Solar-Powered LED Exterior Lighting

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Shawinigan

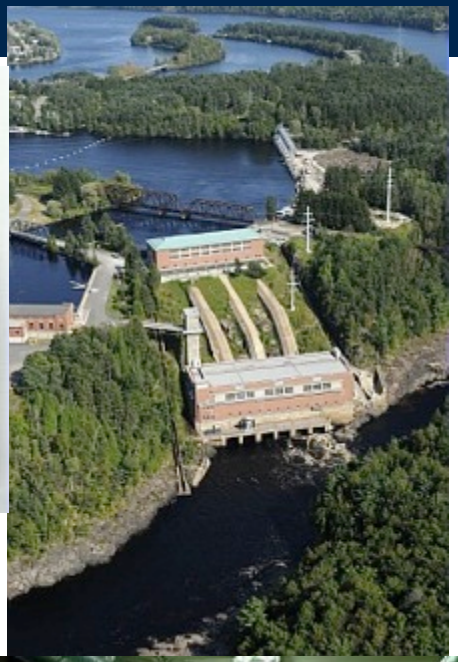
CNC/CIE Workshop 2012, Toronto

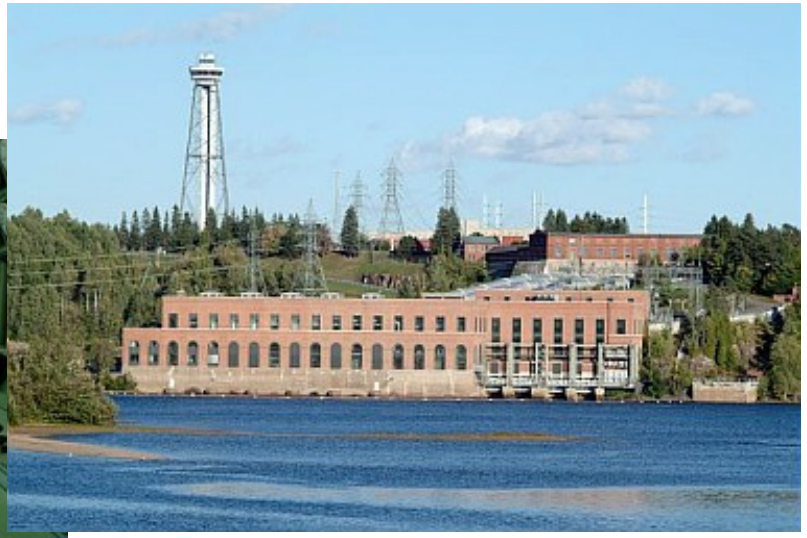
November 30

Opportunities and Challenges in Energy-Efficient Lighting

Hydro Québec

Shawinigan, the beginning of Hydro-Québec





Sustainable development

« The mission of Hydro-Québec is to deliver reliable electricity service throughout Québec. The company has fully embraced the concept of sustainable development and works tirelessly to meet the needs of the present while preserving the environmental heritage and energy future of generations to come. »

Substainable development

« *Québec enjoys abundant water resources: some 500,000 lakes and 4,500 rivers cover 12% of its territory. On 75 of these rivers, Hydro-Québec operates 60 generating stations, 26 large reservoirs, 579 dams and 97 control structures*.»

http://www.hydroquebec.com/sustainable-development/index.html

Solar-Powered LED Exterior Lighting

QUESTION : IS IT POSSIBLE TO COMBINE LED TECHNOLOGY AND SOLAR ENERGY ?

THE CRITERIA

1) Expensive to bring power to a remote area
2) Lighting is needed for security purposes for specific time frame.
3) Light only the area needed (Light pollution)
4) Energy efficient and aesthetic
5) Easy to install
6) Meet lighting criteria for a specific task (uniformity, light levels,...)

METHODOLOGY
Laboratory and Field study

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200899-0

Spectralux Laboratory
Montreal, Quebec H4S 1M2
CANADA

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

ENERGY EFFICIENT LIGHTING PRODUCTS

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2010-10-26 through 2011-09-30
Effective dates

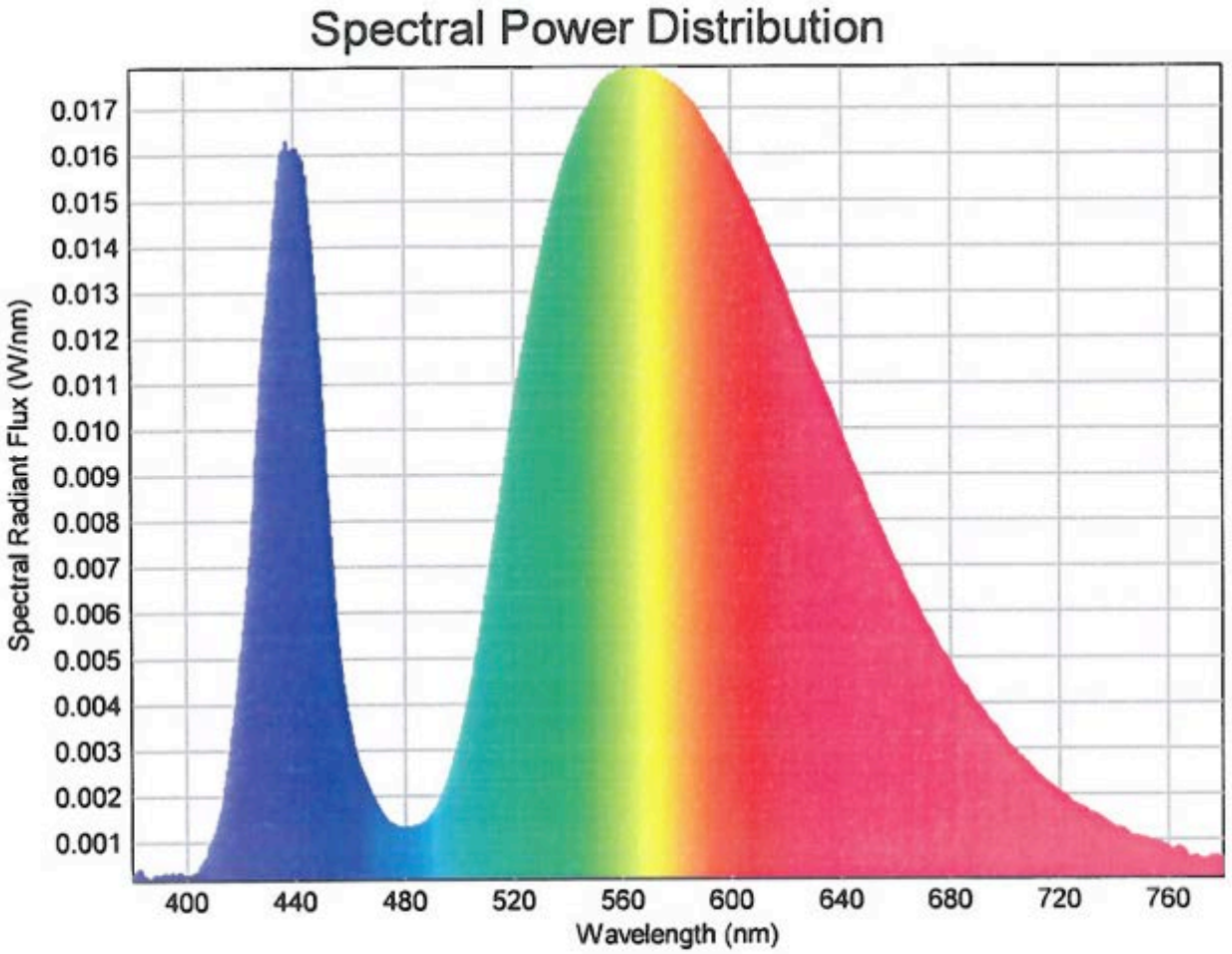
Sally S. Bruce
For the National Institute of Standards and Technology

