Green ProcA

Green Public Procurement in Action

GREEN PROCA

Green Public Procurement

Procurement and Climate Protection

Lighting

Co-funded by the Intelligent Energy Europe Programme of the European Union

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www.gpp-proca.eu/it

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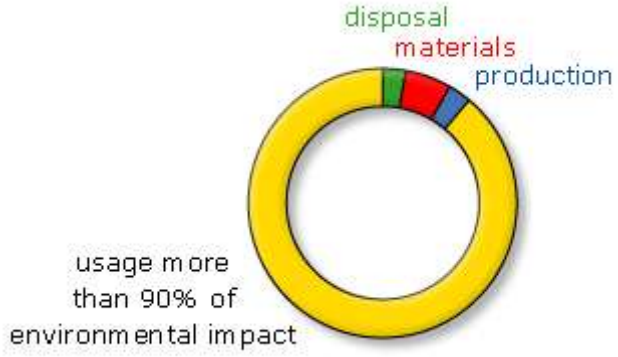
Content

1. Introduction

In Europe, lighting accounts for about 14% of the total electricity consumption, thus lighting has a substantial impact on the environment and energy costs. Lighting accounts for up to 40% of electricity used in non-residential buildings. Major cost and energy savings can be achieved if efficient lighting solutions are implemented. Examples have shown that between 30% and 50% of electricity used for lighting could be saved and a 15 times longer life-span could be achieved by investing in energy-efficient lighting systems.[1] While the environmental impact of most products occurs during resource use, production, transport and disposal phase, lamps have the highest environmental impact during their use phase - this can reach up to 90% depending on the lamp type.

Environmental impact throughout a incandescent lamp's life



Source: European Lamp Companies Federation: *www.elcfed.org*

Thus, it is worthwhile to consider of energy-efficient lamp types when replacing or installing new systems or lamps. With the procurement of lamps an ergonomic, environmentally sound and economical lighting of the working place should be assured. A new lamp can be considered eco-efficient if it achieves the same performance with a lower energy consumption. Besides the initial costs, the energy consumption as well as the life time is considered in the economic evaluation.

In this Annex fluorescent lamps, compact fluorescent lamps (CFLs, energy saving lamps), improved incandescent bulbs, LEDs, halogen lamps, sodium lamps, metal-halide lamps, and electronic ballasts are covered. Additionally energy and environmental labels, which are relevant for the purchase of lamps, are introduced briefly. References for energy savings by purchasing efficient lamps are also specified. Finally, tips how to decrease electricity consumption in the daily office life by implementing efficient lighting solutions are given.

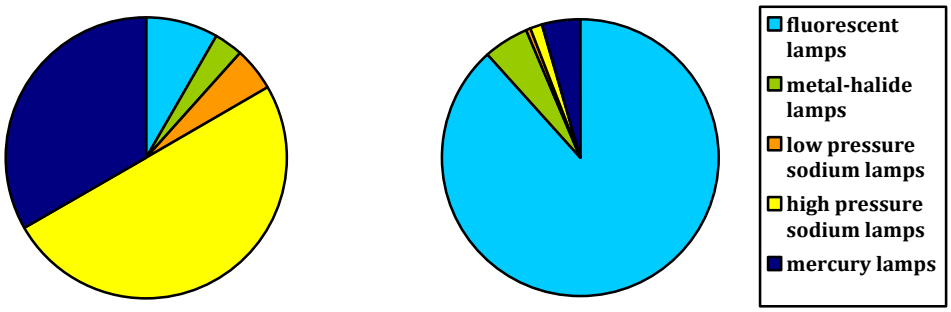
The European Union has introduced new regulations concerning light bulbs. The production of old-style incandescent bulbs gradually deceased from 2009 until 2012. By replacing incandescent lamps, up to 40 TWh (by 2016) can be saved in Europe (equivalent to the electricity consumption of 11 mio

[1] Bertoldi Paolo, The European GreenLight Programme, 2011, p.3

households) and 15 mio t CO_2 emissions can be reduced annually.

Compared to conventional light bulbs, new types are more efficient and include: LED bulbs, compact fluorescent lamps (CFLs) and improved incandescent bulbs. CFLs, for example, use between 65 % and 80 % less energy than conventional incandescent bulbs. Improved incandescent bulbs work with halogen technology and use 20 % to 45 % less energy for the same light output compared to the best conventional incandescent bulbs.

Number of presently used lamps in EU countries [in million pieces]



street lighting *industry lighting*

Source: LTG

2. Energy efficient lighting solutions

Energy efficient lighting is more than illuminants (the lamps). In an optimised system, an overall lighting solution is implemented including the following components:

- **Energy efficient illuminants (lamps):**
  installation of lamps with the highest light efficiency possible and adjusted to the specific application area. Quality criteria as for example colour rendering or meeting of lighting standards must be considered.

- **Ballasts:**
  Ballasts are necessary for the operation of discharge lamps and electronic ballasts should be used whenever possible. Electronic ballasts do not only show less electricity losses than conventional ballasts but also a better lighting quality (jitter-free light, quick, soundless and flicker-free starting).

- **Luminaires** (with illuminant inside):
  the following criteria should be considered for procurement:
  - high luminaire operating efficiency level (> 80%)
  - optimal lamp reflector
  - highest direct ratio possible

- **Light control:**
  Light control should ideally be implemented by using daylight control. Light sensors allow for daylight use to the greatest possible extent and in most cases they can be installed easily. Presence detectors recognise the presence of persons by infrared signals and switch the lighting in line with the demand. The later implementation of a presence-dependent control of the lighting system by presence detectors is recommended. Daylight control in combination with presence detectors reduces energy costs by 75 % in comparison to not regulated conventional lighting systems.

- **Interior decoration:**
  Light colour walls and ceilings should be preferred for interior decoration as the reflectance level is much higher.

- **Replacement of inefficient lamps:**
  Although an overall lighting concept for modernisation of the whole lighting system is the best solution, it is also possible to modernise step by step. When replacing only lamps, the following approach can be recommended:

  - replace light bulbs by CFLs or LEDs
  - replace halogen lamps by more efficient (infra-red coated) halogen lamps or CFLs

(screw socket)
- switch from "T8"-fluorescent lamps (26 mm Ø) to "T5"-fluorescent lamps (16 mm Ø) (however, this requires change of luminaires)
- switch from mercury lamps to sodium or metal-halide lamps
- consider LED solutions
- use electronic instead of conventional ballasts

2.1 Energy efficient lamps

Illuminates are the most important element of energy efficient lighting solutions. The following overview outlines the main characteristics of different types of lamps.

