

**LIFTING THE FOG ON
STREET LIGHTING**
- Putting hard numbers to
the performance of new
lamp technologies.

Steve Coyne

Street Lighting Energy Footprint

Australia street lighting is responsible for:

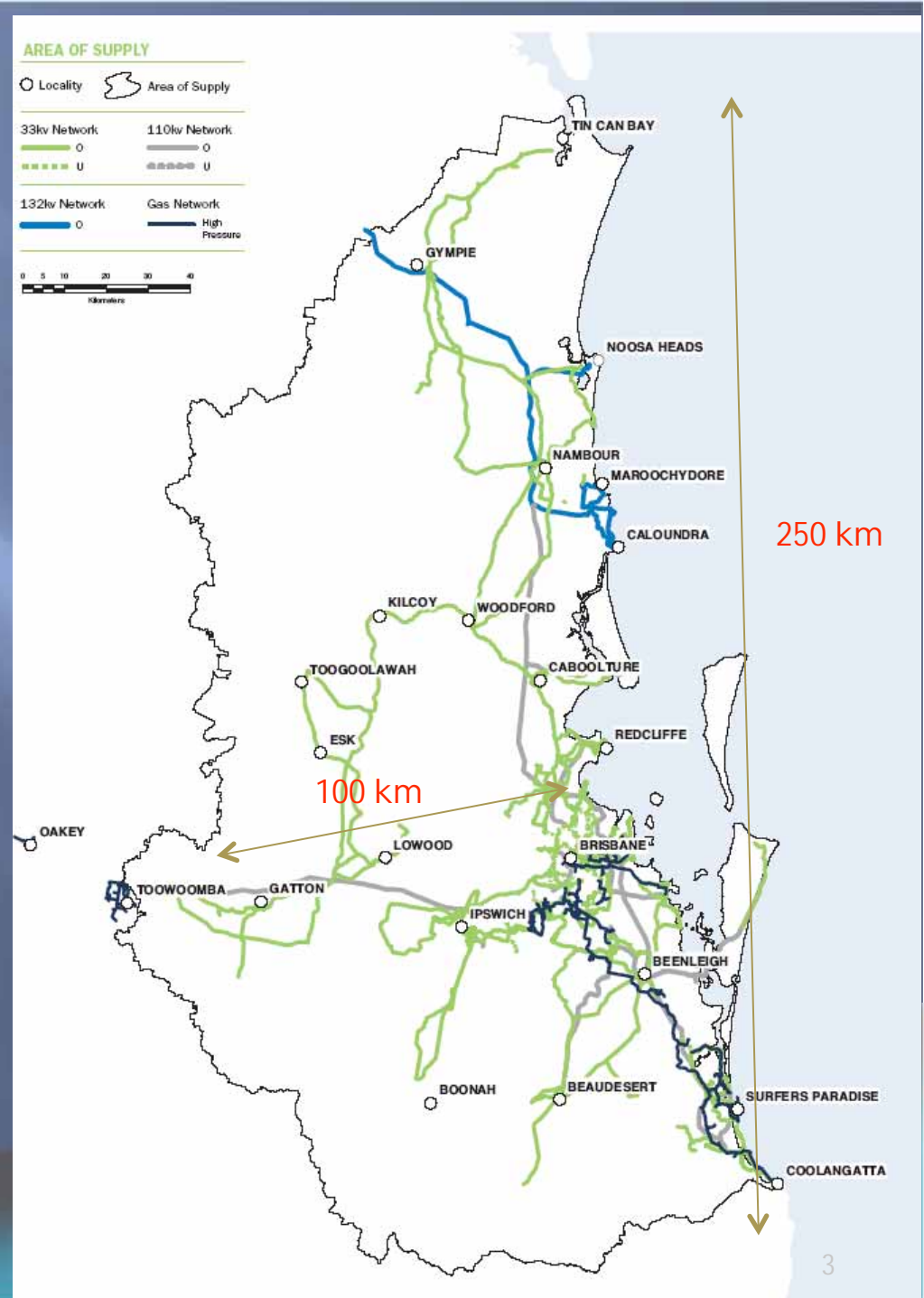
- ▣ Over 1 million tonnes of CO₂ emissions,
- ▣ Consumes over 1 Tera Watt hour of electricity
- ▣ An annual cost of over \$200 M.

