

Quality of road lighting

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Road lighting



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).

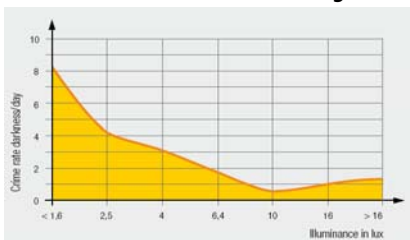
Fact



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 road lighting

Quality of life with road lighting

Quality of road lighting

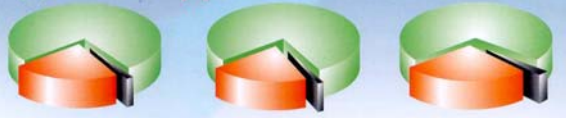


Quality of life: Road lighting can significantly improve the quality of life (less accidents, less crime, more business opportunities)

Quality of life

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

Moderate injuries, Severe injuries, Fatal injuries



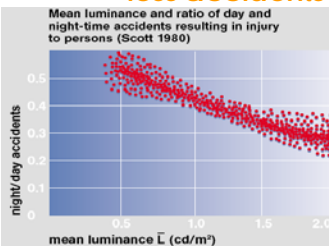
Number of injured in total

Number of injured during the day

Number of injured during the night

Quality of life

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



Mean luminance and ratio of day and night-time accidents resulting in injury to persons (Scott 1980)

The ratio between the number of accidents with injuries at night and during the day vs luminance of road surface in cd/m^2 .

Quality of life



Light protects against crime.

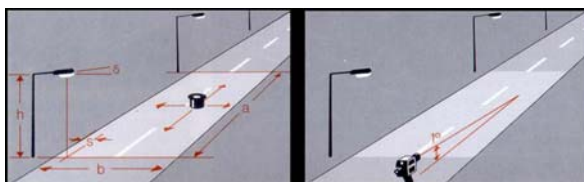
With the increased illuminance of residential areas the crime rate drops.

Quality of road lighting

Technical quality of road lighting

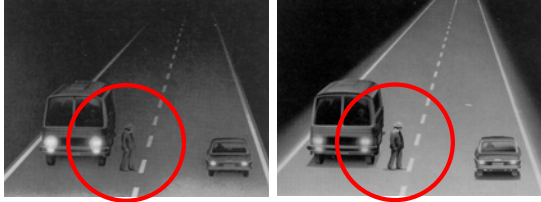
Quality of road lighting

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

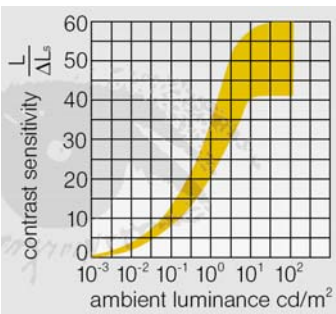


Technical quality

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

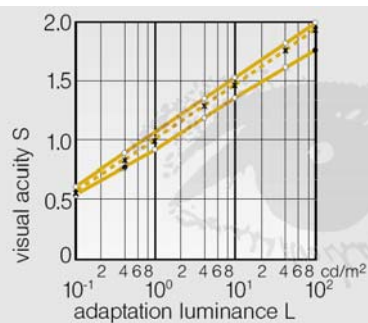


Technical quality



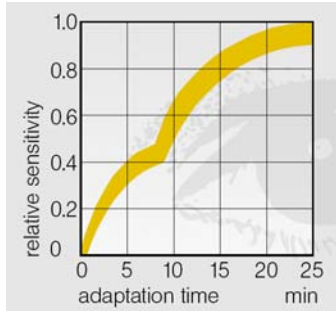
Visual ability of people depends on luminance in their field of vision.

Technical quality



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

Technical quality



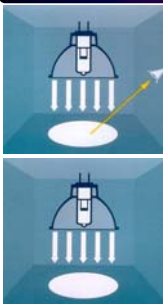
Visual ability of people depends on luminance in their field of vision.

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/m^2)
- illuminance (v lx)

Technical quality

So what should we take care off 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.

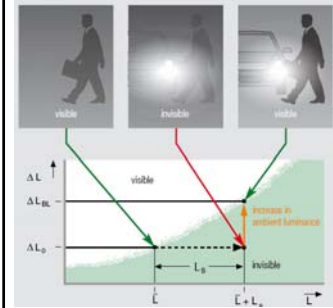
What is important at road lighting?

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!

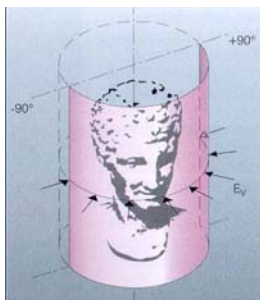


What is important at road lighting?



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

What is important at road lighting?



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:

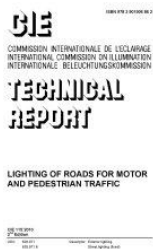
- area, course and borders of traffic surfaces,
- driveways and intersections,
- obstacles on the road,
- other road users.



