



IRISH GPP  
CRITERIA:

**INDOOR AND  
OUTDOOR LIGHTING**

# IRISH GPP CRITERIA: INDOOR AND OUTDOOR LIGHTING



This document sets out the proposed core and comprehensive Green Public Procurement (GPP) criteria for the purchase of indoor and outdoor lighting systems by Irish public bodies. The criteria cover the procurement of:

- Lighting audits (a professional service to assess lighting needs and assist in drafting specifications)
- Lighting units
- Lighting controls
- Road lighting
- Traffic signals

Lighting units and lighting controls are included in the SEAI Triple E Register, meaning that it is a requirement under Irish law<sup>1</sup> that public bodies only purchase products which meet the Triple E Register criteria (which are incorporated in these GPP criteria). The Triple E Register refers to products that are specifically designed to provide high efficiency interior or exterior illumination). In addition, under the Energy Efficiency Directive public bodies should only purchase lighting products in the highest energy efficiency class, provided this is compatible with sufficient competition.<sup>2</sup>

The criteria are divided into core and comprehensive versions. The core criteria are expected to have minimal effect on costs or verification effort. The comprehensive criteria go beyond the core requirements to target enhanced environmental performance and may imply some additional costs or verification effort.

The criteria have been developed based on the *EU GPP Criteria for road lighting and traffic signals*, the *SEAI Triple E Register criteria*, relevant Irish and European legislation and a consultation with Irish public bodies and sectoral experts. Further context for the development of the criteria, and

advice on how they can be applied and verified within tender procedures, is given in the accompanying EPA guidance document.

For lighting, the pre-tender activities of **needs assessment** and **market engagement** are particularly important. This is to ensure specifications adequately reflect your lighting requirements and the current state-of-the-art (including energy efficiency), which changes quickly for lighting. The needs identified and market offerings will inform the choice of contract type – audit, design, installation and maintenance may be combined in a single contract or these may be separated into one or more contracts. In some cases, lighting will form part of a larger construction or retrofitting contract. It may also form part of an **energy performance contract**. Further information on how to carry out needs assessment and market engagement is available in the main EPA guidance document and the *EU GPP Toolkit*.

The design and efficiency levels of lighting will determine **life-cycle costs** (LCC) of installations, which can vary considerably depending on the choices made in your tender. Information on LCC for this product group, including links to dedicated tools, is included in the *Life-cycle costing section*.

<sup>1</sup> Under S.I. No. *151/2011* and S.I. No. *426/2014* as amended by S.I. No. *646/2016*. To ensure adequate competition, there is an exception to the requirement to purchase items meeting these criteria where, in the opinion of the public body concerned, there is, or is likely to be, an insufficient amount of equipment which meets the criteria.

<sup>2</sup> Article 6 and Annex III of Directive 2012/27/EU, as implemented by S.I. No. 426/2014 and amended by S.I. No. 646/2016.

## WHAT DO THE CRITERIA COVER?

The following table summarises the core and comprehensive GPP criteria for Lighting. A merged cell indicates the same criteria apply at both levels.

### PROCUREMENT OF LIGHTING WITH REDUCED ENVIRONMENTAL IMPACT

TOPIC	CORE GPP CRITERIA	COMPREHENSIVE GPP CRITERIA
A. LIGHTING AUDIT SERVICES	SC1. Competencies of service provider	
	TS1. Audit of existing lighting assets	
B. LIGHTING UNITS	TS1. CE marking, Ecodesign and Energy Label	
	TS2. Minimum power factor	
	TS3. Photometric data	
	TS4. Minimum efficacy	
	TS5. Additional requirements for LEDs and LED lamps	
	AC1. Life-cycle costs	
	C. LIGHTING CONTROLS	TS1. CE marking, Ecodesign and Energy Label
TS2. Dimming controls		
TS3. Time, daylight and occupancy controllers		
TS4. Central control units		
TS5. Complete control systems		
AC1. Extended warranty		
D. ROAD LIGHTING	SC1. Competencies of the design team	
	SC2. Competencies of the installation team	
	TS1. Luminaire efficacy	TS1. Luminaire efficacy
	TS2. Dimming control compatibility	TS2. Dimming control compatibility

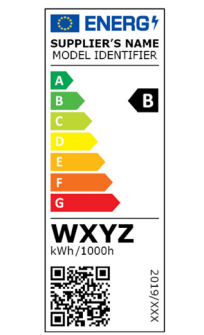

TOPIC	CORE GPP CRITERIA	COMPREHENSIVE GPP CRITERIA
	TS3. Minimum dimming performance	TS3. Minimum dimming performance
	TS4. Annual Energy Consumption Indicator (AECI)	
	TS5. Metering	TS5. Metering
	TS6. Power factor – LED luminaires	TS6. Power factor – LED luminaires
	TS7. Ratio of Upward Light Output (RULO) and obtrusive	TS7. Ratio of Upward Light Output (RULO) and obtrusive
	TS8. Annoyance	
	TS9. Ecological light pollution and star visibility	TS9. Ecological light pollution and star visibility
	TS10. Provision of instructions	
	TS11. Waste recovery	
	TS12. Reparability	
	TS13. Ingress protection (IP) rating	
	TS14. Product lifetime, spare parts and warranty	TS14. Product lifetime, spare parts and warranty
	TS15. Failure rate of control gear	TS15. Failure rate of control gear
	TS16. Labelling of LED luminaires	
	AC1. Life-cycle costs	
	AC2. Extended warranty	
	CPC1. Dimming control	
	CPC2. Commissioning and correct operation of lighting controls	
	CPC3. Compliance of actual energy efficiency and lighting levels with design claims	
	CPC4. Waste recovery and transport to suitable sites	
<b>E. TRAFFIC SIGNALS</b>	TS1. Product lifetime, spare parts and warranty	TS1. Product lifetime, spare parts and warranty
	AC1. Life-cycle costs	
	AC2. Extended warranty	

## IRISH GPP CRITERIA - HOW TO READ THE TEMPLATE

<b>Scope</b>	Defines the products and services to which the criteria apply.
<b>Exclusions</b>	Identifies any related products or services which are not covered by the criteria.
<b>References</b>	The primary sources consulted to develop the Irish GPP criteria.
<b>Eco-labels</b>	Type I eco-labels and other labels which address relevant environmental characteristics of the products or services and may be used either to define GPP criteria, verify compliance or both. Labels with equivalent criteria must also be accepted.
<b>Legislation and Standards</b>	Relevant EU and Irish legislation which applies within the sector and International, European or Irish standards which may be referenced in technical specifications (accompanied by the words 'or equivalent').
<b>Notes</b>	Practical tips and advice on applying the criteria, and explanations of the environmental impacts being addressed.
<b>Core Criteria</b>	Criteria which can be applied by any Irish public body and which are expected to have minimal effect on costs or verification effort.
<b>Comprehensive Criteria</b>	Criteria which go beyond the core requirements to target enhanced environmental performance and may imply some additional costs or verification effort.
<b>Selection Criteria</b>	Criteria which operators must meet in order to be eligible for tender submission (in a two-stage procedure) or award (in an open procedure).
<b>Specification</b>	Minimum requirements which all tenders must meet. Where multiple specifications are included in the criteria, these may be used together (recommended) or separately.
<b>Specification - Variant</b>	An optional alternative to the specification, which allows alternative solutions to be considered.
<b>Award Criteria</b>	Criteria which target environmental performance beyond the minimum requirements of the specification. These may be qualitative or quantitative in nature and must be weighted for evaluation. It is up to the contracting authority to determine an appropriate weighting based on its priorities and the totality of criteria which it is applying in a specific tender.
<b>Contract Management</b>	Clauses which can be inserted into contracts in order to manage environmental aspects and promote progressive improvements in delivery.

SCOPE, REFERENCES, LEGISLATION AND CERTIFICATIONS/LABELS	
<b>IN SCOPE</b>	<ul style="list-style-type: none"> <li>• New installations of indoor or outdoor lighting.</li> <li>• Replacement of light sources or luminaires on a like-for-like basis in existing lighting installations.</li> <li>• Retrofitting of different luminaires to existing lighting installations.</li> <li>• Retrofitting of different light sources or controls to existing luminaires.</li> <li>• Traffic signals: Red, yellow and green signal lights for road traffic with 200mm and 300mm roundels, in line with standard EN 12368.</li> </ul>
<b>NOT IN SCOPE</b>	<ul style="list-style-type: none"> <li>• Luminaires for emergency lighting.</li> <li>• Portable signal lights.</li> <li>• Military, marine lighting and other types not subject to Ecodesign regulations.</li> </ul>
<b>LEGISLATION AND STANDARDS</b>	<ul style="list-style-type: none"> <li>• <i>S.I. 151/2011 European Union (Energy Efficient Public Procurement) Regulations 2011</i></li> <li>• <i>S.I. 366 of 2011 European Union (Energy Labelling) Regulations, as amended by S.I. 351 of 2014</i></li> <li>• <i>S.I. 454 of 2013 European Union (Ecodesign Requirements for certain energy related products) Regulations, amended by S.I. 228 of 2016</i></li> <li>• S.I. No. 426/2014 - <i>European Union (Energy Efficiency) Regulations 2014, as amended by S.I. No. 646/2016</i></li> <li>• Regulation (EU) 2017/1369 <i>setting a framework for energy labelling</i></li> <li>• Directive 2009/125/EC <i>establishing a framework for the setting of ecodesign requirements for energy-related products</i></li> <li>• Directive 2012/27/EU <i>on energy efficiency</i>, as amended by Directive <i>2018/2002</i></li> <li>• Regulation (EU) No 2019/2015 <i>on energy labelling of light sources</i> (taking effect from 1.9.2021)</li> <li>• Regulation (EU) No 2019/2020 <i>on ecodesign requirements for light sources and separate control gears</i> (taking effect from 1.9.2021)</li> <li>• Commission Regulation (EU) 2021/341 (<i>Ecodesign Omnibus Regulation</i>) amending various Ecodesign regulations</li> <li>• Commission Regulation 2021/340 (<i>Energy Label Omnibus Regulation</i>) amending various Energy Labelling regulations</li> <li>• Directive 2011/65/EU on the Restrictions of Hazardous Substances in Electrical and Electronic Equipment</li> <li>• <i>Directive 2012/19/EU on waste electrical and electronic equipment</i> (WEEE Directive)</li> <li>• EN 12464 (Lighting of Indoor Workplaces)</li> <li>• EN 13201 (Road Lighting)</li> <li>• EN 12368 (Traffic Signals)</li> <li>• IEC 60598-1 (Luminaires: General Requirements and Tests)</li> <li>• IES LM-84 (Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaires)</li> <li>• IES TM-28 (Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaires)</li> </ul>