There are approximately 2 million lamps in public lighting, of which

- ▣ ~ 200 000 are 50 W mercury vapour lamps
- ▣ over 700 000 are 80 W mercury vapour lamps.

Energex's Street Light Stock

- ~ 279,000 public lights in Energex supply area
- ~ 118 000 are 50W Mercury Vapour lamps



Improved Energy Efficiency in Street Lighting

Keen interest by local authorities and energy distributors due to

- ▣ advances in lamp technologies
- ▣ the strain on summer electricity supply
- ▣ the increased community sensitivity to green house gas emissions

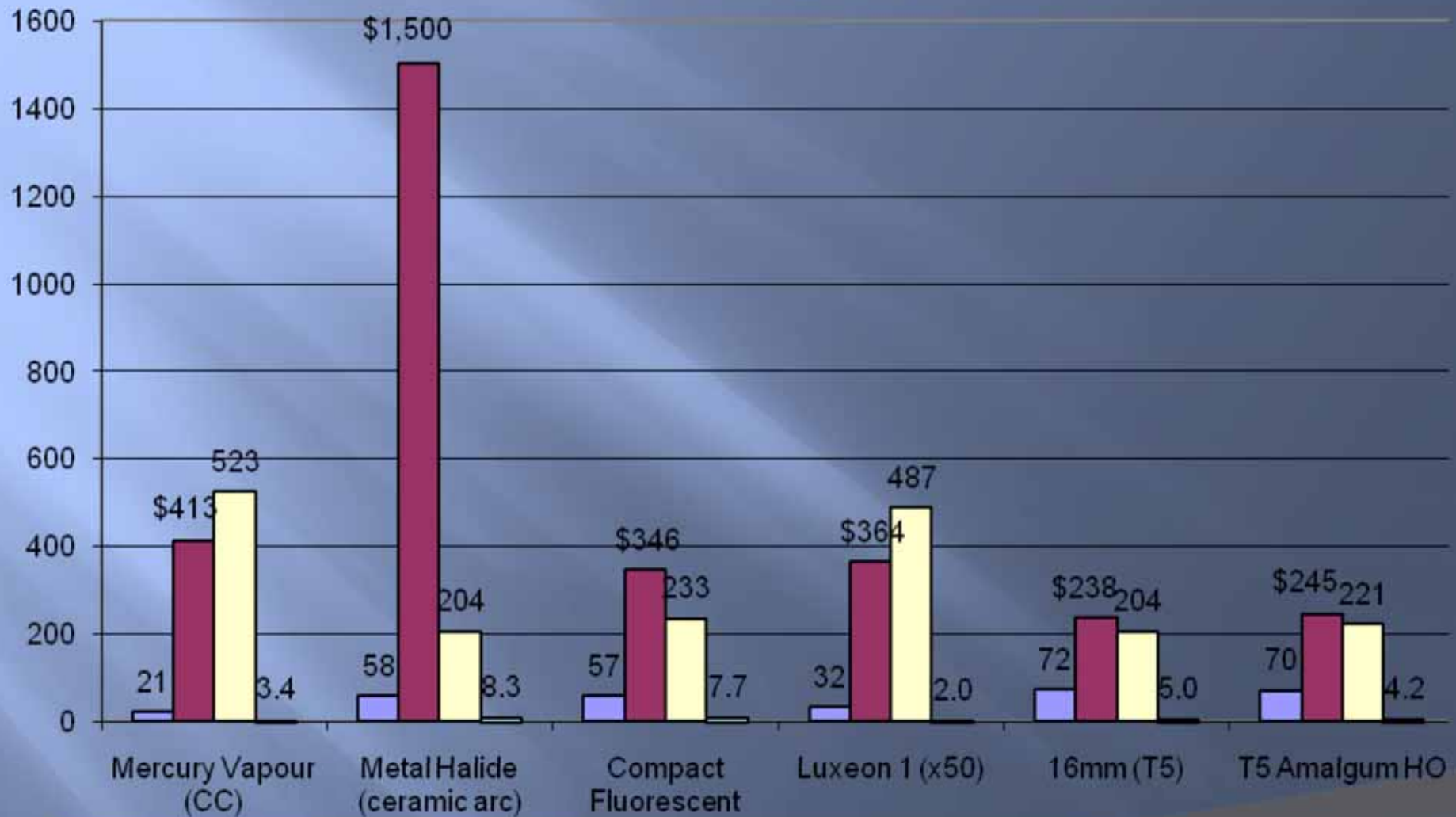
Technology Transfer Risk

- ▣ The gross uptake of new lamp technologies has stalled due to uncertainty of survival of the lamps and electronic gear when exposed to extreme environmental hostility, pole vibration, and reduced quality of electrical supply. (lamps designed for stable interior environments)
- ▣ Ultimately, the “underwriting” or attributing of the risk of economic and performance failure has halted mass adoption.

