climatewise
SMRC response to climate change

Report

Sustainable Public Lighting Workshop

July 2008

This report presents the summary of 'Sustainable Public Lighting Workshop' held on 25 June 2008 in the City of Canning. The sustainable Public Lighting is a program under the SMRC's Climate Wise project being implemented in regional partnership with the Cities of Canning, Cockburn, Fremantle and Rockingham and Towns of East Fremantle and Kwinana.

The workshop was participated by the Councils staffs involved in Public Lighting management, Cities for Climate Protection (CCP) officers, SMRC staffs and guest presenters from Sage Consulting Engineers Ltd and WA Local Government Association.

SMRC thankfully acknowledges the contributions from all the workshop participants.

Published: July 2008

Table of Contents

Workshop agenda

Sustainable Public Lighting (SPL) Workshop 25 June 2008, 10:00 am – 2:30 pm, Training Room, City of Canning	
10:00 – 10:15 Introductions	Welcome by Chair
	Introduction of the participants
	Agenda and process of the day
10:15 – 11:15 Present situation	Overview of existing public lighting status in SMRC , presentation by *Anis Zaman*, SMRC
	Energy Efficient Streetlighting, presentation by *Mike Sage*, Sage Consulting Engineers Ltd.
	Presentation by *Stephen Grose*, Western Power
	Summarising the present situation, facilitated group discussions
11:15 Tea Break (5 min)	
11:20 – 12:10 Goal setting	WALGA's activities on SPL, presentation by *Melanie Bainbridge*, WALGA
	Scopes to implement SPL , facilitated table group discussion
12:10 – 12:50 Gap analysis	Identification of existing gaps and potential for energy efficiency improvement, facilitated table group discussion
12:50 Lunch break (30 min)	
13:20 – 14:10 Opportunity analysis	Identification of the existing opportunities for implementation of SPL, facilitated table group discussion
14:10 – 14:30 Next steps/ wrap up	To agree on where to from here **Workshop Close**

Workshop participants

Melanie Bainbridge	Climate Change Coordinator	WA LGA
Mike Sage	Director	Sage Consulting Engineers Ltd
Troy Bozich	Manager of Engineering Services	City of Canning
Les Williams	Senior Patrol Officer	City of Canning
Clare Bush	Environmental Health Officer	City of Canning
Emily Pinku s	Environmental Officer	City of Cockburn
Shelley Cocks	Principal Environmental Health Officer	Town of East Fremantle
John Wong	Project Coordinator	City of Fremantle
Cameron Bartkowski	Community Safety Officer	City of Fremantle
Isabella Jennings	Environmental Officer	City of Fremantle
Colin MacMillan	Engineering Services	City of Cockburn
Paddy Strano	Environment & Sustainability Coordinator	City of Rockingham
Winnie Killick	Green Enterprise Facilitator	SMRC
Anis Zaman	Regional Greenhouse Coordinator	SMRC
Michelle Black	Workshop Facilitator	Sustainable Consulting

Introduction

Anis Zaman welcomed everyone and provided some brief background and context for today's workshop. The workshop commenced by going around the room and introducing the participants. Anis outlined that

- The workshop is an initiative of the Southern Metropolitan Regional Council's 'Climate Wise' project
- The purpose of the workshop is to examine sustainable public lighting (SPL) barriers and opportunities for SMRC Councils
- The outcomes from today's workshop will be an important input into a regional action plan for implementing SPL in the SMRC region
    - Today is not about making decisions per se, but gaining a comprehensive understanding on SPL from a range of important perspectives, including energy, greenhouse, management, cost, technology and safety.

Anis introduced Michelle Black, the Facilitator, to the participants.

Expected outcome

Michelle Black reiterated the proposed purpose for today's workshop:

- To identify barriers to, and opportunities for, improving the energy efficiency of public lighting managed by SMRC member councils (as input to a regional action plan for implementing sustainability in the SMRC region)
- We agreed to proceed with the workshop purpose as proposed.

Michelle then helped the participants to set the workshop's expected outcome. The following desired workshop outcomes were identified:

- Understand the SPL products and technologies available
- Understand what local government needs in terms of SPL , and translate this to tangible policy
- Check whether purchasing GreenPower is a feasible option
- Ensure that whatever we develop balances safety and compliance with reduced impact (e.g. greenhouse and energy)
- Come up with a way to reduce energy use and carbon footprint e.g. improve energy by a small reduction in amount of lighting without increase in crime
- Streetlights make up 40% of some councils greenhouse gas profile
- Improve communication with Western Power
- Learn how SPL works and what other councils are doing in this area
- Meet people working in this area
- Start with a plan to reduce emissions and keep costs down
- Identify potential and possibilities for a regional approach e.g. developing policy, deploying technology.
- Identify a clear way forward - move on from the 'stops and starts'

