Lighting the way to road safety – A policy blindspot ?

Godfrey Bridger & Bryan King

Bridger Beavis & Associates Ltd, Lighting Management Consultants Ltd

Introductions

- Godfrey – Electronic Engineer, MBA (with Bryan), EECA CEO, Science Manager
- Bryan – Mechanical Engineer, MBA, ex owner of Modus Lighting for 29 years, AS/NZS 1158 Review Committee
- NB abstract in programme incorrect (is for May 2012 NZTA report)

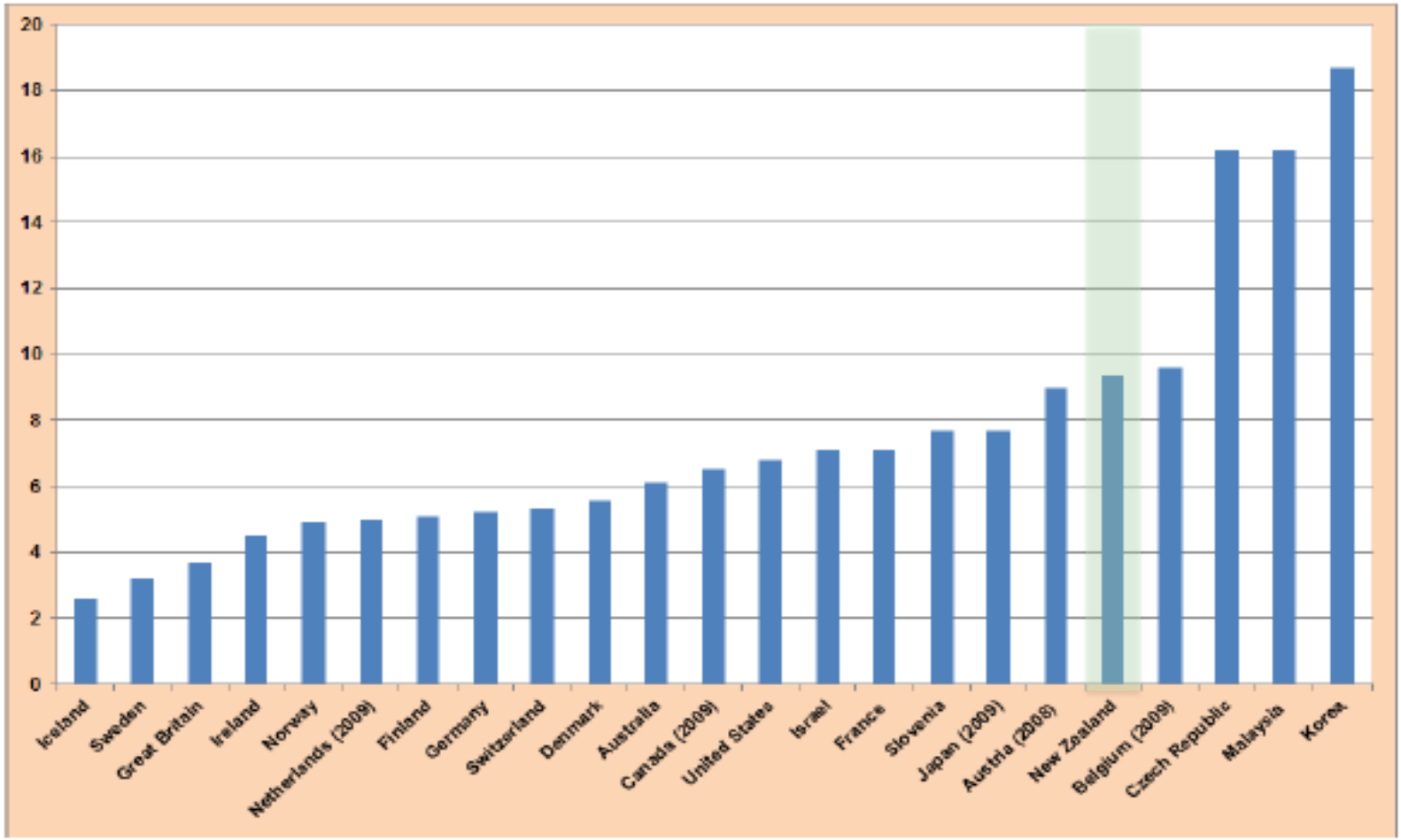
Acknowledgements

- NZTA – “Strategic road lighting opportunities for NZ”, Lynley Hutton, Bernie Cuttance, Dr Fergus Tate
- Ministry of Transport, Dr Wayne Jones
- EECA, Hamilton City Council, Odyssey Energy

Bad news ➔ Good news

- NZ injury & fatality comparatively poor
- NZ driving at night more dangerous than overseas
- NZ street lighting standards lower than overseas
- Improving lighting decreases injuries & death
- New technologies provide very cost effective opportunities to upgrade
- Benefit cost ratios appear to be very high

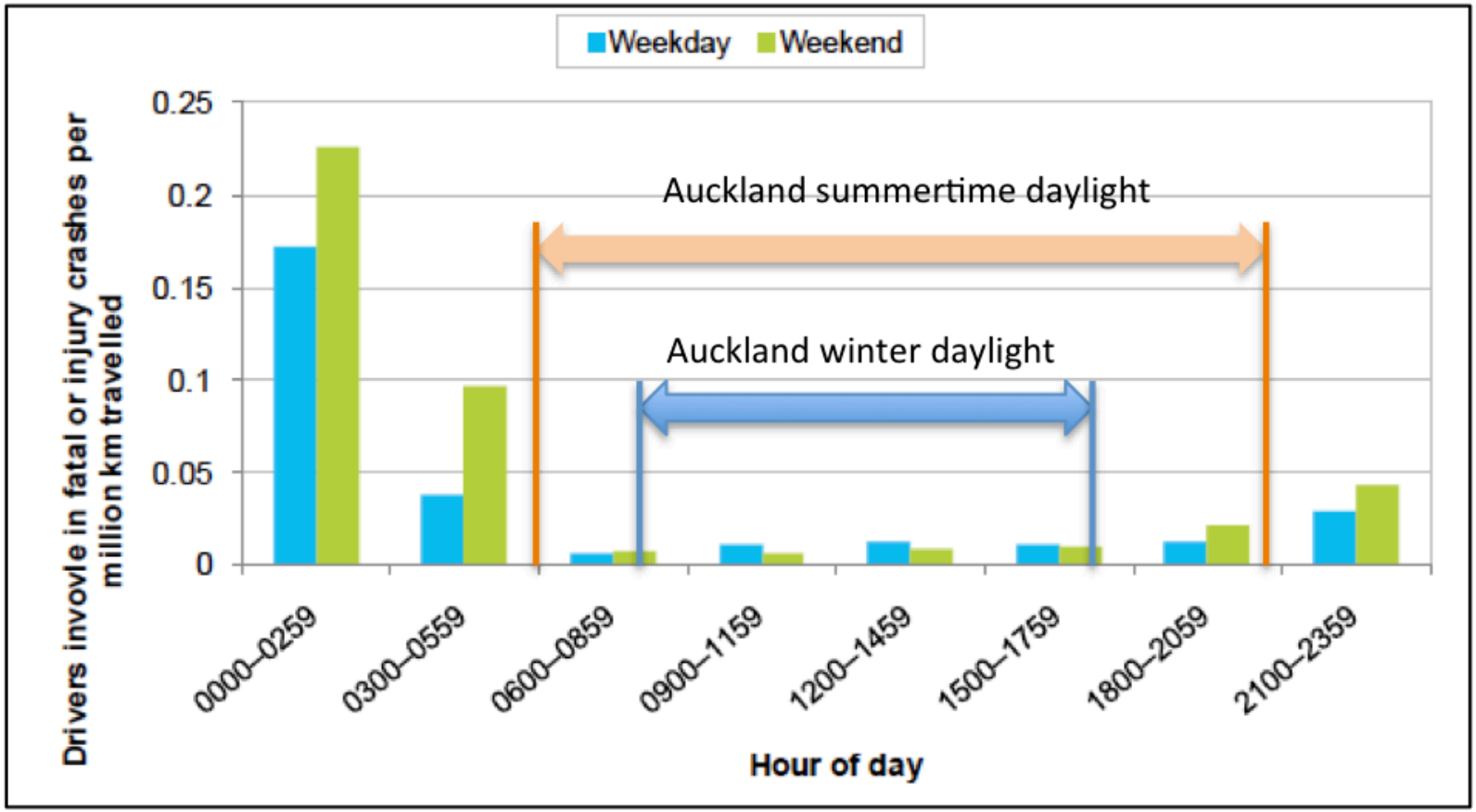
NZ Road Injury & Fatalities



(**Source**: IRTAD 2011)

