recent, consumer awareness is low and as a result the recovery rate is estimated to be around 20%.

In voluntary initiatives and individual actions of Member States regarding promotion and financial incentives for more energy-efficient lighting, DLS play only a minor role. Most of the focus has gone to NDLS CFL promotion. And also there - according to the Impact Assessment of Regulation 244/2009 - the effect was limited.

3. Difficult to address with incentives

Much more than with non-directional light sources (NDLS), the aesthetic qualities of DLS play an important role in the purchase decision. This is more difficult to address with the "rational" economic and environmental incentives that are traditionally used in promoting energy efficient appliances.

Actions of a non-legislative nature, such as promoting demonstration projects and R&D funding, might prove to be particularly effective for this product group, actively pursuing solutions that are both aesthetically pleasing and energy-efficient.

But ultimately, policy measures setting minimum requirements might prove to be the most adequate way forward, even more than with NDLS.

4. Affordability

Although overall the payback-time of even the newest and most expensive lamp types is very favourable, i.e. it can be much less than 1 year, affordability is definitely a barrier. The energy saving alternatives to the low voltage halogen lamps may cost up to 2-3 times more : € 7,- to € 8,- per unit instead of € 2,40 for a standard unit. LEDi-R lamps are currently offered at prices up to € 40,- per unit.

A related barrier for energy efficiency is the fact that consumers are not able to consider the overall cost-efficiency of high-efficiency reflector lamps. The purchase price is well visible and is typically higher for more efficient DLS. On the other hand, information on running costs/cost savings is not explicit and can be obtained only with difficulty**.**

5. Split incentives

[24] OJ L 153, 18.6.2010, p 13
[25] OJ L 114, 27.4.2006, p 64
[26] OJ L 174, 1.7.2011, p. 88.
[27] OJ L 197, 24.7.2012, p. 38.

As regards DLS in the tertiary sector, it is common that one budget is responsible for the lighting design and/or purchase of the lamps (and luminaires) but that another budget is responsible for the running cost, whereas the maintenance costs are allotted to a third budget. The budget manager responsible for the purchase cost will not be inclined to have an interest in savings shown in other budgets.

In addition, the efficiency improvements achieved by DLS are often perceived as relatively small compared to the total electricity bill.

6. Negative 'lock-in' effect

The preparatory study identifies the lock-in effect as a possible barrier. It relates to dimensional and technical constraints posed by the luminaire on the lamp and vice versa, either hindering ('negative lock-in') or promoting ('positive lock-in) the use of energy efficient light sources. The 'negative lock-in' may be caused by available space and/or socket types in the luminaire, not allowing energy efficient types. Also electrical wiring may play a role, including for other equipment than luminaires. The preparatory study presents some scenarios 'with lock-in' (less ambitious than scenarios 'without lock-in') that delay minimum energy efficiency requirements for certain lamp-types because there would be no immediate energy-efficient substitute fitting the luminaire and other equipment.

2.3 Eligibility under Ecodesign and EU's right to act

As reported in the preceeding and following paragraphs DLS are eligible for measures under Article 15(2) of the Ecodesign of Energy-related products directive 2009/125/EC[28] (hereafter 'Ecodesign Directive'), possibly in combination with Energy Labelling measures under 2010/30/EU directive[29](hereafter 'Labelling Directive').

According to the Ecodesign directive (Art. 15(2)), products are eligible for measures if they meet the following criteria :

(a) the product shall represent a significant volume of sales and trade, indicatively more than 200 000 units a year within the Community according to the most recently available figures;

(b) the product shall, considering the quantities placed on the market and/or put into service, have a significant environmental impact within the Community, as specified in the Community strategic priorities as set out in Decision No 1600/2002/EC[30]; and

(c) the product shall present significant potential for improvement in terms of its environmental impact without entailing excessive costs, taking into account in particular:

(d) the absence of other relevant Community legislation or failure of market forces to address the issue properly; and

(e) a wide disparity in the environmental performance of products available on the market with equivalent functionality.

28 DIRECTIVE 2009/125/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (recast). OJ L 285, 31.10.2009, pp. 10-35. This is a recast of 2005/32/EC on ecodesign requirements for energy-using products

29 DIRECTIVE 2010/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products (recast). OJ L 153, 10.6.2009, pp. 1-12. This is a recast of Framework Directive 92/75/EC on energy labeling of household appliances (OJ L 297, 13.10.1992, p. 16-19)

30 refers to the Sixth Community Environmental Action Plan (hereafter '6th EAP')

The **sales volume** of directional lamps is estimated at a yearly 330 million units, and is anticipated to grow in the coming years, according to the baseline scenario.

For **environmental impacts,** the lifecycle analysis carried out in the preparatory study using the common Methodology for the Ecodesign of Energy-using Products[31] concluded that energy-use in the use phase was overwhelmingly the single most important environmental aspect in the case of directional lamps. The electricity consumption of directional lamps is estimated to grow to 50 TWh / year by 2020.

The **saving potential** in terms of electricity consumption was estimated to be around 25 TWh/per year in 2020 on the territory of EU-27.

The sales volume is orders of magnitude above the lower limit of a significant volume of sales (200 000 units) as provided in Article 15.2.a. The most significant environmental impact (energy use in the use phase) and the saving potential would represent respectively almost 2% and almost 1% of total electricity consumption in the EU today, which is significant, considering the specificity of directional lamps in the perspective of all electricity using products and installations. Ecodesign and energy labelling measures have been adopted to obtain electricity savings that are just a fraction of this saving potential.

The Ecodesign Directive and, more specifically, its Article 16 provides the legal basis for the Commission to adopt an implementing measure that would tackle the problem defined in the preceding paragraphs.

The legal basis of the Ecodesign Directive is Art. 95 of the Treaty of the European Communities (currently Article 114 of the Treaty on the Functioning of the European Union) concerning the harmonisation of legislation targeting the establishment and functioning of the internal market.[32] It uses 'CE marking' of products brought on the market by manufacturers as the operational implementation instrument.

The legal basis of the Energy Labelling Directive is the new Art. 194 on energy policy of the Treaty on the Functioning of the European Union TFEU[33].

2.4 Subsidiarity and proportionality

The principle of subsidiarity as is defined in Article 5 of the Treaty establishing the European Union intends to ensure that decisions are taken as closely as possible to the citizen; the Union should take action only in areas which fall within its exclusive competence and which do not lead to a more effective action if taken at national, regional or local level.

It is to be expected that Member States may want to take individual (non-harmonised) action on directional light sources to speed up the increase in their energy efficiency. This possibility, in the absence of EU action, is strengthened due to the continued introduction and tightening of minimum requirements in third countries. Such action would hamper the functioning of the internal market and lead to high administrative burdens and costs for manufacturers, in contradiction to the goals of the Ecodesign Directive.[34]

Such individual Member State action would be taken closer to the citizen but would fail in ensuring level playing field in the internal market. Measures introduced under the Ecodesign

---

31 http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/methodology/index_en.htm

32 Council of the European Union, Consolidated versions of the Treaty on European Union and the Treaty on the functioning of the European Union, (2010/C 83/01) O.J. C 83/389 of 30.3.2010. The Treaty on the European Communities (TEC) was replaced by the TFEU which entered into force on 1st of December 2009, following the Lisbon Treaty of Lisbon 13 Dec. 2007.

33 Ibid.

34 The likelihood of such Member State action is assessed in Annex 13.

and Energy Labelling Directives help bringing down barriers and simplifying existing rules to enable everyone in the EU - individuals, consumers and businesses - to make the most of the opportunities offered to them by having direct access to 27 countries and 480 million people. The Consultation Forum meeting has shown unanimous Member State approval for EU wide regulatory framework for DLS.

Under the principle of ***proportionality***, the content and form of Union action shall not exceed what is necessary to achieve the objectives of the Treaties.

The EU will respect this principle as it will limit itself only to setting the legislative framework. As far as certain aspects of the implementation are concerned, i.e. market surveillance and monitoring, EU action is not necessary to achieve the objectives, as Member States assume these responsibilities under the Ecodesign Directive. Again, this was confirmed by the response of Member States and other stakeholders during the Consultation Forum.

2.5 Baseline scenario

The preparatory study on directional light sources provided a technical, environmental and economic analysis. The study provided amongst others, the following key-elements:

- Description of the product scope;
- Annual sales with projections up to 2025, the installed base ('stock') and a definition of the average DLS product-mix ('basecase);
- Lighting demand (in Tera-lumen per year) for DLS with projections up to 2025, based on continuation of the current trends in penetration rate, lumen output and burning hours per DLS lamp type, evolution of population and housing stock, etc.;
- Environmental analysis of basecase appliances, identifying the main environmental parameters over the product life and including the relationship between environmental parameters like annual electricity consumption, emissions from fugitive and end-of-life mercury, etc.;
- Description of technologies relevant for the environmental saving potential, i.e. boosting resources efficiency and reducing the environmental impacts, and their incremental costs compared to the current basecase.

The 2008-2010 economic crisis has been taken into account, but there is anecdotal information suggesting that the DLS market has suffered less (if at all) from the economic crisis than most other consumer good markets because there was an ongoing upward market trend in consumer preferences.(see par. 2.7 on Sensitivity analysis)

The following sections describe in more detail the inputs used to define the baseline scenario for calculating future economical and environmental impacts.

2.5.1 Product scope and technical parameters

The scope was decided on the basis of the Ecodesign Directive Articles 15 and 16[35]. The scope and product categorising were refined during the preparatory study together with stakeholders in search for a functional approach[36]. Important decisions concerned the inclusion of LED[37] directional lamps and LED-retrofits and the inclusion of functional performance characteristics in order to avoid possible consumer dissatisfaction with this

[35] In particular Point 2 of Article 16.
[36] Ecodesign Directive Article 15, Point 2(ii).
[37] LED: Light Emitting Diode

promising energy-efficient technology. For DLS and related products a 'special purpose' category, i.e. not intended for illuminative lighting, is foreseen.

As regards the category of 'related products' it was decided to include halogen converters, used predominantly with extra low voltage (ELV)[38] halogen spots, and also other types of lamp control gear for a more limited no-load energy consumption requirement. Lighting equipment with a negative lock-in effect, in particular luminaires (see par. 2.2, point 6) will also be addressed.[39] Given the nature and impact of the measures and in order to reduce the administrative burden, the measures for these related products are incorporated in the ecodesign provisions for DLS and in the energy labelling provisions for lamps.

2.5.2 Sales volume

DLS represent unit sales of around 330 million units per annum[40]. On a total of ca. 2800 million units of all lamp types sold in the EU-27 this is less than 12%, but at an average consumer price of around € 4 it still constitutes a turnover in consumer prices of ca. € 1,3 billion. And the market for reflector lamps is still growing.

Growth is at a pace of 1 extra reflector light source per household every 5 years (15% annual growth rate). For 1995 the preparatory study reports 2 out of 21,3 lights in the house to be reflector lamps (1,5 GLS-R and 0,5 HL-R-LV). In 2005 this number has doubled to 4 out of 24 lights and for 2020 it is believed that the average household will use 7 reflector lamps.

In total, for all sectors, the preparatory study estimates an EU-27 stock of 1,1 bln. installed reflector lamps in 2007, growing to 1,66 bln. units in the 2020 baseline scenario ('BAU').

2.5.3 Lighting demand

The preparatory study proposes as the functional parameter (FP) for the impact analysis of DLS the luminous flux in lumen per hour (lm.h).

The preparatory study has constructed a baseline ('BAU') scenario 2007-2020, built on a simplified analysis of representative models in the 4 main base-case categories:

- incandescent reflector lamps (GLS-R)
- high-wattage halogen mains-voltage reflector lamps (HL-MV-R-HW, >80W, 230 V),
- low-wattage halogen mains-voltage reflector lamps (HL-MV-R-LW, <80W, 230 V),,
- halogen low-voltage reflector lamps HL-LV-R.

In particular the study has, amongst others, provided the following key elements:

- A set of definitions of lamp characteristics and operating conditions applied for the 4 categories, averaged for all sectors (ca. 75% residential, 25% other);
- A stock model ("installed lamps"), based on the projections for the penetration per dwelling and number of dwellings;
- Annual sales, derived from the stock model and based on typical product life per category;

[38] e.g. 12V or 24V, converted from mains-voltage 230 V.

[39] E.g. for luminaires that through socket-type (e.g. G9, R7s and possibly GU10) and/or available space for the light source would not be suitable to host an energy-saving lamp.

[40] ELC 2006: 244 mln., others 86 mln. For EU-27, all sectors in the preparatory study:

In the impact analysis the model has been extended backwards to the reference year 1990 (reference for Kyoto Treaty and "20-20 in 2020" target) and forward to the year 2025. Furthermore, some minor corrections to improve consistency were implemented.

The structure of the methodology of the technical, environmental and economic analysis is contained in Annex 2.

The graph below shows the total lighting demand, expressed in the functional unit of Tlm ('Tera lumen'= 10^{12} lumen) per year, covered by reflector lamps of the 4 types.

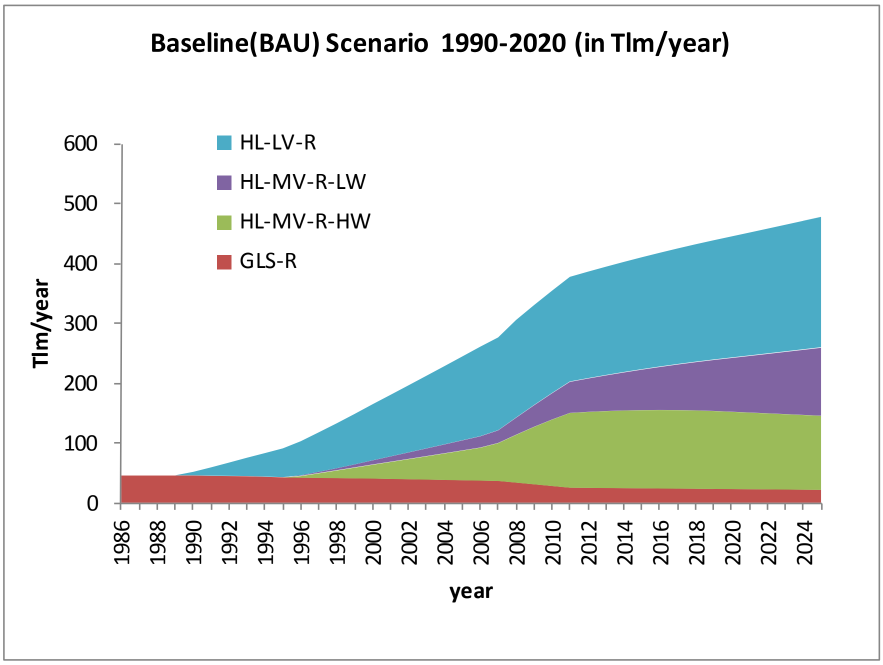


Fig. 1. Reflector lamp: Baseline luminous flux demand in Tlm/yr.

The baseline projection builds on the existing trend whereby the penetration of luminaries for reflector-lamps is growing at a pace of 1 new lamp per household in every 5 years. Today (2011) the lighting demand of DLS is over 350 Tlmh/year (10^{12} lumen hour per year).

More quantitative data can be found in the summary table.

2.5.4 Environmental impact

The preparatory study identified electricity consumption, as well as GHG and other emissions linked to electric power generation (including mercury) as the most important environmental impacts.

The annual electricity consumption is projected to grow from around 30 TWh/year in 2007 to 50 TWh/year in 2020. This is significantly higher than the electricity use of reflector lamps in the policy reference year 1990, i.e. around 10 TWh/year.

Carbon emissions in the EU-27 in the year 2007 are estimated at 12-13 Mt CO2 eq.[41], running up to 18-20 Mt in 2020.

The environmental analysis in the preparatory study shows that 80-90% of the environmental and lifecycle cost impacts are attributable to the use-phase (operation of DLS). Only for the PAH[42] emissions (from diesel engines in transportation) the distribution phase was more

[41] Carbon dioxide (CO_2) equivalent of greenhouse gas ('carbon') emissions

[42] PAH: Polycyclic Aromatic Hydrocarbons.

important. For dust (PM[43]) and eutrophication (EP) the impact in the end-of-life phase was comparable to that in the use phase.

Figure 2 illustrates the outcomes of the analysis for GLS-R but is similar for all basecase types.

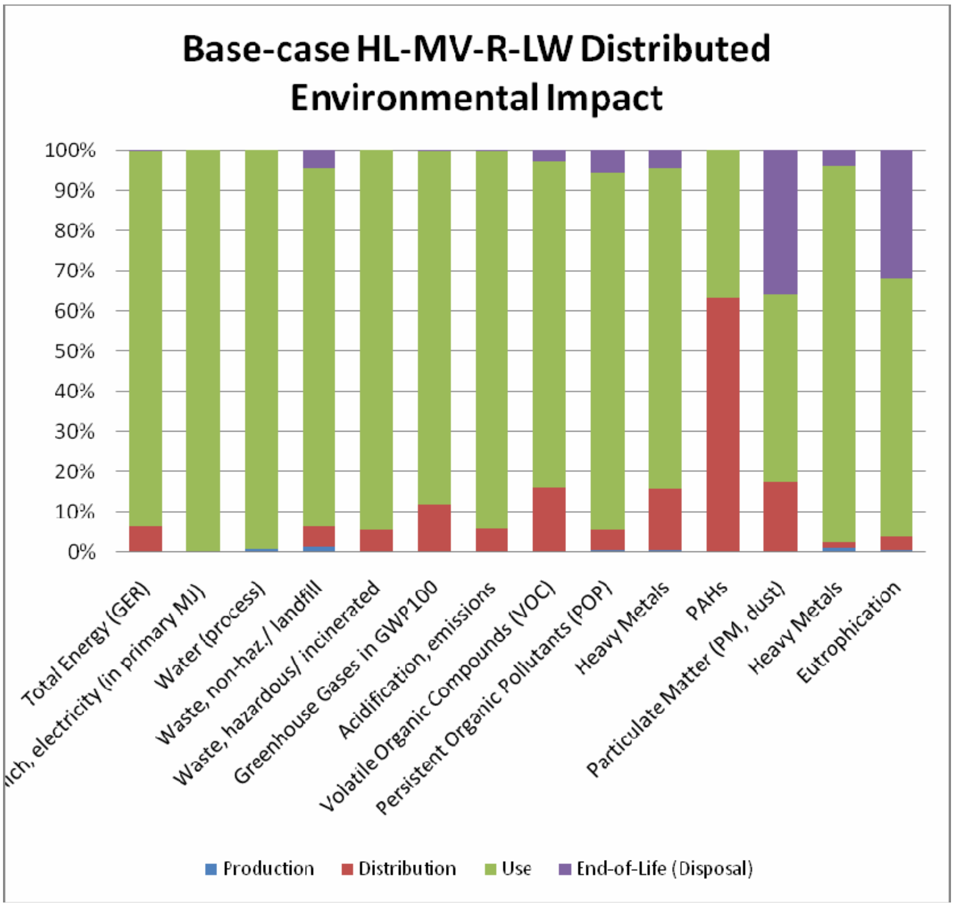


Fig. 2. Environmental impacts GLS-R

Mercury (Hg) emissions at end-of life, due to the mercury content of fluorescents and an incomplete recovery rate, were a subject of discussion with NDLS, but with DLS the impact is much less. Only a few market-niche lamp types - CFLi-R and HID-R lamps —contain mercury emissions. Not only is this impact covered by other relevant Community legislation[44], but also the impact is very small. CFLi-R lamps constitute 2% of reflector lamp sales. At the pre-2012 RoHS maximum Hg-content of 5 mg/unit, the EU-27 sales of 6 million CFLi-R units/year do not contain more than 30 kg Hg (0,03% of EU-27 total[45]) . The Hg-emissions to the environment would constitute a non-recoverable fraction thereof (e.g. 80%, which equals 24 kg Hg/year or 4 mg/CFL-lamp).[46] The mercury emissions of power generation for the electricity consumed by DLS (currently at 0,016 mg Hg/kWh) are around

[43] PM: Particulate Matter. EP: Eutrophication Potential

[44] Regulated through the RoHS directive, setting a maximum mercury content on CFLs of 5 mg/lamp, and the WEEE directive that aims to regulate the disposal and recycling of the lamps

[45] Source: European Environmental Agency (EEA) 2010, Total mercury emissions 89 t/year (EU-27, 2007)

[46] These figures would be substantially lower if the analysis was carried out using the 3.5 mg Hg limit applicable from 1 January 2012 or the 2.5 mg Hg limit applicable from 1 January 2013. The new limits resulted in an even larger drop of mercury content observed in CFLs. According to certain consumer tests they contain today less than 1 mg of mercury.

600 Hg kg/year[47]. Hence, even if the End-of-Life mercury emissions of HID-R lamps are estimated in the same order of magnitude as CFLi-R, the use phase plays a much more important role.

2.5.5 *Saving potential*

There is a wide disparity in reflector lamps as regards electricity use and there is no specific EU legislation tackling the energy and environmental impact of DLS.

Energy savings and greenhouse gas (GHG) emission abatement are possible through a shift from GLS-R and conventional HL-R lampsto improved HL reflector-types, using a different gas (Xenon) technology, optimised design of filament wire, dichroid or silver reflectors, better reflective coating, infra-red coating (IRC).

Further penetration of CFLi-R types for widebeam applications, transition of HID types also in residential applications and a timely promotion of new LED technology are other means to realize the energy saving potential.

Applying the most efficient technology at the lowest Life-Cycle Costs (LCC) in certain circumstances would yield payback times measurable in months rather than years. In the BAT[48] scenario the saving potential would be in the order of 25 TWh/year (50%) with respect to the 2020 baseline. For GHG emissions this would result in a reduction of ca. 10 Mt CO2 eq. per year.

These savings are calculated versus the 2020 baseline. Versus the policy reference year of 1990 there would be no absolute saving, because the market for reflector lamps has been growing rapidly over the last two decades and is foreseen to do so in the near future.

2.5.6 *Market structure, actors and employment*

Currently the reflector lamp industry is dominated by a handful of global general manufacturers such as Philips (NL), Osram (DE), General Electric (US) and global specialists such as Megaman (China, specialist in CFLi-R). The most likely reflector lamp retailers are DIY-stores, lighting specialists, larger supermarkets. Some hardware stores and general household appliance retailers also keep reflector lamps in stock. About 80% of the lamps are purchased for households and 20% for professional applications (largely retail and HORECA).

In Europe the lamp manufacturers are represented by ELC, who report that their members employ 50.000 staff and have a turnover of € 5 bln. in the EU.

Based on the employment data in the Impact Assessment study on NDLS it is estimated that the employment related to reflector lamps is comparable to that in NDLS, i.e. around 8.000 employees. Important production sites are in Belgium, Germany, France, Czech Republic, Poland.

The EU-27 2010 turnover of reflector lamps in manufacturing selling prices (msp) is estimated at ca. 660 million, based on the assumption that the msp is around 40% of the consumer price including taxes.[49] This equals around 13% of ELC's total turnover. In terms of employment it would mean around 6000 to 7000 EU-27 industry jobs. To this, the OEM-jobs (suppliers) have to be added. It should be noted that this is only a fraction of the total employment, as the industry tends to outsource most of its production mainly to Asia.

---

[47] Based on ca. 35 TWh/year (35 x 10^9 kWh).

[48] BAT: Best Available Technology.

[49] See Impact Analysis NDLS, European Commission Staff Working Document, accompanying Commission Regulation on NDLS, 2009.

Luminaire manufacturers are represented at EU level by CELMA. It unites 19 manufacturers associations from 13 EU countries with over 1.000 companies (mainly SMEs), 107.000 people employed in Europe and a € 15 billion annual turnover in Europe. CELMA has an important stake also in lamp measures.

The retail and wholesale sector for reflector lamps in the EU-27 is estimated at around 300-350.000 companies. This estimate is based on an EU-25 proprietary analysis of national and EU NACE statistics. The most likely lamp outlets are DIY-stores, lighting specialists, the non-food section of larger supermarkets (>100 m2). There might also be some hardware stores and general household appliance companies that keep reflector lamps in stock. The table below gives an overview of the number of companies.[50]

The added value of reflector lamps for the trade sector is assumed at 43% of sales in consumer prices, resulting in around € 700 mln. for 2010. The total added value of the trade sector in the EU-27 is 11% of GDP, i.e. around € 1.300 billion[51]. So reflector lamps represent 0,054% of the trade total.

Employment in the trade sector is 31 million jobs. Partitioning on the basis of revenue, this means that around 17.000-20.000 retail/trade jobs depend on reflector lamps.[52] These figures imply € 41.000 added value and € 96.000 turnover per employee in the trade sector. To this, jobs in physical distribution (transport) and wholesale have to be added, arriving at a total of 22.000 jobs, mostly –more than 85% according to Eurostat data—with Small and Medium sized Enterprises.

The trade sector is represented at EU level by Eurocommerce.

Table 2: Retail outlets EU-25, ca. 2005 *(source VHK analysis of Member State and Eurostat NACE statistics)*

NACE number & Descriptions	No. of companies
52.113 Superettes (100 m2 - 400 m2)	50192
52.114 Supermarkets (400 m2 - 2500 m2)	124985
52.115 Hypermarkets (>2500m2)	15213
52.121 Other department stores, non-food (>2500m2)	1772
52.122-129 Retail sale in non-specialized stores n.e.c.	18703
52.444 Stores for lighting equipment	4650
52.445 Stores for household appliances n.e.c.	17408
52.461 Stores for hardware, plumbing and building materials	94522
52.462 Do-it-yourself / paint stores	37982
Total	365426

The national government tax offices collect the taxes and levies. In the scenario calculations some 19-20% VAT and taxes were assumed on top of the consumer price without taxes. This translates into around 17% of sales, i.e. around € 280 million in 2010.

The running costs of reflector lamps in the EU are € 6,21 bln. in 2010. This represents around 2% of the gross revenue of the electricity companies, represented at EU level by Eurelectric.

50 Note that one company may own several outlets. On the other hand, a part of the population may choose not to have reflector lamps on stock, which together makes for the estimate of 250-300.000 outlets.

51 Source www.eurocommerce.be

52 Total employment data are based on Eurocommerce data. Note that the figure of € 41.000 added value per employee is used in the analysis of suboptions.

As mentioned in Table 1, the total consumer expenditure in 2010 is estimated at a total of € 7,87 bln. in 2010. Per capita this comes down to ca. € 16 and per household close to € 40,-. Consumer associations are represented at EU level by ANEC/ BEUC.

Other relevant stakeholders are the green NGOs (e.g. ECOS) and of course the Member States.

2.5.7 Extra-EU Legislation

In a 'no policy change' baseline scenario the developments outside the EU-27 are important, because they may lead to 'dumping' in a 'no policy change' scenario, i.e. if manufacturers in global production centers (mainly Asia) are faced with MEPS in important export markets banning certain low-efficiency products there is a probability that they will try to compensate the overcapacity of their production lines by exporting to the EU-27 at low prices.

The international dimension is also important in the context of WTO obligations and to avoid a negative impact on industry which predominantly consists of global players. Globally there are four countries that have MEPS for DLS: US, Canada, South Korea and Australia. The legislation in these countries is discussed in detail in Annex 4, whereby it is also explained how the various target levels were corrected for a fair comparison. (see also section 5.2.12 on impact on trade).

2.5.8 Baseline summary

The main outcomes of the baseline ('BAU', Business-as-Usual) scenario are summarized in the Table 2 below.

Table 3: Directional Light Sources: EU-27 Key figures 'Baseline'

	1990	2000	2007	2010	2020
Average DLS/dwelling	1,8	3,19	4,53	5,31	6,58
DLS bln. installed	0,4	0,75	1,1	1,3	1,7
Tlmh/yr. (light demand)	51	164	276	354	477
TWh/yr. electricity use*	10	20	30	39	50
Mt CO2/yr	5	9	13	17	19
€ bln. electricity**	1,5	3,1	4,6	6	7,7
€ bln. purchase**	0,3	0,6	1,3	1,6	2,1
€ bln. total consumer expenditure**	1,8	3,7	5,9	7,6	9,8

*excluding transformers and drivers. In 2007 they accounted for ca. 5% (30,3 TWh/yr. excluding, ca. **32 TWh/yr** including transformers and drivers)

**= in € 2005 (inflation corrected.

In summary, the baseline scenario shows that the installed stock of directional lamps will continue to grow fast in the coming years, and without intervention, the related electricity consumption will also grow proportionally, increasing the environmental impact of directional lighting.

2.6 Future trends

General future trends have been discussed in the previous paragraph on the Baseline scenario. Hereafter the trends are discussed in more detail per lamp type.

It is foreseen that GLS-R lamps will continue to be replaced by halogen lamps. The preparatory study estimates that GLS-R unit sales market share (and stock) will evolve from 30% (stock 26%) in 2007 to ca. 16% (stock 11%) in 2020.

So far, the halogen low voltage reflector lamps (HL-LV-R) are the most popular and –at a market share of 53%-- have long surpassed the GLS-R lamps. In 2007 the HL-LV-R stock amounted to 53% of total reflector lamps, but already the 36% unit sales share in that year shows that this type is losing grounds. For 2020 it is foreseen that HL-LV-R lamps constitute 44% of stock and 34%.

In recent years there is a trend towards mains voltage halogen reflector lamps (HL-MV-R). The latter do not need a transformer and thus can be easily used as retrofits for originally GLS-R fixtures. In luminaires they facilitate a simpler (cheaper) construction than HL-LV-R fixtures, while at the same time offering the same attractive light output as low-voltage halogens.

In terms of energy efficiency the increasing popularity of HL-MV-R is not a positive development: while low-voltage halogens are some 30% more efficient than GLS-R, the efficacy of most standard mains voltage halogens is comparable or only slightly (ca. 10%) better than GLS-R.

The preparatory study anticipates that in a baseline scenario the market share of lower wattage HL-MV-R-LW lamps (<80W) will increase from 18% of unit sales (11% of stock) in 2007 to 38% of unit sales in 2020 (31% of stock).

The share of higher wattages, i.e. HL-MV-R-HW (>80W), is estimated to be more stable at around 10% (2007) to 13% (2020) of stock and 16% (2007) to 12%(2020) of unit sales. This type of lamp is more typical of non-residential applications (shops, restaurants).

As regards the newer lamp types (CFLi-R, HIDi-R, LED) the preparatory study has chosen a conservative approach for its ‘no policy’ baseline scenario. It is acutely aware of current functional drawbacks of these technologies and estimates that a significant consumer uptake without any supporting policy measures might still be a few years away (see also sensitivity analysis hereafter). For that reason it was decided to keep the baseline scenario simple and include only the incandescent/halogen base-cases.