Present situation

A. Overview of existing public lighting status in SMRC

Anis Zaman presented an overview of the present energy, cost and other issues associated with public lighting in SMRC councils (see attachment A). Based on the information provided by the Councils, he summarized the following:

- Coverage of Public Lighting
  - Street lights
  - Park, reserve and garden lights
  - Car park lights
- Service providers
  - Western Power for infrastructure
  - Synergy for electricity
- Electricity use and cost per Council for public lighting
  - Smaller councils use about 600 MWh per year (~ 600 tCO2-e) and pays about $100,000
  - Larger councils use about 4,500 MWh (~4,500 tCO_2-e) and pays about $1 million.
- Maintenance
  - Maintenance is done by the Western Power and council pays on service basis or through annual contract
- Installation /replacement
  - Service provided by the Western Power and paid by the Councils
- Types of lights
  - Mostly three types – Mercury vapour, high pressure sodium and metal halide.
- Concern about lighting quality
  - Lighting level too low
  - Lights fail frequently
  - Takes longer to repair

B. Energy efficient streetlighting

Mike Sage presented an overview of the different types of SPL technologies available, and how they have been applied in other Councils (see attachment B).During Mike's presentation, it was sought to clarify the existing roles with regards to ownership and management of public lighting in WA

- This has been an area of some confusion in the past
- The different roles and responsibilities of various stakeholders are summarised below and in the following diagram (see Figure 1).
  - Local government is responsible for lighting to major and minor streets, car parks, garden lights and parks and reserves
  - Western Power own the lighting infrastructure and assets, and distributes electricity (via retailer Synergy) to local governments

- Local councils pay Western Power (via Synergy) for the installation, operation, maintenance and replacement of lighting assets
- Main Roads is responsible for providing lighting to major highways and freeways.

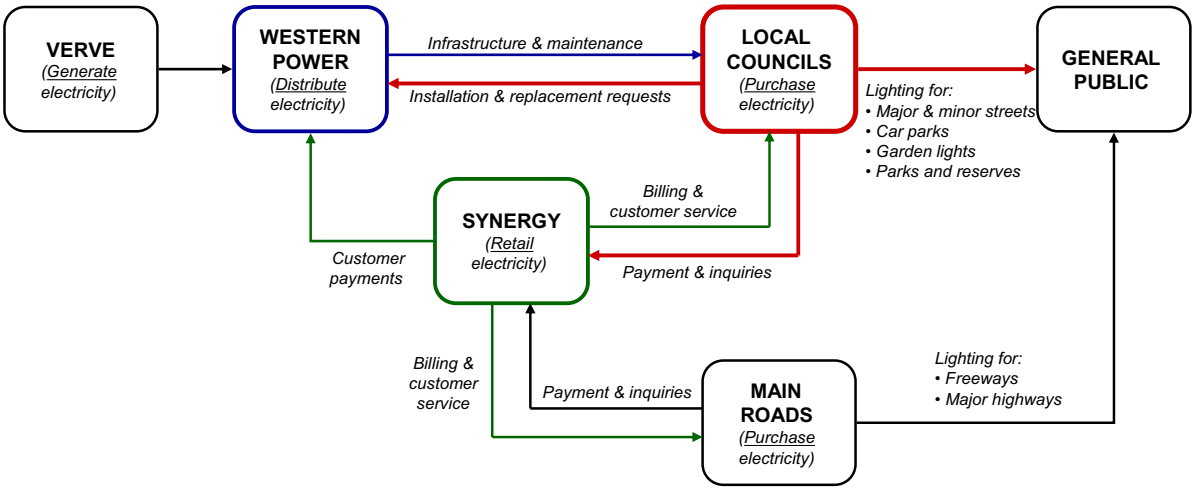


Figure 1: Roles and responsibilities of various stakeholders in public lighting management

The following questions arose during and after Mike Sage's presentation

- *Is there is a cost estimate available for changing to energy efficient streetlighting?*
  - It is difficult to estimate costs because a number of factors affect prices across different local government areas
  - Sage Consulting Engineers suggest an estimate cost of $800 per light in reports to the City of Gosnells and City of Cockburn
    - This was to replace lights on existing poles, not install new lights and poles
    - The cost covers everything but the pole (such as writing, disposal of old light, luminaire)
    - An estimated range would be $500 to $1,000 per light
- *Who should local governments be liaising with in Western Power regarding streetlighting issues (e.g. policy-related)?*
  - The WA Local Government Association (WALGA) should be engaged to work with Western Power around any difficulties council experience in dealing with public lighting
  - WALGA is engaging with Western Power on a broader scale, which will be discussed shortly by Melanie Bainbridge (see discussion section for Goal Setting)
- *Do faulty mercury vapour (MV) lamps get replaced with mercury vapour, or a more efficient option?*
  - Faulty MV lamps get replaced with new MV lamps, unless otherwise requested by the Council