MoT Household Travel Survey

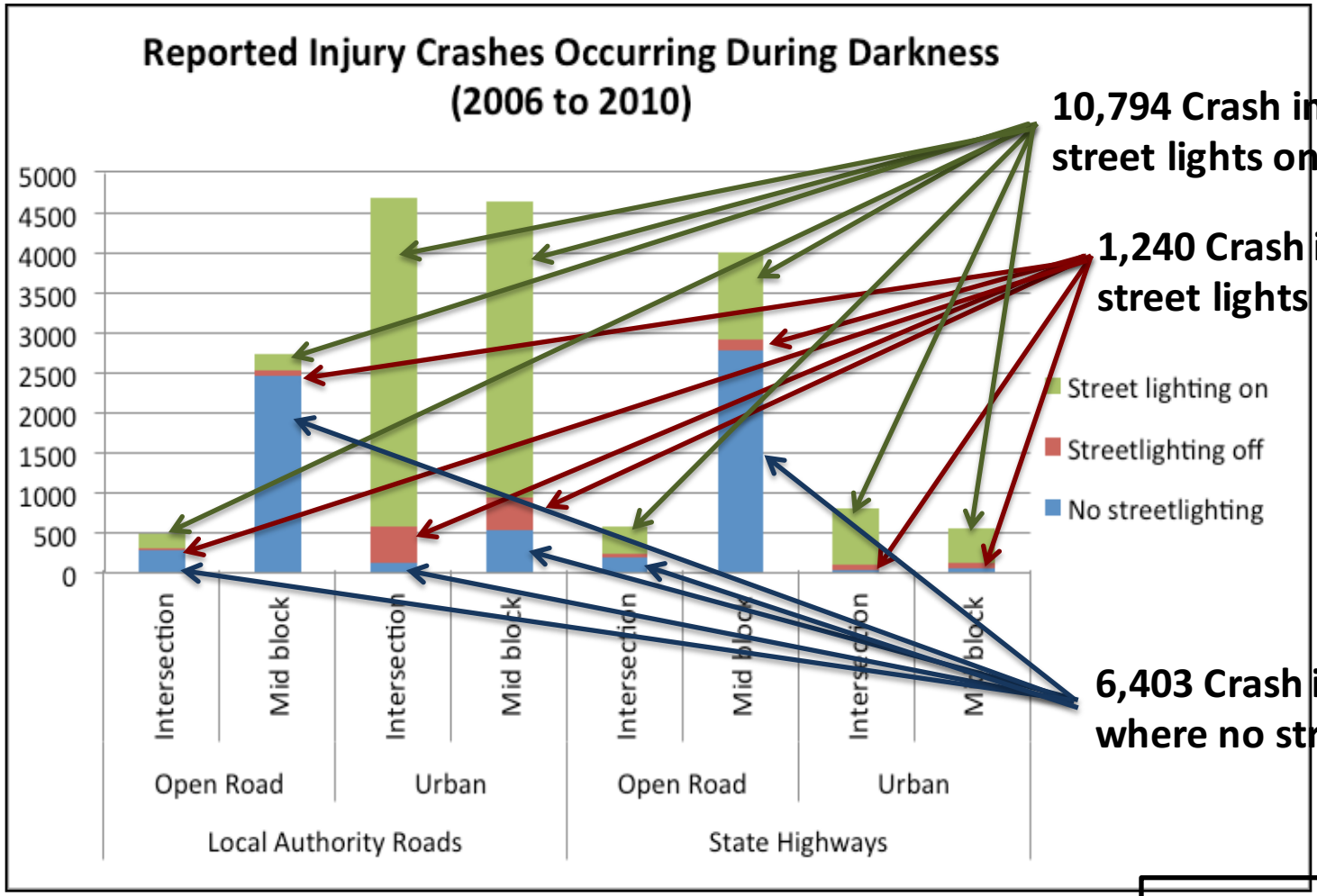
4,600 households



Night time risk 5.8 x Daytime risk

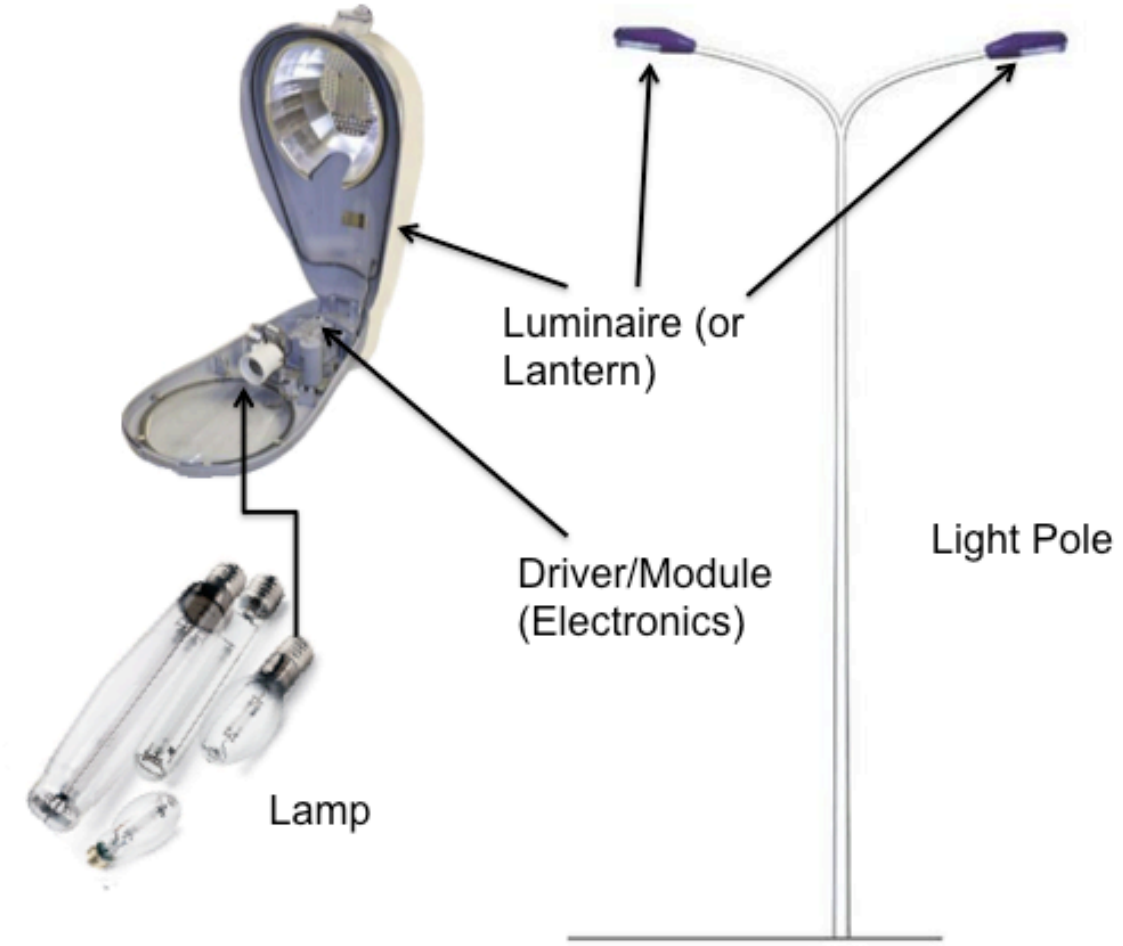
Source: Ministry of Transport October 2011 (seasonal daylight times added)

Injury Crashes in NZ 2006-10



Source: Tate, NZTA 2012

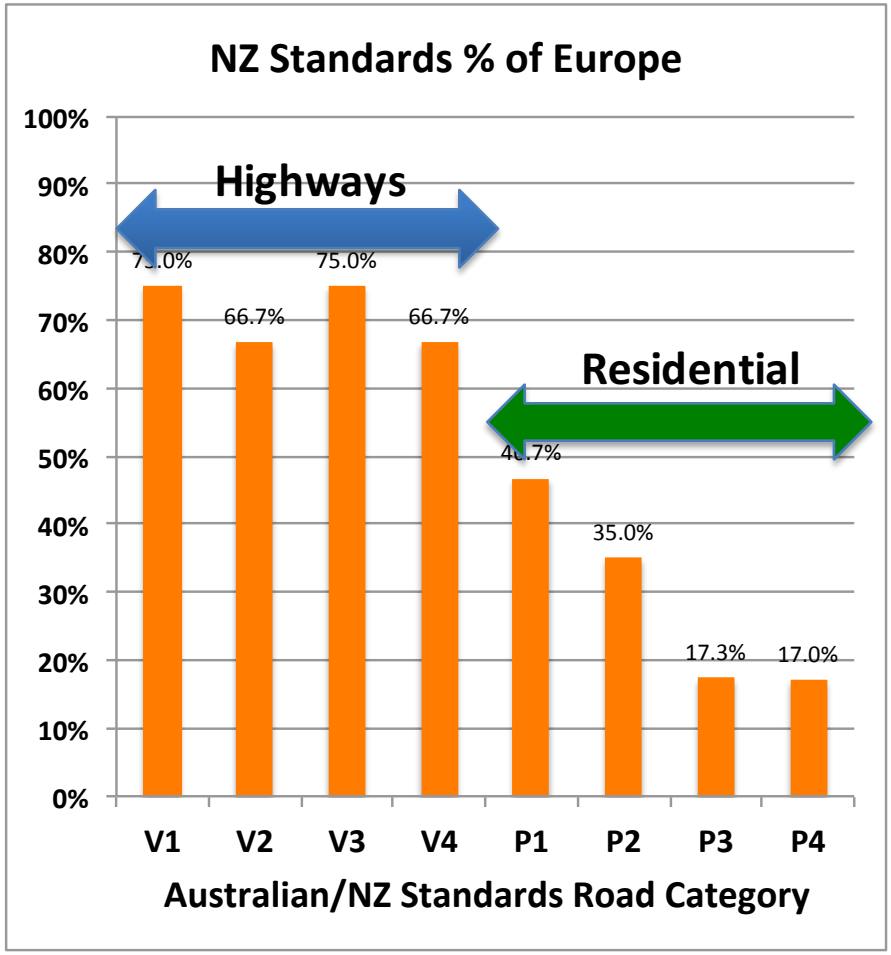
Street light



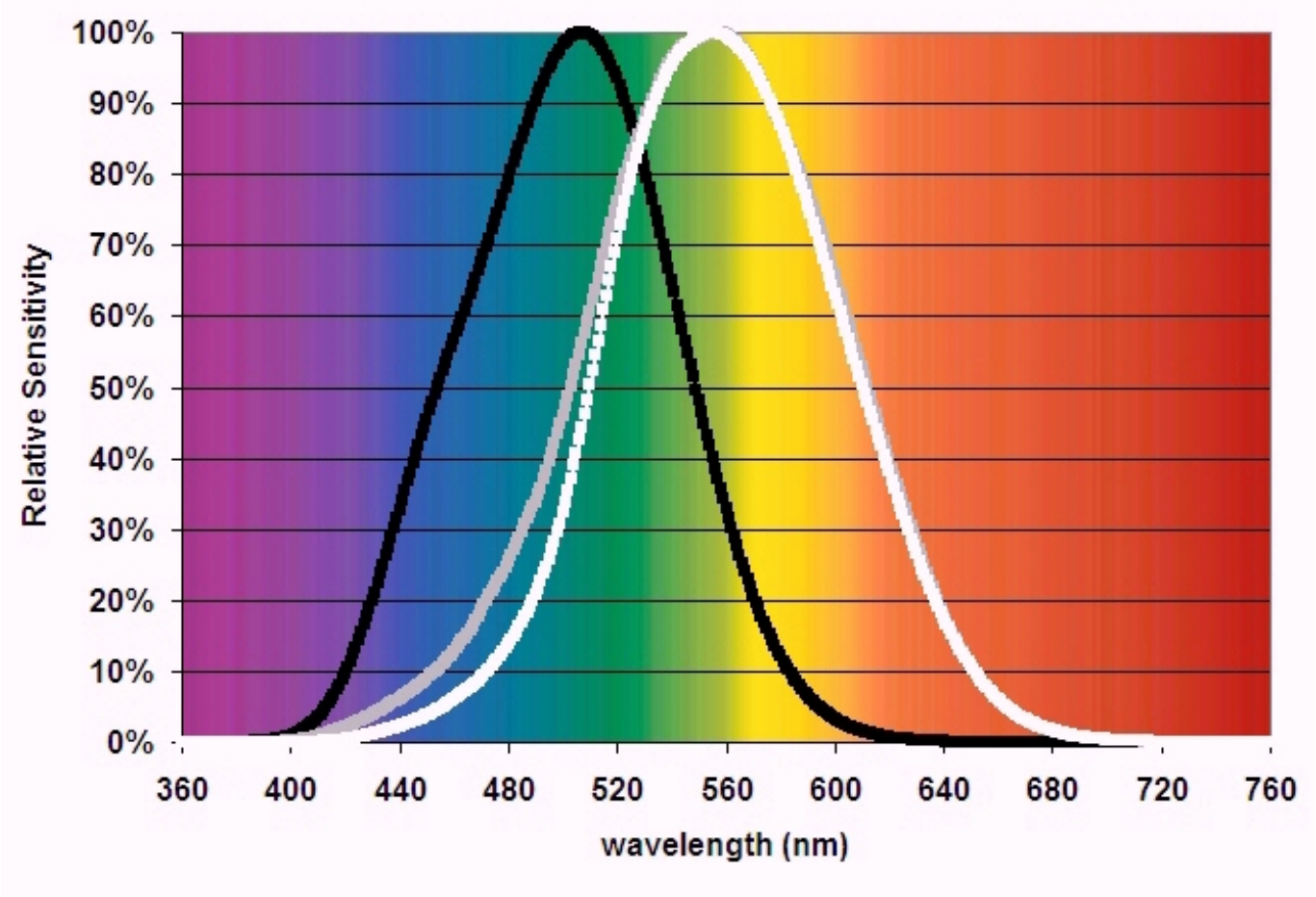
Australia NZ Street Lighting Standard AS1158

1. Comparatively low lighting levels
2. Eye not as sensitive to yellow light at low lighting levels
3. White light is better for reaction times and peripheral vision
4. Assumed reflectance values not correct
5. LED luminaires “excluded”
6. Under review