NVLAP-01C (REV. 2009-01-28)

How to evaluate the technology ?

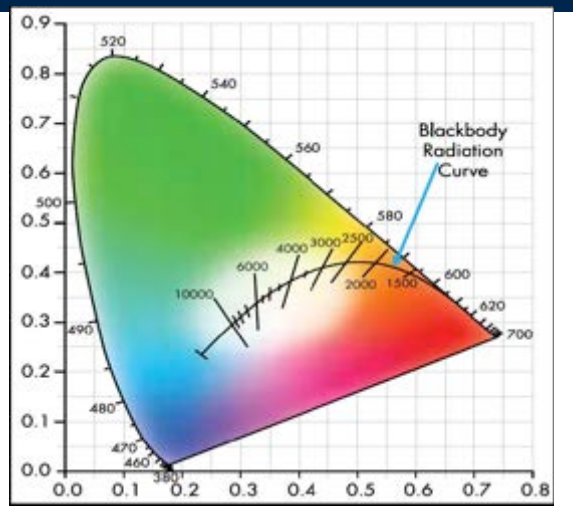
STEP 1 : An integrating sphere

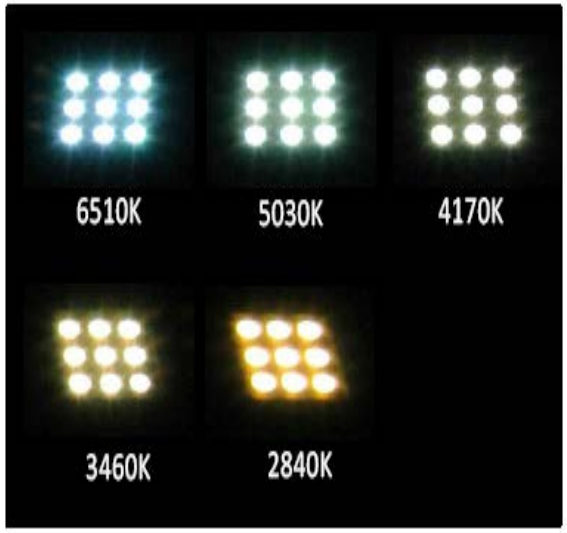
Spectral Radiant flux



Power spectral distribution

	Luminaire 12,6 Vdc	Luminaire 13,1 Vdc
Lumens	1 020	1 004
Power (Watts)	13,53	13,50
Lumens / Watt	75,4	74,4
CRI	66	66
CT (° K)	3 969	3 974





Results from the sphere

1) **Luminous efficacy : OK reaching 75 lumens/Watt**

2) **Color temperature : OK reaching moon color temperature**

3) **Light stability (effect of voltage variation) : OK**

Maintain lumens output while battery voltage is reduced

4) **Color Rendition Index (CRI) : OK around 70 as compared to HPS around 20**

Why a high CRI ?

« The higher CRI white light is much better in a number of ways, including for security. For example, colors of a vandal's shirt or hit and run car can be much better seen with white light than with the yellow light. »

How to evaluate the technology ?

> STEP 2 : A goniophotometer

Simulation using IES file

Low Pedestrian and Conflict Areas (IES RP-8)

Table 7: Recommended Values for Low Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min} *
Rural/Semi-Rural Areas	2.0/0.2	0.6/0.06	10.0
Low Density Residential	3.0/0.3	0.8/0.08	6.0
Medium Density Residential	4.0/0.4	1.0/0.1	4.0

* Horizontal only

E_H = average horizontal illuminance at walkway/bikeway

E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Lighting criteria: Rural / Semi-rural

1) CRITERIA 1 : > 2 lux horizontal average illuminance

Obtain minimum horizontal average value of illuminance

2) CRITERIA 2 : > 0,6 lux minimum vertical illuminance
(vertical illuminance at 1,5 m above bikeway)

Obtain minimum value of illuminance for facial recognition

3) CRITERIA 3 : < 10,0 horizontal avg / min

Reach good uniformity horizontally

Simulation using IES file:

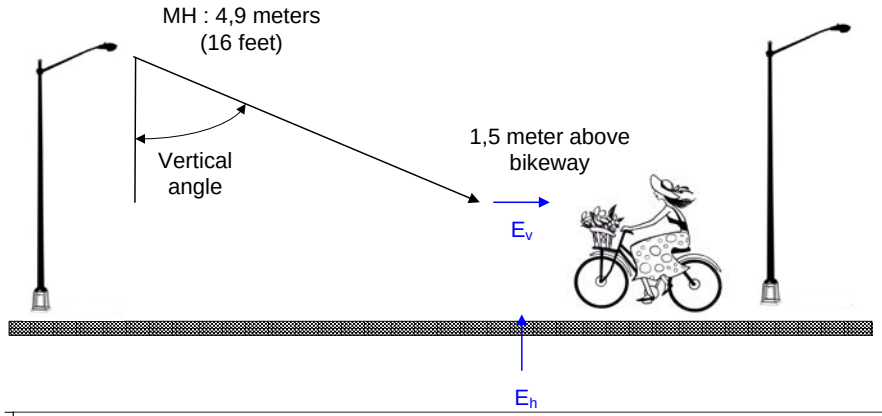
- Mean Hor. illuminance : 5,5 lux (2 IES)
- Max Hor. illuminance : 15,1 lux
- Min Hor. illuminance : 0,69 lux
- Avg / min Hor. : 8,0 (< 10 IES)

