Buying Bright

A guide for procuring energy efficient street and office lamps

Contents

Foreword

Using Europe's energy more efficiently has rightly become a key goal for its policy-makers. It is a vital component in the EU's efforts to maintain and enhance the competitiveness of its industries and businesses in a challenging global marketplace. It also offers immediate and massive reductions in CO_2 emissions. These reductions are considered essential in the short-term if the world's climate is not to pass a 'tipping point' after which it may be too late to prevent irreversible and highly damaging change. It also reduces the vulnerability of the EU's energy supply to what appear to be insecure foreign imports and the unsettling prospect that Europe's citizens will literally see their lights go out!

For anyone in public administration, this all makes a compelling case not just to take the issue seriously, but to lead by example. And with public lighting, in government buildings and on the streets, accounting for such a large proportion of total central, regional and local government energy consumption and costs, energy-efficient lighting offers an ideal opportunity to show the way. Currently in EU25, only 3% of total streetlighting stock is renovated per annum. If the above reasons are not sufficient, the significant potential savings to tax-payers alone should also help public purchasers improve on the shockingly low percentage of EU citizens, 43%, who take energy consumption into account when purchasing their lighting[1].

'Green' procurement is a key element of Europe's plan to curb consumption of energy in Europe. Europe's local authorities spend up to 14-16% of EU GDP on public procurement each year[2]; it makes sense to use this money to help save energy through the procurement of green or energy efficient technologies such as lamps. Although in general these lamps are initially more expensive, based on their "total cost of ownership[3]", they will save substantially on running costs, both in electricity, maintenance and disposal.

Of course there are genuine barriers to overcome: the lack of appropriate incentives, available financing mechanisms and information all hamper real progress in this area. That is why, for the past two years, the ELC[4], as representative of the member companies accounting for 95% of EU lamp production, has been working closely with Europe's public sector to on a range of projects to improve the uptake of energy efficient lamps.

On 30th and 31st of May 2006, the ELC and partners Energie Cites, CEMR, CELMA and WWF, brought together participants from across Europe for the Buy Bright Initiative. **Buy Bright** looks at the practical ways to assist European public purchasers and procurement officers to make the switch to energy efficiency lighting ranging from green procurement initiatives, public private partnerships, local energy services and more.

The ELC was recently successful in its application to the ***Intelligent Energy Europe Programme*** for funding for the Bottom Up to Kyoto (**ButK)** pilot project. Over the next three years, BUtK aims to assist 6 municipalities from 4 new EU member states; Estonia, Hungary, Poland, Slovenia, and one EU accession country; Romania, to address the market barriers for energy efficient public lighting in these countries with a view to gaining increased acceptance and environmental awareness of energy efficient lamps.

This new publication **Buying Bright,** a simple guide for procuring energy efficient street and office lamps in Europe, is a further example of such efforts. The guide gives the energy profiles for a range of common street and office lamps to help public procurement professionals make informed decisions about the procurement of public lighting and hopefully make a significant contribution to saving energy at a local level.

We hope you find the guide useful.

Gerald Strickland, Secretary General of the ELC

[1] http://europa.eu.int/comm/public_opinion/index_en.htm

[2] http://europa.eu.int/comm/environment/gpp/pdf/gpphandbook.pdf

[3] The total cost of ownership of a product represents the cost incurred throughout its life cycle. For energy efficient lamps, although the consumer purchase price is higher than conventional less energy efficient lamps, the total cost of ownership is **significantly** lower as the lamp is replaced less frequently and uses less energy, with a consequently lower cost for electricity consumption for the consumer

[4] The members of ELC are Aura, GE, LEUCI, NARVA, OSRAM, Philips and Sylvania. These companies employ 50,000 people in Europe and account for 5 billion Euro European turnover.

1. Introduction

Energy efficient technology is seen to play an important role in the future approach to energy both in the short and medium to long term. According to the European Commission by 2010 about 180 million tones of CO_2, the equivalent annual output of around 50 power stations, could be prevented with energy-efficient products and appliances alone in Europe - around half of the EU's commitment under Kyoto.

More than 50% of all lamp technologies installed in Europe are still not the most energy efficient; as such the potential for improvements and savings (of energy, costs and CO_2 emissions) for Europe are significant[5]. The majority of these savings (between 75 and 80%) can be achieved in the area of professional lighting (in streets and offices for example), therefore the public sector has an important role to play in setting an example and influencing the market place through green procurement.

