



Green Public Procurement Street Lighting and Traffic Signals Technical Background Report

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1 Introduction

Following on from previous work in developing GPP criteria for ten product groups¹, a further ten products and sub-products have been identified for the development of GPP purchasing criteria to add to the European Commission's GPP training Toolkit Module 3, which presents recommended GPP criteria for products and services. Green Public Procurement is a voluntary instrument.

This Technical Background Report provides a summary of the GPP criteria developed for the '**Street Lighting and Traffic Signals**' product group. This report provides background information on the environmental impact of Street Lighting and Traffic Signals and outlines the key relevant European legislation affecting this product group. It then goes on to describe existing standards and ecolabels that cover these technologies. Finally, it outlines the rationale for the core and comprehensive environmental purchasing criteria that are being proposed.

This report accompanies the associated **Product Sheet** that contains the proposed purchasing criteria and ancillary information for green tender specifications and as such they should be read alongside one another.

The format for the purchasing recommendations comes in the form of two sets of criteria:

- 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.

Within the core and comprehensive criteria, the guidance follows the various stages of a public procurement procedure and explains how best to integrate environmental criteria at each stage:

- Subject matter. It means the title of the tender, i.e. a short description of the product, works or service to be procured.
- Technical Specifications. Provide a clear, accurate and full description of the requirement and standard to which goods, works or services should conform. Description of the minimal technical specifications which all bids need to comply with. Set specific environmental criteria, including hurdles and levels that need to be met for specific products.
- Selection Criteria. It is based in the capacity / ability of the bidders to perform the contract. Assist in the identification of appropriate suppliers, for example to ensure adequately trained personnel or relevant environmental policies and procedures are in place.
- Award Criteria. The award criteria on the basis of which the contracting authority will compare the offers and base its award. Award criteria are not pass/fail criteria, meaning that offers of products that don't comply with the criteria may still be considered for the final decision, depending on their score on the other award criteria.
- Contract Performance Clause - Specify the conditions that must be met in the execution of the contract, for example as to how the goods or services are to be supplied, including information or instructions on the products to be provided by the supplier.

It should be noted that the contractor is bound by the existing legal framework.

Where the verification for the criteria states that other appropriate means of proof can be used, this could include a technical dossier from the manufacturer, a test report from a recognised body, or other relevant evidence. The contracting authority will have to satisfy itself on a case by case basis, from a technical/legal perspective, whether the submitted proof can be considered appropriate.

¹ <http://www.ec.europa.eu/environment/gpp>

2 Abbreviations

CELMA	Federation of National Manufacturers Associations for Luminaires and Electrotechnical Components for Luminaires in the European Union
CFL	Compact Fluorescent Lamp
CLRTAP	Convention on Long-range Transboundary Air Pollution
CO ₂	Carbon Dioxide
EEE	Electrical and Electronic Equipment
EEl	Energy Efficiency Index
ELC	European Lamp Companies Federation
EMC	Electromagnetic Compatibility Directive
EPCC	European Programme on Climate Change
EU	European Union
EuP	Energy Using Product
GHG	Greenhouse Gas
GJ	Gigajoule = 10 ⁹ Joules
GPP	Green Public Procurement
HID	High Intensity Discharge lamp
HPS	High Pressure Sodium lamp
HPM	High Pressure Mercury lamp
kWh	Kilowatt hours
LCA	Life Cycle Assessment
LED(s)	Light Emitting Diode(s)
LLMF	Lamp Lumen Maintenance Factor
lm	Lumen
LMF	Luminaire Maintenance factor
LPS	Low Pressure Sodium lamp
LPM	Low Pressure Mercury lamp
LSF	Lamp Survival Factor
MEEuP	Method for the Evaluation of Energy using Products
MEPs	Minimum Energy Performance Standards
MHL	Metal Halide Lamp
PAH	Polycyclic Aromatic Hydrocarbons
PBB	Polybrominated biphenyls
PBDE	Polybrominated diphenyl ethers
PM	Particulate Matter
POP	Persistent Organic Pollutants
Ra	Colour Rendering Index
RoHS	Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Directive
SL	Street Lighting
TWh	Terawatt hours = 10 ⁹ kWh
TS	Traffic Signals
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultra Violet
W	Watt
WEEE	Waste Electrical and Electronic Equipment

3 Definition, Scope and Background

3.1 Product Description

Street lighting and traffic signals are widespread and common elements in our towns and cities of what is sometimes referred to as street furniture. To put this into a general context, these are objects that exist on roads in the urban and suburban environment. Full definitions of street lighting and traffic signals relevant to this study are provided in the sections below.

Both street lighting and traffic signals are made up of several component parts, including the lamp that provides the light, the housing that directs or filters the light, known as a luminaire, as well as the stands, poles and other mounting fixtures that hold it all in place. Likewise there are several technical terms that describe the characteristics of lighting. These are explained further here.

3.2 Lighting Terminology

There are many terms used in the lighting industry to describe the characteristics and properties of the various components and how they perform. It is important to appreciate what they mean as they are used when explaining the energy performance and other environmental characteristics. Subsequently it is with these technical terms that one can set criteria to use when procuring such items.

Box 1 provides a brief summary of these terms, taken from the European Lamp Companies Federation² and the EuP Lot 9 study³ (ultimately from European Standard EN 12655).

Box 1. Definition of Lighting Terms

Luminous flux [lm]

The luminous flux (light output) quantifies the total amount of light emitted by a light source. The unit lumen [lm] in which the luminous flux is measured is used to rate the output of lamps typically the lumen output at 1000 hours life is quoted. For example:

- The flame of a candle generates about 12 lumen.
- A standard 60W incandescent⁴ lamp is rated at 720 lumen.
- A compact fluorescent lamp (CFL) 11 W is rated at 600 lumen.

Watt [W]

The electrical energy a light source consumes is measured in Watt [W]. Part of the power input is transformed into light (visible radiation), while the rest is considered as loss (heat). For example, incandescent lamps transform 95% of the electric power input into heat and only 5% into light.

Efficacy “lumen per watt” [lm/W]

Efficacy describes light output in relation to power input and is expressed in lumen per Watt. The higher the efficacy value, the more energy-efficient lamps or lighting systems are. For example, the efficacy of an incandescent light bulb of 60W is 12 lm/W and of a compact fluorescent lamp (CFL) of 11W is 55 lm/W.

Energy consumption [kWh]

The amount of electric energy consumed by a lamp over a certain period is expressed in kWh (kilowatt-hours). For example a 100W incandescent lamp consumes 1 kWh in 10 hours (10 hours \times 100W = 1000Wh or 1 kWh). The amount of electricity used for lighting is generally based on energy consumption per year (kWh per year).

² European Lamp Companies Federation, 'Saving Energy through Lighting' http://buybright.elcfd.org/uploads/fmanager/saving_energy_through_lighting_ic.pdf

³ EuP Lot 9 Study: Public Street Lighting, VITO, January 2007, <http://www.eup4light.net>

⁴ These are the more traditional lamps, sometimes known as tungsten filament lamps

Light Quality – Colour Rendering (Ra)

Unlike natural daylight discharge lamps⁵ may not display all the colours of the visible spectrum. The ability of lamps to render colours faithfully is measured on the Ra scale. The scale runs from 20 (indicative of severe colour distortion) until 100 (no colour distortion). Good colour rendering not only improves visual amenity but also enables the observer to see well through colour contrast.

The Lamp Lumen Maintenance Factor – LLMF

This is the ratio of the luminous flux emitted by the lamp at a given time in its life to the initial luminous flux.

The Lamp Survival Factor – LSF

This is the fraction of the total number of lamps, which continue to operate at a given time under defined conditions and switching frequency.

Although there are several types of lighting that are considered under the scope of street lighting and traffic signals, and their physical properties may differ, they all require the same generic components. These are described by EN 12665 Light component definitions and given in Box 2.

Box 2. EN 12665 Lighting System Component Definitions⁶

1. *Lamp*: a “source made in order to produce an optical radiation, usually visible”

2. *Ballast*: a “device connected between the supply and one or more discharge lamps which serves mainly to limit the current of the lamp(s) to the required value”

Note that a ballast⁷ may also include means for transforming the supply voltage, correcting the power factor and, either alone or in combination with a starting device, provide the necessary conditions for starting the lamp(s)

3. *Luminaire*: an “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”

Using these definitions we can then consider what the main types of street lighting and traffic signals are and what components they use.

3.3 Street Lighting Components

Both the EuP Lot 9 Study on Street Lighting⁸ and the main trade body for lamps⁹ consider that the most predominantly used lamps in street lighting are high-intensity discharge lamps (HID), examples of which include:

- High pressure sodium lamps
- Low pressure sodium lamps
- Metal halide lamps with quartz arc tube
- Metal halide lamps with ceramic arc tube
- High pressure mercury lamps

Of these the mercury and sodium variants are the most commonly used in street lighting, although mercury lamps are generally less efficient in their energy use than sodium, or even metal halide lamps⁸. Both metal halide and high pressure sodium lamps are used in street lighting, but for different kinds of applications, each with its own advantages. For example, metal halides are best suited for clear white illumination, for example in city centre streets, where the light gives the true colours of objects around it. Whereas high pressure sodium lamps are well suited to general street lighting, including in residential areas, with their yellow colour which has the advantage of attracting fewer

⁵ The main type of lamp used in street lighting, explained further in section 3.3 below

⁶ EN 12665 Light and lighting - Basic terms and criteria for specifying lighting requirements and EN 60598-2-3 Luminaires Part 2-3: particular requirements - luminaires for road and street lighting

⁷ Sometimes known as ‘control gear’

⁸ EuP Lot 9 Study: Public Street Lighting, VITO, January 2007, <http://www.eup4light.net>

⁹ http://www.elcfd.org/documents/-56-finelc_road_map_11_07.pdf

insects and thereby requiring less maintenance and cleaning. They also have long operational times from three to six years².

These HID lamps are collectively classified under the heading of gas discharge lamps, along with other similar technologies including fluorescent lamps. They work by creating a beam of electrons, otherwise known as a discharge, inside the lamp when power is supplied to the lamp via the ballast. On their way from the cathode to the anode the electrons excite other gaseous atoms in the lamp, often containing mercury or another metal like sodium, by passing some of their energy on. These excited atoms then release their excess energy back as radiation, either ultra-violet (UV) in the case of mercury-containing lamps or visible radiation for others. As UV radiation is not visible, the inside of those lamps therefore have a phosphor coating which absorbs the UV, re-emitting it as visible light. Other lamps containing different metals such as sodium emit directly in the visible part of the electromagnetic radiation

All fluorescent lamps are discharge lamps, including compact fluorescent lamps (CFLs) commonly found in the home and the straight lamps found in offices and shops (linear fluorescent lamps) and work along the same principles.

The other main components of street lighting include the ballast which regulates the flow of power and current to the lamp and can be either electromagnetic (older technology, generally less energy efficient) or electronic in design, and the luminaire which houses the lamp and circuitry as well as protecting the lamp from the weather and directing the light as necessary to its intended destination.

Specifically for street lighting, European Standard EN13201 draws on the definitions of components as described in EN 12665 above and defines public street lighting equipment as

“Fixed lighting installation intended to provide good visibility to users of outdoor public traffic areas during the hours of darkness to support traffic safety, traffic flow and public security”.

The details of the lamps considered in the EuP Lot 9 study are given in Appendix 1 - Overview of lamps, control gear and luminaires considered in the EuP study.

In addition to HID lamps, compact fluorescent lamps do find some use for street lighting. However as stated above, HID lamps are considered to be the most predominately used lamp types in street lighting applications and CFLs are not used to the same levels as HID although increasingly, public finance Initiatives are using CFLs meaning the market share is growing. Additional consideration to this is provided in Section 3.7 below. CFLs are more commonly used in domestic and office lighting applications. The Ecodesign measures for tertiary lighting also focus on HID lamps with regard to street lighting, although it is inferred that through these measures the focus is fluorescent lighting, including CFLs, for office lighting applications.

Therefore CFLs have not been included in the scope of this GPP specification given the limited use of these lamp types in street lighting.

LEDs are another type of lamp that may be suitable for use in street lighting, although these are not widely used at present. The final report for the EuP Preparatory study on street lighting (Lot 9) states that ‘LEDs are actually rarely applied in street lighting’, however experts are predicting this will change as these become more cost effective. Although still seen as a relatively radical solution for street lighting applications some of the more forward thinking organisations will consider LEDs.

The EuP report discusses further some of the current limitations in using LEDs for street lighting. This includes their relatively low power compared to *HID lamps*, which makes the latter more suited for street lighting. Therefore LEDs are not included within the scope for the GPP criteria for street lighting. Although the use of LEDs for street lighting is an emerging market there is currently no significant evidence base on which to develop criteria and they are therefore not included in this GPP specification. The development of criteria for LED street lights would be worth considering as part of future revisions to the GPP criteria as their use and reliable evidence base is developed. It is proposed to include an explanatory note in the accompanying product sheet, to ensure that LEDs are considered as part of the decision making in choosing which lighting system is best suited to a specific use. Where the use of HID lamps is proposed then the GPP criteria would be applicable.

In addition to the product based approach identified above and used in the development of these GPP criteria, the contracting authority should be aware that other approaches have been used. For example the Dutch authorities have developed criteria on a whole installation approach.

It is important to note that the wider installation aspects of street lighting are important, however the scope of the current project is such that it focuses on the key environmental aspects, for example energy consumption by the lamps. It is difficult to include full installation criteria and develop these to ensure they are applicable across Europe. Further information regarding the Dutch criteria is included in the Section 7 of this Background Report

Development of full installation criteria would need to take into account local legislation, which across all EU members would be a complex task, although there is evidence that this is being addressed for example The EU BLISS Project being led by St Helens Council which aims to examine further ways to reduce the amount of energy consumed by street lighting using tailored design techniques and the application of energy saving products across a range of highway scenarios whilst examining the effects that this has on crime / accident statistics, citizen's perceptions and socio economic impacts. In addition some elements such as pole spacing and lighting levels are addressed by local health and safety requirements, whereas the focus of the GPP criteria is on the key environmental impacts. Extensive research would be required to assess whether this approach would be feasible on a Europe wide basis and identify the evidence base on which to develop criteria for the full installation. Such research is outside the scope of this project.

The product based approach used in the development of these GPP criteria is currently considered the most appropriate as the Ecodesign measures used as the basis of the criteria are applicable across Europe, whereas difficulties may be encountered using installation criteria developed for a specific country, for example the Netherlands. Further, the Ecodesign measures have been subject to EU wide consultation, resulting in a higher degree of stakeholder agreement with the proposals.

Section 4.5 'Other Considerations' below gives more information on the design and installation aspects of street lighting.

