Quality of road lighting

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In today’s world, feeling of safety is more and more important. Light and lighting contribute to better safety on roads and streets.

Fact

There is less traffic during the night (25%) but there are more accidents resulting in death or severe injury (45% of traffic fatalities occurs during the night).
**Fact**

Good road lighting means better safety and less accidents (some research show that lighting can reduce number of accidents during the night for up to 30%).

**Fact**

Increased illuminance means better visibility and less crime.

The ratio between the number of crimes at night and during the day at a certain illumination at night.

**Fact**

Needed electrical energy per capita (Finland 2009): 148 kWh yearly.
Fact

Yearly costs for electrical energy for road lighting (Finland, 2009): 7,5 €/capita.

Quality of road lighting

The quality of road lighting has many aspects:
• quality of life,
• technical quality,
• financial quality and
• ecological quality.

Quality of life with road lighting
Quality of road lighting

Quality of life: Road lighting can significantly improve the quality of life (less accidents, less crime, more business opportunities)

Quality of life

During the night traffic accidents are more frequent and have more serious consequences than during the day.

Number of injured

- Number of injured in total
- Number of injured during the day
- Number of injured during the night

More light on a road surface means less accidents and better safety.

The ratio between the number of accidents with injuries at night and during the day vs luminance of road surface in cd/m².
Quality of life

Light protects against crime.

With the increased illuminance of residential areas the crime rate drops.

Quality of road lighting

Technical quality of road lighting

Technical quality: road lighting should meet standard criterions to ensure other quality aspects.
Technical quality

The basic motto of road lighting: good visibility and be easily visible for all traffic participants.

Technical quality

Visual ability of people depends on luminance in their field of vision.

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Technical quality

Recognition of shapes (objects) depends on luminance or colour contrast (or both).

Technical quality

The basis for adequate vision is therefore appropriate luminance in our environment (field of vision). It can be defined by:

- luminance (cd/m²)
- illuminance (lx)
Technical quality

So what should we take care of when planning road lighting?

What is important at road lighting?

Minimum required level of luminance or illuminance:

On roads for motorized traffic, lighting is planned according to required luminance.

On streets and traffic area for mixed traffic, lighting is planned according to required illuminance.

What is important at road lighting?

Not just luminance or illuminance but also their uniformity!

If one lamp is switched off or broken, the resulting dark area might be dangerous for the road users (especially pedestrians and cyclists).
What is important at road lighting?

Limitation of glare!

Also:
- direction of light
- shadows
- colour of light
- colour rendering

On pedestrian areas (semi-cylindrical) vertical illuminance on the head level is also very important (for face recognition).
Technical quality

The criteria for road lighting depend on potential risk:
• density of traffic,
• participants in traffic,
• speed of traffic,
• road construction parameters.

Technical quality

Road lighting must provide participants in traffic good visibility of:
• area, course and borders of traffic surfaces,
• driveways and intersections,
• obstacles on the road,
• other road users.

Technical quality

Needed luminance and illuminance values for different roads can be found in:
• National standards,
• CIE documents,
• EN standards (13201).
Technical quality - Roads

Tasks and evaluation criteria for road lighting:
- direction of view is defined so we use luminance concept;
- density of traffic;
- tasks: to see course and borders of traffic areas, obstacles on road and other participants in traffic.

Technical quality - Roads

Optical guidance:
- luminaires should be placed so that they show the course of the road;
- different colour of light can be used to warn on dangerous areas (pedestrian crossings, crossroads ...)

Technical quality - Roads

<table>
<thead>
<tr>
<th>Separation of carriageways</th>
<th>Interchange spacing</th>
<th>Intersection density/km</th>
<th>Traffic flow (vehicles per day)</th>
<th>Standards and recommendations state minimum luminance (cd/m²) based on traffic and road parameters.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>≥3 km</td>
<td>0.75, 1.00</td>
<td>&lt;25,000</td>
<td>1.00, 1.50</td>
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</table>
Technical quality - Streets

Tasks and evaluation criteria for street lighting:

- less numbered but more diverse traffic participants;
- direction of view is not defined so we use concept of illuminance;
- tasks: to reduce threats to the weakest street users (pedestrian, cyclists), appearance of the street.

Technical quality - Streets

Standards and recommendations state minimum illuminance (lux) based on conditions

<table>
<thead>
<tr>
<th></th>
<th>Traffic flow pedestrians and cyclists</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>Parked vehicles</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3,0</td>
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<tr>
<td>Higher</td>
<td>5,0</td>
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<tr>
<td>Yes</td>
<td>5,0</td>
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<tr>
<td>Higher</td>
<td>7,5</td>
</tr>
</tbody>
</table>

Quality of road lighting

Financial quality
Quality of road lighting

Financial quality: the energy use and costs for maintenance and investments should be as low as possible.

Financial quality

The cost of road lighting:
• investments costs;
• maintenance costs;
• operating costs (costs of electrical energy).

Financial quality

The cheapest possibility: no lighting at all?!

Not always true!
**Financial quality**

Road lighting is relatively inexpensive:
Germany: 17.15 € per capita yearly:
- 10.00 € for operating costs;
- 7.15 € for electrical energy.

- Electrical energy
- Operating costs

**Financial quality**

Cheap luminaires doesn't always mean also low operating costs.

- Lighting installation with low-quality luminaires
- Maintenance: 5 years
- Maintenance: 7 years
- Maintenance: 9 years
- Maintenance: 11 years
- Maintenance: 13 years
- Maintenance: 15 years
- Maintenance: 17 years
- Maintenance: 19 years
- Maintenance: 21 years

**Financial quality**

More expensive luminaires could save maintenance costs.

- Maintenance in installation
- Maintenance after installation
- Maintenance: 3 years
- Maintenance: 5 years
- Maintenance: 7 years
- Maintenance: 9 years
- Maintenance: 11 years
- Maintenance: 13 years
- Maintenance: 15 years
- Maintenance: 17 years
- Maintenance: 19 years
- Maintenance: 21 years

- Energy Balance
Financial quality

With new and more effective lighting sources and lamps, up to 80% of electric energy can be saved. Investment return period: 2 to 6 years.

Financial quality

Refurbished lighting could also bring better light conditions and not only savings.

Financial quality

Also user acceptance and sense of security might be higher.
Quality of road lighting

Ecological quality

Ecological quality: impacts on the environment should be minimized to lowest level possible.

Ecological quality

Electrical energy consumption: production of electrical energy contributes to the CO₂ emissions.
Ecological quality

Lighting pollution: light which doesn't reach road surface but goes to nearby property or sky is not useful for road lighting.

"The Good"  "The Bad"  "The Ugly"

Ecological quality

Lighting pollution: A luminaire which does not cause light trespassing should be used.

Ecological quality

Recycling of lamps and luminaires: lamps and luminaires contain various (including toxic and harmful) substances, and represent a potential source of raw materials, so they should be recycled.
Ecological quality

Effects on insects and animals: artificial light at night can disrupt the rhythm of life of different types of insects and animals.

Effects on insects: UV part of the spectrum can attract insects

Conclusions...

- Street lighting is an indispensable part of our lives.
- Quality street lighting improves safety, saves energy and is environmentally friendly.
- Unfortunately, this is not always the case, so it is necessary to think about ways to improve street lighting.
Questions?