City Street lighting

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United for Efficiency

01 - Benefits and Warning

02- Light sources

03 - Luminaires and control

04 - Off grid street lighting

05 - A comprehensive approach

01

Generalities

Public lighting

Safety

Development

Night life

Health

CO_2

Urban spread

Light pollution

Cost

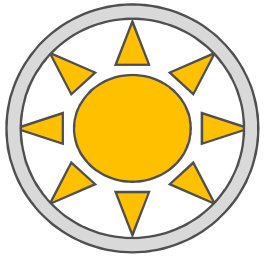
Maintenance

02

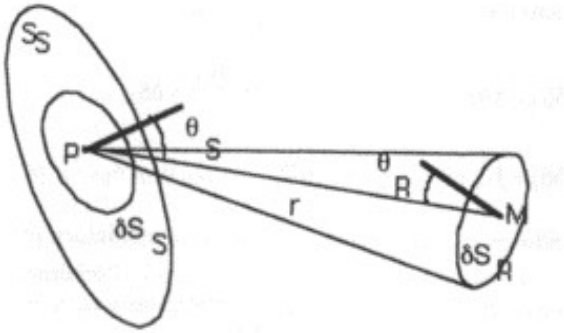
Light sources

Luminous flux

Flow of photons



Total flux
= quantity of light



Integrating sphere

lumen

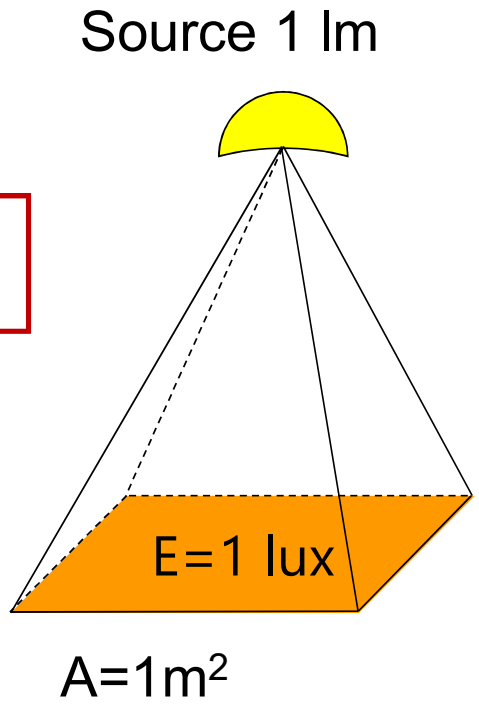
luminous flux of light produced by a light source of intensity one candela over a solid angle of one steradian

Illumination

A flux f of 1 lumen arriving on a surface of surface A = 1m^2 produces an illumination of 1 lux :