3.4 Traffic Signal Components

The main component of traffic signals is the 'head', which contains the lamps. Traditionally these have been 50W incandescent (tungsten halogen) lamps¹⁰. As well as the head there needs to be the support arms and poles to hold it all up as well as the electric controller, which may receive input from a range of controls like traffic sensors or timers.

Other lighting technologies are used in traffic signals, namely light emitting diode (LED) lamps. These lamps have lower energy consumptions and invariably longer lifetimes compared to incandescent lamps for all the colours used in traffic signals.¹¹ As well as saving on direct energy costs by using LEDs instead of conventional incandescent filament lamps one also saves on less frequent maintenance operations for lamp replacement. LEDs can also have better light output than incandescent lamps providing a better contrast with the surrounding daylight and thus clearer visibility of the signals for road users.

A number of definitions in relation to traffic signals are available through the standards that exist. The European Standard EN 12368:2006 for Traffic Control Equipment – Signal Heads¹² describes the scope of traffic signals as follows:

"This European Standard only applies to red, yellow and green signal lights for road traffic with 200mm and 300mm roundels. It defines the requirements for the visual, structural, environmental performances and testing of signal heads for pedestrian and road traffic use. Portable signal lights are specifically excluded from the scope of this European Standard."

It defines a signal head as:

¹⁰ Quick Hits, Traffic Signal, UK ERC, December 2006
http://www.ukerc.ac.uk/Downloads/PDF/06/0612_Traffic_Signals_QH.pdf

¹¹ MTP Briefing Note BNCL12: Light-emitting diodes - Innovation Briefing Note, version 1.0, 14/4/2008, www.mtprog.com

¹² 2006 Traffic Control Equipment - Signal Heads EN 12368:2006 and http://www.led2.org/pdf/Engelse_versie_Eisen_Led2-lamp.pdf

a “device which comprises one or more optical units, including the housing(s), together with all the mounting brackets, fixings, hoods, visors, cowls and background screens, whose task is to convey a visual message to vehicle and pedestrian traffic”.

This EN standard provides limited environmental requirements, which include the specification that signal heads should comply with one of the following classes for operational temperature ranges, indicating the variety of climatic conditions traffic signals may operate under.

- Class A +60°C to -15°C
- Class B +55°C to -25°C
- Class C +40°C to -40°C

Outside of Europe the US Energy Star specification for traffic signals provides a wider definition as follows:

A. Vehicular Traffic Signal: A power-operated illuminated traffic control device, other than a barricade warning light or a steady illuminated lamp, by which traffic is warned or directed to take some specific action.

B. Modules: Standard 8-inch (200 mm) or 12-inch (300 mm) round traffic signal indications (balls). They consist of the light source and the lens (usually a sealed unit) that communicate movement messages (stop, caution or prepare to stop, and go) to drivers through red, yellow, and green colours. Arrow modules in the same colours are used to indicate turning movements. Pedestrian modules are used to convey movement information to pedestrians.

C. Traffic Signal Head: The combination of the traffic signal housing, with the modules (red, yellow, and green) installed in it. The head typically contains three modules and the necessary wiring, although it may also include arrow modules.

D. LED Lamps or LEDs: The individual light-emitting diodes (LEDs), which can be set on a circuit board in any arrangement.

E. LED Traffic Signal: The generic term used to describe the combination of signal heads or modules that use LEDs as the source of light. The combination also incorporates the housing unit at an intersection along with any internal components and support structures

Potentially the Energy Star scope and definition includes a wider range of traffic signals than the EN standard and could also include traffic signals such as motorway signs / information warning signs. The criteria included in the Energy Star relate to wattage specifications for red and green lights and also Combination Walking Man/Hand, Walking Man and Orange Hand. Further details regarding this are provided in Section 7.

This GPP specification focuses on traffic signals as defined by the EN standard above. Traffic signals under this definition are a key element of traffic signals generally and by using this scope will allow the criteria to be focused. Portable traffic signals are excluded, as these will not necessarily be of the same standard as fixed traffic signal installations.

For both Street Lighting (SL) and Traffic Signals (TS) the units themselves are considered with respect to life-cycle impacts. Poles, building mounts, catenary wire systems or any other type of support and the required fixing mounts are considered a separate product group⁸.

Both of these products are considered to be Energy-using Products by virtue of both containing energy using parts and being an energy consumer in itself, therefore it is included at ‘part’ and ‘product’ level.

3.5 Product Scope for Street Lighting

For the purpose of this report, a public street light will be defined⁸ as a:

“Fixed lighting installation intended to provide good visibility to users of outdoor public traffic areas during the hours of darkness to support traffic safety, traffic flow and public security”

This is derived from EN13201 and does not include tunnel lighting, private car park lighting, commercial or industrial outdoor lighting, sports fields or installations for city beautification for example monument, building or tree lighting. As highlighted in Section 3.3 above, the following types of HID lamps are those mainly used in street lighting:

- High pressure sodium lamps
- Low pressure sodium lamps
- Metal halide lamps with quartz arc tube
- Metal halide lamps with ceramic arc tube
- High pressure mercury lamps

Therefore for the purposes of this GPP specification, only high intensity discharge lamps for street lighting are considered. As outlined in Section 3.3, other types of lamps, which are used to a much lesser extent for street lighting, including low intensity lamps such as CFLs and other types including LEDs, are excluded from the scope of this GPP specification.

3.6 Product Scope for Traffic Signals

For the purposes of this report traffic signals will be defined as:

“Red, yellow and green signal lights for road traffic with 200mm and 300mm roundels (whose task is to convey a visual message to vehicle and pedestrian traffic). Portable signal lights are specifically excluded from the scope of this European Standard.”

This in accordance with EN12368: 2006 Traffic Control Equipment – Signal Heads.

3.7 Road Classifications

The type of road and the volume of traffic it carries largely influences the required lighting levels and therefore the choice of street lighting. It is important to understand the different requirements for lighting conditions under these various circumstances. To this end road classifications are set out in EN 13201-2 along with guidance on how to apply these classes. A simplified classification system was used in the EuP Lot 9 preparatory study on Street Lighting⁸ and is summarised below with the equivalent European Norm classifications. The full correlation is provided in Appendix 2:

- Category F “fast traffic” with fast motorised traffic use only, having only luminance requirements (cd/m^2). These correspond to the road classifications ME1, ME2, ME3a and ME4a in EN13201
- Category M “mixed traffic” with motorised traffic, slow moving vehicles, and possibly cyclists and pedestrians with only luminance requirements (cd/m^2). These correspond to the road classifications ME2, ME3a and ME4a in EN13201
- Category S “slow traffic” for mainly urban and pedestrian areas, with illuminance requirements only (lx). These correspond to the road classifications CE2, CE3, CE4, S2, S4 and S6 in EN13201

As stated, High Intensity Discharge lamps have been identified as the main types of lamps used for street lighting and this is further emphasised by an assessment in the EuP study that considers the types of lamps used for different road categories. The typical breakdown of the lamp types used for different road categories is summarised below.

Road category F (fast traffic)

Here sodium lamps are the most commonly used with the typical wattages and lamp types being 150W, 250W High Pressure Sodium (HPS), 131W, 135W and 180W Low Pressure Sodium (LPS) and 400W and 600W high pressure sodium lamps, although widely available are less commonly used. The only EU Member States still with substantial shares of LPS luminaires in category F in their existing stock are Belgium, Holland, Sweden, UK and Ireland. The trend is that these are being replaced by HPS.⁸

Road category M (mixed traffic)

In this situation mainly sodium and high-pressure mercury (HPM) lamps are used. The typical wattages and lamps types used are 250W, 400W HPM and 100W, 150W, 250W HPS. There are still some LPS luminaires in use that use lamps with wattages of 90W, 131W and 135W however these are being gradually replaced with HPS lamps and luminaires.⁸

Road category S (slow traffic)

For slower traffic areas sodium and mercury lamps are the most widely used and to lesser extent compact fluorescent and metal halide lamps. Here, the typical wattages for HPM lamps are either 50 or 125W and 70W for HPS. For the metal halide variety they are generally 70W and for CFLs they come in at 36W. The use of LPS lamps represents a minor share of the current stock with 35W and 55W lamps being used. HPM are currently being replaced but still represent a substantial proportion of the installed stock⁸.

Some CFLs are used for slow road categories, however they are not used at all for medium and fast road categories. For the slow road category, CFL sales (including both new and replacement lamps) is calculated as 13%, which is minor compared HID lamps, which make up the remaining sales and in particular sodium lamps which make up 53% of sales for slow road categories⁸.

It is important that the contracting authority is aware of the road classifications, as this will influence the type of lighting required. The contracting authority should ensure they consult with the lighting designers to ensure the correct, most efficient street lighting installation is purchased to meet the lighting needs of that road. When considering street lighting design and the purchase of lamps for specific circumstances it is important to take into account the EN standard and the guidelines contained within it. It provides performance requirements for road lighting, covering a range of different aspects for example road safety, engineering and factors relating to pedestrian crossings.

3.8 Market Data

The EuP Lot 9 study gathered market data on street lighting by searching the Eurostat databases. They concluded that some data is available but it is often aggregated to *total* lighting product sales in the EU, rather than specifically for street lighting, or that matter or traffic signals. This would be due to the lack of data with enough detail, due either because data was not made available for reasons of commercial confidentiality or because the data had simply not been collated in the past. As such, data on HID lamps was made available for all uses of HID lamps, not just street lighting applications. Notwithstanding these issues, some information is presented below on the main market data for street lighting lamps and their component parts; luminaires and ballasts.

3.8.1 Lamps

In 2004 around 28.8 million mercury vapour discharge lamps were manufactured in the EU. When imports and exports are taken into account the apparent sales of these lamps was 30.0 million. Similarly for sodium discharge lamps the production statistics are 39.5 million with just slightly less, at 39.0 being actually consumed in the EU after import/exports have been factored in. These numbers are applicable to HID lamps for all uses, not just for street lighting.

From other data¹³ for the same year mercury vapour lamps accounted for 27% of all sales of HID lamps in the EU25, sodium lamps accounted for 37% and metal halide lamps made up the remaining 36%. Furthermore, the trend since 1999 has been for fewer mercury lamps to be bought (these are generally less energy efficient than other HID technologies, more in section 4) with their market share dropping from 38% to 27%, whilst on the other hand the market share for metal halides has risen from 24% to 36%.

The EuP study went on to estimate the numbers of lamps sold in the EU for street lighting in 2004, segregated by lamp technology. They sub-divided it out by whether or not the lamps were bought as replacements or for new applications. The headline results were that 7 million mercury lamps were purchased for replacement works whereas 285,000 were bought for new installations. For sodium

¹³ Data from the ELC used in the Lot 9 EuP study

lamps nearly 9.6 million were bought for replacement and 562,000 were bought for new lighting installations.

Data from the ELC estimates that there were around 62.2 million street lamps installed in the EU25 in 2004, having an average lifetime of three years. There are variations in lamp technology used from Member State to Member State though. Whereas in Germany almost half of all lamps in place are mercury vapour they only make up a small fraction, 5%, in Belgium, where high-pressure sodium lamps predominate with over 50% of the share.

3.8.2 Ballasts

The two most common types of ballast used in the EU are ferromagnetic and electronic.

According to the sales statistics collected by the industry the EU market for HID ballast for all indoor and outdoor applications is roughly 20 million pieces (II/2007 + I/2008)¹⁴. In outdoor applications magnetic ballasts are the dominant technology, as electronic ballasts have just recently entered to market. In indoor and particularly in shop and office applications, where metal halide lamps are increasingly used, the electronic ballast has become a dominant technology in new installations. Unfortunately it is not possible from the information currently available to identify how many of the 20 million pieces are for street lighting.

3.8.3 Luminaires

The Eurostat database holds no data on luminaires. As such data used in the EuP study was gathered from CELMA¹⁵. In 2005 there were 2.5 million luminaires sold in the EU at a cost of €388 million. In addition to this there were 18.3 million lamps replaced which cost €208 million. Electricity use cost €2.805 million while installation and maintenance cost €105 million. The installed stock of street lighting luminaires in the EU25 is estimated at some 56.2 million, which compares well with the 62.2 million lamps above.⁸

3.8.4 Traffic Signals

As with street lighting there is no disaggregation of data specifically on traffic signals. No other data could be found on the levels of sales or consumption of LEDs for traffic signals¹⁶.

¹⁴ Personal communication with CELMA

¹⁵ The trade federation for national manufacturers associations for Luminaires and Electrotechnical components for luminaires, www.celma.org

¹⁶ Personal Communication with Buildings Research Establishment – 12/09/08

4 Key Environmental Impacts

This section discusses the key life cycle environmental impacts relating to street lighting and traffic signals that will help inform the GPP criteria specified for this product group.

Like many other products that are manufactured from raw materials, the life cycle of lighting can be split into a number of phases, each of which has a level of environmental impact. The different phases can be broadly described as follows:

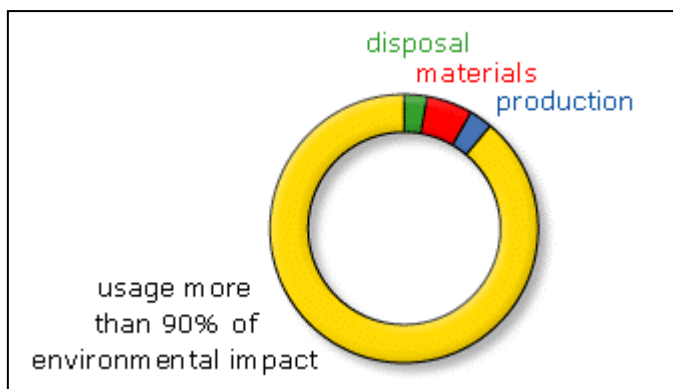
- Manufacture
- Distribution
- Use
- End of life

The different components of street lighting i.e. the lamp that provides the light, the ballast or control gear that regulates current and the luminaires that direct and shade the light will have different environmental impacts at different stages of the life cycle. However an assessment of street lighting as a whole as part of the EuP study concluded that energy consumption in the use phase, predominantly by the lamps, but also the optical parts of the luminaires and ballasts, is the main environmental impact, due to the associated greenhouse gas emissions¹⁷. Other impacts relate to the materials used in some types of lamps and the subsequent end-of-life disposal and treatment of these materials.

There have been a limited number of studies looking at the life-cycle impacts of street lighting and traffic signals. However, the final EuP Lot 9 report for street lighting uses the 'Method for the Evaluation of Energy using Products' (MEEuP) methodology to assess these impacts. This data, along with other sources, namely from trade federations, has been used in assessing the environmental impact of manufacturing, using and ultimately disposing of street lighting and traffic signals.

The key impact from the use of lamps in lighting is the use phase, as depicted by Figure 1, from European Lamp Companies Federation¹⁸. Applicable to all kinds of lighting, this shows that over 90% of the environmental impact is from energy consumption and associated GHG emissions whilst the lights are being used.