IRISH GPP CRITERIA: OFFICE BUILDING DESIGN, CONSTRUCTION AND FACILITIES MANAGEMENT

<p><b>ECOLABELS</b></p>	<p>The <b>EU Energy Label</b> must be affixed to lighting products sold in the EU and shows the energy efficiency class. Until 1 September 2021, the energy classes range from A++ (the most efficient) to E (the least efficient). After this date, the rules under Regulation (EU) No 874/2012 will be repealed and replaced by new energy labelling requirements for light sources under Regulation (EU) 2019/2015. Using a scale from A (most efficient) to G (least efficient), the new labels will give information on the energy consumption, expressed in kWh per 1000 hours and have a QR-code that links to more information in an online database.</p>  <p>The <b>ENEC+ marking</b> for electrical products demonstrates compliance with European standards (EN).</p> 
<p><b>REFERENCE DOCUMENTS</b></p>	<ol style="list-style-type: none"> <li>1. European Commission Joint Research Centre (2018) <i>EU GPP Criteria for Road lighting and Traffic Signals, Technical Background Report and Procurement Guidance Slides</i></li> <li>2. Sustainable Energy Authority of Ireland (various dates) Triple E Register Criteria for <i>Lighting Units</i> and <i>Lighting Controls, Lighting Upgrade Tool, Lighting Upgrade Calculation Workbook, Lighting Replacement Calculation Workbook</i> and <i>Tubular Fluorescent Lighting and Controls Evaluation Tool</i></li> <li>3. Institution of Lighting Professionals (various dates) <i>Guidance Notes and Reports on Lighting Design and Installation</i></li> <li>4. Premium Light Pro Project (2017) <i>Indoor Lighting in the Public and Private Service Sectors</i></li> <li>5. Enigma Project (2014) <i>Report: State-of-the-Art in Urban Public Lighting</i></li> <li>6. SPP Regions Project (2018) <i>Model Tenders for Lighting</i></li> <li>7. Reports from the <i>French Association Nationale pour la Protection du Ciel et de l'Environnement Nocturne</i></li> </ol>
<p><b>NOTES</b></p>	<p>Ecodesign rules are mandatory for almost all light sources sold in the EU. These regulations set minimum energy efficiency requirements and other criteria such as bulb lifetime and warm-up time. Further information is available on the <i>Ecodesign Website</i>. The criteria for Road Lighting and Traffic Signals are aligned with the scope of standards EN 13201 and EN 12368 respectively.</p>

## HOW CAN THE CRITERIA BE APPLIED AND VERIFIED?

Information about how each of the criteria can be verified is included. **The verification methods form an essential part of the criteria and must be included in tender documents to ensure that suppliers are aware of how compliance with the criteria will be assessed.** The forms of verification referred to in the criteria include:

- The product **Certificate of Conformity or Product Information Sheet**;
- A valid **Energy Label** and evidence of the product's registration on the EPREL database;
- Where the criteria are based on the **SEAI Triple E Register** criteria, inclusion of a specific product on this Register can verify compliance. Alternatively, technical documentation and/or test results which demonstrate compliance with the criteria should be accepted;
- Provision of **test results** based on the specified EN standards for each product type EN 12464/EN 13201/EN 12368, or equivalent standards;
- Provision of a relevant **Type 1 Ecolabel** which addresses the specific criteria, e.g. the EU Ecolabel;
- **Shipping information** for equipment intended for re-use, in accordance with Annex VI of WEEE Directive 2012/19/EU. For WEEE exported to be treated outside the EU, a **third-party certificate of compliance** with the minimum WEEE requirements, or with the technical requirements of EN 50625-1 or an equivalent compliance scheme.

There should be a clear link between all supporting documentation supplied and the product being submitted. This will typically take the form of a product code or product name that can be cross referenced between the submitted product and relevant supporting documentation. If product codes/names have been changed since publication of the supporting documentation, then a record of this must be provided with the supporting documentation supplied. Any deviation from these requirements should result in the supporting documentation not being considered adequate for the purposes of demonstrating compliance with the criteria.

### Test Reports

A test report must include the following elements: An outline of the complete test including introduction, details on test conditions and standards, the specific model details of the product tested, the steps taken in the test, the results, graphical representations, and a conclusion. All documents should be on headed paper and the document should be officially signed off. All documentation must be in English or include an adequate translation.

### Certification

If certificates are provided, tests must be carried out by an organisation accredited by a national accreditation body recognised via the European Cooperation for Accreditation or the International Accreditation Forum. All documentation must be in English or include an adequate translation.

### Equivalence

Some criteria conditions allow for scientifically equivalent tests and/or standards to be used. In the event that a product has not been designed, manufactured or tested to the specific standard named, then documentation relating to an equivalent internationally recognised standard may be used. In such cases, the onus is on the tenderer to demonstrate satisfactory equivalence of the standards.



According to Article 44(2) of Directive 2014/24/EU, other appropriate means of proof may be accepted where the bidder concerned had no access to test reports, ecolabels, certificates etc. or no possibility of obtaining them within the relevant time limits for reasons which are not attributable to the economic operator. This could include, for example, a technical dossier from the manufacturer. In this case, the bidder must prove that the works, supplies or services it provided meet the requirements or criteria set out in the technical specifications, the award criteria or the contract performance conditions.

Some simple market research in advance of tendering should be sufficient to confirm that suppliers, products and services are available which meet the criteria and verification requirements. Further information on techniques for market engagement linked to GPP, including legal and practical considerations, is available in the EPA guidance document and in *Module 6 of the GPP Training Toolkit*.

## KEY ENVIRONMENTAL IMPACTS – LIGHTING

### KEY ENVIRONMENTAL IMPACTS

- CO<sub>2</sub> and other greenhouse gas emissions as a result of electricity consumption in the use of road lighting.
- Emission of acidifying gases as a result of electricity consumption in the use of road lighting.
- Loss of star visibility caused by upward light output from unshielded luminaires and reflection from the ground.
- Disruption of nocturnal species' behaviour with potential adverse effects on biodiversity, especially with blue light.
- Poor resource efficiency in cases where products or components need to be replaced before the end of their stated lifetime due to, for instance use of lower quality (and cheaper) LED chips and difficulties with repair or to poor installation.



### GPP APPROACH

- Procure luminaires, lamps or light sources that exceed minimum luminaire efficacies.
- Encourage the use of dimming and metering to ensure that energy consumption of a particular lighting installation can be optimised and monitored in real time.
- Require that all luminaires have 0.0% upward light output ratio and, at comprehensive level, to ensure that 97% of all light falls within a downward angle of 75.5° to the vertical for the reduction of obtrusive light and glare.
- Encourage obligatory dimming in areas of concern and to set limits on the proportion of blue light (G-index) in lamp/luminaire output.
- Procure durable and fit-for-use road lighting equipment that is repairable and covered by a warranty or extended warranty.
- Set minimum requirements for the person responsible for signing off the lighting installation.

*Please note that the order of environmental impacts above does not necessarily correspond to their importance.*

## DEFINITION OF TERMS USED IN THE GPP CRITERIA

- **Building luminaires:** high efficiency luminaires which are generally for internal use but may also include flood lights and exterior amenity lanterns. They can include both light emitting diode (LED) and non-LED luminaires according to the definition of each type given below.
- **Central control units:** manage the overall operation of artificial lighting installations that include some or all of the categories of lighting controls above.
- **Complete control systems:** complete control systems consisting of, but not limited to, a central controller, communication network, software interface, field devices and interfaces. Central Management Systems for use on exterior lighting fall into this category.
- **Daylight controllers and sensors:** monitor daylight availability, and automatically switch off lighting or dim it down to the level needed to sufficiently illuminate the area.
- **Lamp:** a unit whose performance can be assessed independently and which consists of one or more light sources. It may include additional components necessary for starting, power supply or stable operation of the unit or for distributing, filtering or transforming the optical radiation, in cases where those components cannot be removed without permanently damaging the unit.
- **Light emitting diode (LED) lamps:** Solid state lighting devices consisting of a lamp with LEDs, integrated LED driver and lamp base suitable for existing light fittings.
- **Light source:** a surface or object designed to emit mainly visible optical radiation produced by a transformation of energy. The term 'visible' refers to a wavelength of 380 - 780 nm.
- **Luminaire:** an apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply (EN 12665:2011).
- **Luminaire efficacy:** ratio between luminous flux output from the luminaire (in lumens) and power consumption (in Watts)
- **Occupancy controllers and sensors:** monitor occupancy or movement of personnel, and automatically switch off, or dim down, lighting when the area is unoccupied.
- **Road lighting:** fixed lighting installations 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.
- **Street-lighting luminaires:** high efficiency lanterns designed specifically for illuminating roads and car parks. They can include both light emitting diode (LED) and non-LED luminaires.
- **Time controllers:** automatically switch off lighting, or dim it down, at predetermined times.
- **Traffic signals:** Red, yellow and green signal lights for road traffic with 200mm and 300mm roundels, in line with standard EN 12368. Portable signal lights are specifically excluded.