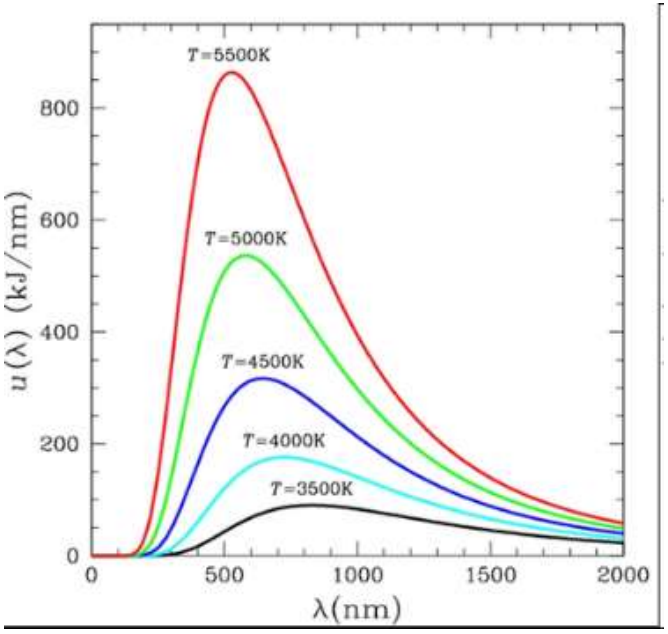
Luxmeter

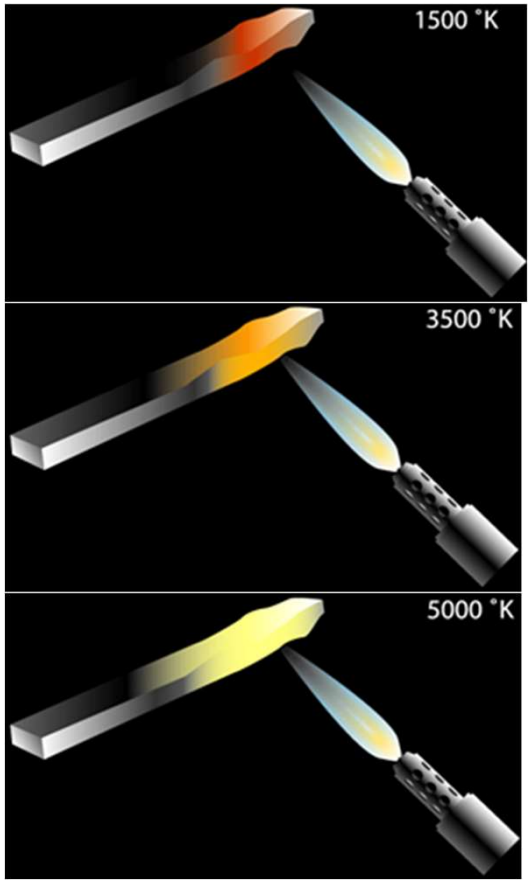
$$E = f / A$$



Colour temperature

The colour temperature of a source is the heat of a blackbody that produce a light of a similar appearance





Colour rendering index

Ability of a light source to keep their “real” colour to objects. Its values goes from 0 (no colour) to 100

Low pressure sodium

Power: 18 - 180 W

Efficacy: 98 - 200 lm/W

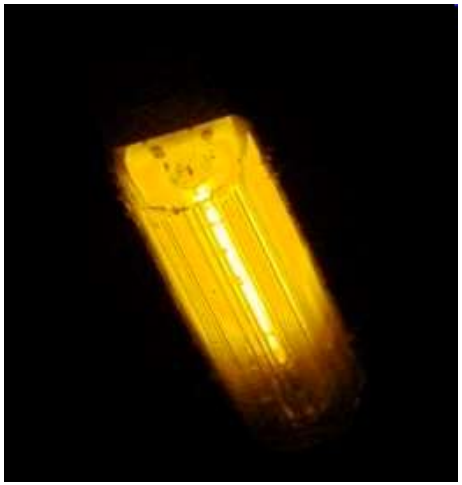
Energy efficiency: 40%

Lifetime: 12 000 - 18 000 h

CRI: N/A

Tcp: 1 700 - 1 800 K

Time to full light: 15 min



High pressure sodium (HPS)