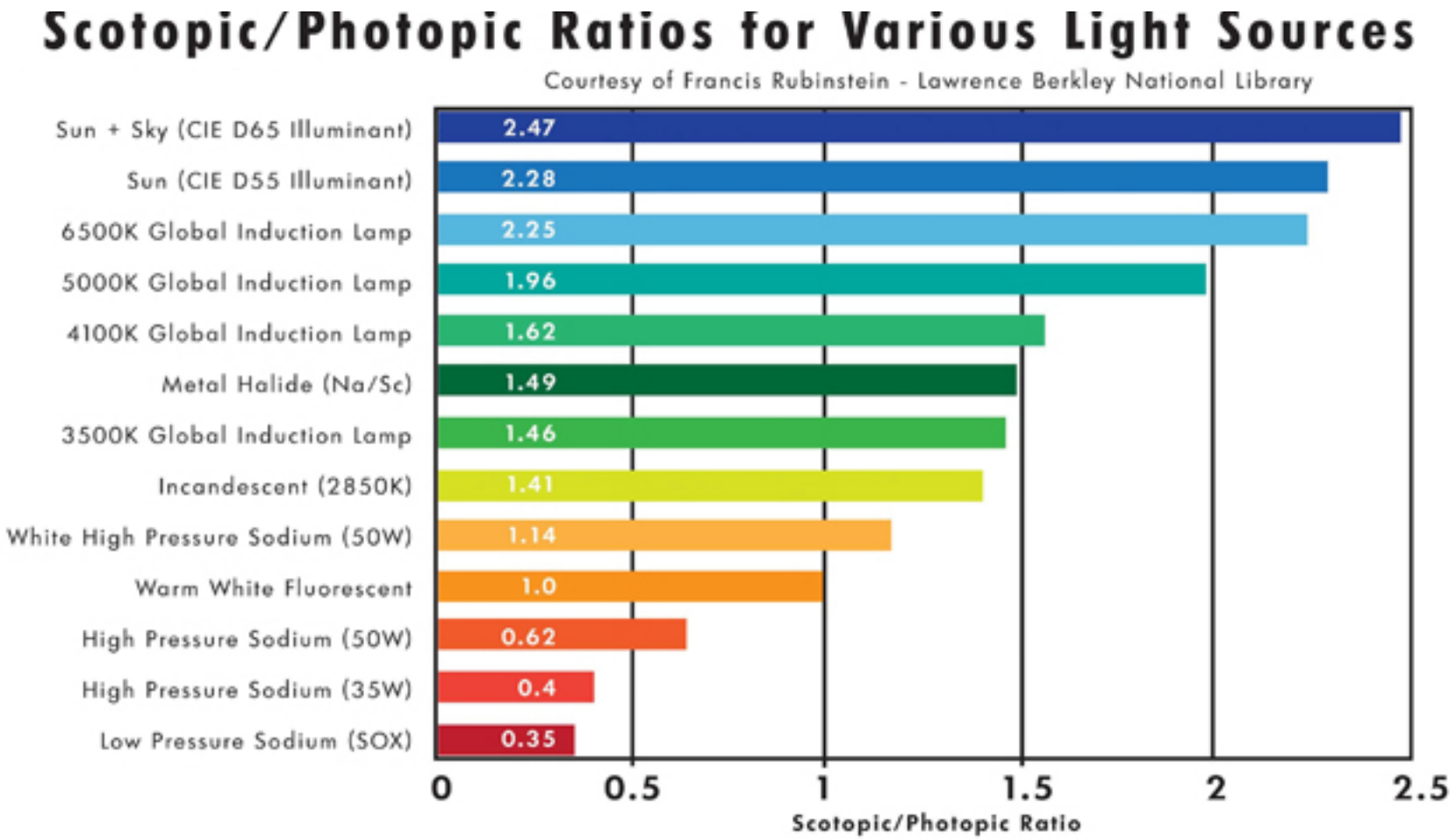
NZ Lighting Standards % of Europe



Mesopic Vision



Scotopic/Photopic Ratio



Source: Lawrence Berkley National Laboratory

CIE correction factors

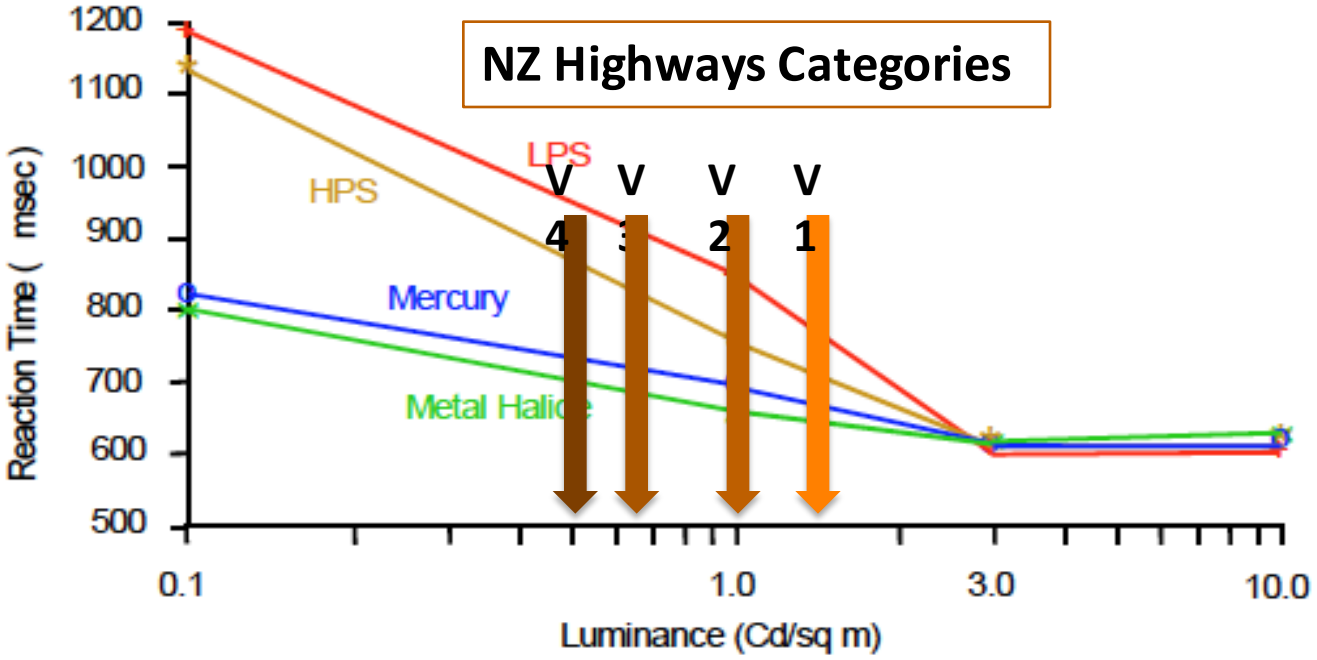
Table 1. Differences between mesopic and photopic luminances (%) calculated with the recommended mesopic system for a range of light source S/P-ratios.

		Photopic luminance cd·m^{-2}									
	S/P	0,01	0,03	0,1	0,3	0,5	1	1,5	2	3	5
LPS ~	0,25	-75 %	-52 %	-29 %	-18 %	-14 %	-9 %	-6 %	-5 %	-2 %	0 %
	0,45	-55 %	-34 %	-21 %	-13 %	-10 %	-6 %	-4 %	-3 %	-2 %	0 %
HPS ~	0,65	-31 %	-20 %	-13 %	-8 %	-6 %	-4 %	-3 %	-2 %	-1 %	0 %
	0,85	-12 %	-8 %	-5 %	-3 %	-3 %	-2 %	-1 %	-1 %	0 %	0 %
	1,05	4 %	3 %	2 %	1 %	1 %	1 %	0 %	0 %	0 %	0 %
MH warm white ~	1,25	18 %	13 %	8 %	5 %	4 %	3 %	2 %	1 %	1 %	0 %
	1,45	32 %	22 %	15 %	9 %	7 %	5 %	3 %	3 %	1 %	0 %
	1,65	45 %	32 %	21 %	13 %	10 %	7 %	5 %	4 %	2 %	0 %
	1,85	57 %	40 %	27 %	17 %	13 %	9 %	6 %	5 %	3 %	0 %
LED cool white ~	2,05	69 %	49 %	32 %	21 %	16 %	11 %	8 %	6 %	3 %	0 %
	2,25	80 %	57 %	38 %	24 %	19 %	12 %	9 %	7 %	4 %	0 %
MH daylight ~	2,45	91 %	65 %	43 %	28 %	22 %	14 %	10 %	8 %	4 %	0 %
	2,65	101 %	73 %	49 %	31 %	24 %	16 %	12 %	9 %	5 %	0 %

"*Finally, in 2010 we will have a mesopic photometric system to accompany the photopic V(λ), which has served since 1924.*" Liisa Halonen, Chairman CIE TC 1-58,

CIE = Commission International de L'Eclairage = International Commission on Illumination

White light reaction times improved



Source: Arizona Department of Transportation

Peripheral reaction times faster

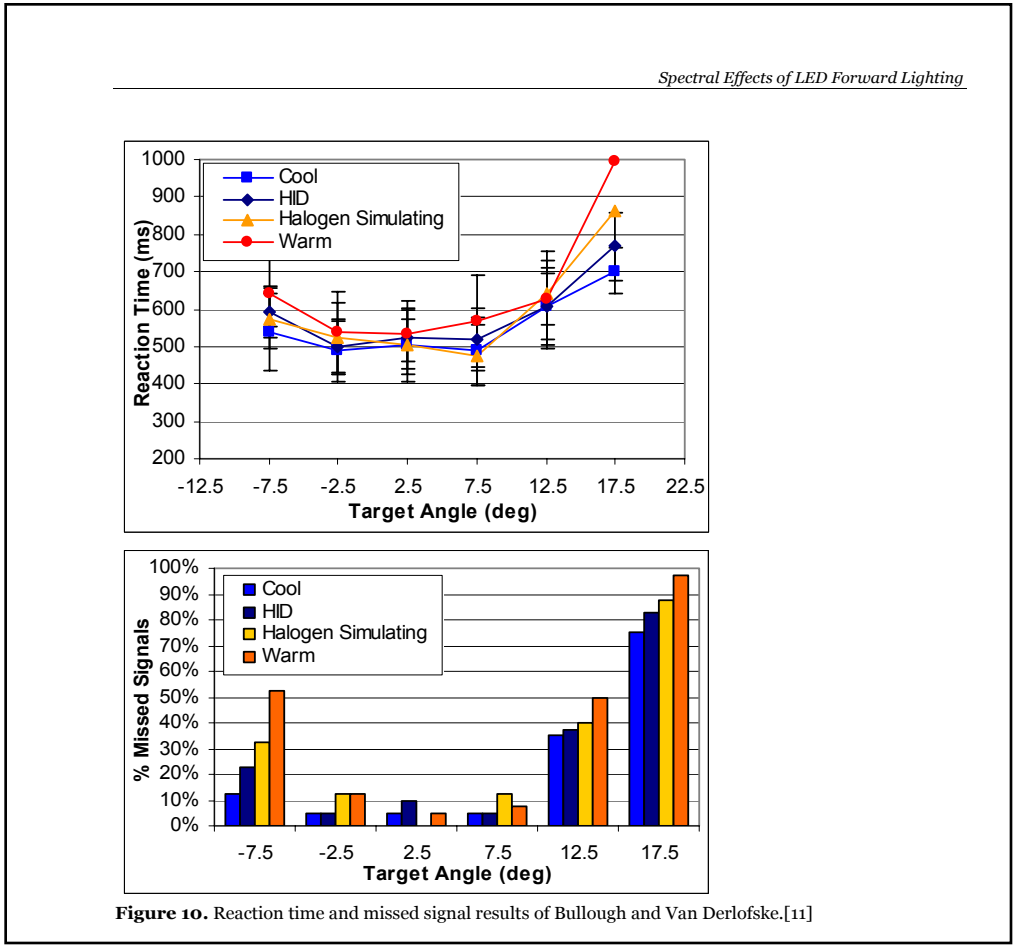


Figure 10. Reaction time and missed signal results of Bullough and Van Derlofske.[11]

Source: Rensselear Polytechnic Institute, April 2005

Road Reflectance

Source: *Measurement of the reflection properties of road surfaces to improve the safety and sustainability of road lighting*, NZTA #383, Jacket & Frith 2009