Halogen lamps / improved incandescent bulbs

- Halogen lamps have a higher efficiency than incandescent bulbs but are not the most energy efficient lighting solution.
- Conventional mains voltage halogen lamps do not fulfil the new energy efficiency requirements for household lamps (low-voltage lamps do).
- However, alternative products are already on the market ("C-class lamps"), consumers can choose from two types of halogen lamps with xenon gas filling.
- When filled with xenon-gas, halogen lamps use about 20 to 25 % less energy for the same light output compared to the best conventional incandescent bulbs.
- Apart from the xenon-gas filling, the socket and the dimensions of the new generation halogen lamps are the same as for conventional halogens. They can therefore only be used in luminaires with a special halogen socket. These halogen lamps will remain available after 2016 to be used in luminaires which have this kind of special halogen socket.
- The B-class improved incandescent bulbs are currently only available up to the equivalent of a 60 W conventional incandescent bulb.
- This type of lamp can last up to 3000 hours – three times longer than conventional incandescent bulbs – and is dimmable.

- For improved incandescent bulbs with halogen technology, the improved halogen capsule is placed in glass bulbs shaped like conventional incandescent bulbs with a traditional socket. This makes them one-to-one replacements to conventional incandescent lamps. C-class improved incandescent bulbs are to be further improved to class B or A from 2016 onwards.
- Both versions provide light of equivalent quality to conventional incandescent bulbs, but last twice as long (2 years). These lamps are fully compatible in size with existing luminaires and dimmable on any dimmer.

Infra-red coated halogen lamps

- Normal low voltage halogen lamps can be replaced by more efficient halogen lamps (IRC infrared coating – resp. ES Energy Saving).
- A special infrared coating applied to the bulb improves the energy efficiency by more than 45 % compared to the best conventional incandescent bulbs. However, this is only possible with low voltage lamps. A transformer is in fact needed to make this technology available for mains voltage lamps.
- The transformer can be a separate unit or a component integrated into the luminaire. It can also be integrated into the bulb itself, which can then replace conventional incandescent bulbs in the same luminaire. As with the C-class lamps both the special socket capsules and the improved incandescent bulbs exist in B-class.

Linear fluorescent lamps

- Modern fluorescent lamps (T5, three-band) have a significantly better energy efficiency than older models. Fluorescent lamps differ in colour rendering and light colour. A lighting ballast is necessary to operate discharge light, for efficiency reasons, only electronic ballasts should be used.
- The greatest saving potential can be achieved when changing from T8 (26 mm diameter) to T5 lamps (16 mm diameter). However in such cases the luminaries have to be exchanged as well.

Compact Fluorescent Lamp (CFL)

- The generic name for a family of single-ended fluorescent lamps of folded or bridged tube design with high colour rendering and long life.
- Compact fluorescent lamps such as energy saving lamps represent the energy efficient alternative to incandescent bulbs and halogen lamps and can be used for many purposes in private homes and businesses.
- A range of different designs and qualities are offered.

Saving potential of a CFL compared to an incandescent bulb

	Incandescent Bulb	Compact Fluorescent Lamp
Power input	100 W	20 W
Average durability	1,000 h	10,000 h
Luminous flux	1,400 lm	1,400 lm
Relation heat to light	95 % to 5 %	75 % to 25 %
Necessary lamps in 8 years (3 h/day*365 days = 1095 h/year)	8	1
Energy consumption in 8 years with a burning time of 3 h/day	876 kWh	175.2 kWh
Energy costs (0.14 EUR/kWh)	122.64 EUR	24.53 EUR
Costs per lamp	0.50 EUR	10.00 EUR
Total costs in 8 years	126.64 EUR	34.53 EUR
Savings	--	**92.11 EUR**

Sodium bulbs

- High-pressure sodium lamp is a high-intensity discharge (HID) lamp in which light is produced by radiation from sodium vapour operating at a partial pressure of about 13.300 Pa. This category includes clear and diffuse-coated lamps. Standard high pressure sodium lamps are phased out under the EC Regulation 245/2009.
- Low-pressure sodium lamp is a discharge lamp in which light is produced by radiation from sodium vapour operating at a partial pressure of 0.1 to 1.5 Pa.
- Low/high-pressure sodium lamps as well as metal-halide are high intensity discharge lamps (HID). The vast majority of street lighting installations are based on one of the high intensity discharge (HID) lamp systems.
- High-pressure sodium lamps are generally very efficient at higher wattages. However, low-pressure sodium lamps have very poor colour characteristics.

Metal-halide lamps

- Metal-halide lamps belong to the group of high-intensity discharge (HID) lamps. They produce high light output in relation to their size, making them a compact, electricityful, and efficient light source.
- Originally created in the late 1960s for industrial use, metal halide lamps are now available in numerous sizes and configurations for commercial and residential applications.
- Like most HID lamps, metal halide lamps operate under high pressure and temperature, and require special fixtures to operate safely.
- Metal halide lamps are frequently used for general indoor lighting and industrial purposes, for street lighting and sport installations.

LEDs (Light-Emitting-Diodes)

- LEDs – which stands for light-emitting diode – are a fast emerging technology. LEDs are based on

the semiconductor diode. LEDs offer many advantages compared to conventional light sources including lower energy consumption, longer lifetime, improved robustness, smaller size and faster switching.

- The efficiency of LEDs is equal to CFLs or even a bit higher, however they do not conain mercury and live even longer.
- LEDs for indoor lighting are in the first phases of commercialisation and provide the replacement of both, clear and non-clear light bulbs. They are likely to become alternatives to the full range of lamps in the near future.

LEDs for street lighting & traffic light

LEDs are a very interesting option for street & traffic lighting because they:

- achieve up to 90 % energy saving compared to conventional light bulbs
- have a longer lifespan and show extremely good reliability results in combination with reduced maintenance and lower running costs!
- LEDs require no reflector as conventional lamps, thus there are no problems with sunlight reflections in the traffic lighting (known as the phantom effect)
- LEDs require low voltage supply, which results in safer installations

Street lighting pilot projects exist and rapid development is expected within the near future.