A task report of a follow-up study to the preparatory study[53] looked at future trends in more detail, interviewing manufacturers, visiting trade fairs, comparing LED prices in shops and went through US research reports. The main message is that, despite some minor barriers still ahead, LED lamps are definitely perceived by industry as “The Future”.

Thermal management of LEDs and the heavy diffuser blocks that currently go with it, may be an obstacle in some applications that require minimal volume and very low lamp weight (e.g. G9 or smaller). The sometimes low precision of colour temperature reproduction (expressed

[53] Study commissioned by the United Kingdom’s Department of Environment, Food and Rural Affairs, by the Swedish Energy Agency, and by the European Council for an Energy Efficient Economy, entitled ‘Technology prospects of directional lamps’, March 2011. The study was carried out with the agreement of the European Commission, and involved similarly large-scale stakeholder consultation as the preparatory study itself. See more details in Annex 5.

in MacAdam ellipses) in mass produced LEDs is a minor issue to be fixed. The quality and product-life of LED-drivers is an issue. The overall light quality, or rather the consumer satisfaction with LED as halogen-retrofit, is another R&D subject.

And naturally the largest obstacle is still the relatively high purchase price of quality-LED lamps.

The follow-up study looked at prices for LEDs in US shops and found more or less the same price levels as in the EU. According to US DoE reports the strict production costs of LED-lamps are set to go down dramatically in the coming years, but consumer prices, although certainly low enough to make LEDs economically attractive, are likely to stay relatively high for still some time to come.

The biggest driver for LED is the lighting efficacy: The follow-up study mentioned two LED companies now claim they will be ready by 2010 Q4 to market cool-white LED packages with an efficiency of 160 lm/W. This achievement, when commercialised, will give lamp manufacturers the opportunity to push to even higher efficiencies in their products, probably within two years (on store shelves by 2013).[54]

Until the LED market reaches maturity, manufacturers of other lamp types –like halogen incandescents or CFL - believe there is plenty of room to flourish. But on the really long run (>10 years) it is possible that HID-lamps and especially Ceramic Metal Halide lamps will be the only DLS type to survive alongside LED. Unfortunately, most lamp manufacturers still restrict their distribution effort in HID to non-domestic applications.

2.7 Sensitivity analysis

How robust are the projections in the baseline scenario? First of all, it must be mentioned that the data availability for this sector is poor. This is not only due to the 'usual' confidentiality issues, but also because the DLS have largely been ignored from an energy perspective by most stakeholders. As a result, not only market data but also technical data regarding efficacy and light distribution are difficult to find and a large part of the underlying analysis had to be based on anecdotal rather than systematic information. An extra difficulty is introduced by the fact that DLS projections relate to both the domestic and the tertiary sector, which makes projections of sales and stock more uncertain. The follow-up study referred to in section 2.6 suggests that due to this, the sales and stock of DLS may have been underestimated in the preparatory study. Increasing those values would only reinforce the beneficial impact of any measure improving the energy efficiency of DLS. This impact assessment opted for a prudent approach, ie. historical trends in households were also applied to DLS in the tertiary sector.

Economic Crisis

In several consumer product sectors the 2008-2009 crisis has led to drops in sales up to 20 or 30% (air-conditioners, boilers, etc.). Sales data for reflector lamps over this most recent period are not available, but there is no evidence –not even anecdotal—that the projected growth path of reflector lamps has suffered from the crisis. This may be explained by another trend, where people go out less and spend more time entertaining indoors, giving more attention to certain elements of interior decoration (like lighting).

More in general, economic considerations play a limited role in the purchase decision.

If economics and environmental considerations were the overriding purchase arguments CFLi-R market penetration would be much higher than the current 2%, considering the fast and large return on investment when upgrading from GLS-R or HL-R (see Annex 12).

[54] For a warm-light LED with good colour rendering 120 lm/W may be more realistic [ed.].

In other words, the current projections in the baseline scenario will not change notably under the influence of e.g. electricity rates and also the influence of the economic crisis is not expected to affect the baseline projections in a very significant way.

In fact, the reduced spending power of consumers is more likely to confirm the conservative nature of the baseline scenario, which does foresee a growth, but mainly of the existing, cheaper product types such as halogens.

Functionality

The development of prices and functional characteristics of the newer reflector lamp technologies constitute a main uncertainty. For CFLi-R and HIDi-R types no drastic changes are expected. Both types will find and possibly increase their own niche markets in wide beam applications (CFLi-R) or tertiary sector/shop-floor applications (HIDi-R). A novelty is that the preparatory study also sees a place for HID in the residential sector, which so far has largely been neglected by HID-producers. Of course the long warming up and restrike time as well as its reduced dimmability limit its applications, but it may well become a new inspiration e.g. for uplighter designers, looking to compete with the energy-consuming halogen torchieres.

For LEDi-R types the situation may be different. If the industry succeeds in improving the LEDi-R lamps in terms of efficacy (lm/W), colour temperature (Tc in K), excessive glare (e.g. characterised by peak intensity), colour rendering (CCI in Ra or a better measure), colour deviations (number of MacAdam ellipses) and can drastically reduce its price level, this might seriously disrupt – in a favourable way for the energy efficiency- the baseline prognosis.

Yet, there is a wide disparity in opinions on the LED Roadmap between policy makers, lamp manufacturers and luminaire manufacturers. Some may claim that the product is ready today to substitute all existing reflector lamp applications, whereas many lighting professionals see definitely problems that –in their opinion—will take at least half a decade to solve. Also the preparatory study signals these problems and estimates that LEDi-R lamps will certainly not be ready before 2013 as a mature generally applicable GLS/HL substitute.

The US DoE 2010 Multi-Year Program Plan contains projections for ‘Cool White’ LED package prices going down to $ 2,- per klm (kilo-lumen) in 2015[55], but individual experts doubt that future price drops will be dramatic.[56] See also Annexes 4 and 5.

What becomes clear, is that there is uncertainty regarding a possible LED-breakthrough on the market. Market research reports speak of a 2007 global HB (High Brightness) LED lighting market of $ 340 mln. in 2007, expecting to rise tenfold in 2013.[57] Taking the EU as 25% of that market and assuming current market prices, it is estimated that EU-27 unit sales in 2007 may have been around a negligible 2 mln. LED units and could be as much as 30 million units in 2013. A part of this will be reflector lamps (say 30%), which means that the maximum error in unit sales for the baseline projection is around 3%. In terms of electricity consumptions, a LED-breakthrough may alter projections by 10%.

Trends in lighting design

Currently most reflector lamps can be found in kitchens and bathrooms, with the odd spot-light illuminating a painting or two in the living room. But clearly, lighting designs with built-

55 US Dept. of Energy, Multi-Year Program Plan Solid-State Lighting Research and Development, March 2010.

56 Pers.comm. Kate Conway, www.ledsconsulting.com

57 Strategies Unlimited, The Market for High-Brightness LEDs in Lighting: Application Analysis and Forecast 2010. (Announced).

in reflector-lamp downlights have also invaded many living rooms and studies, replacing the classic lay-out of suspension fixtures at central spots (dining room, parlour). Annex 10, illustrating market trends in the Netherlands, sketches a picture where DLS might well surpass NDLS in number in the residential sector.

Depending on the extent to which this trend will become the standard in Europe in the future, it might well lead to an underestimation of the electricity consumption in the baseline scenario.

Commercial sector reflector lamps

As mentioned, the baseline scenario incorporates all sectors, including the reflector lamps being sold in the commercial sector (shops, restaurants). This simplification was necessary for reasons of data availability. However, assuming that the commercial sector will behave with the same market mechanisms as the residential sector, might lead to errors. For instance, the number of annual operating hours is much higher (1800 instead of 400-550 h [58]), which leads to different economics. The buyers are ‘professionals’ and/or advised by ‘professionals’, which means that they may be much quicker to adopt –within often very high aesthetic and performance standards—the most (economically) rational solution. And there are very obvious differences, i.e. the fact that the ceiling height and lighting level requirements can be (much) higher than in residential dwellings.

Especially because of this latter issue, it is estimated that the high-wattage (>80W) halogen reflector lamps (HL-MV-R-HW) will predominantly be a category for the commercial sector. And as such it may be much faster than households to adopt e.g. new HIDi-R or LEDi-R reflector lamps. If this happens, the projections for HL-MV-R-HW may look very different. Currently they contribute 20-25% of the electricity consumption totals, but this may well drop to less than half.

Conclusion

Based on the above, the accuracy of the baseline scenario in predicting the electricity consumption of reflector lamps in 2020 is estimated not to be higher than ± 20%.

2.8 Risk Assessment

For a sector like DLS which is going through turbulent times, there are also many risks involved in policy measures. There is an almost irreversible risk in pre-mature market forcing as regards an imprudent market push of LED-lamps without proper quality standards, which the measures are trying to anticipate by setting those quality standards and by introducing an intermediate review that can take into account the latest developments in the field.

Having said that, there are no risks grave enough to qualify for the conditions that would warrant a Risk Assessment as specified in the EU IA Guidelines.[59]

3. Objectives

As laid out in Section 2, the preparatory study has confirmed that a large cost-effective potential for reducing electricity consumption of DLSs exists. This potential is not captured, as outlined above. The general objective is to develop a policy which corrects the market failures, and which:

58 Preparatory study

59 European Commission, Impact Assessment Guidelines, SEC(2009)92, 15 Jan. 2009. Note that a risk assessment will only be necessary when: there is a non-zero probability that a certain adverse event or development will occur AND it is not predictable who will be (worst) affected AND the negative consequences for certain parties (individuals, businesses, regions, sectors) will be very serious (invalidity, mortality) and irreversible.

– Reduces energy consumption and related CO_2 and pollutant emissions due to DLS following Community environmental priorities, such as those set out in Decision 1600/2002/EC or in the Commissions European Climate Change Programme (ECCP);

– Promotes energy efficiency hence contribute to security of supply in the framework of the Community objective of saving 20% of the EU's energy consumption by 2020.

The Ecodesign Directive, Article 15, requires that ecodesign implementing measures meet all the following criteria:

- there shall be no significant negative impacts on the functionality of the product, from the perspective of the user;
- health, safety and the environment shall not be adversely affected;
- there shall be no significant negative impact on consumers in particular as regards affordability and life cycle cost of the product;
- there shall be no significant negative impacts on industry's competitiveness;
- in principle, the setting of an ecodesign requirement shall not have the consequence of imposing proprietary technology on manufacturers;
- no excessive administrative burden shall be imposed on manufacturers.

As regards the operational objectives it is clear that the 2020 time horizon, used in several overarching policy objectives for energy security of supply and environment, is very important. Savings in 2020, with respect to the reference year 1990, will indicate the relative contribution of measures.

4. Policy Options

4.1 Option 1: No policy change ('baseline')

This option would have the following implications:

– The market failures would persist, and only very slowly the consumers would become aware of the advantages and disadvantages of the different types. The impact of this option is described in more detail in Section 2.

– It is to be expected that Member States may want to take individual non-harmonised action on DLS efficiency. This possibility, in the absence of EU action, is further reinforced due to the rapid introduction of minimum requirements on DLS in third countries across the world. This would hamper the functioning of the internal market and lead to high administrative burdens and costs for manufacturers, in contradiction to the goals of the Ecodesign Directive.

– The specific mandate of the Legislator would not be respected.

Therefore this option is discarded from further analysis.

4.2 Option 2: Self-regulation

This option would have the following implications:

– No initiative for self-regulation on DLS has been brought forward by any industrial sector.

– Industry has called for a clear legal framework ("level playing field") ensuring fair competition, while voluntary agreements could lead to competitive advantages for free-riders and/or non-participants to the "self-commitment".

– The specific mandate of the Legislator would not be respected.

Therefore this option is discarded from further analysis.

4.3 Option 3: Energy labelling targeting DLS

This option would include specific labelling of DLS efficacy through an update of the existing Lamp Energy Labelling Directive (98/11/EC). This option would imply the following:

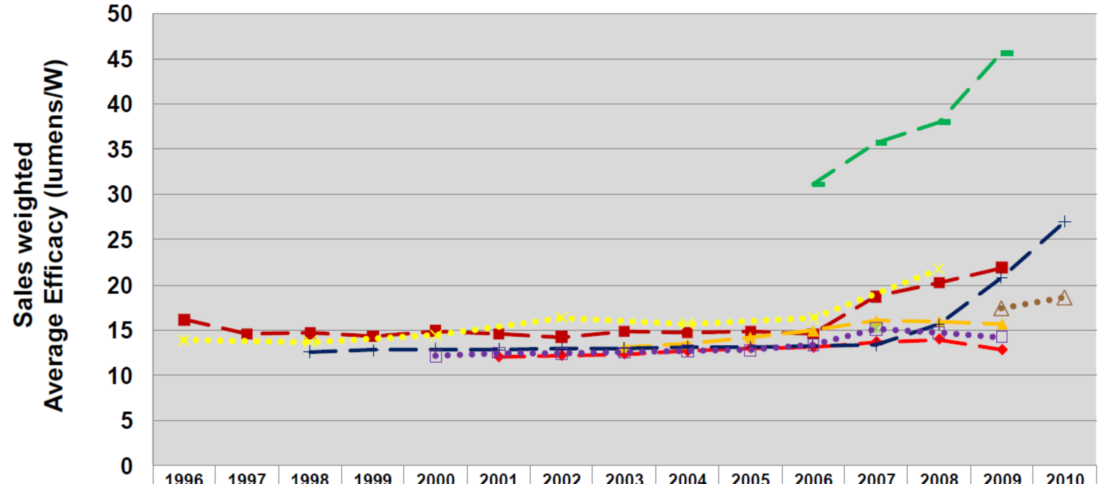
– In general, two main objectives of labelling schemes are to increase the market penetration of, in this case, energy efficient products by providing incentives for innovation and technology development, and to help consumers to make cost effective purchasing decision by addressing running costs. The first aspect is especially relevant, because of the many new technologies that are available.

– Furthermore, the energy label would be an ideal vehicle to inform the consumers on the performance characteristics of the new(er) technologies.

However, a policy option that relies only on labelling would not be sufficient. Especially with DLS many possible buyers are relatively insensitive to apparently 'rational' economic and environmental arguments. They are confused by the higher purchase price of the efficient alternatives, in spite of the high return on investment in almost every case. These buyers would not be reached by labelling alone. The quantitative effect of 'labelling only' scenario can be derived from the generic 1998 Lamp Energy Label under directive 92/75/EEC, where recent IEA analysis[60] has shown that over the first 10 years of its existence lamp efficiency (in lm/W) increased by only 10% (see Annex). This means that with respect to the baseline a maximum efficiency increase of 1%/year can realistically be expected.

The new energy label would also extend to professional lamps, where the efficiency increase would depend on the willingness of lighting system installation designers and owners to take into account the energy class of the lamps in the installation when making design or purchasing decisions. However, in the absence of experience or of other evidence on the attitudes of professional buyers in the lighting field, we assume the achievable efficiency increase in the professional sector by labelling alone to be also 1% / year.

[60] IEA, Lighting: Market Impact of "Phase-out" Regulations, International Energy Agency, Mapping and Benchmarking Annex of the Efficient End-use Electrical Equipment Implementing Agreement (4E), July 2011.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Australia	16.1	14.6	14.6	14.2	14.9	14.5	14.2	14.8	14.6	14.9	14.6	18.7	20.3	21.9	
Austria						12.0	12.2	12.3	12.6	13.0	13.0	13.6	13.9	12.8	
Canada								13.1	13.4	14.1	14.9	16.0	15.9	15.7	
Denmark	13.8		13.6		14.4		16.3		15.7		16.3		21.7		
France												15.1			
Republic Of Korea											31.1	35.7	38.0	45.7	
United Kingdom			12.5	12.7	12.8	12.8	12.9	13.0	13.0	13.1	13.2	13.3	15.6	20.8	27.0
USA					12.1	12.5	12.4	12.5	12.7	12.7	13.3	15.1	14.7	14.2	
EU														17.4	18.6

Solid line = robust data *Dashed line = indicative data* *Dotted line = illustrative data*

Fig. 3. Time series sales weighted average efficacy of lamp sales by country/region (Source: IEA, 4E implementing agreement, July 2011)

4.4 Option 4: Ecodesign implementing regulation on DLS (MEPS)

This option aims at improving the environmental impact of DLS, i.e., setting minimum efficacy levels for their power consumption. This sub-section contains details of the rationale for the elements of the corresponding regulation, as listed in Annex VII of the ecodesign framework directive.

In itself this is an effective measure, because it is largely independent of consumer and market behaviour and would take the worst performing products from the market.

On the other hand, it would not tap the additional saving potential of the most efficient remaining technologies, as consumers would have no clear indication as to the energy efficiency of the alternatives. There would be no independent and systematic guidance and ‘market pull’ towards the best new technologies and the legislator would have to be very prudent in timing and ambition level because – as mentioned – there would be no clear message to the end-user explaining why certain types could be phased out in the future. Energy saving alternatives would be promoted only by the manufacturers' own unverifiable and incomparable claims, leading to an erosion of public trust and interest in energy saving lamps. As a result, the average efficiency of the stock would be largely stuck at the level of the minimum requirements.

4.5 Option 5: Labelling and Ecodesign MEPS combined

The most adequate solution is a combination of options 3 and 4, i.e. labelling and MEPS. It combines the advantages of the two options discussed earlier and avoids their pitfalls.

MEPS would remove the least performing products from the market. and labelling would ensure further shift towards the most efficient remain alternatives. Labelling would be more effective than in its standalone application (Option 3), because the purchase price differences between the remaining alternatives would not be as big as between the currently least efficient and most efficient products.

But within that option there are still some sub-options related to the final target levels, as is elaborated in Chapter 5.

4.5.1 Definition of the types of energy-using products covered

The scope of the product categories addressed by an ecodesign measure on DLS is in line with the scope of the preparatory study and stakeholder consultations. The main scope is directional lamps, with some subsidiary requirements on NDLS LEDs, on halogen lighting converters and on luminaires.

Excluded are:

– lamps covered by EC Regulation No 245/2009 on LFL with non-integrated ballast and HID.

– Special purpose lamps and lamps incorporated into other products not providing a lighting function.

Measurement standards

At an operational level most of the relevant measurement standards are in place and listed in Annex 9 (References, section *European Standards and guidelines related to the functional unit*). The exception is LEDs where there is still discussion on how luminance measurement methods should be shaped in order to guarantee a reproducible and accurate assessment. However, according to the latest messages from the EU industry, consensus will be reached on the most appropriate test methods before measures are foreseen to enter into force. More information can be found in Annex 9 on LEDs.

4.5.2 Implementation of ecodesign requirements

According to the 2009/125/EC the target levels for measures should be set at least life cycle cost (LLCC), which presumes that at some point the price of the product increases so much with extra design options to save energy that the life cycle costs (purchase price plus running costs) will start to rise again.

However, as has been argued in Chapter 2 and confirmed in the preparatory study, even the most expensive/ efficient lamps are ‘economical’ in terms of Life Cycle Costs. Payback times are generally less than 1 year. In other words, the LLCC point typically coincides with the BAT (Best Available Technology) point and it will be mostly the maturity of the latest technologies and the affordability to restrict the target levels.

Efficacy requirements reflector lamps

For reasons mentioned under Risk Assessment (Chapter 2) and in order to allow industry enough time for the transitions it is proposed to introduce MEPS in a 3-tier approach (2013/2014/2016), gradually working up – if appropriate according to an intermediate review - to an energy efficiency index (EEI) of 0.95 (which would phase out current day mains voltage halogen lamps) in 2016. This review is foreseen between the 2nd and 3rd tier, i.e. around 2015.

Chapter 5 studies the impacts of the 3 options ‘label only’, ‘minimum requirement only’ and a combination of both. The latter is subdivided in 2 sub-options, one sub-option ‘Min+Lbl I’ where the 2016 target level corresponds to an EEI level of 1.75 (allowing mains voltage halogen lamps) and one sub-option ‘Min+Lbl II’ where it corresponds to the energy label level of 0.95. The latter corresponds to the envisioned 2016 target level, but is bound by the condition that the 2015 revision provides evidence that there are sufficient affordable models on the market that are equivalent in performance to mains voltage halogens and that are sufficiently compatible with mains voltage halogen lighting installations. If this condition is not met then the EEI level 1.75 would apply. All options and sub-options involving minimum requirements apply the 3-tier approach in terms of timing and intermediate target levels.

Alongside the core requirements applicable to mains voltage halogen reflector lamps, the energy efficiency of other reflector lamp technologies (extra low voltage reflector halogens, HID-R, CFL-R, LED-R) will also be required to improve gradually, in order to eliminate the worst products from the market and to ensure an incentive to develop the LED technology further.

Functional performance requirements on lamps

In order to avoid bad consumer experience, all DLS types (except HID) and NDLS LEDs will have to comply with minimum performance requirements similar to the ones already applicable to NDLS in accordance with Ecodesign Regulation 244/2009. These include requirements related to lifetime, light quality and speed of starting. Lifetime requirements are set at levels attainable by the mainstream, so that only the cheap low-end products are banned. Light quality and speed of starting requirements approach as far as possible the performance of the conventional incandescent and halogen lamps the targeted lamps are supposed to replace, especially in the case of lamps claimed to be retrofits to particular filament lamps. However, the requirements are such that the market is not restricted to expensive high-end products. There is also a requirement for CFLs and LEDs to be compatible with lighting equipment operating filament lamps (incandescent lamps and halogen lamps), in order to facilitate retrofitting such installations with efficient lamps.

Product Information requirements

Product information requirements should help the transition process and help avoid disappointing consumer experience with energy-saving DLS.

All information should be available on free-access websites, the URL of which should be in the packaging of the product.

The information most relevant to finding identical replacement lamps (light output, beam angle, colour temperature) should be provided on the lamps themselves as much as possible, to be available at the end of life of the product.

Other important information should be on the packaging, at least in a number and unit, where needed accompanied by a language-neutral icon.

The denomination of ‘energy-saving reflector lamp’ in publications is reserved only for lamps that meet the requirements of energy label class ‘A’.

The comparison of the product with a standard filament reflector lamp (GLS-R or HL-R) is subject to certain rules, as proposed in the preparatory study. Similarly, conditions apply to claiming an LED tube as retrofitting particular fluorescent tubes.

References to relevant European measurement standards can be found in Annex 9 (References, sections relating to European standards).

Ecodesign requirements for equipment with a potential negative lock-in effect

For lighting equipment, there will be a generic compatibility requirement with energy-saving lamps, and an information requirement for warning the user if the equipment is after all not suited. Compatibility will be determined in harmonised standards or in other documents the reference numbers of which are published in the Official Journal. In the case of luminaires, the information requirement will take the form of a standardised mandatory label (see 4.5.3). If lamps are included with the luminaire, they will have to be lamps of one of the two highest energy classes with which the luminaire is labelled to be compatible, in order to advance the market penetration of efficient lamps.

Ecodesign requirements for lighting converters

Halogen lighting converters (transformers) are used with extra low voltage halogen lamps (12 or 24V). There shall be a full load minimum efficiency requirement of 91% and a requirement (applicable also to control gear operating other lamp technologies) that whenever the on/off switch of the luminaire does not switch off the gear, its power consumption shall be limited to 0.5W.

Note that losses in transformers/drivers contribute around 1-2 TWh to EU-27 electricity consumption, which is small but not negligible.[61]

4.5.3 Implementation of labelling

For labelling an important consideration in setting criteria for classes is consistency with existing legislation. Indeed, minimum requirements in Commission Regulation 244/2009 on non-directional household lamps are set at the same level as the current 'E', 'C', ‘B’ and 'A' energy label classes in Directive 98/11/EC. Consumers are used to current classes, which adequately reflect efficiency differences in remaining technologies, so it seems reasonable to keep the existing scale intact.

On the other hand, new classes (A+, A++) need to be introduced on top of the existing scale, so as to ensure that new efficient technologies such as LEDs can distinguish themselves in the future from the current best-in-class products in class A. The A+ reflects the best available LEDs today, and A++ reflects an assumption on the efficiency that the best LEDs will reach by 2016.

The formula for calculating the energy efficiency index of the lamps has to take into account that in professional lighting (and more and more also in household lighting) incandescent and halogen lamps have been replaced by other technologies. Therefore, at least in the higher light output range typical of professional lighting, the formula can be simplified, as it does not need to take into account any more the unique physical characteristic of filament lamps, namely that their efficiency increases with light output. Instead, the limits can be established in a simpler way which also provides a level playing field for all technologies, resulting in a constant lumen / watt requirement independently of light output.

For DLS, a new set of energy label classes have to be introduced, as they were not labelled before. The label class limits are established taking into account that the label should exercise the same pressure towards more efficient light generating technologies regardless if they are NDLS or DLS (e.g. NDLS and DLS infrared coated halogens should both be B class), with some correction applied for the optical efficiency of DLS. Indeed, it is taken into account that in a DLS –with respect to a NDLS—at least 15-20% of light output is lost due to the fact that the light has to be concentrated in a cone. Lamps with a bad optical efficiency are penalised by being classified in a lower class than they could normally belong to.

Lamp ballasts and transformers cause additional losses, so there is a correction factor "LWF" (Lamp Wattage Factor) for lamps that use them.

In addition, a mandatory label is required for display in shops alongside luminaires, showing the energy classes of the lamps that the luminaires are compatible with, and also the energy

[61] The estimate of 1-2 TWh is derived from upscaling the Australian experience, where a similar requirement entered into force in 2010.

classes of any lamps included in the packaging of the luminaire. The meaning of the label is explained in the relevant language in the label itself, so as to make sure the consumers understand its scope.

The proposed label design for both lamps and luminaires is given in Annex 7.

4.5.4 Date for evaluation and possible revision

The main issues for a possible revision of the Regulation, foreseen for 2015, relate to the appropriateness of the product scope and the appropriateness of the levels for the ecodesign requirements.

5. Impact Analysis

5.1 Introduction

Given that options 1 and 2 have been discarded in Section 4, this Section looks into the impacts of option 3, 4 and 5. For option 5 an assessment of 2 sub-options is carried out regarding the "intensity" of the measure regarding mains voltage halogens, as mentioned in 4.5.2. The savings calculated in this chapter relate to measures for reflector lamps; the (relatively small) expected savings on halogen converters or the effect of luminaire requirements are mentioned elsewhere in the underlying report.

The assessment is done with a view to the criteria set out in Article 15(5) of the Ecodesign Directive, and the impacts on manufacturers including SMEs. The aim is to find a balance between quick realisation for achieving the appropriate level of ambition and the associated benefits for the environment and the user (due to reduction of life-cycle costs) on the one hand, and potential burdens related e.g. to un-planned re-design of equipment for achieving compliance with ecodesign requirements on the other hand, while avoiding negative impacts for the user, in particular as related to affordability and functionality. The methodology of the analysis, included the source of the data used is explained in Annex 2.

The quantitative bases assumed for the options are:

- Option 3 ('Lbl only'): introduction of the label in 2013. An efficiency (lm/W) improvement of 1%/year above the baseline
- Option 4 ('Min only'): minimum requirements implemented in 2013 (>banning non-xenon filament lamps with a power > 60W) and in 2014 (> banning remaining non-xenon filament lamps); products accumulate in energy class just above the minimum and no further market pull from energy label.
- Option 5: Combination of the above, without accumulation in the class above the minimum and with continued market pull from energy label at 1%/year. See previous arguments. With 2 sub-options:
- ('Lbl+Min I). The 3rd tier – in 2016, after review – will remain at a relatively high level with an EEI of 1.75. In this case, 2-3 years after the 3rd tier the products will be in classes D, C, B, A, A+ with a 20-30-30-10-10% split. After 2019 the improvement will continue at 1%/year.
- ('Lbl+Min II). The 3rd tier –after review – will be set at an EEI level of 0.95. In this case, 2-3 years after the 3rd tier the products will be in classes B, A, A+, A++ with a 40-30-20-10% split. After 2019 the improvement will continue at 1%/year.

5.2 Impacts

5.2.1 Electricity

The aggregated results for electricity savings are presented in Figure 5. The differences between the scenarios in respect of energy use are clear. While the Baseline foresees an increase in electricity consumption, all policy options produce savings compared to the present situation, with the Lbl+Min II option resulting in the the highest savings. From an estimated 40 TWh/year energy use in 2010, the Baseline scenario leads to a 23% increase in 2020. Apart from some small extra savings in the first years (2013-2014) the Lbl+Min I option where the target level stays at EEI=1.75 has the same impact as the 'Lbl only' scenario and the increase is limited to 4 TWh versus 2010 and there is a 5 TWh saving in 2020 versus the baseline. The Lbl+Min II gives a 32% cut with respect of 2010 (almost 50% cut with respect of the baseline in 2025). The Min only option achieve only a slight improvement compared to the Baseline by 2020.

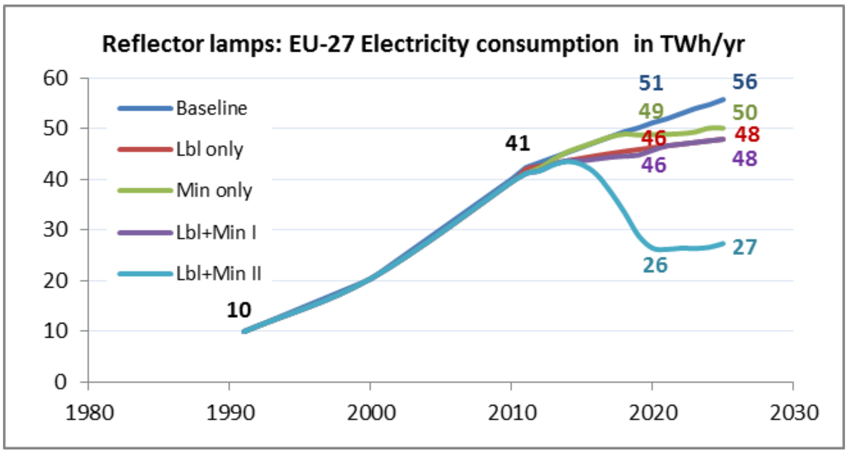


Figure 4

5.2.2. Emissions: Carbon and mercury

As only electricity use is involved with lighting, the ranking of the scenarios from the point of view of carbon emissions mirrors closely the results on electricity consumption in section 5.2.1. However, the curves are less steep, as the CO2 emissions of electricity generation are assumed to decrease equally in all scenarios (see Annex 3 for details).