Reflection Properties of New Zealand Road Surfaces for Road Lighting Design

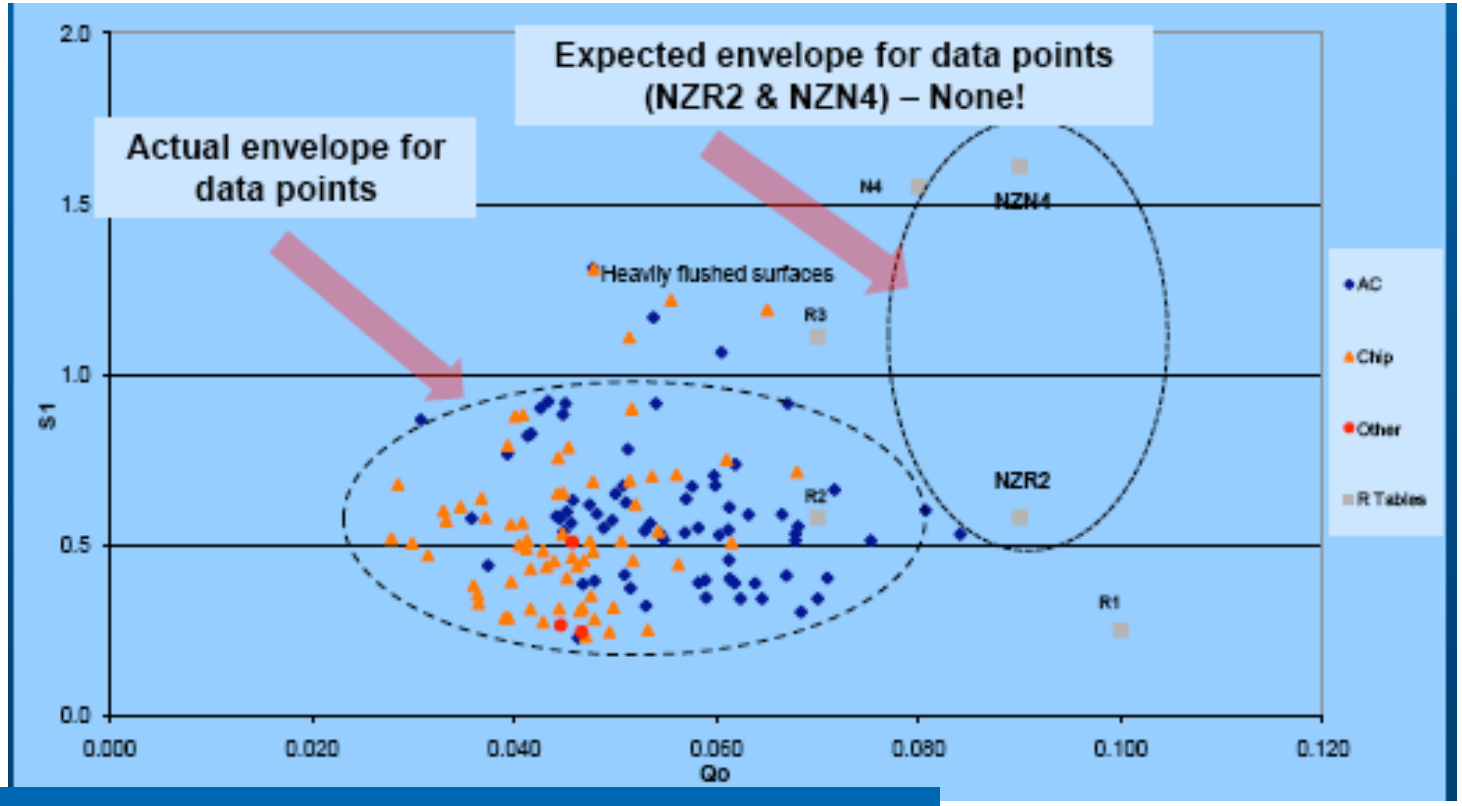
Mike Jackett Jackett Consulting and
Bill Frith Opus International Consultants, Central Laboratories

The objective of road safety lighting is to provide a bright road surface that allows drivers to see by silhouette.

Light surface (Q0 = 0.09)

Dark surface (Q0 = 0.05)

AS/NZS 1158 assumes wrong reflectance values



- Current road lighting designs are likely to be
  - underachieving on luminance (-45%)
  - producing higher disability glare (+60%)
  - overachieving on uniformity (+15%)

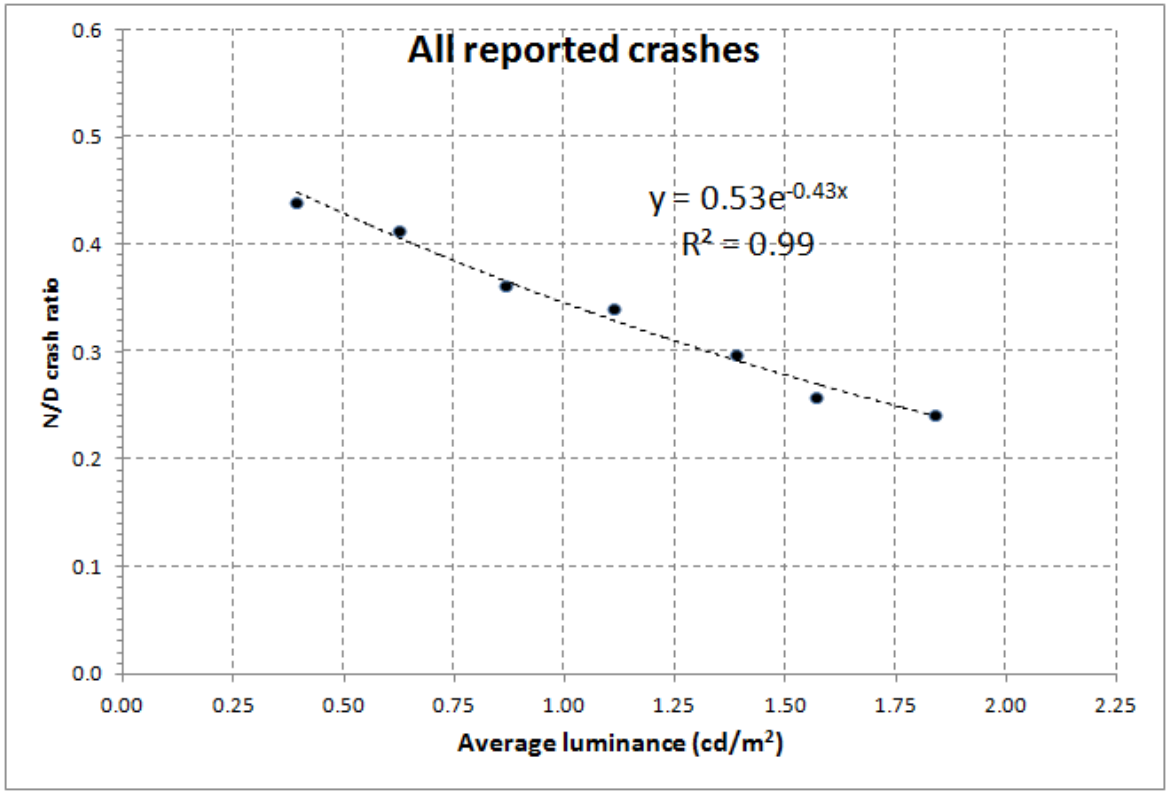
Source: Jacket & Frith 2009

Research shows improving lighting saves lives & injuries

- EG: *Handbook of Road Safety Measures* (Elvik 2009)
- @ 2007, 70 studies, 503 results on road lighting "largest number of studies are available for road lighting …"
- reductions in risk from 87% for fatal accidents in rural roads to 4% for injury accidents on motorways
- NZTA guidelines = 35%

Jackett & Frith 2012

For every 0.5cd/m^2 increase in lighting level, injury crashes reduce by 33%, n = 7,944 (2006-10)

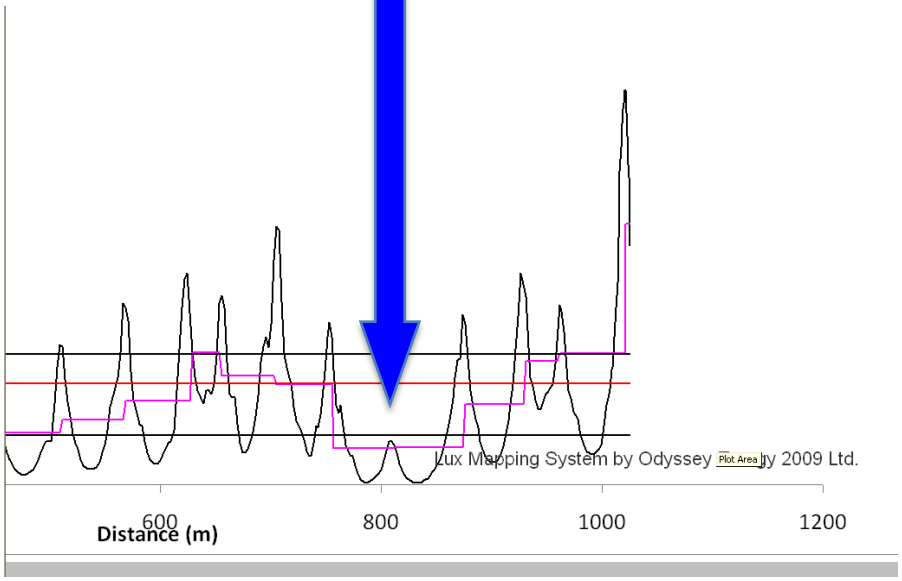


Reducing crash injuries through lighting maintenance

- Dirty luminaires
- Crooked installation
- Vegetation encroachment
- Lamp failure
- Better lighting – eg LED
- No research to relate maintenance to crash injuries

