Basic V-Category LED Street Lighting Replacement Business Case for the EAGA Councils

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Prepared for
Eastern Alliance for Greenhouse Action

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V0a	James Tait	19/2/18	First Initial Draft
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About Ironbark Sustainability
Ironbark Sustainability is a specialist consultancy that works with government and business around Australia by assisting them to reduce energy and water usage through sustainable asset and data management and on-the-ground implementation.

Ironbark has been operating since 2005 and brings together a wealth of technical and financial analysis, maintenance and implementation experience in the areas of building energy and water efficiency, public lighting and data management. We pride ourselves on supporting our clients to achieve real action regarding the sustainable management of their operations.

Our Mission
The Ironbark mission is to achieve real action on sustainability for councils and their communities.

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1. Introduction and Summary

All eight Eastern Alliance for Greenhouse Action (EAGA) councils have either completed, or are in the process of completing, a P-Category[1] street light bulk change to energy efficient technology. These projects have resulted in significant savings for these councils. This document provides a basic V-Category[2] LED bulk replacement business case, including assumptions, methodology and outcomes for all eight EAGA councils in the AusNet Services, CitiPower and United Energy distribution regions.

There are between 180,000 and 200,000 V-Category street lights across Victoria with an estimated 40% of these being cost-shared between councils and VicRoads. This business case considers replacing all V-Category lights within the EAGA region (see Table 1) which accounts for close to 26,000 lights, of which roughly 16,000 are cost-shared between EAGA councils and VicRoads.

This report considers two basic scenarios:

1. All Lights

   All V-Category lights are replaced with LED including both lights that are fully funded by EAGA councils and cost-shared with VicRoads

2. All Council Funded Lights

   All V-Category street lights fully funded by EAGA councils are replaced with LED (i.e. excluding VicRoads/Council cost share lights)

There are significant additional savings - in the region of $39 million - when considering the inclusion of cost-shared lights, while project costs increase from $8.6 to $23.2 million. Greenhouse gas savings range from 85,000 tCO_2-e when considering scenario 2, to 237,000 tCO_2-e when considering scenario 1 (see section 3). By replacing all lights in a given area through a combined approach amongst EAGA councils, substantial savings and project synergies can be achieved through reduced project management and material costs.

The council areas, abbreviations used throughout this document, and the DNSP areas each Council belongs to are outlined in Table 1 below.

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[1] P (Pedestrian) Category lighting is a term used to define lighting designed for vehicle safety under the Australian Standard 1158 series. These lights are located on residential streets and are considered P (Pedestrian) Category lighting for the benefit of pedestrian safety.

[2] V (Vehicular) Category lighting is a term used to define lighting designed for vehicle safety under the Australian Standard 1158 series. These lights are typically used for intersections, main roads, freeways and collector roads.

Table 1: Council and DNSP areas included in this business case

Council	Abbreviation	CitiPower	United Energy	AusNet Services
Boroondara Council	BOR	✓	✓	✗
Glen Eira City Council	GLE	✓	✓	✗
Knox City Council	KNO	✗	✓	✓
Maroondah City Council	MAR	✗	✗	✓
City of Monash	MON	✗	✓	✗
City of Stonnington	STO	✓	✓	✗
City of Whitehorse	WHI	✗	✓	✗
Yarra Ranges Council	YAR	✗	✗	✓

2. Background to the Financial Analysis

This section provides a summary of the financial analysis outlined within this document. The outcomes are summarised within Section 3. The structure of this section is as follows:

1. Technology Choice

2. Models (the range of assumptions used for the analysis); and

3. Scenarios (the project options)

The various scenarios and models available to Council are broad, however, for the purpose of this document only a simple range of options have been considered.

2.1 Technology Choice

Recommended light replacements in the business case meet the requirements of the local DNSP as a like for like replacement option given typical mounting heights and spacing of existing lighting. During the project preparation stage of any street lighting upgrade, a detailed design will confirm each light and its replacement.