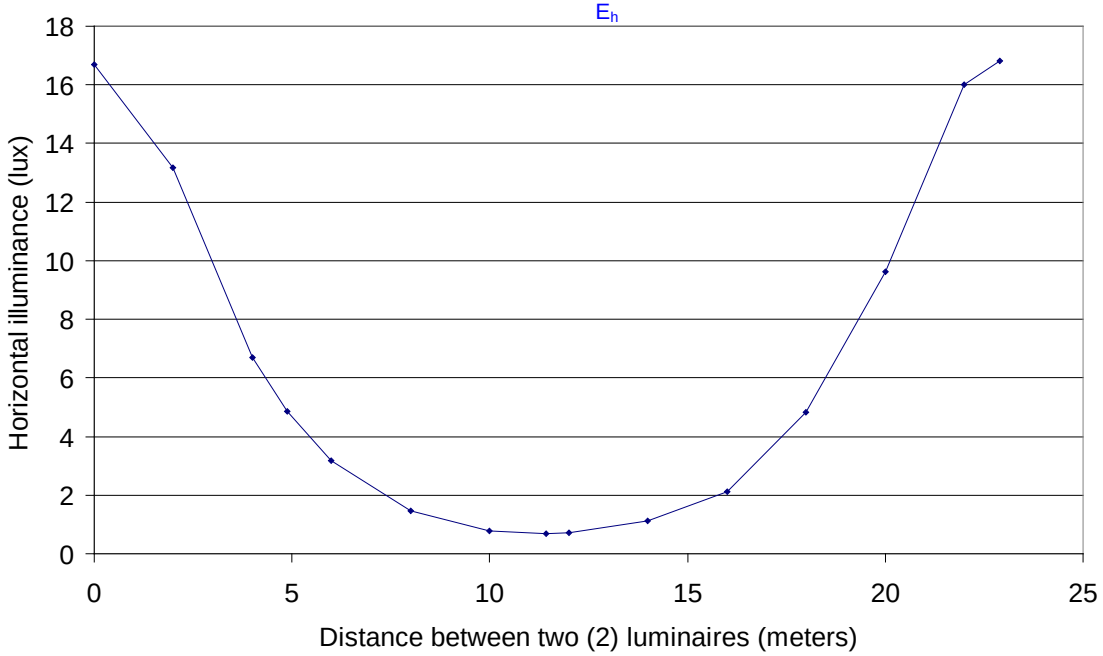
Spacing : 22,9 meters (75 feet)

Width : 1,2 meters (4 feet)

Mounting height : 4,9 meters (16 feet)

Horizontal illuminance





Avg. E_h: 5,5 lux

Min. E_h: 0,69 lux

Avg. E_h / Min. E_h = 8

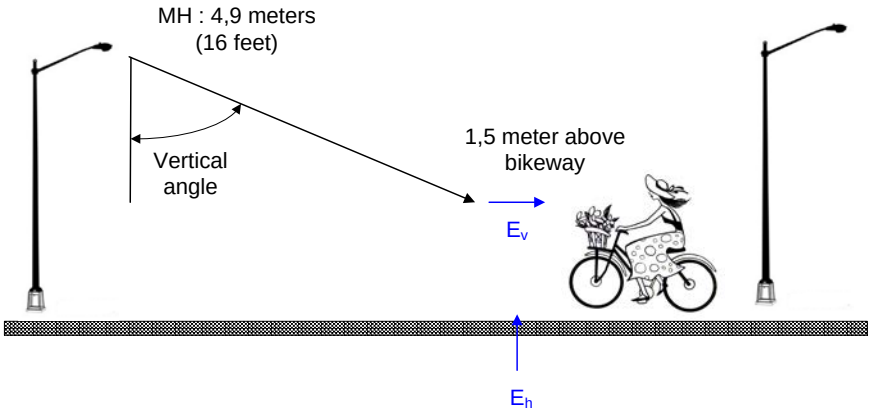
Vertical illuminance for facial recognition

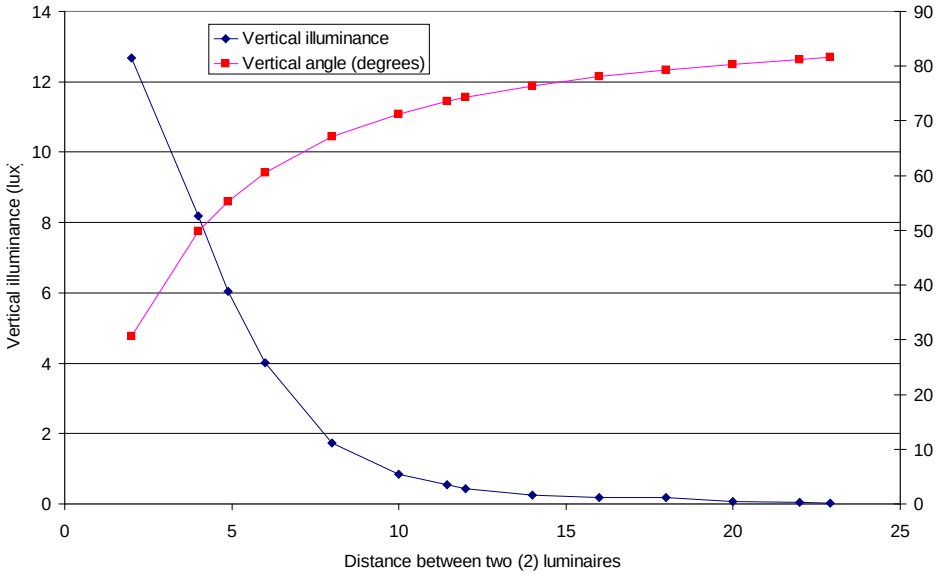
Vertical illuminance not calculated (facial recognition) in CIE 115: 2010 if facial recognition not necessary

