# Dynamic Controls and Lighting Zones

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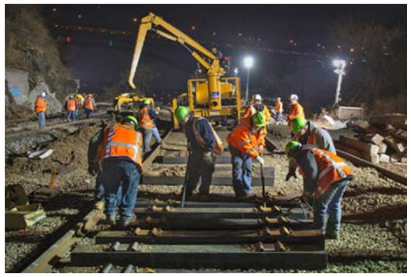
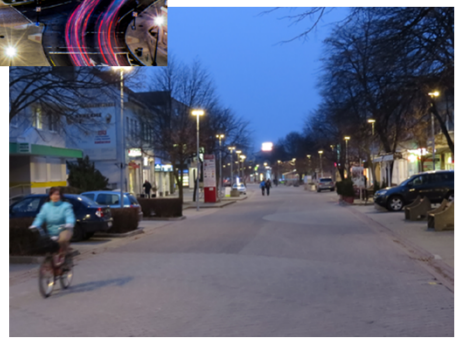
# CIE Division 4: Diversity of outdoor lighting applications

ROADWAYS

MEANS OF TRANSPORTATION



OUTDOOR WORKPLACES

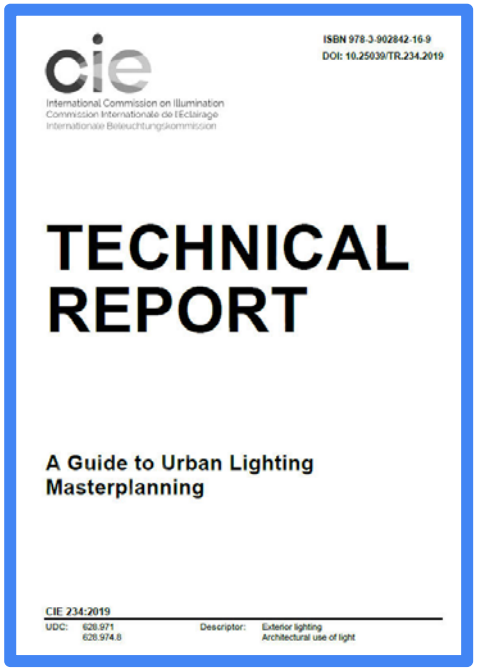


PEDESTRIANS & CYCLISTS

FLOODLIGHTING

SPORTS LIGHTING

# 1. Urban Lighting Masterplan




## CIE 234:2019

Framework document establishing general policy for public lighting installations in a city

- Rules for static and dynamic lighting
- Zoning of the territory (urbanistic, traffic, environmental)
- Also floodlighting of private properties

# 1. Urban Lighting Masterplan

Masterplanning should avoid this:

Excess luminance of a hotel (private property)

Traffic node with bus stops

# 1. Urban Lighting Masterplan

Features of masterplan in brief:

- Holistic approach
- Participation of all stakeholders
- Long-term team work
- Three key aspects are functionality, expression and environmental considerations

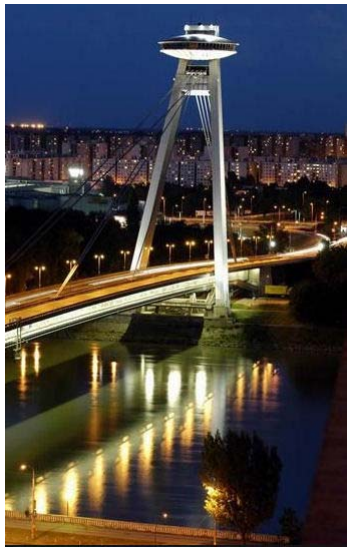
**CIE 234:** Obtrusive light is subject of a self standing chapter dealing with sky glow, light trespass, glare, saturated and dynamic colours

# 1. Urban Lighting Masterplan

Two major forms of lighting in lighting masterplan:

Technical lighting

Architectural lighting



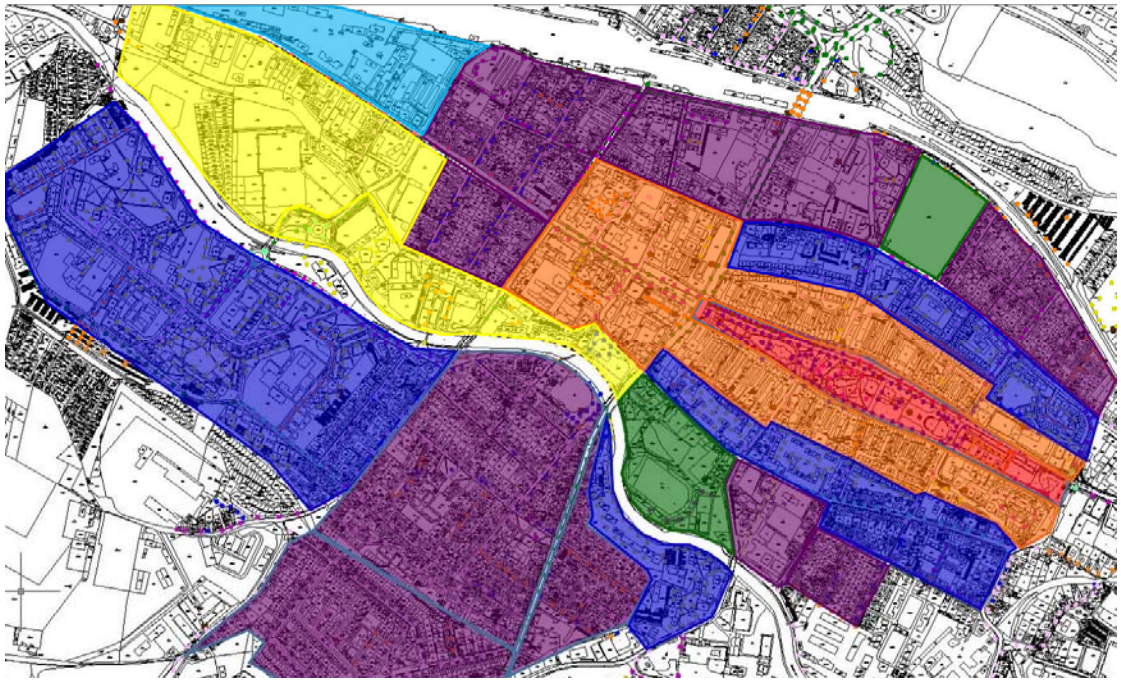
Three main stages of lighting masterplan:

1. Analytical stage

2. Design stage

3. Implementation stage

# 2. Lighting zones

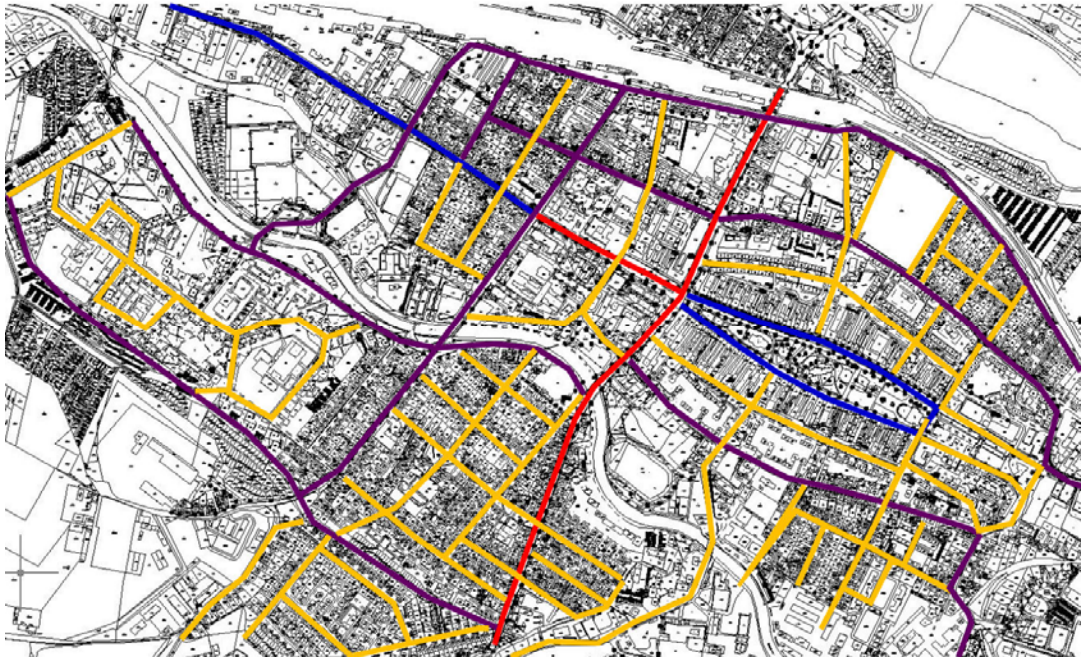


## Urbanistic zones:

- Analysis of city districts
- The initial stage which determines further analyses and zonings

| | |
|---|---|
| 1 | City centre |
| 2 | Wider city centre |
| 3 | Neigbourhood settlements |
| 4 | Residential areas |
| 5 | Green zones |
| 6 | Commercial zones |
| 7 | Industrial zones |
| 0 | Unused areas |

# 2. Lighting zones



## Utility lighting zones:

- Motorized traffic routes
- Pedestrians and cyclists
- Squares and plazas
- Parks and green places
- Playgrounds
- Etc.