We have assumed for the purpose of the *Scenarios* that Council will install the standard luminaire with the highest savings in a given jurisdiction and for a given replacement option. It is important to review pricing and wattages of the approved luminaires in the lead up to any street light bulk changeover these can change, therefore influencing payback periods of the approved luminaires. In future, lighting choices will be available at lower wattages and capital costs.

2.2 Models

Depending on variables such as the rate of energy price increases and the increase in maintenance tariffs, the savings of the transition will vary.

There are nearly endless assumptions that can be applied. We have only presented the "average" model in this report, however to give context we have described three distinct "models" below that are included in a detailed business case:

Pessimistic - High Cost, Low Savings. Whereby the capital costs and ongoing operating costs are high.

Average – Moderate Cost & Savings. Whereby the capital costs and ongoing operating costs are average.

Optimistic - Low Cost, High Savings. Whereby the capital costs and ongoing operating costs are low.

To give a sense of the likelihood of each model we consider the Average model to be realistic, hence why it is presented in this report. Some items could be achievable in the short term (e.g. reduced capital cost of the program) whilst some will take a little longer to negotiate (ongoing maintenance pricing). The Optimistic model is ambitious, and, although similar outcomes have been achieved in other jurisdictions, this should be considered "optimistic". The Conservative model is achievable currently with little negotiation.

The variables considered and the differences in each model are summarised in Table 2 below.

Table 2: Assumptions for each model

Variables	**Pessimistic**	**Average**	**Optimistic**
Description	The capital costs and ongoing operating costs are high.	The capital costs and ongoing operating costs are average.	The capital costs and ongoing operating costs are low.
Maintenance (OMR) price rises for regular lights	Low	Medium	High
OMR price rises for energy efficient lights	High	Medium	Low
Energy price rises	Low	Medium	High

One of the main inputs to the modelling outlined in the table above is the energy price forecast. The effect of future electricity prices on energy savings affects the long-term savings of the project – the higher the energy price increase, the larger the electricity savings will be from changing to LEDs. Therefore, a high energy price growth is considered optimistic and low growth considered conservative.

Another major input in the model that has a large effect on long term project savings is the OMR price forecast. The model has two OMR forecasts, one for older, inefficient and increasingly unavailable lights (MV, HPS) and one for newer, more efficient lights (LEDs, CFLs and T5s). A higher OMR price forecast for older technology means larger savings from replacing to LED options. Similarly, a lower OMR price forecast for LED luminaires means larger savings from replacing to LED options. This relationship is shown in Table 2.

2.3 Scenarios

This report considers only two basic Scenarios:

1. All Lights

   All V-Category lights are replaced to LED including both lights that are fully funded by EAGA councils and cost-shared with VicRoads

2. All Council Funded Lights

   All V-Category street lights fully funded by EAGA councils (i.e. excluding VicRoads/Council cost share lights)

3. Financial Outcomes

3.1 Replace All Lights

This section provides the project financials for replacing all lights and is separated into three tables;

- Table 3 provides the total project financials
- Table 4 provides Councils share of the total project financials
- Table 5 provides VicRoads share of the total project financials

3.1.1 Total Project Financials (Average Model)

The following table shows the total project financials (Council and VicRoads share) using the average model for replacing all major road lights to LED, for each of the council areas in EAGA.

Table 3: Outcomes from modelling for replacing all lights (average model)

Council	Total EAGA	BOR	GLE	KNO	MAR	MON	STO	WHI	YAR
Number of lights	25,985	4,234	2,992	3,243	2,570	4,769	2,860	3,164	2,153
Total Cumulative Project Cost	$23,261,086	$4,348,213	$2,822,678	$2,740,550	$2,170,816	$4,009,369	$2,673,088	$2,670,351	$1,826,020
Cumulative Simple Net Savings (20 yrs)	$61,595,790	$9,353,526	$6,088,499	$10,182,439	$8,534,632	$8,727,688	$5,713,842	$5,944,843	$7,050,319
Savings First Year	$3,341,330	$538,475	$340,187	$505,905	$418,536	$511,248	$334,491	$346,144	$346,345
Net Present Value	$32,257,187	$4,633,107	$3,025,986	$5,671,089	$4,792,177	$4,361,625	$2,835,577	$2,990,759	$3,946,866
Cumulative Greenhouse Savings from commencement (20 years, tCO_2 –e)	236,682	37,389	26,603	30,396	24,588	43,391	26,101	28,231	19,982
Average Greenhouse savings per year	11,834	1,869	1,330	1,520	1,229	2,170	1,305	1,412	999
Payback period (yrs)	5.5	7.5	7.4	5.2	5.0	7.3	7.5	7.2	5.0
Potential number of VEECs	82,200	14,500	9,800	9,400	8,300	14,900	8,800	9,900	6,600