Realities of street lighting maintenance

Dirty Luminaires



Source: Odyssey Energy

Crooked Luminaires

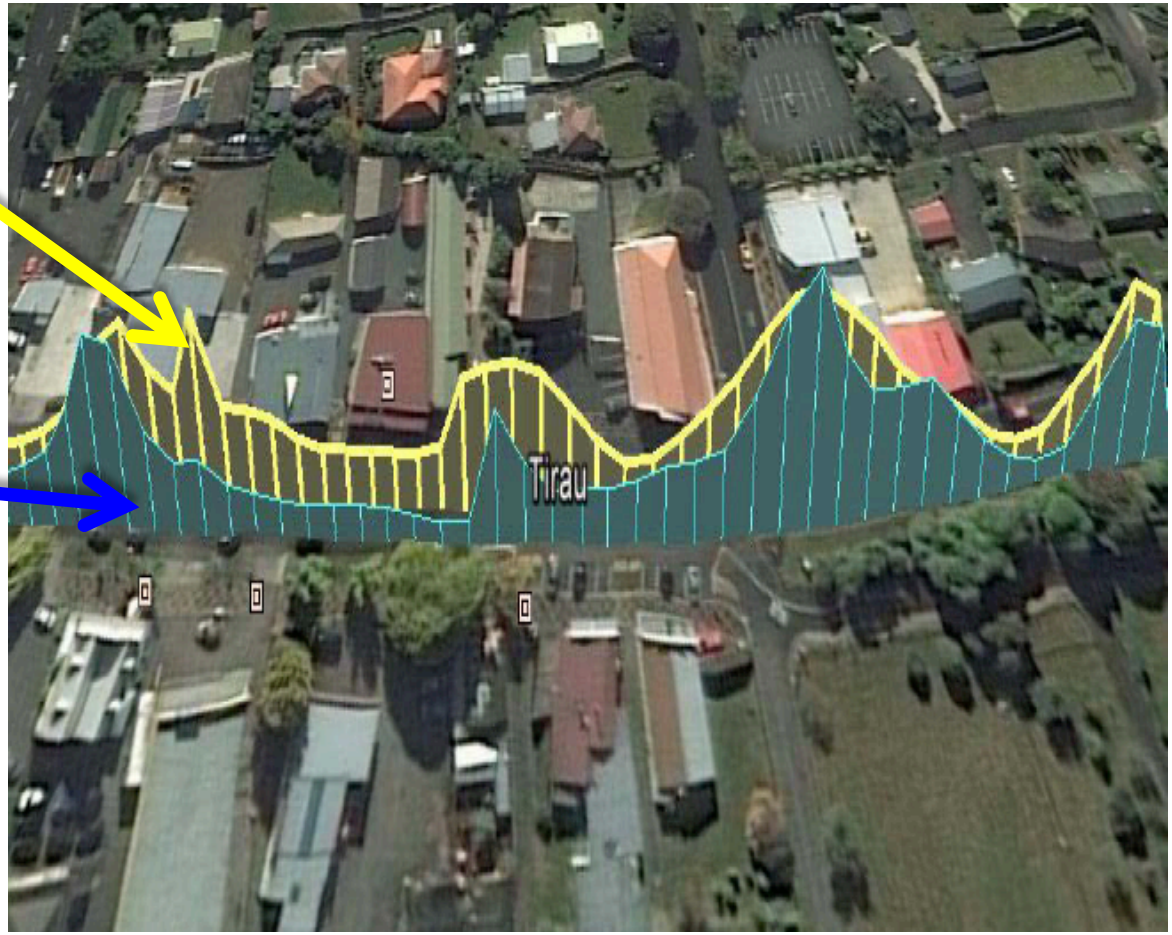
Source: Odyssey Energy

Obstructed luminaires

Source: Odyssey Energy

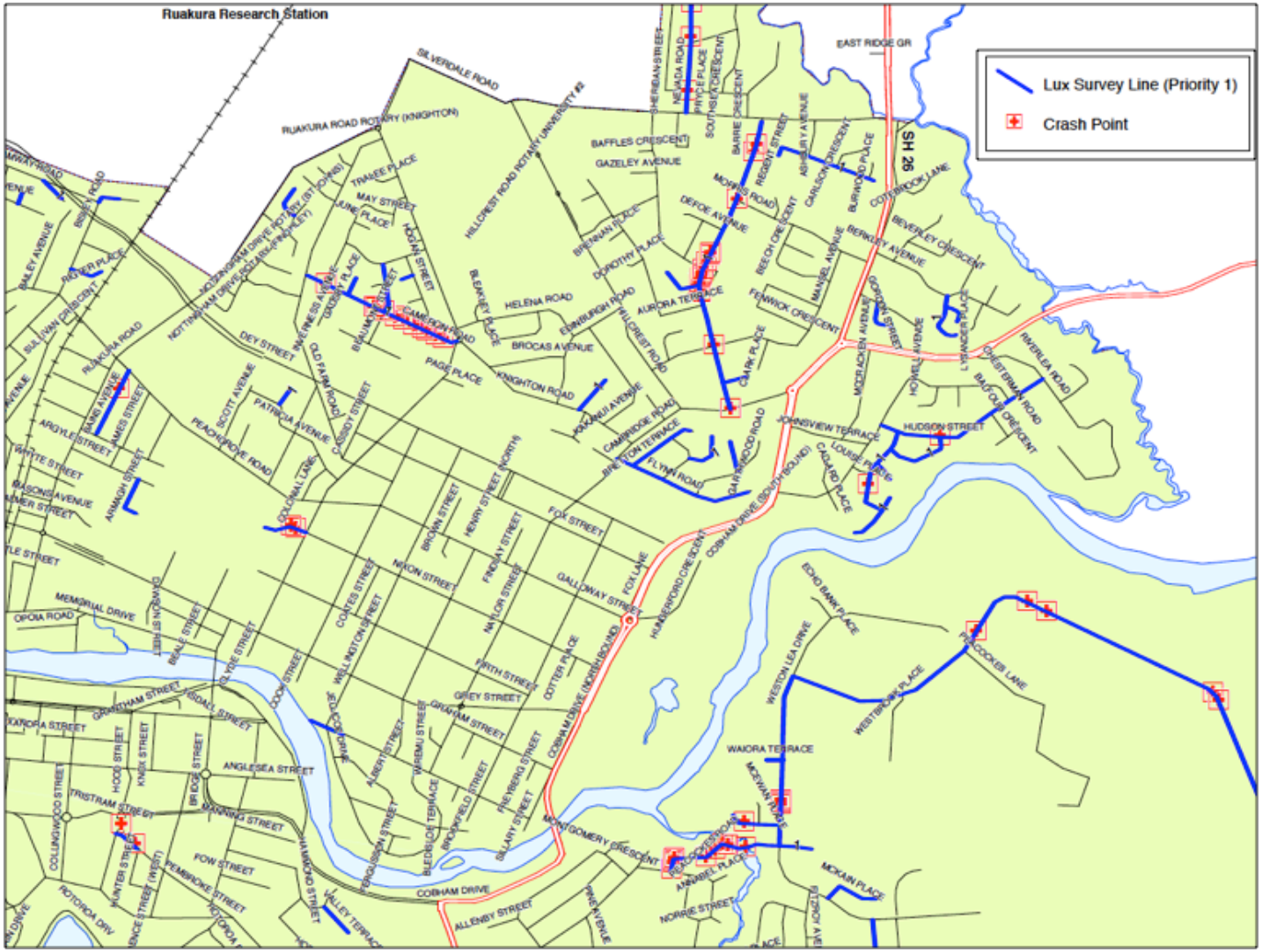
Lux Mapping – Odyssey Energy

Before & After LED Road lights



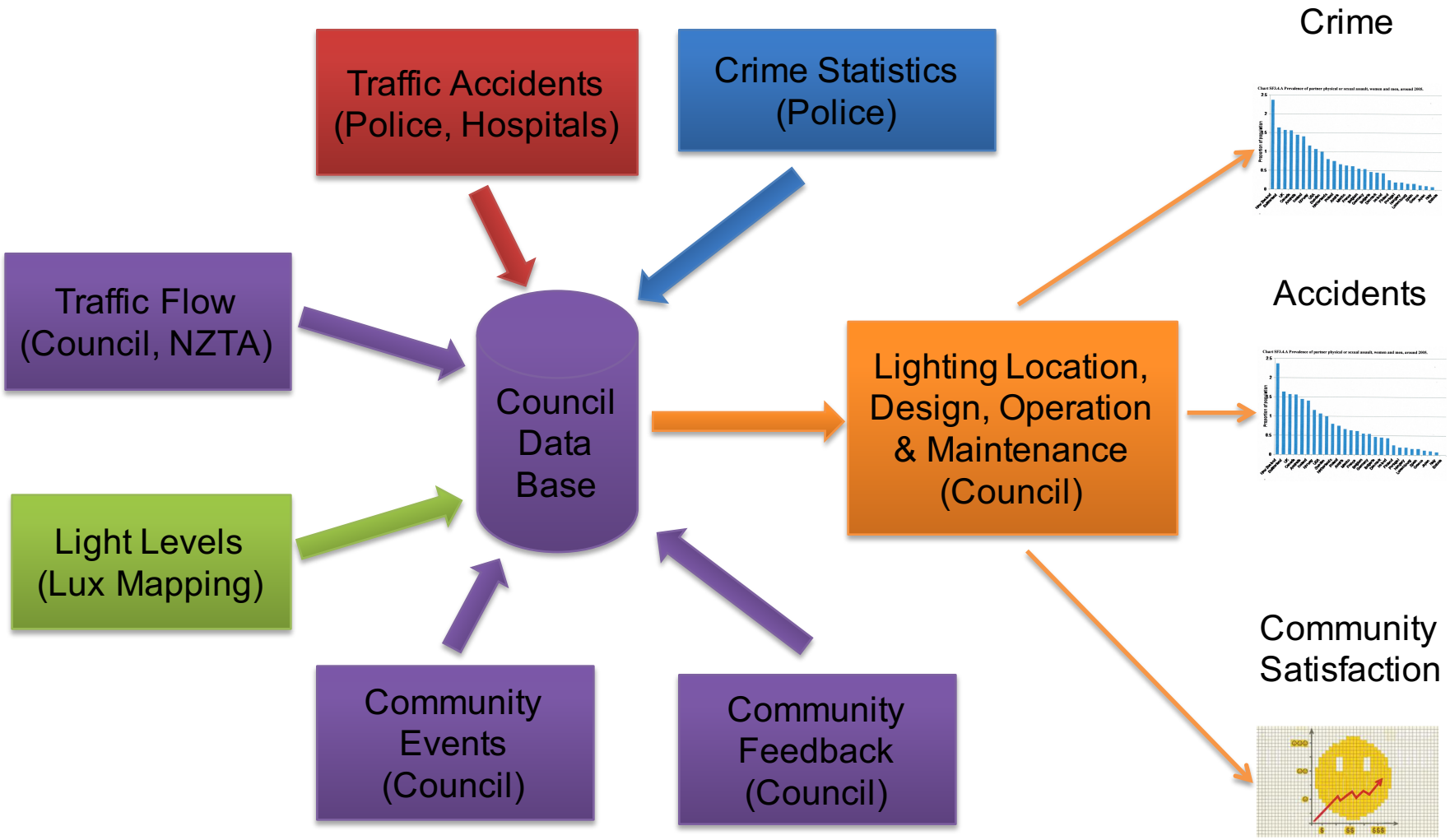
Source: Odyssey Energy

Crash Mapping



Source:
Hamilton
City Council

Value created from data integration



Extra cost?

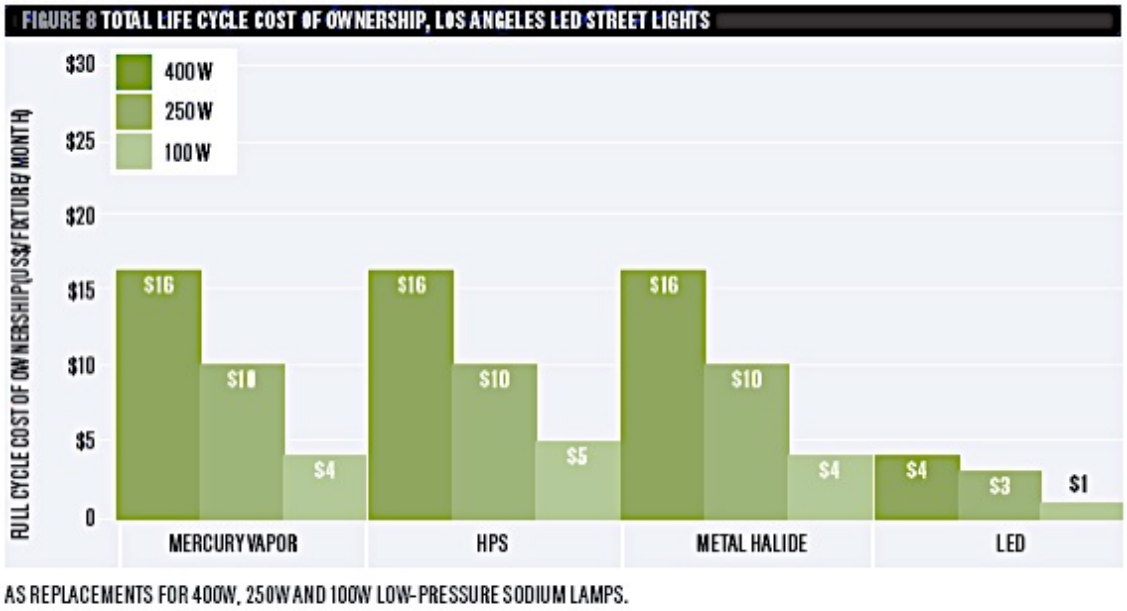
NO! – reduce lifetime cost of ownership substantially using revolutionary new technologies

LED Lighting – “A Revolution” (McKinsey & Co, 2011)