Classification of roads for motorized traffic based on analysis of traffic (M-classes)

M3 M4 M5 M6

# 2. Lighting zones

## Lighting levels for motorized traffic

| Lighting class | $L_{av}$ (cd.m$^{-2}$) | $U_o$ | $U_l$ | $f_{TI}$ (%) | $R_s$ |
|---|---|---|---|---|---|
| M1 | 2,0 | 0,40 | 0,70 | 10 | 0,5 |
| M2 | 1,5 | 0,40 | 0,70 | 10 | 0,5 |
| M3 | 1,0 | 0,40 | 0,60 | 15 | 0,5 |
| M4 | 0,75 | 0,40 | 0,60 | 15 | 0,5 |
| M5 | 0,50 | 0,35 | 0,40 | 15 | 0,5 |
| M6 | 0,30 | 0,35 | 0,40 | 20 | 0,5 |

Road surface luminance

Quality parameters:
- uniformity (overall, longitudinal)
- threshold increment (glare)
- edge Illuminance Ratio

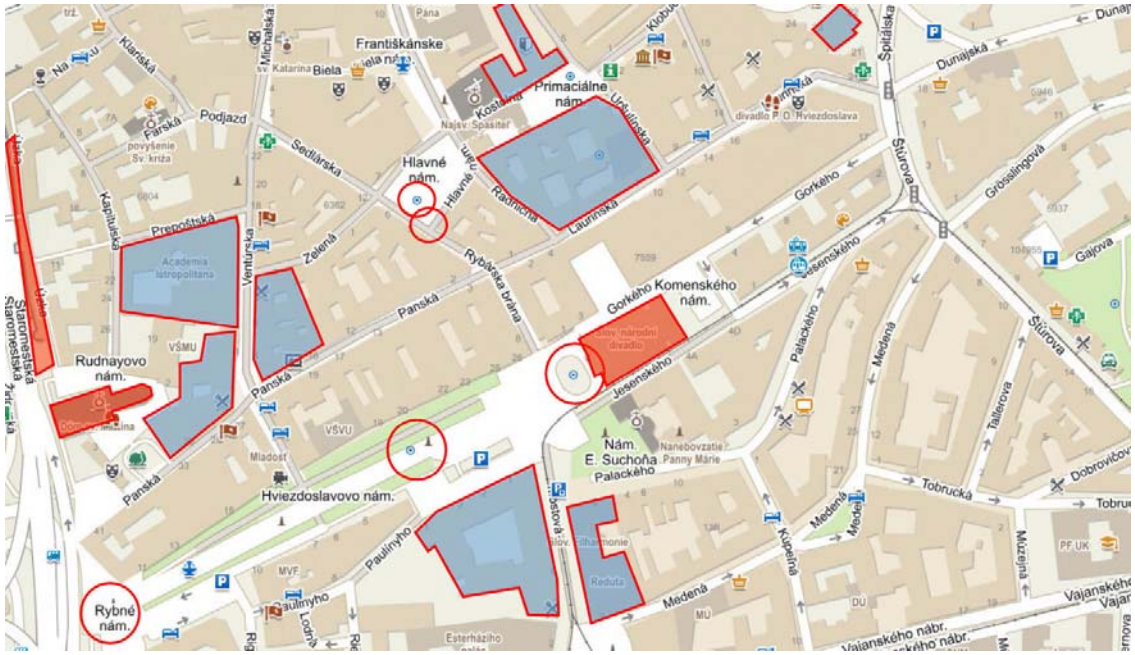
## Lighting classes for pedestrian and low-speed traffic

| Lighting class | $E_{h,av}$ (lx) | $E_{h,min}$ (lx) | $E_{v,min}$ (lx) | $E_{sc,min}$ (lx) |
|---|---|---|---|---|
| P1 | 15 | 3,0 | 5,0 | 3,0 |
| P2 | 10 | 2,0 | 3,0 | 2,0 |
| P3 | 7,5 | 1,5 | 2,5 | 1,5 |
| P4 | 5,0 | 1,0 | 1,5 | 1,0 |
| P5 | 3,0 | 0,6 | 1,0 | 0,6 |
| P6 | 2,0 | 0,4 | 0,6 | 0,4 |

