E-street Initiative

Work Package 4.2

National guidelines
4.7.2008

On behalf of the E-Street project (www.e-streetlight.com)

Intelligent Energy Europe

TABLE OF CONTENTS

1. INDRODUCTION

This report gives state of the art in the field of national guidelines.

Contents is based on the information from the participating countries.

Extent and accuracy of documents vary moderately. Some countries have the national lighting policy, European standards, especially EN 13201, are widely adopted. Adaptive road lighting is already mentioned in few cases.

2. STATE OF THE ART IN PARTICIPATING COUNTRIES

2.1 Bulgaria

2.1.1 Abstract

There isn't a special National Administration in Bulgaria, responsible for road lighting and lighting policy.

The municipality of the town is the proprietor of the street lighting and it elaborates its own specific lighting policy according to the local problems and the financial possibilities.

The Executive Road Agency takes care of road lighting in Bulgaria but usually only for concrete proposals to illuminate one or another road and provide the necessary investment. There isn't a special section or team of specialists, which lay down the lighting policy.

For many years the code for street lighting was BSS 5504/1982 (Bulgarian standard for street lighting). Two years ago the European standard for street lighting BSS EN 13201/2005 was accepted – official only parts 2, 3 and 4, but part 1 is used always too. The differences between the two standards are not considerable.

The quality of lamps and luminaires have to correspond to the requirements of Bulgarian and European standards and CIE Recommendations. National standards for lamps and luminaires are harmonized with the European standards.

There is an independent control upon the projects and the realization of street lighting.

2.1.2 Lighting policy

Municipalities are the proprietors of the street lighting equipments in the towns.

The lighting of roads between towns is public property and the Executive Road Agency controls it in all the country.

The municipalities and the Executive Road Agency plan and invest in the construction of new lighting and refurbishment of obsolete road lighting. The maintenance of road lighting is different. In some towns private firms maintain the road lighting. In other cases, the municipality has its own service.

The street lighting is automatically switched on 30 minutes before sunrise and switched off 30 minutes after sunset. For this purpose radio control is used and in rural areas – electrical clockworks with seasonal correction. Now adaptive street lighting is very topical. A few pilot projects for will probably be realized next year.

2.1.3 National code of practice for road lighting

The Bulgarian standard for street lighting BSS 5504/1982 is still valid. But our designers use now only the European standard for street lighting BSS EN 13201/2005.

2.1.3.1 Need for road lighting

Basic parameters of street lighting:
Average luminance
Average illuminance
Overall uniformity
Lengthwise uniformity
Glare restriction (TI %)

2.1.3.2 Performance requirements for lighting parameters

Lighting situation is defined in conformity with type, speed and volume of traffic, as it is indicated in European standard.

Choice of lighting class is according to European Standard and CEN recommendation.

All recommendations of European Standard for dry road surface are considered.

Tables with the values of lighting requirements for motorized traffic, conflict areas and pedestrian, given in European standard are taken into account.

2.1.3.3 Public roads in rural areas

The lighting in rural areas is designed and implemented according to the requirements of the European Standard. The lighting class of the streets is usually ME5, ME6 or ES.

2.1.3.4 Roads and streets on urban areas

The beautification aspects of street lighting has become important in resent times.

The beautiful night picture of the town depends on the quality of street lighting.

That is why the contemporary trend is characterized by using " architectural street luminaires " with special design, illumination of representative avenues, boulevards, residential areas, parks and gardens, shopping areas with white light with improve color rendering.

2.1.3.5 Tunnels

The tunnel lighting in Bulgaria is designed and implemented according to the requirements of the European Standard for tunnel lighting. Traffic weighted L_{20} method and high-pressure sodium lamps and asymmetrical counterbeam lighting system to diminish the electricity consumption are used.

The electrical installation is defined in conformity with the recommendations in RABT – DIN 67524

2.1.3.6 Planning and design

- Preliminary study of the object and elaboration of assignment for design.

- First stage (level) of design: principle technical solution of all part of street lighting equipment.
- Second stage (level) – final design is based on the preliminary design. It is worked out separately for each detail of lighting equipment and describes the technical implementation of the proposed solutions in the first stage of design. It is the basic document of the activity planning for the construction.
- There is an independent control upon the projects and the realization of street lighting.

2.2 Czech Republic

Private companies or companies owned by municipality maintaining public lighting or "Directorate of roads and highways" has the responsibility for planning and design, installation and maintenance of road lighting. There are one basic document based on the european standard for road lighting, which is in effect since April 2007 and consits of four parts:

ČSN CEN/TR 13 201-1: *Road lighting – Part 1: "Selection of lighting classes*"
ČSN EN 13201-2*: Road lighting – Part 2: Performance requirements.*
ČSN EN 13201-3*: Road lighting – Part 3: Calculation of performance.*
ČSN EN 13201-4*: Road lighting – Part 4: Methods of measuring the light performance of installations.*

The first part standard offers further guidance on the selection of lighting classes and also specifies the lighting classes set out in EN 13201-2 and gives guidelines on the application of these classes. It is stated the way of reclassification of illuminated relevant area during different periods of the night also in different seasons of the year. Significant variation of parameter values can apply at different periods of the night, particularly in respect of ambient luminance and traffic flow.