Figure 1. Life cycle impacts of lamps



For luminaires most of the environmental impacts occur in the production and end of life phases. The importance of the different impact categories, for example energy use or emissions in the production and end of life phases will vary depending on the materials used. The key environmental impacts are discussed below in more detail.

¹⁷ This assumes conventional fossil fuel-derived power generation. Of course, if lighting is powered by renewable energy sources to a considerable extent then these global warming impacts can be reduced.

¹⁸ http://www.elcfed.org/1_health.html

4.1 Energy Use and Efficiency

4.1.1 Street Lighting

System lifespan is difficult to assess if you consider the variety of components, for example lighting columns may last more than 40 years, luminaires 20 year, control gear 10 to 15 years and lamps 2 to 6 years. However, on average lighting units are on for 4,000 hours a year¹⁹ and have a lifespan of around 30 years meaning there is potential for a range of energy efficiency measures to be implemented including technology changes and improved management and control.

The estimated energy consumption in 2005 for street lighting was 35 TWh²⁰ for the EU25 representing approximately 1.3 % of the final energy consumption of electricity in the EU25⁸.

Table 1 below demonstrates the importance of the use phase in terms of energy consumption. This data is for the weighted average (based on share in sales) for the base case of lamp/ballast/luminaire configurations for category F, M and S roads.

Table 1. Energy Consumption for street lighting in different life cycle phases⁸.

Road Category	Energy Consumption	Production	Distribution	Use	End of Life	Total	Use as a % of total
F (Fast Traffic)	Total Energy (GJ)	1.2	0.3	356.9	0.1	358.5	99.5
	Of which, electricity (GJ)	0.3	0.0	356.9	0.0	357.2	99.9
M (Mixed Traffic)	Total Energy (GJ)	1.1	0.3	325.9	0.1	327.4	99.5
	Of which, electricity (GJ)	0.3	0.0	325.9	0.0	326.2	99.9
S (Slow Traffic)	Total Energy (GJ)	1.0	0.3	126.1	0.1	127.5	98.9
	Of which, electricity (GJ)	0.2	0.0	126.1	0.0	126.3	99.8

Note: 1GJ = 1GW (per second)

The estimated 30-year lifespan of these products means there is likely to be a large number of older, less efficient installations in the EU. Although refitting and replacement of street lighting and traffic signal units will require capital investment, the annual maintenance and running costs are significantly reduced through the product's life. The Institution of Lighting Engineers (ILE) and the UK Lighting Board in consultation with the County Surveyors' Society (CSS) published advice on the reduction or removal of street lighting without compromising safety as part of their Invest to Save research.²¹

In addition to the types of lamps used, energy efficiency of street lighting is also influenced by the ballast used. Older ballasts can also significantly increase energy consumption of street lighting.

The use of more efficient lamps and ballasts / control gear will reduce the energy consumption of the street lighting and traffic signals, thereby reducing CO₂ emissions from fuel combustion required to generate the electricity in the first instance. In addition there will also be reduced impacts in the life cycle of the fuel, included reduced emissions from exploration, extraction, refining, processing, transportation and storage. Similarly, there will be less maintenance required for more efficient, longer lasting lamps and luminaires and hence reduced impacts from these operations.

The light output from a lamp is measured in lumens, and it gives the amount of light provided in a given area. Lamps are available that meet various ranges of lumen output and thus provide choice on the specific lamp light output characteristics that are desired to fulfil the need. In order to achieve this, lamps will likewise have a range of power consumptions.

¹⁹ EN 12665 Light and lighting - Basic terms and criteria for specifying lighting requirements and EN 60598-2-3 Luminaires Part 2-3: particular requirements - luminaires for road and street lighting

²⁰ Terawatthours = 1,000,000,000 kWh

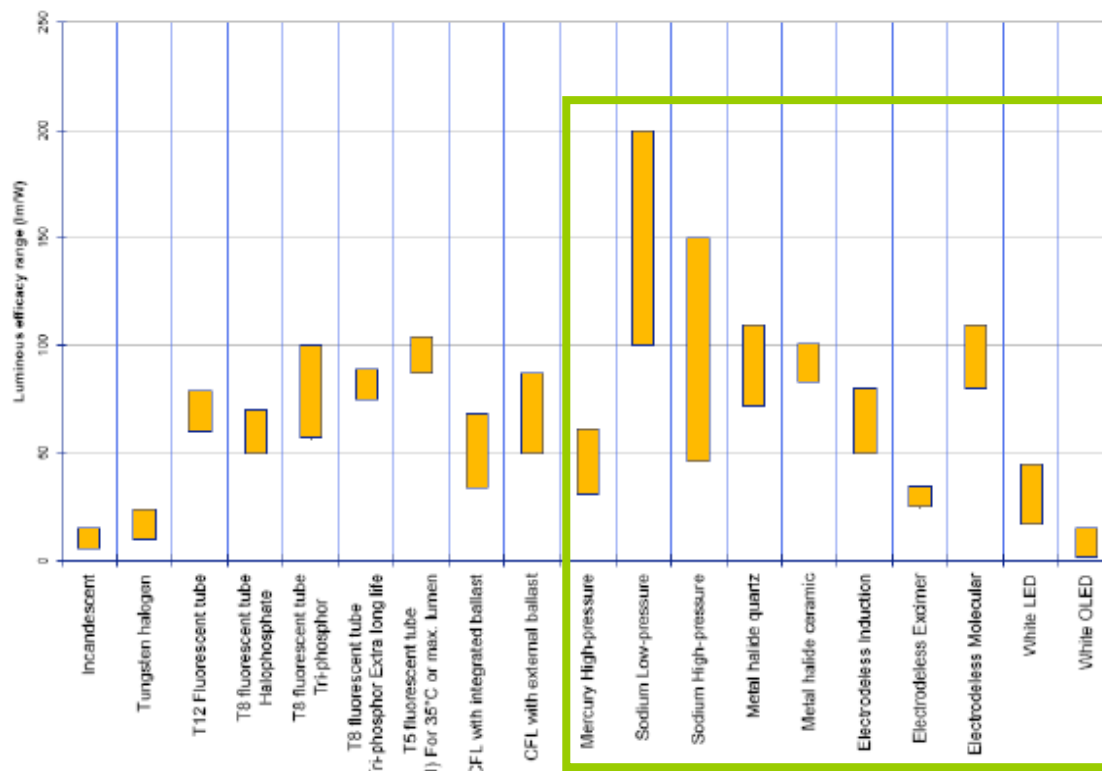
²¹ <http://ile.org.uk/uploads/File/Technical/Street%20Lighting%20-%20Invest%20to%20Save.pdf>

The efficiency by which a lamp uses the electricity supplied to it to create the lumen output is denoted as the lamp’s lumen efficacy, the relative ranges are presented in the green box of figure 2. It is measured as the number of lumens provided per watt of power consumed, lm/W. It is this measure by which lamps can be compared to each other to understand how efficient one is with respect to another.

Lamp efficacy varies between the different types of lamps. Figure 2 below clearly shows that sodium lamps (high and low pressure) as well as metal halide lamps are far more efficient with their energy consumption than more conventional high-pressure mercury lamps. This means that they provide more light for a given power consumption, or conversely, they consume less power in providing a set light output.

Setting limits in relation to lamp efficacy will encourage the use of the most efficient lamp types. The level of lamp efficacy varies between different types of lamps. Metal Halide and HID Sodium lamps are considered the best available technology for modern street lighting²².

Figure 2. Luminous efficacy range of lamp technology⁸
 (source: Laborelec, from EuP 8 Lot Study on Office Lighting)



Note: Although the luminous efficiency of the individual lamps will remain constant regardless of application it should be noted that the type of installation will affect how ‘efficiently’ this light is used.

As part of the Buy Bright Initiative²³ a procurement guide for efficient lighting highlighted the need for procurement criteria for lighting to enable energy savings²⁴. This initiative recommended lamp efficacy for metal halide lamps and high pressure sodium lamps and excluded the less efficacious mercury vapour lamps.

The implementing measure²⁵ for tertiary sector lighting products under the Ecodesign Directive (245/2009) also considers lamp efficacy. As such the development of GPP criteria in this specification has taken this lead and used efficacy. Although the Ecodesign measures will eventually be requirements for all products brought onto the market, the Ecodesign measures are introduced in

²² http://buybright.elcfd.org/uploads/fmanager/saving_energy_through_lighting_ic.pdf
²³ <http://buybright.elcfd.org/index.php?page=21>
²⁴ http://buybright.elcfd.org/uploads/fmanager/061016_sse_05_054_buy_bright_report.pdf
²⁵ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:076:0017:0044:EN:PDF>

stages, and will generally be brought into effect at one, three and eight year intervals after the entry into force of the Ecodesign Regulation for tertiary sector lighting. It is proposed that first stage Ecodesign measures are not used, as these will soon be mandatory requirements²⁶, however the second and third stage requirements will require market transformation such that products can meet the performance demands. Including these second and third stage requirements in GPP specifications now, ahead of their implementation under the Regulation will promote the purchase of more efficient lamps and drive this market transformation process. The Ecodesign Regulation also identifies current best available technology on the market, and again these indicative benchmarks can be used to develop GPP criteria where appropriate.

Therefore, the proposed core GPP criteria for lamp efficacy are based on the second stage requirements, and the comprehensive criteria on the indicative best available benchmarks. Ultimately GPP criteria based on the Ecodesign measures will need to be reviewed in time, as market transformation takes place, product efficiency improves and there are an increasing numbers of products meet these requirements. A review will also be required to take account of future technological advances that means standards are developed beyond the existing best available.

Furthermore, the type of ballast used and its efficiency will also impact the overall energy efficiency of street lighting. The Ecodesign measures include minimum energy efficiency standards for ballasts, and these have therefore been used in the development of GPP criteria. The core criteria for ballasts are based on the second stage Ecodesign measures, which will not be mandatory requirements until three years after the Ecodesign Regulation comes into force. Similarly the comprehensive criteria are based on the third stage Ecodesign requirements, which will not be mandatory requirements until eight years after the Ecodesign Regulation comes into force. The use of the Ecodesign implementation measure is considered suitable as they will not be mandatory straight away and allow differentiation between products. As above for lamps, the GPP criteria based on these measures will need to be reviewed, as market transformation takes place and an increasing numbers of products meet these requirements and standards are developed further.

In addition ballasts have the ability to dim street lighting that further reduces energy consumption. This ability has been incorporated in the criteria where appropriate as there are a number of factors that will influence where the use of variable control²⁷ ballast is suitable, including the location of the street lighting, levels of ambient lighting, traffic intensity and security considerations..

Whilst it is accepted that the efficiency of the luminaire will influence energy use, at present there is insufficient information available to develop objective criteria for luminaires, for example with regard to their minimum efficiencies. This is a result of the decision to postpone the detailed luminaire's ecodesign efficiencies requirements under the Ecodesign Regulation for tertiary sector lighting products to the phase two of the Domestic Lighting Ecodesign Regulation to be developed in 2009.

However, in order to avoid wasted light and therefore improve energy efficiency and reduce other impacts such as obtrusive light, discussed in section 4.3, the luminaires should be designed and installed in order to limit the proportion of light going above the horizon. This is an important feature to reduce unwanted light but is considered to be secondary, in terms of overall environmental impacts, to the primary lumen efficacy (energy efficiency) of the lamps being used. Therefore it has been included in the criteria after lamp efficacies and lifetimes.

Depending on the specific location characteristic e.g. climate and available systems, it may be possible to use technology that allows street lights to generate and store electricity during the day, for example by using solar panel systems, to power themselves, at least in part during the night. The contracting authority may wish to consider such systems, but would need to ensure road safety issues were addressed to ensure the street lighting would not fail. Criteria are not included as part of this product group in relation to this, and separate GPP criteria are available that promote the use of renewable energy.

²⁶ The Eco-design Regulation for Tertiary sector lighting products was published on 24th March 2009. As such, first stage measures will not take effect until April 2010 and second stage implementing measures would not take effect before April 2012.

²⁷ The term "dimming" infers that the normal state is "un-dimmed" – when in fact the normal state may be "dimmed" with the light levels increased (a) over time or (b) for special purposes (e.g. for large outdoor public events such as football matches)

4.1.2 Traffic Signals

For traffic signals, LEDs offer improved energy efficiency compared to incandescent lamps. The use of LEDs is considered the best available technology (BAT) for traffic signals and can reduce energy consumption by at least a factor of three or four with currently available technology²⁸.

In the UK for example, it is estimated that converting all traffic signals to LED lights would save 57,000 tonnes of CO₂ per year by 2010. The energy consumption for LED traffic signals is around 17W bright and 8W dim, compared to 50W bright and 25W dim for ordinary incandescent signals²⁹. This alone offers significant savings in energy consumption without detracting from the performance of the lighting system.

In more remote areas where grid electricity can be difficult to connect to, further greenhouse gas emissions savings can be made through the use of photovoltaic cells to power traffic signals. Obviously this will be dependant on factors such as climate, availability of sunlight to the right degree, aspect and location of the traffic signals, performance criteria and planning controls.

4.1.3 Night-time Dimming

The use of light-sensors or photocell sensors can be used to dim both street lighting and traffic signals relative to the ambient light levels. This provides a level of control meaning lights are not simply on or off but are illuminated to the levels required at the time. The amount of reflected light on the road surface is also reduced so that glare and light pollution is also reduced. This can be applied to both street lights and traffic signal provided the minimum health and safety standards are met and as such will save energy and costs.

The savings potential is greater for roads with a high lighting class, for example motorways. Variable control³⁰ could be linked to the traffic density meaning lighting on these roads could be reduced at times of low traffic volume.

LED traffic signals can also be dimmed at night, which reduces the energy consumption further, typically in the UK voltage is reduced from 240V to 160V²⁹.

4.2 Product Durability – Lifetimes

4.2.1 Lamp Survival and Lamp Lumen Maintenance Factors

In addition to the key aspect of increased lamp efficacy and reduced energy consumption, there are a number of other benefits linked with the use of certain types of high intensity discharge lamps for street lighting and LEDs for traffic signals. These are primarily how long the lamps last for, the lamp survival factor and how well they maintain their light output, the lamp lumen maintenance factor.