Horizontal illuminance

Quality parameters:
- Vertical illuminance
- Semicylindrical illuminance

# 2. Lighting zones




## Architectural lighting zones:

- Landmarks, hotspots, places of interests
- Attributes: function, historical value, appearance, visual quality, symbolic quality, silhouette
- Viewing distances (near, medium, large) – affects the luminance value
- Viewing angles

# 2. Lighting zones

CIE Environmental zones

| Zone | Lighting Environment | Examples | Additional recommendations |
|---|---|---|---|
| E0 | Intrinsically dark | UNESCO Starlight Reserves, IDA Dark Sky Parks, Major optical observatories | All locations within 100 km of a major optical astronomy observatory regardless of the level of urban development |
| E1 | Dark | Relatively uninhabited rural areas | |
| E2 | Low district brightness | Sparsely inhabited rural areas | Locations within 30 km of an operating urban optical astronomy observatory and locations between 100 km and 300 km from a major optical astronomy observatory regardless of |
| E3 | Medium district | Well inhabited rural and urban settlements | |
| E4 | High district bightness | Town and city centres and other commercial areas | |

Area where specific activities take place or are planned and where specific requirements for the restriction of obtrusive light are recommended

Environmental zones:

- Air quality and pollution (ingress protection and maintenance factor of luminaires)
- Light pollution

**CIE 150:2017** Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations

# 2. Lighting zones

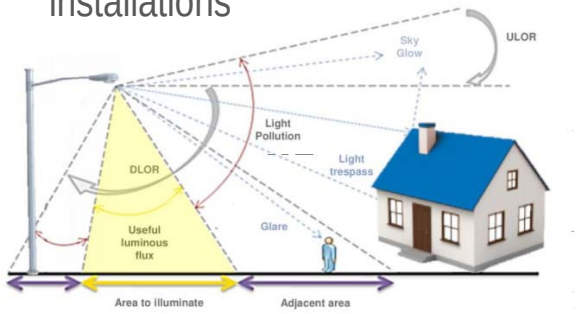
Maximum values of ULR of luminaires and UFR of lighting installations

| Light Technical Parameter | Type of installation | Environmental Zone | | | | |
|---|---|---|---|---|---|---|
| | | E0 | E1 | E2 | E3 | E4 |
| Upward Light Ratio (ULR) | | 0 % | 0 % | 2,5 % | 5 % | 15 % |
| Upward Flux Ration (UFR) | Road | N/A | 2 % | 5 % | 8 % | 12 % |
| | Amenity | N/A | N/A | 6 % | 12 % | 35 % |
| | Sports | N/A | N/A | 2 % | 6 % | 15 % |

Upward light/flux ratio is proportion of luminous flux emitted to the upper hemisphere (above horizon) to the total luminous flux (*simplified description*)

## Upward ratios:

- Upward Light Ratio (ULR): comparison of luminaires
- Upward Flux Ratio (UFR): comparison of lighting installations



# 2. Lighting zones

CIE Environmental zones

| Environmental zone | Building facade | Sign |
|---|---|---|
| | $L_b$ (cd.m$^{-2}$) | $L_s$ (cd.m$^{-2}$) |
| E0 | < 0,1 | < 0,1 |
| E1 | < 0,1 | 50 |
| E2 | 5 | 400 |
| E3 | 10 | 800 |
| E4 | 25 | 1 000 |