If there is a significant change of traffic flow and/or luminance during the night, it is recommended to use proper means to reduce lighting level and so the comsumption of electrical energy. By dimming it is necessary to sustain illuminance uniformity. Reduction of lighting level might be underlaid by analysis of variation of the traffic flow on the relevant area (analysis of AHT-average hour traffic) and/or change of ambient luminance during the night (during the operation of lighting system). It is allowed to reduce the lighting level up to 50% nominal lighting level (average value of maintained luminance or illuminance) correspondig to appropriate lighting class. In the case of extreme decrease of the traffic flow, it is allowed to reduce lighting level up to 25 % nominal lighting level. Reduction of lighting level about more than 50 % nominal lighting level must be underlaid by analysis of variation of traffic flow on the relevant area and must be approved by appropriate road authority.
In the case of road lighting with increased crime risk and/or accident frequency in night time, dimming of lighting systems is not recommended.

Obtrusive light and disturbing light from outside are discussed in accordance with CEN standard.

2.3 Denmark

2.3.1 Abstract

In Denmark the European norm is published as DS/EN 13201, but local Danish recommendations from 1999 is still in force.

The L- , LE- and L- classes in the Danish recommendation corresponds to MEW ,CE- and A- classes in the European norm, but there are differences in specifications on disability glare, lengthwise uniformity and wet road uniformity

2.3.2 National code of practice for road lighting

2.3.2.1 Content

The Danish “Vejbelysningsregler, 1999”.has the following chapters

1. Introduction

2. Planning of road lighting

3. Establishing of road lighting
   3.1.1 General
   3.1.2 Motor- and motor traffic roads
   3.1.3 Traffic roads
   3.1.4 Crossings
   3.1.5 Round abouts
   3.1.7 Parths, pedestrian areas/streets and park-inlots
   3.1.8 Pedestrian crossings
   3.1.9 Speed limmiting obstructions

3.2 Roads in open land

4. The installation
   4.1 Mast geometry
   4.2 Height of masts
   4.3 Lighting of pedestrian crossings
   4.4 Luminaires
   4.4.1 Surroundings
   4.4.2 Glare
   4.4.3 Vandal classes
   4.5 Lamps
   4.6 Masts

   4.7 Lighting of surroundings
   4.8 Estetical aspects
   4.9 Optical guidance

5.. Changing of existing in-stallations
   5.1 General
   5.2 Changing of electrical installation
   5.3 Changing of light technical quality

6. Periodical dimming of road lighting

7. Annex A – Lighting classes
   Annex B - Luminaires

2.3.2.2 Performance requirements for lighting parameters

Requirements for motor traffic are based on luminance concept in accordance with recommendations of CIE and CEN standards. Wet surfaces must be taken into account. Illuminance concept is used on conflict areas and for pedestrian and bicycle traffic and quality control.

Example of specifications:

Belysningsklasser i L-rækken	motorveje o.l.			trafikveje o.l.				
	L1	L3	L5	L2	L4	L6	L7a	L7b
Luminanser på tør kørebane:								
Middelluminans (L_m) cd/m^2 (driftsværdi) minimum*):	2,0	1,5	1,0	2,0	1,5	1,0	0,75	0,50
Regelmæssighed (R) minimum:	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
Langsregelmæssighed (R_L) minimum:	0,60	0,60	0,60	0,30	0,30	0,30	0,30	0,30
Luminanser på våd kørebane:								
Regelmæssighed (R) minimum:	0,20	0,20	0,15	0,20	0,15	0,15	0,15	0,15
Synsnedsættende blænding: (TI) % maximum:	6,1	6,5	6,8	6,1	6,5	6,8	7,0	7,0
Belysningsklasse på de nærmeste 3,5 m langs kørebanen:	E1	E1	E2	E1	E1	E2	E2	E2
*) Når minimumkravet til middelluminans har stærkt uheldige konsekvenser for belysningsanlæggets udformning, og der opnås væsentlige fordele herved, kan kravet underskrides med højst 10%.								

Skema A.1. Krav til L-rækkens belysningsklasser.

2.3.2.3 Additional guidance documentation:

As a suplement to ”Vejbelysningsregler” a handbook on technical issues and one about eastetical aspects are published.

2.4 Finland

2.4.1 Abstract

The Finnish National Road Administration has the responsibility for planning and design, installation and maintenance of road lighting on public roads. There are three basic documents: lighting policy, code of practice for road lighting and general requirements and specifications.

Lighting policy gives general rules.

Code of practice includes eight chapters with coherent guidelines for the practical planning and design. The Third edition was published in 2006. This revised version is based on the latest CIE recommendations and CEN standards. Saving of energy, minimizing of LCC costs and the use of adaptive road lighting are emphasized.

General specifications include requirements for construction and installation works. Furthermore there are performance requirements for the adaptive road lighting.

2.4.2 Lighting policy

Document gives general rules:
- Owner of road lighting
- Construction of new road lighting
- Need for road lighting
- Rehabilitation of obsolete road lighting
- Maintenance of road lighting

  Conditions for dimming, night-time switching off and adaptive lighting is given in this chapter

Example

Profitable traffic volumes from traffic economics point of view. Volumes are predicted numbers ten years after installation of road lighting

Road category	ADT (veh/d)		
Motorway - central reserve > 12 m - central reserve < 12 m Semi-motorway	 40 000 18 000 13 000		
	Junction density (pc/km)		
Roads in the basic network	0	2	5
Roads with central guard rail	12 000	10 000	8 000
Other main roads - cars only - all-purpose		 8 000 6 000	 5 000 4 000
Collector roads - all-purpose		 5 000	 3 000

2.4.3 National code of practice for road lighting

The third edition was published in 2006. Publication No TIEH 21003-v-06 (the Finnish title "Tievalaistuksen suunnittelu") can be downloaded from web side of FinRA www.tiehallinto.fi/thohje.