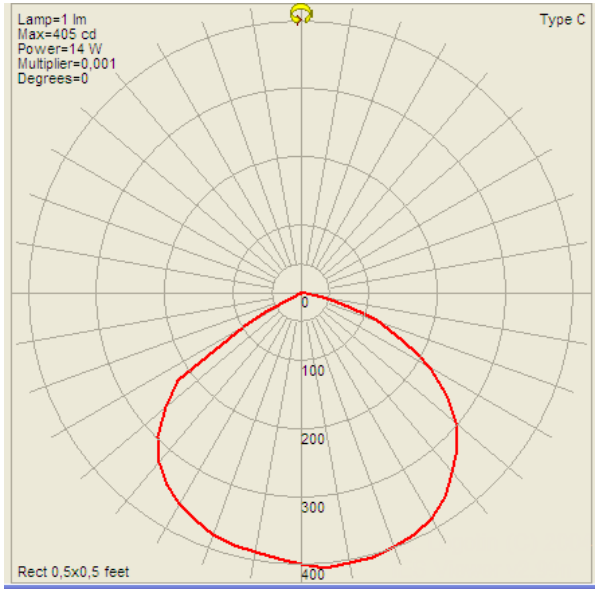
CIE 115 : 2010 Lighting of roads for motor and pedestrian

Cat.	Éclairement moyen horizontal $E_{h,av}$ (lux)	Éclairement minimum horizontal $E_{h,\min}$ (lux)	Critères additionnels si la reconnaissance faciale est nécessaire	
			Éclairement minimum Vertical $E_{v,\min}$ (lux)	Éclairement semi-cylindrique minimum Vertical $E_{sc,\min}$ (lux)
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

Vertical illuminance (Ev) at 1,5 meter above bikeway

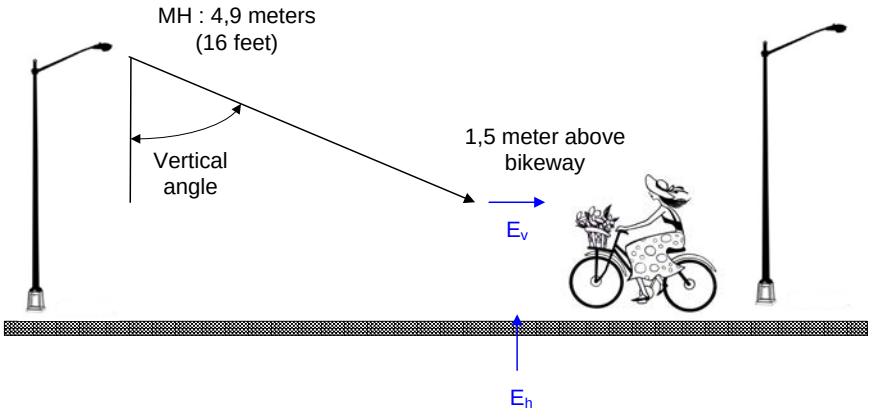


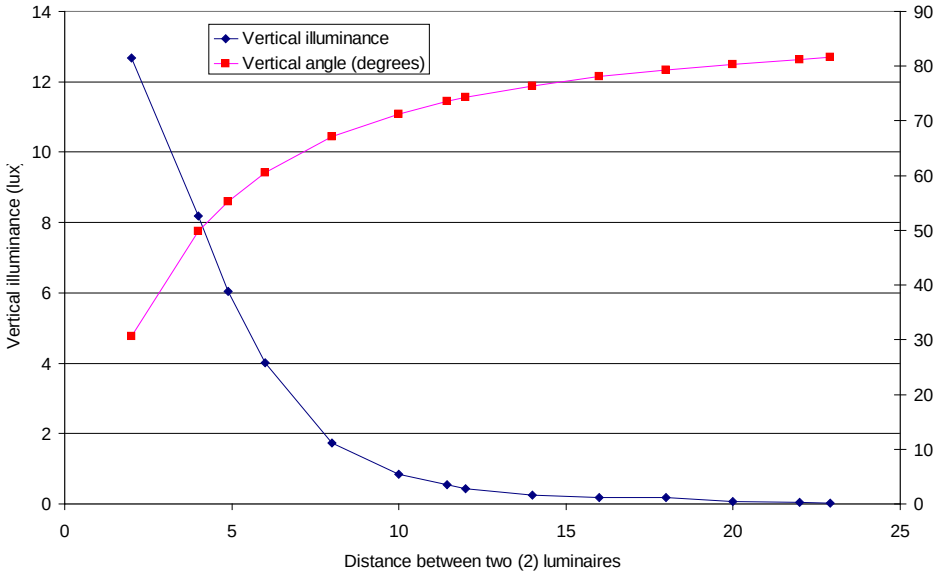




Min. E_v: 0,03 lux

Vertical illuminance (Ev) at 1,5 meters above bikeway





1) Low mounting height

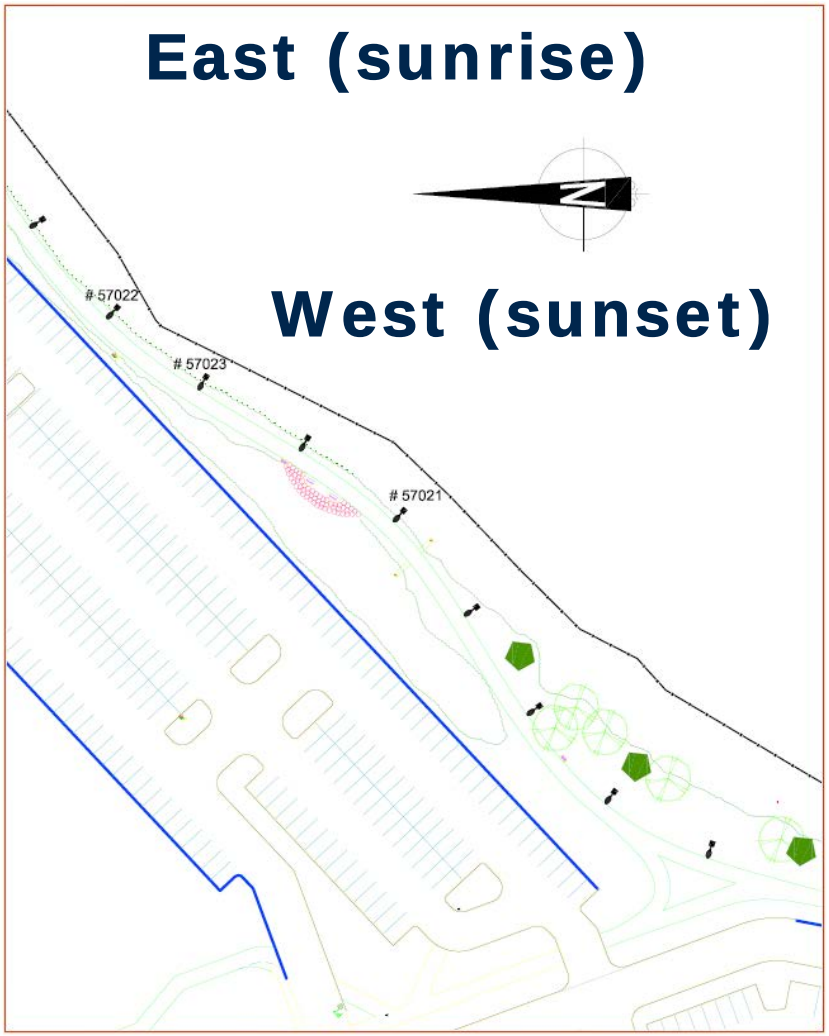
2) High vertical angle

3) Glare at high vertical angle

4) E_v criteria for a bikeway ??

