Shedding new light

To boldly go

Recent news of more funding plus the release of a world-first strategic plan for road lighting provide councils with a huge boost to their lighting plans. **Godfrey Bridger & Bryan King** report.

Two critical events have recently taken place that will lighten the way for New Zealand. The most recent took place in early March when the New Zealand Transport Agency (NZTA) announced that all qualifying upgrades to light emitting diode (LED) street lighting by councils would receive 85 percent funding by NZTA.

This subsidy, which replaces the earlier 50 percent rate, is sensational news and clearly re-establishes the NZTA and Ministry of Transport as leaders in policy recognition of the benefits available from using LED public lighting. This policy is intended to accelerate the conversion of street lighting to LED by New Zealand councils – and is highly likely to achieve that goal.

The second pivotal event was the release of a world-first strategic plan for road lighting. Funded by the Australian government, *Roadmap: Street Lighting and Smart Controls Programme* (the *SLSC Roadmap*) outlines the plans of the Institute of Public Works Engineering Australasia (IPWEA) and is freely available to all.

It is a robust quantitative and qualitative analysis of all aspects of road lighting in Australia. Importantly, much of it is also relevant to New Zealand and we are unaware of any other document in the world that treats the subject so comprehensively.

The *SLSC Roadmap* details international research and analysis of road lighting's effects on public health, energy usage, environment and liveability improvements through smart city infrastructure. The significant benefits and disadvantages of blue-rich white lighting are covered, for example, along with the highly-misquoted American Medical Association (AMA) report. (See box story *American Medical Association announcement*.)

All these issues are extremely relevant to New Zealand as is the report's coverage of new technology and innovation, infrastructure costs and benefits, and most of the information on barriers, stakeholder engagement issues and associated risks.

SAME BUT DIFFERENT

New Zealand's road lighting differs to that of Australia in many ways. A key difference is that only about one percent of New Zealand's 370,000 road lights are mercury vapour (MV). In contrast, 39 percent of Australia's 2.4 million road lights use the 50-year-old white-light MV technology that is soon to be replaced by LED.

As a result, New Zealand has enjoyed a more efficient lighting system as MV lights need more electrical energy to provide the same amount of light.

Unfortunately, New Zealand's almost 330,000 yellow high-pressure sodium (HPS) road lights (which represent about 90 percent of the total number) deliver visual conditions that mean it takes significantly more time for humans to react to any change.

Yellow sodium lighting is more efficient than white mercury vapour lighting, but it takes up to 200 milliseconds longer for humans to react than in white light. At 100 kilometres per hour this is more than an eight-metre difference in vehicle stopping distance.

We've all seen the TV advertisements that show what a difference that can make. But now with LED so strongly supported by NZTA, we can swap the yellow lights for white, and save more than 50 percent of energy use and more than 50 percent of the maintenance costs at the same time.

American Medical Association announcement

In June 2016, the American Medical Association (AMA) generated considerable US and international media attention when it published its report *Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting.*

Much of the mainstream media coverage has not been accurate in reporting the AMA's findings and recommendations.

Specifically, the AMA has not made a general finding against LED street lighting. In fact, its position has been the opposite. It says that it "supports the proper conversion to community-based light emitting diode (LED) lighting, which reduces energy consumption and decreases the use of fossil fuels".

However, the AMA report did provide a warning on the problems of LED street lighting when improperly designed and / or having higher than necessary blue light content.

The key AMA recommendation is that it encourages the use of 3000K or lower lighting for outdoor installations such as roadways.

"All LED lighting should be properly shielded to minimise glare and detrimental human and environmental effects, and consideration should be given to utilise the ability of LED lighting to be dimmed for off-peak time periods."

A colour temperature of 3000K or lower is generally referred to as 'warm white' and contains lower blue light content than light of higher colour temperatures.

US Department of Energy: The US Department of Energy (DOE) is a highly credible source of impartial information on LED application and its response statement to the AMA is recommended.

