

KEY FACTS CONCERNING STREET LIGHTING

The following is based on information from various sources, including the **International Dark-Sky Association**, www.darksky.org. No responsibility is taken for the accuracy of this information and readers should make their own judgements before using it. Always check with manufacturers to confirm operational data for specific products.

Introduction

Most high efficiency light sources decline in light output with time. HPS have a maintenance life time of about three years (85% at 12000 hrs), while mercury vapour almost never "burns out"; it just keeps getting fainter and fainter (65% at 12000 hrs). Metal Halide tend to fail quicker than HPS & MV with a 50% failure rate at the expected life span, (between 60 & 70% output lumens at 10000 hrs for 175 & 250 Watt, & 20000 hrs for 400 watt). You can estimate the relative effects by looking at the row titled "mean lumens" in the table below. This is the average output of the lamp during its usable lifetime. In New Zealand streetlights, on average, are on for 4250 hours per year, (12750 hrs in 3 years). Mean lumens is a measure of how much light the lamp is putting out after about two or three years of usage. We assume a typical lifetime for the lamp, either due to burnout of the lamp or to group replacement. Many communities replace lamps after a specified interval, (3 years) so as to minimize any outages due to lamp burnout. The cost of a lamp is much less than the cost of an accident due to a lamp burning out, but with higher quality lamps and good monitoring, we believe managers should be seeking to maximise the replacement interval.

High Pressure Sodium

Lamp Wattage	400	250	150	100	70
Circuit Wattage	465	294	193	130	88
Initial Lumens	50000	28500	16000	9500	6300
Mean Lumens	45000	25700	14400	8550	5670
Initial Lum/Watt	108	97	83	73	72
Mean Lum/Watt	97	87	75	66	64

Mercury Vapour

Lamp Wattage	400	250	175	100	*80
Circuit Wattage	455	285	205	135	92
Initial Lumens	20500	11850	7850	4100	3700
Mean Lumens	18570	10540	7140	3230	3650
Initial Lum/Watt	45	42	38	30	40
Mean Lum/Watt	41	37	35	24	39

*Figures Calculated from Philips Lighting data

Metal Halide

Lamp Wattage	400	250	150	100	70
Circuit Wattage	456	295	184	115	88
Initial Lumens	36000	20500	13000	9000	5500
Mean Lumens	28800	12700	8700	6400	4000
Initial Lum/Watt	79	69	71	78	63
Mean Lum/Watt	63	58	47	56	45

MV Lamps are very energy inefficient compared to some other lamps. HP Sodium are about twice as energy efficient for the same lumen out put as MV, & Metal Halide have a lamp life shorter than other lamps and energy consumption approximately mid way between MV & HP SON.

Although lighting is not the area usually associated with traffic engineering, it has been estimated that 35% to 50% of light pollution is caused by roadway lighting. This, coupled with the fact that roadway lighting design and construction is handled by the traffic engineering sections of municipal and provincial engineering departments makes it the responsibility of traffic engineers. Whilst a number of traffic engineers are well versed in the detail design of street lighting, they do not have specialist electric power engineering knowledge or experience to be able to introduce energy efficiency improvements to street lighting installations. Hence most managers work under a "business as usual" cloud that prevents adoption of innovative technologies that are key to improved energy efficiency.

Light Pollution

Light pollution is a broad term associated with three major areas of potential concern. These include light trespass, glare, and urban sky glow. A few of the more minor but related problems consist of confusion caused by light sources, adverse aesthetic effects caused by clutter, energy waste, and general annoyance. All of these problems can have adverse effects not only on the general public but also can affect the safety of the driving motorist.

To properly understand the adverse effects of roadway lighting, one must have a basic understanding of the theory of lighting and the design of roadway lighting.

When the lighting design principles are properly applied, the increased visibility provided on the roadways can provide social and economic benefits to the public, including:

- Reduction of night-time accidents
- Aid to police protection
- Facilitation of traffic flow
- Promotion of businesses
- Inspiration of community growth
- Safety for pedestrians

Light pollution is a generic term that encompasses many different aspects of improper lighting.

The solutions to minimizing the problems of light trespass are simple and inexpensive. First, the designers must take care to use luminaires with distributions suitable to the roadway. For example, the use of a V1-V3 distribution is inappropriate for a narrow residential road where a P3-P4 distribution is more applicable. (Note: V1-V3 are commonly used lighting categories for main roads in Australasia and P3-P4 are common for minor roads.) Second, the designer must take care to carry out the calculations properly to ensure the most efficient placement and design. Design levels should correspond as closely as possible to the appropriate standards. In Australasia this is the AS/NZS 1158 series. It is not necessary to apply an

arbitrary "safety factor" and over light an area. And finally, the use of full-cutoff luminaires greatly increases the control of the stray light.