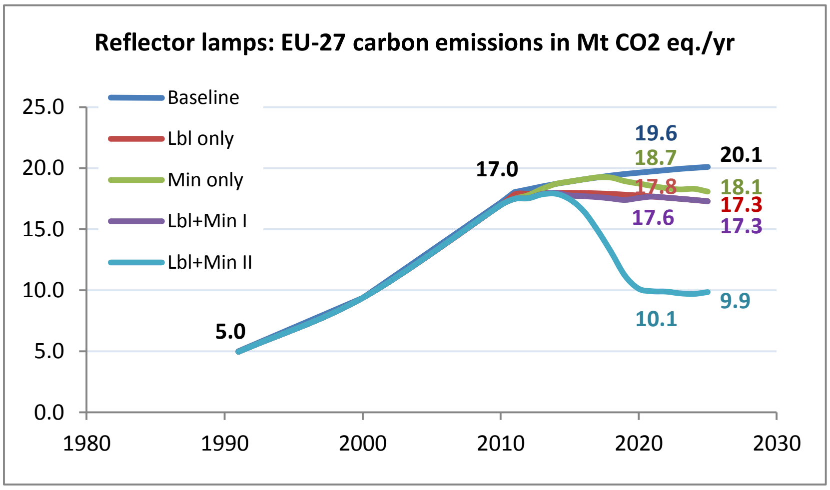


Figure 5

In spite of the increasing number of mercury containing lamps in use, the mercury emission balance is positive for the Lbl only, Lbl+Min I and Lbl+Min II policy options compared to the Baseline, and also the other options stay close to the baseline even when assuming that all mercury containing lamps are discarded with no recycling at the end of their lives. This is due to the larger decrease in mercury emissions in electricity generation as electricity consumption decreases. The scenario assumes that the mercury-containing lamps are discarded after 5 years of use. Note that despite this worst case scenario the 1 t of mercury (Hg) related to DLS is only slightly more than 1% of the total EU mercury emissions to air in 2007.[62]

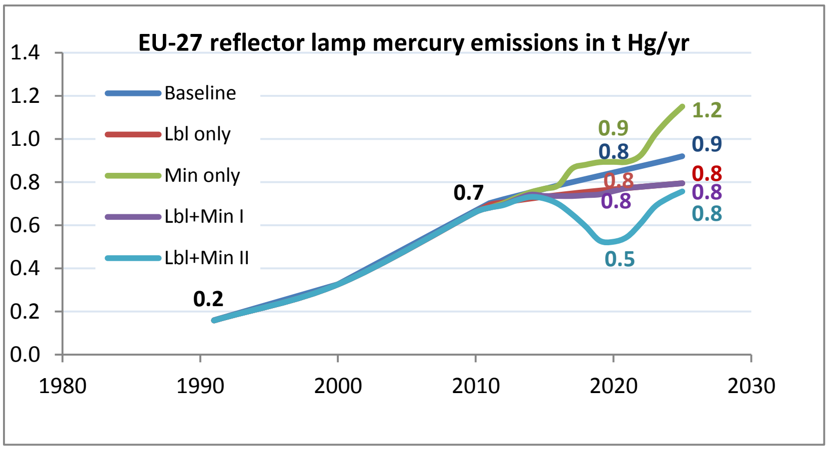


Figure 6

5.2.3 Consumer expenditure

The savings in electricity costs by 2020 outweigh the increased purchase costs of more efficient lamps, clearly with option Min+Lbl II and also slightly with the Min+Lbl I and the Lbl only option. In these options, after a short period of return on investment on newly purchased lamps when expenditure rises sharply, consumer expenditure is expected to drop in parallel to electricity consumption (see 5.2.1.).

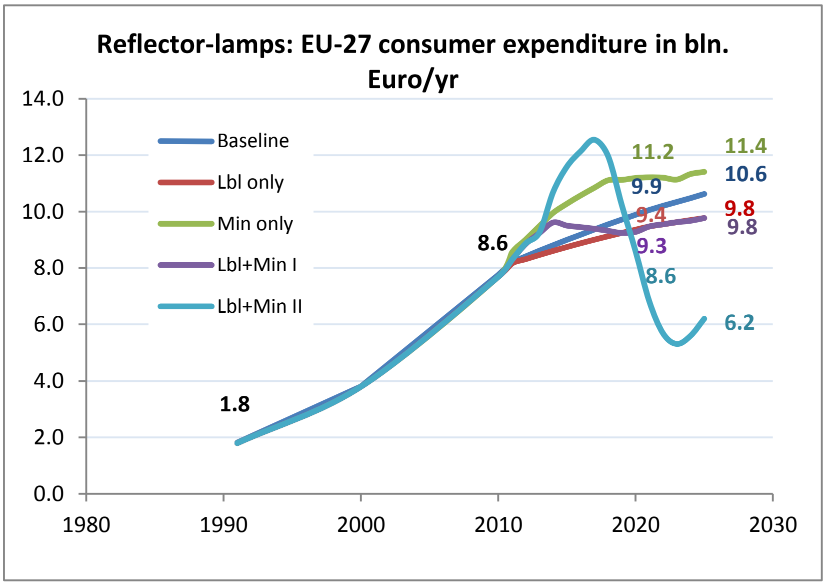


Figure 7

[62] VHK, draft MEErP methodology report Part 1, 2011. (table 22 on normalization factors; the original source for the total Hg emissions is a European Commission paper on Ambient air pollution from As, Cd, Hg and Ni compounds. Corrected to EU-27 2007 by VHK.)

5.2.5 *Affordability*

It may appear from Fig. 7 that there is a (temporary) affordability problem for several scenarios. However, in reality it largely shows the limitation of long-term financial modelling, whereby the scenarios are actually showing a worst case scenario with

- uncertainty over Member State spending on financial incentives, also in view of the monetary crisis. Hence the scenarios assume no government subsidies whatsoever;
- uncertainty over price developments of IRC halogen lamps and LED-lamps in a truly competitive market. Hence, the scenarios are calculated with current DLS market prices, despite the predictions by some experts that prices of aforementioned DLS types may drop 40-50% in the coming 5 years.
- uncertainty over energy prices. Hence, the scenarios are calculated with the historical electricity price increase over the 2000-2006 period (2006 being the reference year used in the preparatory study), which amounts the 2%/year. However, more recent trends e.g. over the period 2005-2010 show an electricity price increase of 5%/year making the payback time even more attractive.
- uncertainty over the spread in longevity of the newer lamp types. Hence, the scenarios assume minimal spread in product life with respect to the nominally indicated operating hours, despite the fact that past experience has shown that this spread, also due to differences in consumer behaviour can be considerable.
- uncertainty over the role of ESCOs[63] and other options for financing the investment, as energy-saving DLS constitute one of the economically most attractive options to save energy.

Considering all the above factors, it is believed that there is no significant affordability problem. As an illustration Figure 8 shows a scenario where prices of new technologies are reduced by 50% and the electricity price increase from 2010 onwards is set at 5%/year.

Furthermore, should it become apparent after the introduction of the first 2 tiers of the measures that such an affordability problem would indeed exists, the planned review in 2015 - before the introduction of the 3rd tier - would give policy makers the opportunity to act.

Finally, the uncertainty mentioned above applies also in part to the business impact and the employment. If, as can be expected, prices of LED and IRC halogen lamps drop, the business revenues will also drop proportionally. And with a larger spread in product life, also the fluctuations between 2015 and 2025 will be smaller.

[63] Energy Service Companies.

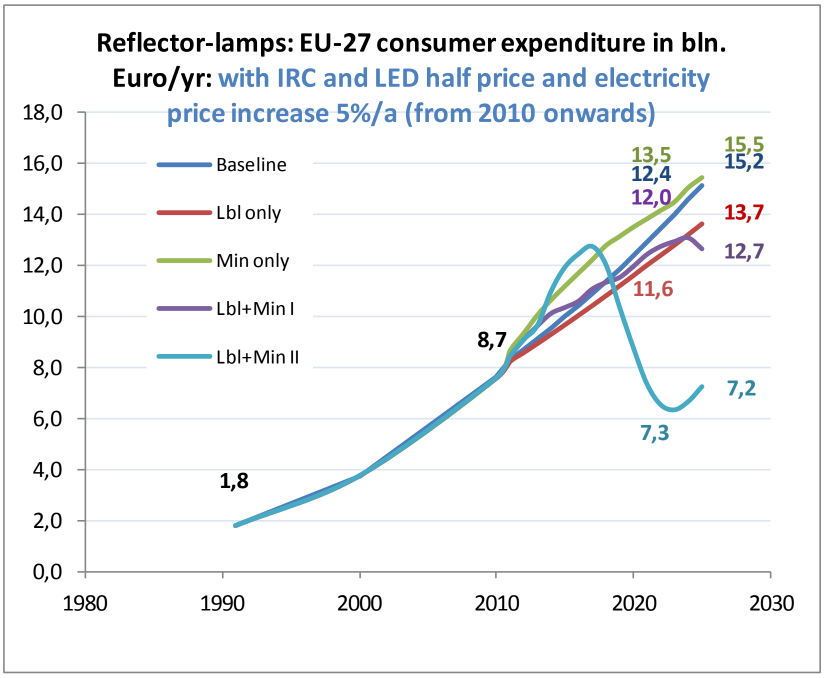


Figure 8

5.2.6 User satisfaction

a) Compatibility issues

Energy efficient directional lamps are produced for all luminaire socket / lamp cap combinations. However, in the case of infrared coated halogens, CFLs and HIDs that are supposed to be used in place of mains voltage lamps, the size of the built-in transformer, driver or ballast prevents the lamps from being used in many luminaires. It is therefore important to allow on the market alternatives that do not require built-in electronics, namely xenon-filled halogen reflector lamps. However, it can be reasonably assumed that technology advances will fill in current gaps in the market of more efficient lamps, therefore a move towards the infrared coated halogen level is scheduled already now for 2016. This provision can be changed if necessary during the review of the Regulation in 2015.

Dimmability constitutes another compatibility constraint. While halogens are always dimmable, in the case of CFLs and LEDs, even those claimed to be dimmable will have problems operating on some dimmer types because of their complex electronics. A standardisation of dimmers and dimmable lamps would be needed first, followed by the replacement of all installed dimmers with ones complying with the new standards. Such a process would clearly stretch beyond the time-frame of the Regulation; a complete phase-out of halogen technology is therefore not envisaged.

The regulation introduces a generic compatibility requirement in order to foster the standardisation processes needed to overcome these problems.

b) Functionality issues

While there are no substantial differences between the functionalities of filament lamps, the following functionalities of CFLsand LEDs vary considerably:

- start delay and warm-up times (except for LEDs)
- operating temperature
- colour rendering

- colour consistency (for LEDs only)
- colour temperature ("colour" of the light)
- lifetime
- number of switching cycles the lamp can endure
- light loss with age ("lumen maintenance")

Users may be dissatisfied with lamp performance in terms of these functionalities if the lamp is of low quality, or if they do not have the information to select a lamp with the performance they need. The Regulation therefore sets minimum requirements on functionality to remove the worst lamps from the market, and sets product information requirements for display on the packaging, so that consumers are able to select the right lamp for the application in which they need it. The Regulation also sets functionality requirements that CFLs and LEDs claimed to be retrofits to particular filament reflector lamps need to fulfil.

The impact of quality standards is likely to be beneficial for all the actors involved (consumers, business users and producers alike). From the perspective of users, it would be highly risky to introduce minimum efficiency requirements that would promote the uptake of LEDs, without at the same time making sure that the same LEDs conform to quality and lifetime requirements. The experience with compact fluorescent lamps in the past two decades shows that energy efficiency alone is not sufficient to prevent large-scale disappointment with the technology, if at the same time it comes with a drop in lighting performance and erratic quality. Therefore it is essential that minimum functionality requirements are introduced alongside efficiency requirements for LEDs. These functionality requirements would also benefit those producers (SMEs and large companies alike) who put an emphasis on the quality of their products. Indeed, the requirements would remove from the EU market the products of competitors who engage into a downward price spiral by cutting costs through making unacceptable allowances in lamp performance. While appealing to the consumers at first with their price tags, such lamps would contribute to disappointment with the entire technology.

5.2.7 Health impacts

The Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) published an opinion in March 2012[64] on the Health Effects of Artificial Light. SCENIHR did not find risks for the general public relating to exposure to the light of directional lamps. Lamps sold in shops are safe. There are LED lamps that may cause retina damage if not properly installed, however they are clearly labelled, normally not directly available to consumers and are supposed to be installed by professionals. In any case, EU product safety legislation (Low Voltage Directive[65] and General Product Safety Directive[66]) ensures that only safe lamps can be placed on the market.

SCENIHR did not find evidence that the light spectrum of lamps used in household illumination would have an impact on circadian rhythms, sleep patterns or health in general.

The conclusions of a previous 2008 SCENIHR opinion as regards light sensitive patients[67] were confirmed in the 2012 opinion. A number of individuals (around 250,000 EU citizens=0,05%) are exceptionally sensitive to UV/blue light exposure. Clearly, the risk for

64 http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_035.pdf

65 Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits, OJ L 374, 27.12.2006, p. 10–19

66 Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety, OJ L 11, 15.1.2002, p. 4–17

67 http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_019.pdf

this group of patients is not limited to CFLs, but includes all light sources with notable UV/blue light emissions, including certain incandescent bulbs. For these patients, retrofit LED lighting, which does not emit UV, would provide an option alongside CFLs with double envelopes, where the outer glass usually filters out most of the UV. SCENIHR recommended that more information is made available to light-sensitive patients and to health professionals treating them on the light spectrum of lamps on the market.

The Scientific Committee on Health and Environmental Risks (SCHER) did not find evidence in their opinions of May 2010[68] and March 2012[69] that the accidental breaking of NDLS compact fluorescent lamps would release mercury vapour quantities dangerous to health, even in a worst case scenario. Recent tests by the German Federal Environmental Agency have demonstrated that the presence of a second lamp envelope reduces the risk of mercury spill in case of breakage. CFL and HID reflector lamps are usually double envelope lamps.

As regards the general public health, the decreased emissions of toxic pollutants and particulate matter from lower electricity production that the measures hope to achieve can only be regarded as positive.

The regulation exempts from its requirements lamps specifically designed for light-sensitive patients. There is now a product information requirement to present more detailed information on the light spectrum of directional lamps, which could be useful both for lighting designers and light sensitive patients.

5.2.8 Business impact

The graph below gives the projected sales volume of the baseline and 3 sub-options.

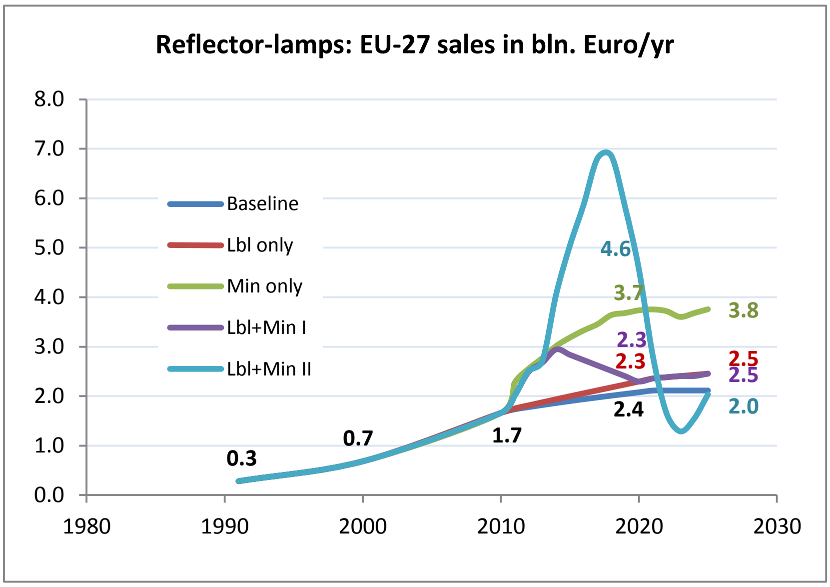


Figure 9

The graph and table below give an estimate on how the revenues from the sales are divided over EU-trade and industry.

[68] http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_124.pdf

[69] http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_159.pdf

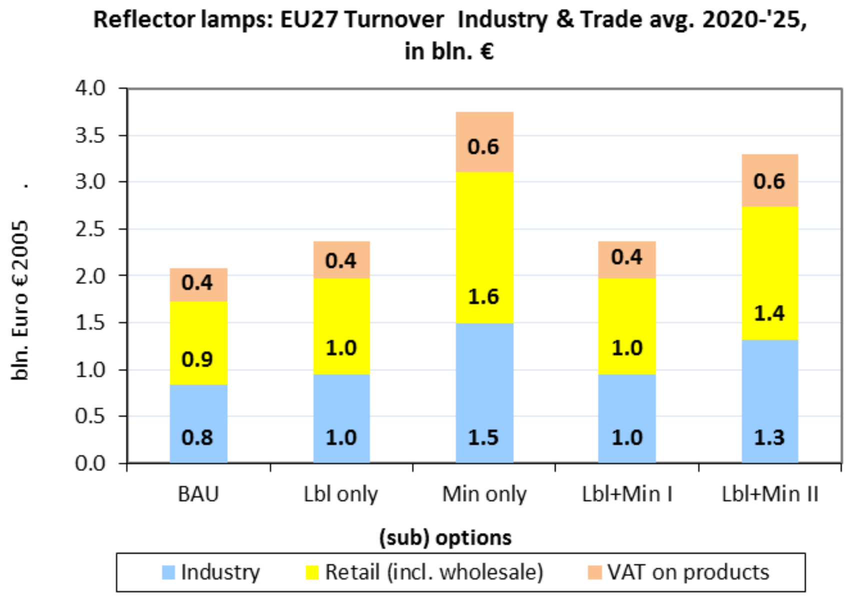


Figure 10

Table 4: TURNOVER avg. 2020-2025* (bln.€/a)

	BAU	Lbl only	Min only	Lbl+Min I	Lbl+Min II
Industry	0.8	1.0	1.5	1.0	1.3
Retail (incl. wholesale)	0,9	1,0	0.9	1.0	1.6
VAT on products	0,4	0,4	0.4	0.4	0.6
subtotal purchase costs	*2.1*	*2.4*	*3.7*	*2.4*	*3.3*
Electricity costs	7.8	7.1	7.5	7.0	4.0
Total costs consumers	**9.9**	**9.4**	**11.2**	**9.4**	**7.3**

**= calculated from average 2020-2025 because of large fluctuation*

5.2.9 Employment

The analysis shows positive employment impacts for all considered sub-options (see graph)

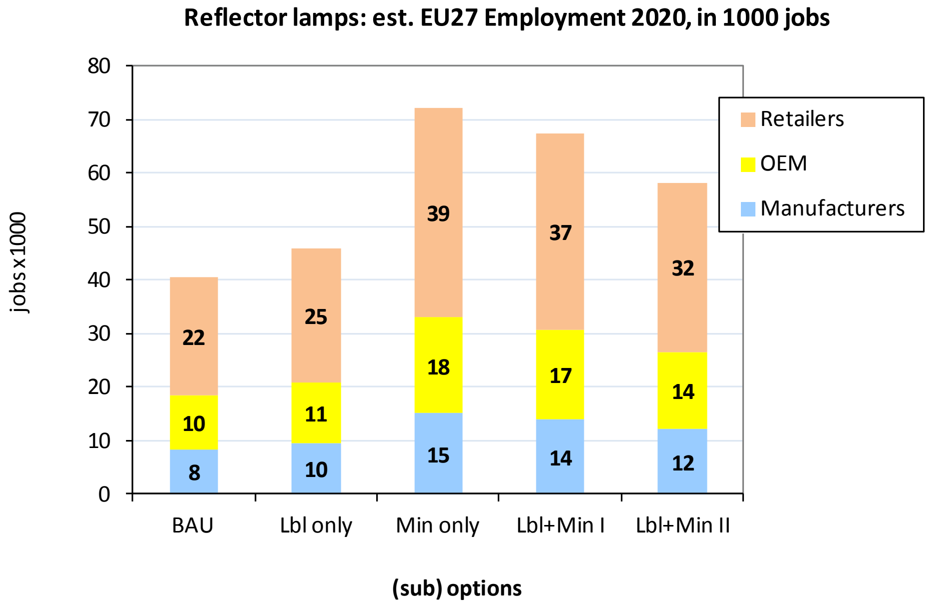


Figure 11

Table 5: EU-27 EMPLOYMENT avg. 2020-2025 (jobs x 1000)*

	BAU	Lbl only	Min only	Lbl+Min I	Lbl+Min II
Manufacturers	8	10	15	10	13
OEM	10	11	18	11	16
Retailers	22	25	39	25	35
Total jobs	**40**	**46**	**72**	**46**	**64**

*=calculated from average 2020-2025 because of large fluctuation

5.2.10 Impact on SMEs

As mentioned in paragraph 2.5.6 (baseline, employment), manufacturers of DLS are generally large multinational companies. Most SMEs (Small and Medium-sized Enterprises, <250 employees) can be found amongst the materials- and parts-suppliers. Based on Eurostat manufacturing industry averages[70], around 85% of OEM-jobs, presumably 60% outside the EU, are with SMEs. Of the 3000 extra OEM jobs in e.g. the ‘Lbl+Min’ scenarios (Table 7), around 1500 will be with EU SMEs. Most of the SMEs can be found in the retail sector, where SMEs are more than 85% of the total. This means that around 25.000 extra retail jobs of the ‘Lbl+Min II’ scenario compared to the ‘BAU’ will be with SMEs. Similar fractions apply to the revenues, also according to Eurostat data.[71]

For related products under the measures it can be mentioned that the ‘soft’ measures (compatibility requirements, warnings and luminaire labels) are not expected to have a significant impact on the sector. Compatibility will be defined in standards to be developed by the industry itself, and will ensure a wider public acceptance for the products involved. Warnings and labels do not need to be included with the packaging of each product, it is sufficient to make them available on websites. The sector of halogen converters, representing

70 Eurostat, employment database, Table tin 0052.

71 Eurostat, Statistical Yearbook 2010

hardly any EU industrial jobs and very little retail activity (mainly B2B), the effects of the proposed efficiency on SMEs are also believed to be insignificant.

5.2.11 Administrative burden

The proposed ecodesign measure includes requirements to provide information on the efficiency of the DLS. It requires the lamp industry to produce efficiency and performance data that are currently standard practice and that are standard items in the documentation of the light sources. The energy labelling measure includes the provision of an energy label. As this is current practice for the 1998 lamp label, there is hardly any change in administrative burden, apart from some packaging redesign and including the label also on the packaging of DLS and on websites for professional lamps. Administrative burden for luminaire manufacturers has been minimized with respect of the original plans (see Chapter 1), allowing the publication of labels on company websites, for the shops to download. Shops can display luminaire labels on the shelves in the same location where they would have to publish other technical information on the displayed luminaires. For halogen converter manufacturers, who are no longer a significant part of the EU industrial landscape, measurement of full load efficiency is current practice and does not constitute a barrier to trade nor a significant administrative burden.

For Member States, the legislative costs are minimal as the format of the measures is a regulation, thus avoiding transposition costs. There are some extra testing costs for the market surveillance authorities, because DLS testing requires new and more specific measurements within a restricted cone area, as opposed to the general tests that these authorities had to undertake for the 1998 lamp energy label. As the frequency of the spot checks and the exact extra testing costs are unknown, it is difficult to make an estimate of the extra burden. However, also taking into account the experience in other regions outside the EU, it is believed that the extra costs will not be significant and certainly not excessive.

5.2.12 Impacts on trade

The process for establishing ecodesign requirements has been fully transparent, and after endorsement of the regulation by the Regulatory Committee a notification under WTO-TBT will be issued.

As mentioned, the market of directional lamps is dominated by a handful of global players. For that, it is relevant that the requirements in the EU do not dramatically differ from the rest of the world. This has been investigated and it is found that the EEI=0.95 level in 2016 for mains voltage filament lamps is ambitious but even less ambitious than the ambition level of Australia 2010/2012. It is at the level of the US 2012 for incandescents, but – whereas Australia covers all mains voltage lamps – the US and Canada do not cover GU10 and other typical halogen caps. This might well be subject to a second US DoE revision cycle for reflector lamps due in June 2014. Generally speaking, the differences are small, therefore no competitive disadvantages for EU manufacturers exporting affected products to third countries are expected. As regards the possibility of mass dumping of imports of mains voltage filament lamps before 2016 – or after 2016 if the EEI stays at a high level of e.g. 1.75 –it will depend very much on the regulatory practice in the Asian Pacific area. If the practice of Australia is copied e.g. in China (where they have already decided to phase out non-directional incandescent bulbs between 2012 and 2016) there may be a local production overcapacity in that area which could make mass dumping in the EU an attractive option (see Annex 4 for more details).

On the other hand, the minimum quality requirements on LEDs would be unique in the world at this stage. They could exercise a beneficial impact on other economies, where in order to simplify workflows local producers could apply the EU quality criteria also to products not destined to the EU market.

5.2.13 Intellectual property rights

In order to investigate the potential for infrared coated (IRC) halogen efficacy levels to become the minimum ecodesign performance requirement for directional lighting in the EU market, Ecos performed a preliminary examination for ECEEE of patents and related intellectual property rights with regard to halogen lamps.[72] This is necessary as ecodesign requirements should avoid the setting of minimum performance standards that require a single proprietary technology. The report concluded that ownership of patents associated with IRC technology and halogen lamps appears to be spread equally among manufacturers The European Lamp Companies' Federation commented on the report, disagreeing with its conclusions and stating that the situation correctly detailed in the report is actually one where patent ownership is not equally spread.

In summary, due to intellectual property rights, direct or indirect barriers may exist to the manufacturers intending to produce IRC lamps. It was therefore not considered appropriate to raise the level of requirements on halogen lamps to a level that can only be achieved by IRC halogens.

5.2.14 Summary of impacts

The table below gives an overview of the most important savings for the (sub)-options versus the baseline.

Table 6:

Savings parameter	**Lbl**	**Min**	**Lbl+**	**Lbl+**
Versus Baseline				
TWh saving in 2020	4.9	2.3	5.4	24.7
TWh saving in 2025	7.8	5.6	7.8	28.4
Accumulative TWh saving 2011-2020	25.8	7.1	32.2	89.3
Accumulative TWh saving 2011-2025	58.8	29.1	65.2	225.8
Mt CO2 saving in 2020	1.9	0.9	2.1	9.5
Mt CO2 saving in 2025	2.8	2.0	2.8	10.3
Accum. Mt CO2 saving 2011-2020	10.2	2.9	12.8	35.1
Accum. Mt CO2 saving 2011-2025	22.4	11.0	25.0	85.6
El. costs saving in 2020 (in bln. Euro)	0.7	0.4	0.8	3.8
El. costs saving in 2025 (in bln. Euro)	1.2	0.9	1.2	4.3
Accum. el.costs saving 2011-2020 (bln Euro)	3.9	1.1	4.9	13.6
Accum. el.costs saving 2011-2025 (bln.Euro)	9.0	4.4	10.0	34.5
Extra purchase cost in 2020 (in bln. Euro)	0.2	1.7	0.2	2.5
Extra purchase cost in 2025 (in bln. Euro)	0.3	1.6	0.3	-0.1
Accum.extra purch. cost 2011-’20 (bln.Euro)	1.1	12.5	6.4	27.1
Accum. extra purch. cost 2011-‘25 (bln. Euro)	2.6	20.4	7.8	25.9
Total cost saving in 2020 (in bln. Euro)	0.5	-1.3	0.6	1.3
Total cost saving in 2025 (in bln. Euro)	0.9	-0.8	0.9	4.4

[72] Mason, L. , Caldwell C., Moorefield, L.., *Evaluating the potential of halogen technologies, European ecodesign and labelling requirements for directional lamps*, prepared by Ecos(US) for the European Council for an Energy Efficient Economy (eceee) with funding from the European Climate Foundation, Defra, the Department for Environment, Food and Rural Affairs (UK) and the Swedish Energy Agency.

Accum. costs saving 2011-2020 (bln. Euro)	2.8	-11.4	-1.5	-13.5
Accum. costs saving 2011-2025 (bln. Euro)	6.4	-16.0	2.2	8.6

6. CONCLUSIONS

The impacts of the three options for Ecodesign measures, options 3, 4 and 5 as described in section 4, were investigated. Option 5, the combination of and ecodesign regulation and a delegated regulation on labelling for DLS, two sub-options with different target levels were studied. The study revealed option 5 to be the most effective. As regards the ambition level, the long-term effect of the sub-option with the most ambitious target level – set at minimum EEI level of 0.95 corresponding to 'B' energy class —optimally fulfils the objectives as set out in Section 3. In particular, this option implies:

- cost-effective increase of DLS efficacy;
- correction of market failures and proper functioning of the internal market;
- no significant administrative burdens for manufacturers or retailers;
- increased purchase cost, mitigated by economies of scale for efficient technologies and quickly compensated by savings during the use-phase of the product;
- that the specific mandate of the Legislator is respected;
- reduction of the electricity consumption of about 25 TWh/year versus the baseline in 2020;
- an accumulated impact by 2020 of 89 TWh in electricity saving, of 35 Mt reduction in CO_2 emissions, and of € 14 billion saving in electricity costs;
- an accumulated impact by 2025 of 226 TWh in electricity saving, of 86 Mt reduction in CO_2 emissions, and of € 34 billion saving in electricity costs;
- a clear legal framework for product design which leaves flexibility for manufacturers to achieve the efficacy levels;
- costs for re-design and re-assessment upon introduction of the regulation, which are limited in absolute terms, and not significant in relative terms (per product);
- fair competition by creation of a level playing field;
- no proprietary technology imposed on market players;
- no significant impacts on the competitiveness of industry, and in particular SMEs;
- positive impact on employment, in particular for SMEs.

7. MONITORING AND EVALUATION

The appropriateness of scope, definitions and limits will be reviewed after maximum 3 years from the adoption of the measure (as required by Annex VII.9 of the Ecodesign Directive and laid down in the implementing measure). Account will be taken also of speed of technological development and input from stakeholders and Member States. Compliance with the legal provisions will follow the usual process of "New Approach" regulations as expressed by the CE marking.

The review will monitor the situation of the sales and stock of directional lamps with respect to the technical parameters linked to environmental aspects that were considered significant and addressed in the planned ecodesign regulation (energy efficiency, mercury content). In addition, progress in relation to the functionality (quality) parameters of energy saving lamps will be monitored.

Compliance checks are mainly done by market surveillance carried out by Member State authorities ensuring that the requirements are met. Further information from the field as e.g. complaints by consumer organisation or competitors could alert on possible deviations from the provisions and/or of the need to take action.

Input is also expected from work carried out in the context of upcoming ecodesign activities on further product categories and related activities.

ANNEX 1: Minutes of Consultation Forum meeting

MINUTES OF THE MEETING OF THE ECODESIGN CONSULTATION FORUM HELD ON 5 JULY 2011

Subject: Possible Ecodesign implementing measure on directional lamps, LED lamps and halogen lighting converters under the Ecodesign Directive (2009/125/EC) and possible Energy Labelling measure on lamps under the Energy Labelling Directive (2010/30/EU)

Place: Centre Albert Borschette (CCAB), rue Froissart 36, 1049, Brussels.