3.1.2 Council Only Project Financials (Average Model)

The following table shows the Council project financials using the average model for replacing all major road lights to LED, for each of the council areas in EAGA.

Table 4: Outcomes from modelling for replacing all lights (average model) – Council costs and savings only

	Total EAGA	BOR	GLE	KNO	MAR	MON	STO	WHI	YAR
Number of lights	25,985	4,234	2,992	3,243	2,570	4,769	2,860	3,164	2,153
Total Cumulative Project Cost	$14,491,755	$2,679,247	$1,827,740	$1,691,604	$1,384,779	$2,218,343	$1,968,335	$1,483,429	$1,238,279
Cumulative Simple Net Savings (20 yrs)	$38,109,362	$5,672,986	$3,970,613	$6,175,599	$5,328,922	$4,789,314	$4,220,633	$3,244,692	$4,706,604
Savings First Year	$2,072,985	$328,093	$225,225	$307,687	$262,178	$281,125	$247,205	$189,673	$231,799
Net Present Value	$19,923,268	$2,796,382	$1,978,570	$3,429,496	$2,982,219	$2,387,380	$2,097,328	$1,623,546	$2,628,347
Cumulative Greenhouse Savings from commencement (20 years, tCO_2 –e)	145,577	22,714	17,543	18,329	15,243	23,736	19,453	15,278	13,280
Average Greenhouse savings per year	7,279	1,136	877	916	762	1,187	973	764	664
Payback period (yrs)	5.2	7.6	7.4	5.2	5.0	7.4	7.4	7.3	5.1
Potential number of VEECs	50,700	8,800	6,500	5,700	5,100	8,200	6,600	5,400	4,400

3.1.3 VicRoads Project Financials (Average Model)

The following table shows the VicRoads project financials using the average model for replacing all major road lights to LED, for each of the council areas in EAGA.

Table 5: Outcomes from modelling for replacing all lights (average model) – VicRoads costs and savings only

	Total EAGA	BOR	GLE	KNO	MAR	MON	STO	WHI	YAR
Number of lights	16,453	2,770	1,680	2,079	1,564	3,585	1,217	2,378	1,180
Total Cumulative Project Cost	$8,769,330	$1,668,967	$994,938	$1,048,946	$786,037	$1,791,026	$704,754	$1,186,922	$587,741
Cumulative Simple Net Savings (20 yrs)	$23,486,428	$3,680,540	$2,117,886	$4,006,840	$3,205,710	$3,938,375	$1,493,210	$2,700,152	$2,343,715
Savings First Year	$1,268,345	$210,382	$114,962	$198,218	$156,358	$230,122	$87,285	$156,471	$114,546
Net Present Value	$12,333,919	$1,836,725	$1,047,416	$2,241,593	$1,809,958	$1,974,245	$738,249	$1,367,214	$1,318,519
Cumulative Greenhouse Savings from commencement (20 years, tCO_2 –e)	91,104	14,674	9,061	12,066	9,345	19,656	6,647	12,953	6,702
Average Greenhouse savings per year	4,555	734	453	603	467	983	332	648	335
Payback period (yrs)	6.3	7.4	7.5	5.1	4.8	7.3	7.5	7.1	4.9
Potential number of VEECs	31,500	5,700	3,300	3,700	3,200	6,700	2,200	4,500	2,200

3.2 Replace All Council Funded Lights

3.2.1 Total Project Financials (Average Model)

The following table shows the total project financials using the average model for replacing all major road lights to LED that are fully funded by Council, for each of the council areas in EAGA.