Green at a Cost?

- ▣ A review of the Potential for Energy Efficient Street Lighting in Queensland highlighted the opportunity for GHG emissions reduction BUT also signalled it could come at a financial cost to the local governments.

900 - 1800 Lumens



- Average Efficacy through life (Lm/W)
- Cost per 100,000 hours of operation (excluding labour costs of retrofit & service) (\$)
- Greenhouse gas emissions (kg)
- Number of average life lamp replacements

Assessment of Previous Trials

Conclusion

- ▣ All trials conducted had no (or very little) quantitative data on lamp performances.
- ▣ Any lamp failures could not be attributed to any specific environmental parameter
- ▣ If lamps survived there was no indication that it had been subjected to the full range of environmental conditions.
- ▣ Need to conduct own trial with quantitative performance monitoring!

Financing the Trial

Jointly funded project between

- ❑ Qld Department of Mines and Energy,
 - ❑ Aust Dept. Environment, Water, Heritage and the Arts
 - ❑ ENERGEX,
 - ❑ Brisbane City Council,
 - ❑ Sunshine Coast Regional Council (formerly Maroochy),
 - ❑ Gold Coast City Council,
 - ❑ Ipswich City Council and
 - ❑ Moreton Bay Regional Council (formerly Caboolture)
- ❑ The project is managed by ENERGEX under a Memorandum of Understanding



Trial Design

- ▣ M50 replacement trial
- ▣ Total of 300 lamps/poles over 13 locations
- ▣ Select two types of lamps
 - (that could replace now)
- ▣ Select three other types of lamps
 - (leading edge lamp technologies for future proofing)
- ▣ Instrumented in-situ monitoring of lamp performances
- ▣ Total of 170 will be directly monitored
 - (150 Type A & 20 Type B PLPDCUs)

Monitoring Instrumentation



Public Lighting Performance Data Collection Unit (PLPDCU)