Chairman: P. Hodson (ENER.C.3)

EC participants: E. Cabau, A. Toth (ENER.C.3), D. Minotti (ENV.C.1)

EC experts: P. Van Tichelen, L. Vanhooydonck (VITO) and R. Kemna, VHK.

Documents:

The Commission services (COM) presented Commission Staff Working Documents (2 draft regulations and 1 explanatory note) on ecodesign requirements for directional lamps and labelling requirements for lamps. The working documents were sent out one month before the meeting to the members of the Consultation Forum, and to the "Meetings of Commission / National Experts" functional mailbox of the European Parliament for information. The working documents were published on DG ENER's ecodesign website, and were included in the Commission's CIRCA system alongside the stakeholder comments received in writing before and after the Consultation Forum meeting.

Meeting notes:

The meeting started with a presentation of the key issues in the Working Documents. It was also announced that the Commission had the intention to hold in early autumn a meeting of a technical subgroup (TSG) of the Ecodesign Consultation Forum, in order to discuss details of the draft regulations that are too technical for discussion with the entire Forum. All interested Forum members could join the subgroup.

The following comments were raised during the ensuing discussions.

<u>Questions common to the two working documents</u>

Scope

ELC/CELMA (European Lamp Companies Federation / Federation of National Manufacturers Associations for Luminaires and Electrotechnical Components for Luminaires) want to limit the scope to 'household' directional lamps (DLS) only, as there may not be enough evidence about the impact on professional products in the preparatory study. The Professional Lighting Designers' Association (PLDA) agree, professional lamps have characteristics that are much needed, they should not be regulated together with household lamps.

DE, NL, UK support the broader scope (incl. professional). ELC/CELMA, AT and the European Environmental Citizens' Organisation for Standardisation (ECOS): professional lamps could also be addressed in another regulation if needed.

The Commission services (COM) refer to a follow-up study by the European Council for an Energy Efficient Economy (ECEEE), the Swedish Energy Agency (SEA) and the UK Department for the Environment, Food and Rural Affairs (DEFRA), which says professional lamps were well covered in the preparatory study. COM want to go ahead with single measure, but the issue can be further discussed in the technical subgroup (TSG) meeting to see if there is any concrete problem with that.

Definitions

COM ask for views on the principles underlying the draft definitions. COM would like to keep the definitions as simple as needed for the EU legislation.

The European Committee for Standardisation (CEN), PLDA, ELC/CELMA stress the need to follow ongoing international and European standardization work (CEN TC 169, EN 12665, Mandate M 485) in definitions, for consistency and for avoiding confusion.

Working document on the Labelling regulation

Calculation of label classes and setting class limits

COM ask for views on the principles underlying the establishment of class limits, e.g. whether they should be drawn to reward the same technologies in the DLS label as in the existing non-directional lamps (NDLS) label.

PLDA stress that the DLS label and the minimum energy efficiency requirements should be technology-neutral (no separate requirement on halogens). COM: in Regulation 244/2009 there were already technology specific functionality requirements. The proposed efficiency requirement would be tougher on LEDs than on halogens, in order to keep the latter available, which should be in line with the PLDA position.

AT: not sure if it makes sense to distinguish filament lamps in separate classes, as they are only a few lm/W away from each other.

DE: does the consumer really not make choices between DLS and non-directional lamps in the shop? According to their data, there is no clear border between technologies, it is not possible to set limits based on them, and anyway, what benefit would it have?

The European Consumers' Organisation's (ANEC/BEUCANEC/ANEC/BEUC) priority is to foster development in the compact fluorescent lamp (CFL) market, not in the filament lamp market, which is the past. We should make distinctions - for the NDLS label - between 45 and 70 lm/W CFLs (range found in tests).

DK fear negative consequences in moving away from existing scheme. We should stay with existing classification with 'A' and below and use the new calculation method for the new classes (A+, A++ etc.).

NL: we should have technology neutral objectives, not class limits protecting particular technologies. But we should also watch out that classes are populated and make sense from a consumer perspective.

ECEEE: the label should differ from one cap type (e.g. E27, G9) to the other, as that is the basis of choice for consumers. Otherwise, it should be technology neutral.

ECOS, International Network for Sustainable Energy (INFORSE) would like to rescale A-G in order to avoid "plusses" (A+, A++) and to have more space to expand. Energy labelling of lamps has not been very successful so far in driving the products towards A class.

COM: reluctant to go into rescaling before review of the Energy Labelling Directive (2010/30/EU) in 2014.

IT, FR: "A" class lamps were not purchased by consumers, because CFLs did not perform well in the beginning. It is not the label that was a failure, but the product.

ELC/CELMA: market surveillance did not work very well, that is why some products were bad.

FR: energy efficiency should be the only criterion in establishing label classes, even if we discriminate against technologies with that.

DE support sticking to existing calculation method, as option proposed by COM would unduly favour LED lamps compared to others.

COM: it would be useful to stick to the practice of defining the label classes according to light generating technologies, with additionally taking into account optical efficiency inside the lamp (cutting off the technologically defined classes so that the worst performers in that technology come one class below).

NL: the 1998 lamp label may not have been very helpful in moving the market, as there were only two choices, and people knew without a label that CFLs were the efficient ones. The new label will have to guide consumers among the many new lamps and more nuances.

COM defend current label and proposed A+ and A++ classes as accurately reflecting the character of the market: halogens are still around but are not so energy efficient (from B class to A class, there is a doubling of energy efficiency), energy saving lamps (which should be promoted) all get A class or better.

ANEC/BEUC disagree and would like to see research underpinning this. The consumer's priority may not be to distinguish between halogens, but to see which is a good CFL and which is a bad CFL.

Label design, additional parameters

DE: energy demand indication needed, three versions are not needed.

ANEC/BEUC proposes that product information which must be provided anyway on the package be instead provided on the Energy Label, which would thus serve as a “One-stop-shop” for information for consumers. They do not support simple version, as multiple versions decrease the comparability of labels. Also, label should give the efficacy in lm/W.

NL support ANEC/BEUC on the matter of more info in a standardised way and place in the label, on the product (not having to search the packaging for further info). They do not support the use of a simple label.

ECOS: kWh/year should be on the label, we should get rid of wattage indication.

ELC/CELMA agree with COM proposal. The main thing consumers want to know from the label is whether the lamp is efficient, so it should be readable at first sight, not overloaded with other parameters.

FR: want to show lumen clearly on the label, not watts.

DK: A simple label may be too simple, energy consumption should be included.

COM defend the proposed three versions of the label (independent, full and short) as necessary and conform to established practice since 98/11/EC because of small packagings. Wattage should remain on the packaging (but not in the label itself) at least for safety reasons (luminaires set max. W of operated lamps, so W should be known).

Luminaire labelling

ELC/CELMA: Where to put the luminaire label in the shop, where it is detrimental to aesthetics? Placing in the manual should be enough. The dealer should have options where to put the information. Delete product-fiche etc.; info already provided elsewhere and would add to the administrative burden especially for many SME luminaire makers. COM: to be discussed further in TSG in light of the specific needs of the sector.

DE, IT: Is there an added value in the label? There is a tendency to have many small lamps in a luminaire instead of a big one, whereas the latter solution is more efficient. This would not be reflected in the luminaire label.

IT: What is a 'household luminaire' and how to distinguish from a 'non-household' luminaire? COM: What is 'household' may depend on where it is sold, but definition should be discussed in TSG.

ECOS ask for genuine energy labelling of luminaires including their optical efficiency. Luminaires with negative lock-in should be addressed, ultimately by a phase-out of such luminaires.

ANEC/BEUC agree with ECOS that phase-out of luminaires with lock-in effect is the solution. Are ecodesign requirements on luminaires impossible for aesthetic reasons? COM: Indeed, and administrative burden on small SMEs producing decorative lamps by imposing measurement requirements for every individual model they produce.

AT: labelling of household luminaires does not make sense, perhaps for professional ones in the future. A simple warning sign that the luminaire is not compatible with efficient lamps could be used instead. INFORSE agree to the proposal.

DE: Luminaire label should only look at 'negative lock-in effect'. If a lamp is sold with the luminaire, the lamp label could be displayed alongside the luminaire. COM worry that in such a case, some luminaires would have labels and others would not in the shop, which may be confusing unless it is made very clear that the label applies to the lamp.

ANEC/BEUC: consumers will be frustrated in a few years for being locked-in by their luminaires for which they will not be able to buy lamps. This could be prevented by some basic ecodesign requirements for luminaires.

IT: the label may claim that luminaire is compatible with efficient lamps, but in practice they might not work. Also, how to do market surveillance of lamp compatibility with the luminaire?

NL: we should leave it to the retailer to give advice on which lamp is compatible with which luminaire, we cannot foresee all combinations.

ECOS: we need to tackle the lock-in effect. We should require sufficient space in the luminaire to allow efficient alternatives.

PLDA: such luminaire labelling would not be helpful on the domestic side, as E27 socket is compatible with lamps A to E class. In response, ECOS refer to lock-in effect with G9, where the problem is clear.

DK: not in favour of proposed labelling. Optical performance labelling could be done easily, but can accept the COM position.

FR: labelling optical efficiency overall is difficult; propose to apply only to 'functional' and not to 'decorative' luminaires. ELC/CELMA think it is impossible to make the distinction. Difficult to ensure that hand-made products always respect the optical efficiency limit values.

INFORSE: in Switzerland, labelling for domestic luminaires exists.

ECOS: it could be required that luminaires are either sold without lamps, or with efficient lamps. That would drive consumers towards luminaires compatible with efficient lamps.

COM: Would a warning sign be acceptable for certain caps, e.g. G9 and R7s? ELC/CELMA could agree to a warning sticker for G9 and R7s (although they also support the COM proposal).

<u>Working document on the Ecodesign regulation</u>

Useful beam angle measurement

COM: clarification on additional cost of measuring in 90°/120° compared to 180°. Since Regulation 244/2009, authorities have been already supposed to measure in 120° to determine if a lamp is NDLS or DLS. DK disagree: it is not necessary to measure beam angle in such situations, as the tested light bulbs are NDLS in a manner visible to the naked eye.

LED modules in integral luminaires

COM: ELC/CELMA commented that only removable LED modules should be covered. That would leave LED modules in integral luminaires out of scope. Is that the intention?

NL: LED module in integral luminaires should be included, otherwise loophole. If it cannot be dismantled it should be measured as whole. ELC/CELMA: Integral LEDs are often in chandeliers, they cannot be measured because of their dimension.

INFORSE agree. LED should be removable also for recycling purposes.

PLDA: integral luminaires should not be included because they are not a lamp. Lamps in luminaires cannot be compared to lamps. Do we deal with luminaires in this regulation?

ECOS: LEDs can be integrated into other products too, e.g. furniture. LED module should be required to be removable. For surveillance purposes it should always be possible to test the individual module.

COM: the real question is whether LED modules can be always removed, at least for testing. If yes, no need to cover the luminaire level to prevent loophole. ELC/CELMA: luminaire makers always start from module level when building a luminaire. It is useful to be able to replace the module only (in case there are better ones in the future, and also for recycling). Modules can be measured on their own, luminaire makers do it themselves. You can always go back to the level of the module.

PLDA: How to deal with Chinese luminaires which are often completely integrated, with no possibility to remove the LED modules? You have to require that modules should be removable. This might be a challenge for market surveillance, as the market is not operating that way now. ELC/CELMA support PLDA. We need workable legislation, not overly complicated.

COM: a number of other pieces of legislation exist on the dismantleability of equipment for recycling, so it would not be a premiere.

NL: Dismantleability criteria would be a clear message to everyone, in third countries alike.

IT: For surveillance, we need to define what removability is. It is a requirement on the luminaire, not on the lamp.

COM: more examination in TSG is needed.

Ambition and timing of efficiency requirements

ELC/CELMA do not want to fix stage 3 already now. Technology is evolving fast. LEDs fall under WEEE, they have to be recycled. We should see where the technology evolves, and set stage 3 criteria at 2015 revision.

FR: Why does industry not agree to fix a target in the third stage, which can be reviewed just before? It's good to have a target.

ECOS why not set stage 3 earlier for non-filament lamps? Stage 1 and 2 bring only small improvement for filament, we need at least a signal for the market for later stages. The usual explanatory note to the working document is missing, we need to understand what is the objective, which level LEDs should achieve ultimately. We also need a comparison of different scenarios, in terms of savings, in order to be able to decide. COM: it is not the A++ class that we are defining here, it is minimum requirements in 2012. Dynamic progression is ensured by making what is top class in 2012 minimum requirement in 4 years.

AT: in filament lamps, division between low voltage (LV) and mains voltage (MV) lamps could help, so that we are more ambitious with low voltage lamps, and more cautious with MV. Cost and availability issues for the latter could be rediscussed in 2015, before a tougher target comes into force.

COM: ambitious early requirements for the low voltage halogen are an interesting idea, to be further discussed in the TSG, as there are also patent issues.

ELC/CELMA: intellectual property rights are not the only obstacle. Infrared coating (IRC) brings huge price increase, maybe it does not even pay off over the lifetime.

ECEEE: agree with AT. 3 euro price increase, 4.5 euro in savings over the lifetime. Australia already adopted such requirements, they also set a cap on light output to ensure that 50W conventional halogens are replaced by 35W IRC halogens, not 50W IRC halogens.

PLDA: the best available technology (BAT) in halogens is not being mass-produced, because if they are phased out in 2016 anyway, there is no incentive to invest in mass production. Maybe we should push for BAT now, but then allow their sales for a longer time into the future.

Additional packaging information

ECOS: as indication on mercury content, nobody understands "2 mg Hg". The requirements for format and content should standardise a better indication.

SE: on amalgam lamps, the promotional statement "no liquid mercury" can lead to consumers believing there is not mercury at all.

ANEC/BEUC and DE: more information should be on the package to inform consumer what to do when mercury (from CFL, HID) is emitted in a room when the lamp breaks. DE made studies of breaking lamps and will publish the results. COM warn against bad reporting of scientifically accurate results, in light of recent negative press.

ANEC/BEUC: information on functionalities (pictograms) should be provided in a standardized way, ideally in the energy label. COM wonders whether it would make packagings more "monotonous" visually. ELC/CELMA are against standardised pictograms, because it would interfere with the corporate identity due to the small packaging. ANEC/BEUC: this proves that standardised icons are a marketing issue only. Shall we favour marketing over clarity and comparability?

INFORSE: Info on free access websites: designated authorities or central NGO website should get a copy of the information so that consumers can access it in one place.

ELC/CELMA: E-lumen.eu website could be used for that, but ELC/CELMA need to check how it would work in practice. COM: We have to check if legally it is possible to establish via an Ecodesign Regulation an EU-wide database or national databases requiring manufacturers and importers to register all lamps placed on the market and their product information.

Health and safety

BE express concerns over health aspects of ultraviolet (UV) emissions. Allegedly blue LED light would be dangerous for children. SE: In terms of LED safety - should we regulate glare and blue light, should it be linked to IEC standards, or should we have our own standards? UK agree that the forthcoming opinion of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) on UV should be taken into account when deciding on labelling.

COM: there is other EU legislation apart from Ecodesign where we could regulate safety issues, we should be careful not to duplicate.

Retrofit LEDs

COM: requirements on LEDs that are retrofits to fluorescent lamps were introduced on request of industry, but because of lack of independent evidence, the working document proposes an approach applying a principle (retrofits should offer the same service as the lamps they replace), rather than concrete limit values.

CEN: remind the meeting of ADCO work on safety of LED retrofits.

PLDA: this regulation is not the place to tackle retrofits to fluorescents, it is about DLS. COM: We target NDLS LEDs anyway in this regulation, it is not only about DLS. PLDA: would like to see one legislation applying to one set of products, not to complicate things.

FR: agree that retrofits should have the same light quality, but it is difficult to achieve for halogen retrofits. They also need to be more efficient, which is in the end the main objective of a retrofit.

ECOS: how is a 'retrofit' lamp defined? Does it mean that when it is not declared as retrofit, the performance is not regulated? COM: DLS lamps are standardised in size and shape, it is obvious if they try to replace a particular model, even without the manufacturer claiming it.

ELC/CELMA: the proposed approach may not work, as it could bring competition issues if luminaires and lamps from other manufacturers need to be mentioned for the purposes of comparing the retrofit to them. COM: this could be perhaps solved by restricting to the technical documentation (available only to market surveillance authorities) the obligation to provide references to other products.

Halogen transformers

ELC/CELMA: operating the lamp close to the transformer is possible for electronic ones, which can be efficient. But magnetic ones should be kept, as only they can operate lamps at more than 2 metres distance (e.g. museums, restaurants etc). TSG should refine the proposal.

COM: What about the 91% efficiency requirement set in Australia in 2010, which did not abolish all converters? What about toroid magnetic transformers that can have efficiencies even higher than electronic ones?

ELC/CELMA: COM draft requires an average efficiency over 4 active modes; Australia just for full load. It is true that toroid transformers are very efficient, but they are so expensive it does not make sense to use them.

Verification procedure

DK: there were many problems in verifying compliance with Regulation 244/2009 because of the single tolerance, we should avoid them under the new regulation.

COM: precise tolerance limits should be developed in TSG.

NL: if retrofit LED lamps are considered retrofits even without explicit claim by the manufacturer, that is a challenge for market surveillance, who would have to keep comparing lamps with each other to see if they happen to comply with the retrofit definition in the Regulation.

Functional requirements (life, lumen maintenance, etc.)

COM: ANEC/BEUC say consumers expect the same functionality from every lamp, so why do we need separate requirements? The question is really: should functionality requirements be common to all lamps, meaning they would have to be set at level of the lowest common denominator, or should we be more ambitious per technology? A related question: do we want all LEDs to work reasonably, or should we have a class of excellence rewarded by some sort of label?

IT: the proposed requirement on colour temperature (CCT) for retrofit LEDs should have in all logic also applied to retrofit CFLs in 244/2009. COM: a CCT requirement could make sense for retrofit DLS CFLs, but most of the time they cannot be claimed as retrofits because of their wide beam angle.

PLDA: professional lighting would require a separate set of functionality requirements. We have to set the bar high, so that they are OK for professional use. COM: yes, we need to make sure that the combination of efficiency and functionality requirements are such that they do not remove from the market professional lamps.

AT: the number of switching cycles for LEDs is rather low.

DK: we should not repeat mistake that was made by allowing low-quality CFLs in the beginning. The functionality requirements for LEDs should be strict, prices will go down with volume.

ECOS wonder about differences compared to LED Quality Charter. A minimum colour rendering of 80 should be enough, there is no need to have a higher requirement for retrofits. It is not needed either to have a higher power factor than in the Quality Charter. In the US, there is a warranty system required with Energy Star. Could that be done in the EU under Ecodesign? COM explain that working document is a starting point, not a final proposal, it should be refined.

ANEC/BEUC: Why set lamp survival factor (LSF) and lumen maintenance requirement differently for CFLs and LEDs? COM: in order to avoid locking in CFLs by imposing too high lifetimes, we rather require more lamps to survive after a certain time. For LEDs, there are no such considerations in mind for the moment. ANEC/BEUC and AT: The consequences of setting LSF at 50% are not understood by consumers.

ELC: overview matrix in relation to the table would be useful, to compare positions. We should remember that these are mandatory requirements, and the CE marking's credibility needs to be re-established. The power factor discussion is to be continued in TSG on the basis of another ELC table. Postulate 'the more efficient the LED, the worse the other performance characteristics'.

ECEEE disagree: there are now LED solutions that are both efficient and performing.

FR: an Annex under the International Energy Agency (IEA-4E) is currently investigating the functionalities of LEDs. For example, the CCT of LEDs is not measurable the same way as for CFLs. New standards will be adopted soon, we should leave space for them with the

Regulation. COM: there seems to be a general wish to move ahead with functionality requirements, even if they will not be fully compatible internationally.

On request of NL, COM confirm that the functionality requirements are meant to apply both to self ballasted and non ballasted lamps.

Time schedule of further steps:

Additional comments before 12.7.2011, COM will circulate questions to the TSG on 19.7.2011. Preliminary answers will be expected one week before the TSG meeting on 23.9.2011. Forum members will be give some time afterwards to refine their position papers in light of the TSG meeting.

General remark from Member States that they want to stay involved and not delegate all to technical consultation. DE, IT and UK would like to have the regulatory committee vote on the Ecodesign measure before the labelling measure is adopted by the COM.

COM provided a brief overview of the status of the ongoing work on ecodesign requirements for other product groups than lighting.

ANNEX 2: Impact assessment methodology

The impact analysis uses the variable **inputs** as defined in the following paragraphs and used in Chapter 5. The analysis is based on the data collected in the ecodesign preparatory study. [73]

The **calculation method** for the analysis is a so-called **Stock Model,** which means that it is derived from accumulated annual sales of DLS over the period 1990-2020 (with a start-up period 1986-1990).

The stock-model sets the pace for the sub-options. The direction is determined by trends in market penetration (DLS/dwelling), number of households and lamp-characteristics (operating hours, lumen, W). From these stock data the fitting sales data were calculated

Outputs for each sub-option are:

- Electricity consumption in TWh/a;
- Primary energy consumption in PJ/year (conversion 1 TWh electric = 2,5 *3,6 PJ primary);
- Carbon emission in Mt CO2 equivalent/a, using a multiplier based on electricity and gas shares (see below) and the values from the EcoReport in the preparatory study;
- Mercury emissions in t Hg/a;
- Customer-related economical parameters: purchase price, energy expenditure, repair cost and total expenditure in € billion/year (2005 Euro, inflation-corrected at 2%/a);
- Business-related economical parameters: turnover per sector (industry, trade, etc.);
- Employment: calculating job creation/loss using the sector-specific turnover per employee.

Final outcomes are presented at a high aggregation level (totals), but in the intermediate stages a distinction is made by the typology and by size.

For the economic calculations, an average energy price in €/ kWh primary energy is built from:

- Electricity rates per kWh primary energy. For electricity, the assumption is to use industrial (SME) electricity rates excluding taxes in 2006, i.e. € 0,152/kWh;
- Annual (long-term 2000-2006 average) electricity price rate increase of 2%.

Data from Chapter 2 and 5 are used for the definition of the base case and calculated on the basis of the relative market shares of the lamp categories considered. The table below gives the characteristics of the base-case reflector lamps and their substitutes. Note that not all levels are filled

Table 7: Directional lamp base-cases and substitutes used in the stock model

		base-cases				substitutes: GLS			HL-MV-HW		HL-MV-LW			HL-LV	
		1	**2**	**3**	**4**	**1.1**	**1.2**	**1.3**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**4.1**	**4.2**
	unit	**GLS**	**HL-MV-HW**	**HL-MV-LW**	**HL-LV**	**HL-MV-LW**	**HL-MV-LW**	**LEDi**	**CFLi**	**HIDi**	**HL-MV-LW**	**CFLi**	**LEDi**	**HL-LV**	**LEDi**
Wattage	W	50	100	50	35	50	40	7,4	34	25	40	11	4,7	20	4,4

[73] Tichelen, P. van (VITO) et al., Preparatory study Lot 19: Domestic lighting - Part 2 Directional Lampas and household luminaires, 2009; documentation available on www.**eup4light**.net

Lam Wattage Factor		1	1	1	1,06	1	1	1	1,1	1,1	1	1	1	1,06	1,2
lumen 90° cone*	lm	258	1054	315	392	315	388	247	954	846	388	180	145	350	116
Label lm/W*		8,3	14,5	9,2	15,4	9,2	14,2	48,0	35,0	46,5	14,2	29,7	44,3	24,1	37,9
tlife	h	1000	2000	1500	3000	1500	2000	15000	8100	8100	2000	6000	10000	3000	10000
toperating	h	**484**	**555**	**555**	**695**	**484**	**484**	**484**	**555**	**555**	**555**	**555**	**555**	**695**	**695**
tlife in years	yr	2,07	3,60	2,70	4,32	3,10	4,13	30,99	14,59	14,59	3,60	10,81	18,02	4,32	14,39
price incl. VAT	€	1,3	13,5	3,6	2,4	3,6	8,1	10	27	40	8,1	18	10	8	10
klm/yr (at LWF=1)		125	585	175	272	152	188	120	528	470	215	145	80	243	81
€ (price)/Glm.yr		10	23	21	9	24	43	84	51	85	38	124	124	33	124
Wh/lm (at real LWF)		0,194	0,095	0,159	0,095	0,159	0,103	0,030	0,057	0,033	0,103	0,042	0,032	0,061	0,046

Electricity saving	€/yr	ref	ref	ref	ref	0,67	1,73	3,13	3,39	5,58	1,49	3,12	3,38	1,34	1,93
Extra price	€/yr	ref	ref	ref	ref	0,53	1,33	-0,31	-1,90	-1,01	0,92	0,33	-0,78	1,30	0,14
Payback period**	yr	ref	ref	ref	ref	0,8	0,8	-0,1	-0,6	-0,2	0,6	0,1	-0,2	1,0	0,1

**= 120° cone for CFLi. Label lm/W=(lumen 90° /W)/LWF*

***= SPP, Simple Payback Period (not discounted) against base cases. Negative values when no price increase*

****=projected LEDi price 2016*

Table below shows some of the key economic and environmental inputs

Table 8: Economic and mercury-related data used in the stockmodel

ECONOMIC VARIABLES		
Rel	0,153	Electricity rate 2006 [€/ kWh electric]
Relinc	0,02	Annual price increase electricity / a
PriceDec	0	Annual product price decrease / a
ManuFrac	0,4	Manufacturer Selling Price as fraction of Product Price [%]
RetailMargin	0,43	Margin Retailer on product [% on wholesale price]
VAT	0,17	Value Added Tax [in % on retail price]
ManuWages	0,1	Manufacturer turnover per EU employee [mln €/ a]
OEMfactor	1,2	OEM personell as fraction of WH manufacturer personell [-]
RetailWages	0,041	Retail turnover per employee [mln €/ a]
ExtraEUfrac	0,8	Fraction of OEM personell outside EU [% of OEM jobs]
Inflation	0,02	Inflation rate/a
Discount	0,04	Discount rate/a
MERCURY		
Hg_CFL	4	mg Hg/CFLi
Hg_HID	2,5	mg Hg/HID
Hg_kWh	0,016	kg Hg/TWh

For the impact assessment, the environmental analysis used the EuP EcoReport results from the preparatory study. The table below gives the environmental impacts per lumen and per hour.

Table 9: Environmental impacts per lumen and per hour (prep. study)

		GLS-R	***HL-MV-R-HW***	***HL-MV-R-LW***	***HL-LV-R***
main env. indicators	**unit**	per lm.h	per lm.h	per lm.h	per lm.h
Energy (GER)	J	2247	1037	1787	1088
share electricity	J	2036	999	1670	1042
Water (process)	µltr	137	68	84	70
Waste, non-haz./ landfill	µg	2726	1411	2169	1285

Waste, hazardous/ incin.	µg	51	24	41	25
Emissions (Air)					
Greenhouse Gases (GHG)	mg CO_2 eq.	107	47	83	49
Acidifying agents (AP)	µg SO_2 eq.	573	265	457	279
Vol. Org. Comp. (VOC)	ng	1035	467	777	450
Pers. Org. Pollut.(POP)	10^{-3} pg i-Teq	15	8	12	7
Heavy Metals (HM)	ng Ni eq.	47	22	36	21
PAHs	ng Ni eq.	15	3	9	4
Particulates (PM, dust)	µg	28	24	20	9
Emissions (Water)					
Heavy Metals (HM)	ng Hg/20	14	8	34	7
Eutrophication (EP)	ng PO_4	107	88	395	42

The Figure below shows EU27 Electricity rates 2007[74].

[74] Source: Eurostat Oct. 2008 relating to retail prices on 2nd semester 2007. Range for annual consumption of household band Dc (2 500 kWh — 5 000 kWh) and industry band Ic (500 MWh — 2 000 MWh).