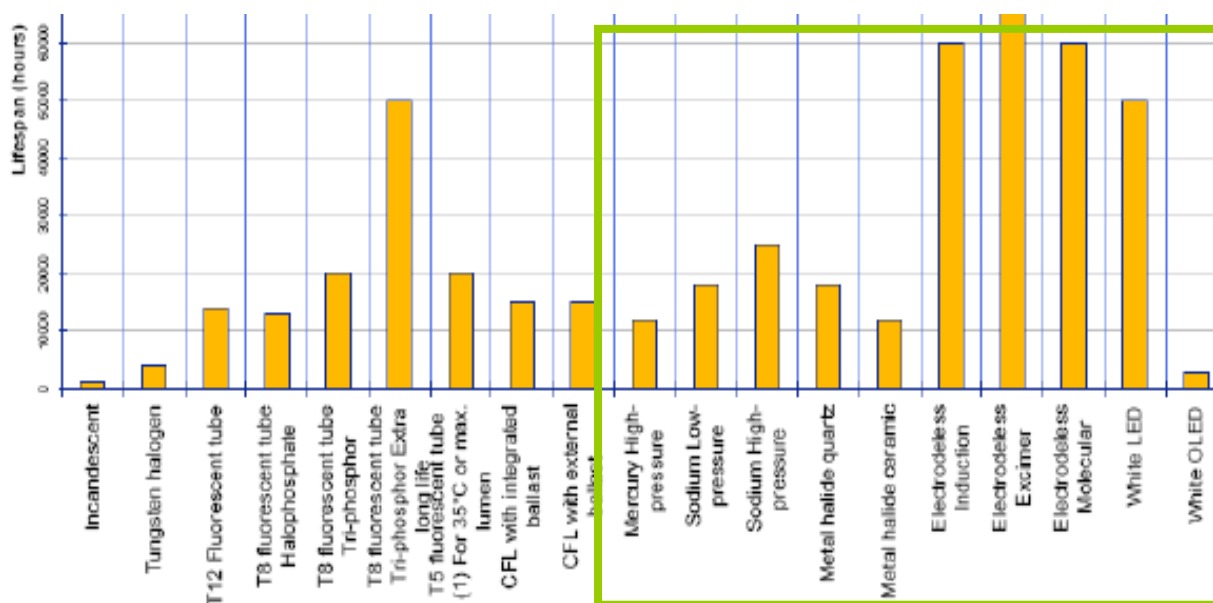
The following graph, Figure 3, demonstrates that the more efficient high-pressure sodium technologies also in general have longer lifetimes than the high-pressure mercury alternatives, up to twice as much. The benefits of this are two-fold: lamps last for longer before needing to be replaced so fewer of them need to be made and so less material is used in manufacture, furthermore fewer maintenance operations are required in replacing lamps. In addition to lasting longer these lamps maintain their lumen output such that they remain near to the original output when they were first installed and the need to over-light on initial installation to maintain sufficient illumination later in the lifetime is avoided. This reduces the need to replace older lamps that, whilst they still work, have dimmed beyond the necessary, useful and safe level of light required.

²⁸ Policy Brief: Improving the energy performance of street lighting and traffic signals, DEFRA, July 2008
http://www.mtprog.com/spm/files/download/byname/file/2006-07-10%20Policy_Brief_street_lighting%20fin.pdf

²⁹ Quick Hits, Traffic Signal, UK ERC, December 2006
http://www.ukerc.ac.uk/Downloads/PDF/06/0612_Traffic_Signals_QH.pdf

³⁰ The term "dimming" infers that the normal state is "un-dimmed" – when in fact the normal state may be "dimmed" with the light levels increased (a) over time or (b) for special purposes (e.g. for large outdoor public events such as football matches)

Figure 3. Typical lifespan of lamp technology⁸
 (source: Laborelec, from EuP 8 Lot Study on Office Lighting, VITO et al.)



Other similar data, as given in Table 2 below, shows the LLMF and LSF for the three main street lighting types. For example it can be seen that 92% of high-pressure sodium lamps survive to 20,000 hours of operation, whilst maintaining 94% of their original lumen output. On the other hand for high pressure mercury lamps only 50% of them survive this long, and those that do only have 76% of their original light output. It should be noted that high efficiency lamps and ballasts, with increased efficiencies and life spans, for example the ‘cosmo’ lamp, are available and economies of scale is reducing the cost of these.

Table 2. LLMF and LSF Data for the Three Main Street Lighting Technologies⁸

Lamp Type	Factor	Burning Hours			
		10,000	12,000	20,000	30,000
High pressure Mercury	LLMF	0.79	0.78	0.76	
	LSF	0.86	0.79	0.50	
Metal Halide	LLMF	0.60	0.56		
	LSF	0.80	0.50		
High pressure Sodium	LLMF	0.97	0.97	0.94	0.90
	LSF	0.99	0.97	0.92	0.50

This information can be translated into common average lifetimes of these lamps, which indicate the usual length of time they will last both in elapsed time, years, and number of hours of burning.

Table 3 Average lifetimes of street lighting lamps by lamp technology⁸

Lamp Type	Lifetime	
	Years	Hours
High pressure mercury	3	12,000
Low pressure mercury	3	12,000
High pressure Sodium	6.25	25,000
Low pressure Sodium	3	12,000
Metal Halide (quartz)	4.5	18,000
Metal Halide (ceramic)	3	12,000

To ensure lamps with a sufficient life span are purchased for street lighting, it is proposed to include criteria in the GPP specification, which relate to the lamp survival factor. To reiterate, the lamp survival factor is a measure/indication of the fraction of the total number of lamps, which continue to operate at a given time under defined conditions and switching frequency.

4.2.2 Ballasts and Luminaires

Depending on the type of ballast, manufacturers data suggests that ballasts can last anywhere between 40,000 to 60,000 hours of use, equating to ten to fifteen years. According to the relevant standards magnetic ballasts shall have minimum life of ten years continuous operation. However in practice this can be exceeded and field experience has shown that lifetimes of thirty or even fifty years can be achieved.

The life span duration for ballasts will be affected by conditions such as working temperature of the lighting system; if it is not optimal i.e. too hot then the lifetime can be decreased. The types of ballast used will also be important, for example magnetic versus electronic ballasts. Whilst experience has shown that magnetic ballasts have a long lifetime, there is currently not the same field evidence available for electronic ballasts used outside. However the experience from the indoor applications show that the failure rate is clearly higher, that the life time is clearly shorter compared to magnetic ballasts and it will be expected that electronic ballasts would need to be replaced during the life time of the luminaire, though it should be noted the ability of the luminaire to resist dust and moisture ingress will affect the life of the lamp and ballast.

Luminaires are normally only affected by climatic conditions of wind and rain as well as vibrations and pollution due to the passing traffic. Depending on their location they can remain in situ for anywhere between ten and thirty years.⁸

Due to the relatively long life span of luminaires and ballasts in comparison to lamps, depending on how they are configured, it can be viewed that lamps are replacement parts for street lighting system luminaires. As such, procurement decisions will need to bear this in mind when commissioning street lighting (and traffic signal) systems, such that the luminaire is as compatible with various existing and potential future types of lamps as well as ballasts where appropriate. Furthermore, it is imperative that local conditions of climate, geography as well as national legislation are taken into account in any procurement decision, as these will affect the design, installation and operation parameters.

At present there is insufficient information available to develop objective criteria for luminaires, for example with regard to their minimum efficiencies. This is a result of the decision to postpone the detailed luminaire ecodesign efficiencies requirements under the Ecodesign Regulation for tertiary sector lighting products to the phase two of the Domestic Lighting Ecodesign Implementing Regulation to be developed in 2009.

This aspect should be considered in the future once an evidence base is available on which to base the development of GPP criteria for the efficiency of luminaires.

4.2.3 Luminaire Maintenance Factor (LMF)

The lifetime of a luminaire and the length that it gives out good quality light can be extended through its design and maintenance to reduce the amount of dirt and water getting inside as well as their resistance to heat. This is known as ingress protection (IP rating) in the lighting industry and describes how well the luminaire performs against these environmental factors, including when they are repeatedly opened for lamp or control gear replacement⁸. More recent developments include self-cleaning luminaires that function with UV light activating the coating on the luminaire to degrade the dirt on it such that it can be washed off more easily by rain.

During the life of a lighting installation, the available light progressively decreases. The reduction rates are a function of time and environmental and operating conditions. Lighting design takes this into account by the use of a maintenance factor and a suitable maintenance schedules to limit the decay should be planned. The International Commission on Illumination's guide CIE 33-1977³¹ along with British Standard 5489:2003 provides information on suggested maintenance factors and the selection of suitable equipment. It describes the parameters influencing the depreciation process and develops the procedure for estimating the economic maintenance cycles for outdoor electric lighting installations and gives advice on servicing techniques.

³¹ <http://www.cie.co.at>

4.2.4 LED traffic signals

The same benefits are also realised when using LED traffic signals, which last much longer compared to incandescent bulbs, which in the UK are typically replaced every six – twelve months²⁹. This replacement frequency is required to ensure the lamps are working, as incandescent bulbs will burn out quickly. This is in contrast to LEDs, which gradually lose brightness over time. This loss can be monitored and LEDs replaced when required.

4.3 Obtrusive Light

Another environmental impact that is worth covering is what is known to the lighting industry as "obtrusive light", or more commonly known as "light pollution".

Light pollution is defined as the sum of all adverse impacts of artificial light on the environment, including the impact of obtrusive light²⁵.

More specifically, obtrusive light is defined as *"that part of the light from a lighting installation that does not serve the purpose for which it was designed"*. Examples of obtrusive light include light improperly falling outside the area to be lit, diffused light in the neighbourhood of the lighting installation and sky glow²⁵.

Or put another way it is where it is considered that excessive light is provided into the local environment and can be felt to disturb the natural night-time biorhythms of human activity and other plant and animal ecosystems. There is limited research available to allow obtrusive light to be quantified, however there are indications that it is affecting the natural bio-rhythms of terrestrial and aquatic ecosystems and is considered an important factor related to direct emissions in particular from street lighting³².

The industry sets standards on obtrusive light for their manufacturing members with limits provided by CELMA in the Guide on Obtrusive Light – 1st Edition, June 2007³³. Similarly, national associations provide guidance on reducing obtrusive light, such as the Institution of Light Engineers in the UK³⁴ and the French Lighting Association ("l'Association Française de l'Eclairage") with their "2006 AFE Guide – Les Nuisances dues à la lumière³⁵" which includes methods endorsed by CELMA, to optimise the luminous flux towards the sky. The industry also sets standards on obtrusive light for their manufacturing members with limits provided by CELMA in the Guide on Obtrusive Light – 1st Edition, June 2007 and CIE in documents such as 150:2003 Guide on the limitation of the effects of obtrusive light from outdoor lighting installations and document 126:1997 Guidelines for minimizing sky glow."

The guidance centres on avoiding over lighting areas and directing the light as best as possible to the area where it is intended through a combination of the correct luminaire, *installation and the correct light (lumen) output*. This will not only reduce obtrusive light but can improve energy efficiency by requiring less energy to light the desired area.

The explanatory note for the Commissions draft Regulation for the ecodesign measures for tertiary lighting indicates that *methods* for assessing the environmental impact of light pollution are still under development and although obtrusive light is identified as an important environmental impact, it is not proposed to include specific GPP criteria in relation to levels of obtrusive light at the present time. However, related criteria on reducing the proportion of light going above the horizon³⁶ should contribute to a reduction in obtrusive light, as discussed in the Implementing Measures documentation²⁵.

Once further research is carried out and there is a better understanding of the impact of light pollution on ecosystems it may be possible to include specific GPP criteria for light pollution in the future.

³² Ecological Consequences of Artificial Night Lighting, Edited by Catherine Rich and Travis Longcore, Published 2005

³³ http://www.celma.org/archives/temp/First_edition_Celma_Guide_on_obtrusive_light.pdf and CIE 150, www.cie.co.at

³⁴ Guidance Notes for the Reduction of Obtrusive Light: http://www.ile.org.uk/uploads/File/02_lightreduction.pdf

³⁵ http://www.lux-editions.fr/recommandations_guides.asp?acc=A

³⁶ That is, light going up and above the luminaire.

4.4 Materials and Substances, including End of Life and Waste Management

Many materials are used in lamps, luminaires and ballasts; glass, metals and plastics being chief among them, as Appendix 1 elaborates on. For example⁸, a 125W HPM lamp is largely glass (~80%) with the other contributors being brass for the cap (~10%) and soldering metals (tin, lead ~6.5%). An electromagnetic ballast for a 125W lamp on the other hand contains far more metal; ~85% steel, 8% copper, as well as 3% plastics. As for luminaires, they are ~45% metal (largely aluminium, with some copper wire) and ~55% plastics.

The substance that is most relevant in terms of environmental impact is considered to be the mercury used in certain HID lamps. The mercury content in HID lamps can vary significantly depending on the types of lamp. Typical mercury content for HID lamps is 20-25mg in HPM lamps, 10-15mg in HPS lamps and 1-5mg in ceramic MH lamps⁸.

As outlined in section 6 below, the RoHS Directive does not restrict the mercury content in HID lamps, as it is covered by an exemption. For this reason it was left out of the scope of the ecodesign measures for HID lamps (with the exception of describing current best practice). As the setting of relevant limits are dealt with through this Directive and are potentially subject to change it is proposed to address the mercury emissions of lamps in the GPP specification through the setting of energy efficiency requirements for lamps, which will lead to a decrease of their overall mercury emissions. This is in line with the approach taken by the Ecodesign measure.

Annex V of the Ecodesign measure for tertiary lighting provides, for information only, that the very best HID lamps have no more than 12mg of mercury. It is not appropriate to use this limit in the GPP criteria, as it is not clear to which types of HID lamps the 12mg is relevant or how many products can meet this requirement.

It is important that the lamps are dealt with correctly at the end of their life. This is generally covered by the requirements of the WEEE Directive, which is outlined in Section 6 of this report. Mercury can be recovered from lamps using specialist plant and this should be undertaken wherever possible. A key issue in the end of life management of lamps is mercury and the release of mercury vapour. Lamps should be sent to facilities that have the required technology to dismantle the lamps and recover the mercury appropriately.

In addition to mercury, other substances are contained in lamps, depending on their types, for example sodium and lead. It is important that potential environmental impacts of these substances e.g. ecotoxicity are managed, and in particular at the end of life phase.

The EuP study on street lighting⁸ identifies certain materials that can impact specific stages of the life cycle in different ways. For example, environmental impact categories where materials can have a large effect include PAH release due to aluminium production, particulate matter from the incineration of polyester housing and eutrophication from the production of the luminaire polyester housing. For example, in the case of luminaires the production phase and materials contribute most to environmental impacts over the life cycle of the product. This is in contrast to the use phase for lamps being the most important due to electricity consumption.

The use of different materials for luminaires, such as a mix of aluminium and glass fibre reinforced polyester or all aluminium, and whether the front cover is made from glass or polycarbonate will influence the overall weight of the luminaire and therefore the relative life cycle environmental impacts.

The use of different materials for luminaires will influence which of the different impact categories are most important, in the production and end of life phases. For example luminaires can be made of all aluminium or be a mixture of aluminium and glass fibre reinforced polyester. In addition the front cover material can differ, for example it may be glass or polycarbonate.