Large areas

Small areas

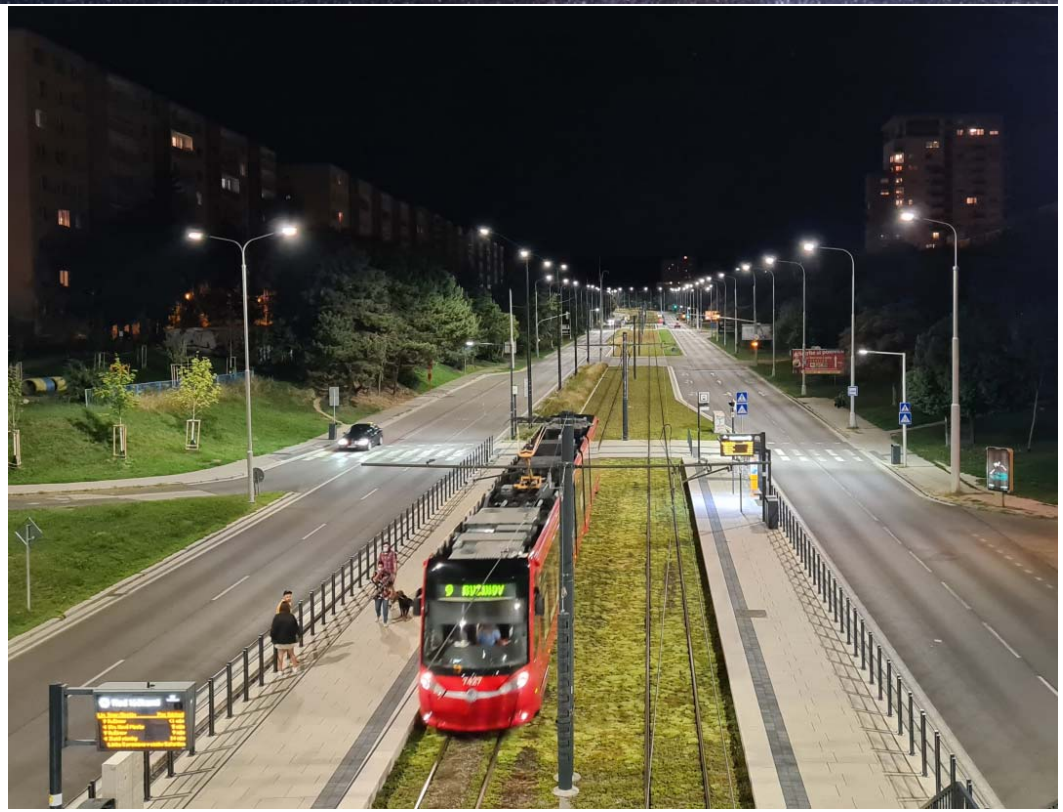
## Curfew:

- The values apply for both pre- and post-curfew
- Zones 0 and 1: the values shall be ZERO post-curfew

# 3. Dynamic controls

**Adaptive lighting** (ILV, 17-29-027)
lighting responding to circumstances or according to predefined conditions, while maintaining the lighting quality within the specified requirements for these circumstances or conditions

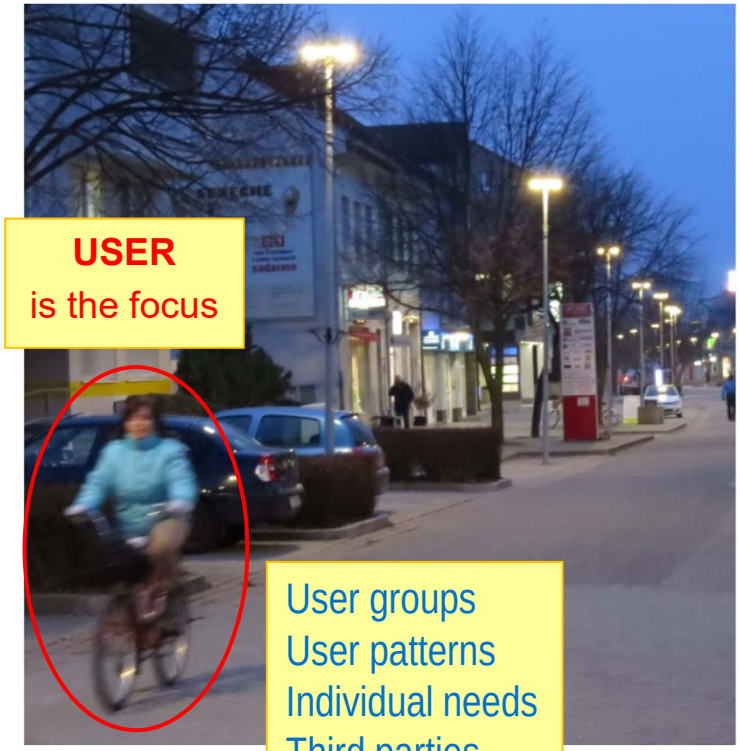
- The requirements can focus on different aspects such as energy efficiency, dynamic user needs, visual task or ambience
- The terms "smart" and "intelligent" lighting are sometimes used with a similar meaning



# 3. Dynamic controls

**INPUTS:**
Traffic composition
Traffic intensity
Presense of vehicles/persons
Climatic conditions
Actual weather
Local conditions
Individual preferences/needs
...