## GPP CRITERIA FOR LIGHTING

### A LIGHTING AUDIT SERVICES

This section relates to the assessment and auditing of existing lighting assets and performance and the provision of expert advice on the upgrade or replacement of lighting. The criteria are designed to be applied in standalone contracts for these services, however it is also possible to combine audits with design, supply, installation and maintenance of lighting, for example as part of an energy performance contract.

**NOTE:** A merged cell for the core and comprehensive criteria indicates that the same criteria apply

CORE CRITERIA	COMPREHENSIVE CRITERIA
<b>SELECTION CRITERIA</b>	
<p>SC1. <b>Competencies of service provider</b></p> <p>Evidence of technical and professional ability and prior experience in carrying out lighting audits in a similar setting must be provided. This should include details of the personnel involved, their qualifications and experience, software and equipment used.</p> <p><b>Verification:</b> A list of similar contracts carried out within the previous three years, together with contact details for referees from these projects, must be provided. A sample of a lighting audit report should also be provided.</p>	
<b>TECHNICAL SPECIFICATIONS</b>	
<p>TS1. <b>Audit of existing lighting assets</b></p> <p>The currently installed lighting assets identified by the authority within a defined area must be assessed for the following aspects <i>[additional/different points may be included]</i>:</p> <ul style="list-style-type: none"> <li>• mapping of light points and assignment of unique light point ID numbers (if not already done)</li> <li>• luminaire model, efficacy, ratio of upward light output and year of installation (where information is available)</li> <li>• lamp technology, rated power, correlated colour temperature (CCT) and year of installation</li> <li>• presence/absence of dimming controls</li> <li>• column or network pole condition</li> <li>• existence of legacy cable issues</li> <li>• whether the installation complies with a standard, or remedial works are required</li> <li>• any existing complaints from residents regarding nuisance light</li> </ul>	

CORE CRITERIA	COMPREHENSIVE CRITERIA
<b>TECHNICAL SPECIFICATIONS</b>	
<p>TS1. <b>Audit of existing lighting assets</b> (continued)</p> <p>The entire lighting network must be split into sub-areas (if not already previously done by the authority) and each sub-area must be assessed to determine lighting recommendations and whether specific metering of lighting electricity consumption is in place. A report must be produced clearly identifying:</p> <ul style="list-style-type: none"> <li>• The assessed lighting needs</li> <li>• The potential for energy and cost savings</li> <li>• The state-of-the-art for available lighting solutions to meet the assessed needs</li> <li>• Recommendations for the design and specification of the lighting installation</li> </ul> <p><b>Verification:</b> Tenderers must indicate their proposed methodology for completing the above detailed tasks, together with the personnel who will be responsible and timeline for completing the audit. Any specific data or access requirements to be provided by the authority, and any dependencies for delivering the report must be clearly identified. The software or other technical resources which will be used to complete the audit should be identified.</p>	

## **B** LIGHTING UNITS

CORE CRITERIA	COMPREHENSIVE CRITERIA
<b>TECHNICAL SPECIFICATIONS</b>	
<p>TS1. <b>CE marking, Ecodesign and Energy Label</b></p> <p>All equipment and/or components must be CE marked as required by the applicable EU directive(s) and/or regulations.<sup>3</sup> They must also comply with the applicable Ecodesign and EU Energy Labelling Regulations.<sup>4</sup> Where the product is subject to the European Standards covered by the ENEC mark, it must bear this marking or equivalent.<sup>5</sup></p> <p><b>Verification:</b> Tenderers must provide the product Declaration of Conformity and Energy Label confirming compliance with the above requirements. Evidence of the product's entry in the EPREL database should be provided.</p>	

<sup>3</sup> Further information on CE marking is available [here](#).

<sup>4</sup> For example, Regulation (EU) No 2019/2015 *on energy labelling of light sources* and Regulation (EU) No 2019/2020 *on ecodesign requirements for light sources and separate control gears*

<sup>5</sup> See [this page](#) for information on the scope of the ENEC mark.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS2. Minimum power factor**

All lighting units must have a minimum power factor of 0.7 at all levels of product light output.

**Verification:** Technical documentation must be provided demonstrating compliance with this requirement. Products which are included on the *Triple E Register* will be deemed to comply.

**TS3. Photometric data**

**3.1 Non-LED luminaires:** The photometric data of the luminaire must have been measured and tested in accordance with EN 13032-1&2 "Light and lighting – Measurement and presentation of photometric data of lamps and Luminaires" or scientific equivalent.

**3.2 For LED luminaires:** The photometric data of the luminaire or lamp must have been measured and tested in accordance with IES LM-79-08 "Electrical and photometric measurements of Solid-State lighting products" or EN 13032-1&2 "Light and lighting – Measurement and presentation of photometric data of lamps and Luminaires" or scientific equivalent.

**3.3 For LED lamps:** The photometric data of the luminaire or lamp must have been measured and tested in accordance with IES LM-79-08 "Electrical and photometric measurements of Solid-State lighting products" or scientific equivalent.

**Verification:** Products which are included on the *Triple E Register* will be deemed to comply. Alternatively, test reports must be provided demonstrating compliance with this requirement.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS4. Minimum efficacy**

**4.1 Luminaires** must meet the minimum efficacy requirements specified in Table 1. Linear and Compact Fluorescent and HID luminaires must have high frequency control gear incorporated into the fitting.

Luminaire type	Minimum efficacy (l I/cW)
<b>Building Luminaires</b>	
High-pressure sodium ≥250W per lamp*	80
High-pressure sodium <250W per lamp*	65
Metal halide*	65
Linear Fluorescent*	60
Compact Fluorescent*	55
Induction	55
LED 75	75
<b>Street-Lighting Luminaires</b>	
Street-lighting 80	80

\* Lamp rating

Table 1: Luminaires minimum efficacy

**For all luminaires the lI/cW calculation is:**

$$lI/cW = \text{Luminaire Lumens per circuit Watts} = \frac{\text{Total Lumen Output} \times \text{Light Output Ratio}}{\text{Ratio Circuit Power Drawn}}$$

**WHERE:** Total lumen output (Lumens) = the total light output of all the lamps in the fitting (measured in Lumens),

Light Output Ratio (LOR) = ULOR and DLOR values may be combined where the fitting is designed to provide direct and indirect lighting, otherwise only the LOR in the intended lighting direction may be used.

Circuit Power Drawn (Watts) = the electrical power drawn by the whole luminaire from main circuit connection point to lamp, including losses in the control gear (ballast).

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**

TS4. **Minimum efficacy** (continued)

**4.2 LED lamps** must meet the minimum efficacy requirements specified in Table 2.

LED lamp type	Minimum efficacy (l l/cW)
LED lamps excluding LED Tubes	60
LED tubes	90

Table 2: LEDs minimum efficacy

$$\text{l/cW} = \text{Lumens per circuit Watts} = \frac{\text{total lumen output}}{\text{circuit power drawn}}$$

**WHERE:** Total lumen output (Lumens)= the total light output of the lamp

Circuit Power Drawn (Watts) = the electrical power drawn by the whole lamp, including losses in the LED driver.

**Verification:** Products which are included on the *Triple E Register* will be deemed to comply. Alternatively, technical documentation and test reports must be provided demonstrating compliance with this requirement.

TS5. **Additional requirements for LEDs and LED lamps**

LEDs and LED lamps must have:

- a light output (in lumens) not less than 90% of initial\* light output after 6,000 hours of continuous operation
- A minimum lumen output of 250 lumens for the whole luminaire
- A colour rendering index not less than:
  - Ra80 for Building Luminaires and Lamps
  - Ra65 for Street lighting Luminaires
- A rated Correlated Colour Temperature between 2500 and 6500K

\*Initial light output is measured after 100 hours operation

**Verification:** Products which are included on the *Triple E Register* will be deemed to comply. Alternatively, technical documentation and test reports must be provided demonstrating compliance with this requirement.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**AWARD CRITERIA**
**AC1. Life-cycle costs**

The cost of each valid and responsive tender will be evaluated on the basis of total life-cycle costs (LCC). Tenderers are required to complete the spreadsheet included in the tender documents with the requested data regarding their products. This information will be used to calculate LCC and the tender with the lowest life-cycle cost will be awarded **[X]** marks, with other tenders being scored according to the following formula:

$$\text{Score Tender A} = \mathbf{[X]} * \frac{\text{Lowest LCC}}{\text{LCC}_{\text{TENDER A}}}$$

**Verification:** The completed spreadsheet must be submitted with the tender and where indicated, supporting documentation verifying the data must be provided. The data entered in the spreadsheet regarding costs, energy consumption, time to replacement and other parameters will become binding under the contract with the successful tenderer.

**NOTE:** Contracting authorities may choose to evaluate LCC using an existing template such as the *European Commission LCC Tools for Indoor and Outdoor Lighting*, or based on their own bespoke template. In either case, certain information such as the area to be lit, evaluation period, energy costs and cost of maintenance/replacement (if not included in the tender) will need to be completed by the contracting authority. See the *Life-cycle costing section* for further information.