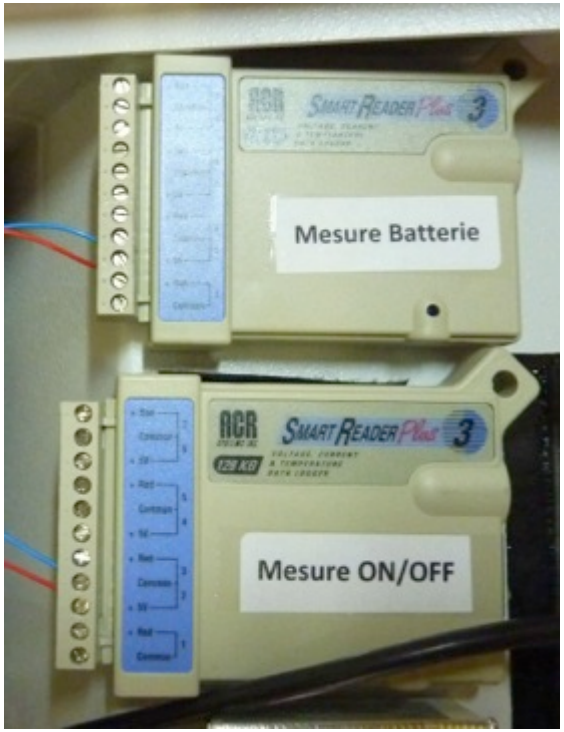
Min. E_v: 0,03 lux

STEP 3 : Field testing



Field testing

Field testing



Data logger installed in the luminaire

Check point

- 1) State of the luminaire : light ON or OFF
- 2) Charge level of the battery

i) Measurement is the mean value of two minutes interval

ii) Open circuit voltage of the battery :

13,1 Vdc = 100% of the charge

12,8 Vdc = 75 % of the charge

11,7 Vdc = 25 % of the charge (luminaire not activated to protect the battery)

Principle of the luminaire

Dusk:

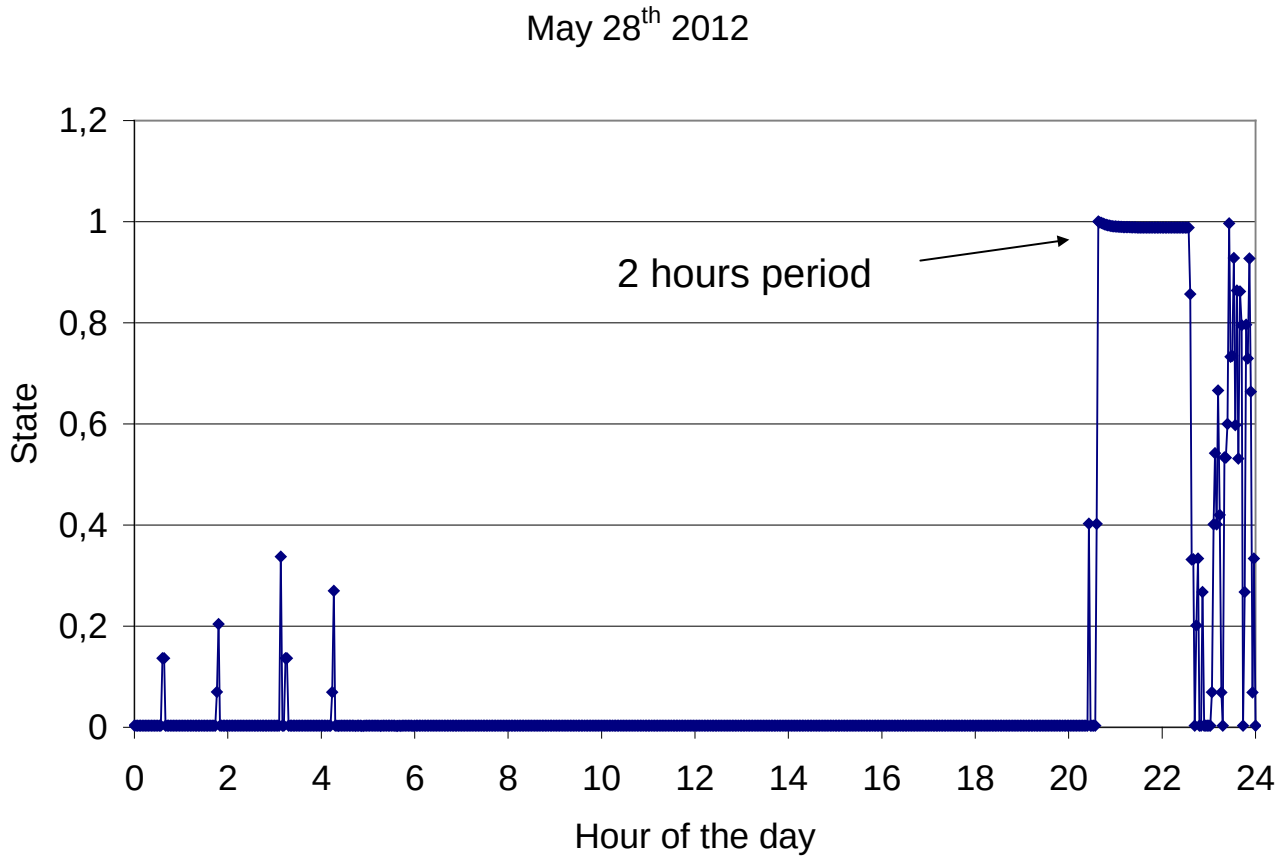
Step 1: 2 hours full ON activated by a photocell