Table 6: Outcomes from modelling for replacing all Council funded lights (average model)

	Total EAGA	BOR	GLE	KNO	MAR	MON	STO	WHI	YAR
Number of lights	9,532	1,464	1,312	1,164	1,006	1,184	1,643	786	973
Total Cumulative Project Cost	$8,645,535	$1,566,603	$1,164,448	$992,307	$860,754	$1,024,326	$1,498,499	$692,148	$846,451
Cumulative Simple Net Savings (20 yrs)	$22,451,743	$3,219,293	$2,558,688	$3,504,372	$3,191,782	$2,163,731	$3,225,159	$1,444,591	$3,144,127
First Year Savings	$1,227,421	$187,838	$148,584	$175,541	$157,939	$127,710	$189,015	$85,359	$155,434
Net Present Value	$11,700,655	$1,571,899	$1,280,293	$1,935,101	$1,775,580	$1,071,217	$1,605,161	$712,070	$1,749,335
Cumulative Greenhouse Savings from commencement (20 years, tCO_2 –e)	84,841	12,932	11,502	10,285	9,013	10,632	15,022	6,643	8,812
Average Greenhouse savings per year	4,242	647	575	514	451	532	751	332	441
Payback period (yrs)	5.6	7.7	7.3	5.4	5.2	7.5	7.4	7.6	5.2
Potential number of VEECs	31,000	5,000	4,400	3,800	3,400	3,900	5,000	2,500	3,000

Appendix 1: Assumptions for Modelling

Energy Price Projections

As with any long-term economic projections, the modelling of energy price increases over the next two to four decades can present challenges. Any number and combination of factors can render projections obsolete within a number of years, if not months.

Ironbark relies on relatively conservative price modelling. The source of information used in this business case is as follows:

- 2018 to 2022 modelling is based on AEMO forecasts (Detailed summary of 2017 electricity forecasts.pdf) (Victorian modelling used)
- Beyond 2022;
    - energy price increases for the pessimistic models is based on AEMO data (sourced from correspondence with AEMO) (Victorian modelling used)
    - energy price increases for the optimistic models is the average of the optimistic models from
        - AEMO data June 2017
        - data provided on Page 123 Australian Government 2011, Strong Growth, Low Pollution: Modelling a Carbon Price (national average used)
- Energy price increases for the average models is the average of the optimistic and pessimistic models.

Price increases are based upon low energy price rise (conservative) or the high price in the model above. An average of the two is also used. The initial electricity price is based on invoice data provided by Council.

Technology Power Consumption

The true power consumption wattage of a light is different to the nominal lamp rating. For example, an 80W MV has a power consumption of 95.8 Watts. All data has been sourced from the AEMO Public Lighting Load Table except for LEDs where an estimate has been used based on manufacturer data.

LED OMR Assumptions

All DNSP areas in Victoria offer an LED option for residential and major roads street lighting. For standard street lighting, all (or most) of the spot and scheduled maintenance associated with the fixture is included within the annual Operating, Maintenance and Replacement (OMR) fee associated with the luminaire. Although there are some variations in different DNSP areas, in general, the OMR fee for the standard residential LED offer includes:

- Bulk PE Cell changeover (every 8 years)
- Luminaire inspection for damage and visor cleaned and minor repairs completed (this may include visor replacements, broken/missing clips and tightening of bolts etc. as required)
- Luminaire, LED module and/or LED driver replacement. Noting that if there are high failure rates this will be reflected in future OMR prices
- Pole inspections including visual observations of any damage or performance impediments to the luminaire (any observations that require attention would be actioned as part of a DNSPs maintenance program included in the OMR price - note this inspection cycle would vary depending on non-fire/fire areas).

For major roads and decorative lighting these practices differ (for example PE Cells are not bulk replaced at 8 years). For standard fixtures, the DNSP will keep replacement parts in stock. This means councils won't have to source a replacement if items not covered under the OMR fail. For standard street lighting all or most of the spot and scheduled maintenance associated with the fixture is included within the annual Operating, Maintenance and Replacement (OMR) fee associated with the luminaire.