  - Energy efficient lamps are not a direct replacement for MV lamps e.g. it's not as simple as replacing incandescents with CFLs in the home. The changeover process is more complex
  - Councils can choose more efficient lighting technologies listed on Western Power's load table
  - This is also a way to show policy support for more sustainable lighting options
  - Councils will need to cover the additional cost if more expensive than MV

- *Is it possible to obtain a breakdown of Western Power's and Synergy's costs for public lighting service provision to Councils (e.g. maintenance, replacement, energy use and administrative costs)?*
  - The price breakdown has been difficult to obtain in the past
  - This was a recommendation in the report completed by Sage Consulting Engineers, which examined options for upgrading street lighting to Australian Standards in the most energy efficient way
  - WALGA is advocating for the breakdown to be provided, as part of ongoing, broader SPL efforts
  - Local councils who have not adopted the StreetVision contract (i.e. annual contract) are on gazetted price tariffs
    - The streetlighting tariff has been frozen since Western Power was broken up
    - The tariff is due to be unfrozen shortly.

Goal setting

Melanie Bainbridge from the WA Local Government Association presented an overview of WALGA's activities on sustainable public lighting, and some recommendations for setting goal/s for the SMRC.The following questions and comments arose after Melanie's presentation:

- *What is the best lamp to replace MV with?*
  - The Sage report recommended that a 42W compact fluorescent (CFL) is a suitable replacement, or 2 x 24W T5 fluorescent lamps
  - The technology is mature, has same light output as 80W MV and offers half the energy use and greenhouse gas emissions
- *Does the recent budget surplus and the gas crisis form part of a strong case to take to the Premier?*
  - WALGA is working with the State Council to promote the issue
  - The State Council has endorsed the recommendations of the Sage Report, and is working to push the issue up through the Australian Local Government Association (ALGA) and the Council of Australian Governments (COAG)
    - This is happening alongside the development of a business case for SPL in standard bulk globe replacements
    - Individual councils need to be kept informed by WALGA about deadlines regarding the business case
    - The key issue in implementing SPL still comes back to cost
    - A 12-month trial underway in the City of Armadale is going to be used to develop preliminary cost estimates for sustainable bulk globe replacement.

After Melanie's presentation, discussions took place about the possible goals for implementing SPL in SMRC Councils, and how SMRC might support broader policy efforts. It was noted that:

- In general, goals need to have both a policy component and a technical component
- Ultimately, the goal is to improve energy efficiency and reduce greenhouse gases associated with public lighting, with no adverse impact on community safety and security

The following options were put forward:

- Replace all or some MV lamps with 42W CFL lamps, in collaboration with Synergy, Western Power and WALGA
- Councils could incorporate SPL into local planning policy, making it a requirement for new subdivisions and new developments
  - This would also require collaboration and consultation with developers
- One or more SMRC member councils could conduct a trial replacing a substantial number 100MV with 42W CFL

        - The trial would not be to test the technology – the technology is already proven
        - Rather, the trial would be about raising lighting to meet Australian Standards, and to test cost, energy and greenhouse gas savings, and safety performance
        - The trial would also be important for demonstrating commitment to SPL and support for broader advocacy efforts, particularly the phase out of MV lamps
    - Explore switching lights off to reduce operating hours, which further reduces energy
        - This strategy has mainly been used with High Pressure Sodium lamps on major roads
        - It is often used for shopping centre car-parks
    - Upgrade public lighting in SMRC councils to be compliant with Australian Standards, whilst being energy efficient
    - Change energy supply by purchasing Natural Power/Green Power option for Councils.

Gap analysis

- The workshop participants discussed to identify the barriers to implementing SPL in the SMRC region.
- Later in the workshop, it was examined on how to address these barriers, and who would be either responsible or a key partner.
- The barriers and potential strategies to overcome them are presented in the Table 1.
- Follow-up actions from today's workshop that were identified during the course of this discussion are also presented in Table 1.

Next step

The workshop concluded with a summary of the next steps from today, and the major agreed outcomes to take forward.

- The next steps from today are to:
  - Distribute the outcomes, and all presentations, to workshop participants and invitees (SMRC)
  - Incorporate ongoing SPL work for SMRC into CCP Working Group (SMRC/CCP Working Group)
    - This group will be responsible for carrying forward the outcomes from today, and future SPL policy work
  - Develop a regional action plan for implementing SPL into SMRC member councils (SMRC, liaising with WALGA where necessary)
    - This will take into account the input and suggestions from today's workshop
  - Scope a trial and submit relevant funding application, with support from WALGA (SMRC)
  - Organise a briefing with Stephen Grose from Western Power to ensure he is informed of the workshop outcomes and can respond to questions and concerns raised today (SMRC)
  - Organise for a Western Power representative to speak at the next CCP Working Group meeting (SMRC).