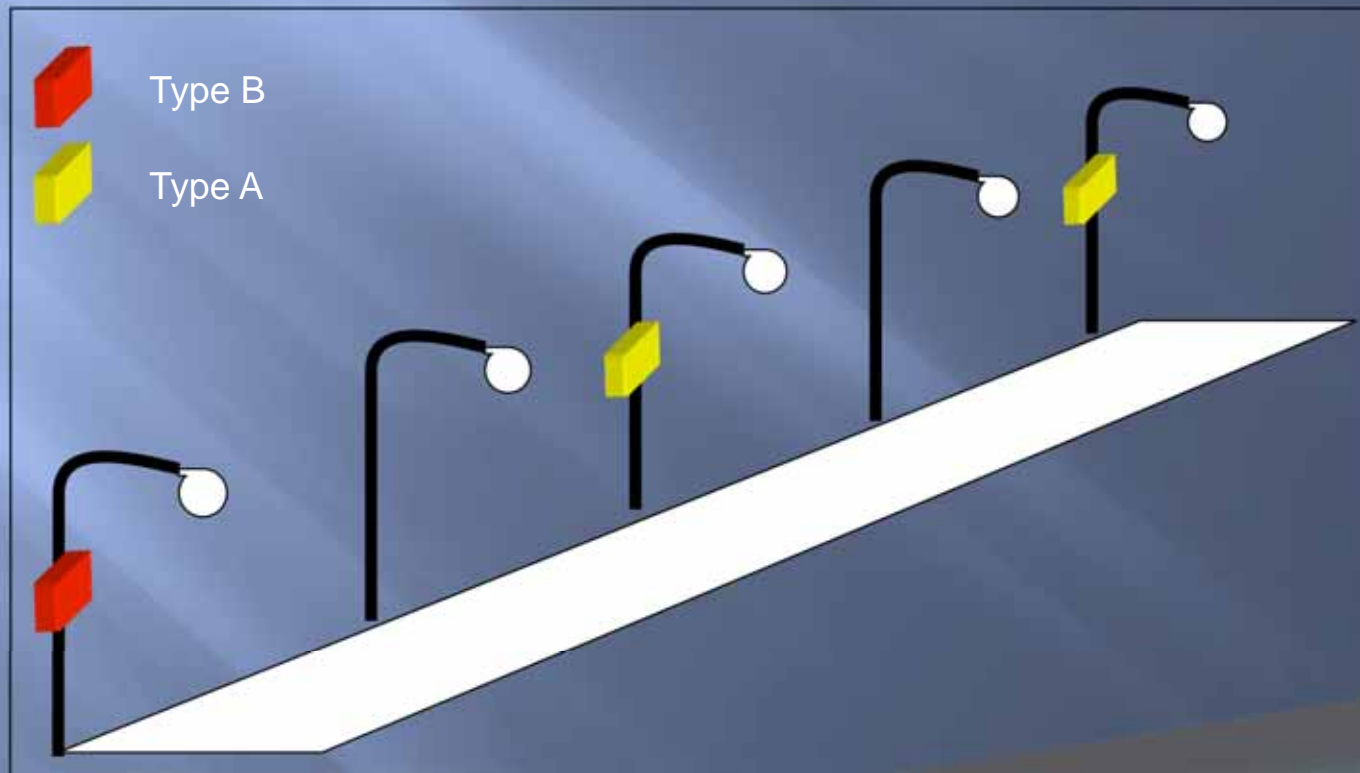
Must be robust

Have a life of greater than 5 years

Data security



Representative Pod of streetlights for trial



Instrumentation

Parameter	Range	Resolution	Recorded data	Unit type	
Ambient temperature	-5 - 50 °C	0.5 °C	T_{average}	B	
Relative Humidity	10 - 95 %	2 %	RH_{average}	B	
AC Voltage	180 - 260 Vrms	1 Vrms	V_{average} , V_{min} No of V_{surges} (>290V)	B	
AC Current	0 - 500 mA	0.1 mA	I_{average} , I_{max}	B	
Illuminance (@ lens)	10 - 50 k lux	0.01 k lux	E_{average}	A	B
Vibration events (Acceleration)	0.1 - 0.2 g 0.2 - 0.4 g 0.4 - 0.6 g 0.6 - 0.8 g 0.8 - 1.0 g 1.0 - 1.5 g 1.5 - 2.0 g 2.0 - 2.5 g 2.5 - 3.0 g 3.0 - 5.0 g	0.1 g	Number of events recorded in each range	A	B

All data recorded on 30 minute intervals from dusk to dawn

Data delivery

- ▣ Each monitoring unit downloads its data daily via the GPRS/GSM modem to a PC server.



Lamp Selection Process

Held workshop of stakeholders to consider trial lamp options



Lamp Type Selection Criteria

Consideration given to:

- ▣ White light appearance
- ▣ Capital cost
- ▣ Colour Rendering Index (CRI)
- ▣ Lamp survival
- ▣ Lamp efficacy
- ▣ Lumen Depreciation
- ▣ Operation Maintenance Replacement (OMR) cost
- ▣ Lamp Life

Lamps Selected

Market ready lamp technologies:

- ▣ Compact Fluorescent (electronic)
- ▣ Linear Fluorescent T5 lamp (electronic)

This is due to their:

- ▣ relatively low cost,
- ▣ low levels of lumen depreciation,
- ▣ high quality of white light,
- ▣ low wattage relative to lumen output and
- ▣ adequate life.

Lamps Selected

Future lamp technologies:

- ▣ LED,
- ▣ Metal Halide and
- ▣ Xenon arc lamps.

These three lamp technologies have issues requiring investigation that may make a large scale roll-out not practical at this stage.

Control samples of Mercury Vapour lamps will also be installed.

Lamps Selected

It is important to emphasize that the trial is to test the performance of the lamp technology and will not be an endorsement of the lamp brand nor the luminaire trialled.