Power: 50 – 1 000 W

Efficacy: 58 - 131 lm/W

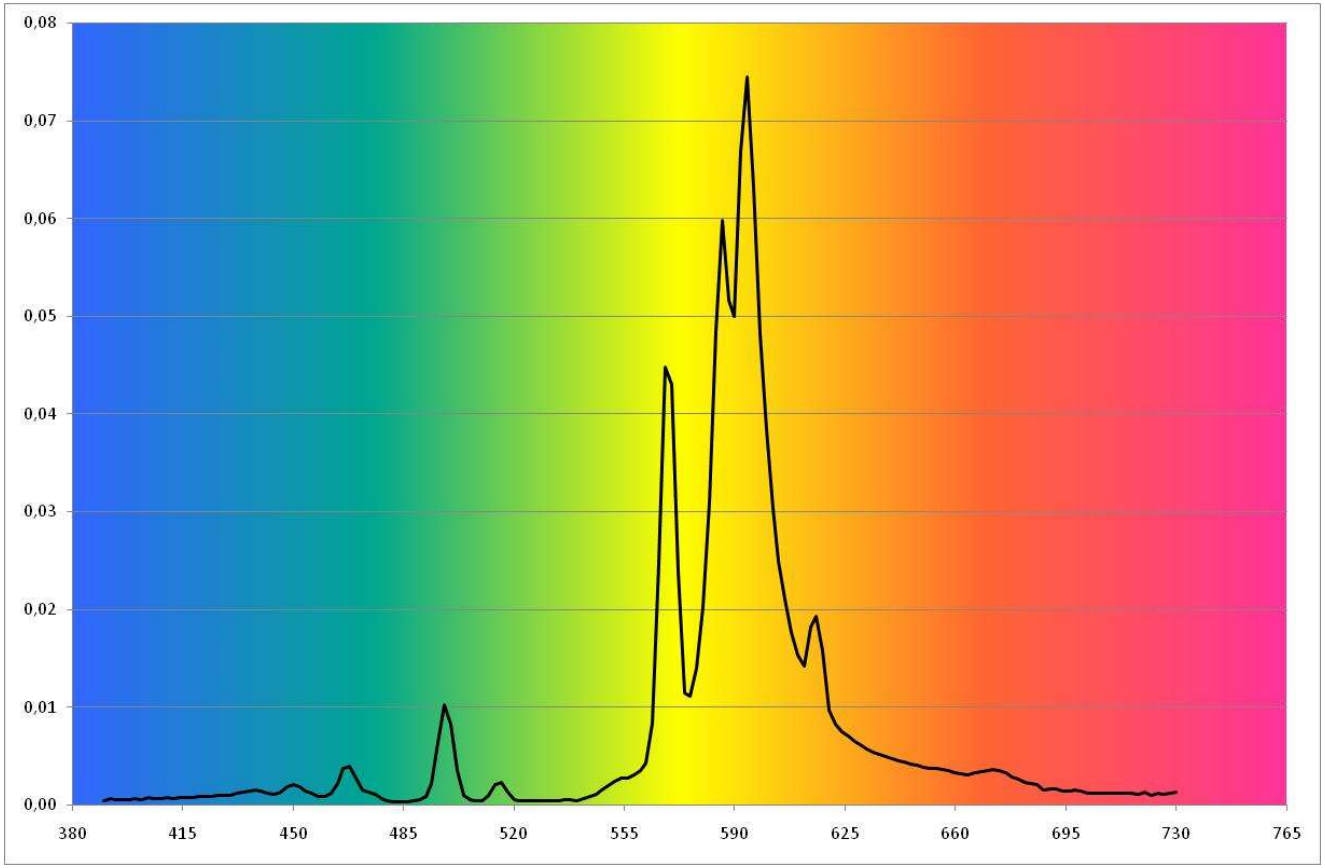
CRI: 20 - 65

Tcp: 2 000 – 2 150 K

Lifetime: 9 000 - 24 000 h

THORN

Spectrum of HPS



Ceramic metal halides lamps (CMHL)

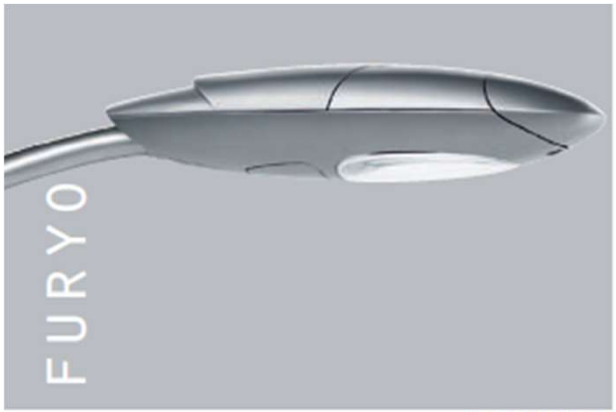
Power: 20 - 400 W

Efficacy: 70 - 115 lm/W

CRI: 86 - 95

Tcp: 3 000 – 4 500 K

Lifetime: 7 000 - 18 000 h



Design: Michel Tortel

High pressure mercury lamps

Power : 50 - 400 W

Efficacy: 25 - 50 lm/W

CRI: 15 - 60

T_{cp}: 3 000 – 5 500 K

Lifetime: 7 000 - 20 000 h

Mixed lamps (mercury vapor)