Table 1: Barriers to SPL, strategies to overcome and future actions

BARRIERS	STRATEGIES TO OVERCOME	RESPONSIBILITY	ACTIONS FROM TODAY
Unsure of Western Power standards (i.e. Australian Standards)	Seek clarity from Western Power	WALGA, with 'direction' from SMRC	SMRC to write a request to WALGA seeking clarity on AS
	Consult with Western Australian Planning Commission (WAPC) about standards		
Lack of communication between Western Power and local governments	Brokerage provided through WALGA, in connection with activities they are progressing	WALGA, with 'pressure' from local governments	
Lack of communication between local government departments	Clearly identify public lighting stakeholders within local government	Individual CCP Officers	
	Communicate CCP measures regularly to all operational areas, through existing CCP communication mechanisms		
Inconsistent, irregular communication between WALGA and local governments	Local governments to broaden out networks	SMRC, individual councils and WALGA	
Too many unknowns make it hard to commit or make decisions (e.g. costs)	Improved, regular communication particularly between local councils and WALGA about new developments	WALGA and individual councils	
Lack of SMRC policy on SPL	Support for individual councils to adopt SPL policy	SMRC	SMRC to write a request for template SPL policy
	Template SPL policy for local governments to adapt and use	WALGA, with request from local governments	SMRC to adapt and use template to develop regional SPL policy
Nobody likes change	Difficult to overcome – any change needs a change management process to support it		
Lack of leadership and forward-planning (short time horizons)	Get clear on the 'big picture' (i.e. where SPL fits in to broader strategy)	SMRC – start with regional approach	
	Seek Council endorsement and support for an SPL policy		
	Engage the leaders and decision-makers after today	Individual councils, with support from WALGA	
High upfront replacement costs	Replace globes in stages	Individual councils	

BARRIERS	STRATEGIES TO OVERCOME	RESPONSIBILITY	ACTIONS FROM TODAY
Lack of internal knowledge, particularly on Australian Standards and available technologies	Develop simple guidelines for new developments – how to specify SPL	WALGA, in collaboration with local councils and assistance from Sage Consulting Engineers	WALGA to specifically address 'new developments' in policy template
	Conduct 'introduction to SPL' workshops to help educate councils	Individual CCP Officers to initiate	
	Circulate ICLEI public lighting toolbox	SMRC	SMRC to provide website address when circulating workshop outputs
Lack of technical support from Western Power (e.g. outsourcing design, slow response times)	Provide opportunity for presentation from Western Power to today's participants/invitees to discuss questions and concerns raised today	SMRC	SMRC to organise follow-up presentation with Western Power
	Western Power looking to set up a 'bank' of contractors to develop more reliable response times (Melanie Bainbridge)	Western Power	
Lack of ownership from Western Power on public lighting (e.g. not taking on replacements as assets)	Continue lobbying and engaging with WP on all public lighting issues	WALGA, through current processes with further support from SMRC	WALGA to reinforce the message from today's workshop, on behalf of SMRC councils
Changing and emerging technologies (potential for today's 'best practice' to be out of date in five years)	Conduct bulk replacement in stages (e.g. start with CFLs and move to LEDs when technology becomes more cost-effective)	Western Power/WALGA, through current bulk replacement work	
Western Power not likely to commit to changing technologies throughout bulk replacement (i.e. more likely to prefer sticking with one technology)	Establish commitments to bulk replacement in terms of emissions targets rather than focusing on technologies	WALGA, through current bulk replacement work	
	Ensure new technologies are adaptable to old technologies		
	Examine scope for installing new technology at same capital cost, and recovering differences through higher daily tariff		
Lack of State Government leadership (e.g. no pressure to meet Australian Standards)	Continue lobbying Sustainability and Climate Change Council (partnership between State and Local Government)	WALGA, with support and pressure from SMRC and individual councils	

Achieved outcomes

The key outcomes from today were that:

- A regional approach to SPL within the SMRC makes sense, and provide a useful framework for individual member councils
  - A starting point would be for SMRC to develop a regional SPL policy to support improvement of public lighting efficiency and safety standards, with assistance from WALGA
  - A SPL policy template, available to all local governments in WA, would greatly assist individual councils to progress SPL policy
- Balancing greenhouse and energy objectives with safety and security is critical
  - Replacing lights to meet Australian Standards will achieve these mutually beneficial outcomes
- SMRC needs to work alongside WALGA with broader advocacy efforts, providing support and making commitments
  - The SMRC action plan needs to address a range of communication issues (interdepartmental and with Western Power)
- Education on a range of aspects (technology, Australian Standards etc) would greatly enhance the decision-making ability of local governments with regards to SPL.