2.4.3.1 Need for road lighting

There are six paragraphs dealing with
- effect of road lighting on the traffic safety
- light as a part of the road environment
- objects to be lighted
- economic calculations
- adaptive road lighting with intelligent control

  Concept is based on the findings of E-Street project

2.4.3.2 Performance requirements for lighting parameters

Requirements for motor traffic are based on luminance concept in accordance with recommendations of CIE and CEN standards. Wet surfaces must be taken into account. Illumi-

nance concept is used on conflict areas and for pedestrian and bicycle traffic and quality control.

Choice of lighting class is a simplified method in line with CEN recommendation. This paragraph includes also instructions how luminance can vary depending on traffic volume and road conditions in accordance with the functional and quality requirements presented in the final engineering.

Obtrusive light and disturbing light from outside are discussed in accordance with CEN standard.

2.4.3.3 Public roads on rural areas

Instructions for selection of the lighting solutions. Saving of energy and minimising on LCC costs are important measures. Examples of arrangements for road in different functional classes of roads, intersections, interchanges, other areas, bridges etc.

2.4.3.4 Roads and streets on urban areas

Basic principles as above. In addition city beautification aspects.

2.4.3.5 Tunnels

Instructions are in accordance with CIE and CEN recommendations. The traffic weighted L_{20} method is used.

2.4.3.6 Planning and design

Design tools for lighting technics, columns, foundations, electricity systems, and cost calculations.

Paragraph “Electricity systems” includes instructions for the intelligent control of the adaptive road lighting.

2.4.3.7 Lighting plans

Implementation of road lighting requires usually three plans of different level. They have their own goals and accuracy.

Working-out and contents of plans are presented.

Feasibility study

In the feasibility study of lighting the long-term (> 15 a) objectives and program of the road and street lighting in built-up areas, towns or urban areas are described.

Consideration of adaptive road lighting is included
- profitability of adaptive lighting
- areas and road sections to be maintained under different level of intelligent control

Preliminary engineering

This type of plan is needed for dedicated road section or for a restricted and specific area of a town, city or community. Preliminary engineering will be worked out mainly due to environmental reasons and for city beautification.

Final engineering

The final engineering of lighting is a plan which is based on the feasibility study or on the preliminary engineering or some other similar plan. The final engineering is worked out separately for each road. It is the main document of installation and describes the final result of the work. It is also the basic document of the activity planning for construction.

Document “Special specifications” describes among others for the intelligent control functional and quality requirements, equipment and components, control properties, software, tests etc.

2.4.3.8 Procurements

- Conventional method: separate design, construction and maintenance
- Total contract including design
- LCC method which includes financing, design, construction and maintenance

2.5 Germany

Selected German standards and national guidelines in the field of exterior lighting.

Road lighting

DIN 13201-1:2005 Road lighting – Part 1: Selection of lighting classes; German version of CEN/TR 13201-1:2004

DIN EN 13201-2:2004 Road lighting – Part 2: Performance requirements; German version of EN 13201-2:2003

DIN EN 13201-3:2004 Road lighting – Part 3: Calculation of performance; German version of EN 13201-3:2003

DIN EN 13201-4:2004 Road lighting – Part 4: Methods of measuring lighting performance; German version of EN 13201-4:2003

Tunnel lighting

DIN 67524-1:2008 Lighting of street tunnels and underpasses; general quality characteristics and guide values

DIN 67524-2:1992 Lighting of street tunnels and underpasses; calculation and measurement (revision pending, 2009?)

RABT 2006 **Richtlinien für die Ausstattung und den Betrieb von Straßentunneln**

Outdoor work place lighting including parking lots

DIN EN 12464-2:2007 Light and lighting – Lighting of work places – Part 2: Outdoor work places; German version of EN 12464-2:2007

Railway lighting (exterior)

DIN EN 12464-2:2007 Light and lighting – Lighting of work places – Part 2: Outdoor work places; German version of EN 12464-2:2007 (to be applied to the lighting of platforms, approved by EBA Eisenbahnbundesamt)

Lighting of locks

DIN 67500:1987 Illumination of lock areas; requirements, design and measurement

Lighting of pedestrian crossings

DIN 67523-1:1988 Lighting of pedestrian crossings (sign 293 StVO) with additional lighting; part 1: general quality characteristics and guide values

DIN 67523-2:1988 Lighting of pedestrian crossings (sign 293 StVO) with additional lighting; part 2: calculation and measurement

R-FGÜ 2001 **Richtlinien für die Anlage und Ausstattung von Fußgängerüberwegen**

Obtrusive lighting

DIN EN 12464-2:2007 Light and lighting – Lighting of work places – Part 2: Outdoor work places; German version of EN 12464-2:2007 (evaluation of TI on nearby traffic routes)

Licht-Leitlinie 2001 **Leitlinie des Ministeriums für Landwirtschaft, Umweltschutz und Raumordnung zur Messung und Beurteilung von Lichtimmissionen (veröffentlicht im Amtsblatt für Brandenburg, kommt in allen Bundesländern zur Anwendung beim Vollzug des Bundes- und Landesimmissionsschutzgesetzes)**

2.6 Ireland

2.6.1 Lighting Policy for National Roads and Motorways (Draft)

In normal circumstances, lighting should be provided at the following locations:

1. Inside an Urban Area:

- ie speed limit 60 km/h or less. This does not include lighting where periodic special speed limits are in place eg. at schools

2. At-Grade Junctions:

- At roundabouts
- At junctions with raised islands
- At-grade junctions on dual carriageways where there is a median break for use by turning traffic
- At junctions where the mainline flow > 12,000 and the sideline flow > 3,500

Junctions on 2 plus 1 roads should not be treated differently – lighting should depend on junction type and flows as outlined above.