Step 2: Following the 2 hours, passive infrared (PIR)detector set to 1 minute

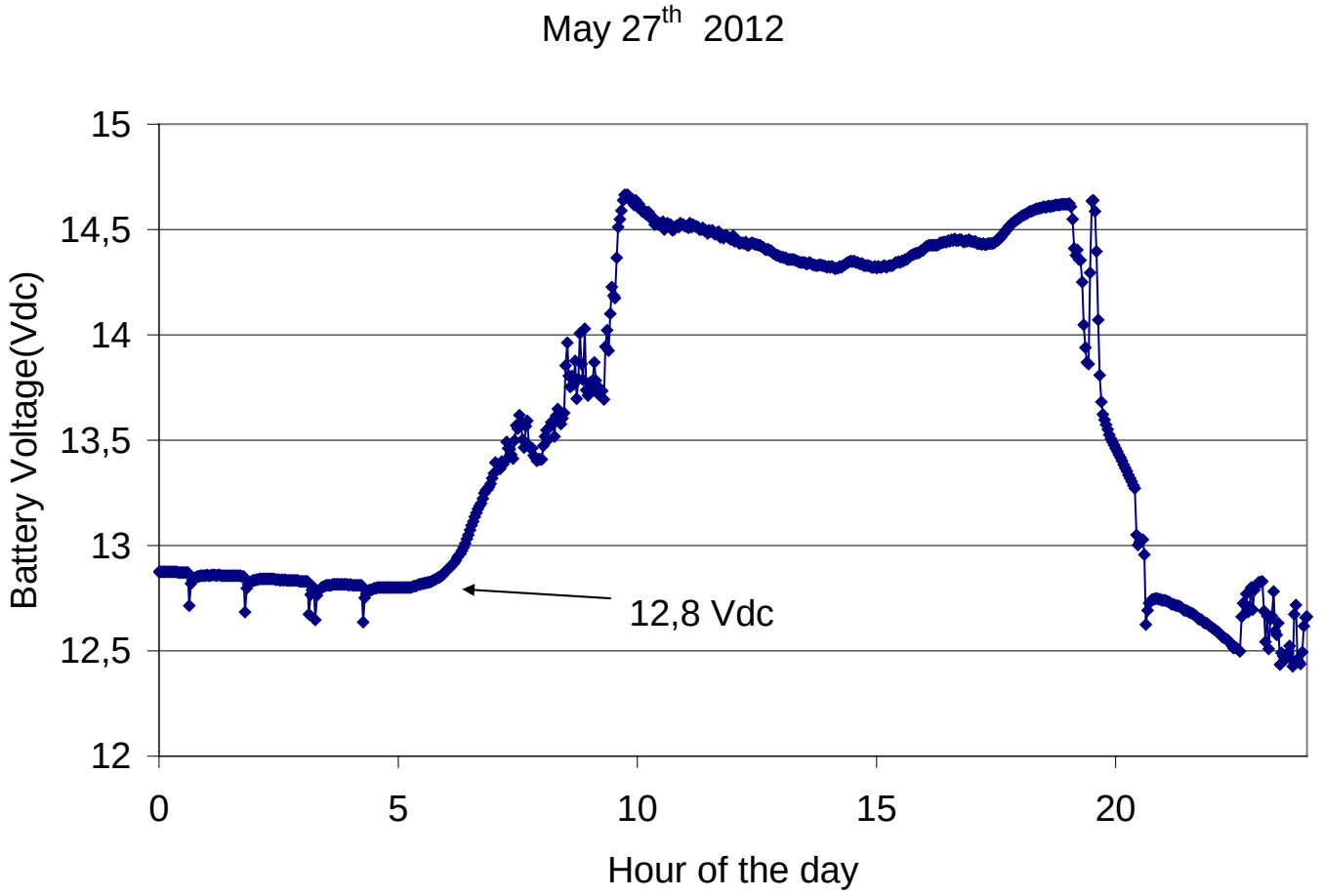
Dawn:

Luminaire not lighted and recharge of the battery

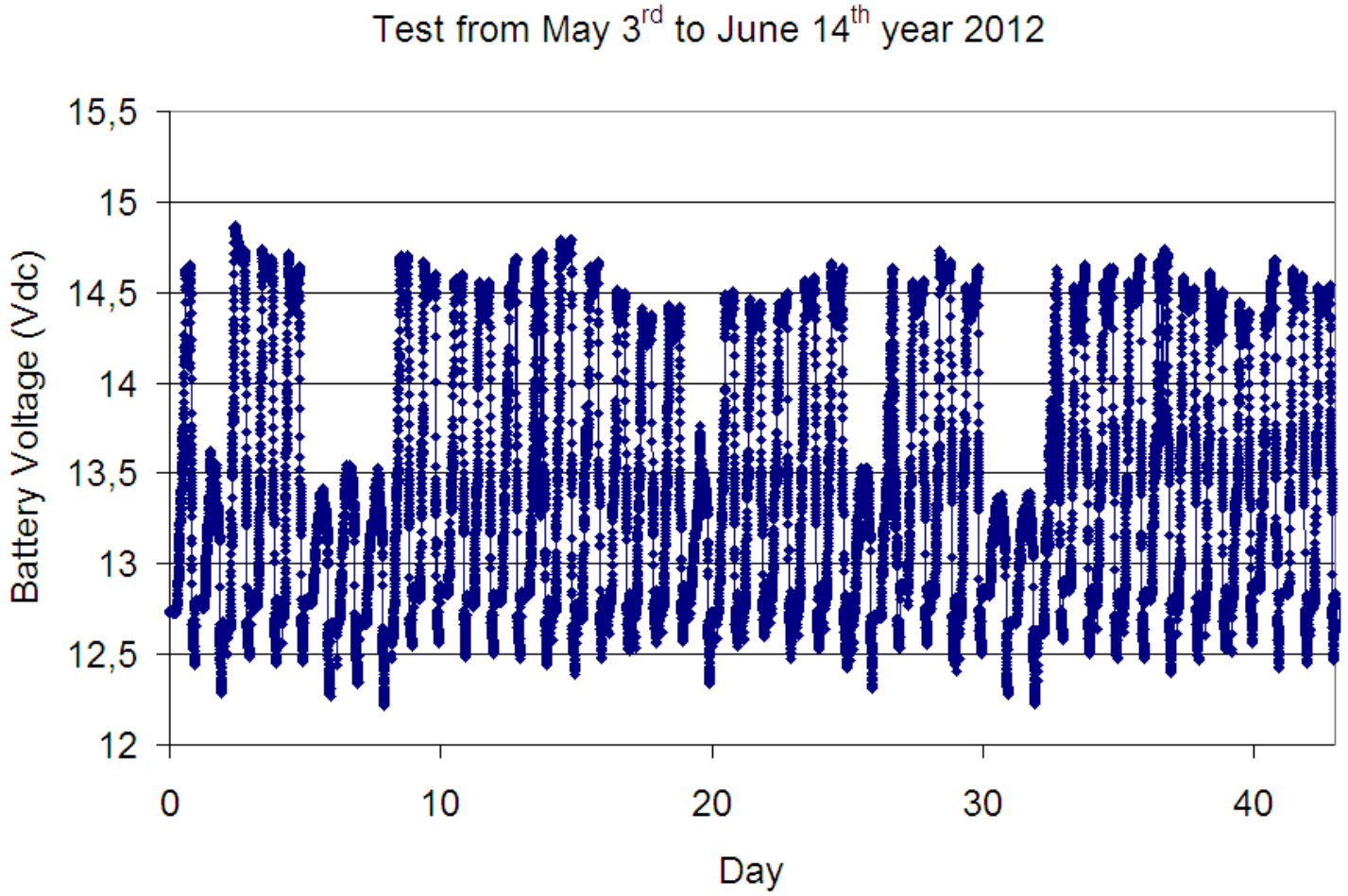
Principle of the luminaire



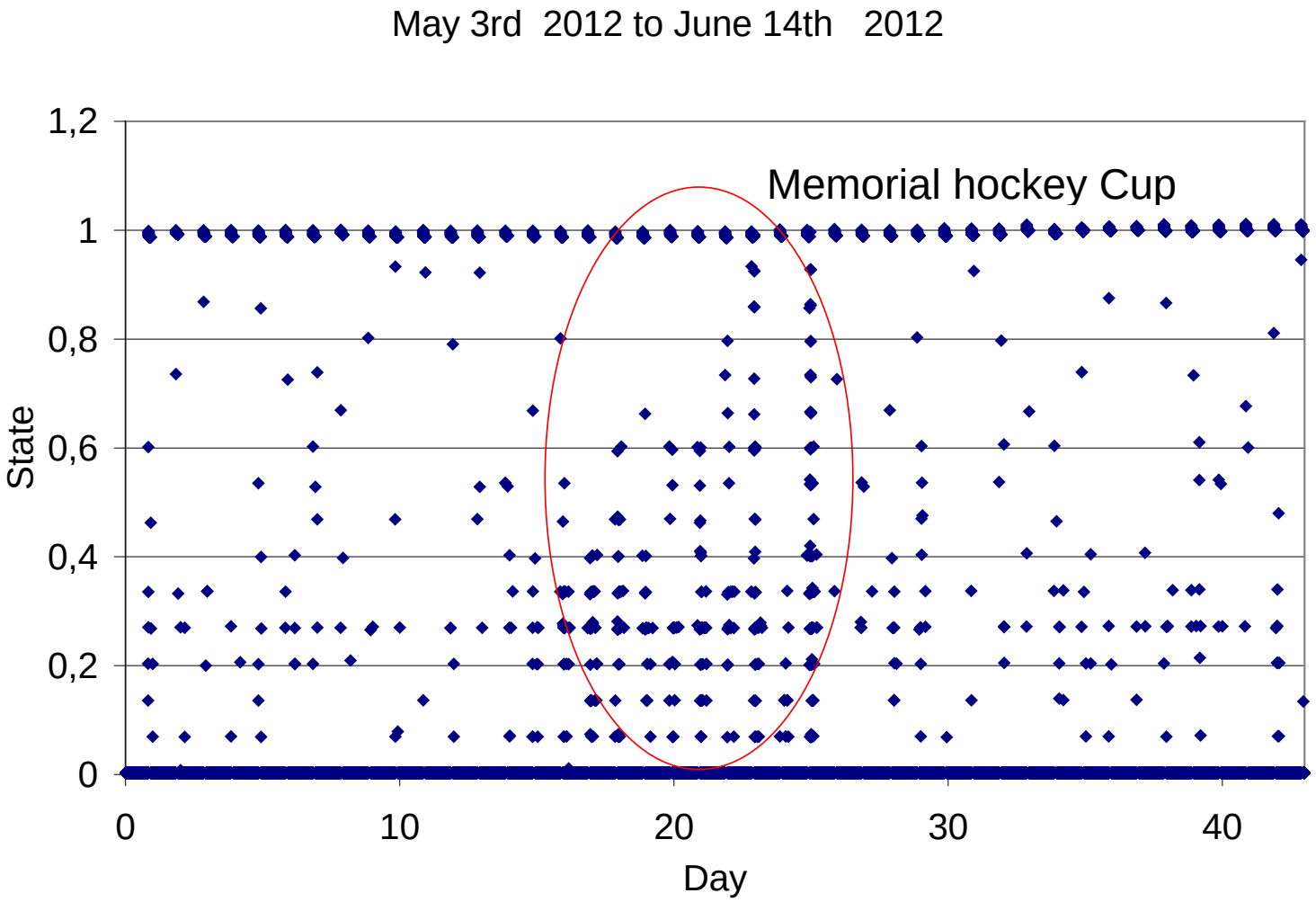
Voltage variation during the day



Battery Voltage during the test

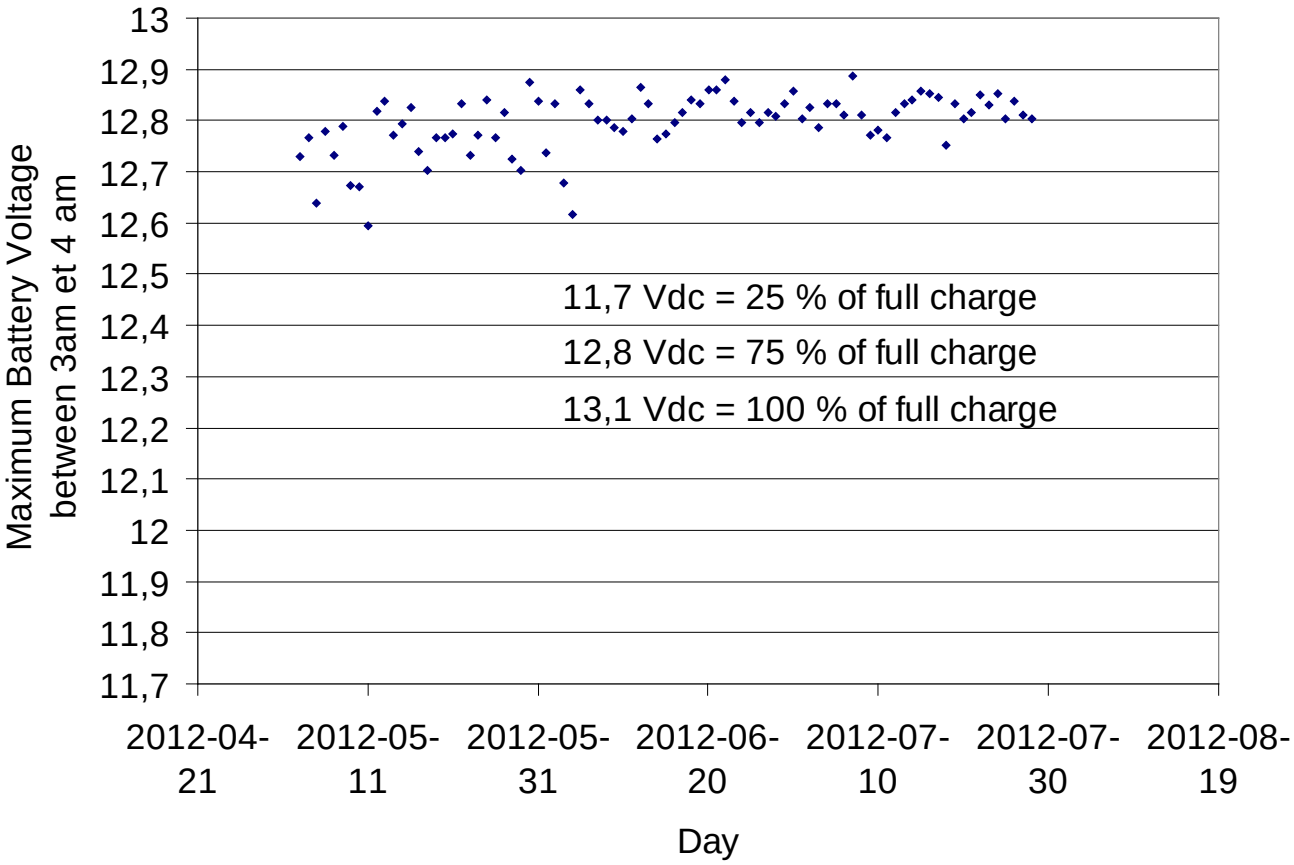


Luminaire state



Centre Bionest near the pedestrian pathway and the Memorial Hockey Cup

Maximum Battery Voltage



Consumer satisfaction

VILLE DE SHAWINIGAN

Shawinigan, le 2 novembre 2012

M. André Laperrière ing. M. Sc. A.
Chercheur – Utilisation de l'énergie
Laboratoires des technologies de l'Énergie
600, avenue de la Montagne
Shawinigan (Québec) G9N 7N5

Re : Projet de démonstration «Éclairage solaire à DEL» de l'entreprise Vision Solaire

Bonjour Monsieur Laperrière,

Nous sommes heureux d'avoir participé au projet de démonstration cité en rubrique. Notre participation consistait à faire l'installation des socles, des fûts et des luminaires. Les commentaires entendus par notre équipe d'installateurs sont très positifs quant à la facilité d'installation et le niveau d'éclairement au sol. L'installation du luminaire sur le fût est d'une grande simplicité, l'installation prend moins de trois minutes à partir du moment où il est retiré de son emballage jusqu'au moment où il est prêt à entrer en fonction.

Des économies importantes d'installation sont envisageables par l'utilisation de ce produit surtout lorsque l'on a des applications nécessitant de grandes distances à parcourir pour effectuer le raccordement électrique. L'économie d'énergie qui découle du fonctionnement de ce luminaire versus un luminaire standard est aussi non négligeable. Lors des Jeux du