Organic Light Emitting Diodes (OLED)

OLEDs are light emitting panels made from organic (carbon based) materials that emit light when electricity is applied. Currently, OLEDs are used to design beautiful and efficient displays, but it is also possible to use the technology to create white light panels for lighting. An OLEDs 'light bulb' is a thin film of material that emits light. OLEDs provide an area-lighting panel (i.e. not point-lighting like LEDs) and feature good colour temperature. In fact some OLEDs are colour tuneable. OLEDs can also be made flexible or transparent.

OLEDs are not only very efficient (between CFLs and LEDs) they also do not contain metals such as mercury. Several companies already offer lamps built from OLED panels, however they are still very expensive.

Ballasts

- A current-limiting electrical device used with electric discharge lamps (fluorescent, mercury vapour, metal-halide, high- pressure sodium) to provide the electrical circuit conditions necessary to start and operate the lamp.
- A more modern, efficient type is the electronic ballast instead of electromagnetic.
- An electronic lighting ballast uses solid state circuitry to transform voltage, but unlike electromagnetic ballasts, can also alter the electricity frequency. This means that an electronic lighting ballast can greatly reduce or eliminate any flicker in the lamps.
- Further advantages of electronic ballasts: higher energy efficiency, multiple lamp, can replace magnetic ballasts in a retrofit, lamp flicker is eliminated, lower noise level than magnetic ballasts, non-toxic materials, lighter weight.
- It is recommended to exchange electromagnetic ballasts wherever possible.
- HID lamps have used magnetic ballasts until recently, because they have a longer life span and are robust. New developments use electronic ballasts for HID-lamps outside. Moreover, ecodesign requirements will progressively phase out non efficient ballasts.

2.2 Infobox: Phasing out of incandescent light bulbs

The EU has set new energy efficiency requirements that lamps produced for the EU market need to fulfill as from 1 September 2009. Traditional incandescent and less efficient halogen bulbs will be gradually phased out from the market by the end of 2012. Lamps that cannot meet the minimum energy efficiency and performance requirements (e.g. durability) are gradually phased out from the EU market beginning in September 2009.

The measure distinguishes between lamps that are "clear" (transparent) and non-clear. Non-clear lamps will need to reach the A-class according to the EU's lamp energy label, which means energy savings of 75 % or more as compared to traditional incandescent bulbs. Only compact fluorescent lamps and LED lamps can achieve such a high efficiency level.

New requirements on the functionalities of lamps (starting times, lifetime etc.) are also introduced so that only quality lamps will be allowed on the market. Additional product information will also be required on the packaging to help consumers to make the right choice for the intended purpose.

The measure applies to lamps manufactured and sold by the manufacturer or the importer as from 1st September 2009. Wholesalers and retailers will be able to continue selling existing stocks even after that date. This means that the lamps that are banned will only gradually disappear from the shop shelves.

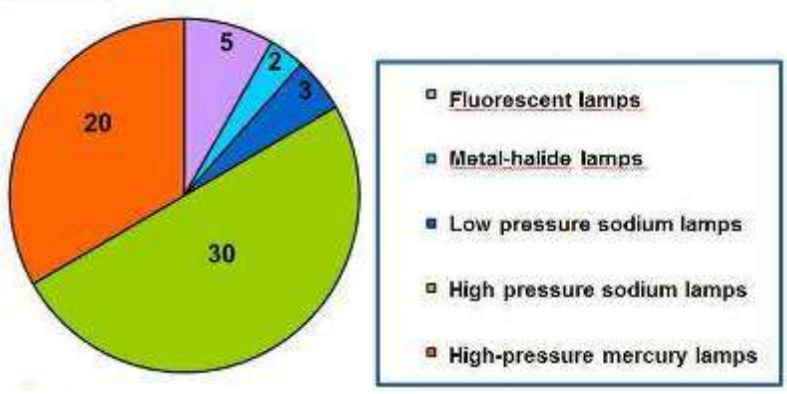
In addition, not only "household lamps" but all inefficient lamps are affected by the EU regulation as well as inefficient ballasts and luminaires:

2010	• Phasing out of linear fluorescent lamps ("halophosphat") • Labelling of ballasts for fluorescent lamps • Minimum efficiency of ballasts required
2011	• Obligatory product information for luminaires
2012	Phasing out of: • T12 (38 mm) fluorescent lamps • Stating efficiency of ballast for high-intensity discharge lamps • Minimum requirements for lamp lumen maintenance factor (LLMF) & lamp survival factor (LSF)
2015	Phasing out of: • High-pressure mercury lamps • high-pressure sodium plug-in lamps
2017	• higher requirements for metal-halide lamps • phasing out of magnetic ballasts, only electronic ballasts

2.3 Infobox: Street lighting

The "phasing out" of inefficient lamps affects also street lighting, where a hugh potential for energy and cost saving is given.

Number of currently installed lamp types in the European Union (in million):



Source: LTG

Example Austria: Overview lamps for street lighting and their main applications

**share of Austrian street lighting; 100% = 0,84 Mio lighting points*
Source: Philips, January 2010

Retrofitting options:

1. **Plug-in solutions:**
   - exchange of lamps by lamps of a new technology keeping the existing luminaire (plug in lamps)
   - socket, ballast, reflector remain in place
   - advantages: low costs, simple
   - inconvenients: small amount of energy savings, feasible only until 2015

Example: Exchange of a 125 W high pressure mercury vapor lamp by a 110 W plug in high pressure sodium vapor lamp:
- energy savings of approx. 10% - yellow instead of white light - Light directing characteristics change, danger of blinding, unplanned brightening, etc. - loss of type permission (certificate) of the lamp (liability claims)

2. **Retrofitting**
   - exchange of the lamp and the electronic device of the luminaire
   - socket and reflector remain unchanged
   - advantage: significantly higher energy efficiency compared to plug in lamps

3. **Exchange of the luminaires**
   - in terms of energy efficiency, the best solution is exchanging the complete luminaire (incl. ballast, reflector and lamp)
   - disadvantage: higher investment costs
   - advantages: enduring best conversion efficiency and highest energy efficiency, all aspects of ecology, economy, safety and aesthetics can be considered when professionally planned