LCA studies on sustainable material use in traffic management systems have shown that there is no advantage to be found for any particular material type. The main environmental gains to be had are in recycling and reusing the materials, in particular poles and mounts.

For an average luminaire the distribution of environmental impacts over the entire life cycle is summarised in Table 4 below. It should be noted that table 4 below is for representative of the lifecycle of a ‘typical’ luminaire. Luminaires of a higher efficiency will help increase the overall efficiency of the light through improved use of light and reduced losses as obtrusive light.

Table 4 : Distribution of impacts over life cycle of a typical luminaire⁸

Life Cycle phases -->			PRODUC TION	USE	DISTRI- BUTION	END-O F-LIFE	TOT-AL
Other Resources & Waste							
8	Total Energy (GER)	%	74%	16%	1%	10%	100%
9	of which, electricity (in primary MJ)	%	100%	0%	1%	-1%	100%
10	Water (process)	%	100%	0%	1%	-1%	100%
11	Water (cooling)	%	100%	0%	1%	-1%	100%
12	Waste, non-haz./ landfill	%	94%	1%	1%	4%	100%
13	Waste, hazardous/ incinerated	%	1%	0%	0%	99%	100%
Emissions (Air)							
14	Greenhouse Gases in GWP100	%	66%	21%	1%	13%	100%
16	Acidification, emissions	%	82%	12%	1%	5%	100%
17	Volatile Organic Compounds (VOC)	%	13%	71%	0%	16%	100%
18	Persistent Organic Pollutants (POP)	%	82%	2%	1%	14%	100%
19	Heavy Metals	%	42%	8%	0%	50%	100%
	PAHs	%	97%	2%	1%	0%	100%
20	Particulate Matter (PM, dust)	%	23%	13%	0%	63%	100%
Emissions (Water)							
21	Heavy Metals	%	93%	0%	1%	6%	100%
22	Eutrophication	%	86%	0%	1%	13%	100%

The environmental impacts related to luminaires will be managed mainly in the production phase of the luminaire and at the end of life phase.

The end of life management of Street Lights and Traffic Signals is mainly regulated by the requirements of the WEEE Directive; as such, units have to be collected for proper disassembly, treatment and recycling of parts. Much of the components of Street Lights and Traffic Signals can be recycled with a minimum of treatment, for example glass, plastics and metals. This should be undertaken at the end of use phase.

4.5 Other Considerations

It must be remembered though that lamps are chosen primarily for the amount of light they provide in order to meet the needs of a given application, such as lighting a given road length to a suitable extent for the safe passage of vehicles and pedestrians. Contracting authorities will also procure lamps for a number of different scenarios, including the replacement of lamps, retrofitting of lamps and installing completely new lighting systems. Aesthetics will play a part too, in the colour and brightness of the lamp, as well as its shape.

It is therefore important in the design and commissioning phase that the correct lighting system is chosen for the intended application. Care must be taken to define the procurement needs in terms of the required lighting output for the given area, in terms of the lumen output from the lamps and associated ballasts as well as characteristics of the luminaires to direct the light. This is the role of the contracting authority working closely with suppliers and designers. This will maximise the use of natural ground and other surface reflections, ambient light and local surroundings and environment in maximising energy efficiency. Not only choosing components with the right light output but also those

with long and good quality lifetimes will reduce the need for failed component replacement and other more general maintenance, such as cleaning.

It is important to remember that not all street light installations can be retrofitted with more efficient lamp types, as they are not always compatible. HID lamps need an appropriate ballast and so in many cases this will require replacement of whole installations; luminaire, lamp and ballast. Some older and worse performing technology is still available and installed today⁸. The replacement of the existing street lighting stock that is still in good working order (albeit older and potentially less energy efficient) with newer more efficient street lighting will be a major capital investment in most cases and would depend on the policies of the relevant contracting authority. As a consequence, the market for replacement or renovation of those installations is large. However, new energy efficient technologies are not often known to procurers and traditionally, energy efficiency isn't a recognised reason to speed up renovation rates. Enforcing this significant change is seen as outside the scope the GPP specification and the criteria are worded accordingly to reflect this.

Street lighting is generally chosen with regard to the requirements for light output and the specific application. As shown above this will be influenced by several factors, such as road category. A comparison of the environmental impacts of lamp/ballast combinations per lamp lumen output is shown in Table 5; the EuP report concluded that for the same road category the environmental impact is comparable for different types of lamp/ballast combinations. This therefore demonstrates that the key consideration for contracting authorities is the specific application of the street lighting. Section 3.7 outlines the key types of lamps used for specific road categories; mainly HID lamps.

Table 5: Life Cycle Impact per Base Case Lamp/Ballast, expressed per lamp lumen output over 30 years.⁸

LAMP + GEAR, time period 30 year		Road category A		Road category B		Road category C			
		131W LPS	250W HPS	150W HPS	400W HPM	125W HPM	70W HPS	70W CMH	36W CFL
<i>PER LUMEN</i>									
Other Resources & Waste									
Total Energy (GER)	MJ	5,79E-02	3,28E-02	5,34E-02	5,49E-02	1,60E-01	1,24E-01	2,03E-01	2,17E-01
of which, electricity (in primary MJ)	MJ	9,95E-03	6,28E-03	8,65E-03	7,17E-03	1,05E-02	1,34E-02	1,49E-02	7,00E-03
Water (process)	ltr	6,69E-03	2,11E-03	3,40E-03	1,49E-03	1,78E-03	7,48E-03	8,70E-03	4,50E-03
Water (cooling)	ltr	1,27E-03	3,17E-03	4,30E-03	2,78E-03	4,10E-03	6,45E-03	7,49E-03	7,16E-05
Waste, non-haz./ landfill	g	7,60E-01	5,64E-01	7,58E-01	8,38E-01	1,58E+00	1,31E+00	1,64E+00	3,10E-01
Waste, hazardous/ incinerated	g	2,00E-02	1,68E-02	3,07E-02	4,14E-03	1,16E-02	8,29E-02	8,84E-02	4,16E-03
Emissions (Air)									
Greenhouse Gases in GWP100	kg CO2 eq.	4,34E-03	2,38E-03	3,97E-03	4,22E-03	1,30E-02	9,57E-03	1,63E-02	1,86E-02
Ozone Depletion, emissions	mg R-11 eq.	0	0	0	0	0	0	0	0
Acidification, emissions	g SO2 eq.	1,94E-02	1,35E-02	2,02E-02	2,01E-02	4,87E-02	4,11E-02	6,14E-02	5,03E-02
Volatile Organic Compounds (VOC)	g	1,25E-04	7,61E-05	1,28E-04	1,34E-04	3,88E-04	3,07E-04	4,86E-04	2,12E-04
Persistent Organic Pollutants (POP)	ng i-Teq	4,38E-03	3,67E-03	5,00E-03	5,50E-03	1,15E-02	8,56E-03	1,12E-02	1,54E-03
Heavy Metals	mg Ni eq.	6,67E-03	2,76E-02	3,51E-02	2,54E-02	3,42E-02	4,00E-02	4,93E-02	1,11E-02
PAHs	mg Ni eq.	2,09E-03	1,49E-03	2,52E-03	2,21E-03	7,53E-03	6,13E-03	1,09E-02	1,19E-02
Particulate Matter (PM, dust)	g	5,50E-03	2,36E-03	3,69E-03	3,96E-03	1,01E-02	8,05E-03	1,26E-02	3,83E-03
Emissions (Water)									
Heavy Metals	mg Hg/20	3,06E-03	2,16E-03	3,43E-03	1,14E-03	2,50E-03	7,63E-03	9,40E-03	1,08E-03
Eutrophication	g PO4	5,69E-05	1,47E-04	1,91E-04	1,23E-04	1,55E-04	2,42E-04	2,93E-04	1,47E-05
Persistent Organic Pollutants (POP)	ng i-Teq	0	0	0	0	0	0	0	0

5 Cost Considerations

5.1 Street Lighting

When purchasing HID lamps, it is important to not only consider the initial cost of the lamps, but also the lamp efficacy. Although HPM lamps may appear to be cheaper, it must be remembered that these types of lamps have a lower lumen efficacy; therefore they will require more watts to give the same lumen output as an HPS lamp or MH lamp.

This will provide energy savings, and therefore cost savings, as HPS lamps and MH lamps will use less power (watts) than a HPM lamp to provide the same lumen output. These benefits will however depend on other factors, for example, are the sockets the same and will the light distribution change therefore requiring other changes to the street light installation e.g. a different luminaire/ballast. On a replacement only basis, long payback would be expected due to the cost of the whole fitting i.e. lamp, ballast and luminaire e.g. greater than ten years³⁷.

Therefore to ensure street lighting is economic it is important in terms of cost considerations for the contracting authority to consider this GPP specification and the best available fittings for new lighting installations and refurbishment of existing installations, for example upgrading ballasts. Obviously where fittings allow, more efficient lamps should be used depending on the location and specific light use requirements.

Good street lighting design may be able to reduce costs by the resulting increase in distance between the streetlights and lower lamp power. However this will need to be balanced against requirements, for example local health and safety requirements regarding spacing and lighting requirements for specific uses. EU research is showing that good design, the application of the rights standards, competent designers and control systems can save an additional 30% over Ecodesign.

Furthermore, using lamps that have longer lifetimes and better lumen maintenance will result in longer maintenance times, therefore reducing costs. This will also reduce the indirect impacts incurred through replacement and maintenance, such as vehicular emissions and the associated impacts from manufacturing and distributing more components, mainly lamps.

5.2 Traffic Signals

There are a number of cost considerations that the contracting authority will need to taken into account when purchasing traffic signals.

The cost of LED traffic signals has been a barrier to the wider implementation of these types of traffic signals over the years, although some countries such as USA and Germany have implemented replacement programmes to upgrade traffic signals to LEDs.

The costs³⁸ for a standard (incandescent) red-amber-green *head* is currently around €187.5 compared to over €750 for an equivalent LED model however LED prices are falling rapidly. Therefore, although the initial up-front costs are more for LEDs, overall lifetime costs are lower thanks to a reduction in energy used and far lower maintenance costs³⁹. Other designs allow the use of LEDs with common traffic controllers and reduce replacement costs to €250 – €375 per head²⁹.

Although the initial capital costs for installation of LED traffic signals is more than conventional (incandescent) versions, the payback following the installation of LED traffic signals has proved to be relatively short as a result of reduced electricity charges and maintenance costs, as the examples below demonstrate. The benefits will be further increased if the price of energy keeps on increasing, as has been the trend over recent times.

³⁷ Policy Brief: Improving the energy performance of street lighting and traffic signals, DEFRA, July 2008
http://www.mtprog.com/spm/files/download/byname/file/2006-07-10%20Policy_Brief_street_lighting%20fin.pdf

³⁸ Costs have been converted from Pounds Sterling to Euros using an exchange rate of €1.25 to £1

³⁹ <http://www.reuk.co.uk/UK-Traffic-Lights-57000-Tonnes-Of-CO2.htm>

A European example of replacing conventional traffic signals with LED traffic signals is provided by the city of Freiburg in Germany. Here 53 traffic signals were replaced in 2006 with projected annual savings of €155,000 as a result of lower maintenance costs and a reduction of 350,000 kilowatts in power consumption, equating to a reduction in emissions of CO₂ of 240 tonnes. The financing of this project is over 15 years, with annual repayments of €140,000, which is less than the total savings per year⁴⁰.

In the USA for example, the California Energy Commission has estimated that a city converting all traffic signals at an intersection (cross-roads) with LEDs will reduce energy use by an estimated 70%, resulting in a simple payback of three to five years. In the city of Portland, Oregon nearly all red and green incandescent traffic lights were replaced in 2001 with LEDs. This resulted in net payback in less than three years due to energy and maintenance savings totalling \$400,000²⁹, approximately⁴¹ €284,000.

⁴⁰

http://w1.siemens.com/innovation/en/news_events/innovationnews/innovationnews_articles/lighting/smart_financing_for_new_traffic_signals.htm

⁴¹ Savings have been converted from US Dollars to Euros using an exchange rate of €0.71 to \$1

6 Relevant European Legislation and Policy

This section details EU legislation that is relevant to street lighting and traffic lights, which is important in setting the background context in which standards and labels have been developed. Contracting Authorities should also be aware of and take into account any additional local, regional or national legislation pertinent to their situation with respect to a particular product or service. It should be noted that this list is complete as of April 2010.

6.1 The Construction Products Directive (CPD) 89/106/EEC

The Construction Products Directive (CPD)⁴² is aimed at creating a single market for construction products, through the use of CE Marking. It defines the Essential Requirements of construction works (buildings, civil engineering works) which indirectly determines the requirements for construction products (in function of the works design and the climatic and geological conditions in the place where the construction works are situated).

Construction products must declare their performance for mechanical strength and stability, fire safety, health and environment effects, safety of use, sound nuisance and energy economy if EU or national regulatory requirements exist. Under the Directive, the Commission may give a mandate to standardisation organisations such as CEN to develop standards in consultation with industry. A list of the adopted standards can be found on the European Commission's website⁴³. Where harmonised standards are not available, existing national standards apply.

It should be noted also that Directive 93/68/EEC⁴⁴ amended the CPD 89/106/EEC on the approximation of laws, regulations and administrative provisions of the Member States relating to Construction Products.

The Commission has adopted a proposal to replace Council Directive 89/106/EEC by a Regulation (CPR) with the aim to better define the objectives of Community legislation and make its implementation easier⁴⁵. It now includes a specific extra essential requirement related to the sustainable use of natural resources, stating that:

"The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and ensure the following:

- (a) Recyclability of the construction works, their materials and parts after demolition.
- (b) Durability of the construction works.
- (c) Use of environmentally compatible raw and secondary materials in the construction works."

6.2 Directive on Waste Electrical and Electronic Equipment (WEEE) 2002/96/EC

The WEEE Directive⁴⁶ and RoHS Directive⁴⁷, which is discussed below, were developed and adopted to address the increasing amount of waste electrical and electronic equipment generated in Europe, therefore reducing the environmental burden on conventional disposal routes whilst closing the loop and improving resource efficiency through recycling.

The requirements of the Directive are transposed into national law by individual Member States and it is important to be aware of national take back and recycling schemes and arrangements in specific

⁴² <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31989L0106:en:HTML>

⁴³ <http://ec.europa.eu/enterprise/newapproach/standardization/harmstds/reflist/construc.html>

⁴⁴ OJ L 220, 30.8.1993, p. 1–22 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0068:EN:HTML>

⁴⁵ http://ec.europa.eu/enterprise/construction/index_en.htm

⁴⁶ OJ L 37, 13.2.2003, p. 24–39

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0096:EN:HTML>

⁴⁷ OJ L 37, 13.2.2003, p. 19–23

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0095:EN:HTML>

Member States. The Directive requires electrical and electronic equipment to be taken to a suitable authorised treatment facility at the end of its life so that it can be treated/dismantled and materials recovered for recycling where possible. The Directive outlines minimum requirements for the treatment and recovery of WEEE.