Where developments on side roads result in the thresholds being exceeded, the cost of providing lighting should be covered by the developer.

Retrofit of the existing network should be carried out.

For new schemes, where the traffic flows will not exceed the thresholds at year of opening, but are expected to exceed the thresholds within 10 years, then ducting should be provided during scheme construction.

3. Motorways / High Quality Dual Carriageways:

At grade separated **interchanges:**

The mainline should be lit from the start of the diverge taper to the end of the merging manoeuvre – approximately 100m past the end of the merge taper. The slips should also be lit, along with the junctions of the slip roads with the side road(s).

Where there is only an off-slip:
The mainline should be lit from the start of the diverge taper to 50m after the end of the diverge nose. The slip should also be lit, along with the junction of the slip with the side road(s).

Where there is only an on-slip:
The mainline should be lit from 215m back from the start of the merge nose to 100m after the end of the merge taper. The slip should also be lit, along with the junction of the slip with the side road(s).

UK (and Ireland) DMRB
BS 5489-1:2003
8.3.3 Lighting for slip roads:
Where slip roads connect two levels of road, particular attention should be given to the following:
View of the rising slip road from both the upper and lower levels
Clear definition of routes and turn-off points
Clear revealing of merging traffic

Light between **lit interchanges** when the distance between them < 1.5 km

4. Apart from the above, lighting will not normally be provided, except:

- Where there is an above-average history of night time accidents, and an examination of the crash history at those locations indicates that improved lighting should reduce the possibility of collisions.

2.6.2 National code of practice for road lighting

Design of lighting is carried out in accordance with BS 5489 parts 1 and 2. In addition following aspects are to be taken into account:

- Consistency of lighting within the scheme and with the adjacent network
- Safe positioning of lighting columns, signals and operational equipment
- Confusion or conflict between lighting and traffic signals
- Positioning of heads for traffic and pedestrian signals to ensure clarity to appropriate road user, and avoid confusion to others to whom they do not apply
- Safe access and servicing arrangements

2.7 Netherlands

2.7.1 Abstract

The Dutch National Road Administration (Rijswaterstaat) has the responsibility for planning and design, installation and maintenance of road lighting on public roads. The provinces and Cities all have their won repsoibilities. There are three basic documents used and often referred to: Verlichting Openbare Ruimte, Nederlandse Praktijk richtlijn (NPR 13201-1) and the Handboek Dynamische Verlichting.

Handboek Openbare Verlichting gives general rules on Public Lighting.

The Handboek gives guidelines for the practical planning and design of outdoor lighting systems. The newest edition was published in 2007. This revised version is based on the latest CIE recommendations and CEN standards as well as the NPR. Saving of energy, minimizing of LCC costs and the use of adaptive road lighting are emphasized but not described on the sense of Dynamic Lighting Systems although they are mentioned.

General specifications include requirements for construction and installation works as well as directives for lighting design.

All cities and provinces have their own policy document and their own vision on how to do public lighting. Because of this it is hard to describe any of these “sub” documents because there are just too many of them.

2.7.2 **Verlichting Openbare Ruimte** (Lighting of public areas)

Document gives discusses the different parts of the outdoor lighting system in relation to the following factors:

- Energy
- Environment
- Light Pollution

The document lists the different parts of the system and does recommendations for them when it comes to luminaires, lamps, electronics, poles, cables and maintenance of the solutions . There is an extensive part about the legal aspects, rules and regulations and the pro’s and con’s of outdoor lighting.

There are several links in the document to other publications when it comes to LED, and other light sources.

2.7.3 **Nederlandse Praktijk Richtlijn (NPR 13201-1)** (Practical Dutch guidelines)

In the Netherlands there are no formal rules and regulations the government has to comply with. However in General it is safe to say that most city policies act according to the NPR what is a normalization document based on European directives.

In the NPR the lighting and road classes are defined based the visual needs of people using the road in various transportation modes. The requirements are related to the various technical aspects of road users and behavior under different circumstances.

In a separate chapter there is a discussion about ethical aspects, light comfort and environmental issues in relation to outdoor lighting and safety.

In the appendix there is a lighting classification explanation.

2.7.4 **Handboek Dynamische Verlichting** (Handbook for dynamic lighting)

This handbook is published but the Dutch road authorities and give a very comprehensive overview of the possibilities, requirements and regulations with regards to Dynamic Outdoor Lighting systems for the Dutch road authorities.

The handbook describes:

2.7.4.1 System architecture

In this chapter the complete systems architecture of a Dynamic Outdoor Lighting (DOV) system is explained. It goes into detail on Lamp Controllers, Segment controllers and management software. The handbook gives very detailed specification for the DOV solution components.

2.7.4.2 Systems functions

The system functions chapters givens a detailed description of all the functions a Dynamic Outdoor Systems should deliver to the various system beneficiaries. It talked about constant light levels, virtual lamp power, dimming capabilities and alarming.