Power: 10 - 500 W

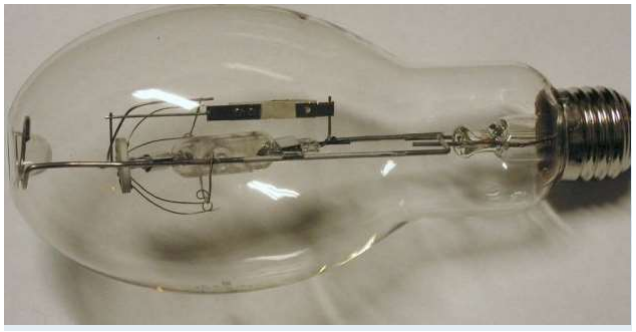
Efficacy: 15 - 25 lm/W

CRI: 15 - 60

T_{cp}: 3 000 – 5 500 K

Lifetime: 4 000 - 5 000 h

No control gear or starter



Induction lamps

Without electrodes

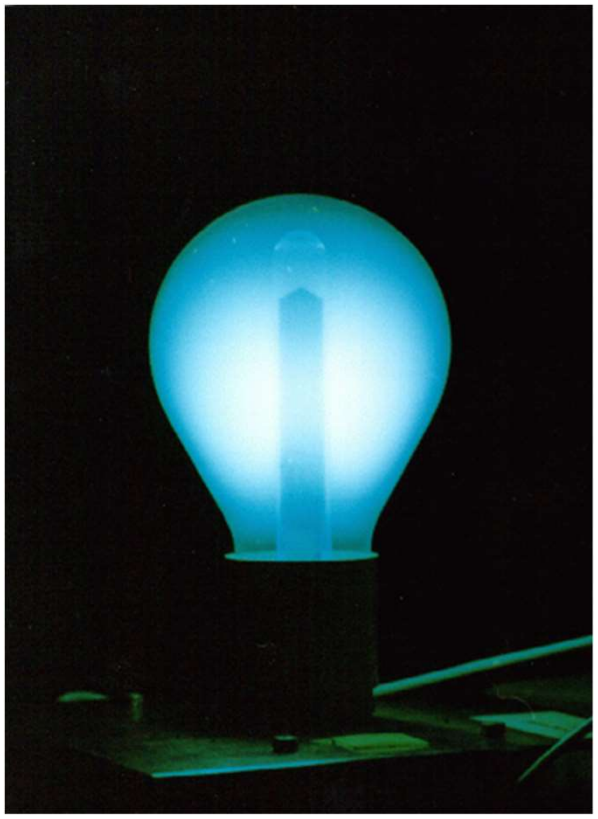
Power: 55, 85 et 165 W

Efficacy: 65 - 74 lm/W

CRI: > 80

Tcp: 2 700, 3 000 et 4 000 K

Lifetime: 60 000 h



LED module luminaire

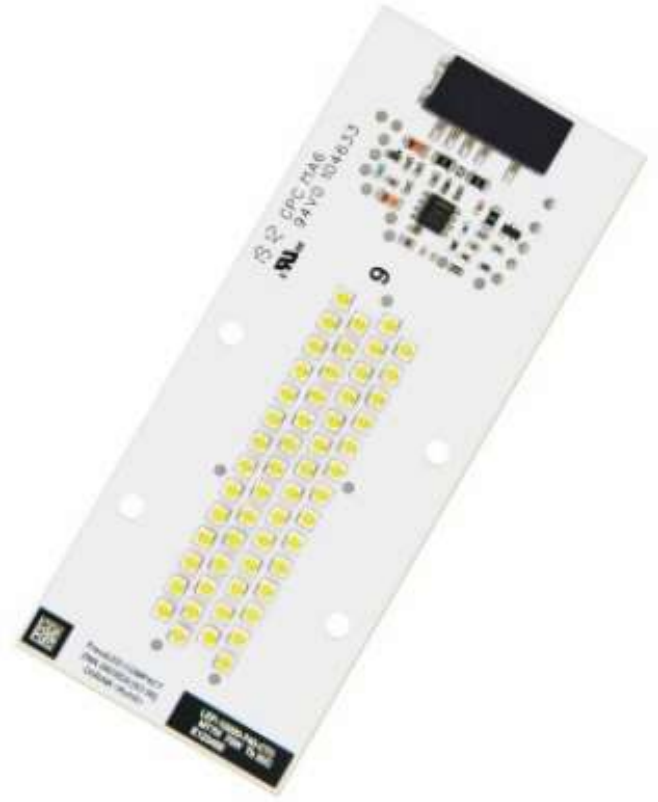
Puissance: 20 - 100 W

Efficacité: 58 - 150 lm/W

IRC: 70

Tcp: 3 000 – 5 000 K

Durée de vie: 20 000 – 100 000 h



Comparison

Technology	Efficacy max.	Lifetime max.
Low pressure sodium	200 lm/W	18 000 h
High pressure sodium	131 lm/W	24 000 h
Metal halides	115 lm/W	18 000 h
High pressure mercury	51 lm/W	20 000 h
Mixt	25 lm/W	5 000 h
Induction	74 lm/W	60 000 h
LED luminaire	150 lm/W	100 000 h

The best technology depends on flux, average

LPS : 200 lm/W for 32 000 lumens, lifetime 18 000 h (> 4 years)

Deep Yellow

→ Tunnel, industrial platforms

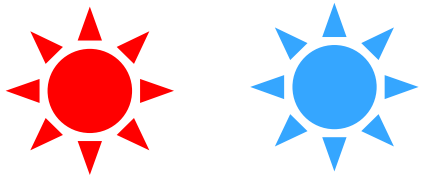
HPS : 130 lm/W for 33 000 lumens, lifetime 25 000 h (> 6 years)

Clear Yellow

→ Roadway lighting, higher than 8 meters

MH : 115 lm/W for 10 000 lumens, lifetime 18 000 h (> 4 years)

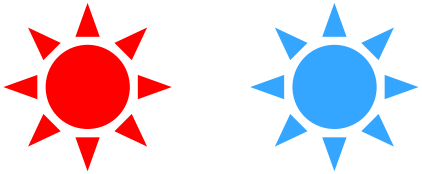
White Light



→ Town center, commercial areas, not higher than 6 m

LED : 120 lm/W for every flux , 80 000 à 100 000 h (> 20 years !)

All colors



→ Everywhere !

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Mercury

25 mg

HPS

60 mg

Hg HID

Mercury is dangerous, needs a dedicated recycling system.

LEDs have nor mercury and must be recycled as a WEEE.