The WEEE Directive also requires products to be labelled, in order to identify them as EEE, with the aim of minimising the wrong disposal of WEEE. Where it is not feasible to put the label on the actual product it should be included in the documentation accompanying the product.

This Directive therefore deals with many of the end-of-life environmental impacts of electrical and electronic equipment.

A stakeholder consultation on the WEEE Directive took place in 2008, resulting in a proposed revised WEEE Directive that sets a new binding target for the collection of electrical and electronic equipment. The Commission proposes to differentiate the targets by setting mandatory collection targets equal to 65% of the average weight of electrical and electronic equipment placed on the market over the two previous years in each Member State. The recycling and recovery targets of such equipment now include the re-use of whole appliances, and weight-base targets will increase by 5%.⁴⁸

The recast of the WEEE Directive is still in progress. Information regarding the latest status and schedule of this recast can be found on the European Parliament's website: <http://www.europarl.europa.eu/oeil/file.jsp?id=5723502>

6.3 Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) 2002/95/EC

The RoHS Directive, in tandem with the WEEE Directive prevents the use of certain hazardous materials in new electrical and electronic equipment (EEE) placed on the market from 1 July 2006 onwards. This will limit the impact of the EEE at the end of its life and it also ensures harmonisation of legislation on the use of hazardous materials in EEE across all Member States.

Electrical and Electronic Equipment must not contain the following substances; lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE). There are some exemptions and limit values listed in the Annex to the Directive for some equipment where it is understood that one or more of these substances is required for their functioning and no economically viable alternatives exist in sufficient quantity at present. Therefore, some of these substances may still be found in some electrical and electronic equipment.

The Annex has been revised on a number of occasions, altering the list of exclusions and limit values.

A number of these exemptions relate to lamps, and in particular Exemption 4 allows the use of mercury in high intensity discharge lamps. This states that 'Mercury in other lamps not specifically mentioned in this Annex' are exempt from the requirements of Article 4 (1) i.e. the exclusion of hazardous substances in EEE. These exemptions are required, as the use of substances such as mercury is needed for the product to operate effectively.

The recast of the RoHS Directive is currently in progress. It is proposed that the list of banned substances should apply to all electrical and electronic equipment unless specifically excluded. In addition it is proposed that a number of substances not currently restricted are evaluated further, including halogenated flame retardants and PVC.

Information regarding the latest status and schedule of this recast can be found on the European Parliament's website:

<http://www.europarl.europa.eu/oeil/FindByProcnum.do?lang=en&procnum=COD/2008/0240>

⁴⁸ http://ec.europa.eu/environment/waste/weee/index_en.htm

6.4 Directive establishing a framework for the setting of Ecodesign Requirements for Energy-related Products (ErP) 2009/125/EC

The original Directive (2005/32/EC) on the eco-design of energy using products was adopted in July 2005 and focused on energy using products. This Directive has subsequently been repealed by Directive 2009/125/EC⁴⁹, which is a recast and increases the scope from energy using product to energy related products.

It provides clear EU wide rules for eco-design, aimed at avoiding disparities in regulation amongst individual Member States, which could impede the free movement of products within the internal market.

The Eco-design Directive does not in itself set binding requirements for specific products, however it does define conditions and criteria for setting, through subsequent implementing measures, minimum requirements regarding environmentally relevant product characteristics and allows them to be improved quickly and efficiently.

The framework provided by the Directive aims to encourage manufacturers to develop products where they have taken into account the environmental impact of the product throughout its entire life cycle.

Regulations setting binding requirements for specific product groups are gradually been developed, and would only be set for those energy related products which meet certain criteria, for example, key environmental impact and volume of trade across the internal market and only if there is clear potential for improvement of a product. Under the Eco-design Directive, self-regulation, including voluntary agreements offered as unilateral commitments by the industry can, under certain conditions, be recognised as a valid alternative to implementing measures.

6.5 The CLP Regulation (EC) No 1272/2008

The Regulation of 16 December 2008⁵⁰ on classification, labelling and packaging of substances and mixtures entered into force on 20 January 2009 and will ultimately replace the current rules on classification, labelling and packaging of substances (Directive 67/548/EEC) and preparations (Directive 1999/45/EC). Substance classification and labelling must all be consistent with the new rules by 1 December 2010 and for mixtures 1 June 2015.

The Regulation aims to ensure a high level of protection of human health and the environment, as well as the free movement of chemical substances, mixtures and certain specific articles, whilst enhancing competitiveness and innovation. This should be achieved by ensuring that the same hazards will be described and labelled in the same way all around the world.

6.6 The EU Climate-energy Package

In March 2007 the EU's leaders endorsed an integrated approach to climate and energy policy that aims to combat climate change and increase the EU's energy security while strengthening its competitiveness. They committed Europe to transforming itself into a highly energy-efficient, low carbon economy.

To kick-start this process, the EU Heads of State and Government set a series of demanding climate and energy targets to be met by 2020. These are:

⁴⁹ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:093:0003:0010:EN:PDF>

⁵⁰ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF>

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels
- 20% of EU energy consumption to come from renewable resources
- A 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.

Collectively they are known as the 20-20-20 targets⁵¹.

6.7 Ecodesign Requirements for Fluorescent Lamps Without Integrated Ballast, for High Intensity Discharge Lamps, and for Ballasts and Luminaires Able to Operate Such Lamps, Commission Regulation 245/2009/EC and Regulation 347/2010

This ongoing regulation implements Directive 2005/32/EC (now 2009/125/EC) of the European Parliament and of the Council.⁵²

Implemented in three main and two intermediate stages, this directive gives details on the energy requirements related to the ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps.

This Regulation repeals the Directive on energy efficiency requirements for ballasts for fluorescent lighting 2000/55/EC.

Regulation 245/2009/EC has subsequently been revised by Regulation 347/2010⁵³, dated 21st April 2010. The purpose of this amendment is to ensure unidentified impacts on the availability and performance of the products covered by Regulation 245/2009 are avoided and improve coherence regarding the product information requirements between this Regulation and Regulation 244/2009, which covers non directional household lamps.

6.8 Energy Labelling of Household Lamps Directive 98/11/EC

Although this Directive⁵⁴ is not applicable to street lighting, it is worth highlighting that there is an existing energy labelling scheme for other types of lighting, called general lighting products. This Directive is applicable to the labelling of domestic and domestic-like lamps including all technologies; incandescent lamps, fluorescent gas-discharge lamps and LEDs, and implements the requirements of the Labelling of Household Appliances Directive 92/75/EEC⁵⁵.

6.9 Directive on the Promotion of End-use Efficiency and Energy Services (ESD) 2006/32/EC

The aim of this Directive⁵⁶ is to improve energy efficiency, manage demand and reduce energy consumption across Europe. Member States will be required to save at least an additional 1% of their final energy consumption each year from 2008 for nine years. Within these targets are savings targets

⁵¹ http://ec.europa.eu/environment/climat/climate_action.htm

⁵² <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:076:0017:0044:EN:PDF>

⁵³ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:104:0020:0028:EN:PDF>

⁵⁴ OJ L 71, 10.3.1998, p. 1–8

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

⁵⁵ OJ L 297, 13.10.1992, p. 16–19

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0075:EN:HTML>

⁵⁶ OJ L 114, 27.4.2006, p. 64–85 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0085:EN:PDF>

for the public sector of 1.5%⁵⁷ as it is expected that a particular contribution will have to be made by this sector, a large part of which will be as a result of public procurement.

Directive in particular promotes energy efficient public procurement, and street lighting is specifically mentioned in Annex V of the Directive.

6.10 Electromagnetic Compatibility Directive (EMC) 2004/108/EC

The Electromagnetic Compatibility Directive was adopted on 15 December 2004 and repealed Directive 89/336/EEC. The EMC⁵⁸ is in place to ensure that electrical equipment is designed such that it does not interfere with or get disturbed by other electrical equipment and thus functions properly.

Before equipment is placed on the market (including both apparatus and fixed installations) they must be shown to meet the requirements set out in the EMC Directive.

6.11 Low Voltage Directive (LVD) 2006/95/EC

The LVD Directive⁵⁹ covers electrical equipment designed for use with a voltage rating of between 50 and 1000 V for alternating current (AC) and between 75 and 1500 V for direct current (DC). These voltages refer to the input or output voltage and not to those found inside the equipment. The Directive's main objectives are to ensure a high level of protection for the European public and that these products enjoy a single market within the EU. For electrical equipment within its scope, the Directive covers all health and safety risks, thus ensuring that electrical equipment is safe in its intended use.

6.12 REACH Regulation (EC 1907/2006)

The REACH Regulation⁶⁰ came into force on 1 June 2007 and deals with the Registration, Evaluation, Authorisation and Restriction of Chemical substances. It provides an improved and streamlined legislative framework for chemicals in the EU, with the aim of improving protection of human health and the environment and enhancing competitiveness of the chemicals industry in Europe.

REACH places the responsibility for assessing and managing the risks posed by chemicals and providing safety information to users in industry instead of public authorities, promotes competition across the internal market and innovation.

Manufacturers are required to register the details of the properties of their chemical substances on a central database, which is run by the European Chemicals Agency in Helsinki. The Regulation also requires the most dangerous chemicals to be progressively replaced as suitable alternatives develop.

6.13 UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP)

Since 1979 CLRTAP⁶¹ has addressed major environmental issues through scientific collaboration and policy negotiation. The aim of the Convention is that Parties shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution.

The convention has been extended on eight occasions by a number of different protocols.

⁵⁷ <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/03/1687&format=HTML&aged=0&language=EN&guiLanguage=en>

⁵⁸ OJ L 390, 31.12.2004, p. 24–37

⁵⁹ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:390:0024:0037:EN:PDF>

⁵⁹ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:374:0010:0019:en:PDF>

⁶⁰ OJ L 396, 30.12.2006, p. 1–849 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:396:0001:0849:EN:PDF>

⁶¹ <http://www.unece.org/env/lrtap/>

Of particular interest in relation to HID lamps is the Protocol on Heavy Metals (1998), which entered into force on 29th December 2003. This protocol targets mercury, cadmium and lead. It introduces measures to reduce emissions of these heavy metals, for example management measures for mercury containing products, such as electrical components.

7 Existing Ecolabels and Standards for Streetlights and Traffic Signals

7.1 Ecolabels for Street Lighting

The EuP Lot 9 study concluded that there are no specific Ecolabels at present for street lighting or their lamps although many countries have labels and/or minimum energy performance standards (MEPs) for various components of street lighting, focussing mainly on the ballasts. The Ecolabels that do exist are by far and away applicable to fluorescent tubes and compact fluorescent lamps, and not HID lamps.

The summary in Table 6 and Table 7 below presents the kinds of labels currently in use across the world, some voluntary and some mandatory, for the two kinds of ballasts, electronic and magnetic. Many of these relate to ballasts for fluorescent lighting and not HID lamps, for which there is limited information available. In addition, the majority of these Ecolabels are non-European. In Europe, standards for ballasts (and lamps) are largely dealt with through the Energy Labelling Directive and the Ecodesign Directive and its subsequent Regulations. Two examples of the kind of criteria and standards used in Ecolabels for ballasts are given below in Sections 7.1.1 and 7.1.2, whilst Section 7.1.3 provides an outline of the Ecolabels available for general lighting products. Although these are not applicable to the types of lamps used for street lighting a brief summary is given for context.

Table 6. Worldwide Mandatory Labels for Ballasts⁸

Country	Label Title	Electronic	Magnetic
Argentina	Programa de Calidad de Artefactos Electricos para el Hogar (PROCAEH) - Fluorescent Ballasts (22-12-2003)	✓	
Costa Rica	Plaqueo Energetico - Ballasts (1996)	✓	
El Salvador	Mandatory Standard (NSO) No. 29.39.01:03, Energy Efficiency of Double-Capped Fluorescent Lamps. Energy Performance and Labelling Requirements - Electronic Ballasts (2004)	✓	
Israel	Energy Label for Ballasts for Fluorescent Lamps	✓	
Philippines	Label for Electronic Ballasts For Fluorescent Lamps	✓	
Republic of Korea	Energy Efficiency Rating Labelling Program for Electronic Ballasts (01-07-1994)	✓	
USA	EnergyGuide - Electronic Ballasts For Fluorescent Lamps (1994)	✓	
Australia	Labelling Program for Fluorescent Lamp Ballasts		✓
Philippines	Label for Ballasts (Magnetic) – Philippines (2002)		✓
Republic of Korea	Energy Efficiency Rating Labelling Program for Magnetic Ballasts (01-07-1994)		✓

Table 7. Worldwide Voluntary Labels for Ballasts⁸

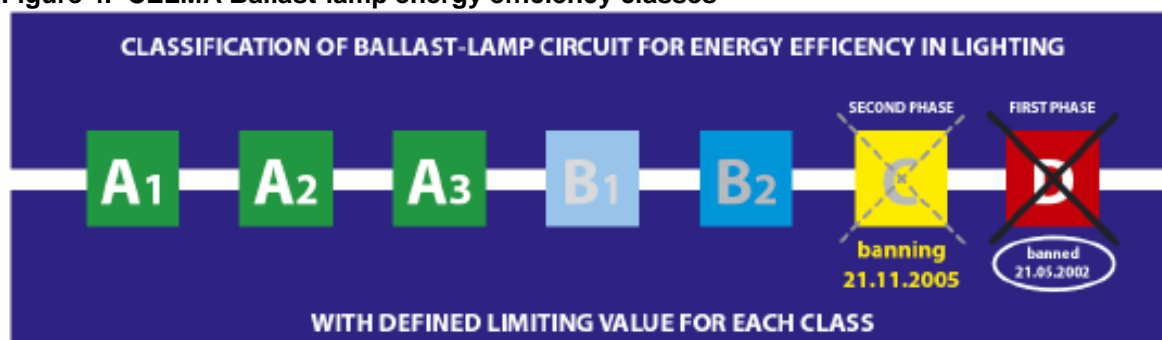
Country	Label Title	Electronic	Magnetic
Europe - CELMA	Energy Efficiency Index for Ballasts	✓	✓
Canada	Environmental Choice Program (ECP) - Ballasts Electronic (1988)	✓	
China	China Energy Conservation Product Certification - Electronic Ballasts For Fluorescent Lamps	✓	
Hong Kong, China	The Hong Kong Voluntary Energy Efficiency Labelling Scheme for Electronic Ballasts (23-12-2004)	✓	
New Zealand	Electronic Ballasts For Fluorescent Lamps	✓	
Republic of Korea	Certification of high energy efficiency appliance program for Electronic Ballasts (1997)	✓	
Singapore	Green Labelling Scheme - Electronic Ballasts - (2000)	✓	
Thailand	Green Label Scheme - Electronic Ballasts For Fluorescent Lamps (08-1994)	✓	
Viet Nam	Label for Electronic Ballasts	✓	
Brazil	Stamp Procel de Economia de Energia (Energy Efficiency)		✓

Country	Label Title	Electronic	Magnetic
	Stamp) - Ballasts (1993)		
Brazil	INMETRO Brazillian Labeling Program (PBE) for Magnetic p/Sodium Reactors		✓
Canada	Environmental Choice Program (ECP) - Ballasts Magnetic (1988)		✓
China	China Energy Conservation Product Certification - Magnetic Ballasts For Fluorescent Lamps		✓
New Zealand	Magnetic Ballasts For Fluorescent Lamps - New Zealand		✓
Republic of Korea	Certification of high energy efficiency appliance program for Magnetic Ballasts (1997)		✓
Singapore	Green Labelling Scheme - Magnetic Ballasts - Singapore (2000)		✓
Sri Lanka	Labels for Ballasts - Sri Lanka		✓
Korea	EL205. Magnetic Ballasts for High Intensity Discharge Lamps: Ballasts for Sodium Lamps or Metal Halide Lamps (EL205-2000/2/2003-200)		✓
Thailand	Energy Efficient Ballast Program - Magnetic Ballasts For Fluorescent Lamps (1998)		✓

7.1.1 Energy Efficiency Index for Ballasts – CELMA, Europe

The Trade Body CELMA¹⁵ have developed an Energy Efficiency Index for lighting-ballast combinations in accordance with Directive 2000/55/EC on 'energy efficiency requirements for ballasts for fluorescent lighting'. This Directive is applicable is related to the Ecodesign directive and although not directly related to street lighting does demonstrate the kind of labelling available for lighting products. The Index indicates how efficient the output is from a ballast-lamp combination for fluorescent lights normally used in office situations. It is defined as the corrected total input power of the lamp ballast circuit. There are seven classes from A1 to D, of which classes C and D have already been phased out, as pictured below in Figure 4.