## C LIGHTING CONTROLS

### CORE CRITERIA

### COMPREHENSIVE CRITERIA

#### TECHNICAL SPECIFICATIONS

##### TS1. **CE marking, Ecodesign and Energy Label**

All equipment and/or components must be CE marked as required by the applicable EU directive(s) and/or regulations.<sup>6</sup> They must also comply with the applicable Ecodesign and EU Energy Label Regulations.<sup>7</sup> Where the product is subject to the European Standards covered by the ENEC mark, it must bear this marking or equivalent.<sup>8</sup>

**Verification:** Tenderers must provide the product Declaration of Conformity and Energy Label confirming compliance with the above requirements. Evidence of the product's entry in the EPREL database should be provided.

##### TS2. **Dimming controls**

- Where automatic dimming controls are used, they must work by reducing the power consumption of the lamps.
- Where LED lighting or fluorescent lighting is being dimmed, the controls must be capable of reducing the power consumption of the controlled lamps by at least 80%.
- Where other forms of lighting are being dimmed, they must incorporate either mains frequency or high frequency control gear with dimmable ballasts.

**Verification:** Products which are included on the *Triple E Register* will be deemed to comply. Alternatively, technical documentation must be provided demonstrating compliance with this requirement.

##### TS3. **Time, daylight and occupancy controllers**

*[Include all which are relevant]*

**3.1 Time controllers:** The product must automatically switch the lighting off, or dim it down, at predetermined times, or after a predefined interval.

**3.2 Daylight controllers:** The product must monitor the availability of daylight and automatically switch the lighting off when sufficient daylight is available to illuminate the area irrespective of switching cycle mode. Controls that incorporate dimming must dim down the lighting to the level needed to sufficiently illuminate the area by a combination of daylight and electric light.

**3.3 Occupancy controllers:** The product must automatically switch off the lighting, or dim it down, after the area has become unoccupied.

**Verification:** Products which are included on the *Triple E Register* will be deemed to comply. Alternatively, technical documentation must be provided demonstrating compliance with this requirement.

<sup>6</sup> Further information on CE marking is available [here](#).

<sup>7</sup> For example, Regulation (EU) No 2019/2015 *on energy labelling of light sources* and Regulation (EU) No 2019/2020 *on ecodesign requirements for light sources and separate control gears*

<sup>8</sup> See [this page](#) for information on the scope of the ENEC mark.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS4. Central control units**

The product must be able to manage the overall operation of the artificial lighting installation that includes time controllers, daylight controllers, occupancy controllers or any combination of these.

**Verification:** Products which are included on the *Triple E Register* will be deemed to comply. Alternatively, technical documentation must be provided demonstrating compliance with this requirement.

**TS5. Complete control systems**

The following requirements apply for complete control systems:

- The system must be computer or microprocessor based, designed to control lighting with the aim of optimising energy use
- The system must automatically switch or dim the lighting in response to daylight levels, occupancy or pre-determined time settings
- The overall system must include a user interface
- Appropriate training must be provided to the end-user, such that the end user can operate the system in an energy efficient manner
- Appropriate operating and maintenance manuals must be available to the end-user to optimise the achievement of energy efficiency gains.
- The system must comprise a complete set of components which are designed to work together as efficiently as possible. All components for the working system are to be obtainable from the same supplier

**Verification:** Products which are included on the *Triple E Register* will be deemed to comply. Alternatively, technical documentation must be provided demonstrating compliance with this requirement.

**NOTES ON CRITERIA FOR COMPLETE CONTROL SYSTEMS:**

1. The criteria do not include modules which can be added to a lighting control system/product but which do not control or monitor lighting.
2. Products may incorporate the facility for local users to manually switch on and off lighting in a local area and thus to override the relevant lighting controls at any particular time. However, the above criteria do not include products that allow local users to locally override the ability of lighting controls to automatically switch off or dim down the lighting.
3. Products that are only capable of manual scene setting are not included in the criteria for central control systems.
4. The criteria do not apply to scene setting controls as used in meeting room and conference facilities.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**AWARD CRITERIA**
**AC1. Extended Warranty**

*[The minimum warranty term and scope should be specified based on prior market consultation for the control systems being purchased]*

A maximum of **[X]** points will be awarded to tenderers offering initial warranties that go beyond the minimum warranty periods stated in the specifications, which cover at least the same scope as the minimum required warranty, and whose cost is included in the bid price. The maximum number of marks will be awarded to the tenderer offering the longest initial warranty period, with other offers being scored proportionately according to the following formula:

$$\text{Score Tender A} = \mathbf{[X]} * \frac{\text{Warranty Period}_{\text{TENDER A}}}{\text{Longest Offered Warranty}}$$

**Verification:** Tenderers must provide a copy of the warranty terms together with a clear summary stating the scope of repair, replacement and other services included during the initial and extended warranty period.

## D ROAD LIGHTING

The below criteria are based on the EU GPP Criteria for Road Lighting. Certain elements of the criteria may be suitable for contracts for other types of outdoor lighting, for example parks, forecourts, car parks, recreation areas or other public facilities. Procurers should confirm whether specific technical standards apply to these types of lighting projects.

CORE CRITERIA	COMPREHENSIVE CRITERIA
SELECTION CRITERIA	
<p><b>SC1. Competencies of the design team</b>  <i>(Applies when lighting design is included in the scope of the tender)</i></p> <p>The tenderer must demonstrate that the design will be checked and approved by staff with the following minimum experience and qualifications:</p> <ul style="list-style-type: none"> <li>• At least three years' experience in lighting design, dimensioning of electrical circuits and electrical distribution network</li> <li>• Involvement in the design of at least three different outdoor lighting installations</li> <li>• A certified level of competency in the use of lighting design software for power density indicator (PDI) and annual energy consumption indicator (AECI) calculations (e.g. European Lighting Expert certificate)</li> <li>• Experience with the use of validated lighting calculation software (e.g. according to CIE 171, road surface reflectance tables or other relevant standards)</li> <li>• Suitable professional qualifications in lighting engineering/design or accredited membership of a professional body in the field of lighting design.<sup>9</sup></li> </ul> <p><b>Verification:</b> The tenderer must supply a list of the person(s) who will be responsible for the project should the tender be successful, indicating their educational and professional qualifications, relevant design experience and, if relevant, experience in using lighting design software. This should include persons employed by subcontractors if design work is to be subcontracted. The contracting authority, at its own discretion, may accept experience in less than three lighting installation designs if the scale of the design project(s) was sufficiently large and/or similar to the tender requirements.</p>	

<sup>9</sup> In Ireland, relevant professional bodies include the *Institution of Lighting Professionals* (ILP) and the *Society of Light and Lighting* (SLL).

## CORE CRITERIA

## COMPREHENSIVE CRITERIA

## SELECTION CRITERIA

**SC2. Competencies of the installation team**

(Applies when responsibility for installation is not assumed by the procuring authority's own maintenance staff.)

The tenderer must demonstrate that the installation works will be planned, checked and approved by personnel with the following minimum experience and qualifications:

- At least three years' relevant experience in the installation of outdoor lighting systems
- Involvement in at least three different installation projects. A list of relevant installed lighting systems indicating the scale of each project should be provided.
- A suitable professional qualification in electrical engineering and membership of a professional body relevant to the work they are undertaking (e.g. certified lighting technician).

**Verification:** The tenderer must supply a list of person(s) responsible for the installation works should the tender be successful, indicating their educational and professional qualifications, training logs and relevant installation experience in previous projects. This should include persons employed by subcontractors if installation work is to be subcontracted. The contracting authority, at its own discretion, may accept experience in less than three lighting installation works if the scale of the works was sufficiently large and/or similar to the tender requirements.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS1. Luminaire efficacy**

*(Applicable when light sources or luminaires are to be replaced in an existing lighting installation and no redesign is carried out. These ambition levels should not be applied when light sources are also requested to be rated with CCT ≤2700K.)*

The lighting equipment to be installed must have a luminaire efficacy higher than the relevant reference value stated below.

Year of ITT	Efficacy (lm/W)
2020-21	137
2022-23	155
2024-2025	

**Verification:** The tenderer must provide a standard photometric file that is compatible with common light planning software and that contains technical specifications on the light output and energy consumption of the luminaire, measured by using reliable, accurate, reproducible and state-of-the-art measurement methods. Methods must respect relevant international standards, where available.

**TS1. Luminaire efficacy**

*(Applicable when light sources or luminaires are to be replaced in an existing lighting installation and no redesign is carried out. These ambition levels should not be applied when light sources are also requested to be rated with CCT ≤2700K.)*

The lighting equipment to be installed must have a luminaire efficacy higher than the relevant reference value stated below.

Year of ITT	Efficacy (lm/W)
2020-21	147
2022-23	165
2024-2025	

**Verification:** The tenderer must provide a standard photometric file that is compatible with common light planning software and that contains technical specifications on the light output and energy consumption of the luminaire, measured by using reliable, accurate, reproducible and state-of-the-art measurement methods. Methods must respect relevant international standards, where available.

**TS2. Dimming control compatibility**

The lighting installation must be compatible with programmed dimming controls.