Dark Sky Association

U4E United for Efficiency

03

Luminaires and control

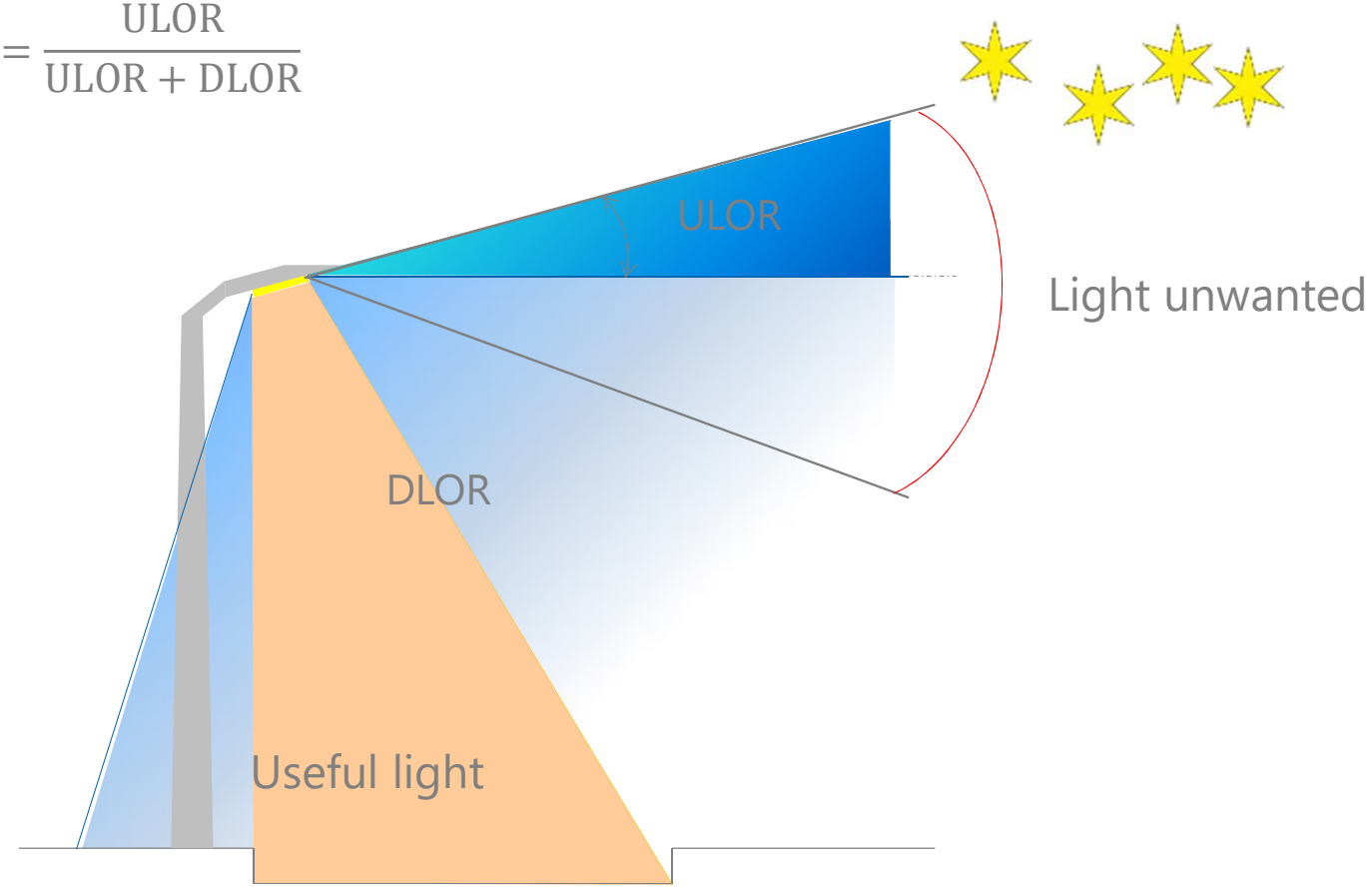
The luminaire

U.L.O.R = Upward Lumen Output Ratio
U.L.R = Upward Lumen Ratio

Loss of energy

Light pollution

$$\mathrm{ULR} = \frac{\mathrm{ULOR}}{\mathrm{ULOR} + \mathrm{DLOR}}$$

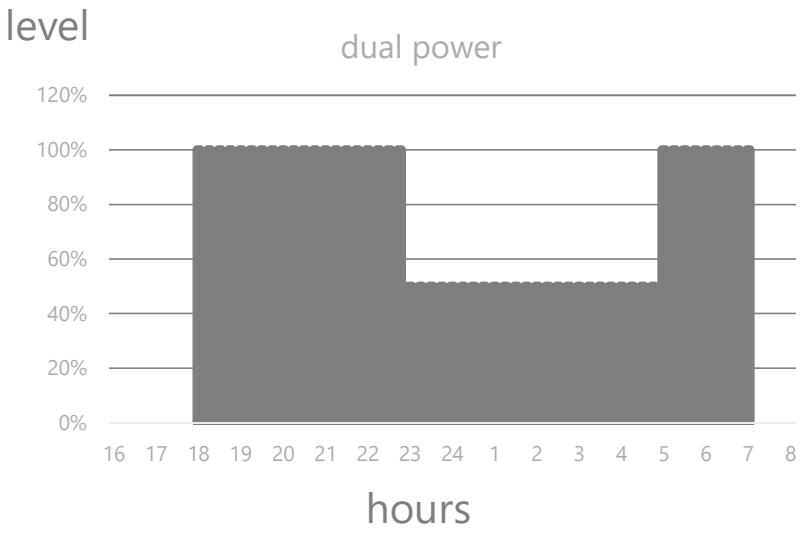


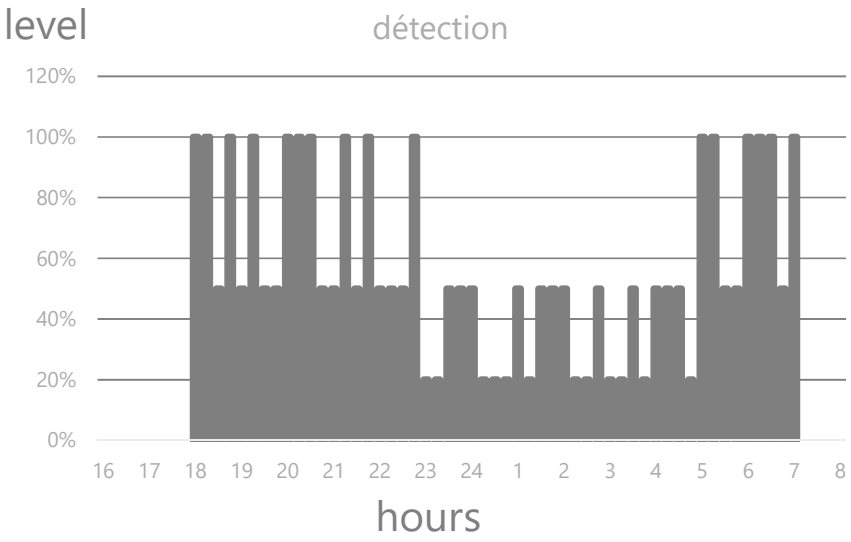
Dimming and presence detector

Dimming

18 h to 23 h : 100 % of flux
23 h to 5h : 50 % of flux
5h to 7 h : 100 %

23 % savings





+ presence sensor :

If presence 100 % or 50 % depending on time
either standby at 50 % or 20 % depending on time

42 % savings

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04

Off grid Street lighting

Guide

SUMMARY	Society, financing & quality issues background
	Quality Charter for Solar Standalone Streetlights
PRELIMINARY DESIGN	Need assessment: what tools for on-site identification?
	Economic analysis: why opting for a solar streetlight project ?
FINANCIAL SETUP	Mobilization of financing: towards a mapping of stakeholders ?
	Contracts & business models: ensuring long-term investment ?