Appendix A

Copy of Anis Zaman's Presentation

Sustainable Public Lighting

Present situation of the Councils

Anis Zaman
SMRC

Present situation (1)

Areas of lighting

- Streetlight
- Car parks
- Garden lights
- Parks & reserves

Service providers

- Western power – Infrastructure
- Synergy - Electricity

Present situation (2)

Electricity use & cost

- Small Councils
  - ~ 600 MWh (~600 tCO2e)
  - ~ $100 K
- Large Councils
  - ~ 4,500 MWh (~ 4,500 tCO2-e)
  - $ 1 million

Present situation (3)

Maintenance

- Maintained by WP
- Council pays for the maintenance
- Service basis or through annual contract.

Installation/replacement

- Service provided by WP
- Council Pays for the service

Present situation (4)

Types of light

- Mercury vapour
- High pressure sodium
- Metal halide

Concerns about lighting quality

- Lighting level too low
- Lights fail frequently
- Takes longer to repair

Thank you

Appendix B

Copy of Mike Sage's Presentation

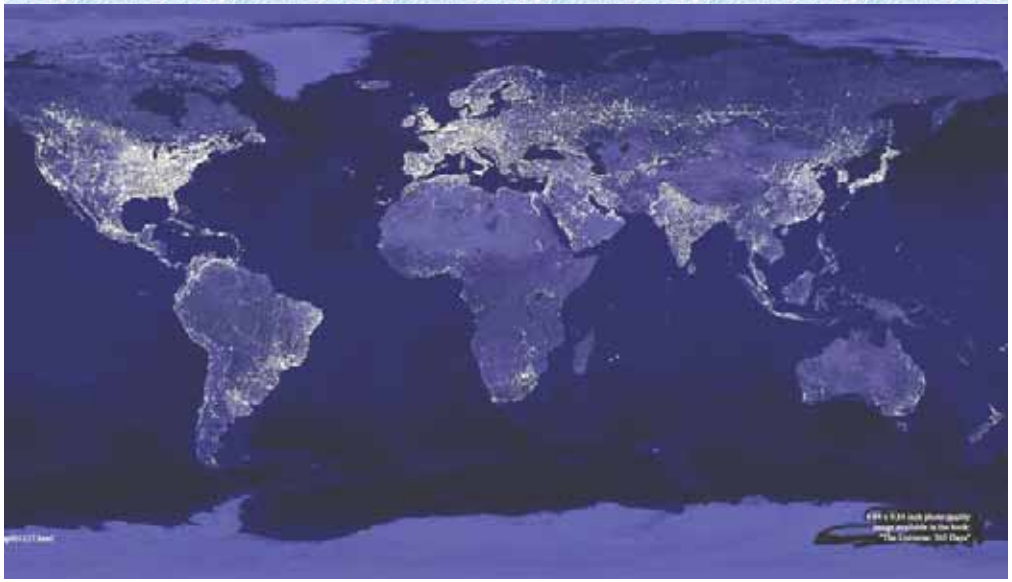
ENERGY EFFICIENT STREET LIGHTING

by

Sage Consulting Engineers

25 June 2008

Lighting and the Environment



Lighting - POSITIVE IMPACTS

- COMMUNITY SAFETY
- COMMUNITY SECURITY
- ROAD SAFETY
- EXTENDED AMENITY

Cost Benefit of Lighting

DUDLEY	74 : 1
STOKE ON TRENT	54 : 1

Farrington and Painter
Institute of Criminology
UNIVERSITY OF CAMBRIDGE

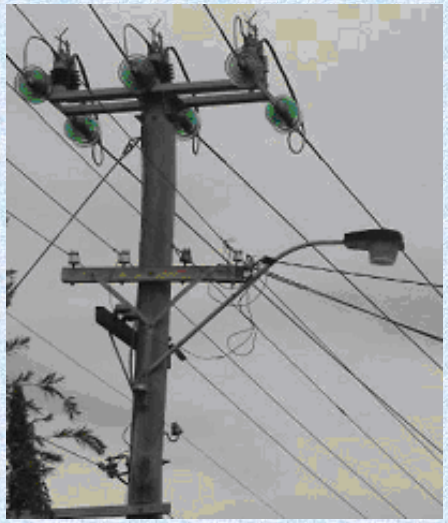
Lighting - NEGATIVE IMPACTS

- ENERGY CONSUMPTION
- GREENHOUSE GAS EMISSIONS
- MERCURY CONTENT
- OBTRUSIVE AND UPWARD SPILL LIGHT

Energy and Greenhouse Gases

AUSTRALIA	W A
1.94 M STREETLIGHTS	199 500 STREETLIGHTS
$210 MILLION P A	$20 MILLION P A
1000 GWh	90 GWh
1 MILLION TONNES CO_2	82 000 TONNES CO_2