Overview of characteristics of different lamps for efficient street lighting

lamp type	light colour	advantages/disadvantages
High-pressure mercury vapor lamps	yellow light	+ ecological + reduced insect landing - bad colour perception
ceramic metal halid lamps	white light	+ good colour perception + warm white light for reduced insect landing (e.g. 3,000 K) - possibly expensive - presently possibly reduced life span
fluorescent lamps and compact fluorescent lamps	white light	+ cheap + long life span - temperature independent - limited possibilities to direct the light

LED	white light, other colours possible	+ efficient technology of the future + no UV/IR portion + long life span + realised projects exist + great potential expected - presently rather expensive - no long-term experience

3. Product identification & labels for lighting products

3.1 Product identification – new requirements

New requirements are in place for lamp identification since 1 Sept. 2010 based on EU-regulation 244/2009. The information to be placed on lamp packing includes the following:

- energy label
- lumen (lm)
- Watt (W)
- comparison light bulb
- life span in hours and years
- switching cycle
- Kelvin (K): light colour
- run up time: until 60% of the lightness is achieved
- dimmable
- dimensions (mm): length, diameter
- amount of mercury (Hg)

How to read the packaging?

Information on key quality criteria is now provided on the lamps' packaging, for example:

- **Light output (in lumens)**
  Measuring the performance of a lamp in lumens allows direct comparison of light quantity (which is the service actually offered by the lamp). Comparisons based on wattage only are not meaningful and can be misleading. The higher the lumen value of a light bulb, the greater the quantity of light the bulb will produce.

- **Energy efficiency**
  The EU Regulation phases out the least efficient lamps. However, it is worthwhile checking the Energy Label to see how efficient a lamp is, because there are still large differences. For the same light output, a compact fluorescent lamp (class A) will for example only need one third of the electricity compared to an incandescent bulb (class C). Since 1998, the mandatory EU energy la-

bel has displayed the energy class of the bulbs in the range A to G, with A being the more efficient and G the least efficient.

- **Lifespan**
  Information on the bulb's lifespan in hours (operating time before the bulb fails) or sometimes also given in years. For household lamps, one year generally means 1000 hours, corresponding to an average of 3 hours of use per day. A longer lamp lifespan means less changing lamps. For professional lamps, lifespan is a very important factor and in general longer lifespan means higher quality standard. This should be taken into account when comparing prices of the different alternatives.

- **Colour of the light (colour temperature)**
  While incandescent bulbs always provide the same light colour ("warm white"), compact fluorescent lamps and LEDs offer a wider range of colour temperatures (measured in Kelvins). These differences are useful in certain applications. Choose 2700K or "warm white" for relaxing and more than 4000K or "cold white" for working areas.

- **Number of switches before failure**
  This information is particularly important for compact fluorescent lamps. Standard compact fluorescent lamps (with 3000-6000 on/off switches) should not be installed in locations where frequent switching is likely, meaning an average of more than three times a day, e.g. in toilets or corridors with motion sensors. They might not reach the lifetime claimed on the packaging. However, there are dedicated compact fluorescent lamps that can endure up to 1 million switches, suitable for such locations. Other light sources are insensitive to switching (such as improved incandescent bulbs).

- **Warm-up times**
  This information is particularly important for CFLs. Standard CFLs take a bit longer to start and to reach their full light output than other lamp technologies (up to 2 seconds to start and up to 60 seconds to reach 60% of their light output). However, dedicated compact fluorescent lamps exist which are almost as fast as other lamp types (such as improved incandescent bulbs). The icon shows whether the bulb warms up quickly or not.

- **Dimming**
  When using dimmers to control the light output, always check whether new types of bulbs offer this feature. Many types of CFLs and LEDs in particular will not work when operating on standard dimmers. A dedicated icon for dimming shows whether the bulb is dimmable or not.

- **Operating temperature**
  CFLs and LED lamps are more temperature sensitive than improved incandescent bulbs. It is important to choose a bulb which will work well at temperatures to which it is exposed (indoor or outdoor, heated or unheated). For outdoor luminaires in climatic zones with cold winters, it is

important to select a lamp that works also when it is freezing outside, otherwise its light output may be reduced in winter nights.

- **Lamp dimensions**
  When switching from one lamp technology to another with the same luminaire, do not forget to check whether the new lamp will fit into the luminaire.

- **Disposal of CFLs**
  CFLs contain a small amount of mercury – less than 5 mg, which is several times less than the amount of mercury contained in other products people use at home, such as thermometers and batteries. Buying CFLs with an outer non-breakable enclosure is a way of dealing with mercury leaks in the case of accidental light bulb breakage. The light bulb packaging displays a reference to a website where the manufacturer explains in more detail how to tackle a broken CFL. Like many other electrical products, new light bulbs should not be discarded with normal household waste but should be returned to the dedicated collection points for waste electronic equipment.

3.2 Relevant environmental labels

The procurement legislation allows:

- The use of the criteria of every label – national and voluntary labels
- The choice of products which are more expensive in purchase but less expensive than others in the useful life
- The choice of products which are more expensive over the useful life but which have less environmental impacts and meet the environmental aims of the institution

The procurement legislation prohibits:

- Insisting on a labelled product (Judgement of the European court of Justice in case C-368/10, European Commission v Kingdom of the Netherlands from 10 May 2012)

3.2.1 EU-Label

Website

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:071:0001:0008:EN:PDF

Product: household lamps (except reflector lamps)

According to the European Union directive electric household lamps supplied directly from the mains have to be labelled with an energy consumption label.

Excluded are reflector lamps, lamps with a luminous flux of more than 6,500 lumens or an input electricity of less than 4 watts, for the use with other energy sources e.g. batteries, lamps not primarily

used for production of light in the visible range (400 – 800 nm) and lamps which are part of a product, the primary purpose of which is not illuminative.[2]

The following parameters have to be declared on the energy label (see figure beside):[3]

- the energy efficiency class from A (more efficient) to G (less efficient)
- the energy efficiency class letter shall be placed at the same level as the relevant arrow
- the luminous flux in lumens
- the electricity input (wattage)
- the average rated life of the lamps in hours

Compact fluorescent lamps are usually classified in energy efficiency class A or B, whereas an incandescent bulb only fulfils the criteria for D to G.[4]

3.2.2 EU Ecolabel (Eco flower)

Website http://ec.europa.eu/environment/ecolabel/
Product: CFLs

Since 1992 the "Flower" has become a European-wide symbol for products providing simple and accurate guidance to consumers. All products bearing the "Flower" have been checked by independent bodies for complying with strict ecological and performance criteria.