DESIGN	Writing tenders: how to guarantee organizational quality ?
	Decrypting bids : how to guarantee technical quality ?
IMPLEMENTATION	Installation : How to sustain service quality over time?
	Maintenance : how to train maintenance technicians?
	Recycling channels
EVALUATION	project evaluation: how to assess social, technical and economic sustainability ?
	Impact measurement: how to measure socio-economic impacts in face of initial objectives ?

Preliminary design

	Main road	Passing through villages ; local roads (width 7m)	Public places
Illuminance (lux)	15 to 20	10 to 15	5 to 10
Uniformity	0,4	0,4	0,4
Duration of light at full power	5 h minimum	4 h minimum	4 h minimum
Minimum level of light when dimming	60 %	50%	30%
Light control	All luminaires together	Presence detector / extinction	Presence detector
Height of luminaire	8	6	4
Colour temperature	3 000 to 5 000 Kelvin		

Quality criteria of system, easy to check

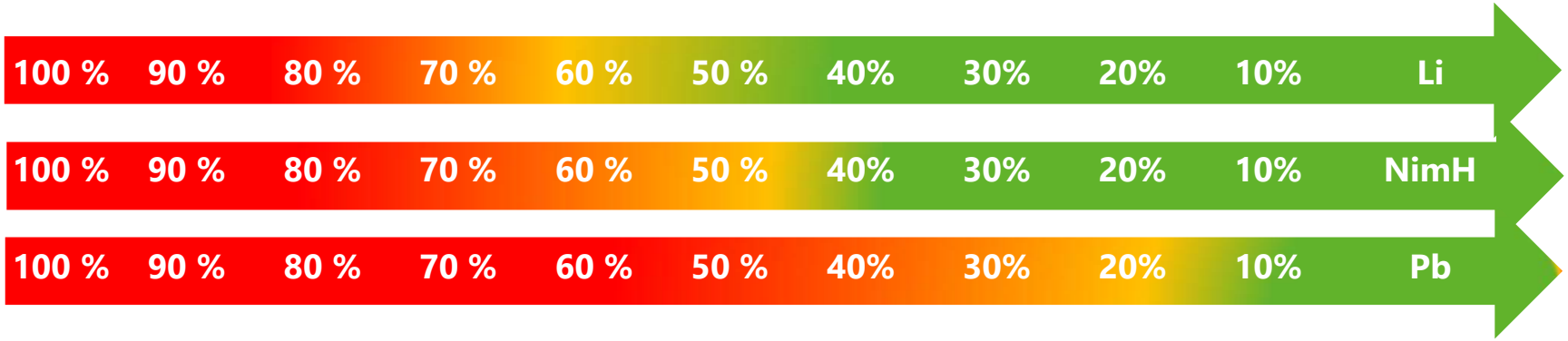
Criterion 1: Power of Modules in Wpeak / Luminaire Power in W :

Criterion 2: Module Power / Daily Reference Consumption :

In equatorial zone

In tropical zone

Battery technology – to keep in mind !