Switching one 125W outdoor mercury vapour lamp to a 70W metal halide will save 92 kg of CO_2.

Note: burning hours per year: 4000 CO_2 per kWh: 0.42

'Green' procurement is a key element of Europe's plan to curb consumption of energy in Europe. Europe's local authorities spend 14-16% of EU GDP on public procurement each year[6]; it makes sense to use this money to help save energy through the procurement of green or energy efficient technologies such as lamps. Although in general these lamps are initially more expensive, based on their "total cost of ownership[7]", they will save on running costs, both in electricity, maintenance and disposal.

The European Commission has also recognised the importance of green procurement for improving energy efficiency in the public sector:

- Under the recent *Directive on the promotion of end-use efficiency and energy services*[8], Member States will be required to establish a number of national energy efficiency programs as soon as 2007.
- The *Green Paper on Energy Efficiency* (Doing more with less[9]) and the forthcoming Commission *Action Plan on Energy Efficiency* will urge the public sector to play an 'exemplary role' which will encourage energy-efficient public procurement[10], energy audits and energy performance contracting.
- Furthermore, in July 2007, the *Directive on the Eco-Design of Energy-using Products*[11] (EuP) will come into force in all EU member states. Under the Directive, lamp specific 'Implementing Measures', initially for street and office lighting, will be developed, this could mean that a range of inefficient lamps will be phased out of the European market in the next few years, with clear implications for Europe's public sector.

A large number of Europe's public purchasers are however new to "Energy Efficiency" and "Green Procurement". As such they will need a steer in the right direction not only to the areas where they can make savings but also towards support mechanisms and initiatives to enable them to "Make the Switch" to energy efficient lighting technology in practice.

This is why the ELC as part of its wider strategy on improving energy efficiency in Europe, has been working closely with European policy makers, national governments, regional and local representatives and energy services companies to help to support the public sector to buy bright and procure energy efficient lamps.

The following energy profiles have been developed by experts from the member companies of the ELC, as a comprehensive tool for procurement and energy professionals' involved green procurement at European, national, regional and local level.

The profiles provide information on the energy efficiency of three types of lamp families. This information can be used as part of or to complement national procurement specifications for lamps. They focus on lamps that can easily be used in general street and office lighting applications in Europe.

[5] See ELC's 'Did you know...that light sources support the European Lisbon Agenda?'

[6] http://europa.eu.int/comm/environment/gpp/pdf/gpphandbook.pdf

[7] The total cost of ownership of a product represents the cost incurred throughout its life cycle. For energy efficient lamps, although the consumer purchase price is higher than conventional less energy efficient lamps, the total cost of ownership is **significantly** lower as the lamp is replaced less frequently and uses less energy, with a consequently lower cost for electricity consumption for the consumer

[8] DIRECTIVE 2006/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC

[9] http://ec.europa.eu/energy/efficiency/index_en.htm

[10] http://europa.eu.int/comm/environment/gpp/guidelines.htm

[11] 2005/32/EC

2. Methodology

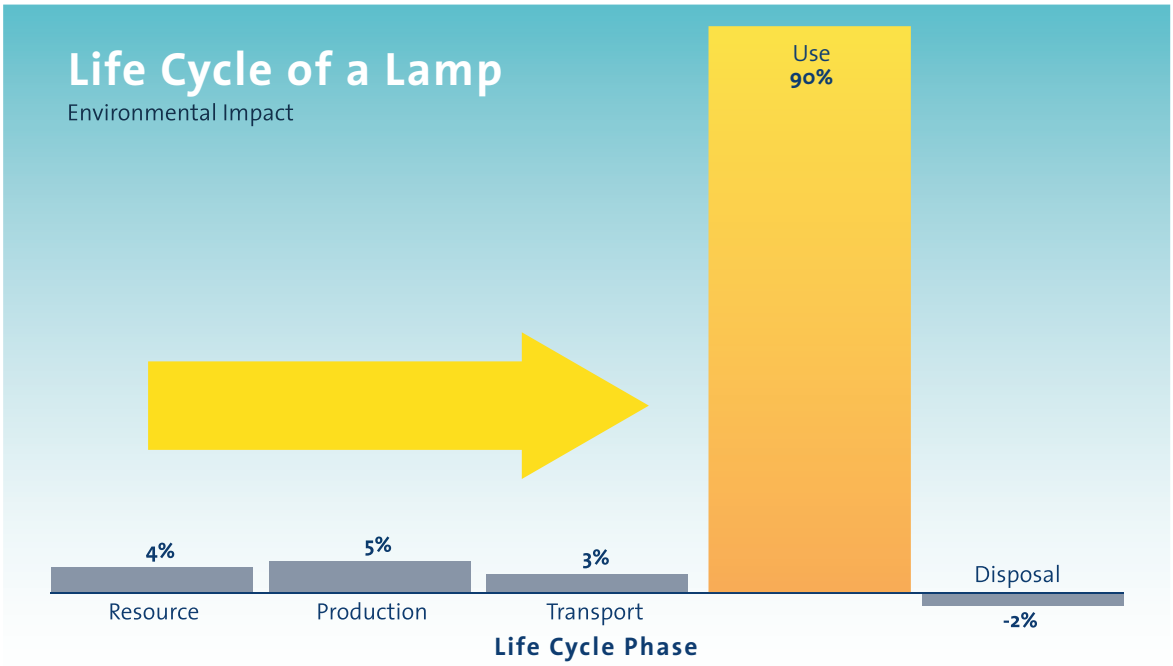
The energy profiles in this document give the performance details for three specific professional lamp families. They are:

- HID lamps for street lighting
- Linear Fluorescent lamps for office lighting
- CFLni (compact fluorescent without integrated ballast) for office lighting

These lamps can be used primarily in street and office lighting and are the most energy efficient on the European market. The guide does not give profiles for the least efficient lamps although comparative information is given to demonstrate the savings potential.

Unlike other green procurement guides (and recent definitions given by the European Commission under the EUP Directive), that look at the environmental impact of products throughout their life–cycle, this guide focuses primarily on the energy consumption of lamps. **This is because lamps have the most energy-related environmental impact during their use phase, an impact that can reach amounts up 90% depending on the lamp type[12].**

For each product the efficacy is given. This describes light output in relation to power input and is expressed in lumen per Watt



[lm/W]. The higher the efficacy value, the more energy-efficient are lamps or lighting systems. *For example*, the efficacy of a domestic incandescent light bulb of 60W is 12 lm/W and of a Energy Saver of 11W is 55 lm/W. Hence the energy saver is almost 5 times more efficient than the incandescent bulb and can last up to 15 times longer depending on the lamp type. Further information about common lamp terms is provided in the annex.

For each lamp the minimum and optimal efficacy is given:

- The **minimum efficacy** gives the European lamp manufacturers' recommended minimum level of light output and efficiency.
- The **optimal efficacy** gives the figures for the best available technology (BAT) currently on the market. These lamps are considered the most optimal products in terms of light quality and energy efficiency.

[12] See ELC's 'Did you know ...about the potential energy savings of an energy efficient lamp?'

3. Energy profiles

3.1. High Intensity Discharge (HID) lamps for street lighting

About HID lamps

High-pressure discharge lamps produce a large quantity of light in a relatively small package. These lamps produce light by striking an electrical arc across tungsten electrode housed inside a specially designed tube. The tube is filled with both gas and metals. The gas helps the lamps to start and the metals then help to produce the light once they are heated to a point of evaporation. Like fluorescent lamps (also profiled in this guide), HID lamps must be operated by ballast controlling the lamp current, and they also need a starting device.

Types of HID lamps used in street lighting include: High Pressure Mercury, Low Pressure Sodium, High Pressure Sodium and Metal Halide.

High Pressure Mercury Lamps (which originally produced a bluish-green light), were introduced in the early sixties. Today, they are also available in a colour corrected whiter light version. They can however be replaced by the newer, more energy efficient high-pressure sodium and metal halide lamps.

HID lamps are available in a wide range of types and wattages from 35 to 3,500 Watt. Their efficacy ranges from 35 lm/W for high pressure mercury vapour lamps to 200 lm/W for low-pressure sodium lamps.

The energy profile of an HID lamp

The **minimum efficacy** specification for a HID lamp is:

Lamp Power	Efficacy (lm/W)
≤ 50 Watt	60
> 50 Watt	70

The **optimal efficacy** specification for a HID lamp *(recommended for new system)* is:

Component	Efficacy (lm/W)
Lamp	80

The following table also gives more detailed information for a range of HID lamps.