Source: The Climate Group, June 2012

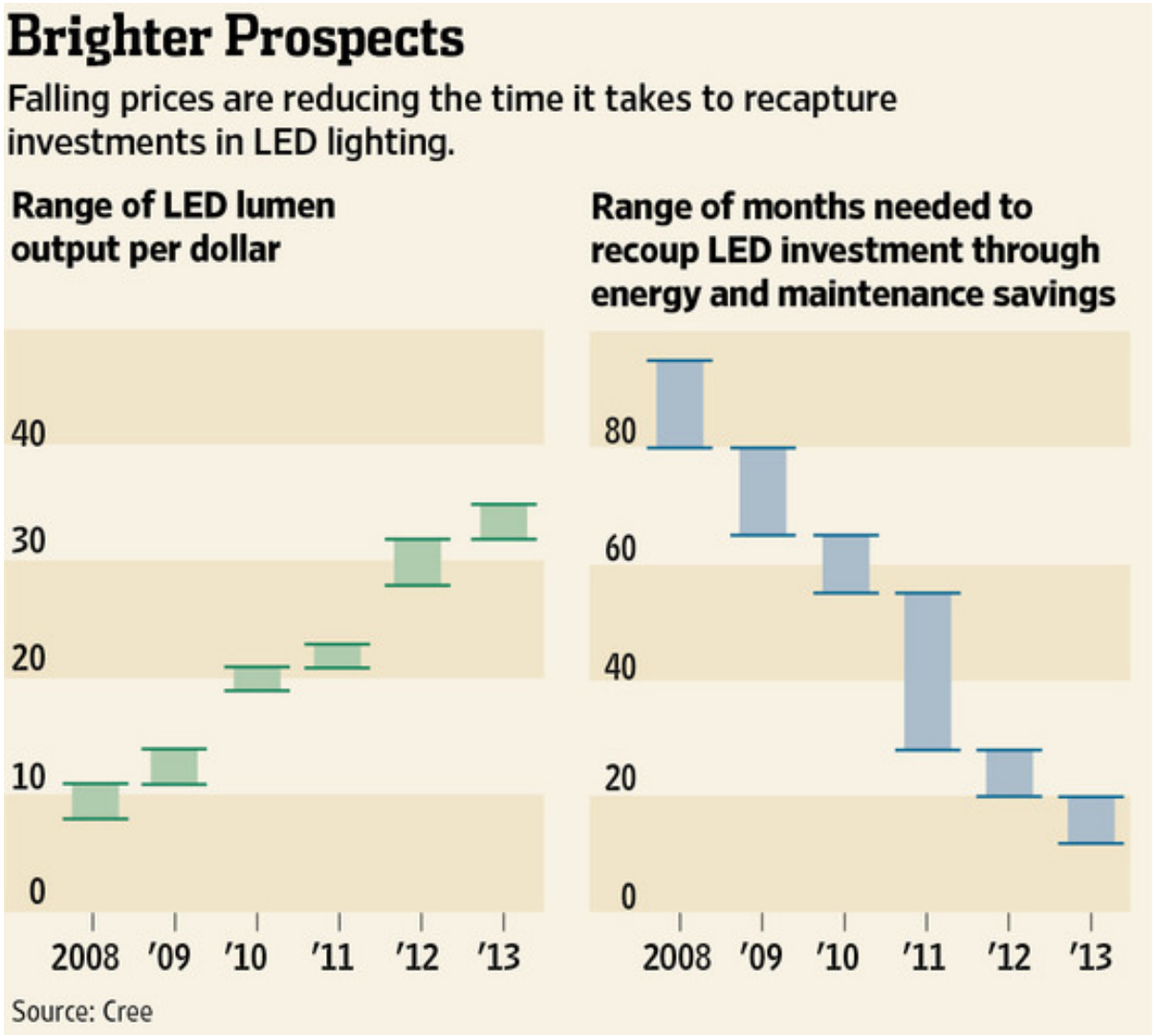
Total Cost of Ownership

CONDUCTING A TOTAL COST OF OWNERSHIP ANALYSIS PUTS LIGHTING TECHNOLOGIES ON AN EVEN ECONOMIC PLAYING FIELD



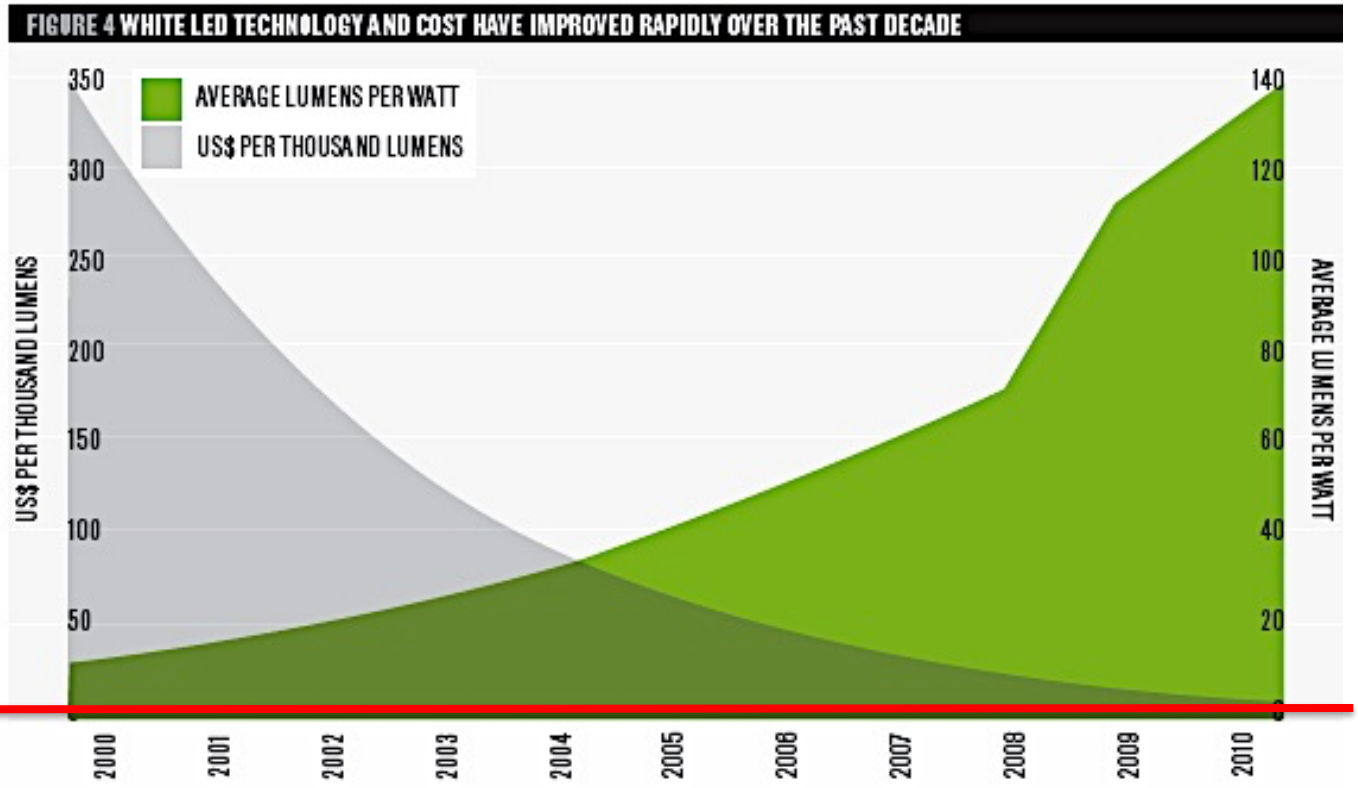
Source: The Climate Group, June 2012

Prices Falling



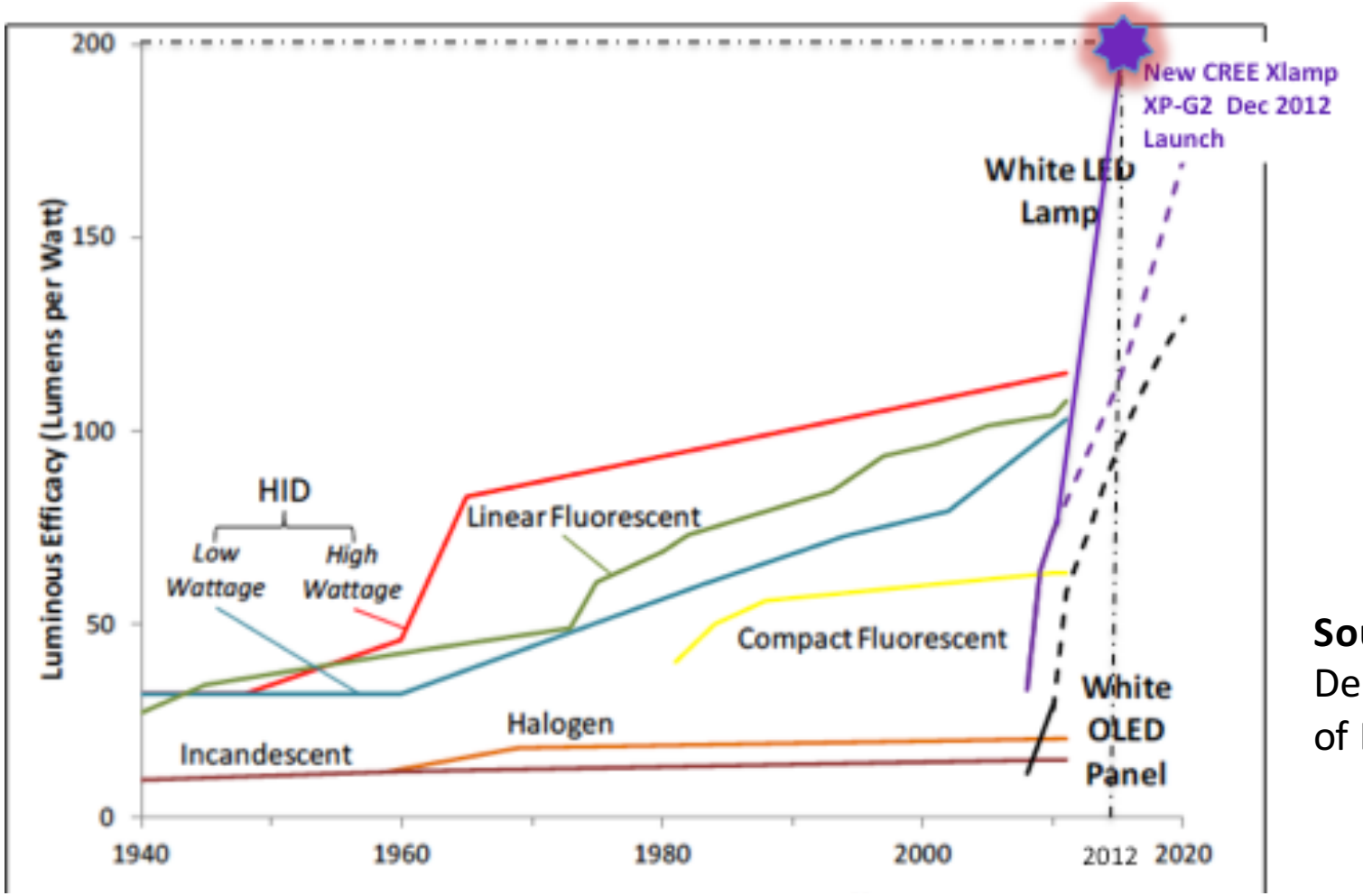
US$ per 1,000 Lumens

Asymptote = “A line whose distance to a given curve tends to zero”



BHANDARKAR, V., 2011, LED LIGHTING MARKET TRENDS, STRATEGIES UNLIMITED, PRESENTATION TO STRATEGIES IN LIGHT CONFERENCE, SANTA MONICA.

LED street lighting efficacy



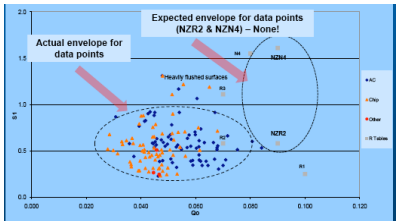
Source: USA Department of Energy

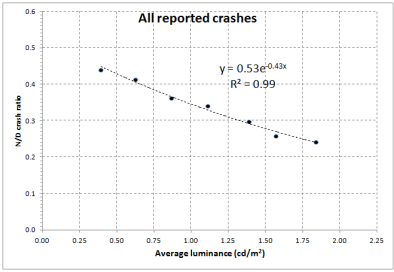
Upgrade all NZ lighting

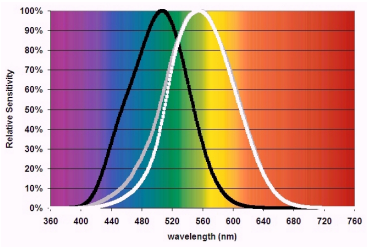
Assumption: NZTA 35% guideline for saving night injuries across <u>whole</u> country (no precedent).