Key responses have been distilled here:

- Colour temperature (measured in degrees K) does not accurately provide the measure of blueness attributed to the potentially harmful aspects of lighting (the melanopic content). Light Spectral Power Distribution (SPD) provides the best scientific measure.
- Using SPD, almost all street lighting has some blue light content with these potentially harmful lights including yellow HPS lighting.
- The potential for harm to humans is highly dependent on the intensity of the light source and the time exposed to the light (often referred to as "dosage"). Neither of these important issues were identified in the AMA report but are of course mitigated by control systems.
- The "raw" melanopic content produced by a light source is only one contributor to any ensuing environmental or health impacts actually realised. Focusing exclusively on a single measure ignores the various means of controlling or offsetting the increased melanopic content of white light sources, and particularly those that are enabled by LED technology such as improved photometric distribution or dimming capability.

New Zealand and Australian standards: In New Zealand and Australia, luminaire technical specification, SA/SNZ TS 1158.6:2015 Luminaires – Performance (which carries less weight than a Standard), states that 4000K is the preferred colour temperature for road lighting. The decision to suggest 4000K was made in 2014 when this was the warmest readily-available colour temperature available at the time. This situation has now changed significantly with an increasing number of luminaires with 3000K LEDs (or less) becoming available.

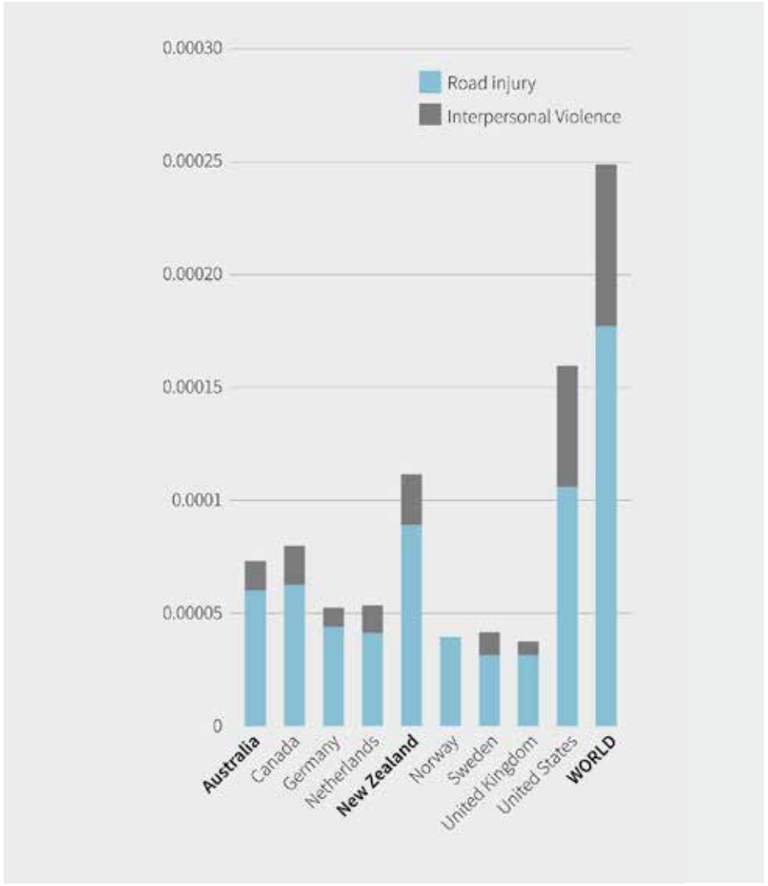


Figure 1: Proportion of population dying from road injuries and interpersonal violence in 2012 (WHO).