**Verification:** Tenderers must explain how the proposed lighting installation is compatible with programmed dimming. This explanation should include any relevant documentation from the manufacturer(s) of the light sources and luminaires proposed for use. In cases where controls are not integrated into the luminaire, the documentation should state what control interfaces can be used for dimming. The documentation must also state what dimming methods are compatible, for example:

- dimming based on pre-set period of expected low night-time road use intensity
- initial dimming of over-designed lighting installations to compensate for gradual decreases in lumen output
- variable dimming to maintain a target illuminance in variable weather conditions

CORE CRITERIA	COMPREHENSIVE CRITERIA
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>TS3. Minimum dimming performance</b>  <i>(Applicable to all calls for tender, unless it is clear that dimming controls would lead to a higher total cost of ownership. Procurers should clearly define the desired dimming performance in the ITT.)</i></p> <p>All light sources and luminaires must be installed with fully functional dimming controls that are programmable to set at least one pre-set level of dimming down to at least 50% of maximum light output.</p> <p><b>Verification:</b> Tenderers must provide documentation from the manufacturer(s) of the light sources and luminaires that are proposed for use by the tenderer, showing that they are compatible with dimming controls. The documentation must also state what dimming controls are incorporated, for example:</p> <ul style="list-style-type: none"> <li>• pre-set dimming, or</li> <li>• variable dimming based on weather conditions or traffic volume.</li> </ul> <p>The documentation must also clearly provide a power curve of light output versus power consumption, state the maximum dimming possible and provide instructions about how to program and re-program the controls.</p>	<p><b>TS3. Minimum dimming performance</b>  <i>(Applicable to all calls for tender, unless it is clear that dimming controls would lead to a higher total cost of ownership. Procurers should clearly define the desired dimming performance in the ITT.)</i></p> <p>All light sources and luminaires must be installed with fully functional dimming controls that are programmable to set at least two pre-set levels of dimming, down to at least 10% of maximum light output.</p> <p><b>Verification:</b> Tenderers must provide documentation from the manufacturer(s) of the light sources and luminaires that are proposed for use by the tenderer, showing that they are compatible with dimming controls. The documentation must also state what dimming controls are incorporated, for example:</p> <ul style="list-style-type: none"> <li>• pre-set dimming, or</li> <li>• variable dimming based on weather conditions or traffic volume.</li> </ul> <p>The documentation must also clearly provide a power curve of light output versus power consumption, state the maximum dimming possible and provide instructions about how to program and re-program the controls.</p>
<p><b>TS4. Annual Energy Consumption Indicator (AECI)</b>  <i>(Applicable when a new lighting installation is being designed or when a redesign is required due to the refurbishment of an existing lighting installation or the retrofitting of new luminaires. Procurers should pay particular attention to the numbers submitted for the maintenance factor and utilance from the designer/tenderer and make sure that they are realistic and justifiable.)</i></p> <p><b>(NB - PDI reference values are higher for comprehensive criteria – see Annex I)</b></p> <p>The procurer must provide technical drawings of the road layout, together with the areas to be lit and the illuminance/luminance requirements. For M-class roads, the procurer must define the surface reflectivity coefficient of the road, which tenderers should use in their luminance calculations.</p> <p>To aid tenderers in their assumptions for design maintenance factors, the procurer should define with what frequency the luminaires will be cleaned.</p>	

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS4. Annual Energy Consumption Indicator (AECI) (continued)**

For the average maintained illuminance/luminance defined by the procurer, the AECI of the design must comply with the equation below:

$$AECI_{\text{design}} \leq PDI_{\text{ref}} \times E_m \times F_D \times T \times 0.001$$

**WHERE:**

- PDI is the power density indicator, in units of W.lx-1.m-2
- $E_m$  is the maximum maintained illuminance (lx)
- $F_D$  is the dimming factor for any programmed dimming
- T is the operating time (h.yr<sup>-1</sup>)
- 0.001 is the number of kW in 1W

The  $PDI_{\text{ref}}$  value used must depend on the road width and year as listed in Technical Annex I. Lower  $PDI_{\text{ref}}$  values than those listed in Technical Annex I are justified in cases where light sources with CCT  $\leq 2700\text{K}$  are also specified.

**Verification:** The tenderer must state what lighting software has been used to calculate the AECI value and provide a clear calculation, where the values for the luminaire efficacy, maintenance factor and utilisation factor of their proposed design are visible. The calculation results must include the measurement grid and calculated illuminance/luminance values.

**TS5. Metering**

*(Applicable to all tenders where no dedicated meter is yet in place for the lighting installation. Any specific technical requirements for the metering system must be stated in the ITT.)*

The tenderer must provide details of the proposed metering equipment and any ancillary equipment required in order to monitor electrical consumption at the lighting installation level.

**Verification:** Tenderers must provide the technical specifications of the metering and measurement system and provide clear instructions on how to operate and maintain this system. A calibration certificate compliant with Measuring Instruments Directive 2004/22/EC must be provided for each control zone.

**TS5. Metering**

*(Applicable to all tenders where no dedicated meter is yet in place for the lighting installation. Any specific technical requirements for the metering system must be stated in the ITT.)*

The tenderer must provide details of the proposed metering equipment and any ancillary equipment required in order to monitor electrical consumption at the lighting installation level. The metering device must be capable of logging data on a 24-hour basis that can later be manually or remotely downloaded.

**Verification:** Tenderers must provide the technical specifications of the metering and measurement system and provide clear instructions on how to operate and maintain this system. A calibration certificate compliant with Measuring Instruments Directive 2004/22/EC must be provided for each control zone.



CORE CRITERIA	COMPREHENSIVE CRITERIA
<b>TECHNICAL SPECIFICATIONS</b>	
<p><b>TS6. Power factor – LED luminaires</b> The power factor for the luminaire to be installed must be <math>\geq 0.90</math>.</p> <p><b>Verification:</b> The tenderer must provide a declaration of compliance with the criterion for the lighting equipment they intend to supply, supported by a declaration from the manufacturer and results from tests carried out in accordance with IEC 61000-3-2 or equivalent.</p>	<p><b>TS6. Power factor – LED luminaires</b> The power factor for the luminaire to be installed must be <math>\geq 0.95</math>.</p> <p><b>Verification:</b> The tenderer must provide a declaration of compliance with the criterion for the lighting equipment they intend to supply, supported by a declaration from the manufacturer and results from tests carried out in accordance with IEC 61000-3-2 or equivalent.</p>
<p><b>TS7. Ratio of Upward Light Output (RULO) and obtrusive light</b> <i>(Applicable to all contracts where new luminaires are purchased.)</i></p> <p>All luminaire models purchased must be rated with a 0.0 % RULO. If it is necessary to use a boom angle, either to optimise the pole distribution or due to site constraints in pole positioning, the 0.0 % RULO must be maintained even when the luminaire is tilted at the required angle.</p> <p><b>Verification:</b> The tenderer must provide the photometric file(s). This must include the photometric intensity table from which the RULO is calculated according to EN 13032-1, EN 13032-2, EN 13032-4, Annex D of IEC 62722-1 or equivalent international standards.</p> <p>In cases where luminaires are not installed horizontally, the photometric file must demonstrate that either:</p> <ul style="list-style-type: none"> <li>tilting the data by the same tilt angle to be used with the luminaire still results in a 0.0 % RULO, or</li> <li>additional shielding has been fitted to the luminaire and the shielded luminaire found to show a 0.0 % RULO when tilted at the design installation angle.</li> </ul>	<p><b>TS7. Ratio of Upward Light Output (RULO) and obtrusive light</b> <i>(Applicable to all contracts where new luminaires are purchased. In situations where glare or obtrusive light is a concern, procurers should consider specifying a requirement for C3 flux codes.)</i></p> <p>All luminaire models purchased must be rated with a 0.0 % RULO and with a C3 flux code of <math>\geq 97</math> according to photometric data. If it is necessary to use a boom angle, either to optimise the pole distribution or due to site constraints in pole positioning, the 0.0 % RULO must be maintained even when the luminaire is tilted at the required angle.</p> <p><b>Verification:</b> The tenderer must provide the photometric file(s). This must include the photometric intensity table from which the RULO is calculated according to EN 13032-1, EN 13032-2, EN 13032-4, Annex D of IEC 62722-1 or equivalent international standards.</p> <p>In cases where luminaires are not installed horizontally, the photometric file must demonstrate that either:</p> <ul style="list-style-type: none"> <li>tilting the data by the same tilt angle to be used with the luminaire still results in a 0.0 % RULO and a C3 flux code of <math>\geq 97</math>, or</li> <li>additional shielding has been fitted to the luminaire and the shielded luminaire found to show a 0.0 % RULO and a C3 flux code of <math>\geq 97</math> when tilted at the design installation angle.</li> </ul>

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS8. Annoyance**

*(The CCT value is directly related to human perception and so should be specified when human annoyance is a concern.)*

In residential areas, in order to reduce the risk of human annoyance, the CCT of light sources must be  $\leq 3000\text{K}$  and a dimming or switch-off programme must be implemented\*.

**Verification:** If requested, the tenderer must provide the light spectra of all lamps to be provided. The tenderer must provide measurements of CCT reported in accordance with CIE 15. With dimming, the tenderer must provide details of the proposed dimming controls and the range of dimming capabilities, which must at least permit dimming or switch-off based on an astronomical clock.

\*As per the authority's specifications (to be defined in TS3 if included in the ITT).

**TS9. Ecological light pollution and star visibility**

*(The G-index value is directly related to blue light content, and so should be specified when light pollution effects on wildlife or on star visibility are a concern.)*

In parks, gardens and areas considered by the procurer to be ecologically sensitive, the G-index must be  $\geq 1.5^*$ .

A dimming programme\*\* must be implemented for parks and gardens that are open during night-time hours.

A switch-off programme must apply to any relevant closing hours for parks and gardens.

A dimming and/or switch-off programme\*\* must be implemented for any other ecologically sensitive areas.

**Verification:** The tenderer must provide measurements of the G-index\*\*\*.

*\*If it is not possible to calculate the G-index, CCT may be used as an orientation, it always being understood that its use as a metric for blue light is not perfect. A G-index of  $\geq 1.5$  would generally (but not always) equate to a CCT of  $\leq 3000\text{K}$ .*

\*\*As per the procurer's specifications (defined in TS3 if included in the ITT).

\*\*\*The G-index can be quickly and easily calculated using the same photometric data used to calculate the CCT via an excel spreadsheet available at [this website](#).