2.7.4.3 Systems interfaces

This part of the document describes how the solutions should communicate with the other existing traffic management systems and what should be the result of this communications. This part also discusses the various possibilities and restriction for communications over the Dutch VIC net what is the network for Road related communications in the Netherlands.

2.8 Northern Ireland

http://www.roadsni.gov.uk/index/whatwedo/whatwedo-street_lighting.htm

2.8.1 Lighting policy

Roads Service is responsible for street lighting on public roads and streets across Northern Ireland.
In April 2007, the number of street lights was just over 261,000.

- Street lights are provided mainly to improve road safety at night, but we know that they also help to reduce crime and the fear of crime, and to enhance the night-time urban environment
- Generally, all roads, car parks and footpaths adopted (owned) by Roads Service in urban areas are lit
- Rural roads are not usually lit unless there is a community of at least 10 houses along a 200-metre stretch, or a history of night-time road collisions
- The street lights in new housing developments are installed by the building developer during construction of the roads
- Roads Service is responsible for maintaining streetlights. On new housing developments, we adopt and maintain the lights after the developer has done the necessary certification of the new system and requested handover to us.
- We inspect street lights at night, every fortnight in winter and every 4 weeks in summer, to identify any that are not working properly

- Our maintenance work is carried out by Roads Service personnel and private contractors
- We aim to have at least 98% of street lights working normally at any one time
- We also aim to repair faults within 10 working days of discovery, unless the fault is due to the electricity supply and repair depends on the response of the supply company
- We have an annual programme of replacing old deteriorating columns
- We spend approximately £17 million per year on electricity charges and maintaining and replacing street lights
- We aim to minimise light pollution and conserve energy by using efficient lanterns for new and replacement lighting schemes.
- Roads Service is not responsible for security lighting to NIHE or housing association houses, or to council parks

2.9 Norway

2.9.1 Lighting policy

In Norway the CEN publication EN 13201 part 2-4 is published as a norm as NS/EN 13201 2-4.

Further on the Norwegian Public Roads Administration, "Statens Vegvesen", publishes it's own standards and regulations that depends on the NS/EN 13201. For roadlighting there are three publications that are most relevant;

017 - Handbook for Road- and Street-design.
237 - Handbook for Road- and Street-light.
264 - Handbook in technical planning of Road- and Street-lighting.

2.9.2 National code of practice for road lighting

The Norwegian Public Roads Administration guidelines are downloadable from their website at www.vegvesen.no .

The two publications Handbook 017 and handbook 264 are newly revised and are currently going through an approval process in the Ministry, but are published as a preliminary draft until it is approved. Handbook 237 was published in 2002.

2.9.2.1 Need for road lighting

The national guidelines in "Handbook 017" states that the MEW classes are to be used for roads with speed limit above 40 km/h, for roads with speed limit of 30 km/h and conflict areas the CE-classes are to be used for footpaths, bicycle paths and other areas separated or alongside the driving path (including parking lots and schoolyards) the S-class are to be used.

The 017 also states at what traffic situations we are to consider lighting the road. This recommendation is based on the presence of physical separation of the carriageways and traffic-flow. The recommendation is shown below in table.

ADT	**<1500**	**1500-4000**	**4000-8000**	**8000-12000**	**> 12000**
Separated carriageways		**MEW3**	**MEW3**	**MEW3**	**MEW3**

Not separated carriageways	**MWE4**	**MEW3**	**MEW2**	**MEW2**	**MEW2**

2.9.2.2 Performance requirements for lighting parameters

The “Handbook 263” gives the more detailed demands for the streetlighting. Requirements for motor traffic are based on luminance concept. Illuminance concept is used on conflict areas and for pedestrian and bicycle traffic. Basically road surface “C2” are to be used for light-calculations with W4 used for the overall uniformity. The table below shows the recommended lighting levels for the respective lighting classes.

Average luminance cd/m2		**2**	**1,5**	**1**	**0,75**	**0,5**			
Class	**CEO**	**MEW1 CE1**	**MEW2 CE2**	**MWE3 CE3 S1**	**MWE4 CE4 S2**	**MWE5 CE5 S3**	**S4**	**S5**	**S6**
Average illuminance lux	**50**	**30**	**20**	**15**	**10**	**7,5**	**5**	**3**	**2**

2.9.2.3 Lamps

The latest guidelines opens for the possibility to lower the level of lighting with 10 % if you are using Metal Halide lamps instead of High pressure sodium lamps, based upon the latest research results concerning mesopic vision. Decisions between lamps are set as an economical issue based upon LLC calculations (if all other requirements concerning quality are fulfilled).

2.9.2.4 Adaptive lighting

Every new installation is to be evaluated based upon their energy efficiency, if adaptive lighting is a costly effective measure it is to be implemented. Electronic ballasts are to be used in every situation where the technology is available, if electronic ballasts are installed they are to be supplied with the ability to be dimmed based on an “open platform” of communication. This secures that dimming can be implemented on a later stage without replacement of the luminaries.

2.10 Poland

2.10.1 Procedures of management of street lighting in Poland

Poland is one of the countries that took enormous effort to restructure economy from the centrally commanded model to a market one that would guarantee efficiency and prosperity to citizens. But Poland is also a very specific country when considerations of the socio-psychological circumstances are to be taken into account because they strongly influence the transformation of the sector which has been playing a significant role in the economic and social dimension of the functioning of society. In Poland the energy market has not yet

fully developed. It has just launched and the process of shaping and improvement is still ongoing.
Here in Poland we have no a uniform lighting policy of all country.