The only way to run a lead-acid battery is to limit the rate of cycling to 15%, which de facto condemns its economic interest

Assumption

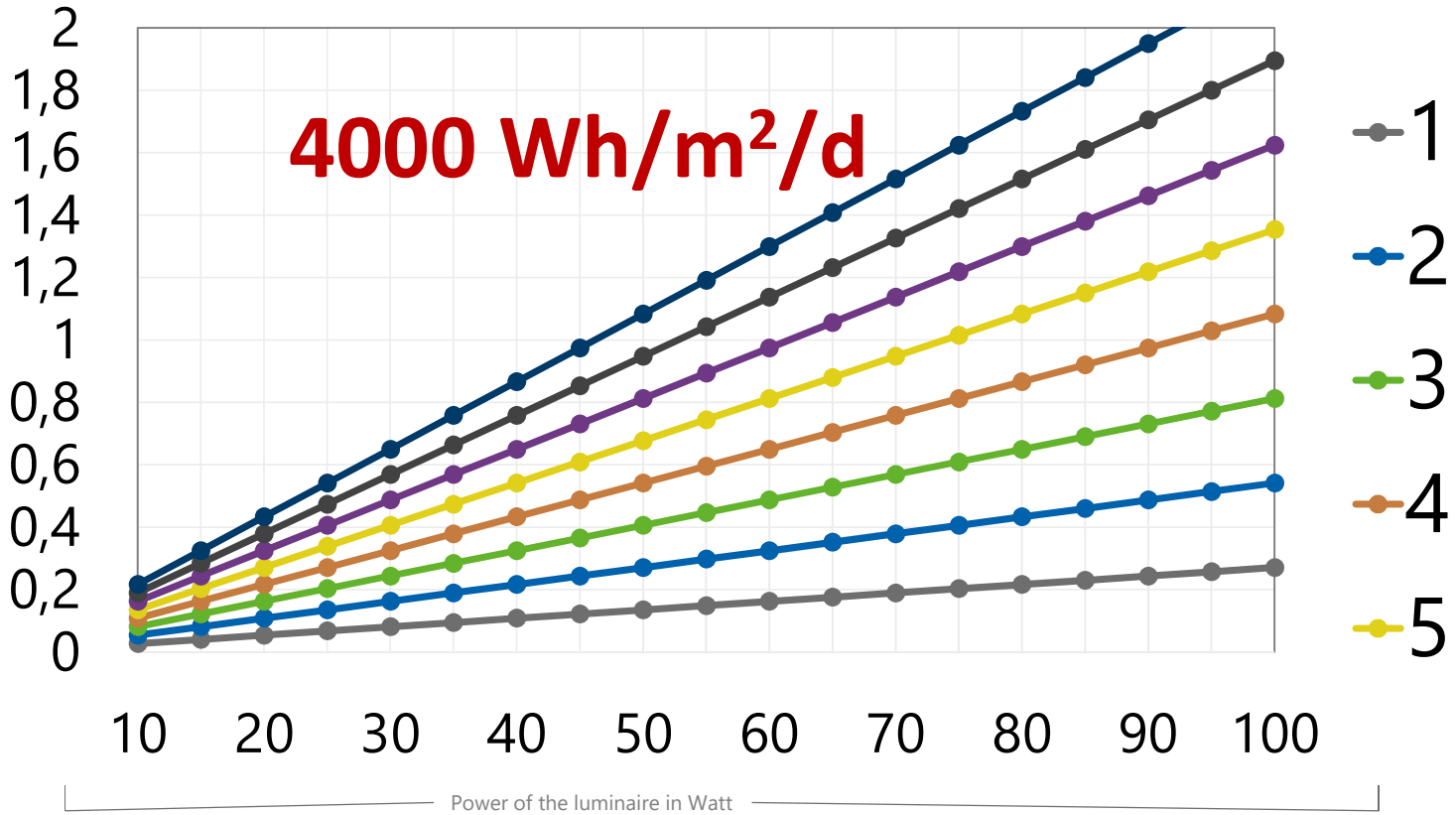
PV cells efficiency	15 %
Loading efficiency	90 %
Battery efficiency	95 %
% of capacity loss before maintenance	20 %
% of useful battery	90 %
Utilization factor of the PV pannel (surface / use surface)	90 %