**TS9. Ecological light pollution and star visibility**

*(The G-index value is directly related to blue light content, and so should be specified when light pollution effects on wildlife or on star visibility are a concern. Procurers should be aware that luminaires complying with this requirement are unlikely to meet TS1 for luminaire efficacy.)*

In parks, gardens, areas considered by the procurer to be ecologically sensitive or any area within a 30km radius of an urban optical astronomy observatory or within a 100km radius of a major optical astronomy observatory, the G-index must be  $\geq 2.0^*$ .

A dimming programme\*\* must be implemented for parks and gardens that are open during night-time hours.

A switch-off programme must apply to any relevant closing hours for parks and gardens.

A dimming and/or switch-off programme\*\* must be implemented for any other ecologically sensitive areas or areas within the defined radii of relevant optical observatories.

**Verification:** The tenderer must provide measurements of the G-index\*\*\*.

*\*If it is not possible to calculate the G-index, CCT may be used as an orientation, it always being understood that its use as a metric for blue light is not perfect. A G-index of  $\geq 2.0$  would generally (but not always) equate to a CCT of  $\leq 2700\text{K}$ .*

\*\*As per the procurer's specifications (defined in TS3 if included in the ITT).

\*\*\*The G-index can be quickly and easily calculated using the same photometric data used to calculate the CCT via an excel spreadsheet available at [this website](#).

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS10. Provision of instructions**

*(Applicable when the equipment and/or controls in the particular lighting installation requested in the ITT are different from the normal equipment installed elsewhere on the wider lighting network operated by the procurer.)*

The tenderer must provide the following information with the installation of new or renovated lighting systems:

- Disassembly instructions for luminaires
- Instructions on how to replace light sources (where applicable), and which lamps can be used in the luminaires without decreasing the energy efficiency
- Instructions on how to operate and maintain lighting controls
- For daylight linked controls, instructions on how to recalibrate and adjust them; and
- For time switches, instructions on how to adjust the switch-off times, and advice on how best to do this to meet visual needs without excessive increase in energy consumption.

**Verification:** The tenderer must provide a declaration of compliance with this criterion, supported by examples of written instructions that will be provided to the contracting authority should the tender be successful.

**TS11. Waste recovery**

The tenderer must implement appropriate environmental measures to reduce and recover the waste produced during the installation of the lighting system. All waste lamps and luminaires and lighting controls must be separated and sent for recovery in accordance with the WEEE directive. Any other waste materials that are expected to be generated and that can be recycled must be collected and delivered to appropriate facilities.

**Verification:** The tenderer must provide details of the waste handling procedures in place and identify suitable sites to which WEEE and other recyclable materials can be taken to for separation, recycling and heat recovery, as appropriate.

**TS12. Reparability**

The tenderer must make sure that it is feasible and practical for a professional to access components (e.g. light source, lamp, LED module, driver) after the luminaire has been put into service. Components must be identifiable, accessible and removable without damaging the component or the luminaire.

Replacement of components must be possible on site (i.e. at luminaire mounting height), without tools (i.e. plug and play) or with one of the following types of screwdriver: standard, Pozidriv, Phillips, Torx, Allen key or combination wrench.

**Verification:** The tenderer must provide a technical manual, which must include an exploded diagram of the luminaire illustrating the parts that can be accessed and replaced. The parts covered by service agreements under the warranty must also be indicated.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**TS13. Ingress Protection (IP) rating**

Luminaires for M- P- and C-class roads must have an optical system with an ingress protection rating of IP65 or higher.

**Verification:** The tenderer must provide the technical specifications, demonstrating that this criterion has been met according to IEC 60598-1 clause 9 or equivalent.

**NOTE:** *The tests for the ingress of dust, solid objects and moisture specified in IEC 60598-1 are not all identical to the tests in IEC 60529 because of the technical characteristics of luminaires. An explanation of the IP numbering system is given in Annex J of the standard.*

**TS14. Product lifetime, spare parts and warranty**

*(The thresholds defined here are applicable to LED-based light sources, lamps and luminaires.)*

Any LED-based light sources must have a rated life at 25°C of:

- L96 at 6 000 hours
- L70 at 50 000 hours (projected)
- C0 at 3 000 hours or C10 at 6 000 hours
- C50 at 50 000 hours (projected).

The repair or provision of relevant replacement parts of LED modules suffering abrupt failure must be covered by a warranty for a period of 5 years from the date of installation.

**Verification:** Test data regarding the maintained lumen output of the light sources must be provided by an International Laboratory Accreditation Cooperation accredited laboratory that meets IES LM-84 or equivalent for actual data and IES TM-28 or equivalent for projected data.

The tenderer must provide a copy of the minimum 5-year warranty to be signed if the tender is successful and provide the necessary contact details (phone and email as a minimum) for dealing with any related queries or potential claims.

For clarity, the warranty must, as a minimum, cover the repair or replacement costs of faulty LED module parts within [X] days (to be defined by the procurer), after notification of the fault either directly or via other nominated agents. Replacement parts should be the same as the originals, but if this is not possible, equivalent spare parts that perform the same function to the same or to a higher performance level may be used.

**TS14. Product lifetime, spare parts and warranty**

*(The thresholds defined here are applicable to LED-based light sources, lamps and luminaires.)*

Any LED-based light sources must have a rated life at 25°C of:

- L96 at 6 000 hours
- L70 at 100 000 hours (projected)
- C0 at 3 000 hours or C10 at 6 000 hours
- C50 at 100 000 hours (projected).

The repair or provision of relevant replacement parts of LED modules suffering abrupt failure must be covered by a warranty for a period of 7 years from the date of installation.

**Verification:** Test data regarding the maintained lumen output of the light sources must be provided by an International Laboratory Accreditation Cooperation accredited laboratory that meets IES LM-84 or equivalent for actual data and IES TM-28 or equivalent for projected data.

The tenderer must provide a copy of the minimum 7-year warranty to be signed if the tender is successful and provide the necessary contact details (phone and email as a minimum) for dealing with any related queries or potential claims.

For clarity, the warranty must, as a minimum, cover the repair or replacement costs of faulty LED module parts within [X] days (to be defined by the procurer), after notification of the fault either directly or via other nominated agents. Replacement parts should be the same as the originals, but if this is not possible, equivalent spare parts that perform the same function to the same or to a higher performance level may be used.

CORE CRITERIA	COMPREHENSIVE CRITERIA
<b>TECHNICAL SPECIFICATIONS</b>	
<p>TS14. <b>Product lifetime, spare parts and warranty</b> (continued) The warranty may exclude the following <i>[to be defined by procurer]</i>:</p> <ul style="list-style-type: none"> <li>a. faulty operation due to vandalism, accidents or other extreme weather events</li> <li>b. lamps or luminaires that have been working for a significant time under abnormal conditions (e.g. used with the wrong line voltage), insofar as this can be proven by the contractor.</li> </ul>	<p>TS14. <b>Product lifetime, spare parts and warranty</b> (continued) The warranty may exclude the following <i>[to be defined by procurer]</i>:</p> <ul style="list-style-type: none"> <li>a. faulty operation due to vandalism, accidents or other extreme weather events</li> <li>b. lamps or luminaires that have been working for a significant time under abnormal conditions (e.g. used with the wrong line voltage), insofar as this can be proven by the contractor.</li> </ul>
<p>TS15. <b>Failure rate of control gear</b> The specified control gear failure rate must be lower than 0.2 % per 1000 h and be covered by an 8-year warranty for control gear.</p> <p><b>Verification:</b> The tenderer must provide a declaration of compliance with the above failure rate for any control gear it intends to supply. The declaration must be supported by relevant industry-standard testing procedures.</p>	<p>TS15. <b>Failure rate of control gear</b> The specified control gear failure rate must be lower than 0.1 % per 1 000 h and be covered by a 10-year warranty for control gear.</p> <p><b>Verification:</b> The tenderer must provide a declaration of compliance with the above failure rate for any control gear it intends to supply. The declaration must be supported by relevant industry-standard testing procedures.</p>
<p>TS16. <b>Labelling of LED luminaires</b> <i>(Applicable when new LED luminaires are installed.)</i> The luminaires proposed to be installed by the tenderer must carry, as a minimum, the following technical information:</p> <ul style="list-style-type: none"> <li>• Manufacturer’s name, code, serial number and date of manufacture</li> <li>• Input power rating</li> <li>• Luminous flux at 25°C</li> <li>• Upward Light Ratio</li> <li>• CIE flux codes</li> <li>• Correlated colour temperature (CCT)</li> <li>• G-index</li> <li>• Indication of the dimming control technology (if applicable)</li> </ul> <p>The information should be included in the luminaire and, where possible, also in a part of the light pole that is accessible from ground level. The tenderer should specify how exactly this information will be displayed (e.g. on a label with a QR code, label with written information, metal plate with engravings).</p> <p><b>Verification:</b> The tenderer must provide a sample description of the label they propose to provide with their lighting equipment if their tender is successful.</p>	

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**AWARD CRITERIA**
**AC1. Life-cycle costs**

The cost of each valid and responsive tender will be evaluated on the basis of total life-cycle costs (LCC). Tenderers are required to complete the spreadsheet included in the tender documents with the requested data regarding their products. This information will be used to calculate LCC and the tender with the lowest life-cycle cost will be awarded **[X]** marks, with other tenders being scored according to the following formula:

$$\text{Score Tender A} = [\mathbf{X}] * \frac{\text{Lowest LCC}}{\text{LCC}_{\text{TENDER A}}}$$

**Verification:** The completed spreadsheet must be submitted with the tender and where indicated, supporting documentation verifying the data must be provided. The data entered in the spreadsheet regarding costs, energy consumption, time to replacement and other parameters will become binding under the contract with the successful tenderer.