The EU Eco-label is administered by the European Eco-labelling Board (EUEB) and receives the support of the European Commission, all member states of the European Union and the European Economic Area (EEA). The Eco-labelling Board includes representatives of industry, environment protection groups and consumer associations.

The number of products and services awarded the EU Ecolabel has increased every year. By the end of 2011, more than 1,300 licences had been awarded, and today, the EU Ecolabel can be found on more than 17,000 products. [5] One of the products labelled are light bulbs.

The EU Ecolabel on light bulbs meets amongst others the following criteria:[6]

[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:071:0001:0008:EN:PDF

[3] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31998L0011:EN:HTML

[4] http://www.stromeffizienz.de/private-verbraucher/eu-energielabel/haushaltslampen.html,http://ec.europa.eu/energy/lumen/doc/full_faq_de.pdf

[5] http://ec.europa.eu/environment/ecolabel/facts-and-figures.html

[6] http://ec.europa.eu/environment/ecolabel/eu-ecolabelled-products-and-services.html

- durability of at least 10,000 hours (5 – 9 years) – i.e. ten times longer than incandescent light bulbs
- electricity consumption is reduced by a factor of five compared to an incandescent light bulb
- it will not flicker when switched on
- very low mercury content
- at least 65% recycled packaging
- it is guaranteed to light at 70% or 90% after 10,000 hours depending on the type of bulb

3.2.3 Blue Angel (Blauer Engel)

Website http://www.blauer-engel.de/en/blauer_engel/index.php
Product: electronic ballasts for fluorescent lamps

The Blue Angel is the first and oldest environment-related label in the world for products and services. It was created in 1978 in Germany. Only those products are awarded, which are clearly less harmful to the environment compared to conventional products. The Blue Angel should help to speed up the structural change of the economy towards a sustainable development. The label is assigned by RAL, an independent institution under private law. The Environmental Labelling Jury decides on the requirements in cooperation with experts and Germany's Federal Environmental Agency. The catalogues of criteria are adjusted to the state of the art in intervals of 3 to 4 years[7]

In the sector of lamps high energy efficiency, long service life time, high switching withstand level, short warm-up time, low mercury content, low UV radiation and electro-magnetic field radiation and good colour rendering are the criteria for assigning of the label.[8]

3.2.4 Energy Star

Website http://www.eu-energystar.org/en/index.html
Product: CFLs, LEDs

ENERGY STAR is a joint programme of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy. In 1992 the ENERGY STAR was introduced as a voluntary labelling programme designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. Computers and monitors were the first labelled products.[9]

[7] http://www.blauer-engel.de/en/blauer_engel/index.php

[8] http://www.blauer-engel.de/en/products_brands/vergabegrundlage.php?id=207

[9] http://www.energystar.gov/index.cfm?c=about.ab_index

In 2001 the European Union signed an agreement with US EPA to introduce the **ENERGY STAR in Europe** as well **(only for office equipment)**, thereby recognizing each other as partner in the ENERGY STAR programme. This allows potential partners in the European Union to sign up through the European Commission, who is responsible for the EU ENERGY STAR Programme.[10]

An ENERGY STAR specification for residential light fixtures was introduced in 1997 assigning the combination of quality and attractive design with highest levels of energy efficiency.[11] Since 2008, the ENERGY STAR label qualifies criteria for CFLs and since 2010, specification for LED bulbs exists. Key performance requirements are energy efficiency, lumen maintenance, lifetime, starting time, warm-up time, mercury content etc.[12] Now the label is on major appliances, office equipment, lighting, home electronics etc. In the sector of lighting the following products are labelled with the ENERGY STAR (for the US market only):[13]

- compact fluorescent light bulbs
- LED lightings
- decorative light strings
- light fixtures

3.2.5 CE Marking (Conformité Européen)

Website http://ec.europa.eu/enterprise/policies/single-market-goods/cemarking/
Product: product conformity to energy efficiency requirements

The CE marking is not an environment or energy label in the first place. It symbolises the conformity of a product to the Community requirements incumbent on the manufacturer of the product. It indicates that the product conforms to all the Community provisions providing for its affixing, e. g. the determination of the energy consumption.

The **CE marking** is required for many products. It states that the product is **assessed before being placed on the market** and meets EU safety, health and environmental protection requirements.[14]

[10] http://www.eu-energystar.org/de/203.shtml

[11] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=LU

[12] http://www.energystar.gov/index.cfm?c=lighting.pr_lighting_landing

[13] http://www.energystar.gov/index.cfm?c=lighting.pr_lighting_landing

[14] http://ec.europa.eu/enterprise/policies/single-market-goods/cemarking/

The CE marking is placed on several categories of products like referring to eco-design of energy related products e.g. street & office lighting and domestic lighting.[15]
At the end of 2002, a mandatory standard was set for the maximum energy consumption of ballasts for fluorescent lamps.

According to the EuP-Directive (Energy using Products - Directive 2005/32/EC) lamps in private homes and street lighting have to achieve minimum efficiency requirements, which are a precondition for the placing of the CE marking. Member states may not restrict the placing on the market and entry into service of
products labelled with the CE marking, unless there is supporting evidence of the product's non-conformity.
The marking should be affixed before the product is placed on the European market and enters into service. It aims to protect public interests such as the health and safety of product users. The CE marking must be affixed by the manufacturer or his agent established within the Community. On national level random sampling is undertaken. The manufacturer bears ultimate responsibility for the conformity of the product.[16]

3.3 Other initiatives

GPP – Green Public Procurement

In Europe public institutions and authorities purchase a significant amount of goods and services. The implementation of energy efficiency and environmental criteria in the procurement process of public bodies can help to stimulate the market for sustainable products and technologies. Furthermore, it can trigger innovations, helps to reduce energy costs and CO_2 emissions as well as improving the role model function of the public sector and to come up with European policies.