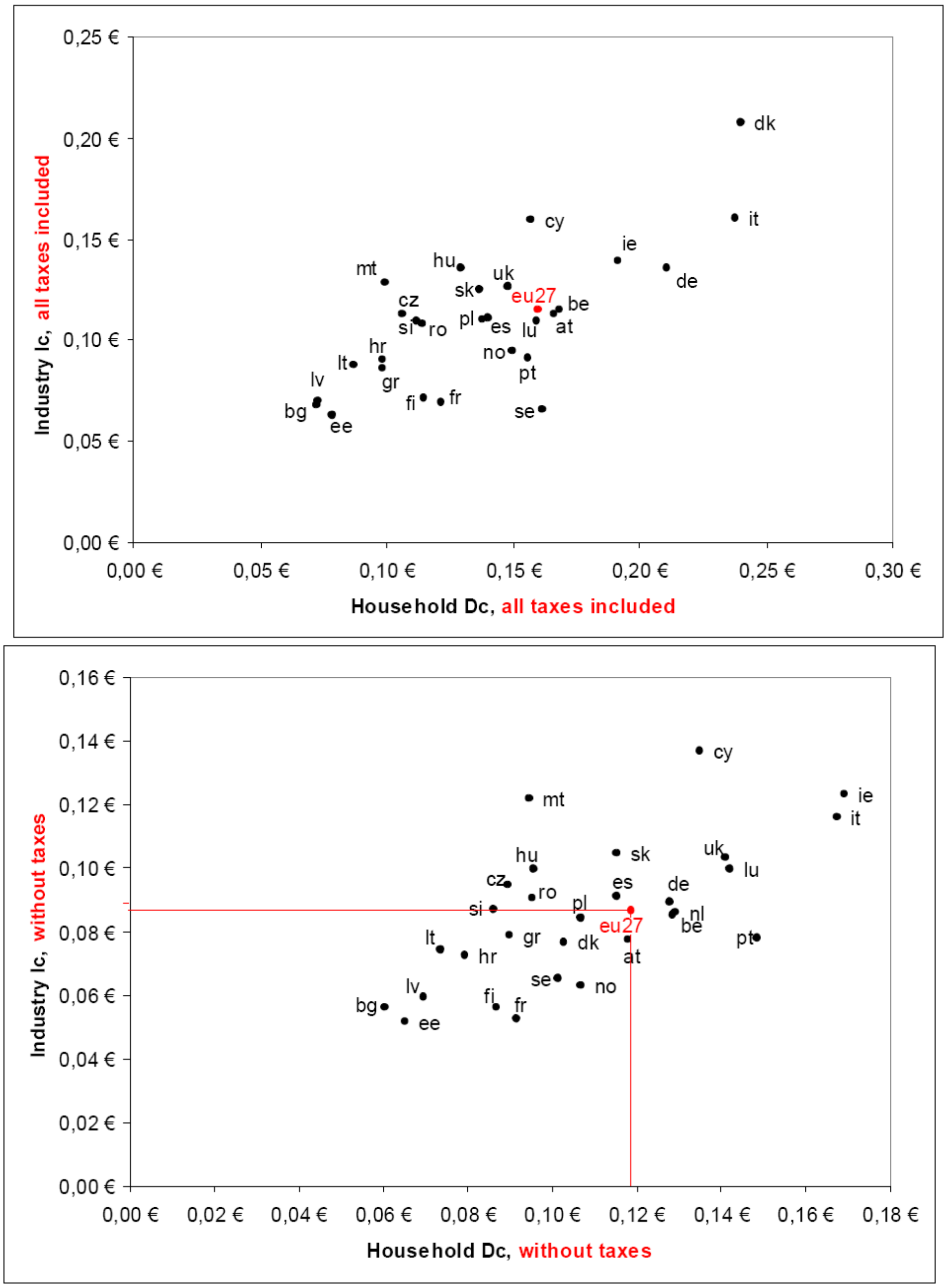

0,25 €
0,20 €
0,15 €
0,10 €
0,05 €
0,00 €
Industry Ic, all taxes included
0,00 €
0,05 €
0,10 €
0,15 €
0,20 €
0,25 €
0,30 €
Household Dc, all taxes included
dk
it
cy
ie
de
mt
hu
uk
sk
eu27
be
cz
si
ro
pl
es
lu
at
hr
lt
no
pt
lv
gr
fi
fr
bg
ee
se
0,16 €
0,14 €
0,12 €
0,10 €
0,08 €
0,06 €
0,04 €
0,02 €
0,00 €
Industry Ic, without taxes
0,00 €
0,02 €
0,04 €
0,06 €
0,08 €
0,10 €
0,12 €
0,14 €
0,16 €
0,18 €
Household Dc, without taxes
cy
ie
it
mt
hu
sk
uk
lu
cz
ro
es
de
si
pl
nl
eu27
be
lt
gr
dk
pt
hr
at
se
no
lv
fi
fr
bg
ee

Figure 12

ANNEX 3: Scenario outputs (tables) to (sub) options

TWh	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	10	20	40	42	43	44	45	46	47	51	56
Lbl only	10	20	39	42	43	43	44	44	45	46	48
Min only	10	20	39	41	42	44	45	46	47	49	50
Lbl+Min I	10	20	39	41	42	43	44	44	44	46	48
Lbl+Min II	10	20	39	41	42	43	43	43	41	26	27

TWh saving	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Lbl only	0	0	0	0	1	1	2	2	3	5	8
Min only	0	0	0	1	1	0	0	0	0	2	6
Lbl+Min I	0	0	0	1	2	1	2	3	3	5	8
Lbl+Min II	0	0	0	1	2	2	2	4	6	25	28

Purchase costs (bln. Euro)

Affordability	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	0.3	0.7	1.7	1.7	1.8	1.8	1.9	1.9	1.9	2.1	2.1
Lbl only	0.3	0.7	1.7	1.8	1.8	1.9	1.9	2.0	2.1	2.3	2.5
Min only	0.3	0.7	1.7	2.3	2.6	2.8	3.0	3.2	3.3	3.7	3.8
Lbl+Min I	0.3	0.7	1.7	2.0	2.5	2.7	2.9	2.8	2.7	2.3	2.5
Lbl+Min II	0.3	0.7	1.7	2.0	2.5	2.7	4.1	5.0	5.9	4.6	2.0

Extra purchase	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Lbl only	0	0	0	0	0	0	0	0	0	0	0
Min only	0	0	0	1	1	1	1	1	1	2	2
Lbl+Min I	0	0	0	0	1	1	1	1	1	0	0
Lbl+Min II	0	0	0	0	1	1	2	3	4	2	0

Mt CO2/TWh	0.5	0.46	0.43	0.43	0.42	0.42	0.41	0.41	0.40

Mt CO2	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	5.0	9.4	17.2	18.0	18.3	18.5	18.7	18.9	19.1	19.6	20.1
Lbl only	5.0	9.4	17.0	17.8	17.9	17.9	18.0	18.0	18.0	17.8	17.3
Min only	5.0	9.4	17.0	17.5	17.8	18.3	18.7	18.9	19.1	18.7	18.1
Lbl+Min I	5.0	9.4	17.0	17.5	17.5	17.9	18.0	17.8	17.7	17.6	17.3
Lbl+Min II	5.0	9.4	17.0	17.5	17.5	17.8	17.9	17.4	16.5	10.1	9.9

Mercury in electricity

t Hg	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025

Baseline	0.2	0.3	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.9
Lbl only	0.2	0.3	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8
Min only	0.2	0.3	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
Lbl+Min I	0.2	0.3	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8
Lbl+Min II	0.2	0.3	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.4	0.4

Mercury in lamps discarded

t Hg	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lbl only	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Min only	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
Lbl+Min I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lbl+Min II	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3

Mercury total

t Hg	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	0.2	0.3	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9
Lbl only	0.2	0.3	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8
Min only	0.2	0.3	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	1.2
Lbl+Min I	0.2	0.3	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8
Lbl+Min II	0.2	0.3	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.8

Electricity costs (at 2007 prices)

bln. Euro	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	1.5	3.1	6.1	6.5	6.6	6.8	6.9	7.1	7.2	7.8	8.5
Lbl only	1.5	3.1	6.0	6.4	6.5	6.6	6.7	6.7	6.8	7.1	7.3
Min only	1.5	3.1	6.0	6.3	6.5	6.7	6.9	7.1	7.2	7.5	7.7
Lbl+Min I	1.5	3.1	6.0	6.3	6.4	6.6	6.7	6.7	6.7	7.0	7.3
Lbl+Min II	1.5	3.1	6.0	6.3	6.4	6.6	6.6	6.6	6.3	4.0	4.2

Total consumer expenditure

bln. Euro	1991	2000	2010	**2011**	2012	2013	2014	2015	2016	2020	2025
Baseline	1.8	3.8	7.8	8.2	8.4	8.6	8.8	9.0	9.2	9.9	10.6
Lbl only	1.8	3.8	7.7	8.2	8.3	8.5	8.6	8.7	8.9	9.4	9.8
Min only	1.8	3.8	7.7	8.6	9.0	9.5	10.0	10.3	10.6	11.2	11.4
Lbl+Min I	1.8	3.8	7.7	8.3	8.9	9.2	9.6	9.5	9.4	9.3	9.8
Lbl+Min II	1.8	3.8	7.7	8.3	8.9	9.3	10.7	11.6	12.1	8.6	6.2

ANNEX 4: International comparison

Extract Chapter 2 of

Navigant Consulting Europe Ltd. for DEFRA, *International directional lamp regulatory review*, DEFRA, London, May 2010.

Overview

There are currently three countries that regulate directional lamps – Australia, Canada and the United States. Although there are differences in coverage between these three countries, generally the regulations for Canada and the United States are similar. Canada and the United States tend to work toward harmonised regulatory requirements in order to reduce burden on manufacturers and associated costs to consumers. In Australia, the scope of coverage is broader than Canada and the United States, and new interim regulatory standards adopted in 2008 are scheduled to be phased in starting October 2010 and then October 2012. The US also recently adopted new regulatory requirements for incandescent reflector lamps, which take effect in July 2012, and Canada is conducting an analysis to determine whether these same levels are appropriate for its market. Overall, after adjusting for voltage differences, the US and Australia have largely comparable efficacy requirements for large diameter lamps, and Australia has stronger efficacy requirements on the small diameter.

Table 10: Summary of MEPS for Directional Lamps Internationally

Country	Minimum Energy Performance Standards	Adopted	Effective	Lamp Types*
Australia	AS NZS 4934.2(Int)-2008 Incandescent lamps for general lighting services - Minimum Energy Performance Standards	March 2008 (Interim)	October 2010	Low-voltage halogen
			October 2012	Mains voltage reflector lamps
Canada	CSA C862-01 Performance of incandescent reflector Lamps (Table 1)	Nov. 1995	April 1996	Incandescent and halogen reflector lamps
		April 2003	Jan. 2003	BR lamps; ER lamps other than ER lamps with a nominal power of 50, 75 or 120 W
Canada	CSA C862-01 Performance of incandescent reflector Lamps (Table 2)	April 2003	Jan. 2003	ER lamps with a nominal power of 50, 75 or 120 W
USA	10 CFR 430.32(n)(4)	EPACT 1992	Nov. 1995	Incandescent and halogen reflector lamps
USA	10 CFR 430.32(n)(5)	July 2009	July 2012	Incandescent and halogen reflector lamps

* Note: at the highest level, these are the categories of lamp types covered, however within each regulatory authority, there are specific scopes of coverage which are discussed in the individual sections that follow.

Australia

Australia's regulatory programme for directional lamps focuses on establishing MEPS for extra low-voltage (ELV) halogen reflector lamps and mains-voltage incandescent and halogen directional lamps. The following definitions for these two product groups were published in the Interim Australian/New Zealand Standard, "Incandescent lamps for general lighting services, Part 2: Minimum Energy Performance Standards (MEPS) requirements" (AS/NZS 4934.2(Int):2008).

ELV halogen reflector - these lamps have the following attributes:

- Shapes: MR 11-16.
- Caps: Bi-pin.
- Nominal voltage: 5–24 V (inclusive).

Mains voltage reflector (including halogen) - these lamps have the following attributes:

- Tungsten filament or tungsten halogen lamp burner, with reflector.
- Shapes: PAR, ER, R, RE, XR, YR, ZR or MR 11-16.
- Caps: E14, E26, E27, B15, B22d or GU10.
- Nominal voltage >220 V.
- Not including primary coloured lamps.

The Australian scope of coverage for directional lamps is more expansive than that of Canada and the United States. The Australian regulation encompasses all the common base-types found both on low-voltage and line-voltage reflector lamps. Standard line voltage in Australia is 240-250V, therefore having the nominal voltage listed as simply greater than 220V will include vast majority of the market. Furthermore, the scope includes a wide variety of lamp shapes, and is not constrained by lamp diameter or by wattage range.

In terms of constraints, the Australian scope of coverage applies to incandescent and halogen lamps, and does not include reflector lamps that are based on compact fluorescent, metal halide or light emitting diode technologies. It is, however, unclear whether these products may be covered under separate regulations are constitute products that the Australian government is intending to cover in the future.

The current Australian MEPS are based on a single equation that is phased in to the covered product in two stages. Although they may be revised in the interim, the MEPS are scheduled to become mandatory for all ELV halogen reflector lamps beginning in October 2010 and for all mains voltage reflector lamps beginning in October 2012. The minimum efficacy requirement for these reflector lamps is a function of the natural log of the lumen output of the lamp:

Initial efficacy shall be $\geq 2.8 \ln(L) - 4.0$

Where:

L = Initial luminous flux of the lamp in lumens

Due to the fact that there is no minimum or maximum nominal lamp wattage, this MEPS level is broadly applicable to reflector lamps sold in Australia. Figure 1 plots the Australian regulation, along with the United States' EPACT 1992 levels for scale. It should be noted that the EPACT 1992 levels were never applicable in Australia, however they represent a halogen technology level that was required in the United States for certain reflector lamps since 1995 and in Canada since 1996. The EPACT 1992 levels are presented in wattage versus efficacy, and thus have been converted to lumen versus efficacy for this figure. Furthermore, the

EPACT 1992 levels were established for 120V wattage lamps, and thus have been adjusted to what levels they would have been (i.e., lower) on a 240V system.

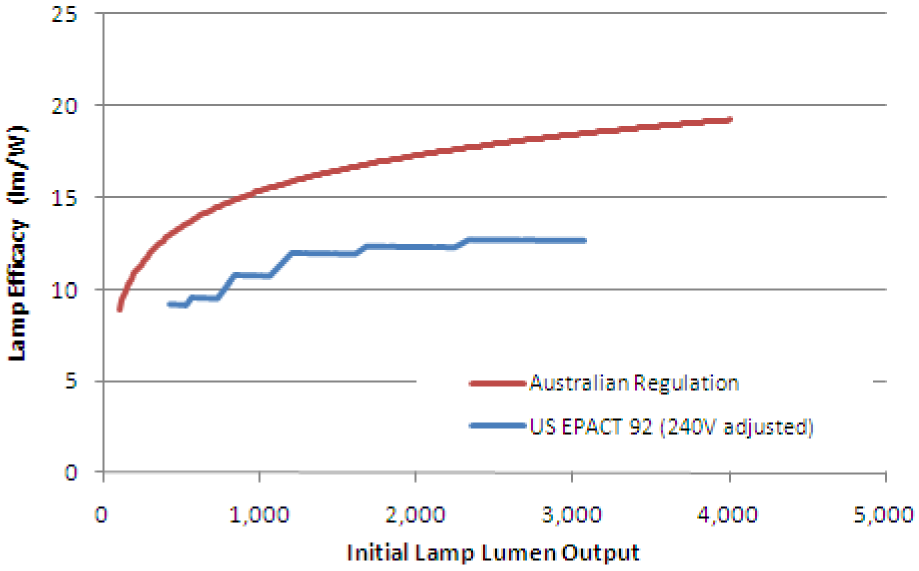


Figure 13. Australian MEPS Compared with Voltage Adjusted EPACT 1992 (240V)

In addition to the efficacy requirement plotted above, the Australian government is also considering the possibility of establishing a maximum wattage limit on MR-16 lamps. The reason for this is to avoid the development of a new group of 50W MR-16 lamps that would take the efficacy requirements and produce more light rather than hold light output constant and lower the wattage. In other words, today's market in Australia includes two types of MR-16 lamp which have approximately equivalent levels of light output – a low efficacy 50W (which represents >95% of sales) and a high efficacy 35W (which has <5% of sales). Consumers can purchase and install lamp as both operate on existing magnetic and electronic control gear. The Australian government is concerned that if the new regulation becomes applicable without a wattage cap, the market may respond by introducing a brighter (i.e., higher lumen flux), more efficacious 50W MR-16 lamp that is compliant with the new MEPS but will not save consumers any energy. By combining an efficacy requirement with the maximum wattage limit for this popular lamp, Australia would ensure the 30% energy savings potential from this technology will benefit consumers in their market. For more detail on this issue, see Annex A.

However, such a wattage cap has also negative impacts for new installations, where users who would have otherwise opted for installing a few efficient high-wattage lamps will have to ensure the same illumination level with many small-wattage lamps, a solution which is less efficient. Also, the European experience of phasing out incandescent bulbs of 60, 75, 100W has not shown the emergence of halogen bulbs of 60, 75, 100W that would simply provide more light. Instead, all of these wattage categories have been replaced by more efficient lamps of lower wattages providing the same amount of light, where equivalence claims help the users identify which lamps they need. This is a spontaneous development which shows that it is more appealing to European consumers to claim an effiency gain than to claim that a lamp provides more light for the same wattage. Thus, a wattage cap will not be necessary in EU legislation.

It should be noted that the Australian regulation also has a minimum median lamp life of 2000 hours and lumen maintenance period of at least 80% of initial lumen output after 75% of rated life. This calculation of lumen maintenance excludes any lamps in the sample that fail prior to the 75% of rated life test.

Canada

In Canada, Natural Resources Canada (NRCan)'s Office of Energy Efficiency establishes regulatory requirements of consumer products and commercial equipment, including incandescent reflector lamps (i.e., directional lamps). In November 1995, Canada updated its Energy Efficiency Regulations (SOR/94-651) to include incandescent reflector lamps, adopting a standard level harmonised with the United States EPACT 1992, and which became effective in April 1996. Canada then issued Amendment 6 to establish minimum energy performance standards for certain products, including incandescent reflector lamps. Amendment 6 was registered on April 10, 2003 and published in the Canada Gazette Part II on April 23rd. This Amendment, which covered and regulated certain bulge reflector (BR) and ellipsoidal reflector (ER) shaped reflector lamps, started on January 1, 2003. Canada is actively working on revisions to its regulations on incandescent reflector lamps (i.e., Bulletin stating NRCan's intentions is expected in May 2010), which will raise the efficacy requirements and increase its scope of coverage for BR and ER shaped lamps.

Canadian MEPS for reflector lamps apply to three lamp categories: (1) general service incandescent reflector lamps; (2) BR lamps and (3) ER lamps. Although they are expected to change in the near future, the current regulatory definitions for each of these terms follow below:

"general service incandescent reflector lamp" means an incandescent reflector lamp[75]

- with an R bulb shape, a PAR bulb shape or a bulb shape similar to R or PAR that is neither ER nor BR, as described in ANSI C79.1,
- with an E26/24 single contact or E26/50 × 89 skirted, medium screw base,
- with a nominal voltage or voltage range that lies at least partially between 100 volts and 130 volts,
- with a diameter greater than 70 mm (2.75 inches), and
- that has a nominal power of not less than 40W and not more than 205W, *but does not include*
- a coloured incandescent reflector lamp, or
- an incandescent reflector lamp that
- is of the rough or vibration service type with
- a C-11 filament, as described in the IES Handbook, with five supports exclusive of lead wires,
- a C-17 filament, as described in the IES Handbook, with eight supports exclusive of lead wires, or
- (C) a C-22 filament, as described in the IES Handbook, with 16 supports exclusive of lead wires,
- is of the neodymium oxide type and has a lens containing not less than 5% neodymium oxide,

[75] The Canadian regulations also define the term "incandescent reflector lamp" as a lamp in which light is (a) produced by a filament heated to incandescence by an electric current, and (b) directed by an inner reflective coating on the outer bulb.

- has a coating or other containment system to retain glass fragments if the lamp is shattered, and is specifically marked and marketed as an impact resistant lamp,
- is specifically marked and marketed for plant growth use and
- (A) has a spectral power distribution that is different from that of the lamps described in paragraphs (a) to (e), and
- contains a filter that suppresses yellow and green portions of the spectrum, or
- is specifically marked and marketed
- as an infrared heat lamp,
- for heat-sensitive use,
- for mine use,
- for marine, aquarium, terrarium or vivarium use, or
- for airfield, aircraft or automotive use.

"BR lamp" means an incandescent reflector lamp as described in ANSI C79.1, but does not include any of those lamps that have: (a) a diameter of 95.25 mm (BR30) and a nominal power of less than 66 W, (b) a diameter of 92.5 mm (BR30) and a nominal power of 85 W, or (c) a diameter of not less than 120.65 mm (BR38) but not more than 127 mm (BR40) and a nominal power of less than 121 W.

"ER lamp" means an incandescent reflector lamp as described in ANSI C79.1.

The pending revisions will address issues such as the diameter (d) in the definition of a general service incandescent reflector lamp. This will be reduced from 2.75 inches to 2.25 inches, to bring it into alignment with the US regulation promulgated by the Energy Independence and Security Act of 2007 (EISA 2007). In addition, the exemption for BR lamps will be narrowed to only include (a) BR30 (95mm) and BR40 (127mm) of 50 watts or less and (b) BR30 and BR40 of 65 watts.

Given these definitions, there are certain reflector lamps that are not included in the Canadian regulations, such as:

- Reflector lamps with base types other than E26 medium screw base, such as common MR-11 and MR-16 base types including 2-Pin GU5.3; GU10, GX5.3 and G4, as well as candelabra and other screw base types smaller than E26.
- MR-16 lamps are a popular directional lamp in the Canadian market, and yet the reflector has a 2-inch diameter, meaning it is not included in the scope of coverage for Canada’s MEPS.
- Compact fluorescent reflector lamps, ceramic metal halide reflector lamps or LED reflector lamps that may be used as replacements for certain halogen directional lamps because the definition of incandescent reflector lamp only applies to heated-filament lamps.
- Certain BR and ER lamps, which exclude the popular 65 watt rated model.

As discussed above, NRCan is in the process of updating its regulatory requirements in to eliminate the separate set of less stringent efficacy requirements for certain ER lamps, and is proposing to adopt one table of efficacy requirements that applies to all covered reflector lamps (see Table 2) with a retroactive effective date proposed of June 1, 2009.

Table 11: Minimum Average Lamp Efficacy – R, PAR, BPAR, BR and ER Lamps*

Nominal Lamp Wattage	Minimum average lamp efficacy (lm/W)
40-50	10.5
51-59	11.0
60-85	12.5
86-115	14.0
116-155	14.5
156-205	15.0

* Note that this regulation will not apply to BR30 (95mm) and BR40 (127mm) lamps of 50 watts or less and BR30 and BR40 lamps of 65 watts which are excluded by definition.

Although Table 2 may look similar to the United States' EPACT 1992 regulatory level, NRCan has modified two of the nominal lamp wattage ranges to slightly increase the efficacy requirement for one group. Table 3 below depicts this change in the second and third product classes. The second and third wattage product classes have been modified to shift lamps with wattages ranging from 60 through 66 watts so they are held to a more stringent efficacy requirement (12.5 lm/W rather than 11.0 lm/W).

Table 12: NRCan Modification to Average Lamp Efficacy MEPS

Product Class	NRCan Lamp Wattage	US DOE Lamp Wattage	Minimum average lamp efficacy (lm/W)
1	40-50	40-50	10.5
2	51-59	51-66	11.0
3	60-85	67-85	12.5
4	86-115	86-115	14.0
5	116-155	116-155	14.5
6	156-205	156-205	15.0

In the anticipated regulatory update, if NRCan intends to harmonize with the US DOE's regulatory standard for incandescent reflector lamps passed in July 2009, presents the MEPS that would be proposed in Canada.

Table 13: NRCan Proposed MEPS for General Service Incandescent Reflector Lamps

Rated Lamp Wattage	Lamp Spectrum	Lamp Diameter	Rated Voltage	Minimum Average Lamp Efficacy (lm/W)
40 – 205	Standard Spectrum	> 63.5 mm (2.5 inches)	≥125 V	$6.8*P^{0.27}$
			<125 V	$5.9*P^{0.27}$
		≤ 63.5 mm (2.5 inches)	≥125 V	$5.7*P^{0.27}$
			<125 V	$5.0*P^{0.27}$
40 – 205	Modified Spectrum*	> 63.5 mm (2.5 inches)	≥125 V	$5.8*P^{0.27}$
			<125 V	$5.0*P^{0.27}$
		≤ 63.5 mm (2.5 inches)	≥125 V	$4.9*P^{0.27}$
			<125 V	$4.2*P^{0.27}$

United States of America

The United States has regulated incandescent reflector lamps (US term for directional lamps) for nearly 15 years. The original efficacy requirements were established legislatively in the Energy Policy Act of 1992 (EPACT 1992), Public Law 102-486. These efficacy requirements were designed to eliminate the standard incandescent reflector (R) lamp, replacing it with a Parabolic Aluminized Reflector (PAR) halogen lamp. DOE was also required by EPACT 1992 to conduct two subsequent reviews to determine if the efficacy levels established for reflector lamps should be revised. DOE completed the first of those two revisions in July 2009, issuing higher efficacy requirements that will take effect in July 2012. The second review will start in early 2011 and is scheduled to be completed in June 2014. While DOE was conducting the first of its reviews of the EPACT 1992 regulation, Congress passed the Energy Independence and Security Act of 2007 (EISA 2007) to revise the legislative language that had previously excluded BR and ER shaped lamps from regulation. These changes to the statutory law have enabled DOE to now start analysing efficacy regulations for these lamp types, which it will be doing in a separate standards rulemaking procedure.

According to the definition established by EPACT 1992 and amended by EISA 2007, the following is the scope of coverage for DOE’s regulatory authority for incandescent reflector lamps, blown-parabolic aluminised reflector (BPAR) lamps, bulge reflector (BR) lamps and ellipsoidal reflector (ER) lamps:

Incandescent reflector lamp (commonly referred to as a reflector lamp) means any lamp in which light is produced by a filament heated to incandescence by an electric current, which: is not colored or designed for rough or vibration service applications that contains an inner reflective coating on the outer bulb to direct the light; has an R, PAR, ER, BR, BPAR, or similar bulb shapes with an E26 medium screw base; has a rated voltage or voltage range that lies at least partially in the range of 115 and 130 volts; has a diameter that exceeds 2.25 inches; and has a rated wattage that is 40 watts or higher.

BPAR incandescent reflector lamp means a reflector lamp as shown in figure C78.21–278 on page 32 of ANSI C78.21–2003.

BR incandescent reflector lamp means a reflector lamp that has—

(1) A bulged section below the major diameter of the bulb and above the approximate baseline of the bulb, as shown in figure 1 (RB) on page 7 of ANSI C79.1–1994, (incorporated by reference, see §430.3); and

(2) A finished size and shape shown in ANSI C78.21–1989 (incorporated by reference; see §430.3), including the referenced reflective characteristics in part 7 of ANSI C78.21–1989.

BR30 means a BR incandescent reflector lamp with a diameter of 30/8ths of an inch.

BR40 means a BR incandescent reflector lamp with a diameter of 40/8ths of an inch.

ER incandescent reflector lamp means a reflector lamp that has

(1) An elliptical section below the major diameter of the bulb and above the approximate baseline of the bulb, as shown in figure 1 (RE) on page 7 of ANSI C79.1–1994, (incorporated by reference; see §430.3); and

(2) A finished size and shape shown in ANSI C78.21–1989, (incorporated by reference; see §430.3).

ER30 means an ER incandescent reflector lamp with a diameter of 30/8ths of an inch.

ER40 means an ER incandescent reflector lamp with a diameter of 40/8ths of an inch.

The scope of coverage provided by the definitions above do not cover all reflector (i.e., directional) lamps that are sold in the US market. A few of the gaps afforded by this scope of coverage include the following:

- The definition only allows for the coverage of E26 medium screw base lamps, which does not include the common MR-11 and MR-16 base types, such as 2-Pin GU5.3; GU10, GX5.3 and G4.
- Although EISA 2007 extended coverage to small diameter reflector lamps (i.e., down from 2.75 inch diameters to 2.25 inches), the popular MR-16 directional lamp has a 2-inch diameter, and is therefore excluded from coverage.
- The definition only applies to incandescent and halogen lamps, it does not include compact fluorescent, metal halide or light emitting diodes (although metal halide may be covered and regulated by DOE in a separate rulemaking).

Although DOE covers medium screw base compact fluorescent lamps (CFL), as directed by section 135(c) of the Energy Policy Act of 2005 (EPACT 2005), the scope of coverage does not include directional (i.e., reflector) CFLs.[76] DOE's authority to regulate CFLs is on 'general service' CFLs, which (by definition) does not include reflector CFLs.

For high-intensity discharge (HID) lamps, DOE is conducting a determination analysis on whether or not to regulate HID lamps (which may include directional ceramic metal halide lamps), scheduled to be completed in June 2010. If DOE makes a positive determination on coverage and regulation of HID lamps, it is likely that this rulemaking will include directional low-wattage ceramic metal halide lamps that can be found in commercial retail applications replacing halogen reflector lamps.

For light emitting diode (LED) lamps, DOE is scheduled to conduct an energy conservation standards rulemaking on LED lamps starting in 2014 and scheduled to be completed in January 2017. The scope of this rulemaking is 'general service LED' lamps, and therefore is

[76] The statutory definition, as incorporated into the Code of Federal Regulations (10 CFR Part 430.2) states that it does not include lamps that are "(ii) Unlikely to be used in general purpose applications, such as the applications described in the definition of 'General Service Incandescent Lamp' in this section;" The definition of General Service Incandescent Lamp explicitly excludes reflector lamps because general service incandescent lamps and incandescent reflector lamps are regulated separately. Therefore, regulated CFLs in the US only include non-directional (i.e., general illumination service), and directional (reflector) CFLs are outside DOE's scope of coverage.

subject to the same list of non-general service exclusions that affects CFLs (see footnote 76 on previous page). Therefore, although directional LED lamps are emerging as a popular application for this light source, it is not expected to be covered and regulated in the scope of that rulemaking.

Table 5 provides the current minimum average efficacy requirements for incandescent reflector lamps. This table of standards was set by the Energy Policy Act of 1992 and became effective in 1995. This table will remain in effect until it is superseded by the new table of efficacy requirements promulgated by DOE in July 2009 which takes effect in July 2012 (see Table 6).

Table 14: United States Efficacy Requirements for Incandescent Reflector Lamps

Nominal Lamp Wattage	Minimum average lamp efficacy (lm/W)
40-50	10.5
51-66	11.0
67-85	12.5
86-115	14.0
116-155	14.5
156-205	15.0

Table 6 presents the new MEPS for incandescent reflector lamps. In this table, separate minimum average efficacy requirements are established for reflector lamps according to the spectral emission, the lamp diameter and the rated voltage of the lamp. To provide a tangible reference point, the minimum efficacy of a 100 watt incandescent reflector lamp is provided in the right-hand most column of Table 6

Table 15: New US Efficacy Requirements for Incandescent Reflector Lamps, 2012

Rated Lamp Wattage / Spectrum	Lamp Diameter (inches)	Rated Voltage	Minimum Average Efficacy (lm/W)	Example lm/W for 100W lamp
40 – 205W, Standard Spectral Emission	>2.5	≥125V	$6.8*P^{0.27}$	23.6
		<125V	$5.9*P^{0.27}$	20.5
	≤2.5	≥125V	$5.7*P^{0.27}$	19.8
		<125V	$5.0*P^{0.27}$	17.3
40 – 205W, Modified Spectral Emission	>2.5	≥125V	$5.8*P^{0.27}$	20.1
		<125V	$5.0*P^{0.27}$	17.3
	≤2.5	≥125V	$4.9*P^{0.27}$	17.0
		<125V	$4.2*P^{0.27}$	14.6

Note 1: P is equal to the rated lamp wattage, in watts.

Note 2: Standard spectrum means any incandescent reflector lamp that does not meet the definition of modified spectrum in 430.2.

Figure 2 illustrates two of the incandescent reflector lamp MEPS adopted by the DOE in July 2009, compared to the Energy Policy Act of 1992 levels which became effective in 1995. The two shown are the efficacy requirements for 40-205 watt standard spectral emission lamps, less than 125 volts and having a diameter greater than 2.5 inches ("large diameter") or less than 2.5 inches ("small diameter"). The new MEPS level will supersede the EPACT 1992 levels on the 15th July 2012. Depending on the product class, the new MEPS will require a 100W reflector lamp to increase its efficacy by between 24 and 46 percent over the EPACT 1992 regulations.