Lamp Technology	Lamp Efficacy (lm/W)	Service lifetime (hours)	Colour rendering (Ra)
Low Pressure Sodium	100 - 210	12.000 – 14000 [1]	NA
High Pressure Sodium	51 - 150	6.000 – 20.000 [1]	20 - 65
(Compact) Ceramic Metal Halide	80 - 120	6.000 - 16.000 [2]	75 - 95

[1]:80% Service lifetime
[2]:70% Service lifetime

3.2. Linear Fluorescent Lamps

About Linear Fluorescent Lamps

Linear Fluorescent Lamps are high efficiency low pressure discharge lamps with a fluorescent powder coating to transform the mercury UV radiation into visible light. There are two main families for office lighting:

- T8 with a tube diameter of 26mm
- T5 with a tube diameter of 16mm

They are also available are in different diameters such as T12 (38mm), T10 (32mm), T2 (7mm). T12 lamps are still used for general lighting purposes, mainly in old installations. Smaller lamp types such as T2 and T1 are used in special application areas for example for architectural and signage purposes.

Linear Fluorescent Lamps are available in a wide range of types and wattages from 14 to 80 Watt. Their efficacy ranges from: 45 lm/W for low wattage colour rendering, 54 lm/W for T8 Linear Fluorescent Lamps and up to 95 lm/W for T5 Linear Fluorescent Lamps in colour rendering <=840. Under optimal conditions this can increase up to 104 lm/W (for a T5-High Efficiency 35W lamp operated at 350C with HF-ballast).

T8 and T5 Linear Fluorescent Lamps with tri-phosphate coating (800-colour ranges) are typically used to replace standard halo-phosphate lamps (colour rendering 54 and lower) in offices. They can have a lifetime of up to 23,000 hours for normal T5 lamps (90% service lifetime at 12 hr switching cycle). Special long life lamps also exist where the life time is up to 68,000 hours with the same energy efficiency. Halo-phosphate lamps have a lifetime of only 6,000 hrs. All lamps with a colour rendering in the range 827-840 are also 20-30% more energy efficient compared to standard lamps with a colour rendering of <=54. Better energy saving can be achieved when the lamps are operated on an electronic HF-ballast, and when daylight controls and presence detectors are used.

Additionally, T8 and T5 3-band/triphospor lamps give at least 10% more light than a conventional Halo-phosphate lamp.

The Energy profile of a Linear Fluorescent Lamp

The typical **minimum efficacy** (colour rendering <=840) values (catalogue values) for T8 Linear Fluorescent lamps are:

Lamp Power	Efficacy (lm/W)
Up to 15W	60
> 15 to 18W	70
>18 W to 30W	75
36W and higher	85

Lamps with colour a rendering between 850 and 865 will have a lower minimum efficacy of 5 lm/W less.

The typical **minimum efficacy** values (catalogue value) for a T5 Linear Fluorescent lamp are:

Lamp Power	Efficacy HE lamps (lm/W)	Lamp power	Efficacy HO lamps (lm/W)
14W	85	24W	70
21-28W	90	39W	75
35W	95	49W	85
		54W	80
		80W	75

Lamps with colour rendering between 850 and 865 will have a lower minimum efficacy of 5 lm/W less.

High Output (HO) lamps look less energy efficient compared to High Efficiency (HE)E-lamps however given the specific applications mainly in up-lighting they enable the most energy efficient lighting (luminaire) solution on the market.

The **optimal efficacy**[13] specification for Linear Fluorescent lamps *(recommended for new system),* is gained by using all lamp types with a higher efficacy as mentioned in the minimum efficacy tables.

[13] *It is recommended that due to their higher efficacy for new installations only lamps of type T5 (ffl 14W) should be used*

3.3 Compact Fluorescent (non integrated) Lamps (CFLni)

About Compact Fluorescent (non integrated) Lamps (CFLni) for office lighting

Compact Fluorescent Lamps (also known as an energy saving lamps) are high energy-efficient, low-pressure discharge lamps with a fluorescent phosphor coating to transform the mercury UV radiation into visible light. In contrast to integrated Compact Fluorescent lamps which combine a bulb and an electronic ballast and which is a retrofit solution to an incandescent lamp, non-integrated Compact Fluorescent lamps need specific pin based fittings and a separate control gear. This is because high quality ballasts last longer than the lamps and can provide more energy savings due to control options such as dimming, daylight control and presence detection. Non-integrated CFLs are more popular for professional users, such as offices and public buildings.