At present in Poland here are the several legislation acts regarding in some parts of street lighting.

- Act of 10 April 1997 – Energy Law (Dziennik Ustaw of 2003, No 153 item 1504 and No 203, item 1966, and of 2004, No 29, item 257, No 34, item 293, No 91, item 875, and No 96, item 959, and No 173, item 1808)
- Regulation by the Minister of Economy of 23 April 2004 concerning detailed principles for setting and calculating tariffs and settlement principles in electricity trading, (Dziennik Ustaw of 2004, No 105, item 1114.
- Act of 13 November 2003 No. 203, item 1966 concerning of the earnings of local authorities

The Energy Law Act that was passed by the Polish Parliament almost ten years ago obliged the President of the Energy Regulatory Office to report annually to the Minister of Economy and inform the public opinion on the regulatory activity. This custom stemming from the experience of the countries that are much more advanced in the implementation of the market rules into the energy sector was adopted with the aim to achieve two goals. Firstly, reporting – according to the rule of transparency – was to identify the object of regulation, tools in use and their scope, but most of all – the results achieved. Secondly – it was to justify public expenditures on energy regulation.
The current set of regulatory tools for promoting energy effectiveness and competition seems to be insufficient. In fact the procedure of extracting information pertaining to energy effectiveness of the machines applied by producers and importers usually boils down to proceedings connected with applying a financial penalty resulting from the control conducted by the Trade Inspection. Due to the fact that by 17 May 2008 the Member States are obliged to implement Directive 2006/32/EC on energy end-use efficiency, the range of tasks and tools available to the President of the ERO, as well as other authorities and institutions should be fundamentally modified.
Some kind of influence for the street lighting legislation development in Poland has the Polish Committee on Illumination http://www.ee.pw.edu.pl/CIEPoland/.
At the country level this is technical - scientific association of the Polish electricians. At the international activity this is The Polish National Committee member of CIE. The main role of this committee is to give a opinion regarding the European lighting standards, to translate it and to prepare assessments for parliamentary commissions.

Professional street lighting should fulfill the base needs of the inhabitants in Poland. Management of street lighting in the towns and regions (gminas - 2560) in Poland generally is hold at the following aspects:

- exploitation / conservation
- modernization
- new installations

All new reconstruction and updating street lighting works in Poland are hold on according to European Standard EN-13201.

2.11 Portugal

2.11.1 Need of road lighting

The main propose of road lighting is to ensure the regular activities of pedestrians and vehicles, in particular when the natural light is insufficient, and within the minimal security and comfort conditions.

For drivers, it is important to perfectly distinguish and locate all the details, within the appropriate time, in particular, the direction, limits and accesses of the road and also the possible obstacles. On the other hand, for pedestrians it is essential to have a perfect visibility of the sidewalk limits, of vehicles and obstacles, and to have absence of shaded areas.

2.11.2 Lighting classes

In Portugal, outdoor lighting installations are grouped by classes (A, B and C), depending on the characteristics of each road, the nature and the importance of traffic and the frequency of pedestrians:

CLASS A:

Lighting for main roads, with fast and intense traffic, for which it is important to have in mind questions related with security, speed and comfort conditions during traffic circulation.

CLASS B:

Lighting for important roads, with significant flow of vehicles and pedestrians and for which it is important to have in mind, besides the vehicles circulation, also the interests of pedestrians and local stores and, also, urban aesthetics.

CLASS C:

Lighting for residential areas, mainly local traffic and with minor importance.

The classes A and B are divided in two subclasses, 1 and 2, according to the importance of the road. Table 1 establishes the link between the outdoor lighting installations and the type of roads. The presented recommendations concern mainly the lighting plan for major routes and other roads of relevant importance.

2.11.3 Performance requirements

Table 1 includes the recommendations, regarding the level and uniformity of luminance, the degree of glare, and the types of luminaires preferred or admitted for each type of outdoor lighting installation. For instance, Class A corresponds to the highest level and uniformity of luminance, while glare should be strictly reduced. However, Class B can include higher tolerance, in what regards the level and uniformity of luminance and glare, what can be easily justified by the particular character of arteries and, specially, the presence of facades.
The figures presented in Table 1, correspond to average values of exploitation, and for that, the depreciation of the installation is considered. The lifetime of lamps and the cleaning level of the luminaires should in fact be considered. In general, if is considered a regular maintenance, the figures presented in Table 1 correspond to 75% of the initial figures, that is, the outdoor lighting project of an installation has to start with values 1,33 times superior to those presented here.
These conclusions are the result of static and dynamic experiments, and are considered necessary and justified by the requirements of safe vision of drivers.

Table 1 – Recommendations for road lighting in different types of roads.

Class of the outdoor lighting installation	Type of road		Average level of illuminance in wet pavement [cd/m^2]	Uniformity of luminance in wet pavements	Glare	Type of luminaries	
A1	Highways		2	Very good	Strictly reduced	Preferred	Accepted
A1	Roads in open field	Intense traffic				Limited distribution (Cut-off)	Semi-limited distribution (Semi cut-off)
A2		Considerable traffic	1	Good			
-		Reduced traffic	Without outdoor lighting system				
A1	Urban roads	Ring roads	2	Very good	Reduced	Limited distribution (Cut-off)	Semi-limited distribution (Semi cut-off)
B1		Main arteries (local traffic)	1	Good	Moderated	Limited or semi-limited distribution (Cut-off or semi cut-off)	Non limited distribution (No cut-off)
B2		Secondary streets (local traffic)	0,5	Satisfactory			

2.12 Slovenia

In Slovenia there is a distinction between roads in responsibility of state and between roads and streets in responsibility of particular municipalities.