Figure 4. CELMA Ballast-lamp energy efficiency classes⁶²



The classification is independent from technology but classes A1, A2 and A3 relate to electronic ballasts which are more energy efficient than magnetic or electromagnetic ballasts, which currently typically fall into classes B1 and B2 (classes D and C were phased out in 2002 and 2001 by the Directive 2000/55/EC),. Category A1 is intended for dimmable ballasts and lamps to operate at lower powers.

7.1.2 Korea Ecolabel - Ballasts for Sodium Lamps or Metal Halide Lamps⁶³

Ballasts can consume a significant amount of electricity over and above the lamp's consumption. The Korean ecolabel applies to magnetic ballasts for sodium lamps or metal halide lamps with both rated input voltage and rated second voltage of 1000 V or less.

⁶² EuP Lot 8 Office Lighting, <http://www.eup4light.net>

⁶³ http://www.koeco.or.kr/eng/business/cover_document/EL205.pdf

Energy Consumption

The energy consumption criteria are highlighted in Table 8 below.

Table 8 Energy Consumption Criteria in the Korean Ecolabel for Ballasts

Class	Electric consumption rate for ballast itself (%)	Change rate of lamp power (%)	
		90% of rated input voltage	110% of rated input voltage
Ballasts for sodium lamps	≤10 (≤15, in case of current transformer type)	≤87	≤113
Ballasts for metal halide lamps	≤8 (≤15, in case of current transformer type)	≤87	≤113

Maintenance and Quality Assurance

In order to extend product life, it shall have the structure to replace some parts (including an igniter at least). The power-factor of the product shall be 90% or higher.

7.1.3 General Lighting Products

In addition to the above Ecolabels relating to ballasts, there are a number of Ecolabels that are applicable to types of lighting outside the scope of this GPP product group. In particular these cover general lighting products for use in domestic and small commercial situations and focus mainly on compact fluorescent tubes. Example of these ecolabels are given here for context:

- European Ecolabel for Light Bulbs (Regulation 2002/47/EC)⁶⁴
- USA Green Seal – Compact Fluorescent Lamps⁶⁵
- Singapore Green Label (Modular and Integral) Compact Fluorescent Lamps⁶⁶
- Ecologo America Compact Fluorescent Lamps⁶⁷
- Energy Star Compact Fluorescent Lamps⁶⁸

These ecolabels focus on key environmental aspects that are also identified in Section 4 of this report, including lamp efficacy, lifetime and materials. The proposed GPP criteria are consistent with the approach taken by these ecolabels by including criteria that cover the same key environmental aspects.

7.2 Ecolabels for Traffic Signals

7.2.1 Energy Star for Traffic Signals

The Energy Star Traffic Signal⁶⁹ specifications are based on the characteristics of low energy consuming LED lamps, although other technologies that meet the requirements are not excluded. The US Congress passed a minimum federal efficiency standard in 2005 on that all traffic signals must meet the same standards as the Energy Star. As such all new traffic signals manufactured after 1st January 2006 have to meet these criteria and as a consequence the Energy Star Traffic Signal Specification was suspended on 1 May 1, 2007. Table 9 gives the Energy Star criteria for traffic signals.

⁶⁴ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:242:0044:0049:EN:PDF>

⁶⁵ http://www.greenseal.org/certification/standards/energy_efficient_lighting_compact_fluorescent_lights_GS_05.pdf

⁶⁶ <http://www.sec.org.sg/greenlabel.htm/>

⁶⁷ http://www.ecologo.org/en/seeourcriteria/details.asp?ccd_id=239

⁶⁸ http://www.energystar.gov/index.cfm?c=cfls.pr_crit_cfls

⁶⁹ http://www.energystar.gov/ia/partners/product_specs/eligibility/traffic_elig.pdf

Table 9 Energy-Efficiency Criteria for ENERGY STAR Qualified Traffic Signal Modules

Module Type	Maximum Wattage (74°C)	Nominal wattage (at 25°C)
12" Red Ball (30cm)	17	11
8" Red Ball (20cm)	13	8
12" Red Arrow (30cm)	12	9
12" Green Ball (30cm)	15	15
8" Green Ball (20cm)	12	12
12" Green Arrow (30cm)	11	11
Combination Walking Man/Hand	16	13
Walking Man	12	9
Orange Hand	16	13

It is proposed to use the green and red ball and arrow requirements from the US Energy Star in the GPP criteria for traffic signals. Whilst the energy star requirements are now mandatory in the USA, there are two key aspects in relation to the development of GPP criteria for traffic signals in Europe. Firstly that LED traffic signals that meet an acceptable standard are purchased, and secondly the promotion of LED traffic signals instead of incandescent lamps. This will be achieved by setting a requirement to purchase a percentage of LED traffic signals as part of the GPP criteria.

The use of the Energy Star requirements allows a quantitative aspect to be included in the GPP criteria. In addition the cost of LED traffic signals needs to be considered when developing GPP criteria. As Section 5 in this report shows, LED traffic signals are initially more expensive than incandescent lamps. Including criteria that exceed the Energy Star requirements will undoubtedly increase the costs further and may discourage the uptake of LEDs.

The sizes of signals to which these relate i.e. 200mm and 300mm is consistent with the product scope for traffic signals taken from EN 12368:2006, and detailed in Section 3.4. The wattage requirements for the Combination Walking Man/Hand, Walking Man and Orange Hand are not included as these are more specific to the USA market and not Europe.

Amber LED modules are not included in the Energy Star requirements as at the time of publication available amber LED modules were not Institute of Transportation (ITE) compliant (see Point 6 in the Energy Star Specification) The subsequent federal efficiency standard, which replaced the Energy Star requirement, does not include standards for amber modules either.

The GPP criteria therefore do not include specific efficiency criteria relating to amber modules, as there is an insufficient evidence base upon which to base criteria development.

7.2.2 Netherlands GPP Criteria for Traffic Management Installations

Recent developments in the Netherlands have seen the development of criteria for traffic management installations, which encompasses traffic lights / signals, traffic information systems and street and ship signage.

Development of the criteria by SenterNovem⁷⁰ started in June 2007, with the final criteria recently published in August 2008 after a period of consultation. The criteria are concerned with energy efficiency (such as energy efficient and dimmable lighting in lit systems for example), material use, as well as sustainable design and traffic management systems. For example they state that 'class II' energy efficient light sources must be installed in new systems, including LED lamps. Class II equates to a maximum of 15 watts power. This ties in with the Energy Star values above, although they, Energy Star criteria, have more flexibility on size and colour of lamp as well as temperature and are therefore considered to have wider application. In addition to Class II light sources Class I light sources are also available, which have a maximum of 50 watts power. Class III light sources, which will be more efficient than both Class I and Class II are currently under development.

⁷⁰ <http://www.senternovem.nl/duurzaaminkopen/Criteria/gww/verkeersregelinstallaties.asp>

The SenterNovem criteria state for sustainable material use that there is no advantage to be found in LCA studies for any particular material type. The main environmental gains to be had are in recycling and reusing the materials, in particular poles and mounts. Sustainable material use is handled through a qualitative award criterion asking for a weighted approach to reducing the use of raw materials, energy use in manufacture, and maximising product lifetime, durability and recyclability. The more energy that is saved and the lower the environmental impact, the more the product is awarded points.

Other criteria that were proposed included, for example, standardising components and limiting the light given out to the local surroundings, but these were rejected during the consultation phase as being unsuitable for various reasons, such as maintaining suitable levels of light for health and safety reasons.

7.3 European Standards

There are a number of standards, listed in Appendix 3, which are relevant to the procurement and installation of street lighting and traffic signals. These do not necessarily cover environmental issues, for example they include safety aspects and product specifications, however it is useful to be aware of their existence. Manufacturers and contractors will apply these where necessary in the design, production and installation of these products.

Contracting authorities should check to ensure that when implementing the GPP criteria, all other requirements, including legislative or within European standards are met as required.

8 Conclusions and Summary

A number of different types of lamps can be used for street lighting, however the main type is high intensity discharge lamps, as outlined by the EuP Study and the trade body for lamps, which include metal halide lamps and high pressure sodium lamps. The GPP criteria for street lighting therefore focus on these types of lamps. The scope of street lighting for this GPP specification is consistent with that used in the EuP study, albeit focussing on HID lamps. HID lamps are used across all types of road categories (Fast, Medium and Slow), whereas other types of lamps, for example CFLs are only used for the slow road category with a limited percentage of sales. Other lamp types, along with CFLs are also excluded, such as linear fluorescent lamps, as they are predominantly used in domestic or office applications, and not street lighting.

There are no ecolabel criteria available for HID lamps, however the GPP criteria focus on the key environmental impact of energy use and include lamp efficacy, lamp survival and lamp lumen maintenance. This is consistent with the key areas considered by existing standards for other types of lighting, for example the EU Ecolabel for light bulbs and the US Energy Star for compact fluorescent lamps. Following on from these key areas in relation to the HID lamps, other criteria consider additional elements of the street lighting installation, including the ballast, luminaire and product information.

The specific limits included in the criteria are derived from the Ecodesign measures for tertiary lighting (including HID lamps, and ballasts and luminaires for use with these types of lamps), that are planned to be introduced after the entry into force of the Regulation implementing Directive 2005/32/EC. Regulation⁷¹ into force²⁶; for this reason first stage requirements, which are generally brought into affect one year after the introduction of the Ecodesign Regulation have not been used in the GPP criteria, as these will be mandatory for all products shortly.

Lamp efficacy has been based on second stage requirements, which are due to be brought into affect three years of the introduction of the Ecodesign Regulation, after January 2012, and Indicative Benchmarks, which represent current best practice available on the market, for the core and comprehensive criteria respectively. At present not all products on the market will meet these requirements, and a process of market transformation in line with the second stage requirement timescales will be required before all products meet these criteria.

The nature of product and market development will necessitate a review of the GPP criteria, regardless of the Ecodesign measures, however it is proposed that this should be undertaken in line with the implementation of the various staged requirements of the Ecodesign Regulation for tertiary lighting.

Mercury content of lamps is identified as a key issue. As the setting of relevant limits for mercury content are dealt with through the RoHS Directive and are potentially subject to change, the mercury content of lamps in the GPP specification is addressed through the setting of energy efficiency requirements for lamps, which will lead to a decrease in their overall mercury content. This is in line with the approach taken by the Ecodesign measures.

In addition to the recommended core and comprehensive technical specifications (which are criteria that have to be met by all products offered for purchase), award criteria are proposed for street lighting to promote the purchase of lamps with further efficiency measures by using dimming ballasts and additional reductions in the proportion of light emitted above the horizon. These are additional criteria on which the contracting authority will base its award decision. Award criteria are not pass/fail criteria, meaning that offers of products that do not comply with the criteria may still be withheld for the final decision, depending on their score on the other award criteria, including the price. To stimulate further market uptake of ever improved environmental products, award criteria should be considered depending on the specific circumstances of each case.

There is a lack of existing standards and detailed studies relating to traffic signals, however the scope used for this GPP specification is consistent with the EN12368: 2006 standard. Traffic signals are a smaller element of this product group in terms of their overall energy consumption compared to street

⁷¹ http://ec.europa.eu/energy/efficiency/eco-design/doc/committee/2008_12_08/draft_domestic_lighting_products_regulation_en.pdf

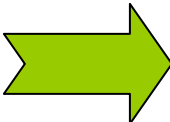
lighting. Nonetheless the main focus in recent years has been the development of LEDs for use in traffic signals to improve energy efficiency and lifetime. The criteria for traffic signals therefore focus on this aspect, with the aim of promoting the use of LED traffic signals by contracting authorities. They include wattage specifications for green and red lights.

Finally, it is important to note that these GPP criteria are applicable to the purchase of retrofitting or replacement lamps as required for existing lighting installations as well as for new lighting installations. It does not however specify that retrofitting and replacements should be undertaken and that lamps that meet the specification outlined in the GPP criteria should only be purchased where the existing lighting installation allows the use of such lamps. It would not be expected to have to replace the lighting installation to be able to purchase lamps that meet the specified criteria. This wider change will be driven through the implementation of the Ecodesign measures and the other policies at EU and Member State level for a gradual reduction in stock of certain lamp types as these measures take place. Obviously, given the lengthy life span of lighting installations it is important that the contracting authority considers this when purchasing new lighting installations and aims for the best available technology.

9 Proposal for Core and Comprehensive Criteria

It is proposed to set core and comprehensive criteria for street lighting and traffic signals. The proposed GPP criteria are designed to reflect the key environmental risks. This approach is summarised in the following table:

Please note that the order of impacts does not necessarily translate to the order of their importance.