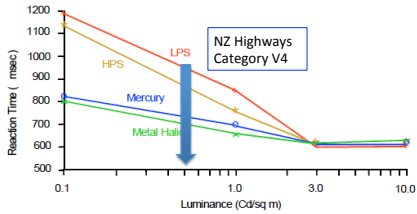
Conservative because:

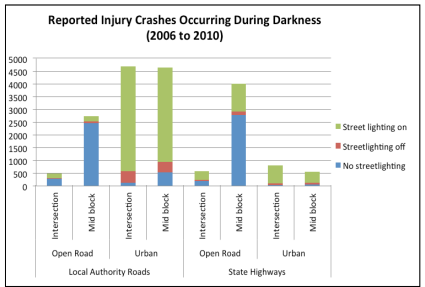
1. Correct NZ lighting levels (+ Jackett & Frith)
2. Use white light
3. Integrate lux mapping, crash, crime, traffic, events to control and design lighting
4. Analyse night crashes
5. Spend $150 million on new lighting

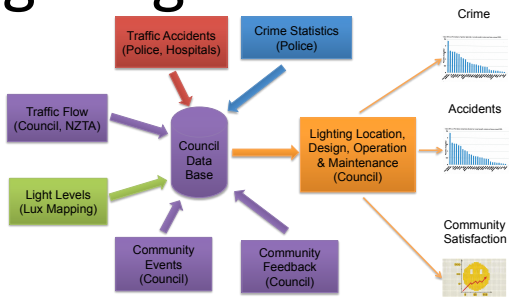


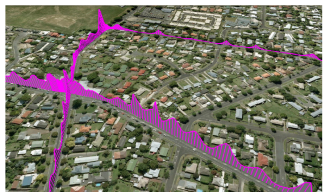












Benefit

- 35% improvement in night crashes = 61 lives, 1,538 injuries
- X $3.5 million per life, $350k per injury
- X 8% discount factor
- = $6.7 billion

Cost

- 400,000 luminaires & control systems say $400 million
- New lighting, say $150 million
- Extra costs including databases, say $150 million
- Total $700 million
- X 8% discount factor over 3 yrs = $649 million

Benefit Cost Ratio BCR

$6.7 billion ÷ $649 million = 10.3

END

- Godfrey Bridger – 021 274 3437
  godfrey@bridgerbeavis.com
- Byan King – 021 300 111
  bryanking@lightingmanagementconsultants.com
- Website for papers and this Powerpoint:
  http://www.bridgerbeavis.com/pdfs

Follow the Leaders

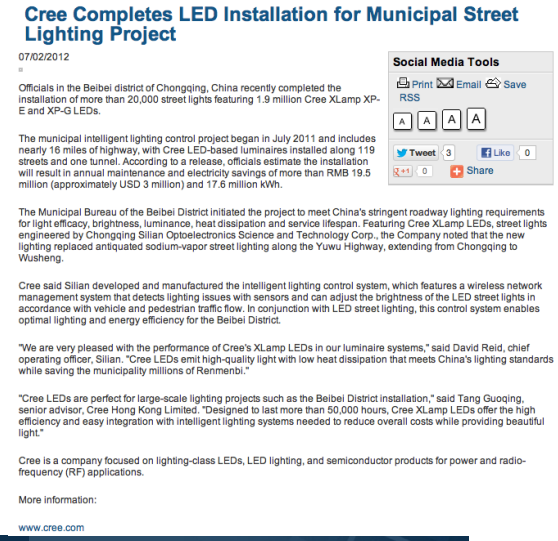
Some of the cities/regions where 20,000 LED lights have been installed and work is underway to install more:

- Los Angeles USA, (149,000)
- Birmingham UK,
- Surrey, UK
- Las Vegas , USA
- Chongqing, China (CREE, USA!)

About to invest:

- Auckland Transport

47 of the 344 Trial sites in USA, most of which have web sites (as shown)



Cree Completes LED Installation for Municipal Street Lighting Project

07/02/2012

Officials in the Beibei district of Chongqing, China recently completed the installation of more than 20,000 street lights featuring 1.9 million Cree XLamp XP-E and XP-G LEDs.

The municipal intelligent lighting control project began in July 2011 and includes nearly 16 miles of highway, with Cree LED-based luminaires installed along 119 streets and one tunnel. According to a release, officials estimate the installation will result in annual maintenance and electricity savings of more than RMB 19.5 million (approximately USD 3 million) and 17.6 million kWh.

The Municipal Bureau of the Beibei District initiated the project to meet China's stringent roadway lighting requirements for light efficacy, brightness, luminance, heat dissipation and service lifespan. Featuring Cree XLamp LEDs, street lights engineered by Chongqing Silian Optoelectronics Science and Technology Corp., the Company noted that the new lighting replaced antiquated sodium-vapor street lighting along the Yuwu Highway, extending from Chongqing to Wusheng.

Cree said Silian developed and manufactured the intelligent lighting control system, which features a wireless network management system that detects lighting issues with sensors and can adjust the brightness of the LED street lights in accordance with vehicle and pedestrian traffic flow. In conjunction with LED street lighting, this control system enables optimal lighting and energy efficiency for the Beibei District.

"We are very pleased with the performance of Cree's XLamp LEDs in our luminaire systems," said David Reid, chief operating officer, Silian. "Cree LEDs emit high-quality light with low heat dissipation that meets China's lighting standards while saving the municipality millions of Renmenbi."

"Cree LEDs are perfect for large-scale lighting projects such as the Beibei District installation," said Tang Guoqing, senior advisor, Cree Hong Kong Limited. "Designed to last more than 50,000 hours, Cree XLamp LEDs offer the high efficiency and easy integration with intelligent lighting systems needed to reduce overall costs while providing beautiful light."

Cree is a company focused on lighting-class LEDs, LED lighting, and semiconductor products for power and radio-frequency (RF) applications.

More information:

www.cree.com

Social Media Tools

Print Email Save RSS

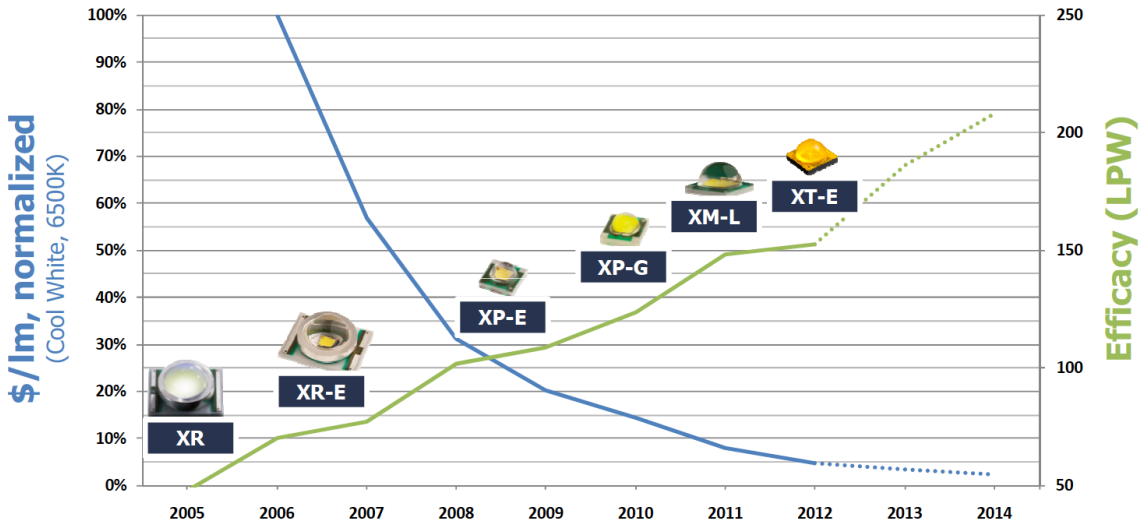
A A A A

Tweet 3 Like 0

+1 0 Share

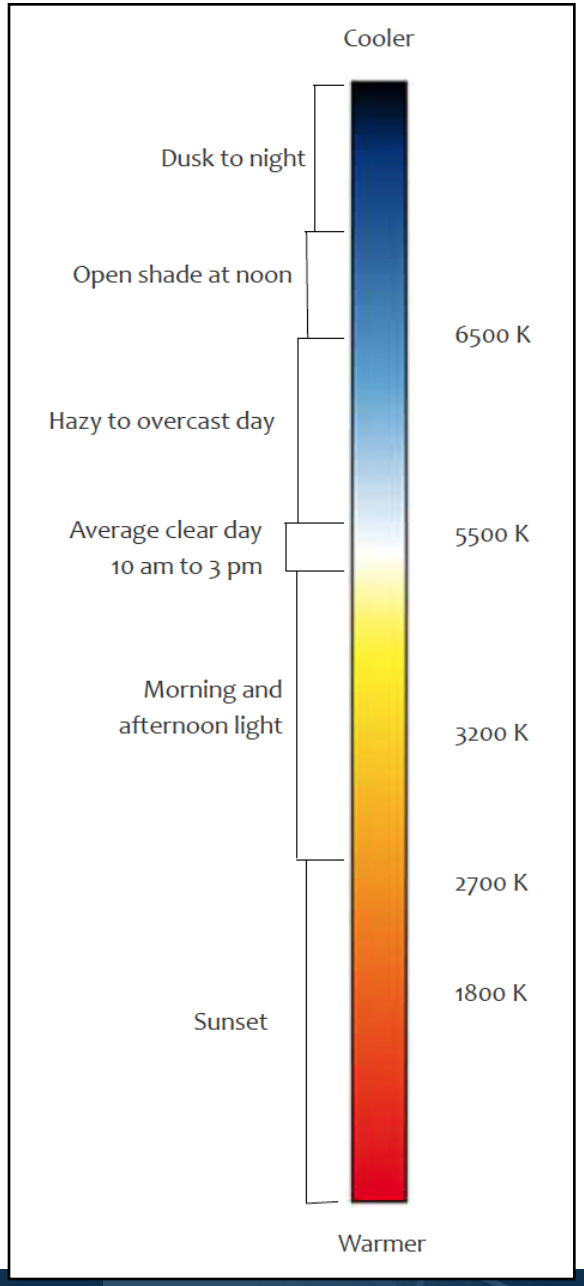
Aberdeen, Maryland, USA
Albany, California, USA
Albemarle, North Carolina, USA
Alberta, Canada
Allentown, Pennsylvania, USA
Alton, Illinois, USA
Ames, Iowa, USA
American Canyon, California, USA
Amherst, Nova Scotia, Canada
Anchorage, Alaska, USA
Ankeny, Iowa, USA
Ann Arbor, Michigan, USA
Appleton, Wisconsin, USA
Arlington, Massachusetts, USA
Arlington Heights, Illinois, USA
Asheville, North Carolina, USA
Auburn, Alabama, USA
Baldwin City, Kansas, USA NEW
Bangor, Maine, USA
Baytown, Texas, USA
Battle Ground, Washington, USA
Beaumont, California, USA
Belmont, California, USA
Benicia, California, USA
Berwick, Nova Scotia, Canada
Biggs, Healdsburg, and Ukiah, California, USA
Blair, Nebraska, USA
Blue Springs, Missouri, USA
Boaz, Alabama, USA
Boca Raton, Florida, USA
Boise, Idaho, USA UPDATED
Boston, Massachusetts, USA NEW
Broken Bow, Nebraska, USA
Brookline, Massachusetts, USA
Brooklyn, Indiana, USA
Brundidge, Alabama, USA
Burbank, California, USA
California Department of Transportation (Caltrans), USA NEW
Camas, Washington, USA
Camden, New Jersey, USA
Campbell River, British Columbia, Canada
Canton, Ohio, USA
Carmel, Indiana, USA
Cary, North Carolina, USA
Cedar Rapids, Iowa, USA
Central City, Nebraska, USA
Ceres, California, USA