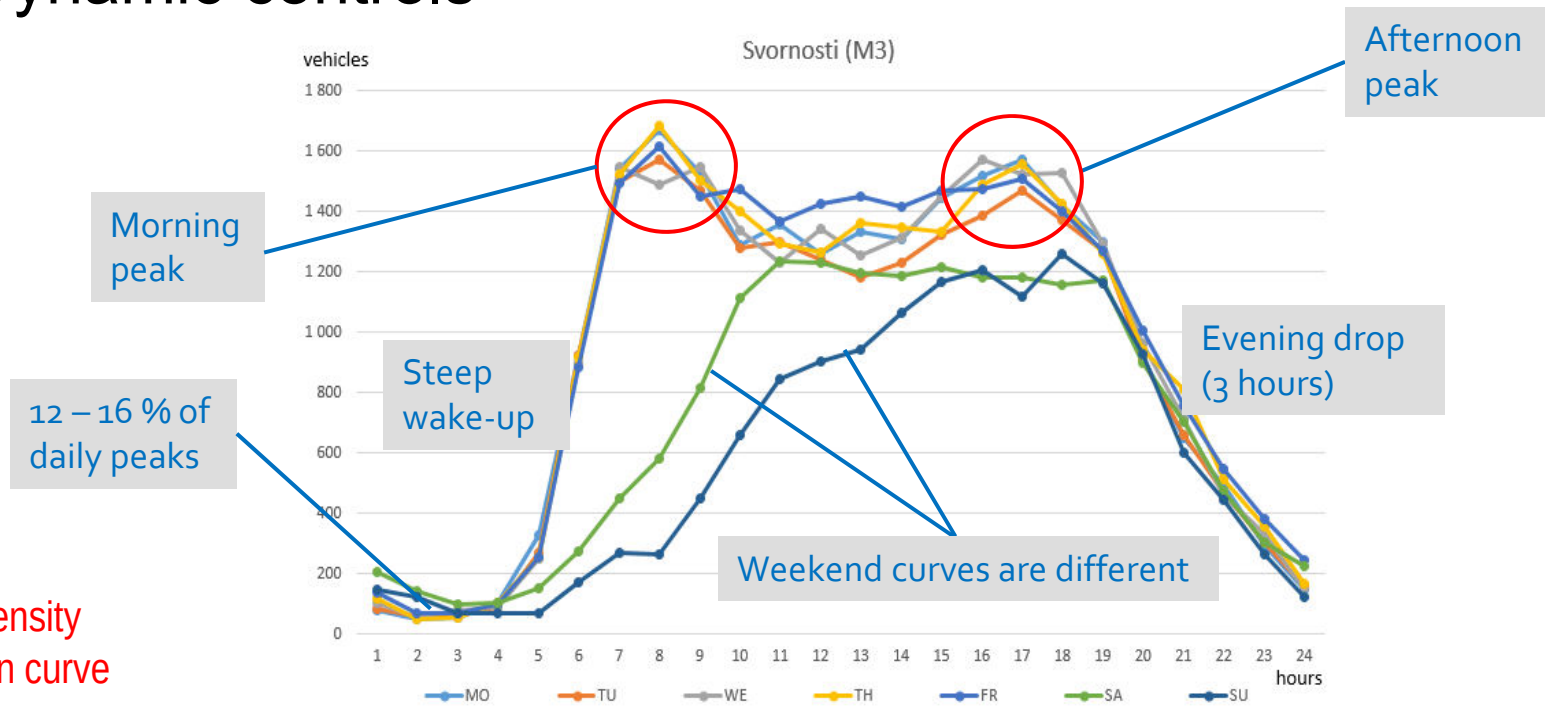
Field of sensors and other data providing equipment