There are different main families of compact fluorescent lamps with plug-in 2 pin base or 4 pin base:

- Small single parallel tube, lamp cap G23 (2 pin) or 2G7 (4pin)
- Double parallel tubes, lamp cap G24d (2 pin) or G24q (4 pin)
- Triple parallel tubes, lamp cap GX24d (2 pin) or GX24q (4 pin)
- Four parallel tubes, lamp cap GX24q (4 pin)
- Long single parallel tube, lamp cap 2G11 (4 pin)
- 4 legs in one plane, lamp cap 2G10 (4 pin)
- Single flat plane tube, lamp cap GR8 (2 pin), GR10q (4 pin) or GRY10q3 (4 pin)
- Four or three parallel T5 tubes, lamp cap 2G8 (4 pin)

CFLs are typically used to replace standard incandescent lamps or to use fluorescent light in a compact form. They can have a service life time of up to 6,000 hours depending on the lamp type (incandescent bulbs last on average for 1000 hours). They use up to five times less electricity. For example, a 20 watt CFL produces the same amount of light as a 100-watt incandescent bulb.

The Energy profile of a Linear Fluorescent Lamp

The typical **minimum efficacy** values for CFLni lamps are shown in detail overleaf (a number of different lamp types exist in this range). In this range only 800-colour lamps are put on the market in contrast to linear fluorescent lamps where there are also lamps with a lower colour rendering (54 and lower).

There are also specific lamp types for special applications, such as **amalgam lamps**. These lamps maintain an optimal light output over a much broader **temperature** range. However in most documentation the value of 25 degress centigade is generally presented due to agreements in standardisation. Therefore these lamp types have a lower value in the catalogue because it is decided to publish the 250C value. However in the luminaire they provide 25% more light output than the conventional CFL-NI lamps.

Additionally the range CFLni offers long life products where the lifetime is doubled.

The minimum efficacy values for CFLni lamps

ANNEX 1 - Minimum Lumen per Watt values for non Ballasted Single Capped Compact Fluorescent Lamps (according IEC/EN 60901)

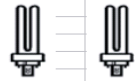
Based on 100h Minimum Value IEC 60901 (90% of 100h initial)

Type	Small single parallel tube, lamp cap G23 (2 pin) or 2G7 (4pin)						
Wattage	**5**	**7**	**9**	**11**			
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**250**	**400**	**600**	**900**			
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**225**	**360**	**540**	**810**			
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**45**	**51**	**60**	**74**			
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**41**	**46**	**54**	**66**			

Cap G23 (2pin) or 2G7 (4pin)
Small single parallel tube

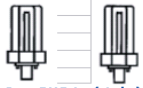
Type	Double parallel tubes, lamp cap G24d (2 pin) or G24q (4 pin)						
Wattage	**10**	**13**	**18**	**26**			
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**600**	**900**	**1200**	**1710**			
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**540**	**810**	**1080**	**1540**			
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**54**	**62**	**60**	**59**			
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**49**	**56**	**54**	**53**			

Cap G24d (2pin) or G24q (4pin)
Double parallel tubes



Type	Triple parallel tubes, lamp cap GX24d (2 pin) or GX24q (4 pin)						
Wattage	**13**	**18**	**26**	**32**	**42**	**57**	**70**
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**900**	**1200**	**1710**	**2400**	**3200**	**4300**	**5200**
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**810**	**1080**	**1540**	**2160**	**2880**	**3870**	**4680**
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**62**	**60**	**59**	**68**	**69**	**68**	**67**
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**56**	**54**	**53**	**61**	**62**	**61**	**60**

Cap GX24d (2pin) or GX24q (4pin)
Triple parallel tubes



Type	Four parallel tubes, lamp cap GX24q (4 pin)	
Wattage	**57**	**70**
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**4300**	**5200**
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**3870**	**4680**
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**68**	**67**
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**61**	**60**

Cap GX24q (4pin)
Four parallel tubes

Type	Long single parallel tube, lamp cap 2G11 (4 pin)					
Wattage	**18**	**24**	**36**	**40**	**55**	**80**
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**1200**	**1800**	**2900**	**3300**	**4500**	**6000**
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**1080**	**1620**	**2610**	**2970**	**4050**	**5400**
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**60**	**68**	**73**	**74**	**74**	**68**
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**54**	**61**	**65**	**67**	**66**	**61**

Cap 2G11 (4pin)
Long single parallel tube

Type	4 legs in one plane, lamp cap 2G10 (4 pin)		
Wattage	**18**	**24**	**36**
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**1100**	**1700**	**2800**
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**990**	**1540**	**2520**
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**55**	**64**	**70**
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**50**	**58**	**63**