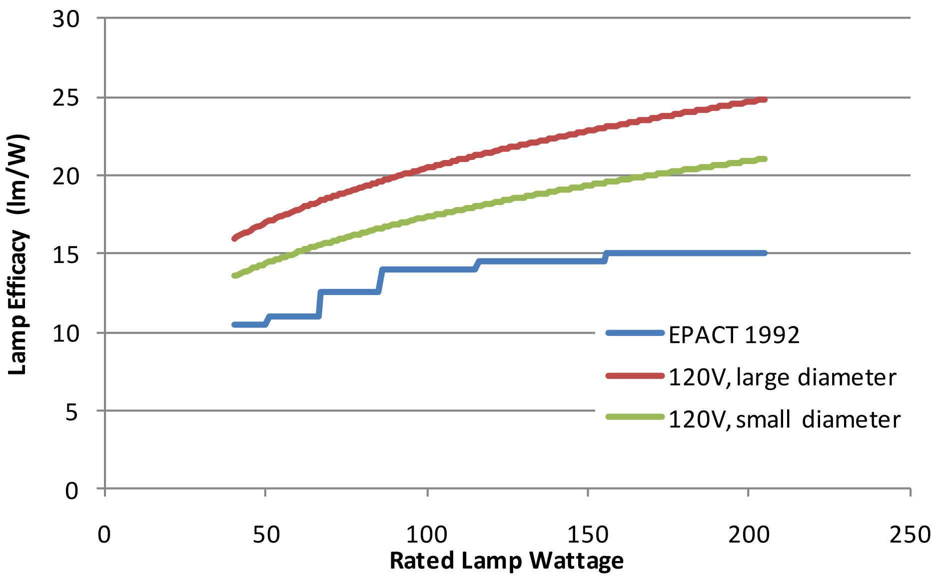


Figure 2. US DOE Minimum Efficiency Standards for Certain Reflector Lamps (120V)

DOE has two subsequent energy conservation standard rulemakings scheduled that pertain to incandescent reflector lamps. The first will be to evaluate and potentially establish MEPS for BR and ER lamps and small diameter incandescent reflector lamps. This rulemaking has recently started and is scheduled to be completed by December 2011. The second will be a review (the second cycle) of regulations on incandescent reflector lamps in general. That rulemaking is scheduled to start in the first quarter of 2011 and be completed by June 2014.

Comparison of Scope of Coverage and MEPS

In this section, some of the key differences between the various regulations of Australia, Canada and the United States are discussed. In addition, a comparison of the MEPS levels is presented.

Table 7 presents a comparison of the scopes of coverage for the various regulatory standards in Australia, Canada and the United States. It should be noted that all three countries are actively reviewing and potentially revising their regulations. The reviews underway include issues relating to coverage as well as the efficacy requirements and schedule for when these requirements would become effective.

Although the table does not provide all the detail associated with the scopes of coverage (e.g., the treatment of BR lamps), in general terms it enables a reasonably rapid, at-a-glance comparison between the countries reviewed. As shown, the Australian scope is the broadest, in part because it encompasses the MR-16 lamp diameter and base-types.

Table 16: Comparison of Scopes of Coverage for Countries Studied

Lamp Property	Australia	Canada	United States
Lamp Shapes	PAR, ER, R, RE, XR, YR, ZR or MR11-16	R, PAR, BPAR, BR and ER	R, PAR, BPAR, BR and ER
< 2.25 Inch Diameter	Yes, includes MR11 – MR16	Not covered	Not covered
Wattages	All wattages	40 – 205 Watts	40 Watts and higher (although only set MEPS up to 205W)
Voltages	5-24V and >220V	At least partially between 100 and 130V	At least partially between 115 and 130V
Base Type	Bi-pin, E14, E26, E27, B15, B22d or GU10	E26 only	E26 only
Modified Spectrum Lamps	Same MEPS for standard lamps and modified spectrum	Anticipate will adopt US requirements	Same requirement, but will have lower target than new regs for standard lamps in 2012

Figure 3 provides a comparison of the MEPS levels that have been adopted by Australia, Canada and the United States. On this graph, it is important to note that the US and Canadian regulations are based on a line-voltage of 120V AC and therefore have been adjusted to be 240V. The Australian regulation is based on lamps operating at 240V AC, which matches that of Europe The reason voltage conversion is important when plotting efficacy requirements from different countries on the same graph is because higher voltage lamps (e.g., 240V) will require the use of a thinner and longer filament for the same power rating, which will naturally have a lower efficacy than the shorter, thicker filaments used at lower voltages (e.g., 120V). For example, a 100-watt, 120V general service lamp will produce about 17 lumens per watt, while a 100-watt, 240V lamp with the same lamp life will only produce about 12.8 lumens per watt. Therefore, the efficacy requirements for the US and Canada were adjusted below to account for the different voltage of Australia (and the EU), enabling a side-by-side comparison of the efficacy requirements.

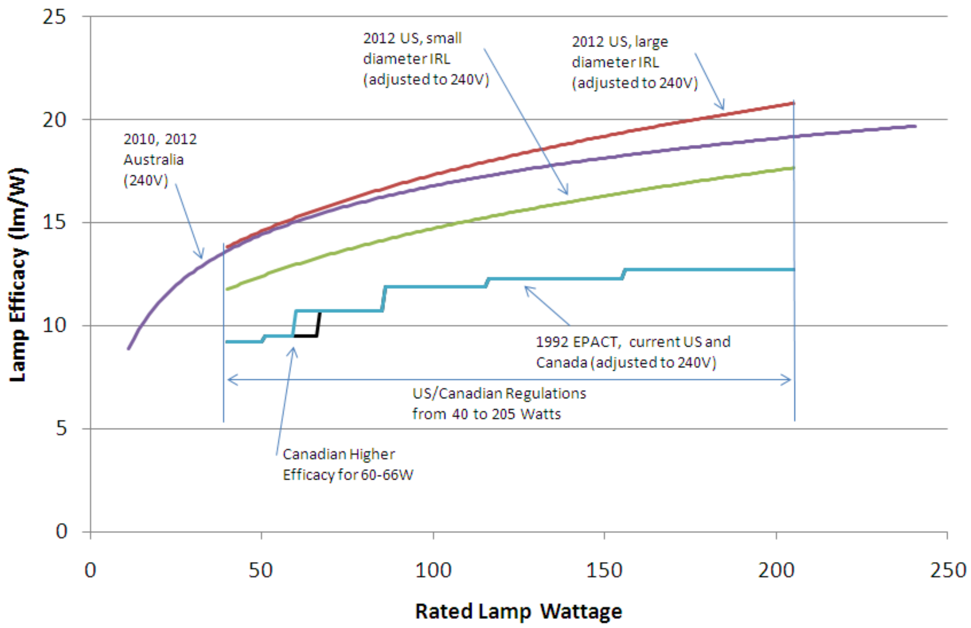


Figure 3. Comparison of MEPS Levels for Incandescent Reflector Lamps (240V)

A few observations can be made about the MEPS curves for these three countries:

- The slope of all the MEPS shows a similar pattern, based on the physics of the tungsten filament. The efficacy is lower at low wattages and increases at higher wattages.
- All of the new MEPS are higher than the original EPACT 1992 levels, which represent standard halogen technology from nearly twenty years ago.
- The Australian regulation spans a wider range of wattages as it is not confined to the 40-205 watt range like the US and Canada regulations.
- The new large diameter (i.e., greater than 2.5 inches) regulation in the US that takes effect in 2012 is similar to the Australian efficacy regulation, after adjusting for differences in mains voltage.
- The new Australian regulation is also applicable to small diameter directional lamps (i.e., less than 2.5 inches), thus after adjusting for voltage, the Australian MEPS are more stringent than the US regulations for these lamp types.
- The Australian government is also considering a maximum wattage limit on MR-16 lamps in addition to the above efficacy requirement, to ensure consumers will benefit from the energy savings of the more efficacious technology. (see section 2.2 and Annex A)

ANNEX 5: DEFRA/ STEM/ ECEEE study

In the period March-July 2010 Navigant Consulting Europe Ltd. performed a study for the UK Department of Environment, Food and Rural Affairs DEFRA, the Swedish Energy Agency and the European Council for an Energy Efficient Economy ECEEE. The study discusses, reviews and extends on relevant aspects of the preparatory study in great detail and was used as an important source for the Impact Assessment. The conclusions in the DEFRA/STEM/ECEEE study strictly reflect the opinion of the authors.

The study consists of the following task reports

Task 1, International DLS regulatory review and LED test methods (see Annex 4)

Task 2, Beam angles and DLS, technical aspects

Task 3, DLS Sales and stock data

Task 4, DLS in non-residential applications

Task 5, DLS Domestic and tertiary sectors in the preparatory study

The full report is available from websites of the sponsors. Task 1 is mostly integrated in the underlying report (Annex 4, section of references). Task 2 was helpful background information in discussions with industrial stakeholders.

The main point in Tasks 3 and 4 is that the projections of the preparatory study as regards the size of the installed stock, energy use and saving potential are too low. Relevant tables are in Annex 11.

Main differences between Navigant and the preparatory study are:

The preparatory study uses data from Eurostat, ELC and individual retailer data to create a picture of DLS sales, whereas Navigant uses MTP projections for the UK and then scales them up –on the basis of the number of households—to the EU-27.

For GLS stock and sales calculations the preparatory study uses the usual product life of 1000h, whereas Navigant has investigated the EU catalogues of main lamp manufacturers which currently mention 1600h. Also on other lamp types there are (minor) differences in product life.

For the growth rates over the period 2010-2020 Navigant again uses their own stock model calculations and –as a check- UK MTP projections. For the number of annual operating hours Navigant assumes the same base values as the preparatory study, e.g. 400 h/year for domestic GLS versus 1800 h/year for non-domestic GLS, and it uses the same assumption as the preparatory study that the unit sales to the domestic sector are equal to those to the non-domestic sector. But the formula for calculating the blended annual number of operating hours (weighted average of domestic and non-domestic) is calculated differently, leading to higher numbers of annual operating hours.

As a result for the reference year 2010

Navigant estimates the stock of GLS-R lamps 88% higher (420 vs. 223 mln. units)

HL-MV stock is estimated 23% higher (545 vs. 441 mln. units)

HL-LV stock is estimated 30% higher (815 vs. 628 mln. units)

CFLi-R stock is estimated twice as high (39,5 vs. 20 mln. units)

Overall the number of installed reflector lamps is estimated 38% higher (1,82 vs. 1,31 mln.)

The Navigant study provided some interesting new insights on the product life of the GLS currently on offer and is probably correct in stating that the popularity of halogen lamps is underestimated. Nevertheless, the Commission did not take on board the proposed changes. The data uncertainty –both of the preparatory study and the aforementioned Task 3 report—is high and therefore it is good practice to pertain to the more conservative estimate of the saving potential, i.e. that of the preparatory study; especially as in this case the figures presented in the preparatory study are more than enough to fulfil the requirements of Article 15 of the 2009/125/EC directive.

More in detail, the use of UK data for projections of the EU-27 as a whole is at least as uncertain as the sources that were used in the preparatory study. The 1998 SAVE DELight study observed that on average the UK domestic electricity consumption for lighting is around 26% above the average EU (see Annex 11).

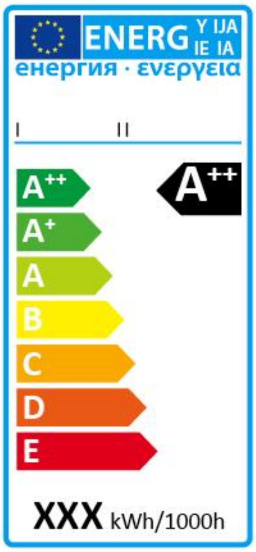
Secondly, a sudden increase in catalogue lamp life (from 1000 to 1600h for GLS) does not overnight invalidate all results from statistics, surveys, etc. of the last decades and does not suddenly increase the GLS-stock by 80%. Before accepting “1600” as the “new 1000” for stock calculations more information should be gathered: When did it start? What prompted it? Is the 1600h lamp life also confirmed in practice? Does this new lamp life also extend to no-name imports? Etc.

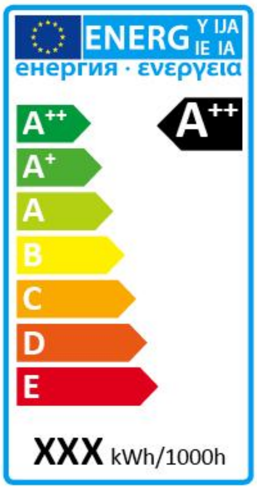
Thirdly, there is no hard data demonstrating that non-domestic DLS sales equal domestic DLS sales in the EU. There are mixed messages, e.g. from luminaire manufacturers that DLS downlights should have no place in a professional lighting design and thus play no role, whereas some lamp manufacturers think that they do play a significant role in the ‘amateur’ sector.

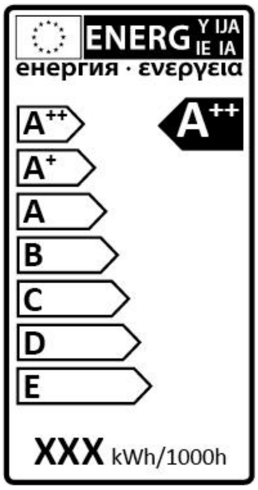
ANNEX 6: Label Design

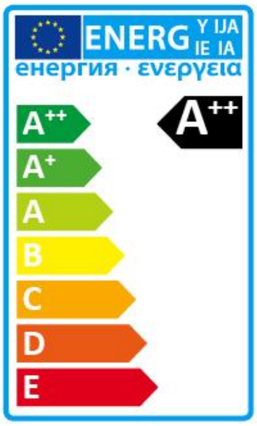
Three versions of the lamp label are needed, (b) and (c) also in black and white:

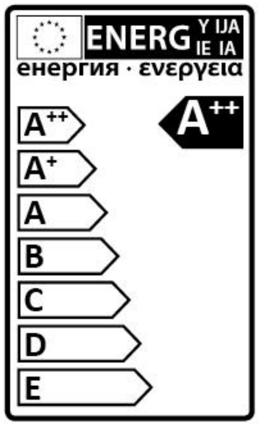
- Independent full label (brand name and model number have to be shown for identification)
- Full label on the packaging (no need to repeat the brand name and model number, to save space)
- Simple label on the packaging (label class scale alone, it is a version allowed by Directive 98/11/EC that provides flexibility in packaging design since 1998)



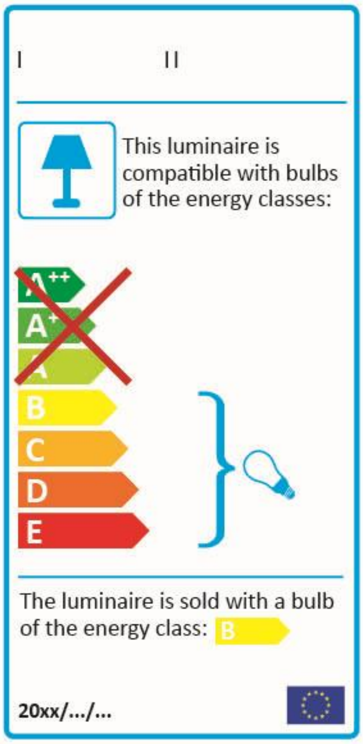


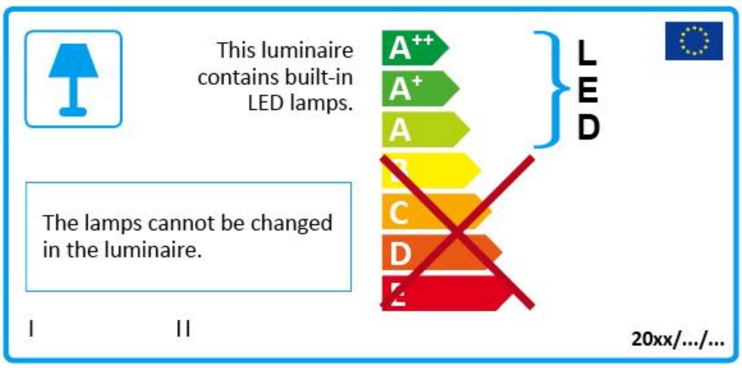






Here are two samples of the luminaire label, which will be allowed to exist in different variations due to a large number of potential combinations:





ANNEX 7: Glossary

DIRECTIONAL LIGHT SOURCES

Product identification

BPAR	Blown-Parabolic Aluminised Reflector
BR	Bulge Reflector
cap	Part of the lamp connected to socket
CFL	Compact Fluorescent Lamp
CFLi	Compact Fluorescent Lamp with integrated ballast
CFLi-R	CFLi-Reflective
CFLni	Compact Fluorescent Lamp with non-integrated ballast
control gear	components between socket and electric supply regulating the characteristics of the electricity supply to the lamp type, e.g. ballasts, HL convertors & transformers, LED drivers
DLS	Directional Light Source (preparatory study: >80% luminous flux inside π sr solid angle (120° cone))
E14/ B15d	screw base cap (typically small incandescent)
E27/ B22d	screw base cap (typically common incandescent)
E40	large screw base cap (typically flood light, i.e. non-domestic)
EEI	Energy Efficiency Index
ELV	Extra Low Voltage (12 V)
ER	Ellipsoidal Reflector
FL	Flood, relates to lamps with wide beam angle (NEMA definition), possible industry subdivisions NFL (Narrow FL), FL, WFL(Wide), VWFL (Very Wide)
GLS	General Lighting Service lamp (incandescent)
GLS-R	General Lighting Service lamp - Reflective
GU10, GU5.3	2 pin (bajonet) fitting ; '10' is pin distance in mm
HID	High Intensity Discharge Lamp
HIDi	HID with integrated ballast
HL	Halogen Lamp
HL-LV	Halogen Lamp – extra Low Voltage (12 V)
HL-LV-R	Halogen Lamp – extra Low Voltage - Reflective
HL-MV	Halogen Lamp - Mains Voltage (230 V)
HL-MV-R	Halogen Lamp - Mains Voltage -

	Reflective
HL-MV-R-LW	Halogen Lamp - Mains Voltage - Reflective - Low Wattage (< 80W)
HL-MV-R-HW	Halogen Lamp - Mains Voltage - Reflective - High Wattage (< 80 W)
integrated	part of the lamp
K	Kelvin, relates here to unit for colour temperature T_C
lamp	source made in order to produce an optical radiation, usually visible (*EN 12665 definition*), including any additional components necessary for starting, power supply or stable operation of the lamp or for the distribution, filtering or transformation of the optical radiation, in case those components cannot be removed without permanently damaging the unit (*preparatory study addition to EN 12665; note that only electrical lamps are in the scope of measures*)
LED	Light Emitting Diode (lamp)
LFL	Linear Fluorescent Lamp
luminaire	apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting the lamps to the electric supply (EN 12665)
MH	Metal Halide lamp (see also HID)
MR	Multifaceted Reflector (e.g. small HL dichroids)
MR16	specification of MR reflector envelope; '16' is diameter in ⅛ inch (MR16 = 50 mm)
narrowbeam	beam angle <90° cone (preparatory study)
NDLS	Non Directional Light Source (preparatory study: 80% of lumen not concentrated in solid angle of π sr)
PAR	Parabolic Aluminised Reflector
PAR38, PAR56, etc.	specification of reflector envelope; '38' is diameter in ⅛ inch (PAR38=R120)
Plamp	Lamp power (at reference operating conditions), in W
R63, R120, etc.	specification of reflector lamp envelope; '63' is diameter in mm
R7	bi-pin fitting (12-24V); '7' is pin distance in mm
Second lamp envelope	Second outer lamp envelope for preventing mercury and glass release into the ambient in case of lamp breakage.

socket	lamp holder (in luminaire), connects lamp to electricity supply
SP	Spot, relates to lamps with wide beam angle (NEMA definition), possible industry subdivisions SP, NSP (Narrow), VNSP(Very Narrow)
switch	device that controls lamp/luminaire electricity supply on the basis of illumnation requirement, e.g. on/off switch, dimmer, occupancy sensors, daylight sensors, etc.
visible light	electromagnetic radiation with wavelength >380 nm and <780 nm (preparatory study)
widebeam	beam angle <120 ° cone (preparatory study)
WLED	White LED
WLED-DLS	White LED lamp that retrofits an incandescent or halogen mains voltage reflector lamp and meets the requirement for a DLS
WLED-NDLS	White LED lamp that retrofits an incandescent or halogen mains voltage lamp and does not meet the requirement for a DLS
WLED-LV-DLS	White LED lamp that retrofits a halogen reflector lamp for extra Low Voltage (12V) and meets the requirement for a DLS

Test methods, standards & policies

AAQD	Ambient Air Quality (framework) Directive 96/62/EC, with daughter directives 2004/107/EC (selected HM), 1999/30/EC (SO2, PM and others), 2000/69/EC (benzene and CO), 2002/3/EC (ground-level ozone)
ANSI	American National Standards Institute
Ballast directive	Relates to directive 2000/55/EC on energy efficiency requirements for ballasts for fluorescent lighting
Base-Case	Reference for the 'average EU product' , i.e. a set of average product characteristics, possibly composed of several subsets (also referred to as Base-Cases but for a certain product category), specific for a certain year and used as a reference for the assessment of the improvement potential.
BAT	Best Avalaible Technology (scenario)
BAU	Business-as-Usual (scenario)
binning	Sorting of LEDs on brightness and colour temperature in the manufacturing process in order to minimize colour and brightness deviation of the finished (multiple LED) product.

BNAT	Best Not yet Available Technology (scenario)
BOM	Bill of Materials, i.e. list of materials and weight fractions specific for the final product including packaging.
CELMA	Federation of national manufacturers associations for luminaires and electrotechnical components for luminaires in the European Union
CEN	European Committee for Standardisation
CENELEC	European Committee for Electro-technical Standardisation
CFR	Code of Regulations (US)
CIE	International Commission on Illumination
discount rate	interest minus inflation (in this study 4%)
DoE	United States Department of Energy
EC	European Commission
Ecodesign	Relates to policy measures in the context of the Ecodesign of Energy-related products 2009/125/EC
Eco-labelling	Relates to (voluntary) Community eco-labelling measures in the context of Regulation (EC) No 66/2010
Ecoreport	MEEuP spreadsheet tool providing environmental profile of a product over its life cycle (production, distribution, use, disposal/recycling), in terms of resources (materials, energy, water, waste) and emission-categories currently addressed in EU-policy measures. Weighting of environmental impacts is in accordance with emission limit values and conversion factors in EU-legislation.
ELC	European Lamp Companies federation
ELV	Emission Limit Value
EMC	Electromagnetic Compatibility (Directive 2004/108/EEC)
EN	European Standard, followed by number and possibly year of publication
EPACT	Energy Policy Act (US, 1992 and 2005)
EPER	European Pollutant Emission Register
EU	European Union (EU-27 in statistics to indicate that data relate to all current 27 Member States)
glare	Blinding by (looking into) light sources
goniophotometer	Device (test method) that measures luminous flux captured by a light sensor attached to a rotating arm and emitted by a light source at the arm’s center, taking samples in 4 to 12 planes and at rotation angles with intervals of typically 1°. It is believed to be the most accurate but also most expensive (slowest) test method for

	the assessment of luminous flux (in lumen).
IA	Impact Analysis
IEC	Internation Electrotechnical Commission
IESNA	Illumination Engineering Society (of North America)
ISO	International Standards Organisation
Labelling	Relates to policy measures within the context of Energy Labelling directive 92/75/EC and/or future recast thereof
LCA	Life Cycle Analysis
LCIA	Life Cycle Impact Assessment
lock-in effect	Relates to dimensional and technical constraints posed by the luminaire on the lamp and vice versa, either hindering ('negative lock-in') or promoting ('positive lock-in) the use of energy efficient light sources. Example 'negative lock-in': available space and/or socket types in the luminairte (also electrical wiring may play a role). Example 'positive lock-in': Luminaire ballast and socket types that accept only energy-efficient types (e.g. CFLni).
LVD	Low Voltage Directive 2006/95/EC
MEEUP	Methodology for Evaluation of Energy-using Products (VHK 2005), LCA/ LCIA methodology used in Ecodesign preparatory studies
MEPS	Minimum Energy Performance Standards
NEMA	National Electrical Manufacturers Association
NGOs	Non Governmental Organisation
NRCan	Natural Resources Canada
preparatory study	Tichelen, P. van (VITO) et al., Preparatory study Lot 19: Domestic lighting - Part 2 Directional Lampas and household luminaires, 2009
PRODCOM	PROduction COMmunautaire, product category denomination in the official CE (Eurostat) publication of EU production and trade data (a.k.a. 'Europroms')
R&D	Research and Development
RoHS	Restriction of the use of certain Hazardous Substances in electrical and electronic equipment, directive 2002/95/EC
SMEs	Small- and Medium-sized Enterprises
seasoning	Also called 'burn-in' of lamps under test, i.e. operation of lamp before start of measurement.
spectroradio-meter	Test method fundamentally the same as goniophotometer, however using a different sensor, i.e. with accuracy > ±0.1 nm over the visible spectrum (380-780

	nm), wavelength repeatability of 0.1 nm and stray light rejection of 10-4 (Australian MEPS)
UL	Underwriters Laboratories
VITO	Lead author of preparatory study
WEEE	Waste of Electrical and Electronic Equipment directive 2002/96/EC
WFD	Water Framework Directive 2000/60/EC, with referenced daughter directives 82/176/EEC (Hg discharges), 83/513/EEC (Cadmium), 84/156/EEC (Hg), 84/491/EEC (Hexachlorocyclohexane discharges), 86/280/EEC (dangerous substances)

Product characteristics

°	degree, used here for lamp beam angle in 2 dimensional plane
°C	Degree Celsius, used here for ambient and lamp temperature
AC	Alternating Current
ALI	Averaged LED Intensity
beam angle	angle between those points on opposite sides of the beam axis where the intensity drops to 50% of the maximum
beam axis	axis between light source and point of maximum luminous intensity (peak intensity in Cd)
CCT	Correlated Colour Temperature, in K
cd	candela, unit of luminous intensity I_v, (1 cd=1 lm/sr)
cd/m²	unit of luminance, also called ‘nits’
chromaticity	Objective specification of the quality of a colour regardless of its *brightness* (luminance), i.e. as determined by its *hue* and *saturation* (or colorfulness, chroma, purity)
colour space or chromaticity diagram	Two-dimensional representation of chromaticity, either using polar coordinates (e.g. sRGB colour space) parting from the white-point or Carthesian (x,y) coordinates based on *x* and *y* values derived from tristimulus values (X, Y, Z values of 3 reference colour stimuli).
CRI	Colour Rendering Index, in Ra
DALI	*Digital Addressable Lighting Interface:* International Standard (IEC 62386) lighting control system providing a single interface for all Electronic Control Gears (light sources) and Electronic

	Control Devices (lighting controllers). The DALI Standard enables dimmable ballasts, transformers, relay modules, emergency fittings and controllers from different manufacturers to be mixed and matched into a single control system.
DC	Direct Current
dimmability	Capability of a light source to operate at intermediate light outputs, regulated by an external control (see ‘switch’) of specific electricity characteristics (e.g. V)
DLOR	Downward LOR (fraction of total lm output in hemisphere below luminaire)
E_v	Illuminance, luminous flux incidence on a surface per unit of surface area, in lx
FP	Functional Parameter (preparatory study: for NDLS lm/h; for DLS lm/h in 0,6π sr or π sr; for street lighting lm/(m².h) = lx/h in task area)
h	hour(s)
hot restrike	start-up after a short switch off period
Hz	Herz, frequency (here: of AC current, e.g. 60 Hz (EU))
integrating sphere	Tool with a large hollow spherical interior –painted white for high diffuse reflectivity—uniformly scattering and diffusing (‘integrating’) light emitted by a lamp or luminaire. After the sphere is calibrated with a reference lamp, a single fixed light sensor inside the sphere provides an assessment of the total luminous flux emitted. ‘Integrating sphere’ is also used as a term to indicate the test method as such, which is believed the fastest and thus least expensive available.
IP code	‘Ingress Protection’, international protection rating, 'IP' followed by a number (IP20; IP40 etc.); rates e.g. luminaire safety with water and possible penetration by particles
I_v	luminous intensity (luminous flux per unit solid angle), in cd
LER	Light Efficacy Ratio (LER=LOR x ηballast x ηlamp x C_{LOR}, where C_{LOR} is correction factor for the power factor, usually C_{LOR}=1)
light distribution	Spatial distribution of the luminous flux from a luminaire or DLS. Graphic representation can be in the form of CEN/CIE flux code (fraction of lm per solid angle zone, in accordance with EN 13203-2), polar intensity curve (in

	cd/klm), Carthesian intensity diagram (used for floodlights) or illuminance cone (in max. lx at different distances, also indicating beam angle; used typically for spotlights and reflector lamps).
LLMF	Lamp Lumen Maintenance Factor (LLMF=instantaneous lm / initial lm)
lm	lumen, unit for luminous flux Φ (1 lm= 1 cd.sr)
lm/W	unit for luminous efficacy ηlamp
LOR	Light Output Ratio (lm luminaire/lm lamp)
LSF	Lamp Survival Factor (fraction of total lamps still operational after X test hours)
L_v	Luminance, in cd/m² (a.k.a. 'nits'), is the luminous intensity per unit area of light travelling in a given direction (solid angle). E.g. used for reflected light from/through flat surfaces
LWF	Lamp Wattage Factor (correction factor for power quality)
LWFe	LWF for HL-LV-R
LWFp	LWF for CFLi-R
lx	Also called 'lux', unit of illuminance and luminous emittance, 1 lx= 1 lm/m²
MacAdam ellipse	Ellipse-shaped colour region in a chromaticity diagram where the human eye cannot see the difference with respect of the colour at the centre of the ellipse. MacAdam ellipses are used e.g. in standards for describing acceptable colour deviation between LED lamps/luminaires of the same model (1 step=1 ellipse area; 2step=2 concatenated ellipse areas, etc.) and especially relevant for luminaires with typically a repetitive application in one space (e.g. wall washers, spotlights, etc.).
M_v	Luminous emittance, luminous flux incidence on a surface per unit of surface area, in lx
mW/klm	milli-Watt/kilo-lumen (10^{-3} W/ 10^{3} lm), unit for UV radiation
nominal value	Value of a quantity used to designate and identify a product
Premature failure rate	Failure rate Fx is the fraction of tested lamps in a sample of x lamps reaching the end of life before the nominal product life
Ra	calculation unit of colour rendering (CCT and T_C), range between 0 (monochrome) and 100 (incandescent, white)
rad	radian, unit of plane angle, equal to 180/π (or 360/(2π)) degrees
Rated value	Value of a quantity used for specification purposes, established for a specified set of operating conditions of a product. Unless stated otherwise, all requirements

	in this document refer to rated values.
s	second, unit of time
SPD	Spectral Power Distribution, in W/(m2.nm), describes the power per unit area per unit wavelength of a light source. SPD curves show the radiant power emitted by the source at each wavelength or band of wavelengths over the visible region (380 to 760 nm).
starting time	Time period needed for the lamp to start fully and remain alight after the supply voltage is switched on
sr	steradian, unit of solid angle, examples π sr=120° ; 2π sr=180°; 4π sr=360°; 0,6π sr=90° cone
T_C	Colour temperature (lamp appearance), in
t_{life}	operational lamp lifetime in h (value usually at 0,5 LSF)
$t_{operating}$	annual lamp operating hours, in h
ULOR	Upper LOR (fraction of total lm output in hemisphere above luminaire)
UV	Ultraviolet radiation, in mW/klm, often subdivided by type: UV-A, UV-B, UV-C.
V	Volt, voltage of electricity supply (110/115 V or 230 V, see also ELV and LV)
VOC	Volatile Organic Compounds (emission of Non-Methane VOC in g, referenced in 2002/3/EC and 1999/13/EC; emissions in mass units not weighted per VOC type)
W	Watt (lamp power)
warm-up time	Time period needed for the lamp to reach 60% (according to ongoing revision EN 60969) of its full luminous flux, after the supply voltage is switched on
ηballast	ballast efficiency (ηballast= Plamp / input power to bare ballast)
ηlamp	lamp luminous efficacy, in lm/W
Θ	beam angle, in degrees or (π) radians of projection on plane
π	pi, number with value 3,141593
Φ, F_v	Luminous flux, in lm (lumen)
Ω	solid angle, in sr

Impacts

a	annum (year)
AP	Acidification Potential (emission to air in g SO_2 eq.)