**NOTE:** Contracting authorities may choose to evaluate LCC using an existing template such as the European Commission *LCC Tools for Outdoor Lighting*, or based on their own bespoke template. In either case, certain information such as the area to be lit, evaluation period, energy costs and cost of maintenance/replacement (if not included in the tender) will need to be completed by the contracting authority. See the *Life-cycle costing section* for further information.

**AC2. Extended Warranty**

*(To be used in conjunction with TS14. Alternatively, extended warranties may be separately costed in the tender)*

A maximum of **[X]** points will be awarded to tenderers offering initial warranties that go beyond the minimum warranty periods stated in TS12, which cover at least the same scope as the minimum required warranty, and whose cost is included in the bid price. The maximum number of marks will be awarded to the tenderer offering the longest initial warranty period, with other offers being scored proportionately according to the following formula:

$$\text{Score Tender A} = [\mathbf{X}] * \frac{\text{Warranty Period}_{\text{TENDER A}}}{\text{Longest Offered Warranty}}$$

**Verification:** Tenderers must provide a copy of the warranty terms together with a clear summary stating the scope of repair, replacement and other services included during the initial and extended warranty period.

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**CONTRACT PERFORMANCE CLAUSES**
**CPC1. Dimming control**

*(To be used in conjunction with TS2 and TS3)*

If the contractor proposes to change the light sources and/or luminaires from those specified in its tender, the new light sources and/or luminaires must be at least:

- Equally compatible with dimming controls as the originals
- Have the same programmable flexibility
- Be able to achieve at least the same maximum dimming, and
- Have a similar power curve.

Agreement on this matter must be settled by the provision of similar documentation from the manufacturer(s) of the new light sources and/or luminaires that would justify the selection of the new luminaires and/or light sources.

**CPC2. Commissioning and correct operation of lighting controls**

*(To be used in conjunction with TS2 and TS3)*

The contractor must ensure that the installed lighting systems and controls are working properly:

- Any daylight linked controls must be calibrated to ensure that they switch off the lighting when daylight is adequate.
- Any traffic sensors must be tested to confirm that they detect vehicles, bicycles and pedestrians, as appropriate.
- Any time switches, CLO drivers and dimming controls must be shown to be able to meet any relevant specifications defined in the ITT.

If, after the commissioning of the system, the lighting controls do not appear to meet the relevant requirements above, the contractor shall be liable to adjust and/or recalibrate the controls at no additional cost to the procuring authority. The contractor must deliver a report detailing how the relevant adjustments and calibrations have been carried out and how the settings can be used.

**NOTE:** *For large utilities the new or renovated installation may simply have to be compatible with the existing control systems used for the wider lighting network. In this situation, this CPC would also refer to the compatibility of the controls with the existing control system.*

CORE CRITERIA	COMPREHENSIVE CRITERIA
CONTRACT PERFORMANCE CLAUSES	
	<p><b>CPC3. Compliance of actual energy efficiency and lighting levels with design claims</b></p> <p>A suitable non-urban road sub-area will be selected by the authority where the luminaire positioning is in line with the PDI photometry study for in-situ photometric measurements (according to EN 13032-2) and energy consumption measurements (according to EN 13201-5) during an agreed period of one week. The selected sub-area will be free of significant interference to lighting from trees, bus stops or parked vehicles and from background light levels caused by advertising boards or buildings.</p> <p>For M-class roads with luminance requirements, it will be acceptable to provide illuminance data instead, if concerns about the effect of real road surface reflectivity deviating significantly from design assumptions are justifiable.</p> <p>During the same one-week period peak power [W] and energy consumption [kWh] will be measured and/or calculated for the relevant light points.</p> <p>The in-situ measured values of PDI and AECI must be <b>±10 %</b> of the design AECI value and <b>± 15 %</b> of the design PDI value after 100 hours of operation.</p> <p>In cases where non-compliance is disputed, the contractor may repeat the measurements on the same sub-area or, if it can be argued that the sub-area was not suitable for measurement, select another sub-area. The procurer will not be liable for the cost of any additional measurements.</p> <p><b>NOTE:</b> <i>The consequences of non-compliance with the design values for PDI and/or AECI should be defined in the ITT. Options could include:</i></p> <ul style="list-style-type: none"> <li>• <i>Remedial works to be undertaken at no additional cost to the procurer.</i></li> <li>• <i>Financial penalties in proportion to the degree of non-compliance (perhaps related to foreseeable additional electricity costs over a defined period caused by the poorer performing installation).</i></li> </ul> <p><i>The parameters influencing the uncertainty in illuminance measurements mentioned in Annex F to EN 13201-4 should be considered. It is advisable to use automated illuminance measurement systems and to agree on the illuminance and data point tolerances before the project (±10 % is suggested).</i></p>





CORE CRITERIA

COMPREHENSIVE CRITERIA

CONTRACT PERFORMANCE CLAUSES

**CPC4. Waste recovery and transport to suitable sites**

*(To be used in conjunction with TS11)*

The contractor must provide a schedule of the waste collected during the project. In addition, the contractor must provide details of any sorting that has been applied prior to transport to suitable sites identified in the original tender or to other suitable sites where waste can be sorted, processed, recycled and, if relevant, subject to heat recovery. Delivery invoices must be submitted as proof of delivery to an authorised disposal facility.

## E GPP CRITERIA FOR THE PURCHASE OF TRAFFIC SIGNALS

### SUBJECT MATTER

Purchase of energy efficient lighting equipment for traffic signalling.

### CORE CRITERIA

### COMPREHENSIVE CRITERIA

### TECHNICAL SPECIFICATIONS

#### TS1. Product lifetime, spare parts and warranty

*(The thresholds defined here are applicable to LED-based light sources, lamps and luminaires.)*

Any LED-based light sources must have a rated life at 25°C of:

- L96 at 6 000 hours
- L70 at 50 000 hours (projected)
- L0C0 at 3 000 hours or C10 at 6 000 hours
- C50 at 50 000 hours (projected)

The repair or provision of relevant replacement parts of LED modules suffering abrupt failure must be covered by a warranty for a period of 5 years from the date of installation.

**Verification:** Test data regarding the maintained lumen output of the light sources must be provided by an International Laboratory Accreditation Cooperation accredited laboratory that meets IES LM-84 or equivalent for actual data and IES TM-28 or equivalent for projected data.

The tenderer must provide a copy of the minimum 5-year warranty to be signed if the tender is successful and provide the necessary contact details (phone and email as a minimum) for dealing with any related queries or potential claims.

For clarity, the warranty must, as a minimum, cover the repair or replacement costs of faulty LED module parts within **[X]** days (*to be defined by the procurer*), after notification of the fault either directly or via other nominated agents. Replacement parts should be the same as the originals, but if this is not possible, equivalent spare parts that perform the same function to the same or to a higher performance level may be used.

#### TS1. Product lifetime, spare parts and warranty

*(The thresholds defined here are applicable to LED-based light sources, lamps and luminaires.)*

Any LED-based light sources must have a rated life at 25°C of:

- L96 at 6 000 hours
- L70 at 100 000 hours (projected)
- L0C0 at 3 000 hours or C10 at 6 000 hours
- C50 at 100 000 hours (projected)

The repair or provision of relevant replacement parts of LED modules suffering abrupt failure must be covered by a warranty for a period of 7 years from the date of installation.

**Verification:** Test data regarding the maintained lumen output of the light sources must be provided by an International Laboratory Accreditation Cooperation accredited laboratory that meets IES LM-84 or equivalent for actual data and IES TM-28 or equivalent for projected data.

The tenderer must provide a copy of the minimum 7-year warranty to be signed if the tender is successful and provide the necessary contact details (phone and email as a minimum) for dealing with any related queries or potential claims.

For clarity, the warranty must, as a minimum, cover the repair or replacement costs of faulty LED module parts within **[X]** days (*to be defined by the procurer*), after notification of the fault either directly or via other nominated agents. Replacement parts should be the same as the originals, but if this is not possible, equivalent spare parts that perform the same function to the same or to a higher performance level may be used.

CORE CRITERIA	COMPREHENSIVE CRITERIA
<b>TECHNICAL SPECIFICATIONS</b>	
<p>TS1. <b>Product lifetime, spare parts and warranty</b> (continued) The warranty may exclude the following <i>[to be defined by procurer]</i>:</p> <ul style="list-style-type: none"> <li>a. faulty operation due to vandalism, accidents or other extreme weather events</li> <li>b. lamps or luminaires that have been working for a significant time under abnormal conditions (e.g. used with the wrong line voltage), insofar as this can be proven by the contractor.</li> </ul>	<p>TS1. <b>Product lifetime, spare parts and warranty</b> (continued) The warranty may exclude the following <i>[to be defined by procurer]</i>:</p> <ul style="list-style-type: none"> <li>a. faulty operation due to vandalism, accidents or other extreme weather events</li> <li>b. lamps or luminaires that have been working for a significant time under abnormal conditions (e.g. used with the wrong line voltage), insofar as this can be proven by the contractor..</li> </ul>
<b>AWARD CRITERIA</b>	
<p>AC1. <b>Life-cycle costs</b></p> <p>The cost of each valid and responsive tender will be evaluated on the basis of total life-cycle costs (LCC). Tenderers are required to complete the spreadsheet included in the tender documents with the requested data regarding their products. This information will be used to calculate LCC and the tender with the lowest life-cycle cost will be awarded <b>[X]</b> marks, with other tenders being scored according the following formula:</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0; width: fit-content; margin-left: auto; margin-right: auto;"> <math display="block">\text{Score Tender A} = \mathbf{[X]} * \frac{\text{Lowest LCC}}{\text{LCC}_{\text{TENDER A}}}</math> </div> <p><b>Verification:</b> The completed spreadsheet must be submitted with the tender and where indicated, supporting documentation verifying the data must be provided. The data entered in the spreadsheet regarding costs, energy consumption, time to replacement and other parameters will become binding under the contract with the successful tenderer.</p> <p><b>NOTE:</b> Contracting authorities may choose to evaluate LCC using an existing template such as the European Commission <i>LCC Tools for Outdoor Lighting</i>, or based on their own bespoke template. In either case, certain information such as the area to be lit, evaluation period, energy costs and cost of maintenance/replacement (if not included in the tender) will need to be completed by the contracting authority. See the <i>Life-cycle costing section</i> for further information. Examples of parameters which may be suitable for LCC for traffic signals are:</p> <ul style="list-style-type: none"> <li>• The evaluation period (e.g. 8 years)</li> <li>• An inventory of the traffic signals required (e.g. red ball signals, amber ball signals, green ball signals, green arrow signals, pedestrian stop signals and pedestrian go signals)</li> <li>• The average duty cycle of each traffic signal (e.g. red signal 55%, amber signal 2%, green signal 43%); and</li> <li>• The projected cost of electricity (e.g. EUR 0.12/kWh)</li> </ul>	