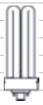
Cap 2G10 (4pin)
4 legs in one plane

Type	Single flat plane tube, lamp cap GR8 (2 pin), GR10q (4 pin) or GRY10q3 (4 pin)					
Wattage	**10**	**16**	**21**	**28**	**38**	**55**
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**650**	**1050**	**1350**	**2050**	**2700**	**?**
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**585**	**945**	**1215**	**1845**	**2430**	**?**
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**59**	**59**	**58**	**66**	**64**	**?**
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**53**	**53**	**52**	**59**	**58**	**?**

Cap GR8 (2 pin), GR10q (4pin) or G
Single flat bent tube

Type	Four or three parallel T5 tubes, lamp cap 2G8 (4 pin)			
Wattage	**60**	**82**	**85**	**120**
nominal light output (lm) for Tc < 5000K (e.g. 827, 830, 835, 840)	**4000**	**6150**	**6000**	**9000**
nominal light output (lm) for Tc ≥ 5000K (e.g. 850, 865)	**3600**	**5535**	**5400**	**8100**
minimum efficacy (lm/W) for Tc < 5000K (e.g. 827, 830, 835, 840)	**60**	**68**	**64**	**68**
minimum efficacy (lm/W) for Tc ≥ 5000K (e.g. 850, 865)	**54**	**61**	**57**	**61**

Cap 2G8 (4pin)
Four or three parallel T5



Remark:

For special applications like lamp operation at low (outdoor) resp. high (hot fixtures) ambient temperatures, lamp manufactures have optimized their lamps for maximizing lumen output under these special conditions. These lamps don't fulfill the data mentioned above at 25 °C, but at an ambient temperature for that the lamp design has been optimized.

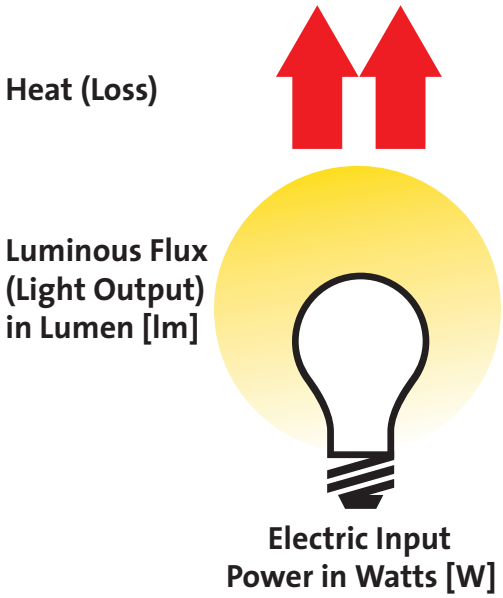
Therefore these lamps have an optimized efficiency in a special temperature range. It is recommended that manufacturers indicate lamps for special applications on the packing. (t.b.d.)

Annex 1 - The language of lamps

The definitions below help explain some common lamp terms in more detail.

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 typically used to rate the output of lamps. For example:

- The flame of a candle generates about 12 lumen.
- A standard 60W incandescent lamp is rated at 720 lumen.
- A compact fluorescent lamp 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 are lamps or lighting systems. *For example*, the efficacy of a incandescent light bulb of 60W is 12 lm/W and of a Energy Saver 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 x 100W = 1000Wh or 1 kWh). The amount of electricity used for lighting is generally based on energy consumption per year (kWh per year).

Light Quality (Ra)
Unlike natural daylight discharge lamps may not display all the colours of the visible spectrum. The ability of lamps to render colours faithfully is measured on the R_a 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 to see well through colour contrast.

Service lifetime
This is the operating time after which the installation luminous flux (the product of the relative luminous flux and the lamps still in operation) is still around 70% (sometimes 80%). This term is not applicable to street lighting or emergency lighting and similar installations where the light beams do not cross each other and where any fail of a single light source will crucial lower the quality of lighting installation (e. g. uniformity of street surface luminance).

For more information please consult our website www.elcfed.org.

EUROPEAN LAMP COMPANIES FEDERATION

CONTACT US

Secretary-General
ELC Federation asbl/vzw
Diamant Building
Boulevard Reyers 80
B-1030 Bruxelles
Belgium
Info@elcfed.org
Tel: +32 (0)2 706 86 08
Fax: +32 (0)2 706 86 09
www.elcfed.org

Aura Light AB
www.auralightgroup.com

BLV Licht- und Vakuumtechnik GmbH
www.blv-licht.de

G.E. Lighting Europe Ltd
www.gelighting.com

Leuci SpA
www.leuci.com

NARVA Lichtquellen GmbH
www.narva-bel.de

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www.osram.com

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