CO2	CO_2 carbon dioxide (used as a reference for GWP100, weighting in accordance with most recent IPCC publication as stipulated in 2002/358/CE, following Kyoto Protocol; example 1 kg CO=1,57 kg CO2 eq.)
EP	Eutrophication potential (emission to water in g PO4 eq.)
eq.	equivalent
GER	Gross Energy Requirement, primary energy expressed in the equivalent calorific value of the fossil fuel consumed, in Joules
GHG	Greenhouse gases (emission in kg CO2 eq.)
GWP100	Global Warming Potential, time horizon 100 years (emission in kg CO2 eq.)
Hg	mercury (Hg/20 is used as reference impact for environmental impact of HM emissions to water with weighting determined on the basis of WFD daughter directives and proven LCA methods (CML 2002, Eco-indicator 95) and monitors (EPER))
HM	Heavy Metals (emissions to air in mg Ni eq., emissions to water in mg Hg/20 eq.)
i-Teq	Total concentration equivalent of tetrachlorodibenzodioxin TCCD (used as a reference for POP, weighting in accordance with 2000/76/EC, following the Stockholm Convention
J	Joule, energy unit, with derived kJ (kiloJoules=10^3 J), MJ (megaJoules=10^6 J), GJ (gigaJoules= 10^9 J), TJ (teraJoules= 10^{12} J), PJ (petaJoules= 10^{15} J)
LCC	Life Cycle Costs (in €, sum of monetary acquisition and discounted running costs over product life for the consumer In this study LCC includes taxes (VAT, leges), because it relates to consumer products
LLCC	Least Life Cycle Cost point, i.e. the (set of) design option(s) for a product or product group with the lowest LCC as compared to alternative design options. In Ecodesign, unless boundary conditions dictate otherwise, the technical characteristics of the LLCC is to be used as a target value for measures.
Ni	Nickel (Ni is used as reference impact for human and eco-toxicity of HM and PAH emissions to air; weighted in accordance with 2004/107/EC, 1999/30/EC, proven LCA methods and monitors (CML 2002; EPER), in line with Århus Protocol; example 1 mg Hg = 5 mg Ni eq.)
ODP	Ozone Depletion Potential (emission in mg R-11)
PAH	Polycyclic Aromatic Hydrocarbons

	(emission in mg Ni eq.)
PM	Particulate Matter (emission in g, referenced in 1999/30/EC, mass unit not weighted by particle size because of current lack of data)
PO4	PO4 phosphate (PO4 is used as a reference impact for EP; weighting is based on ELVs in 91/271/EEC, proven LCIA methods (CML 1992, Ecopoints 97))
POP	Persistent Organic Pollutants (emission in ng i-Teq). Examples are dioxins and furans
R11	$CFCl_3$ a.k.a. CFC-11 (R11 is used as a reference for ODP, with weighting in accordance with EU Regulation No. 2037/2000, following Montreal Protocol)
SO2	SO_2 sulphur dioxide (SO2 is used as a reference impact for AP; weighted in accordance with 2001/81/EC and 1999/30/EC, following Gotheborg convention; example 1 mg SO2 eq.= 0,7 mg Nox)
t	metric tonne (1000 kg), derived Mt (Mega-tonne= 10^6 tonne)
Wh	Watt hour, energy unit (3600 J), derived units are kWh (kilo-Watt-hour, 10^3 Wh), MWh (Mega-Watt-hour, 10^6 Wh), GWh (Giga-Watt-hour, 10^9 Wh), TWh (Tera-Watt-hour, 10^{12} Wh)
€ 200x	Euro equivalent for year 200x, inflation corrected (in this study at 4%/a)

ANNEX 8: References

From preparatory study and underlying impact assessment study

European Legislation

Commission Regulation (EC) No 244/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for non-directional household lamps.

Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council.

Directive 2011/65/EU on Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS)

Directive 2012/19/EU on waste electrical and electronic equipment (WEEE)

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

Commission Decision 2011/331/EU of 6 June 2011 on establishing the ecological criteria for the award of the EU Ecolabel for light sources

Electromagnetic Compatibility (EMC) Directive 2004/108/EEC

Low Voltage Directive (LVD) 2006/95/EC

European Standards and guidelines related to the functional unit

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

EN 60357: 'Tungsten halogen lamps (non-vehicle) - Performance specifications'.

EN 60969 : 'Self-ballasted lamps for general lighting services – Performance requirements'.

EN 60081 : 'Double-capped fluorescent lamps - Performance specifications'.

EN 60901: 'Single-capped fluorescent lamps – Performance specifications'.

EN 50285: 'Energy efficiency of electric lamps for household use – Measurement

methods'. (used for lamp label under 92/75/EC)

EN 13032-1 (2004), Lighting applications — Measurement and presentation of photometric data of lamps and luminaires — Part 1: Measurement and file format

EN 13032-2(2004): Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Part 2: Presentation of data for indoor and outdoor work places

EN 60921: 'Ballasts for tubular fluorescent lamps – Performance requirements'.

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

CIE 127 (2007) : 'Measurement of LED's' (2nd ed.)

Draft EN 62612 (IEC/PAS 62612) : 'Self-ballasted LED-lamps for general lighting services >50V – Performance requirements'.

Other European test standards and guidelines not related to the functional unit

EN 12665 (2002): ‘Light and lighting - Basic terms and criteria for specifying lighting requirements’

EN 60968 : ‘Self-ballasted lamps for general lighting services - Safety requirements’.

EN 60630 : ‘Maximum lamp outlines for incandescent lamps’.

EN 60061 : ‘Lamp caps and holders together with gauges for the control of interchangeability and safety’

EN 60669-2-1 : 'Electronic switches for households and similar use'.

EN 61047 : 'D.C. or A.C. supplied electronic step-down converters for filament lamps. Performance requirements'.

EN 50294 : ‘Measurement Method of Total Input Power of Ballast-Lamp Circuits’.

EN 60927: ‘Specification for auxiliaries for lamps. Starting devices (other than glow starters). Performance requirements’.

EN 61048 : ‘Auxiliaries for Lamps - Capacitors for Use in Tubular Fluorescent and Other Discharge Lamp Circuits - General and Safety Requirements’.

EN 61049 : ‘Capacitors for Use in Tubular Fluorescent and Other Discharge Lamp Circuits Performance Requirements’.

EN 60598-1 : ‘Luminaires Part 1 : General requirements and tests’.

EN 60598-2: ‘Luminaires - Part 2: Particular requirements - Chapter 1: Fixed general purpose luminaires’.

EN 60598-2: ‘Luminaires - Part 2: Particular requirements - Chapter 2: Recessed luminaires’.

EN 60598-2: ‘Luminaires - Part 2: Particular requirements – Chapter 6: Luminaires with built-in transformers for tungsten filament lamps’.

EN 60013-2 (CIE 13.3) : ‘Method of Measuring and Specifying Colour Rendering Properties of Light Sources’

IEC/TS 61231 : ‘International lamp coding system (ILCOS)’.

IEC 62471 (CIE S 009:2002): ‘Photobiological safety of lamps and lamp systems’.

IEC 62386-201:2009. Digital addressable lighting interface - Part 201: Particular requirements for control gear - Fluorescent lamps (device type 0)

Additional standards

Australian and New Zealand standard proposal AS/NZS 4847.1:200X : ‘Test method Energy performance for Self-ballasted lamps for general lighting services’.

AS/NZS 4934.1(Int):2008, “Incandescent lamps for general lighting service. Part 1: Test methods—Energy performance.” (referenced in Australian DLS MEPS regulation)

CSA C862-09, “Performance of incandescent reflector lamps.” (used in Canadian DLS MEPS regulation)

CIE 089 (1989) : ‘Measurement of luminous flux’ (technical report)

CIE 177 (2007) : 'Colour Rendering of White LED Light Sources')

LM–20–1994, IESNA Approved Method for Photometric Testing of Reflector-Type Lamps, approved December 3, 1994 (referenced in US DLS MEPS legislation)

IESNA Approved Method for Electrical and Photometric Measurements of General Service Incandescent Lamps, LM-45-00. (referenced in US DLS MEPS legislation, in particular for DC lamps)

US CFR, 10 CFR Part 430, Subpart B, Appendix R, 'Uniform Test Method for Measuring Average Lamp Efficacy (LE), Color Rendering Index (CRI), and Correlated Color Temperature (CCT) of Electric Lamp' , July 2009 (test methods for US DoE regulation under EPACT of DLS MEPS)

Other references

In (Roisin et al. 2008), the stand by power consumption of an occupancy sensor and DALI controller was found to be about 2.5 W, whereas this is about 2 W for a photosensor and DALI controller.(in Parys et al.)

Parys, W., Saelens, D., Hens, H., (Laboratory of Building Physics, K.U.Leuven), IMPACT OF OCCUPANT BEHAVIOUR ON LIGHTING ENERGY USE, Eleventh International IBPSA Conference, Glasgow, Scotland, July 27-30, 2009

Roisin B., Bodart M., Deneyer A., D'Herdt P.. *Lighting energy savings in offices using different control systems and their real consumption*, Energy and Buildings 40, pp. 514-523, 2008.

LED STANDARDS (from DEFRA/STEM/ECEEE study)

American National Standards Institute (ANSI)

ANSI was founded in 1918, and has its headquarters Washington DC. ANSI is a not for profit organisation with links with a number of international and regional organisations including the: International Organisation for Standardisation (ISO) (official US representative); International Electrotechnical Commission (IEC); Pacific Area Standards Congress; Pan American Standards Commission; Pacific Accreditation Cooperation; and Inter American Accreditation Cooperation. ANSI's role is to monitor the development, circulation, use and accreditation to conformance of standards and guidelines, of which there are thousands.

ANSI typically does not develop standards. ANSI normally lends their designation to standards that have been developed by other groups, such as the IES or NEMA. However, recognising the demand for standards in a particular area, the ANSI Secretary for Committees C78 and C82 established the American National Standard Lighting Group (ANSLG). The ANSLG, much like ANSI, has voluntary membership and is open to all parties. The ANSLG Secretary is based out of NEMA's offices, enabling good coordination between on the development of testing standards. ANSI currently has the following standards and white papers that relate to LEDs:

ANSI C82.SSL1: "Power Supply" – specifies the operational characteristics and electricl safety of SSL power supplies and drivers.

NEMA/ANSI C82.77-2002: "Harmonic Emission Limits – Related Power Quality Requirements for Lighting" – provides specification of the maximum allowable harmonic emission of SSL power supplies. NEMA/ANSLG/ANSI C78.377-2008 - Specifications for the Chromaticity of Solid-State Lighting Products – this standard specifies recommended chromaticity (colour) ranges for white LEDs with various correlated colour temperatures (CCTs).

Illuminating Engineering Society of North America (IES or IESNA)

IES has been active for over 100 years advising industry and the general public on lighting best practice through publications, programmes and services. The IES hosts technical committees of lighting professionals, organises research and forums for professionals to discuss lighting practices, developments and recommendations. IES has over 10,000 members from a variety of sectors within the lighting industry such as architects, government, engineers, manufacturers, researchers and academics.

IES publishes technical documents and jointly develops programmes and standards with other organisations. IES has different letter designations for the publications they issue – "LM" for test methods, "RP" for recommended practice and "TM" for technical memorandums. IES also publishes guidelines. Bearing those designations in mind, the following is a list of publications that IES has issued with respect to LEDs:

IES LM-79-2008: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting Devices - Specifies a standard test method for measuring the photometric properties of SSL devices, allowing calculation of luminaire efficacy. This standard is now entering a review and update phase, although new results will not be available for 1-2 years.

IES LM-80-2008: Approved Method for Measuring Lumen Depreciation of LED Light Sources - Specifies a standard method for measuring the lumen depreciation of LEDs, allowing calculation of LED lifetime. This standard is now entering a review and update phase, although new results will not be available for 1-2 years.

IES RP-16 Addendum a: "Nomenclature and Definitions for Illuminating Engineering" - provides industry standard definitions of lighting terms, including all lighting technologies. This "Addendum a" provides definitions of solid-state lighting terms.

IES RP-16 Addendum b: "Nomenclature and Definitions for Illuminating Engineering" – this standard provides additional relevant terms and definitions for LED. This standard is in the final IES ballast phase

IES TM-16-05: "Technical Memorandum on Light Emitting Diode (LED) Sources and Systems" – a technical memorandum provides a general description of LED devices and systems, and answers common questions about the use of LEDs. IES TM-21: "Lumen Depreciation Estimation Method for LED Light Sources" – provides a method for determining an LED luminaire or integral replacement lamp's expected lumen depreciation as one measure of expected life, based on performance data collected per IES-LM-80. IES TM-21 is currently in development, with multiple models being considered to address the potential degradation paths seen with different LED technologies.

IES LM-XX1: "Method for the Measurements of High-Power LEDs" – when completed, it will provide a standardized method for thermal, electrical, and photometric measurements of high-power LEDs.

IES LM-XX2: "LED Characterization of Light Engines and Integrated LED Lamps" – when completed, it will provide a standardized method for measuring the electrical and photometric characteristics of light engines and integrated LED lamps.

IES Application Guide: Guidelines for LED Applications" – when completed, will provide information on LED technology and guidance for the appropriate and effective application and installation of LED products.

International Commission on Illumination (CIE)

The CIE is an international not-for-profit lighting organisation and undertake a variety of activities including: international conferences; development, guidance and publishing of lighting standards; publication and disseminate lighting related papers; and maintaining relationships and share technical information with other lighting related organisations around the world. The CIE is divided into six divisions which undertake specific allocated technical activities, these are: vision and colour; measurement of light and radiation; interior environment and lighting design; lighting and signalling for transport; exterior lighting and other applications; photobiology and photochemistry. The CIE holds a conference every four years which allows parties with an interest in the CIE's activities to hear about the latest technological developments and advances in industry. The last CIE conference was held in Vienna in March 2010. CIE 177:2007: "Colour Rendering of White LED Light Sources" – a report by a CIE Technical Committee which recommends the development of a new colour rendering index (or a set of new colour rendering indices). The index should not replace the current CIE colour rendering index immediately, but rather would provide information supplementary to the current CIE CRI, and replacement of CRI will be considered after successful integration of the new index. The new index (or set of indices) should be applicable to all light sources and not only to LED light sources.

Technical Report 127-2007: "Measurement of LEDs" (2nd ed) – updating CIE 127-1997, this report captures the significant measurement differences between LEDs and other light sources, providing new quantities for their characterization and measurement conditions. New quantities include "averaged LED intensity" and "partial LED flux". The report provides measurement conditions for these two quantities, and discusses measurements by substitution, which can be simpler, although only comparing similar coloured LEDs or applying colour correction on the measurement results.

Technical Committee 1-69: "Colour Quality Scale" – this committee is working on a Colour Quality Scale (CQS) to address the problems of the CIE Colour Rendering Index (CRI) for solid-state light sources and to enable lighting industry to communicate product performance around colour quality to consumers. The method for calculating CQS is based on CRI, and vision experiments will be conducted to improve and validate the CQS. This working is being led by Yoshi Ohno and Wendy Davis at the National Institute of Standards and Technology at the US Department of Commerce.

Technical Committee 2-46: "CIE/ISO Standards on LED Intensity Measurements" – working to prepare a CIE/ISO Standard on the measurement of LED intensity measurements based on CIE127:2007. Chair: John Scarangello (US)

Technical Committee 2-50: Measurement of the Optical Properties of LED Clusters and Arrays To produce a technical report for measurement of the optical properties of visible LED clusters and arrays, to derive optical quantities for large area arrays and give recommendations for measurement methods and conditions. Chair: Jens Schuette (DE)

Technical Committee 2-58: "Measurement of LED Radiance and Luminance" – working to prepare a CIE Technical Report recommending measurement methods for the luminance and radiance of LEDs, taking particular account of the specific requirements of relevant photobiological safety standards. Chair: Kohtaro Kohmoto (JP)

Technical Committee 2-63: "Optical Measurement of High-Power LEDs" – working to develop a CIE recommendation on methods for the operation of high-power LEDs in DC and in pulse mode, at specified junction temperatures, for optical measurements. Chair: Yuqin Zong (US)

Technical Committee 2-64: “High Speed Testing Methods for LEDs” – working to prepare a technical report on high speed testing methods for electrical, thermal and optical quantities during the production of LEDs and the conversion of the values to DC operational conditions including the related time dependent functions. Chair: Günther Heidel (DE)

Technical Committee 2-66: “Terminology of LEDs and LED assemblies” – working to Review LED and LED assemblies related terms and definitions in other international and regional organizations and prepare a recommendation for CIE. Chair: Janos Schanda (HU)

Technical Committee 3-50: “Lighting quality measures for interior lighting with LED lighting systems” – working to review relevant CIE publications and standards to evaluate the suitability of existing lighting quality measures when applied to tertiary (commercial) interior light-emitting diode (LED) lighting systems. To identify the gaps and weaknesses in existing quality measures, exhibited in one of two ways: either the criterion is valid, but the evaluation method is not (e.g., colour rendering) or a new criterion needs to be taken into consideration (e.g., overhead glare, binning). To prepare a Technical Report, which will include the findings of the review and recommendations for new lighting quality measures and evaluation methods. as well as suggestions for new research if appropriate quality measures and evaluation methods are missing. Chair: Martine Knoop (NL)

Technical Committee 4-47: “Application of LEDs in Transport Signalling and Lighting” – working to review the application and methods of measurement of LEDs in transport lighting and signalling as far as they affect the visual performance of the users of the transport system. To prepare a Technical Report which includes the findings of the review and recommendations for the visual characteristics of LED signals and lighting. Chair: Steve Jenkins (US)

Technical Committee 6-55: “Photobiological Safety of LEDs” – working to report on the differing methods of assessing the photobiological safety of Light Emitting Diodes (LEDs). The assessment measures in the CIE Lamp Safety Standard, CIE S009/E:2002 will be compared to the measures in IEC 60825-1-2001. This entails a review and report on the known effects from a physiological standpoint and a determination of the dose relationships that pose a potential risk for eye injury from excessive irradiation. Chair: Werner Horak (DE)

International Electrotechnical Commission (IEC)

The IEC develops and publishes international standards for electrotechnical (electrical, electronic and related technologies) products. The IEC was founded in 1906 and its members are national committees as opposed to countries. These national committees review and approve the work of the IEC’s technical committees and subcommittees, of which there are currently 179. The technical committees are made up from experts in the fields of electricity and electronics who work together to produce the IEC’s standards.

The IEC publishes international standards (IEC), Technical Specifications (TS), Technical Reports (TR), Industrial Technical Agreement (ITA), Publicly Available Specification (PAS) and Technology Trend Assessment (TTA). The IEC has the following publications pertaining to LEDs:

IEC 60061: Lamp caps and holders together with gauges for the control of interchangeability and safety. Part 1: Lamp caps; Part 2: Lampholders; Part 3: Gauges

IEC/PAS 60612 Edition 1: Performance Requirements for Selfballasted LED lamps.

IEC 60747-12-3 Discrete semiconductor devices; Part 12-3: Optoelectronic Devices - Blank detail specification for Light-Emitting Diodes (LEDs) for display applications

BS EN 60838-2-2:2006 Miscellaneous lampholders, providing guidance on particular design requirements and connectors for LED-modules.

IEC 62031 (2008) LED modules for general lighting - Safety specifications. This International Standard specifies general and safety requirements for light-emitting diode (LED) modules: (1) LED modules without integral control gear for operation under constant voltage, constant current or constant power; and (2) self-ballasted LED modules for use on DC supplies up to 250 V or AC supplies up to 1 000 V at 50 Hz or 60 Hz.

IEC 62384 Ed.1. Performance of controlgear for LED modules D.C. or A.C. supplied electronic controlgears for LED modules. BS EN 62384:2006 D.C. or A.C. supplied electronic control gear for LED modules).

IEC 62471 – Photobiological safety of lamps and lamp systems. Provides guidance evaluating the photobiological safety of lamps and lamp systems including luminaires. It specifies the exposure limits, reference measurement technique and classification scheme for the evaluation and control of photobiological hazards from all sources of optical radiation, including LEDs.

IEC/PAS 62612:2009 - Self-ballasted LED-lamps for general lighting services. Specifies the performance requirements for self-ballasted LED lamps with a supply voltage up to 250 V, together with the test methods and conditions required, intended for domestic and similar general lighting purposes, having: (1) a rated wattage up to 60 W; or (2) a rated voltage of up to 250V AC or DC.

IEC 62663-1 Non-ballasted single capped LED lamps for general lighting - Part 1: Safety requirements

IEC 62663-2 Non-ballasted single capped LED lamps for general lighting - Part 2: Performance requirements

IEC TS 62504: Terms and Definitions for LEDs and LED modules in general lighting.

IEC 62560: Safety Requirements for Selfballasted LED lamps > 50V

National Electrical Manufacturers Association (NEMA)

NEMA was formed by the merging of the Electric Power Club and the Associated Manufacturers of Electrical Supplies in 1926. It is the trade association for the electrical manufacturing industry in North America, has over 450 members. NEMA produces and publishes over 500 technical standards, guides and papers and assists in the development of government regulation for the electrical product industry. NEMA publishes lighting standard division “LSD” documents and standards for solid-state lighting “SSL”. NEMA currently has the following standards that pertain to LEDs:

NEMA LSD 44-2009: “The Need for a New Generation of Sockets and Interconnects” – this report provides the background and history of sockets and interconnects, and recommends standards development for the next generation of lamp and lighting technology. http://www.nema.org/stds/lsd44.cfm

NEMA LSD 45-2009: “Recommendations for Solid-State Lighting Sub-Assembly Interfaces for Luminaires” – this report provides guidance on the design and construction of interconnects (sockets) for solid-state lighting applications. http://www.nema.org/stds/lsd45.cfm

NEMA LSD 49-2010, Solid-State Lighting for Incandescent Replacement—Best Practices for Dimming – this standard focuses on integrated LED lamps intended for replacement of general service incandescent lamps. Future white papers are planned to address other LED dimming topics, such as: colour change; light output and efficiency; dimming protocols; LED modules with auxiliary drivers; and control architectures that dim without modulated power. http://www.nema.org/stds/lsd49.cfm

NEMA/ALA LSD-51: "Solid State Lighting—Definitions for Functional and Decorative Applications" - provides definitions of functional and decorative solid state lighting luminaires (lighting fixtures) designed for general lighting applications for residential and non-residential areas. The document further provides guidelines for the specification of the major characteristics, performance criteria, and evaluation process needed for these luminaires. See: http://www.nema.org/stds/lsd51.cfm

NEMA SSL-1: "Electric Drivers for LED Devices, Arrays, or Systems" – a standard providing specifications for and operating characteristics of electronic drivers (power supplies) for LED devices, arrays, or systems intended for general lighting applications". Under final section ballot, publication expected in third quarter of 2010.

NEMA SSL-3: "High Power White LED Binning for General Illumination" – standard that provides recommendations for a method of binning high power white LED packages for general illumination applications, including sorting, grouping and labelling for LED luminous flux, forward voltage and chromaticity. Completed in early 2010.

NEMA SSL-4: "Form Factors" – a standard that is being restarted in NEMA, which focuses on LED product form factors.

NEMA SSL-6: "Solid State Lighting for Incandescent Replacement – Dimming" (working title, may be revised). This standard is complimentary to NEMA LSD-49-2010. There is a draft in progress, and the publication of the standard is expected by the end of 2010.

Underwriters Laboratories (UL)

UL provides safety certification and testing standards for over 19,000 products. UL has 68 laboratories and operates in 102 countries. UL Marks appear on over 20 billion products in Asia, Europe and North America. UL has been operating in the lighting industry for over a century and provides testing and certification services for lighting products around the globe. There are over 30 types of UL standard for the lighting industry including: proprietary standards; IEC; CSA; and NOM. UL currently has the following safety standard that relates to LEDs:

UL 8750: "Safety Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products" – this standard specifies the minimum safety requirements for SSL components, including LEDs and LED arrays, power supplies, and control circuitry.

UL 1598: "Luminaires" – this standard specifies the minimum safety requirements for luminaires, and should be referenced in conjunction with other documents such as UL 8750 or separately used as part of the requirements for SSL products.

UL 153: "Portable Electric Luminaires" – this standard specifies the minimum safety requirements for corded portable luminaires, including LED.

UL 1012: "Power Units Other than Class 2" – this standard specifies the minimum safety requirements for power supplies other than Class 2 (as defined in the National Fire Protection Association 70-2005).

UL 1310: "Class 2 Power Units" – this standard specifies the minimum safety requirements for Class 2 power supplies (as defined in NFPA 70-2005).

UL 1574: "Track Lighting Systems" – this standard specifies the minimum safety requirements for track lighting systems.

UL 2108: “Low Voltage Lighting Systems” – this standard specifies the minimum safety requirements for low-voltage lighting systems, including LED.

UL 60950-1: “Information Technology Equipment—Safety—Part 1: General Requirements” – this standard specifies the minimum safety requirements for electronic hardware.

Zhaga Consortium

The lighting industry initiated the establishment of the Zhaga consortium to discuss and develop a set of LED interconnects. This consortium has broad support from a range of players in North America, Europe and Asia, including Cooper, Philips, Toshiba, OSRAM, Panasonic, Zumtobel, Acuity Brands, Havells Sylvania, General Electric and Tyco Electronics. With over 23 members participating in Zhaga, the group is defining interfaces for a variety of application-specific light engines. These standards will address physical dimensions, as well as the photometric, electrical and thermal behavior of LED light engines. By standardizing the interconnects for lamps, consumers will be able to replace LED light engines that fail in their new fixtures rather than have to purchase a whole new fixture and/or have it installed. Zhaga has not issued any standards documents at this time, but it is expected to do so in the future.

CITADEL Programme

In France, an R&D initiative led by a consortium consisting of the French Centre for Building Science and Technology (CSTB), the major French academic lighting laboratories and Philips Lighting-France has been formed to research and promote the optimal use of LEDs in buildings. This initiative, called CITADEL, is partly modelled after the US DOE’s CALiPER programme, and will work to develop measurement protocols and benchmarking analyses of LEDs, and accelerated life testing of LED lighting products.