**CORE CRITERIA**
**COMPREHENSIVE CRITERIA**
**TECHNICAL SPECIFICATIONS**
**AC2. Extended warranty**

A maximum of **[X]** points will be awarded to tenderers offering initial warranties that go beyond the minimum warranty period specified, which cover at least the same scope as the minimum required warranty, and whose cost is included in the bid price. The maximum number of marks will be awarded to the tenderer offering the longest initial warranty period, with other offers being scored proportionately according to the following formula:

$$\text{Score Tender A} = \mathbf{[X]} * \frac{\text{Warranty Period}_{\text{TENDER A}}}{\text{Longest Offered Warranty}}$$

**Verification:** Tenderers must provide a copy of the warranty terms together with a clear summary stating the scope of repair, replacement and other services included during the initial and extended warranty period.

## LIFE CYCLE COSTING

Evaluating purchase price alone fails to capture the significant costs associated with owning and operating lighting systems. For this reason, life-cycle costing should be applied in every tender, unless there is no possibility to choose between different types of lighting (for example, due to compatibility issues with existing infrastructure). The major cost categories (other than purchase price) for both indoor and outdoor lighting are:

- Installation costs
- Energy consumption during operational lifetime
- Maintenance and cleaning costs
- Replacement of lamps
- Cost of disposal of lamps

Evidence from public authorities who have installed more efficient lighting systems indicates that cost savings of over 85% over a lifetime of 15 years are available (see example [here](#)), with even higher associated savings in terms of CO<sub>2</sub> and other greenhouse gas emissions. You can assess the potential LCC savings at the pre-tender stage as well as in the tender itself using tools which have been specifically developed for this purpose. In 2019, the European

Commission published two separate tools for indoor and outdoor lighting, along with accompanying user guidance. You can access the tools and guidance [here](#).

The award criteria included in the Irish GPP criteria are designed to be used with these tools, although it is also possible to use other formats for LCC. To ensure that suppliers will be able to provide the data requested, it is highly recommended to publish the spreadsheet at the pre-tender stage, for example as part of preliminary market consultation or in a Prior Information Notice. Ask suppliers to review the 'Bidder Response Sheet' and confirm that they will have access to the relevant technical data during the tender period. The information requested is all based on industry standards, so it should not be problematic to provide this.

The LCC tools will provide you with the cost information needed to compare tenders. In addition to figures, they provide graphical output to illustrate costs.

A recorded webinar introducing the tools and explaining how to use them is available [here](#).

User Guide to the  
**Life Cycle Costing Tool**  
for Green Public Procurement of  
**Indoor Lighting**

User Guide to the  
**Life Cycle Costing Tool**  
for Green Public Procurement of  
**Road lighting & Traffic signals**

## ANNEX 1: PDI AND AECI REFERENCE VALUES

		Year	Ambition level and road width (to be lit)											
			Core ≤5m	Comp ≤5m	Core 5-6m	Comp 5-6m	Core 6-7m	Core 6-7m	Core 7-8m	Core 7-8m	Core 8-9m	Core 8-9m	Core ≥9m	Core ≥9m
PDI reference values $W.lx^{-1}.m^{-2} = 1 / (\text{lum. eff.} \times \text{MF} \times \text{utilance})$		2018-19	0.023	0.018	0.020	0.016	0.018	0.015	0.016	0.013	0.014	0.012	0.014	0.012
		2020-21	0.021	0.016	0.018	0.015	0.015	0.013	0.014	0.011	0.012	0.011	0.012	0.011
		2022-23	0.018	0.014	0.016	0.013	0.014	0.012	0.012	0.010	0.011	0.010	0.011	0.010
AECI 'base values' $kWh.m^{-2}.yr^{-1}.lx^{-1}$ (basically PDI $\times 0.001kW/W \times 4015h/y$ and $\times 1.00$ (core) or $0.73$ (comp.) dimming factor)		2018-19	0.094	0.053	0.081	0.048	0.071	0.044	0.063	0.038	0.057	0.035	0.057	0.035
		2020-21	0.083	0.047	0.071	0.042	0.062	0.039	0.055	0.033	0.050	0.031	0.050	0.031
		2022-23	0.074	0.042	0.063	0.038	0.055	0.035	0.049	0.030	0.044	0.028	0.044	0.028
Actual AECI reference values, which are simply the AECI base values above multiplied by the illuminance (lux).  *C0 or C1 levels must be able to meet to AECI based on 20lux (e.g. via improved dimming).  Note that for M-class roads, the luminance needs to be specified, which will be influenced by the surface reflectivity of the road (luminance = illuminance $\times$ reflectivity).	C0*, C1*, C2 (avg. 20 lux)	2018-19	1.874	1.057	1.607	0.961	1.406	0.881	1.250	0.755	1.125	0.705	1.125	0.705
		2020-21	1.654	0.935	1.418	0.850	1.240	0.779	1.103	0.668	0.992	0.623	0.992	0.623
		2022-23	1.470	0.833	1.260	0.757	1.103	0.694	0.980	0.595	0.882	0.555	0.882	0.555
	C3 / P1 (avg. 15 lux)	2018-19	1.406	0.793	1.205	0.721	1.054	0.661	0.937	0.566	0.843	0.529	0.843	0.529
		2020-21	1.240	0.701	1.063	0.637	0.930	0.584	0.827	0.501	0.744	0.467	0.744	0.467
		2022-23	1.103	0.625	0.945	0.568	0.827	0.520	0.735	0.446	0.662	0.416	0.662	0.416
	C4 / P2 (avg. 10 lux)	2018-19	0.937	0.529	0.803	0.480	0.703	0.440	0.625	0.378	0.562	0.352	0.562	0.352
		2020-21	0.827	0.467	0.709	0.425	0.620	0.389	0.551	0.334	0.496	0.312	0.496	0.312
		2022-23	0.735	0.416	0.630	0.379	0.551	0.347	0.490	0.297	0.441	0.278	0.441	0.278
	C5 / P3 (avg. 7.5 lux)	2018-19	0.703	0.396	0.602	0.360	0.527	0.330	0.469	0.283	0.422	0.264	0.422	0.264
		2020-21	0.620	0.351	0.532	0.319	0.465	0.292	0.413	0.250	0.372	0.234	0.372	0.234
		2022-23	0.551	0.312	0.473	0.284	0.413	0.260	0.368	0.223	0.331	0.208	0.331	0.208
	P4 (avg. 5 lux)	2018-19	0.469	0.264	0.402	0.240	0.351	0.220	0.312	0.189	0.281	0.176	0.281	0.176
		2020-21	0.413	0.234	0.354	0.212	0.310	0.195	0.276	0.167	0.248	0.156	0.248	0.156
		2022-23	0.368	0.208	0.315	0.189	0.276	0.173	0.245	0.149	0.221	0.139	0.221	0.139
	P5 (avg. 3 lux)	2018-19	0.281	0.159	0.241	0.144	0.211	0.132	0.187	0.113	0.169	0.106	0.169	0.106
		2020-21	0.248	0.140	0.213	0.127	0.186	0.117	0.165	0.100	0.149	0.093	0.149	0.093
		2022-23	0.221	0.125	0.189	0.114	0.165	0.104	0.147	0.089	0.132	0.083	0.132	0.083
	P6 (avg. 2 lux)	2018-19	0.187	0.106	0.161	0.096	0.141	0.088	0.125	0.076	0.112	0.070	0.112	0.070
		2020-21	0.165	0.093	0.142	0.085	0.124	0.078	0.110	0.067	0.099	0.062	0.099	0.062
		2022-23	0.147	0.083	0.126	0.076	0.110	0.069	0.098	0.059	0.088	0.056	0.088	0.056

The differences in PDI values for different years are based on a tiered increase in luminaire efficacy that is expected to be delivered by the LED industry, or 17 lm/W every two years between 2018 and 2023. The starting luminaire efficacies are 120 lm/W (core) and 130 lm/W (comp.) in 2018. A simplified calculation of the PDI reference values has been made, where  $PDI = 1 / (\text{luminaire efficacy} \times \text{maintenance factor} \times \text{utilance})$ .

For all PDI reference values a maintenance factor (MF) of 0.85 is assumed. The utilance values vary as a function of road width and criterion ambition level as follows: Core/Comp: ≤5m wide (U=0.42/0.5); 5-6m wide (U=0.49/0.55); 6-7m wide (U=0.56/0.6); 7-8m wide (U=0.63/0.7); 8-9m wide (U=0.7/0.75); ≥9m wide (U=0.7/0.75).