Québec, nous avons dû faire l'installation de luminaires de sécurité pour l'éclairage d'une voie de communication entre deux sites. Nous avons utilisé les luminaires en démonstration pour réaliser rapidement et à moindre coût l'éclairage de ce passage piétonnier.

La période d'hiver nous permettra de vérifier les propos du manufacturier concernant le nettoyage du capteur et constater dans des conditions plus difficiles la durabilité des composants du luminaire. Nous prévoyons, surtout si cette dernière vérification est concluante, utiliser ce type de luminaires dans d'autres applications sur le territoire de la Ville de Shawinigan.

Robert Desjardins
Directeur division Immeubles
Ville de Shawinigan

550, avenue de l'Hôtel-de-Ville
C.P. 400
Shawinigan Qc G9N 6V3

Service loisirs, culture et vie communautaire
Tél. : 819 536-7211, poste 307
Téléc. : 819 536-5546
www.shawinigan.ca

Hydro Québec

Consumer comments

1) Easy to install (3 minutes)

2) Does not require external wiring to the grid for remote installation

3) Proper lighting levels

Improvements to be made

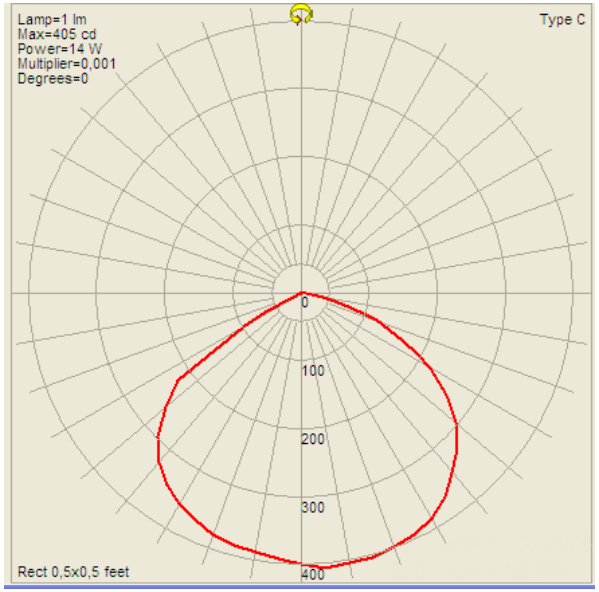
Distribution of the intensity and ISL

$E = I / d^2$

E : Illuminance in lux

I : Intensity in candela

d : distance in meters



Conclusion

- **Happy mix of the LED technology with solar. Winter evaluation underway.**

Natural Resources Canada | Ressources naturelles Canada

NRCan involved in the project

LED TECHNOLOGY AND NEW APPLICATIONS. YES IS IT IS POSSIBLE TO COMBINE LED TECHNOLOGY AND SOLAR ENERGY

Hydro Québec

MERCI

THANKS

André Laperrière, ing. M.Sc.A.

Laboratoire des technologies de l'Énergie d'Hydro-Québec

Hydro Québec