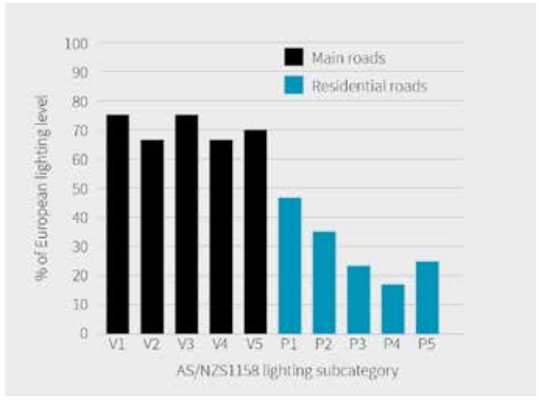


Figure 2: AS/NZS lighting level standards as a percentage of European standards. (Source: Strategic Lighting Partners from relevant standards AS/NZS and EN).

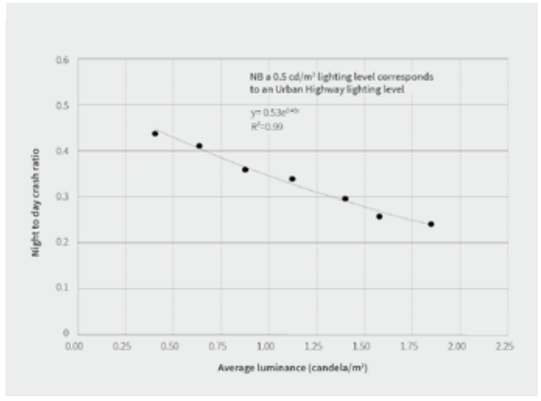


Figure 3: Research in 2012 by Michael Jackett and William Firth showed that for each 0.5 Candela/m² increase in lighting levels, crashes decreased by 19 percent.

FATALITIES

Another vital difference between the two countries, according to the United Nation's World Health Organisation (WHO), is that a larger proportion of New Zealanders die from road accidents than Australians (as shown in figure 1). When placed alongside the fact that between 30 and 50 percent of all such fatalities take place at night, when only about 25 to 30 percent of all travel occurs at night, it is likely that better road lighting could significantly improve our road fatality statistics.

Australia and New Zealand share the same lighting design standards that recommend the minimum lighting levels for their roads.

As shown in figure 2, these AS/NZS lighting levels are as low as 17 percent (for P4 roads) of the levels required in Europe for similar residential roads, with the most well-lit roads in Australia and New Zealand corresponding to 75 percent of the levels (for V1 and V3 roads) required by the standards in Europe. (Note that the very low light level category "P5" is uniquely Australian and does not apply to our country.)

Would increasing the lighting levels in some places reduce night-time fatalities?

New Zealand researchers Michael Jackett and William Frith answered this question in 2012 when they looked at 7944 crashes. The results (as shown in figure 3) have been quoted internationally.

The two researchers showed that for each 0.5 Candela/m^2 increase in lighting levels, crashes decreased by 19 percent. These results were effectively confirmed in another much larger study in 2015. Lighting at night saves lives.

DAYTIME BENEFITS

Night lighting also improves lives during the day. How can that be? In Europe, the answer is called the "humble lamp post" because it has received so little attention in the past. Now it is anything but humble. It is generally publicly-owned real estate that is "up high, powered and everywhere" so it provides the ideal foundation for smart cities and smart rural communities.

Barriers

The *SLSC Roadmap* identifies 20 separate barriers that exist in Australia. This summary picks the "top five" of the ones that apply in New Zealand.

1. Knowledge barriers. The greater complexity of new technologies requires high levels of knowledge to reap substantial community benefits. This was generally not required in the previous traditional road lighting sector. One of IPWEA's actions to address this is the fully-searchable web portal with curated industry news on www.slsc.org.nz.
2. Lighting design standards have been left behind by technological progress and there is no guidance for measurement and verification of performance and safety dependent functions over an asset's lifetime.
3. Lack of historic asset condition and performance monitoring means the status of expensive support assets is uncertain and often very poor.
4. Lack of transparent cost-reflective and service-based electricity network charging for road lighting circuits makes it difficult for councils to benefit from efficiency and innovation.
5. Investments needed to deliver required safety outcomes from illumination levels are not objectively or clearly defined.