Existing



Energy and Greenhouse Gases

Minor Streets - People Security	**Major Roads -** Road Safety
80 W MV @ 80 metres	250 W HPS @ 40-90 m
Substandard	AS1158 Category V3
1.1 kW/km (2 lane)	3-7 kW/km (2 lane)
4 T CO_2/km/pa	3-6 T CO_2/km/pa

Mercury Content

- MERCURY VAPOUR 14 mg
- FLUORESCENT 3 mg
- HIGH PRESSURE SODIUM 0.02 mg
- METAL HALIDE 0.01 mg
- LED's 0
- TUNGSTEN HALOGEN 0
- INCANDESCENT 0

Mercury Disposal

- RECYCLING FACILITY IN VICTORIA
- DEPOT IN MALAGA
- CRUSH IN SEALED CONTAINERS
- TRANSPORT TO VICTORIA

Upward Light

Belfast – Peter Paice

Optics

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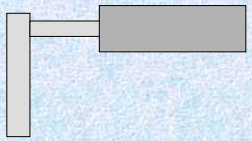

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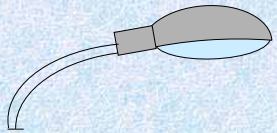

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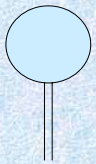

Optics

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Ron Arbour

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Chris Baddiley

Responsibilities

Main Roads WA → Road Lighting of major routes

Local Government → Street Lighting minor & major roads

Western Power → Service Provider to Local Government

WA Trials

"Upgrading street lighting to Australian Standards in the most energy efficient way"

WESTERN AUSTRALIAN LOCAL GOVERNMENT ASSOCIATION

Sustainable Energy Development Office
Government of Western Australia

WA Trials

- **PERFORMANCE – IMPROVED TO AS 1158**
- **GREENHOUSE GASES – UP AND DOWN**
- **RELIABLITY – IMPROVED**
- **DEPRECIATION – NO CHANGE**

Coroner's Recommendations

April 2004, death of Leon Russell Coomerang, Kununurra on 28 February 2002.

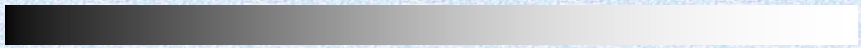
"I recommend that all Local Government bodies ensure that new roads constructed are adequately illuminated and that the illumination is at least in excess of Australian/New Zealand Standards and in the case of existing roads regular reviews are conducted to ensure that all relevant standards are met and effective maintenance programs are in place."

Lighting Standards

Level	Australia & NZ	BS/EN	AMERICA
High	-	S1	-
	-	S2	-
	-	S3	C
	P1	S4	I
	P2	S5	R
	P3	S6	-
	P4	S7	-
Low	P5	-	-