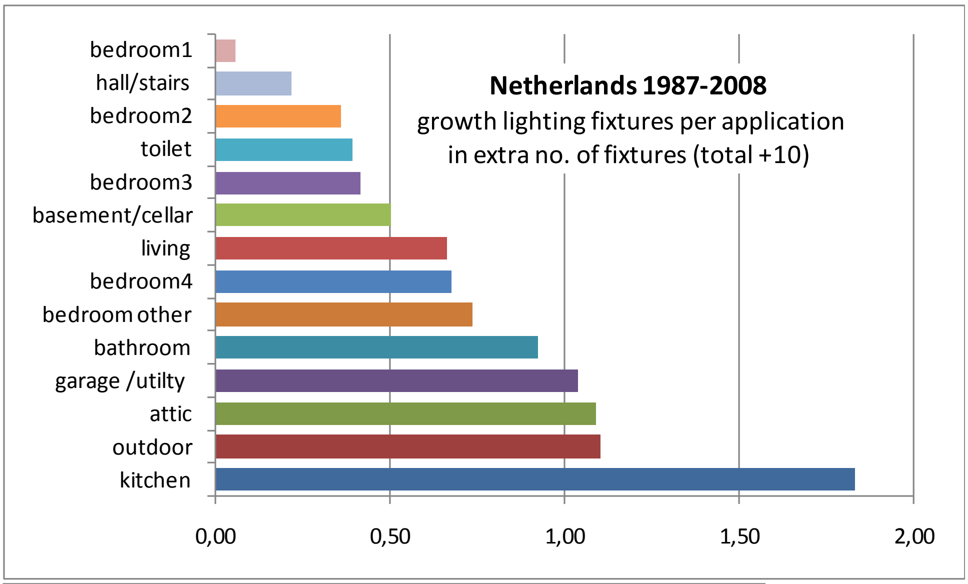
CITADEL will work to define new metrics and measures of visual comfort and colour rendering for LEDs. This is a three-year project started in February 2010 with a budget of 1.5M Euro from the French Environmental Agency (ADEME). LED laboratory measurements will be carried out using a range of metrology, microanalysis and aging setups. It will encompass numerical simulations, focus groups, economic calculations, as well as a complete environmental analysis

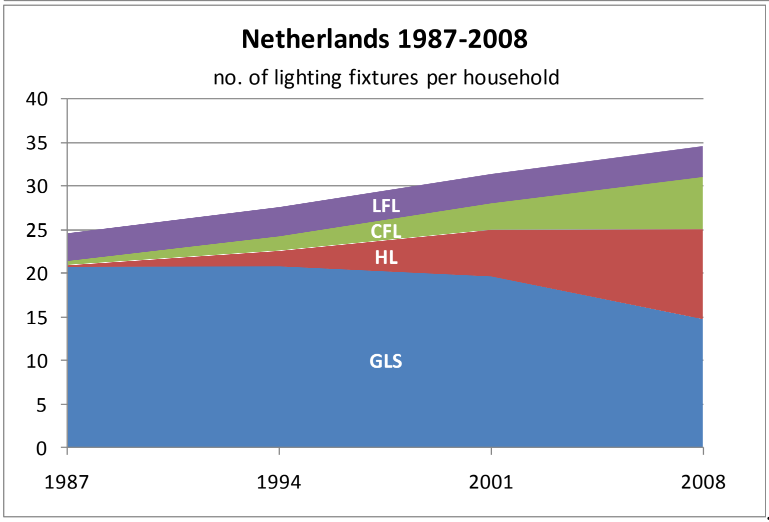
ANNEX 9: Market trends Netherlands

TREND NL 2010

LIVING ROOM (GROUNDFLOOR):
3,80 (w) x 7,2 (d) x 2,65 (h) Floor area: 27,4 m²
Typical of average NL single family dwelling 87 m²

Wall washers side: *7 x 35 W HL-LV*
Wall wash curtain: 5 x 20 W HL-LV
Individual spots: 3 x 35W HL-LV
Cabinet spots: 2 x 35 W HL-LV
Torchiere: 1 x 300W HL-MV



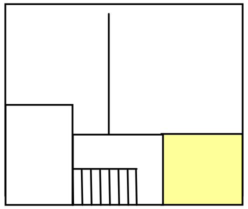


Average number of fixtures (by lamp type) per NL household 1987-2008 (lamps= ca. fixtures+13%, because of mainly 3 spot GLS/HL plafoniere and to lesser degree chandeliers and certain floor lamps)

	GLS (DLS '87: 7% fixt. ;18% lamps)				**HL** (>90% DLS)				**CFL** (>90% NDLS)				**LFL** (NDLS)				**TOTAL**			
	'87	**'95**	**2000**	**'08**	**'87**	**'95**	**2000**	**'08**	**'87**	**'95**	**2000**	**'08**	**'87**	**'95**	**2000**	**'08**	**'87**	**'95**	**2000**	**'08**
living	7,13	5,85	5,49	3,55	0,13	0,97	1,66	3,12	0,22	0,81	1,03	1,73	0,36	0,24	0,18	0,09	7,84	7,87	8,36	8,50
kitchen	1,08	1,65	1,63	0,95	0,00	0,29	0,88	1,91	0,03	0,13	0,18	0,43	1,31	1,19	1,18	0,95	2,42	3,26	3,87	4,25
bathrooom	1,30	1,30	1,25	0,78	0,02	0,16	0,52	1,21	0,00	0,06	0,09	0,26	0,09	0,12	0,11	0,09	1,41	1,64	1,97	2,34
toilet	0,65	0,95	0,96	0,69	0,00	0,01	0,06	0,17	0,00	0,02	0,04	0,17	0,00	0,01	0,01	0,00	0,65	0,99	1,07	1,04
bedroom1	2,43	2,32	2,32	1,47	0,02	0,15	0,35	0,78	0,03	0,07	0,13	0,43	0,24	0,13	0,10	0,09	2,72	2,68	2,90	2,77
bedroom2	1,44	1,67	1,67	1,13	0,00	0,09	0,22	0,43	0,03	0,06	0,11	0,35	0,17	0,11	0,11	0,09	1,64	1,93	2,11	1,99
bedroom3	1,16	1,25	1,21	0,95	0,00	0,07	0,19	0,43	0,03	0,04	0,07	0,26	0,13	0,09	0,09	0,09	1,32	1,45	1,56	1,73
bedroom4	0,55	0,68	0,50	0,69	0,00	0,04	0,10	0,35	0,01	0,02	0,03	0,17	0,06	0,08	0,06	0,09	0,63	0,82	0,69	1,30
bedroom other	0,04	0,23	0,17	0,35	0,00	0,01	0,03	0,26	0,00	0,01	0,01	0,09	0,00	0,03	0,02	0,09	0,04	0,28	0,23	0,78
hall/stairs	2,19	2,06	2,09	1,39	0,00	0,07	0,23	0,52	0,05	0,15	0,23	0,61	0,14	0,05	0,07	0,09	2,38	2,33	2,62	2,60
attic	0,36	0,67	0,68	0,69	0,00	0,01	0,08	0,26	0,00	0,03	0,05	0,17	0,11	0,29	0,34	0,43	0,47	1,00	1,15	1,56
garage /utilty	0,75	0,74	0,80	0,69	0,00	0,01	0,04	0,17	0,04	0,05	0,06	0,17	0,52	0,91	0,95	1,30	1,30	1,71	1,85	2,34
basement/cellar	0,28	0,37	0,40	0,52	0,00	0,01	0,00	0,09	0,00	0,01	0,02	0,09	0,00	0,07	0,07	0,09	0,28	0,46	0,49	0,78
outdoor	1,39	1,06	1,18	0,87	0,00	0,10	0,27	0,61	0,13	0,46	0,64	1,13	0,06	0,05	0,06	0,09	1,58	1,68	2,15	2,69
TOTAL in use	**20,8**	**20,8**	**20,4**	**14,7**	**0,2**	**2,0**	**4,6**	**10,3**	**0,6**	**1,9**	**2,7**	**6,1**	**3,2**	**3,4**	**3,4**	**3,6**	**24,7**	**28,1**	**31,0**	**34,7**
plus in stock	*6*	*5,14*	*5,73*	*4,9*	*0,0*	*0,20*	*0,63*	*1,5*	*0,1*	*0,37*	*0,76*	*2,2*	*0,0*	*0,04*	*0,51*	*0,4*	6,12	*5,75*	*7,63*	*9,0*

*sources: NOVEM 1991 (1987, at 5,76 mln.hh), BEK 1995, BEK 2000, HOME 2008 (corrected *0,867, because lamps and not fixtures)*

Netherlands



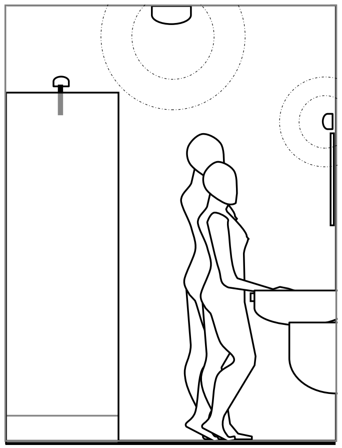
Bathroom (1st floor):
2,10 (w) x 2,5 (d) x 2,65 (h) Floor area: 4,85 m²
Typical of average NL single family dwelling 87 m^2

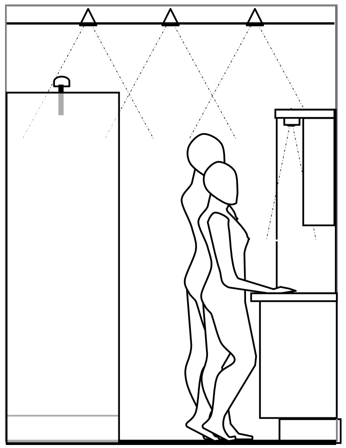
Reference
NL 1990

Central:	*2 x LFL 41 W or 1 x GLS 75-100 W*
Below cupboard:	1 x tubular GLS or (later) 1 x small LFL
Kitchen hood:	1 x GLS 60 W
Oven & Fridge:	2 x GLS 20 W
Total:	**5-6 lamps**
Avg:	**50 W/lamp**
Total:	**250 W**

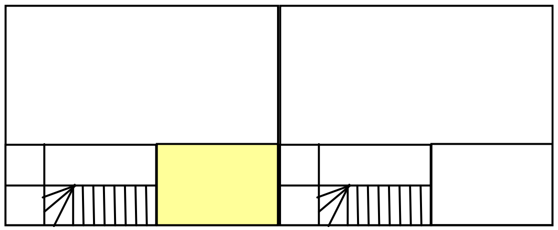
Trend
NL 2010

Central:	1 x CFL /GLS/HL-MV or 2 x CFL/HL reflector
Above cupboard:	3 x HL-LV 20-35 W
Below cupboard:	3 x HL-LV 20 W
Kitchen hood:	3 x HL-LV 20 W
Suspension lamp:	1 x HL 35-50 W
Oven & Fridge:	(2+1) x HL 20 W
Total:	**11 – 13 lamps**
Avg.:	**23-28 W**
Total:	**300 W**





Baseline 1990, Trend 2010



EN

EN

ANNEX 10: Additional Statistics

EUROSTAT Update

LAMPS PRODUCTION & TRADE EU-27, 2008 (in mln. units), according to Eurostat

PRODCOM	NC code	PRODUCT	production 2008	imports 2008	exports 2008	apparent consumption 2008
27401100	85391000	Sealed beam lamp units	17	14	6	25
27401293	***85392192***	***Tungsten halogen filament lamps for a voltage > 100 v***	***198***	***152***	***54***	***296****
27401295	85392198	Tungsten halogen filament lamps for a voltage <= 100 v (excl. those for motorcycles or other motor vehicles)	224	155	95	284*
27401300	85392210	**Reflector** filament lamps of a power <= 200 w and for a voltage > 100 v (excl. tungsten halogen filament lamps)	1131	21	78	1003**
	85392290	Filament lamps of a power <= 200 w and for a voltage > 100 v (excl. tungsten halogen lamps, reflector lamps and ultraviolet or infra-red lamps)		288	358	
27401510	85393110	Discharge lamps, fluorescent, hot cathode, with double ended cap	409	51	213	247
27401530	85393190	Discharge lamps, fluorescent, hot cathode (excl. with double ended cap)	200	542	56	686
27401550	85393210	Mercury vapour lamps	40	9	3	38
	85393250	Sodium vapour lamps		6	8	
	85393290	Metal halide lamps		7	14	
27401570	85394100	Arc lamps	25	3	1	18
	85394910	Ultraviolet lamps		5	13	
	85394930	Infra-red lamps		3	3	
		TOTAL	**2244**	**1257**	**904**	**2597**

* = The preparatory study concluded that ELC-shipments cover less than half of HL-LV and HL-MV market. It estimates for 2006 that 42% of the HL-MV lamps (>100V) and 55% of the HL-LV lamps are DLS. When applied to the updated 2008 figures above this results in 124 mln. reflector (DLS) units sold in both categories.

** = Preparatory study data indicate that in 2006 around 16% of GLS are reflector lamps. The Eurostat export data show a similar proportion (18%). On this basis GLS-R account for 180 mln. of total unit sales in 2008.

EUROSTAT: External Trade Statistics (extract VHK 2010-05) **Partner: extra EU27**

IMPORT (in mln. Units) LAMPS **Reporter: EU27**

NC code	PRODUCT	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
85391000	Sealed beam lamp units	11	19	13	6	9	12	12	22	14	11
85392192	Tungsten halogen filament lamps for a voltage > 100 v	55	62	61	78	109	133	155	175	152	143
85392198	Tungsten halogen filament lamps for a voltage <= 100 v (excl. those for motorcycles or other motor vehicles)	106	100	99	114	148	152	178	203	155	132
85392210	Reflector filament lamps of a power <= 200 w and for a voltage > 100 v (excl. tungsten halogen filament lamps)	10	8	9	8	9	13	22	25	21	22
85392290	Filament lamps of a power <= 200 w and for a voltage > 100 v (excl. tungsten halogen lamps, reflector lamps and ultraviolet or infra-red lamps)	128	136	158	177	202	232	267	314	288	274
85393110	Discharge lamps, fluorescent, hot cathode, with double ended cap	36	36	32	40	40	60	73	58	51	51
85393190	Discharge lamps, fluorescent, hot cathode (excl. with double ended cap)	158	92	87	116	139	198	231	404	542	516
85393210	Mercury vapour lamps	3	3	4	2	3	6	7	7	9	9
85393250	Sodium vapour lamps	0	1	2	2	2	3	3	9	6	3
85393290	Metal halide lamps	4	5	6	10	10	9	7	6	7	7
85394100	Arc lamps	5	2	1	1	1	1	1	5	3	1
85394910	Ultraviolet lamps	2	3	3	3	3	3	3	5	5	4
85394930	Infra-red lamps	1	1	1	1	2	2	2	2	3	3
	TOTAL	**518**	**468**	**477**	**558**	**677**	**824**	**960**	**1235**	**1257**	**1177**

EUROSTAT: External Trade Statistics (extract VHK 2010-05) **Partner: extra EU27**

EXPORTS (in mln. Units) LAMPS **Reporter: EU27**

NC code	**PRODUCT**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
85391000	Sealed beam lamp units	3	5	5	4	5	4	1	2	6	4
85392192	Tungsten halogen filament lamps for a voltage > 100 v	36	33	36	35	53	71	53	58	54	50

85392198	Tungsten halogen filament lamps for a voltage <= 100 v (excl. those for motorcycles or other motor vehicles)	72	75	67	74	95	92	94	109	95	77
85392210	Reflector filament lamps of a power <= 200 w and for a voltage > 100 v (excl. tungsten halogen filament lamps)	51	62	61	70	73	89	88	97	78	73
85392290	Filament lamps of a power <= 200 w and for a voltage > 100 v (excl. tungsten halogen lamps, reflector lamps and ultraviolet or infra-red lamps)	428	409	431	484	464	492	441	492	358	330
85393110	Discharge lamps, fluorescent, hot cathode, with double ended cap	115	117	133	231	177	215	205	233	213	162
85393190	Discharge lamps, fluorescent, hot cathode (excl. with double ended cap)	57	60	56	70	64	52	59	56	56	47
85393210	Mercury vapour lamps	6	4	4	4	3	4	2	3	3	2
85393250	Sodium vapour lamps	4	4	5	4	4	6	3	7	8	6
85393290	Metal halide lamps	4	6	5	4	7	13	11	12	14	14
85393900	Discharge lamps (excl. flourescent, hot cathode lamps, mercury or sodium vapour lamps, metal halide lamps and ultraviolet lamps)	18	23	37	44	30	23	21	18	15	20
85394100	Arc lamps	0	1	0	0	0	0	0	0	1	4
85394910	Ultraviolet lamps	2	3	3	4	6	9	10	9	13	11
85394930	Infra-red lamps	2	2	3	3	3	2	2	1	3	2
	TOTAL	**800**	**804**	**846**	**1032**	**984**	**1074**	**993**	**1100**	**919**	**801**

DELight study

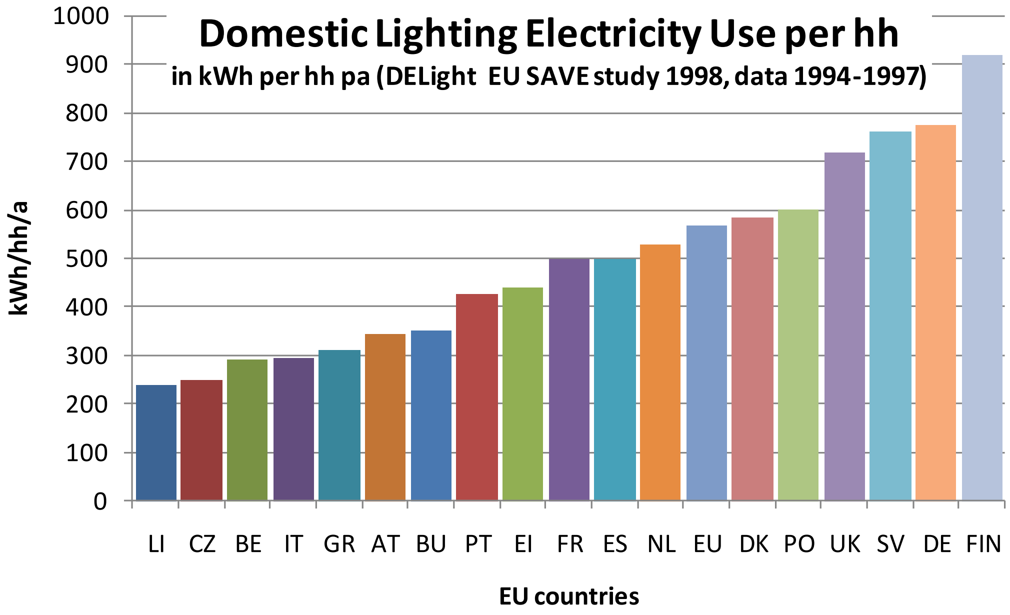
Table. EU Domestic Lighting, 1994-1997 country profiles

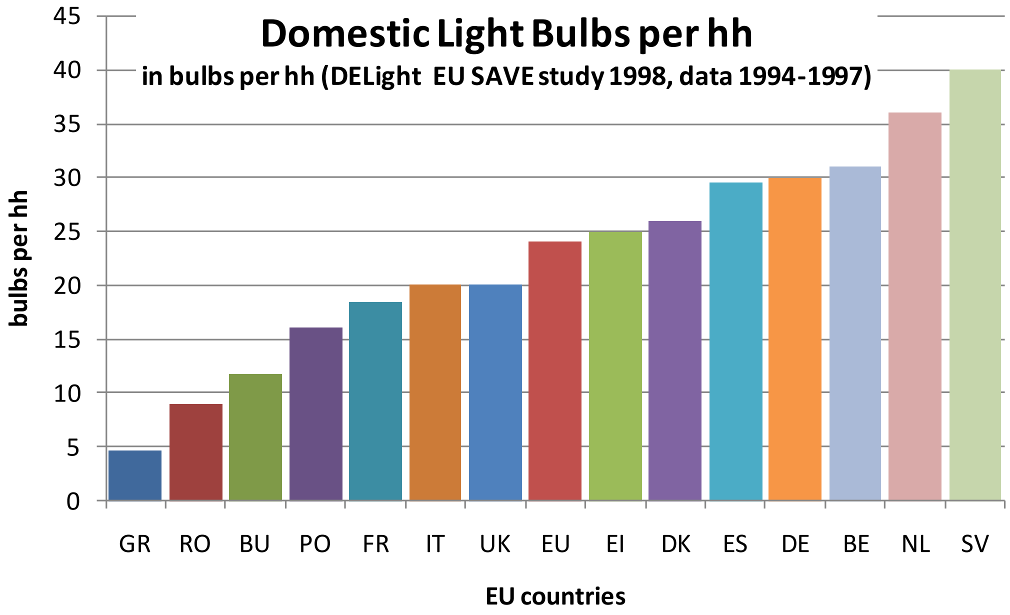
Country	kWh (per hh pa)	kWh/ m2	Bulbs (per hh)
Austria	345 [1995]	4.0	No data
Belgium	291 [1994]	3.4	31
Bulgaria	350 [1994]	*No data*	11.8
Czech Rep.	250 [1997]	*No data*	*No data*
Denmark	585 [1997]	5.5	26
Finland	920 [1993]	12.1	*No data*
France	500 [1994]	6.2	18.5
Germany	775 [1997]	9.3	30
Greece	310 [1988]	3.9	4.7
Ireland	438 [1996]	4.8	25

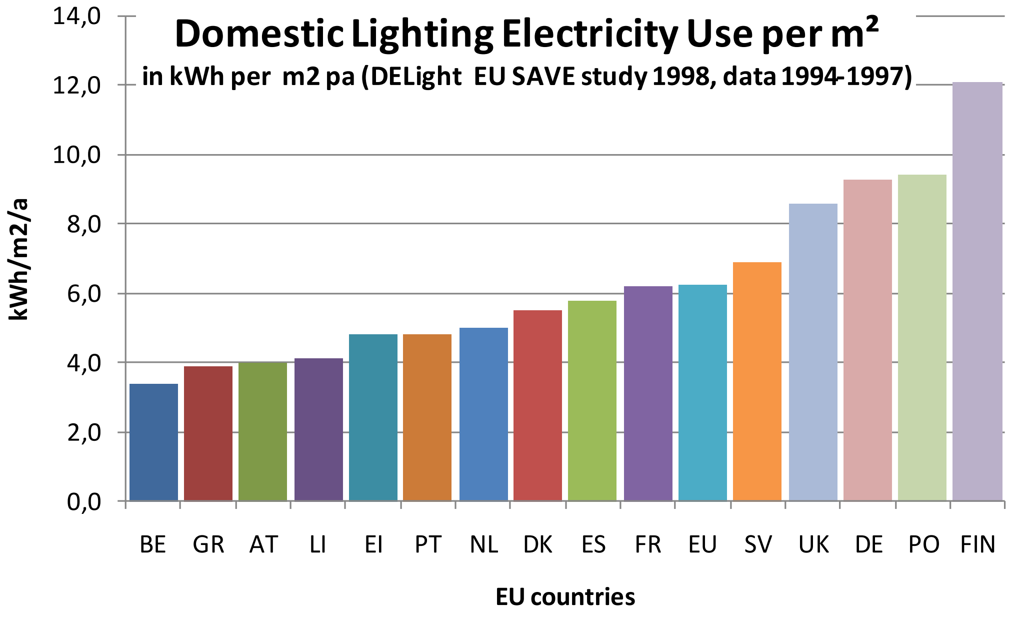
Italy	296 [1995]	*No data*	20
Lithuania	240 [1997]	4.1	*No data*
Netherlands	528 [1996]	5.0	36
Poland	600 [1997]	9.4	16
Portugal	425 [1995]	4.8	*No data*
Romania	*No data*	*No data*	9
Spain	500 [1995]	5.8	29.5
Sweden	760 [1997]	6.9	40
UK *	720 [1996]	8.6	20
EU Average	569 kWh/hh	-	24

Palmer, J. and Boardman, B., *DELight, Domestic Efficient Lighting*, EU SAVE study, ECU/EM/ESH, Oxford, 1998

* = UK high wattage per bulb; Sweden low wattage per bulb


Domestic Lighting Electricity Use per hh
in kWh per hh pa (DELight EU SAVE study 1998, data 1994-1997)
kWh/hh/a
1000
900
800
700
600
500
400
300
200
100
0
LI
CZ
BE
IT
GR
AT
BU
PT
EI
FR
ES
NL
EU
DK
PO
UK
SV
DE
FIN
EU countries


Domestic Light Bulbs per hh
in bulbs per hh (DELight EU SAVE study 1998, data 1994-1997)
bulbs per hh
0
5
10
15
20
25
30
35
40
45
GR RO BU PO FR IT UK EU EI DK ES DE BE NL SV
EU countries


Domestic Lighting Electricity Use per m²
in kWh per m2 pa (DELight EU SAVE study 1998, data 1994-1997)
kWh/m2/a
14,0
12,0
10,0
8,0
6,0
4,0
2,0
0,0
BE
GR
AT
LI
EI
PT
NL
DK
ES
FR
EU
SV
UK
DE
PO
FIN
EU countries

DEFRA/STEM/ECEE (Task 3 report)

Table 2-2. MTP Draft Directional Lamp Shipment Estimate for UK Scaled to EU-27

Year	HL-MV-R	HL-LV-R	Household Ratio	HL-MV-R	HL-LV-R
2010	24,999,828	26,441,393	12.8%	195,546,930	206,822,753
2011	25,605,562	27,082,066	12.8%	200,115,871	211,655,238
2012	17,713,141	18,734,918	12.8%	138,318,307	146,297,160
2013	19,763,462	20,903,371	12.8%	154,201,520	163,095,495
2014	22,592,159	23,895,034	12.8%	176,128,449	186,285,656
2015	22,308,317	23,594,763	12.8%	173,775,767	183,796,832
2016	20,259,133	21,427,498	12.9%	157,060,165	166,117,982
2017	20,398,941	21,575,433	13.0%	157,512,201	166,596,587
2018	22,356,747	23,646,094	13.0%	171,945,277	181,861,621
2019	23,602,048	24,963,144	13.1%	180,808,924	191,235,912
2020	23,627,379	24,989,932	13.1%	180,296,615	190,694,036

Source: MTP draft data estimate of UK national sales of HL-MV-R and HL-LV-R; UK Office of National Statistics, 2010; United Nations, 2002.

Table 2-3. Model-Weighted Average Catalogue Lifetime for Directional Lamps

	GLS-R	HL-MV-R	HL-LV-R	CFLi-R
General Electric	n=23 1,652 hours	n=31 2,161 hours	n=61 4,016 hours	tbd
Philips Lighting	tbd	n=21 2,476 hours	n=59 3,968 hours	tbd
OSRAM	tbd	tbd	tbd	tbd
Industry Average	1,600 hours	2,300 hours	4,000 hours	8,000 hours

Source: Manufacturer's Electronic Catalogues, accessed in May 2010.

Table 2-4. Model-Weighted Average Catalogue Lifetime for Directional Lamps

	GLS-R	HL-MV-R	HL-LV-R	CFLi-R	Notes
Lamp Lifetime (Manufacturer's Catalogues)	1600	2300	4000	8000	
Domestic operating hours per year	400	450	500	800	hours, EuP
Commercial operating hours per year	1800	1800	1800	1800	hours (EuP, 7/d x 250 d/yr)

Weighted operating hours	655	720	783	1108	hours/year
Operating hours per day	1.8	2.0	2.1	3.0	hours/day

Table 3-1 . Preparatory study stock estimate

Year	GLS-R	HL-MV-R	HL-LV-R	CFLi-R	Total
2006	320,492,926	135,276,750	562,212,950	10,103,333	1,028,085,959
2007	291,591,919	228,310,650	584,873,780	12,350,493	1,117,126,842
2008	268,863,050	299,335,970	599,377,647	14,977,744	1,182,554,411
2009	246,134,181	370,361,291	613,881,514	17,604,995	1,247,981,981
2010	223,405,311	441,386,611	628,385,381	20,232,246	1,313,409,549
2011	200,676,442	512,411,932	642,889,248	22,859,497	1,378,837,119
2012	198,644,874	537,463,182	654,094,289	23,486,644	1,413,688,989
2013	196,613,306	562,514,432	665,299,330	24,113,791	1,448,540,859
2014	194,581,739	587,565,682	676,504,372	24,740,937	1,483,392,730
2015	192,550,171	612,616,932	687,709,413	25,368,084	1,518,244,600
2016	190,518,603	637,668,182	698,914,455	25,995,231	1,553,096,471
2017	188,487,035	662,719,432	710,119,496	26,622,377	1,587,948,340
2018	186,455,467	687,770,682	721,324,537	27,249,524	1,622,800,210
2019	184,423,900	712,821,932	732,529,579	27,876,671	1,657,652,082
2020	182,392,331	737,873,182	743,734,620	28,503,818	1,692,503,951

Source: This table is presented as Table 2-16 on page 395 of the Preparatory Study for Eco-design Requirements of EuP, Final report Lot 19: Domestic lighting.

(Task 4 report)

Table 2 2. Revised EU-27 Shipments Estimate of Directional Lamps, All Sectors

Year	GLS-R (million)	HL-MV-R (million)	HL-LV-R (million)	CFLi-R (million)	Total (million)
2010	148.8	180.2	167.7	6.5	503.2

2011	148.0	200.9	172.8	6.8	528.4
2012	147.2	221.7	177.9	7.0	553.7
2013	146.4	242.4	183.0	7.3	579.0
2014	145.6	263.1	188.1	7.5	604.3
2015	144.8	283.8	193.2	7.8	629.6
2016	144.0	304.6	198.3	8.0	654.8
2017	143.2	325.3	203.4	8.3	680.1
2018	142.4	346.0	208.5	8.5	705.4
2019	141.6	366.7	213.6	8.8	730.7
2020	140.8	387.5	218.8	9.0	756.0

Table 2-3. Revised EU-27 Inventory Stock Estimate of Directional Lamps, All Sectors

	GLS-R	**HL-MV-R**	**HL-LV-R**	**CFLi-R**	**Total**
Year	**(million)**	**(million)**	**(million)**	**(million)**	**(million)**
2010	420.0	545.1	815.9	39.5	1,820.5
2011	416.1	617.7	842.5	42.9	1,919.3
2012	413.6	686.5	873.0	46.2	2,019.2
2013	411.3	758.6	899.9	49.5	2,119.2
2014	409.0	832.1	925.0	52.8	2,218.9
2015	406.8	905.8	951.4	56.6	2,320.5
2016	404.5	979.4	978.0	60.2	2,422.2
2017	402.3	1,053.1	1,004.7	62.8	2,522.9
2018	400.1	1,126.8	1,031.4	65.0	2,623.3
2019	397.8	1,200.5	1,058.1	67.1	2,723.6
2020	395.6	1,274.2	1,084.8	69.3	2,823.9

ANNEX 11: Return on investment

In the case of a simple switch of 6 GLS-R lamps (50 W, t_{life} 1000 h/lamp, consumer price € 1,30) to 1 equivalent efficient CFLi-R (12 W, t_{life} 6000 h, price € 8), the energy saving is 38*6000 Wh = 228 kWh over product life. At the 2006 residential electricity rate of € 0,16/kWh this leads to a (non-discounted) saving of € 36,48 over 6000h burning hours. Discounted at 4%/year and assuming a light point that is used 800h/year (i.e. a product life of 7,5 years) the Net Present Value is around € 30,-. In terms of acquisition costs, the 6 GLS-R lamps cost € 7,80, which is barely less than the € 8,- for the CFLi-R and the payback period of this switch is a matter of a few months.[77]

The switching point, i.e. where the switch would no longer be ' economical', lies at a CFLi-price of € 38,- or alternatively at an electricity rate much lower than 1 Eurocent.

The same calculation for the switch of 3 HL-MV-R lamps (50 W, t_{life}=2000h, price € 3,80) to 1 CFLi-R (12 W, t_{life} 6000 h, price € 8) shows similar outcomes. Also in terms of mercury emissions balance this switch might be interesting because we are saving 228 kWh electricity at specific mercury emissions for power generation of 0,016 mg/kWh (preparatory study). This results in 3,6 mg mercury emissions and would offset the CFL-mercury emissions at End-of-Life (est. 2,5 mg).

[77] The simple payback method - with formula Simple Payback Period=investment/net annual cash flow - is inappropriate to make the right economic choice in this case, because lamps represent 'investments with unequal life spans' (i.e. a CFL and a GLS). Instead, a 'chained' or EAC (equivalent annual cost) method is used, whereby two projects are compared with each annual write-off + operating costs. The 'payback period' mentioned is thus intended as the time it takes for the accumulative costs of the more expensive project A (CFL) to be equal to the accumulative spending of the less expensive project B (GLS).

ANNEX 12: Assessment of Member State action in the field of energy efficiency of directional lamps

The extent to which internal market distortions have occurred so far due to actions by individual Member States is rather limited. No national legislation is in place or even planned that would set binding minimum energy efficiency requirements on directional lamps. The "Energy Saving Trust Recommended" label in the U.K. provides a basis for authorities to specify that only directional lamps fulfilling the criteria of the scheme can be purchased in certain circumstances (green public procurement, subsidies). Member States have had the option since 2002 to specify requirements for indoor lighting systems in their national implementation of the Energy Performance of Buildings Directive (2010/31/EU). However, due to the nature of the buildings so far covered by requirements in national legislation, even those Member States where lighting system requirements were put in place have had little influence on the directional lamps market, as the latter are more used in the residential, retail and HORECA sectors.

The preparatory study and the impact assessment did not find evidence that either schemes like the Energy Saving Trust or national implementation of the EPBD Directive would have influenced the market of directional lamps to any measurable extent. However, should the Commission fail to set minimum efficiency requirements under the Ecodesign Directive, it can be assumed that some Member States will want to adopt such requirements for their own markets, resulting in effective market distortion. This possibility, in the absence of EU action, is further reinforced due to the rapid introduction of minimum requirements on directional lamps in third countries across the world (see Annex 4).