Road lights can have sensors that detect flash flooding, fires, gun shots, screams, full rubbish bins and, of course, empty parking spots. Some of the sensors attached to these street lights capture important city data that can provide a variety of revenue streams for cash-strapped councils. So it has become important for councils to treat road lighting as much more than just road lighting.

These humble road lights are not so humble in another most important way. They help keep people safe so it is crucial that they are maintained and repaired properly and quickly.

Modern controlled lights make it easy to monitor and

predict when failures are likely to occur (something LEDs do very rarely) and do not need regular and expensive manual inspections to tell the council to get the asset repaired after vandalism, for example, has taken place. The control system is fully aware and intelligent.

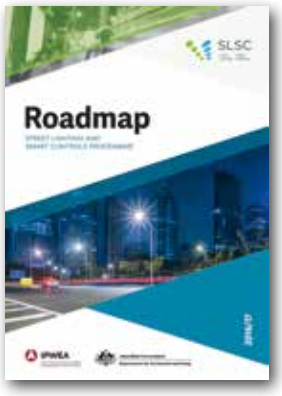
Modern road light control systems are also important because they can turn off or dim each light individually. So, at three in the morning, instead of keeping the birds and insects awake, electricity can be saved and discomfort to ecological systems can be minimised.

While it's important that we should avoid damage to the ecological environment by controlling lights, it is the trade-off nature of controls that is so valuable to society.

Blue-rich white light is needed to keep drivers alert and safe. But that same blue-rich white light keeps humans awake when they should be asleep. If placed incorrectly these lights may cause health problems. And they light up the dark sky.

Figure 4: UK trends in street lighting control (Telensa)

Roadmap: Street Lighting and Smart Controls Programme is available on IPWEA's street lighting and smart controls website portal www.slsc.org.nz.



The more control systems are used to vary light levels (up and down) at every single point, the more everyone gets what they need and avoids what could harm them.

In New Zealand, about 20,000 road lights (about five percent of the total) are controlled by central management systems (CMS). Most are in Auckland. In Australia, there are virtually none apart from small trials and pilot projects.

In contrast, in 2016 the UK – the most advanced country in this respect – had about 36 percent of all its road lights controlled (as shown in figure 4).

New Zealand is a far cry from the UK and if there is a large-scale project to replace old lights with new LED ones, it may be prudent to bear the additional first cost – as Auckland Transport has done – and to fit control systems up-front to avoid the need to expensively re-visit the thousands of street lights at another time in the future. The benefits are usually well worth the extra costs.

BARRIERS

Taking advantage of the many features and benefits that can be delivered by future street lighting may sound like a no brainer. But, unfortunately, the *SLSC Roadmap* outlines many significant barriers that impede the uptake of these better solutions.

Again, the situation is different in New Zealand to Australia. Almost 90 percent of Australian lights are owned by the Electricity Network companies where the new technology reduces the opportunity to sell more energy-based network and maintenance services to client councils.

This means it is much easier to upgrade in New Zealand, and now that NZTA is funding 85 percent of the cost of doing so it will make it even easier for New Zealand.

However, in both countries there are other significant impediments (see *Barriers* box) that the *SLSC Roadmap* suggests will hamper progress unless they are adequately addressed.

However, when these barriers are overcome and road lighting is modernised in an appropriate way, councils and their ratepayers will enjoy some of the best win-win-win opportunities available. The *SLSC Roadmap* lists 13 messages available to Australian council stakeholders of which 10 are relevant to New Zealand.

New-technology street lighting provides an opportunity where changes and improvements are highly visible and economically and socially favourable for all. Councils owning street light assets have a singular opportunity to future proof the prospects for their communities through upgrading this important community infrastructure. **LG**

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