However, the cost of the LED OMR may not include potential future failure of the LED module, LED driver/control gear (ballast) or full luminaire replacements. It is not unusual for the costs of the OMR to not reflect some of the future costs. For example, both the T5 and CFL OMRs do not cover the future failures of their control gear (ballast).

This means that the OMR provided by the distribution business may not be a meaningful reflection of what the ongoing OMR will be. Ironbark has developed a predicted full cost averaged annual maintenance charge inclusive of distribution business OMR fees and other costs. However, given the uncertainties around some aspects of the technical performance over 20 years of the lights, we have provided three models from best-case to worst-case for LED OMRs:

1. Lower value OMR
2. Average value OMR
3. Higher value OMR

To determine these values Ironbark has assessed the expected lifespan, expected mortality rate and cost of individual LED components. This has involved:

- Assessing the technical capabilities, risk and associated costs of dealing with LED chip failures, driver failures, or entire fixture replacements.
- Assessing the implications of cleaning requirements for LED lighting.
- Sourcing and analysis of the latest laboratory test data on mortality and lifespan rates of components of the LED fixture.
- Sourcing of component prices.
- Understanding the existing warranties that apply to individual components of the LED fixture and determining what level of reimbursement applies to these warranties (i.e. parts or parts and labour).

- Understanding the life cycle costs of individual components, including the expected increase (or fall, in the case of LED chips) in costs over time.
- Clarifying council liability and risks for these items.
- Inputting the above data into existing modeling software to provide councils with an accurate cost-benefit analysis.

We have then used the maintenance-pricing model that the Australian Energy Regulator (AER) uses to come up with these more realistic OMR models for the LED.

Assumptions around Optimistic, Average and Pessimistic scenarios for LEDs

Depending on variables such as the rate of energy price increases, and increase in OMR charges, the relevant savings will vary. With LED lights, we can provide a range of outcomes to demonstrate to council the possible range of outcomes from the project. There are nearly endless models you could apply, however to keep it simple we have looked at the average model only. To provide context, three distinct different models are:

1. Optimistic
2. Average
3. Pessimistic

The variables considered and the differences in each model are summarised below.

Table 7: Assumptions for models

Variable	Pessimistic	Average	Optimistic
Description	The capital costs and ongoing operating costs are high.	The capital costs and ongoing operating costs are average.	The capital costs and ongoing operating costs are low.
Maintenance price rises for regular lights	Low	Average	High
Maintenance price rises for energy efficient lights	High	Average	Low
Energy price rises	Low	Average	High
DNSP cost	High	Average	Low
Dimming	No energy savings	8% energy savings	15% energy savings

Assumptions – Other

- OMR (maintenance) prices are for 2018 as stipulated in the 2018 Public Lighting Charges Schedule.
- All savings and cost figures are GST exclusive.
- Capital costs (hardware) are based on Ironbark's experience of current industry pricing for 1,000 – 5,000 units. This information is commercial in confidence. Council may have access to these numbers after discussion with Ironbark or if they are party to the MAV Supplier Panel.
- Capital costs (installation) are based on Ironbark's involvement in public tenders for installation throughout Victoria, projects where councils have tendered directly through distribution businesses, and discussions with relevant stakeholders in the sector (for example, councils, installers, distribution businesses, the Public Lighting Approvals Network or PLAN). This information is commercial in confidence.
- Total project costs include materials (e.g. the lights), labour (the installation), project management, potential expertise and/or consultants. It does not include community education or Council staffing costs.
- Project management costs assume a basic like-for-like design.
- Operating hours of lights are averaged out to 11.94 hrs per day in Vic.
- Emission factor is 1.17 kg Co2-e per kWh for the current year and projected to fall based on Australia's commitment at the Paris talks COP 21.
- The energy price is calculated using data provided to Ironbark from EAGA, along with electricity bills from each Council.
- For energy costs (from Council billing data) we include all of the per/kWh costs, which is what will change once the project is implemented.
- NPV Discount Rate is 4.25%.
- Written Down Value and Avoided Costs are regulated values.