GPP is a voluntary instrument.[17] In cooperation with the Member States and stakeholders GPP criteria including a GPP toolkit for 19 priority products and services were developed. Indoor lighting is one of these product groups and includes concrete examples of environmental criteria, which can be readily introduced in tender documents.

In 2011, the European Commission published the second edition of the handbook “Buying Green!”. The handbook is a concrete tool to help to buy goods and services with a lower environmental impact. The handbook in-

[15] http://ec.europa.eu/enterprise/policies/single-market-goods/cemarking/professionals/manufacturers/directives/index_en.htm?filter=4

[16] http://europa.eu/legislation_summaries/other/l21013_en.htm#

[17] http://ec.europa.eu/environment/gpp/what_en.htm

cludes:[18]

- Guidance on how environmental considerations can be included at each stage of the procurement process

- Examples drawn from contracting authorities across EU Member States
- Sector-specific GPP approaches for buildings, food and catering services, electricity and timber

Public Procurement boosts Energy Efficiency - proEE

In 2008 the European project **pro-EE**, supported by the IEE, started aiming to improve energy efficiency through sustainable public procurement and to implement green criteria in a sustainable way into public procurement processes. Within the 2 years' project-time pro-EE brought together producers and consumers, implemented energy-efficient Green Public Procurement (GPP) procedures in local administrations, and organised training for municipalities' procurement staff.
At the same time, five pilot cities set up integrated energy efficiency action plans, which included the involvement of stakeholders and awareness-raising campaigns for citizens.[19]
The project focused among other on street lighting and LEDs. The project website www.pro-ee.eu informs about relevant technologies, practical policies, industry recommendation and technical criteria for selected and most efficient products.

Smart SPP – innovation through sustainable procurement

Smart SPP is a European project which promoted the introduction of new, innovative low carbon emission technologies and integrated solutions onto the European market. This was done by encouraging early market engagement between public authority procurers and suppliers and developers of new innovative products and services in the pre-procurement phase of public tenders.
The project specifically focused also on lighting systems (LED indoor and outdoor (street) lighting).
A standard approach to the pre-procurement of emerging technologies was developed. The approach includes guidance on managing the pre-procurement risks, assessing the financial benefits (life-cycle costs), and calculating and communicating the CO_2 savings. More information can be found on the website of the project www.smart-spp.eu.

Green ProcA

The main objectives of the IEE-project "Green ProcA" are to consolidate and mainstream green procurement in 8 member states and to transfer the know-how where green procurement is still at an early stage. In total, 18 partners from 15 European countries work in that project. The main focus is on energy related technologies.

[18] http://ec.europa.eu/environment/gpp/index_en.htm

[19] http://www.pro-ee.eu/home0.html?&L=0

The central strategic objective of the project is to increase the share of energy efficient procurement in Europe. This will lead to a higher market impact and therefore support the production and the use of energy efficient goods and services. The project is addressed to both private companies and public authorities. Aside from answering general questions the project offers procurement tools like consultations, guidelines, information on labels, life cycle cost calculation tools etc. for the product groups building components, green electricity, household appliances, lighting, office equipment and vehicles.
Through assisting pilot projects, successful green procurement cases will be initiated and communicated broadly.
The major steps are:

- Green procurement helpdesks providing assistance, know-how and tools in national language
- Dedicated training offers in collaboration with national networks for the private and public sector
- Twinning approach for effective transfer of know-how to newer member states
- Assistance to green procurement pilot projects; addressing of innovative technologies in experienced countries
- Monitoring of the green procurement experiences; policy recommendations for the NEEAPs updates in June 2014

Green Proca is supported by the program “Intelligent Energy Europe”.

More information on the project and the Publishable Report of the precursor Buy Smart project (presents the results and provides an overview over the measures already taken)
can be found on the project website **www.gpp-proca.eu/it.**

4. Practical instructions for green procurement and use phase

In 2004, the Council and the European Parliament adopted two directives aimed at clarifying, simplifying and modernising existing European legislation on public procurement.

- Directive 2004/18/EC covers public works contracts, public supply contracts and public service contracts.
- Directive 2004/17/EC covers the procurement procedures of entities operating in the water, energy, transport and postal services sectors.

Directive 27/2012 on Energy Efficiency : The new Directive entered into force on 4 December 2012. Most of its provisions have been implemented by the Member States by 5 June 2014.

The Directives thus offer a number of opportunities for GPP to be implemented, throughout the contract award process:

- the inclusion of environmental requirements in technical specifications (Article 23(3)b);

- the use of eco-labels (Article 23(6));
- setting social and environmental conditions for the performance of contracts (Article 26);
- requiring economic operators to demonstrate they have met their environmental obligations (Article 27);
- requiring economic operators to demonstrate they can perform a contract in accordance with environmental management measures (Articles 48(2)f and 50); and
- applying award criteria based on environmental characteristics (Article 53).

The basic principles of free movement of goods, services, capital and people are set out in the Treaties[20], along with a prohibition on discrimination based on nationality. From these basic principles a number of more specific principles applicable in the field of procurement have been developed, primarily through the case law of the European Court of Justice. These are the principles of transparency, equal treatment, proportionality and mutual recognition.

It is important to note that these principles are of broader application than the Directives - procedures which are excluded from or fall below the thresholds for application of the Directives must still be awarded in accordance with the principles. Public authorities need to observe these principles when implementing GPP, as in all areas of procurement.

A number of resources for GP implementation can be accessed from the EU GPP website: http://ec.europa.eu/environment/gpp/index_en.htm.

The Buying Green Handbook from October 2011 can be downloaded here: http://ec.europa.eu/environment/gpp/buying_handbook_en.htm.

4.1 Practical procurement instructions

Step 1: Get support

It is advisable to develop a green procurement policy for your institution or company before the actual procurement procedure begins. The procurement guidelines should combine the evaluation basis of the most economic offer with the calculation of life cycle costs. Choose a good title to communicate the policy to your staff and externally.