Roads in responsibility of the state are further devided to:

- highways (in responsibility of National Highway Authority)
- other main roads (in responsibility of National Road Administration)

Concerning road lighting there is no common policy or practice where to apply road lighting. There are some studys giving general guidance for example for highway junctions, but officially there is no exact requirement.

Common to all types of road lighting is, that where road lighting is applied, it has to be designed according to EN 13 201 (in Slovenia SIST EN 13 201).

Other general guidance is given in Recommendations of Slovene Lighting Association for Road lighting. The recommendations are mostly consistent with EN 13201.

Road lighting in municipalities: every municipality is responsible for the road lighting at its own area and creates local policy in local documents.

Where lighting is applied, it shall conform to the requirements of SIST EN 13201.

The other local document dealing with road lighting is national law called “Requirements for the limitation of obtrusive light” in force since september 2007. This law was prepared by non experts, it is obsolete, because in public lighting it enforces the solutions

which are more energy demanding. But lighting designers through the country have to respect the requirements of this document.

2.13 Sweden

2.13.1 Abstract

In Sweden the Swedish Road Administration has the responsibility for planning and design, installation and maintenance of road lighting on public roads. The municipalities have the same responsibility for local roads / streets within city centers.

Guidelines for design of roads and streets are presented by Swedish Road Administration and the Swedish Association of Local Authorities and Regions (Kommunförbundet) in collaboration.

The guidelines are called VGU (VV Publication 2004:80) and replace both VU94 (general advises for national roads) and ARGUS (general advises for streets).
VGU covers most aspects on street- and roadlighting. In some cases it also refers to other publications.

The main purpose of VGU is to increase the safety for pedestrians and cyclists.

2.13.2 Lighting policy

2.13.2.1 General

National roads are owned and maintained by the Swedish Road Administration. All local roads in cities are owned and maintained by the municipalities.

New guidelines for design of roads and streets are presented by Swedish Road Administration and the Swedish Association of Local Authorities and Regions (Kommunförbundet) in collaboration.

The guidelines are called VGU (VV Publication 2004:80) and replace both VU94 (general advises for national roads) and ARGUS (general advises for streets). The purpose of this publication is to increase the safety for pedestrians and cyclists. It is based on the European standards, SS-EN 13201 and SS-EN 13201-2.

In VGU chapter 7 is dedicated to road and street lighting. The chapter describes for example as follows:

- Valid laws and regulations
- Adaption to environmental conditions
- Principal design of lighting installations, fittings, light sources, poles
- Guidelines regarding lighting design

Rehabilitation, maintenance issues is not discussed in the publication.

Principals for night-lighting and dimming are briefly covered.

2.13.2.2 City of Göteborg

In Sweden the guidelines from Swedish Road Administration are generally adapted but when it comes to the next level, the cities and municipalities, local policies and guidelines for implementation can be a bit different.

Traffic & Public Transport Authority, Göteborg has decided to work for a cost-effective investment in energy efficiency together with a way to use the light to make people in the community to see lighting in a new creative way that makes them feel secure.

Göteborg has its own local guideline, TPU. TPU stands for planning and installation of infrastructure. It is also valid for lighting equipment in order to help and guide involved staff eg. architects, engineers etc. In addition, Göteborg has initiated a number of plans to save energy, environment and reduce cost.

Plan for lamp sources

- Started 10 years ago changing lamp sources from mercury lamps to high pressure sodium and in the public areas to metal halogen

Plan for power reduction

- Started two years ago so between 22.00 to 05.00 are all the luminaires from 70 W and upward reduced

Plan for adaptive lighting in Göteborg

- Overall strategy for the town in the future/looking to different solutions through pilot projects starting in 2007 with two main streets (total 270 luminaires) continuing during 2008 with three new main streets (total 250 luminaires)

Development plan for adaptive lighting in Göteborg

- There is now planning in progress for adaptive lighting to get benefits for different events in Göteborg such as the yearly event “Julstaden” at Christmas but also for different sports event

Plan for maintenance

- Exactly planned maintenance activities
- More efficient and less replacement
- Long term investment goals
- Open and flexible systems, possible to adopt to new demands, with longer lifetime

2.13.3 National code of practice for road lighting

2.13.3.1 Need of road lighting

General

Effect of road lighting on the traffic safety

- In the VGU publication it is described estimated relations between installed lighting and accidents in darkness.

Lighting as a part of the road environment and objects to be lighted

- Briefly described in VGU, as adoption to environmental conditions

Economic calculations

- National recommendations for economic calculations are not covered by VGU today. Although, during the work with VGU, economic calculations including traffic safety aspects etc. to find out the traffic limits for different roads, motorways, dual carriageways among others was done. But we have not shown the calculations in the document.

Adaptive road lighting

- In VGU only described in general terms as power reduction in lighting installations.