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

Separation of carriage-ways	Inter-changes spacing	Intersection density /km	Traffic flow (vehicles per day)		
			<15.000	15.000 do 25.000	>25.000
Yes	> 3 km		0,75	1,00	1,00
	< 3 km		1,00	1,00	1,50
	< 3		0,75	0,75	1,00
	> 3		0,75	1,00	1,50
no	> 3 km		1,00	1,50	1,50
	< 3 km		1,50	1,50	1,50
	< 3		0,75	1,00	1,50
	> 3		1,00	1,50	1,50

Standards and recommendations state **minimum luminance (cd/m²)** based on traffic and road parameters.

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

Parked vehicles	Difficulty of navigational task	Traffic flow pedestrians and cyclists	
		Normal	High
No	Normal	3,0	5,0
	Higher	5,0	7,5
Yes	Normal	5,0	7,5
	Higher	7,5	10,0

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

Quality of road lighting

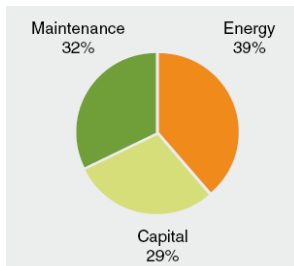
Financial quality

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:

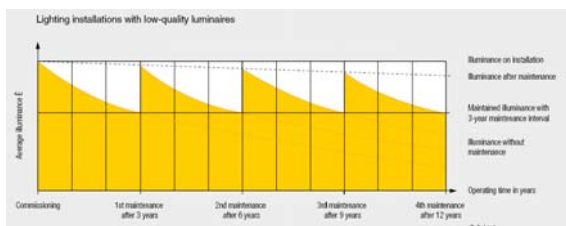
Germany: 17,15 € per capita yearly:

- 10,00 € for operating costs;
- 7,15 € for electrical energy.



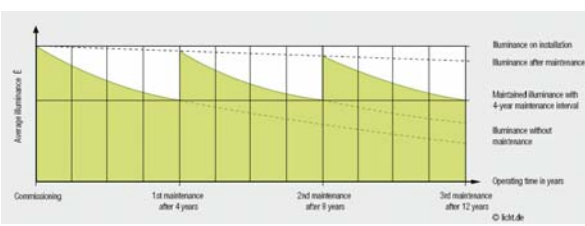
Financial quality

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

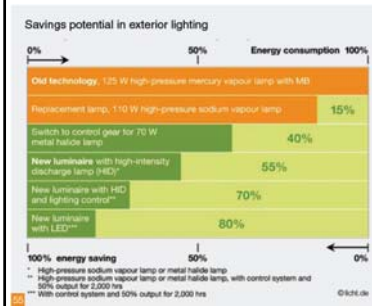


Financial quality

More expensive luminaires could save maintenance costs.



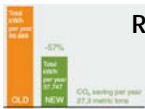
Financial quality



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

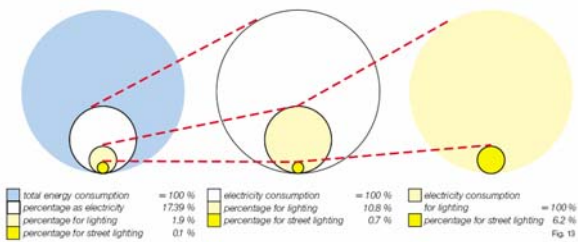
Quality of road lighting



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"



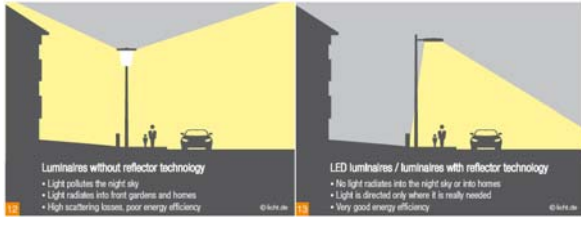
"The Bad"



"The Ugly"

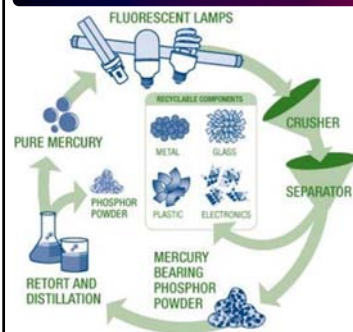
Ecological quality

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.



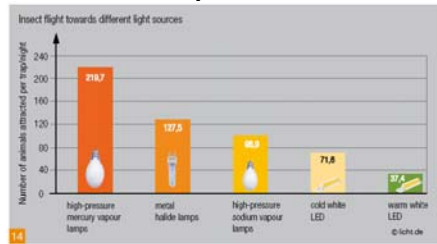
Ecological quality



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

Ecological quality

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.

... and:



Questions?