Site Selection Process

Extremes of parameters

Distribution of lamps

Checking of compliance of retrofit installation



Environmental Conditions for Testing across Trial Sites

- ▣ Low temperature
- ▣ Salt air
- ▣ Vibration
 - (High winds and/or heavy vehicular traffic)
- ▣ Humidity (coastal and non coastal)
- ▣ Lightning strikes
- ▣ Supply load variability
 - (eg heavy industrial, end of line, residential)

Lamp Assignment

Lamp type	Total	Monitoring type			Pod #	Location
		None	Type A	Type B		
2x14W T5	100	50	46	4	all	
2x14W T5	20	10	9	1	2	Brisbane
2x14W T5	20	10	9	1	1	Maroochydore
2x14W T5	20	10	9	1	7	Gold Coast
2x14W T5	20	10	10	-	12	Gold Coast
2x14W T5	20	10	9	1	4	Ipswich
2x24W T5	20	10	9	1	all	
2x24W T5	20	10	9	1	11	Brisbane

		Monitoring type				Location
Lamp type	Total	None	Type A	Type B	Pod #	City
26W CFL	86	44	39	3	all	
26W CFL	20	10	10	-	3	Brisbane
26W CFL	20	10	9	1	8	Gold Coast
26W CFL	20	10	9	1	9	Ipswich
26W CFL	14	7	6	1	13	Caboolture
26W CFL	7	4	3	-	5	Maroochydore
26W CFL	5	3	2	-	6	Maroochydore
32W CFL	28	13	13	2	all	
32W CFL	13	6	6	1	5	Maroochydore
32W CFL	15	7	7	1	6	Maroochydore
42W CFL	26	13	12	1	all	
42W CFL	20	10	9	1	10	Brisbane
42W CFL	6	3	3	-	13	Caboolture

Lamp type	Total	Monitoring type			Pod #	Location
		None	Type A	Type B		
35W MH	20	10	8	2	all	
35W MH	2	1	1	-	9	Ipswich
35W MH	6	3	2	1	5	Maroochydore
35W MH	2	1	1	-	7	Gold Coast
35W MH	2	1	1	-	11	Brisbane
35W MH	2	1	1	-	3	Brisbane
35W MH	2	1	1	-	2	Brisbane
35W MH	2	1	-	1	4	Ipswich
35W MH	2	1	1	-	12	Gold Coast
M50	8	0	8	0	all	
M50	1	-	1	-	11	Brisbane
M50	2	-	2	-	9	Ipswich
M50	1	-	1	-	3	Brisbane
M50	2	-	2	-	1	Maroochydore
M50	2	-	2	-	12	Gold Coast

		Monitoring type				Location
Lamp type	Total	None	Type A	Type B	Pod #	City
LED	20	0	15	5	all	
LED - A	2	-	2	-	10	Brisbane
LED - A	2	-	1	1	12	Gold Coast
LED - B	2	-	1	1	7	Gold Coast
LED - B	2	-	2	-	4	Ipswich
LED - C	2	-	1	1	2	Brisbane
LED - C	2	-	2	-	6	Maroochydore
LED - D	2	-	1	1	9	Ipswich
LED - D	2	-	2	-	8	Gold Coast
LED - E	2	-	2	-	6	Maroochydore
LED - E	2	-	1	1	3	Brisbane

Roll out of Installations

Luminaire change over and PLPDCU install



Data Security & Checking

- ▣ Data downloaded daily
- ▣ Allows for failures to be identified within 24 hours.
- ▣ The data is checked in an SQL database and exceptions flagged (ie data that is outside the predetermined acceptable range)
- ▣ Server data is backed up daily.

Monitoring: Preliminary Results

- Data set of one lamp for a 30 minute interval

Type B PLPDCU 19 records * 48 measurements per day = 912		Readtime : 24/07/2008 0:00		Sendername: PLPDCU-B2	
	Name	Value		Name	Value
				G 0.1-0.2	126
	Deg C	12.715		G 0.2-0.4	5
	Humidity	92.025		G 0.4-0.6	2
	Lux	14616		G 0.6-0.8	1
	mAmpsAvrg	147.37		G 0.8-1.0	0
	mAmpsMax	151.31		G 1.0-1.5	0
	VoltageMin	234.22		G 1.5-2.0	0
	VoltsAvrg	250.72		G 2.0-2.5	0
	VoltSurge	2		G 2.5-3.0	0
	Accel Max G	0.7217		G 3.0-5.0	0