Glare can be easily reduced, although not completely eliminated, by the proper use of cut-off luminaires. Even in the areas not directly related to driver safety, glare is reported as the most annoying aspect of roadway lighting.

Adaptation control is important. The time required to adapt to changing light levels is much longer for the aged. This means going from bright areas to dark ones, and the reverse, can be a real problem. Good visibility is difficult when moving between spaces lighted at very different light levels. The adaptation time is longer when going from bright to dark than the reverse. One example seen frequently these days is in going from an over lit service station back out onto the street or highway. Ironically, the excessive lighting is "justified" in terms of safety rather than marketing. Similar differences can be seen when going from over lit entryways to walkways or parking lots. The solution is not to raise lighting levels in all the darker areas (an impossible task) but to use rational levels in the brighter areas. Large differences in light level should be minimized in transition areas, such as building entrances, parking lots, walkways, and streets. While differences in light level are important in any lighting design, they are of paramount importance for the elderly. In addition, lighting should not be directed toward the viewer's eyes so as to cause glare and veiling luminance. Quality, not quantity, of lighting is what counts. By quality one means: freedom from glare, freedom from veiling reflections, freedom from flicker, smooth transitions, and appropriate spectral distribution. The qualities of night lighting takes into account the strengths and weaknesses of human vision.

Light pollution includes such things as Glare, Light trespass, Energy waste, and sky glow. In some cases it can cause confusion and stress.

Glare: Glare is caused by too much light poorly directed and means reduced visibility, while causing harsh dark shadows and stress; it is also hard on the eyes. People can actually feel unsafe and stressed under such conditions. This is also a situation where the economics of such lighting are not realized. Poorly directed and intense lighting is expensive where better directed lighting with correct lighting levels is more economical, from the installation and running cost through to maintenance. Glare is frequently caused by light sources that are much brighter than their surroundings, and that are directly seen along the line of sight at normal viewing angles.

Light Trespass. Many lighting installations light not only the area that is required to be lit, but also light up adjacent areas. This can cause friction where the adjacent area is owned by a third party, who doesn't like having the light crossing the boundary, in both domestic and commercial areas. Correctly installed and designed fittings in lighting installations can reduce or eliminate most light trespass, frequently reducing installation, running and maintenance costs.

Energy Waste: Over lit areas, especially when not required, is exceptionally wasteful of energy. With correctly lit areas using controls, such as sensors, to operate the lighting only when required can save considerable amounts of energy. Where security is of importance correctly designed and installed

lighting installations can produce better lighting for both visual and CCTV surveillance. Bright or glary lighting causes dark and deep shadows where offenders can hide. Generally lighting is used to illuminate an area, but frequently poorly fitted lights also light the night sky. A well designed installation lights what is required with enough light to illuminate what needs to be illuminated without lighting areas that do not need to be lit, and in such a way that harsh shadows and glare are eliminated. This process means that the light being used is productive and useful, and that energy use is being used economically. The result is more economical and pleasant while doing the job properly.

Sky Glow: This is an obvious source of wasted light. Apart from the wasted energy, there is increasing evidence it adversely affects wildlife, particularly birds which are attracted into the cities. There are also concerns expressed by astronomers, and some in the medical profession relating to adverse effects on human biorhythms.

The Solutions:

- Light only the area or objects that need to be lit, by well designed installations.
- Use downward facing lights, & where possible either shielded or full cut-off fittings to avoid glare.
- Use controls to turn lights on & off as and when they are needed, e.g. IR Sensors, Time switches etc.
- Only use the size of lamp that is required and eliminate the use of high wattage lamps where they are not required.
- Use directional lighting rather than flooding an area with light when visibility only is required.
- Switch off lights when they are not required, and add sensors to those that are only required intermittently on access ways and walkways.
- By following sensible practices a reduction in the energy and maintenance budgets will be experienced.

There are several informative and interesting Information Sheets on the International Dark Sky Association website. These can be accessed free of charge via the link below.

<http://www.darksky.org/mc/page.do?sitePageId=58823#Street%20Lighting>

Portions of this dissertation have been taken from the Information sheets on the above website and others from the Philips Lighting Catalogue.

Lamp data may vary between publications as there are small variations between manufacturers' data.