Driving Lumen Affordability with Innovation



Annual Improvement in $/lm @ 100 LPW	43%	45%	35%	29%	45%	40%		

CREE


Cooler
Dusk to night
Open shade at noon
6500 K
Hazy to overcast day
Average clear day
10 am to 3 pm
5500 K
Morning and
afternoon light
3200 K
2700 K
1800 K
Sunset
Warmer

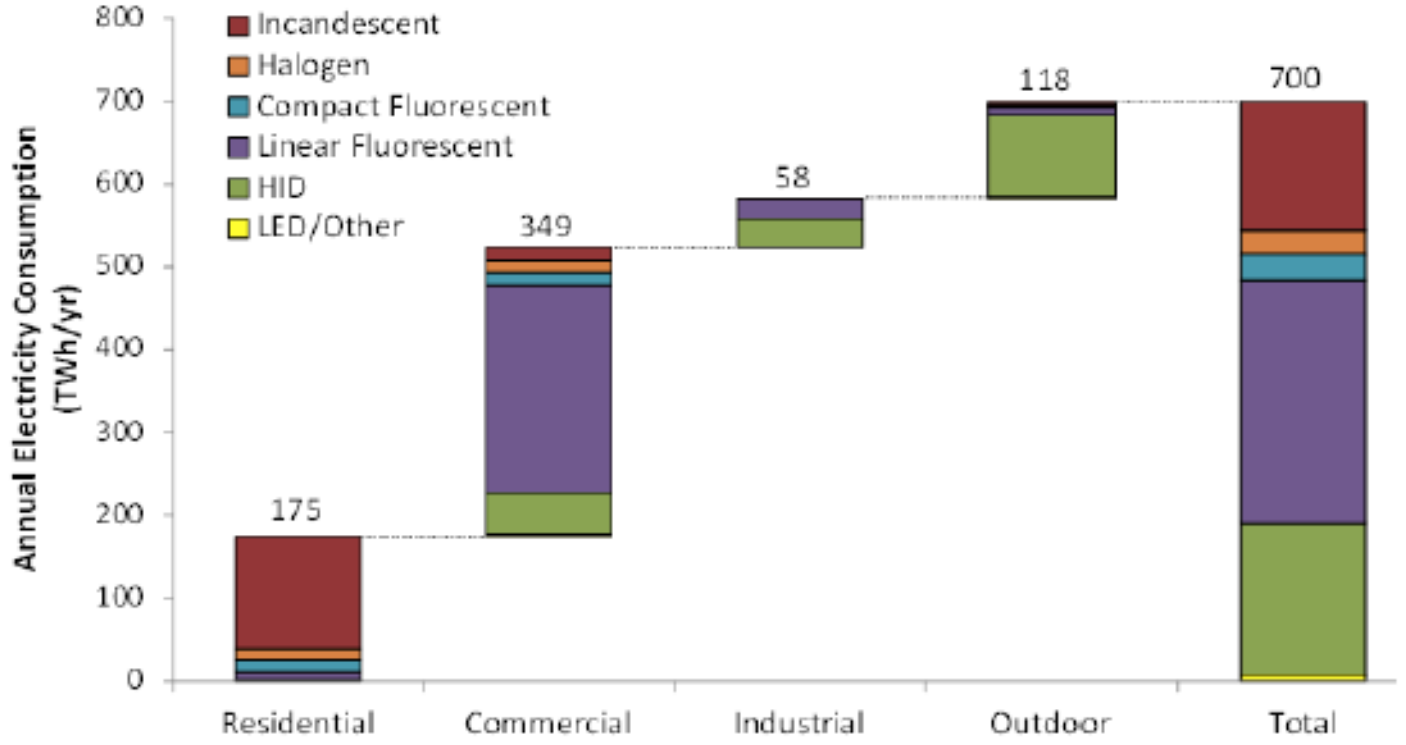


Figure 2.2: U.S. Lighting Electricity Consumption by Sector and Lamp Type in 2010
Source: *2010 U.S. Lighting Market Characterization. Prepared by Navigant Consulting, Inc. for the Department of Energy. Washington D.C. January 2012.*

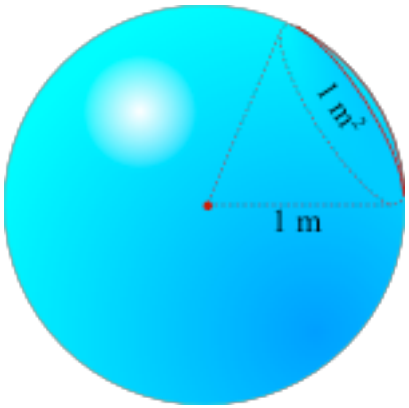
NZ vs European Lighting

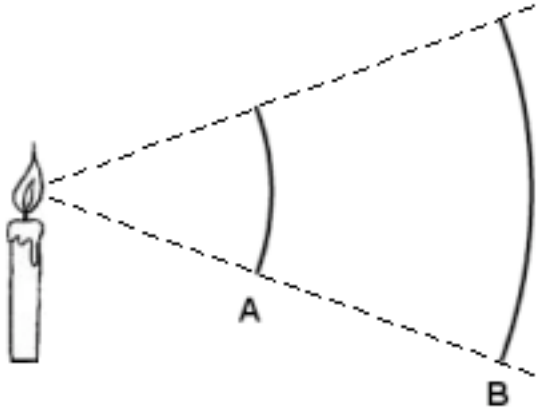
	Category		Light Level		NZ % of European
	Australia/NZ Standard 1158	European EN1302	AS/NZS 1158	European EN1302	
			cd/m2	cd/m2	
Highways and arterial roads	V1	ME1	1.5	2.0	75.0%
	V2	ME2	1	1.5	66.7%
	V3	ME3	0.75	1.0	75.0%
	V4	ME4	0.5	0.75	66.7%
		ME5		0.5	
		ME6		0.3	
			Lux	**Lux**	
Residential roads	P1	S1	7	15	46.7%
	P2	S2	3.5	10	35.0%
	P3	S3	1.3	7.5	17.3%
	P4	S4	0.85	5	17.0%
		S5		3	
		S6		2	

Contents

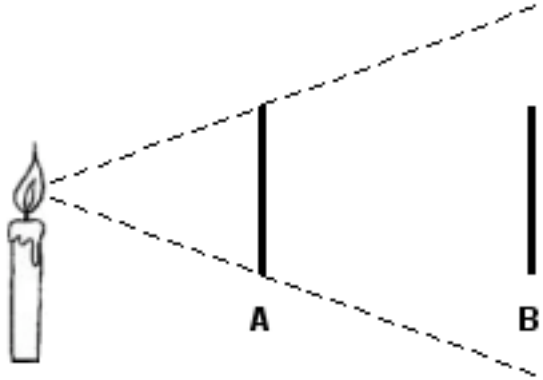
1. NZ injury & fatality comparatively poor
2. MoT night risks
3. CAS night accidents 2006
4. USA: “about 25% of all traffic travels in the darkness while 50% of all fatal accidents occur in darkness.”
5. NZ street lighting standards lower than overseas
6. Improving lighting decreases injuries & death
7. New technologies provide very cost effective opportunities to upgrade
8. Benefit cost ratios appear to be very high

Candela, Lumen, Lux





The candela measures the amount of light emitted in the range of a (three-dimensional) angular span. Since the luminous intensity is described in terms of an angle, the distance at which you measure this intensity is irrelevant.



The lumen (unit lm) gives the total luminous flux of a light source by multiplying the intensity (in candela) by the angular span over which the light is emitted. With the symbol Φv for lumen, Iv for candela and Ω for the angular span in steradian, the relation is:

$$\Phi v = Iv \cdot \Omega$$

ttp://www.compuphase.com/electronics/candela_lumen.htm

Luminance, Illuminance

Luminance is a measure for the amount of light emitted from a surface (in a particular direction). The measure of luminance is most appropriate for flat diffuse surfaces that emit light evenly over the entire surface, such as a (computer) display. Luminance is a derived measure, expressed in Candela per square metre (*cd*/*m*2).

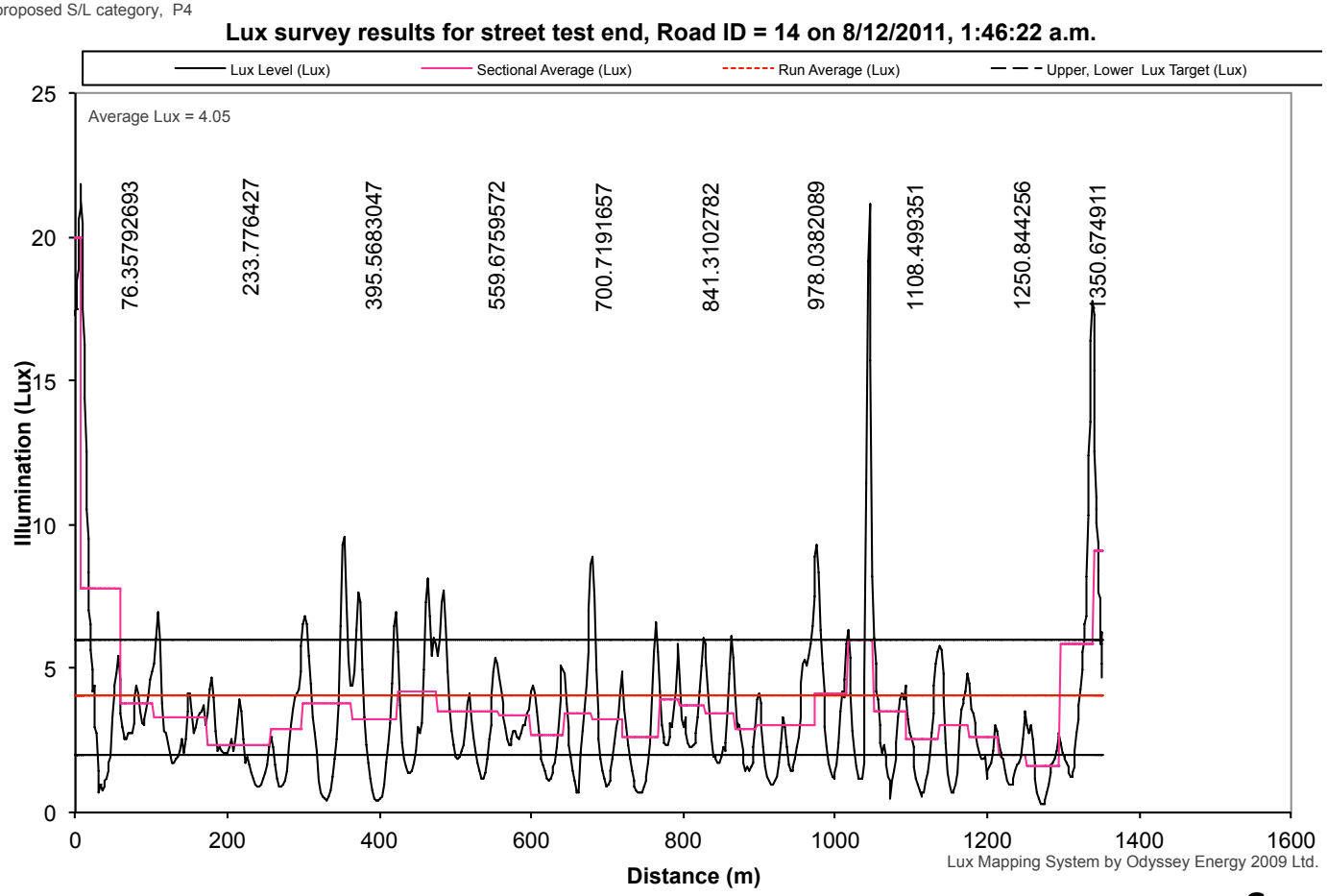
Luminance and illumination ("Lux") are related, in the sense that luminance is typically used for light-emitting surfaces and illumination for surfaces that are *being* lit.

Therefore 1 Candela will illuminate a surface with 1 Lux only at one meter from a light source.

Read more:
http://wiki.answers.com/Q/How_many_candelas_equals_1_lux#ixzz28KNGDHKZ

Lighting survey

proposed S/L category, P4



At max legal speed limit

Source: Odyssey Energy