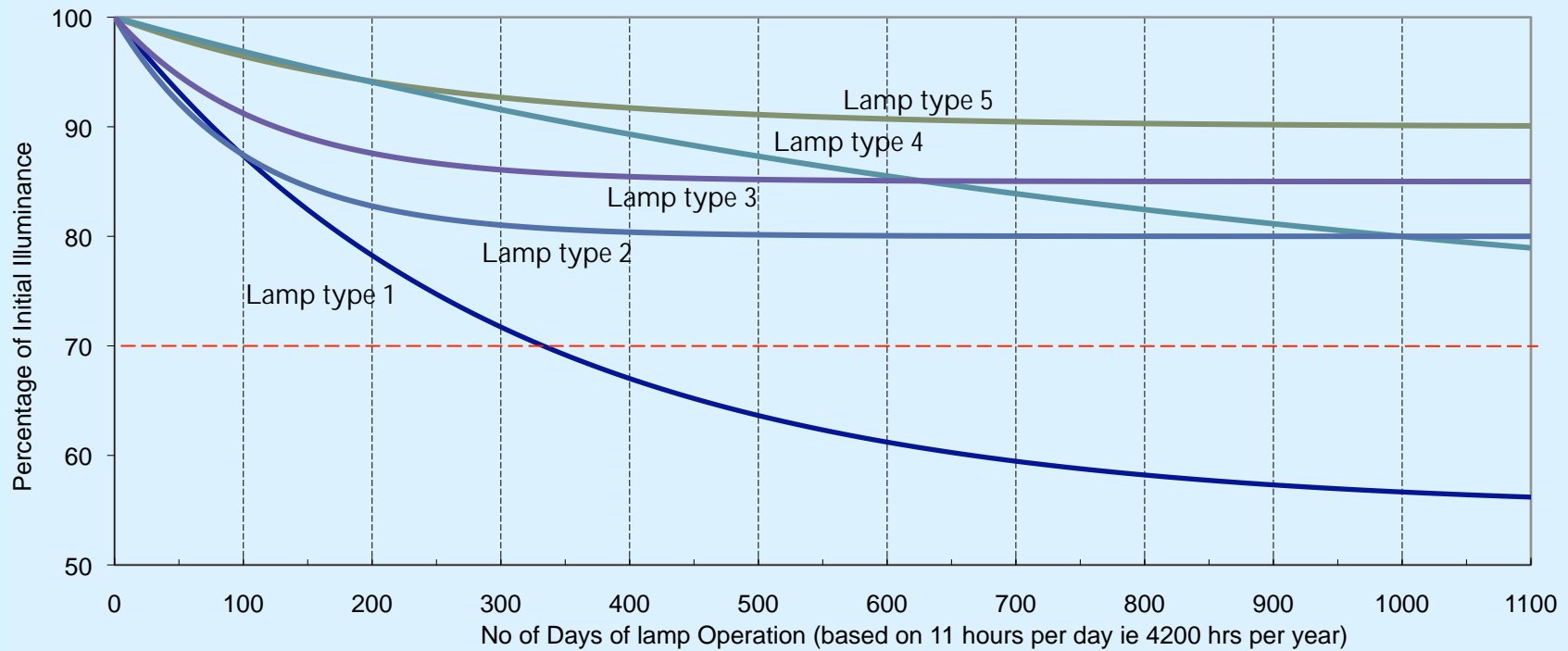
Interim Results and Reporting

Website is being developed for public interest in project as well as for ongoing council update.

Illustrate relative performance of lamps at each site and the environmental extremes to date.

Averaged Performance of Each Lamp Type

Pod 1: Marcoola



Extremes of environmental conditions to date

Parameter	Maximum	Minimum
Temperature (°C)	35.6	7.1
Humidity (%)	87.5	23
No of Vibration events (up to 600 per half hour possible)		
low force (0.1 – 1.0 g)	580	26
medium force (1.0 – 3.0 g)	112	13
high force (3.0 – 5.0 g)	45	2
Cumulative No of Voltage surge events (including lightning strikes)	56	

Trial Start Date

16 July 2008

Go to other Trial Sites (Pods)

Brisbane	Acacia Ridge (10, 11)	Runcorn (2, 3)
Gold Coast	Mudgeerba (8, 12)	Burleigh (7)
Maroochydore	Marcoola (1, 5)	Pacific Paradise (6)
Ipswich	Willowbank (4, 9)	
Caboolture	Caboolture (13)	

Expected Outcomes of Trial

- ▣ Hard performance data for all trialled lamp types under full range of environmental conditions in SEQ.
- ▣ Provide information necessary for distributors and local governments to conduct financial modelling of these lamp technologies
 - ie reduce the financial risk when adopting new lamp technologies for street lighting
- ▣ Proven methodology and instrumentation for evidence based trials of street lighting (internationally??)