Key Environmental Impacts	GPP Approach
<ul style="list-style-type: none"> • Energy consumption, in all phases, but especially the use phase of street lighting and traffic signals • High energy consumption from the use of incandescent bulbs in traffic signals • Use of materials and generation of waste (both hazardous and non-hazardous) • Potential pollution of air, land and water due to the use of hazardous materials e.g. mercury • Light pollution from street lighting 	 <ul style="list-style-type: none"> • Purchase lamps with high lamp efficacy • Purchase energy efficient ballasts • Promote the use of LEDs in traffic signals • Encourage the use of dimmable ballasts where circumstances allow • Promote the purchase of lamps with a lower mercury content • Promote the use of luminaires that limit light emitted above the horizon • Promote the purchase of luminaires with high utilisation factor⁷² for applications where luminaires are going to be used

Please note that the order of impacts does not necessarily translate to the order of their importance.

As already outlined in this report, there is a lack of ecolabel standards available for street lighting, specifically HID lamps and traffic signals. The street lighting criteria are based on the Ecodesign measures for tertiary lighting, which includes HID lamps that are planned to be introduced after the entry into force of the Regulation (245/2009) implementing Directive 2005/32/EC entered into force. The criteria for traffic signals are based on recent developments in relation to LEDs in traffic signals, to promote their wider use.

The core criteria focus on the key environmental impact of energy consumption in the use phase. The criteria use lamp efficacy standards for HID lamps, in particular high pressure sodium lamp and metal halide lamps, to ensure only lamps with acceptable efficacy levels are purchased. These are based on the second stage requirements included in the Ecodesign Regulation for tertiary lighting.

Core criteria for ballast efficiency are also included, and again these are based on the second stage Ecodesign requirements. The core criteria also require lamp product information to be provided on a range of other parameters, which will inform the contracting authority about the product and allow them to compare different products.

The comprehensive criteria develop the lamp efficacy criteria further by using the Indicative Benchmarks included in the Ecodesign Regulation for tertiary lighting, which represent the best available products at the present time. Again these are for two types of HID lamps, metal halide lamps and high-pressure sodium lamps. These criteria are more challenging than the core criteria and provide scope for contracting authorities to go beyond the minimum standards.

⁷² Utilization Factor (UF) of an installation for a reference surface, which means the ratio of luminous flux received by the reference surface to the sum of the individual total fluxes of the lamps of the installation.

Ballast efficiency criteria are included in the comprehensive criteria, based upon the third stage requirements, which are due to come into affect eight years after the introduction of the Ecodesign Regulation.

Criteria are also included in relation to lamp survival rate and lamp lumen maintenance. By setting these at relatively high levels, it will ensure maintenance requirements for street lighting will be kept to a minimum, and will not need to be undertaken as frequently.

Additional comprehensive criteria relate to ballasts and luminaires. This includes product information, ballast efficiency and proportion of light emitted above the horizon. Again these will contribute towards a reduction in energy consumption, and will also affect other environmental impact, such as light pollution.

The availability of products that meet the comprehensive criteria, compared to the core criteria will be limited, however some products will be available, as the comprehensive criteria are generally based on the benchmark standards of what is currently considered best available from the research undertaken as part of the development of the Eco-design measures.

Some of the core and comprehensive criteria are derived from Eco-design measures, which will not come into effect immediately e.g. three years or eight years after the Eco-design Regulation is introduced. By using these Eco-design measures as GPP criteria ahead of their implementation, public procurers will be signalling to the market that they want to be striving for higher product performance credentials ahead of them becoming mandatory for all. Once the market has caught up, e.g. through mandatory measures after x years, then the (core) GPP criteria can be re-cast and revised to keep them forward looking ahead of regulatory measures. Comprehensive criteria are set at current best practice levels in the market, for those who want to buy at this higher level.

The setting of relevant limits for mercury content are dealt with through the RoHS Directive and are potentially subject to change, the mercury content of lamps in the GPP specification is addressed through the setting of energy efficiency requirements for lamps, which will lead to a decrease in their overall mercury content. This is in line with the approach taken by the Eco-design measures.

A periodic review of GPP criteria would be expected in any case as the market and products will naturally develop over time, as technological advances are made. This will be the case for other product groups that are based on Ecolabel criteria, which are reviewed and revised on a regular basis.

The award criteria focus on promoting energy efficiency further, with criteria relating to the use of dimming ballasts and further reductions in the proportion of light emitted above the horizon. For traffic signals the core and comprehensive criteria both focus on the key area of promoting the use of LEDs in traffic signals, which significantly reduce energy consumption and also reduce maintenance frequencies. The core criteria require 50% of traffic signals purchased to be LEDs, and the comprehensive criteria 100%. This is based on the two facts that whilst LEDs are far more efficient with their energy use than traditional incandescent lamps they can have a concomitantly higher purchase price. To ensure energy consumption is minimised, both the core and comprehensive criteria for traffic signals include reference to wattage standards for red and green balls/arrows. These are from the US Energy Star for Traffic Signals, and are for the same size balls/arrows as required under the scope from EN 12368:2006.

Full details of the proposed purchasing criteria are provided in the associated Product Sheet for this product group.

10 Relevant EU legislation and information sources

10.1 EU Legislation

- Directive on Waste Electrical and Electronic Equipment 2002/96/EC:
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0096:EN:HTML>
- Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment 2002/95/EC:
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0095:EN:HTML>
- Directive establishing a framework for the setting of Ecodesign Requirements for Energy-related Products 2009/125/EC:
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:en:PDF>
- The CLP Regulation (EC) No 1272/2008. The Regulation of 16 December 2008 on classification, labelling and packaging of substances and mixtures
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF>
- Regulation (EC 245/2009) 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, repealing Directive 2000/55/EC
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:076:0017:0044:EN:PDF>
- Commission Regulation 347/2010 amending Commission Regulation 245/2009 as regards eco-design requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:104:0020:0028:EN:PDF>
- Energy Labelling of Household Lamps Directive 98/11/EC
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:071:0001:0008:EN:PDF>
- Regulation (EC 1907/2006) concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC:
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:396:0001:0849:EN:PDF>
- Low Voltage Directive (LVD) 2006/95/EC
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:374:0010:01:EN:HTML>
- Electromagnetic Compatibility Directive (EMC) 2004/108/EC
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:390:0024:0037:EN:PDF>
- Directive on the promotion of End-use efficiency and Energy Services 2006/32/EC
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0085:EN:PDF>
- UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP)
<http://www.unece.org/env/lrtap/>
- The EU Climate-energy Package, http://ec.europa.eu/environment/climat/climate_action.htm
- The Construction Products Directive (CPD) 89/106/EEC
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31989L0106:EN:HTML>

- Council Directive 93/68/EEC amending many Directives including 89/106/EEC (construction products)
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0068:EN:HTML>

10.2 Ecolabels and Standards

- European Ecolabel for Light Bulbs (Regulation 2002/47/EC)
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:242:0044:0049:EN:PDF>
- USA Green Seal – Compact Fluorescent Lamps
http://www.greenseal.org/certification/standards/energy_efficient_lighting_compact_fluorescent_lights_GS_05.pdf
- Singapore Green Label (Modular and Integral) Compact Fluorescent Lamps
http://www.sec.org.sg/greenlabel_htm/
- Ecologo America Compact Fluorescent Lamps
http://www.ecologo.org/en/seeourcriteria/details.asp?ccd_id=239
- Energy Star Compact Fluorescent Lamps
http://www.energystar.gov/index.cfm?c=cfls.pr_crit_cfls
- Energy Star - Traffic Signals (Suspended)
http://www.energystar.gov/ia/partners/product_specs/eligibility/traffic_elig.pdf
- EuP Lot 9 Study: Public Street Lighting, VITO, January 2007,
<http://www.eup4light.net>

10.3 Studies and Other Sources of Information

- European Commission's GPP Training Toolkit
<http://www.ec.europa.eu/environment/gpp>
- European Lamp Companies Federation, 'Saving Energy through Lighting'
http://buybright.elcfed.org/uploads/fmanager/saving_energy_through_lighting_jc.pdf
- ELC Federation
<http://www.elcfed.org/>
- CELMA
www.celma.org
- The International Commission on Illumination
<http://www.cie.co.at>
- MTP Briefing Note BNCL12: Light-emitting diodes - Innovation Briefing Note, version 1.0, 14/4/2008,
www.mtprog.com
- Buy Bright Initiative
<http://buybright.elcfed.org/index.php?page=21>
- Quick Hits, Traffic Signal, UK ERC, December 2006
http://www.ukerc.ac.uk/Downloads/PDF/06/0612_Traffic_Signals_QH.pdf

- Ecological Consequences of Artificial Night Lighting, Edited by Catherine Rich and Travis Longcore, Published 2005
- Guidance Notes for the Reduction of Obtrusive Light:
http://www.ile.org.uk/uploads///File/02_lightreduction.pdf
- Information on renewable raw materials and bio-based products
http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/biobased-products/index_en.htm

Appendices

Appendix 1 – Overview of lamps, control gear and luminaires considered in the EuP study

Appendix 2 – Road Classifications according to EN 13201

Appendix 3 – European Standards and Guidance

Appendix 1 - Overview of lamps, control gear and luminaires considered in the EuP study⁸

LAMPS	CONTROL GEAR		LUMINAIRE
High pressure sodium lamps (HPS)			Luminaire 1: housing mix aluminum and polyester; aluminum reflector Luminaire 2: housing mix aluminum and polyester; aluminum reflector Luminaire 3: aluminum housing; aluminum reflector
70 W	electromagnetic ballast 70W, capacitor, ignitor	electronic ballast 70-250W	
150 W	electromagnetic ballast 150W, capacitor, ignitor		
250 W	electromagnetic ballast 250W, capacitor, ignitor		
Low pressure sodium lamps (LPS)			
131 W	electromagnetic ballast 131W, capacitor, ignitor		
High pressure mercury lamps (HPM)			
125 W	electromagnetic ballast 125W, capacitor		
400 W	electromagnetic ballast 400W, capacitor		
Low pressure mercury lamps (CFL)			
36 W	electromagnetic ballast 36W, capacitor	electronic ballast 36W	
High pressure ceramic metal halide lamps (CMH)			
70 W	electromagnetic ballast 70W, capacitor, ignitor	electronic ballast 70W	

Appendix 2 – Road Classifications⁸ according to EN 13201

The tables below, reproduced from the EuP Lot 9 study, show the correlation between the EN 13201-2 road classifications and those used in the EuP study.

Simplified version of selection according to EN/TR 13201-1 guideline and standard EN 13201-2 performance classes						
Road type	typical situation	Luminance concept (objective = vision of road surface)				
		EN 13201 class	Lavg Cd/m ²	U ₀	U ₁	TI %
category 'F' fast traffic only (e.g. motorways,...)	busy and fast	ME1	2	0,4	0,7	10
	busy and normal speed	ME2	1,5	0,4	0,7	10
	not busy and rain	ME3a	1	0,4	0,7	15
	few traffic	ME4a	0,75	0,4	0,6	15
category 'M' mixed traffic	busy	ME2	1,5	0,4	0,7	10
	normal	ME3a	1	0,4	0,7	15
	few traffic	ME4a	0,75	0,4	0,6	15

Simplified version of selection according to EN/TR 13201-1 guideline and standard EN 13201-2 performance classes					
Road type	typical situation	Illuminance concept (objective = light levels to see persons and cars)			
		EN 13201 class	Eavg illuminance (Avg) lx	Umin Uniformity	Emin Illuminance(min)
category 'S' slow traffic	busy	CE2	20	0,4	
	normal	CE3	15	0,4	
	few traffic	CE4	10	0,4	
	busy	S2	10		3
	normal	S4	5		1
	few traffic	S6	2		0,6

Appendix 3 – European Standards and Guidance

- EN13201-3: Road Lighting – Calculation of performance
- EN13201-4: Road Lighting – Methods of measuring lighting performance
- CIE 144(2001) Road surface and road marking reflection characteristics
- CEN/TR 13201-1: Road lighting – Selection of lighting classes
- EN13201-2: Road Lighting – Performance requirements
- EN 12368: 2006 Traffic Control Equipment - Signal Heads.
- EN50294: Measurement method of total input power of ballast-lamp circuits
- EN60598-1: Luminaires – General requirements and tests
- EN60598-2-3: Luminaires – Particular requirements – Luminaires for road and street lighting
- EN50102: Degrees of Protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
- EN60529: Degrees of protection provided by enclosures (IP code)
- EN60662: High pressure sodium vapour lamps – Performance
- EN60901: Single-capped fluorescent lamps – Performance specifications
- EN60921: Ballasts for tubular fluorescent lamps – Performance requirements
- EN60923: Auxiliaries for lamps – Ballasts for discharge lamps (excluding tubular fluorescent lamps) – Performance requirements
- EN60927: Specification for auxiliaries for lamps. Starting devices (other than glow starters) – Performance requirements
- EN60929: AC-supplied electronic ballasts for tubular fluorescent lamps – Performance requirements
- EN61048: Auxiliaries for Lamps – capacitors for use in tubular fluorescent and other discharge lamp circuits – General and safety requirements
- EN61049: Capacitors for use in tubular fluorescent and other discharge lamp circuits – Performance requirements
- EN61167: Metal halide lamps – Performance
- EN62035: Discharge Lamps (excluding fluorescent lamps) – Safety specifications
- CIE01-1980: Guide lines for minimizing urban sky glow near astronomical observatories (Joint publication IAU/CIE)
- CIE 17.4-1987: International lighting vocabulary, 4th ed. (Joint publication IEC/CIE)
- CIE 23-1973: International recommendations for motorway lighting
- CIE 31-1976: Glare and uniformity in road lighting installations
- CIE 32-1977: Lighting in situations requiring special treatment (in road lighting)
- CIE 33-1977: Depreciation of installation and their maintenance (in road lighting)
- CIE 34-1977 Road lighting lantern and installation data: photometrics, classification and performance
- CIE 47-1979: Road lighting for wet conditions
- CIE 66-1984: Road surfaces and lighting (joint technical report CIE/PIARC)
- CIE 84-1989: Measurement of luminous flux
- CIE 93-1992: Road lighting as an accident countermeasure
- CIE 100-1992: Fundamentals of the visual task of night driving
- CIE 115-1995: Recommendations for the lighting of roads for motor and pedestrian traffic
- CIE 121-1996: The photometry and goniophotometry of luminaires
- CIE 126-1997: Guidelines for minimizing sky glow
- CIE 129-1998: Guide for lighting exterior work areas
- CIE 132-1999: Design methods for lighting of roads
- CIE 136-2000: Guide to the lighting of urban areas
- CIE 140-2000: Road lighting calculations
- CIE 144:2001: Road surface and road marking reflection characteristics
- CIE 154:2003: Maintenance of outdoor lighting systems