Step 2: Assess your actual needs

The necessity of the procurement and its complexity are examined. An important part of this phase is also the search for alternatives, possible alternatives to the purchase e. g. the repair of old devices or leasing of a new product as well as measures to improve efficiency and synergy of environmental friendly aspects are examined. A thorough demand analysis is one of the most important steps for an

[20] The Treaty on the Functioning of the European Union, the Treaty on the European Union and, formerly, the Treaty establishing the European Community.

environmentally friendly procurement.

Step 3: Define the subject matter

The subject matter of a contract relates to the product, service or work you want to procure. Purchasers are free to define an environmentally friendly product or performance-based product definition. Describe your needs in a functional manner so as not to exclude alternatives.

Step 4: Define technical specifications

Technical specifications describe the contract to the market and constitute minimum compliance criteria. Apply environmental criteria to save resources and energy as well as to reduce waste and pollution.

The GPP toolkit is one of the key tools used to implement GPP (http://ec.europa.eu/environment/gpp/first_set_en.htm)

The GPP toolkit proposes two categories of criteria for each sector covered:

- The core criteria are those suitable for use by any contracting authority across the Member States and address the key environmental impacts. They are designed to be used with minimum additional verification effort or cost increases.
- The comprehensive criteria are for those who wish to purchase the best environmental products available on the market. These may require additional verification effort or a slight increase in cost compared to other products with the same functionality.

In each category there are minimum compliance criteria and award criteria offered:

a) Minimum compliance criteria: These criteria will be included in the performance specifications and must be fulfilled by the service or product supplier (e. g. the maximum capacity of the electrical equipment). A non-fulfilment of a mandatory criterion excludes the offer from the call for tenders. This procedure demands strict compliance with central environmental criteria.

b) Optional award criteria: These criteria are evaluated with the help of points and considered in relation to other awarding criteria during the awarding process. The total score of the optional criteria (altogether 100 % is possible) represents the degree of compliance with environmental characteristics such as recycling ability or energy efficiency. They enter the offer evaluation depending on the assigned importance of these criteria. Thus, economic and environmental interests can be weighted accordingly. These criteria are described in step 5.

In principle, environmental interests can have a strong impact even without the compliance with mandatory criteria, if they are evaluated with a high score as optional criteria. Thus devices, which do not fulfil a certain criterion, have a chance to be considered, as long as the sum of the environmental characteristics convinces.

The following product groups are covered by the GPP toolkit:

copying and graphic paper; cleaning products and services; office IT equipment; construction; transport; furniture; electricity; food and catering services; textiles; gardening products and services; windows, glazed doors and skylights; thermal insulation ; hard floor-coverings; wall panels; combine heat and electricity (CHP); road construction and traffic signs; street lighting and traffic signals; mobile phones; indoor lighting.

Another helpful tool are "eco-labels" – both, to develop specifications or criteria and to verify the compliance of products and services with these standards. There is a number of eco-labels, for example those which address a single issue such as the Energy Star label or those which cover multiple criteria. It is important to note that, for public institutions, it is not allowed to use the labels in the procurement process but the criteria in the label can be used (European Court of Justice on 10 May 2012, Case C 368/10). However, this does not apply for companies.

Step 5: Define award criteria

Determine award criteria, e.g. better eco-efficiency, and their weighting when evaluating the tenders. The award criteria must relate to the subject matter of the contract. Describe how you will calculate the life cycle cost and how it will be weighted.

Life Cycle Costs

The cost efficiency of an offer does not only depend on the purchasing price, but also on the operating costs. For the comparison of the offers the purchasing, operating and disposal costs are evaluated over the expected useful lifetime ("life cycle costs").

Calculation tools are provided for each product to compare the cost-efficiency of the offers. The following factors have to be considered if energy-related environmental interests are included in the calculations:

- Providers must guarantee the maximum level of electricity / energy consumption for the calculation.

- Factors such as annual utilisation periods in different operating modes should be realistically measured and empirically secured if possible.

- Technical measures to reduce the energy consumption should be considered if possible e.g. energy management in PCs and auto electricity off function.

Step 6: Set contract performance clauses

Use contract performance clauses as a way of setting further relevant energy efficiency/environmental conditions for the green contract.

Step 7: Award the contract

From all offers fulfilling the technical specifications, the contract will be awarded to "the economically most advantageous tender" based on the results from the Green Proca life cycle cost calculation tool and the degree of compliance with award criteria.

4.2 Practical procurement instructions for lighting

Ideally lamps, luminaires and control system are seen as the complete lighting system and all components have to work together. When purchasing new lamps this should be taken into account and the following criteria should be considered in any procurement case:

- **Lamp efficiency [lumen/watt]:**
  Comparisons based on wattage are not meaningful and can be misleading. The performance of a lamp is measured in lumen which allows direct comparisons of light quantity. The higher the lumen value of a light bulb, the greater the quantity of light the bulb will produce. Therefore always check the "lumen value" of the lamp and the ratio "lumen/watt" outlines the efficiency of the lamp (how many watt electricity are necessary for the respective lumen value).

Lamp type	Conversion efficiency [Lumen per Watt]	Life expectancy [hours]	Colour rendering index [CRI]
incandescent bulb	8-15	1,000	100
low voltage halogen	12-25	2,500	100
infra-red coated halogen	25-35	5,000	100
Compact fluorescent lamp	50-84	6,000 – 15,000	85
Fluorescent lamps (T8, conventional ballast)	47-83	8,000	>90
Fluorescent lamps (T8, three-band-lamps, electronic ballast)	up to 100	19,000	
Fluorescent lamps (T5, electronic ballast)	67-110	20,000-30,000	80-90
Metal-halide lamps	84 - 104	10,000 – 15,000	>80
High pressure Sodium lamps	90 - 150	20,000 - 30,000	25
Low pressure Sodium lamps	120 - 200	12,000 - 20,000	
Light emitting diode (LED)	30 – 90 (up to 130)	50,000 +	>80
OLED	25	~10,000	>80

- **High energy efficiency class:**
  For lamps that are labelled, it is recommended to check the energy efficiency class. Where available and depending on the application, preferably "A-class" lamps should be used.

- **Lifespan & maintenance costs:**
  A high lamp durability is recommended for environmental reasons and for the reduction of maintenance costs). Lifespan of products should always be taken into account. Especially for professional lamps, lifespan is a very important factor and in general, a longer lifespan means a higher quality standard. This should be taken into account when comparing prices of the different alternatives.