**OUTPUTS:**
Light level
Uniformity
Spatial characteristics
Spectral characteristics
...

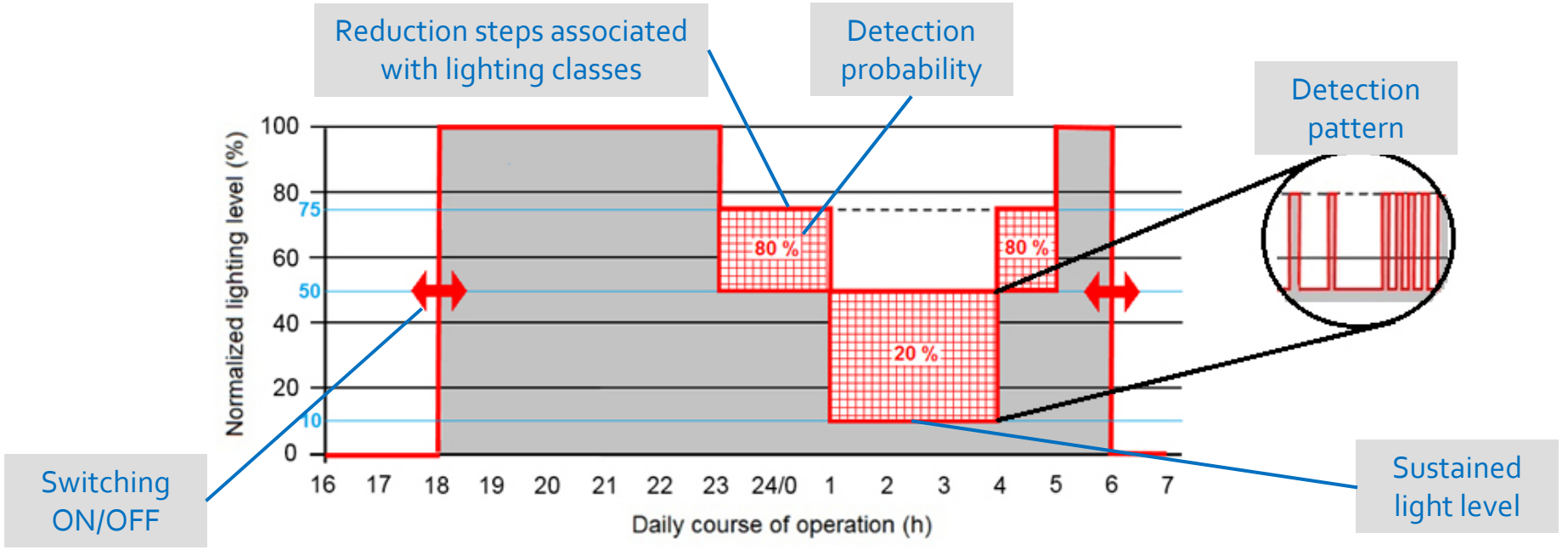
Field of luminaires and other data receiving equipment (interoperability)

# 3. Dynamic controls



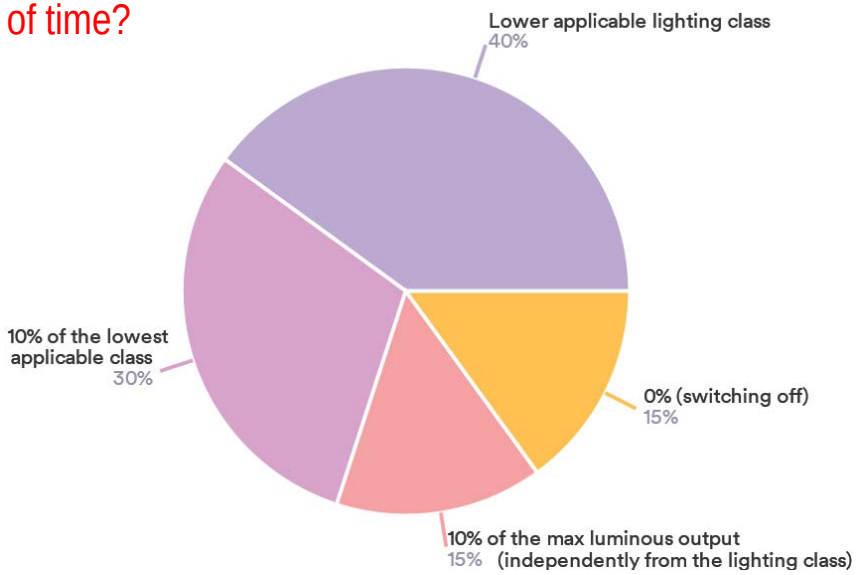

Traffic intensity distribution curve

# 3. Dynamic controls



# 3. Dynamic controls

Q: Which could be the most appropriate dimming level on a residential road when no traffic is detected for a certain period of time?




## Questionaire na ARL:

- Majority of the respondents prefer keeping of certain light level
- Rural roads – the answers are evenly distributed, 30 % opted for switching off the lighting

P6 lighting class (2 lx) is still able to provide basic function to the pedestrians!