City of Göteborg

Effect of street lighting on the traffic safety

- Traffic & Public Transport Authority, Göteborg is having a dialogue with Swedish Road Administration how to evaluate the effect of using Adaptive lighting on two of our main streets in Göteborg (Högsboleden and Tuveleden/ total 270 luminaires) for safety

Lighting as a part of the street environment

- Tests of Adaptive lighting on five different streets in Göteborg to evaluate visibility, atmosphere and environmental aspects during day and night and variations of year (total 520 luminaires)

2.13.3.2 Performance requirements for lighting parameters

This is described in VGU (VV Publication 2004:80).

Roads and streets for motorized traffic

- According to SS-EN 13201
- Luminance concept is used on roads and highways
- Illuminance concept is used in conflict areas as commercial streets, crossings, roundabouts and in areas also used by pedestrians and cyclists
- Recommendations are presented in VGU (VV Publication 2004:80), table 2-2, 2-3, 2-4 and 2-5

Roads for pedestrians and cyclists

- According to SS-EN 13201-2
- Recommendations are presented in VGU (VV Publication 2004:80), table 2-6, 2-7, 2-8 and 2-9

2.13.3.3 Public roads on rural areas

This is described in VGU (VV Publication 2004:80).

Recommendations of lighting in rural areas are described in chapter 3. The need of lighting is considered according to

- Traffic volume
- Specific installations on the roads, eg. roundabouts, crossings, ferry berths, tunnels
- Places with a high number of accidents in darkness
- Places with a lot of light disturbance

2.13.3.4 Roads and streets on urban areas

This is described in VGU (VV Publication 2004:80).

Recommendations of lighting in urban areas are described in chapter 4. Normally lighting is recommended in all urban areas. The lighting should be applied according to traffic situation, users (both traffic and pedestrians/cyclists) and needs of beautification.

2.13.3.5 Tunnels

This is described in VGU (VV Publication 2004:80).

Recommendations of lighting in tunnels are described in chapter 6. The lighting is divided into an number of categories:

- Night-time lighting (according to the same principles as road lighting)
- Day-time lighting (adapted to luminance levels of daylight)
- Emergency lighting (optimized for an evacuation of the tunnel)
- Stand-by lighting (in case of power failure)

2.13.3.6 Planning and design

General

Laws and regulations applied in Sweden are described in VGU (VV Publication 2004:80).

All materials in lighting installations should be designed and installed according to valid laws and regulations and fulfill Swedish norms for testing equipment.

City of Göteborg

Traffic & Public Authority, Göteborg is member of an organization, LUCI which is a network between 80 different cities working for better city beautification.

The work with LUCI is organized around four topics

- Environmental questions
- Architecture/lighting design
- City lighting plans
- Strategy/development for the future when it comes to lighting

2.13.3.7 Lighting plans

General

Implementation is described in VGU (VV Publication 2004:80), chapter 7. It covers a number of issues like:

- The purpose of using lighting
- Adaption to environment
- Light orientation
- Technical issues like recommendations when choosing fittings, bulbs

A number of municipalities in the country have according to the national directives above formed their own lighting plans for a city or a specific area.

City of Göteborg

A lighting plan is under construction for Göteborg including guidelines for lighting in the city including streets, parks, squares etc.

In the lighting policy for the city there are intensions to avoid too much light and get more light where it is needed and requested. In addition, a plan will be established for open air areas taking into consideration the need of a plan for the lighting in the centre of Göteborg after dark. It is important to know how people transport themselves after dark to make this an issue when the plans are worked out.

Feasibility study

In order to analyse the viability of adaptive road lighting a number of pilot project have been realized. The initiators have in most cases been the Swedish Road Administration or bigger cities / municipalities.

There is also a forum for consultation between representatives from Stockholm, Malmö, Göteborg, Västerås, Sundsvall and the Swedish Road Administration. This forum arrange meetings twice a year in order to exchange experiences regarding road- and street lighting.

In addition to these activities the Authority is continuously testing equipment from different manufacturers in order to evaluate possibilities to save energy, reduce maintenance and to use light in new ways within the city area.

Preliminary engineering

Same principles as described in the paragraph 2.11.3.7 are followed.

Final engineering

Today there are no specific national guidelines regarding intelligent control / adaptive lighting. Normally a specification is defined covering the control system for such an installation. This specification is today established by the responsible authority. A specification shall at least contain the following parts:

- General requirements / system design
- Technical requirements, both local and central systems
- Functional requirements, both local and central systems
- Performance requirements, both local and central systems
- Design procedure
- Quality assurance and control requirements
- Documentation requirements
- Maintenance requirements
- Training requirements

2.13.3.8 Procurements

A lighting installation is normally bought by a Contractor as a total contract according to the rules of public purchasing. In most cases both design, installation and maintenance through the warranty period is included in the contract price.

2.14 United Kingdom

2.14.1 General guidelines

While local authorities in the UK used to have individual lighting polices, these have all fallen by the wayside. Most now use the technical documents issued by the ILE (Institute of Lighting Engineers), there is:

TR24 – “A practical guide to the development of a public lighting policy for local authorities.”
TR23 – “Lighting of Cycle Tracks.”
TR27 – “Code of practice for variable lighting levels for Highways.”
TR25 – “Lighting for traffic calming areas.”

2.14.2 British standards

All above mentioned refer back to BS5489 – 2003 and BS EN 13201 – 2004 which deal with the relevant design criteria.

BS 5489 and BS EN 13201 were published on 11th December 2003, and have now

established themselves as well structured, well used standards which provide competent Lighting Engineers with the guidance and tools to design good quality, safe lighting schemes.