- **Colour of the light (colour temperature)**
  While incandescent bulbs always provide the same light colour ("warm white"), compact fluorescent lamps and LEDs offer a wider range of colour temperatures (measured in Kelvins). These differences are useful in certain applications. Choose 2700K or "warm white" for living and more than 4000K or "cold white" for working areas.

- **Further criteria:**
  Further ecologically relevant criteria, which should be considered during the procurement of lamps, are the following:
  - low consumption of auxiliaries
  - less harmful substances
  - electro-magnetic compatibility
  - if necessary electromagnetic ballasts with a high switching resistance (more than 20,000 switches)
  - low idle electricity consumption

4.3 Practical tips for daily use

However with the purchase of energy-efficient lamps only one half of the saving potential for lighting can be exploited. The utilisation behaviour in the daily office life is crucial and thus the employees can make contribution to electricity savings within the lighting sector. The saving potential can be fully exploited only in combination with energy efficient behaviour. The following energy saving tips can be useful:

- **Absence**
  If the room is left for more than 5-10 min the light should be switched off. Of course the use of day-light should be the first priority.

- **Use of daylight**
  Use of daylight is an important energy efficiency measure and large savings are possible. Use of daylight should be taken into account when planning new lighting solutions. It can also be done easily with sensors for existing lighting installations.

- **Halogen lamps**
  If there are low-voltage halogen lamps in the office, the electricity consumption of the transformer can be avoided by switching off light with a switchable connexion plug board.

- **Lighting of adjoining rooms**
  In corridors, toilets or in kitchens the light should be turned-off when not needed. Per-haps motion detectors or time switch devices can be helpful.

- **Motion detector/ stairway automatic**
  In corridors or stairways with small frequentation the electricity consumption can be reduced up to 50% with movement detectors. The high energy savings pay back initial costs quickly. A further possibility for using lamps effectively offers the so called stairway automatic. The mechanism switches off after an adjusted time. This technology is suitable for stairways, stockrooms, garages etc.
- **Regular cleaning**
  Lamps and luminaries have to be cleaned regularly, in order to be able to supply their full light. The cleaning can be linked to other maintenance work.

- **Replacement**
  Defective lamps should be replaced by energy savings lamp. Depending on the situation and the difficulty of replacing, it is possible to exchange a single lamp or the whole lilghting. The simultaneous exchange of all lamps is however recommended, in order to keep maintenance intervals.

- **Disposal**
  Incandescent lamps are disposed with the domestic waste. (Compact) fluorescent lamps contain small quantities of mercury and they have to be collected separately.

The WEEE Directive 2002/96/EG – WEEE for Waste of Electrical and Electronic Equipment – took effect on February 13, 2003. The principal objective of this EU directive is to prevent electrical and electronic waste, and also the reuse, material usage and other forms of use of waste of this kind in order to reduce the amount of waste and to preserve resources, particularly by means of reusage and recycling.

As of coming into effect of the respective national laws, all manufacturers and importers of electronic equipment are obliged to accept returns of their products, and to take steps regarding the handling, usage or recycling.

5. Definitions and Abbreviations

The following terms and abbreviations are used in this Annex:

- **Colour Rendering Index (CRI):**
  The CRI is a scale to measure the ability to accurately render all colours of a light source.

- **Colour Temperature:**
  By convention, yellow-red colours are considered warm, and blue-green colors are considered cool. The Colour temperature of a lamp is measured in Kelvin (K) temperature. Higher Kelvin temperatures (3600–5500K) are what we consider cool and lower color temperatures (2700–3000K) are considered warm. Cool light is preferred for visual tasks, warm light is preferred for living spaces.

- **Efficacy:**
  Ratio of measured lamp lumens divided by measured input electricity, unit: lm/W

- **HID:** high-intensity discharge

- **IRC:** Infrared coating

- **K:** Kelvin

- **kWh:** Kilo Watt per hour

- **Lamp and Luminaire:**
  Lamp: source made in order to produce an optical radiation, usually visible.
  A luminaire: apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps them-selves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electricity supply.

- **LED:** Light-Emitting-Diode

- **Lifespan**
  - average life span → from 0 to malfunction

- useful life span → from 0 to 80% luminous electricity
- 5% failure in time → von 0 to 5% malfunction

- **Lamp Lumen Maintenance Factor (LLMF) & Lamp Survival Factor (LSF):**
  Since 2012 minimum requirements for Lamp Lumen Maintenance Factor (LLMF) & Lamp Survival Factor (LSF) are in place, see example below.

- **Luminous Flux:** Luminous flux, which is generated by a lamp, expressed in lumen (lm)

- **WEEE:** Waste Electrical and Electronic Equipment (Directive)

Requirements LLMF & LSF for linear fluorescent lamps:

Lamp Lumen Maintenance Factor (LLMF)	Operating hours			
	2.000	4.000	8.000	16.000
Double-capped fluorescent lamps on high frequency ballast with warmstart	0,97	0,95	0,92	0,90
Single-capped fluorescent lamps on high frequency ballast with warmstart	0,97	0,90	0,80	

Source: EU-Verordnung (EG) Nr. 245/2009

Lamp Survival Factor (LSF)	Operating hours			
	2.000	4.000	8.000	16.000
Double-capped fluorescent lamps on high frequency ballast with warmstart	0,99	0,97	0,92	0,90
Single-capped fluorescent lamps on high frequency ballast with warmstart	0,95	0,90	0,87	

Source: EU-Verordnung (EG) Nr. 245/2009

6. References & legislation & literature

- **ELCFED:** European Lamp Companies Federation, www.elcfed.org

- **EUROPEAN COMMISSION:**
  Public Procurement: http://ec.europa.eu/internal_market/publicprocurement
  Efficient Lamps: http://ec.europa.eu/energy/efficiency/ecodesign/lumen/index.htm
  http://ec.europa.eu/energy/lumen/overview/avariedchoice/index_de.htm
  www.eup4light.net
  www.e-lumen.eu

- **GPP toolkit:** http://ec.europa.eu/environment/gpp/toolkit_en.htm

- **Directive 2005/32/EC** of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council.
- **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 ballasts, 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 the Council.