Moonlight: up to 0,1 lx

# 3. Dynamic controls

Directions in adaptive road lighting:

- Dynamic adjustment of the most appropriate light levels
- Architecture towards advanced distributed systems
- Enhancing the interoperability with relevant services
- Variable and „future proof“

# 3. Dynamic controls

Outdoor workplaces:

- Major contributions to obtrusive light
- Lighting control techniquest similar to road lighting can be implemented
- Necessary to limit the lighting to the place and in time when it is needed

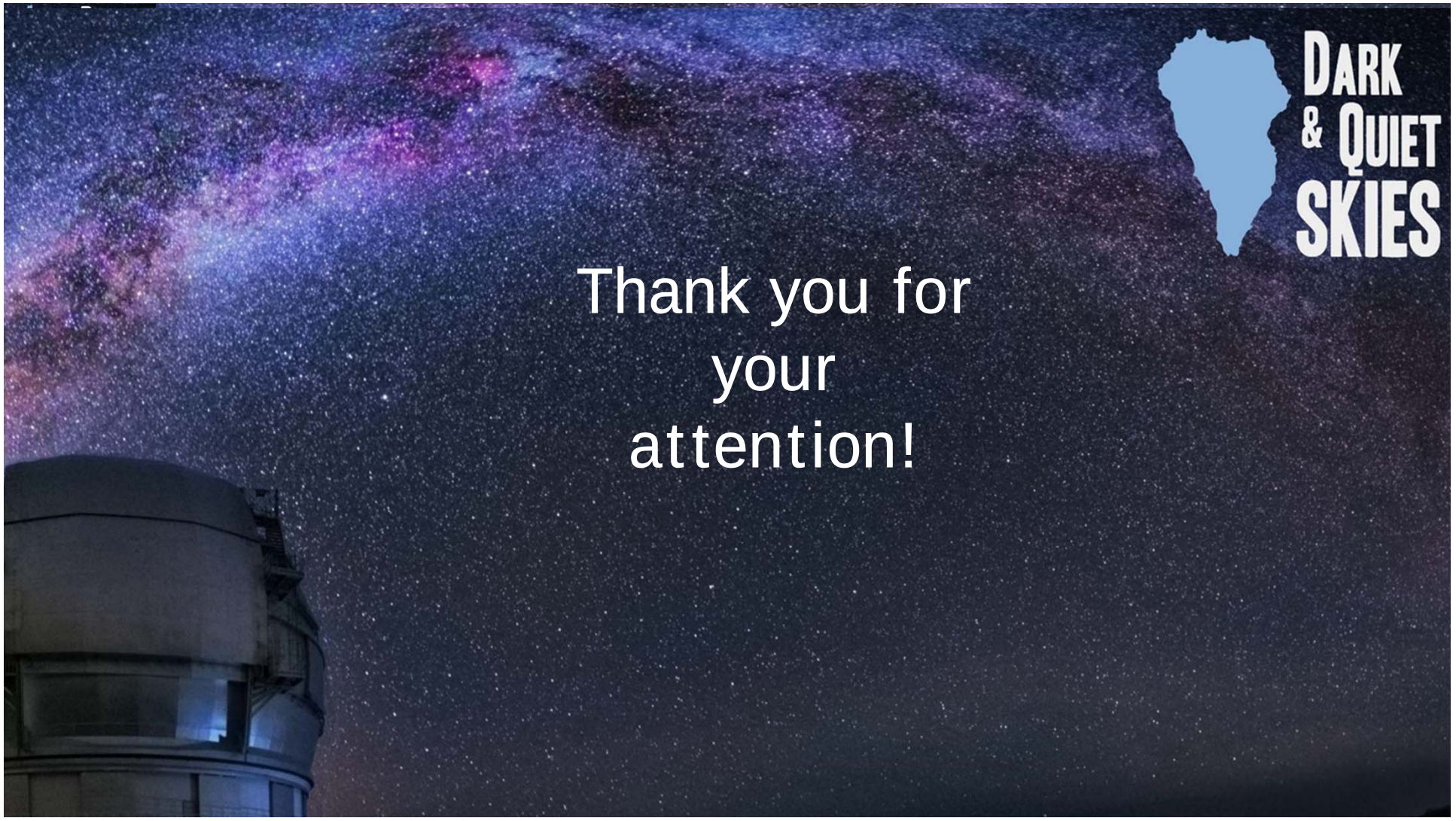
# 4. Conclusions

Urban lighting master plan is a policy-making framework document of paramount importance for all interested parties

Zoning of urban (and other) areas is necessary to establish clear rules on lighting including restrictions where necessary

Adaptive lighting allows to dynamically control light levels, spectrum and other quality parameters

Mitigation of obtrusive light is a strong motivation for implementation of adaptive lighting


DARK
& QUIET
SKIES
Thank you for
your
attention!