Range of Vision


<0.001 cd/m² **0.03 - 3.0 cd/m²** **1000 cd/m²**



SCOTOPIC NIGHT 144 pt | **MESOPIC TWILIGHT 16-6pt** | **PHOTOPIC DAY 4 pt**

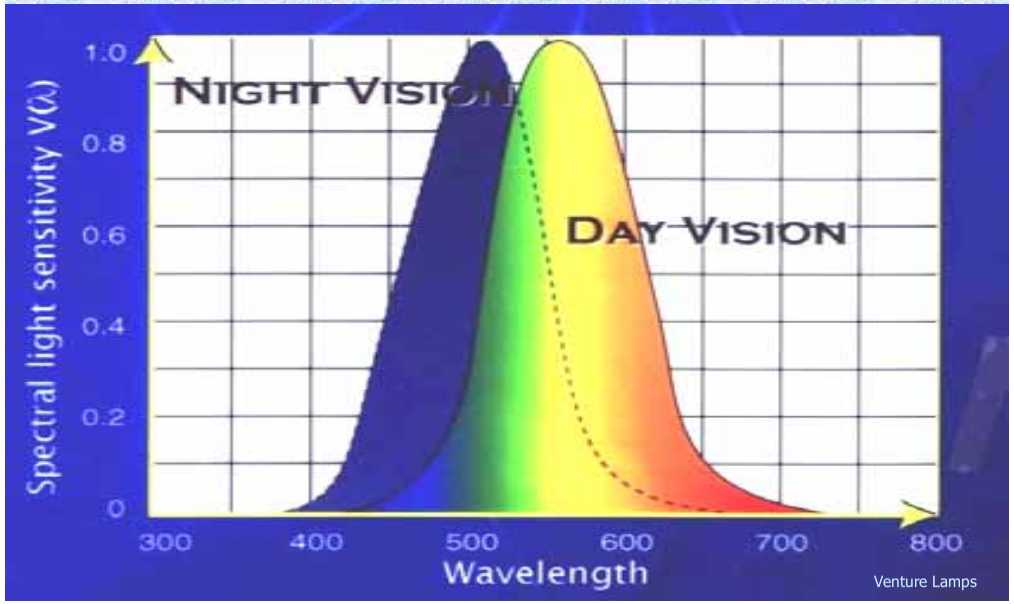
Night Vision



SCOTOPIC NIGHT 144 pt | **MESOPIC TWILIGHT 16 – 6 pt** | **PHOTOPIC DAY 4 pt**

Thorn c1989

White Light

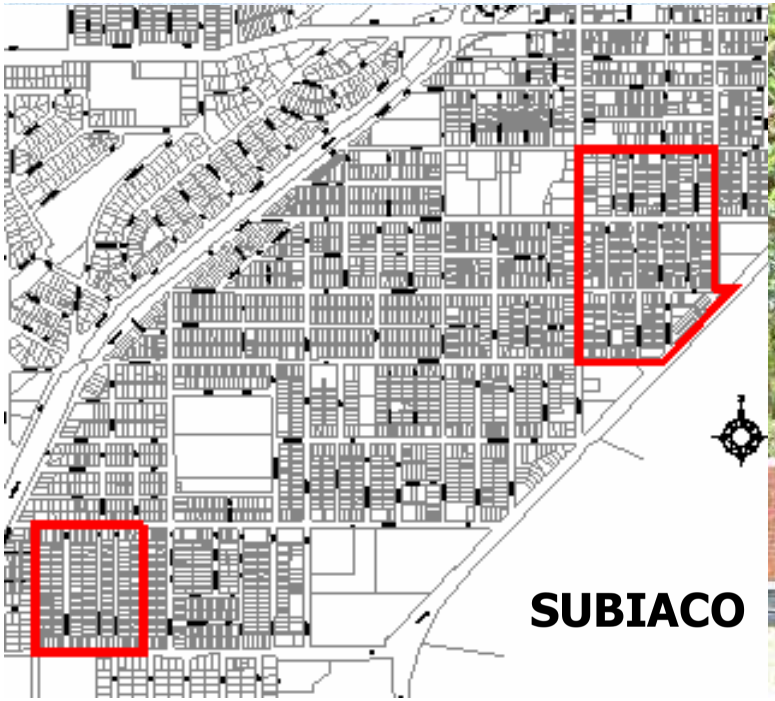


Lamps

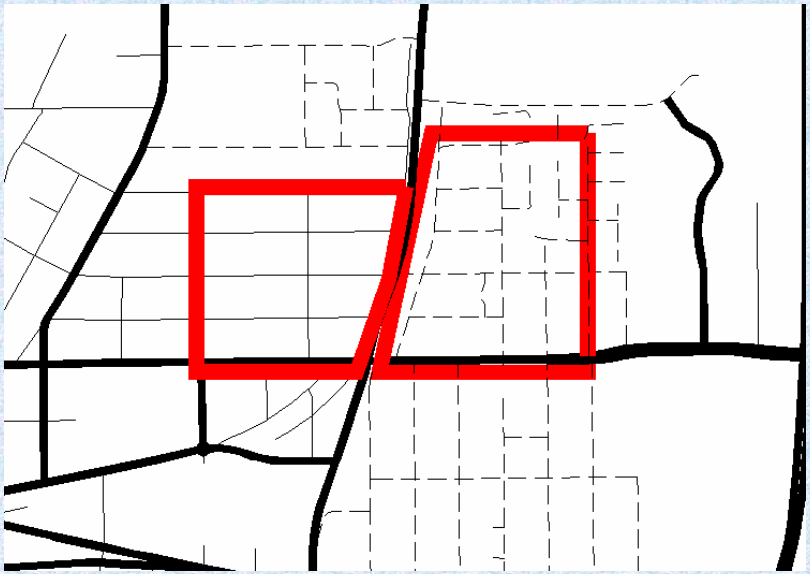
- HIGH PRESSURE SODIUM 68
- METAL HALIDE 128
- FLUORESCENT 80-100
- MERCURY VAPOUR 40-50
- LED's 25/75
- TUNGSTEN HALOGEN 20
- INCANDESCENT 10