Autonomy of 3 days without loading

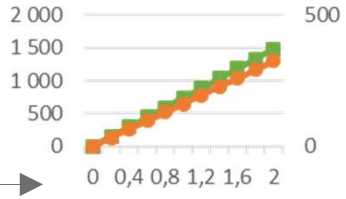
Decision tool

$[time, power\ of\ LED] = battery\ capacity, peak\ power\ and\ surface\ of\ PV$

Surface of PV in m²



Time of lighting equivalent at full power



Battery capacity in Wh
Peak power in Wc

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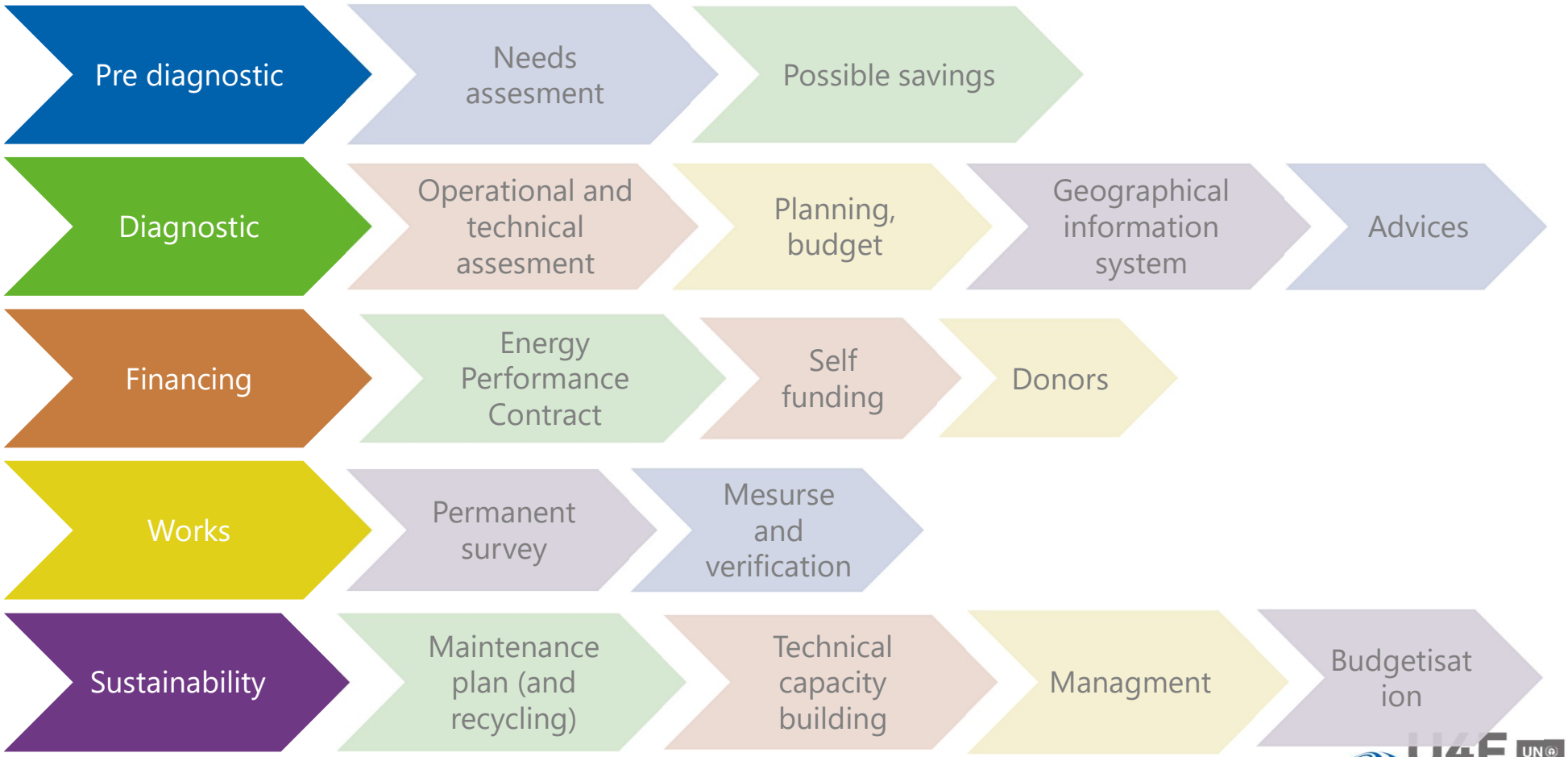
05

A comprehensive approach


Pre diagnostic
Needs assesment
Possible savings
Diagnostic
Operational and technical assesment
Planning, budget
Geographical information system
Advices
Financing
Energy Performance Contract
Self funding
Donors
Works
Permanent survey
Mesurse and verification
Sustainability
Maintenance plan (and recycling)
Technical capacity building
Managment
Budgetisation

THANK YOU !

Contact

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