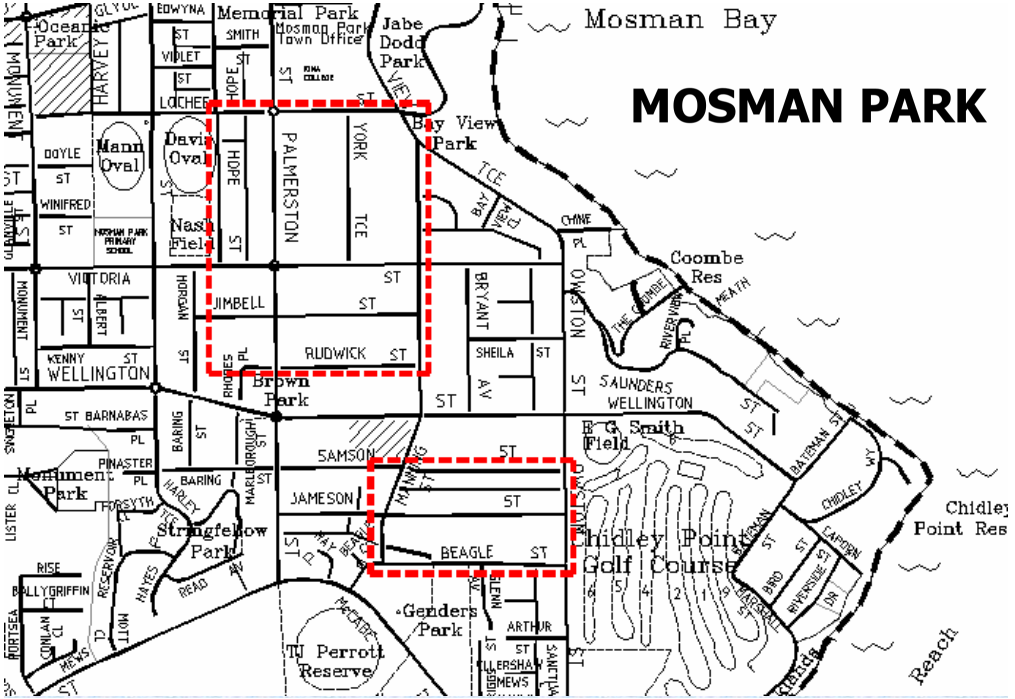
WA Trials

- SUBIACO - 42 W Compact Fluorescent
  40% energy saving + AS/NZS 1158
- MIDVALE -70 W Metal Halide
  14% energy saving + AS/NZS 1158
- MOSMAN PARK - High Pressure Sodium/MH/CFL
  AS/NZS 1158
- JOONDALUP - Lamps/Optics/Ballast/Switching
  60% energy saving + AS/NZS 1158
- COCKBURN – 42 W CFL
  HALVE ENERGY + AS/NZS 1158



MIDVALE





WA Trials

- **PERFORMANCE – IMPROVED TO AS 1158**
- **GREENHOUSE GASES – UP AND DOWN**
- **RELIABILITY – IMPROVED**
- **DEPRECIATION – NO CHANGE**

Summary of Recommendations

Standards
WALGA encourage local government to adopt AS/NZS 1158 as a policy for technical design of streetlight networks. AS/NZS is appropriate, and should not be considered as excessive. There is a risk to local government if they do not comply with a national standard.

Efficient lamp technologies
WALGA encourage Western Power and Local Government to use the more efficient lamp technologies in new and replacement street lights.

State Underground Power Program
The Office of Energy encourages energy efficient street lighting for SUPP projects, and specifies appropriate AS/NZS 1158 Categories.

Synergy/Western Power Invoicing
Synergy provide a price breakdown listing maintenance, replacement, energy, and administrative costs to individual Local Government clients.

Mercury
On overhead power systems, the 80 W mercury vapour street light at 80 m spacing does not comply with AS/NZS 1158. Mercury vapour lamps have half the efficiency of modern lamps. Consequently the use of mercury vapour lamps should be phased out by responsible authorities.

Western Power
WALGA request Synergy and Western Power to include fluorescent lamps such as compact fluorescent and T5 fluorescent lamps in their available stock.

Energy Efficient Street Lighting Technologies
For minor road lighting two technologies are available to Local Government:
- 42 W compact fluorescent
- 2 X 24 W T5 fluorescent

Both lamps are mature, not emerging technologies. The compact fluorescent lamp has been available since 1982 and the 42 W version since the early 1990's. T5 fluorescent lamps have been available since the mid 1990's. Both lamp technologies are available in Australian made street lights.

These technologies are equivalent in light output to the common 80 W mercury vapour lamp and offer a halving of energy consumption and greenhouse gas emissions.

Australian Trials

- AGO - *Challenges & Opportunities*
- COFFS HARBOUR - 50 W High Pressure Sodium
- SSROC - 80 W Mercury → 42 W CFL
- BUNYULE & DEREBIN - 2 x 24 W T5 Fluorescent
- ACT - 5 000 CFL streetlights, reliability?

World Practice

- AUSTRALIA - Mercury / High Pressure Sodium
- SYDNEY - Fluorescent - Mercury → CFL
- NEW ZEALAND - High Pressure Sodium
- BRITAIN - LPS → H P S/Metal Halide
- EUROPE - M V/H P S → Fluorescent/Metal Halide
- NORTH AMERICA - M V/H P S → Metal Halide

The Future

A MIX:

- HIGH PRESSURE SODIUM - bilevel/trilevel
- METAL HALIDE
- FLUORESCENT
- LED's - FUTURE